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Document control

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|          |                  |                    | to meet Control Systems changes. Added 40050. Caputure Updates to 40039 and 40047 |
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This Manual outlines the requirements to be followed when maintaining, interfering with and attending to failed conditions of the operational signalling infrastructure and systems.

The Manual includes 49 parts detailing the safeworking and safety critical maintenance requirements to be followed when dealing with the various situations as listed below.

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Engineering Procedure
Signalling and Control Systems

Signalling Safeworking

PR S 40001

Introduction to Signalling Safeworking Procedures

Version 1.2

Date in Force: 8 March 2019
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1 Introduction

1.1 Purpose

The purpose of the Signalling Safeworking Procedures is to bring to the attention of signalling personnel, engaged in work that affects (or could affect) installed/operational signalling apparatus, the essential requirements, standard practices and instructions, that ensure the signalling system performs reliably and with integrity, thus allowing rail traffic to operate safely on the network and without delay.

1.2 Application

For the purpose of these Signalling Safeworking Procedures the term ‘Signalling’ shall encompass any work associated with both Signals and Control Systems.

The principles and actions in these procedures apply to signals and Control Systems equipment. Wherever there is a reference to a signal engineer, or maintenance signal engineer, the actions as applicable will also apply to the Control Systems engineer for control systems equipment only. Likewise, reference to licensed signalling personnel applies to Control Systems technicians for control systems equipment.

Refer to GL S 41551 Signalling, Communication and Control Systems existing interface diagrams’ for interface boundaries.

1.3 Requirements

Signalling personnel must have access to and familiarise themselves with the Signalling Safeworking Procedures, including any associated or referenced standards. They must keep up to date with any changes that apply and develop an understanding of the principle intention of the changes.

Users of the Signalling Safeworking Procedures must promptly bring to the attention of the Asset Standards Manager (or delegated officer) for determination of any perceived omission, error, ambiguity, inconsistency or lack of clarity with the procedures as well as suggestions for improvement.

1.4 Network Rules and Procedures and Signalling Safeworking Procedures

The Network Rules and Procedures direct how work affecting the operation of signalling must be safely carried out. The Signalling Safeworking Procedures must be read and carried out in conjunction with the Network Rules and Procedures which they are intended to supplement, and in no way supersede.

Signalling personnel must comply with the Network Rules and Procedures and the Signalling Safeworking Procedures.
1.5 Roles and Responsibilities

For the purpose of these procedures licensed signalling personnel refers to roles such as signal engineer, control systems engineer, signal electrician, control systems technician, signals mechanical, air-line fitter, signals ancillary, rail bond welder, cable jointer, etc, and unless otherwise stipulated, means a person trained, qualified, competent and licensed to perform the specific task referred to in the context of the procedures.

All signalling personnel must only act and perform signalling work within their delegated area of authority. Persons who are not competent and suitably licensed must not interfere with operational signalling equipment. Additionally, persons who are not licensed or authorised must not perform signalling work or enter a signalling location unless closely supervised.

Where individual responsibility is not explicit in the text of the Signalling Safeworking Procedures, signalling personnel must contact the relevant signal engineer for clarification.

A full listing of licensed signalling and authorised personnel is available in RG S 41415 Signalling Personnel – Licensing and Authorisation Status.

1.5.1 Professional Head Signalling & Control Systems

The Professional Head Signalling & Control Systems is the person who holds the signalling engineering authority for approving configuration and design changes to the existing or new signalling system in accordance with the Asset Standard Authority & Sydney Trains Engineering Principles, Standards, Specifications, Manuals, Instructions and Guidelines.

The Professional Head Signalling & Control Systems may delegate various engineering authorities and responsibilities provided that they are documented and clearly communicated.

1.5.2 Principal Engineer Signalling Integrity

The Principal Engineer Signalling Integrity is the senior signal engineer accountable for the integrity of the signalling infrastructure within the Sydney Trains infrastructure network.

1.5.3 Signal Engineering Manager

The Signal Engineering Manager is the senior signal engineer within Network Maintenance Division responsible for the safety and integrity of the signalling infrastructure within the Sydney Trains infrastructure network to meet all relevant standards and procedures, and unless otherwise stipulated, may delegate various tasks specified to them in these procedures to the maintenance signal engineer within their area of responsibilities. However, in doing so, does not dispense with the responsibilities. A document stating the responsibilities delegated to others in accordance with these Signalling Safeworking Procedures must be kept by the Signal Engineering Manager to ensure all persons clearly understand their delegated responsibilities.
1.5.4 **Control Systems Operations Manager**

The Control Systems Operations Manager is the senior Maintenance Control Systems engineer within Network Maintenance Division. The position is responsible for the safety and high availability of all Control Systems infrastructure and associated systems within the Sydney Trains network to meet all relevant standards and procedures. Unless otherwise stipulated, the Control Systems Manager may delegate various tasks specified to them in these procedures to the maintenance control systems engineer within their area of responsibilities. However, in doing so, does not dispense with the responsibilities. A document stating the responsibilities delegated to others in accordance with these Signalling Safeworking Procedures must be kept by the Control Systems Operations Manager to ensure all persons clearly understand their delegated responsibilities.

1.5.5 **Maintenance Signal Engineer**

The maintenance signal engineer is the signal engineer responsible for the integrity and performance of signalling infrastructure within their area of responsibility and unless otherwise stipulated, may delegate various tasks specified to them in these procedures to licensed signalling personnel within their area of responsibilities. However, in doing so, does not dispense with the responsibilities. A document stating the responsibilities delegated to others in accordance with these Signalling Safeworking Procedures must be kept by the maintenance signal engineer to ensure all persons clearly understand their delegated responsibilities.

Maintenance signal engineers are accountable for ensuring the task/s are appropriately scheduled, handled and completed safely and in accordance with these procedures within their area of responsibility.

1.5.6 **Signal Asset Engineer**

Signal Asset Engineer is the signal engineer responsible for the management of signal infrastructure asset life cycle within the assigned area of responsibility.

Signal Asset Engineer must manage Interface Coordination Plans, review delivery of new and altered signalling works, notify maintenance signalling personnel of any changes to signalling infrastructure, arrange for post commissioning attendance & activities, manage the control of approved design documentation, manage configuration control process and configuration management changes; and manage & ensure signalling asset registers reflect the installation.

Responsibilities includes:-

a) Managing configuration management (update documentation and databases) to ensure records accurately reflect existing assets.

b) Interfacing with the Network Base Production Planner (or otherwise) to ensure maintenance scheduled tasks (MST’s) are correctly setup/ removed when new assets are commissioned/ removed.

1.5.7 **Commissioning Engineer**

As defined in PR S 47111 Inspection & Testing of Signalling – Roles, Responsibilities and Authorities.
1.5.8 Licensed Signalling Personnel

Licensed signalling personnel are persons who hold a valid Sydney Trains license, as part of their duties, in accordance with their Certificate of Competency and Permit to Work, to interfere with installed/operational signalling system as detailed throughout these procedures.

There are different licensing levels for licensed signalling personnel; they include Signal Electrician, Signals Mechanical, Signals Ancillary, Signal Engineer, Control Systems Engineer and Control Systems Technician. These persons must be assessed as competent by an approved process for the intended work and must only perform signalling work within their delegated area of authority. The different licensing levels are described in detail in MN S 41412 Process for Signals and Control Systems Personnel – Authorisations and Licensing.

1.5.9 Authorised Signalling Personnel

An Authorised Signalling Personnel is a person who is not licensed but who has been assessed and authorised as competent by an approved process to perform defined activities (generally signalling activities) in signalling equipment enclosures or on signalling equipment within their delegated area of authority, where the work will not interfere with operational signalling equipment.

There are different authorisation levels for Authorised Signalling Personnel, these are described in detail in MN S 41412 Process for Signals and Control Systems Personnel – Authorisations & Licensing.

1.6 Basic Signalling Safeworking Requirements

Some basic requirements relating to maintaining the signalling system are set out below. They are described in detail in the procedures in the following sections of the Signalling Safeworking Procedures.

a) Signalling maintenance must be managed and performed to meet the relevant requirements of Australian Standards for Railway Safety Management AS4292 Part 1 General and Interstate Requirements and Part 4 Signalling and Telecommunications Equipment and Systems.

b) The installed signalling system and its components are to be maintained to prevent signalling system failures and associated train delays, and to ensure the safety provided by the system is maintained throughout its operational life.

c) Failed signalling equipment is to be attended to and restored for operational use without undue delay.

d) Details of signalling maintenance, signalling failures and irregularities are to be recorded and analysed to determine any corrective action necessary and to ensure equipment/system safety and reliability levels are maintained.

e) Only licensed signalling personnel, using authorised practices, test equipment, tools, materials and equipment are to maintain the operational signalling system or its components. Test equipment and tools in use are to be in proper working order.

f) Persons who are not licensed or authorised must not have access to enclosures housing vital signalling equipment except under the supervision of a licensed or authorised signalling personnel, or as permitted in accordance with stipulated conditions.
g) Only licensed signalling personnel, or persons directly supervised by licensed signalling personnel, are to disconnect or connect to the operational signalling system equipment and circuits.

h) The movement of trains must be adequately protected when any maintenance action or other interference impairs, or could impair the protection provided by the signalling system or could affect the safety of the line.

i) Where the interlocking is disarranged or vital signalling equipment is disconnected from the interlocking, or is disassembled, or has safety critical adjustments altered, then its safe operation must be certified fit before restoring it for operational use.

j) Signalling equipment which has failed in an unsafe manner must be taken out of service and the train movements affected must be immediately protected.

The irregularity must be fully investigated, the defect rectified or addressed, and the equipment must be tested and certified as operating safely before being restored for operational use.

Subject to the former, should signalling apparatus be defective in any manner which potentially might endanger traffic operations, it is to be immediately repaired or replaced if practical. If it cannot be immediately repaired or replaced, its operation must be discontinued and traffic operations must be protected. Details must be immediately reported to controlling officers.

k) When any function of the signalling system affecting traffic operations is to be taken out of service, the Network Control Officer of the affected area is to be advised.

l) Release of track locking or signal indication locking must only be given as prescribed.

m) Temporary bridging of contacts of vital signalling control devices must only be carried out as prescribed.

n) Trainstops must only be manually suppressed for train services as prescribed.

o) Where locking facilities are normally provided, the signalling equipment is to be kept locked to prevent unauthorised interference.

p) Alterations or additions to the configuration of the signalling system or its components must not be made unless properly authorised.

q) Whenever the signalling system requires additions or modifications, then the requirements of PR S 47110 'Inspection and Testing of Signalling' and these procedures must be observed.

r) Prior approval of the Professional Head Signalling & Control Systems is required before any aspect of the operational signalling system, vital or non-vital, that could affect the safety and/or reliability of the system, is introduced or altered.

This requirement includes, the application of experimental, new or modifications to design, signalling systems, signal equipment, train control systems, automatic train protection equipment, standards for manufacture, construction, operations, maintenance, disposal and procedures and practices, including practices that were not specifically covered by documented standards but for which a documented standard should apply.
Prior approval of the Professional Head Signalling & Control Systems is not required for Like for Like Renewals where the equipment is replaced with an exactly identical item. Signal engineers are delegated to make determinations whether renewal work can be treated as Like for Like where items are not exactly identical. Like for Like Renewal determinations and conducted work must be in accordance with PR S 40011 Renewals Work.

s) Signalling plans, diagrams and circuit books for operating and maintenance use must be available to those who need them to carry out their duties and be maintained up to date.

t) Off-site repair and overhaul of vital signalling equipment must be authorised and controlled to ensure the equipment is restored to the required specification and standard before being re-used. Depot overhaul is not permitted.

u) Temporary repairs of vital signalling equipment must be done to an acceptable and safe standard, and procedures must ensure the temporary repairs are brought up to the permanent standard before they present an unacceptable risk to the safe and reliable operation of the signalling system.

v) Malicious damage or interference to vital signalling equipment or circuits must be reported promptly to the maintenance signal engineer and team manager.

w) Test equipment for measuring signalling system safety and reliability parameters must be calibrated where required to verify acceptance/rejection criteria.

x) Prior approval of the Professional Head Signalling & Control Systems is required before the engagement of contractors in senior signalling roles within Sydney Trains, for example a Commissioning Engineer or maintenance signal engineer.
Engineering Procedure
Signalling and Control Systems

Signalling Safeworking

PR S 40002

Temporary Bridging of Signalling Circuits

Version 2.0

Date in Force: 24 January 2018
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1 References
This procedure should also be read in conjunction with

- PR S 40004 - Failures
- PR S 40006 - Release of Track Locking or Indication Locking
- PR S 40008 - Securing Signalling Apparatus Out of Use
- PR S 40009 - Disconnection of Signalling Apparatus
- PR S 40010 - Risks and Controls Associated with Testing and Certifying Equipment
- PR S 40011 - Renewals Work
- PR S 40016 - Notification of Whereabouts and Liaison with the Network Control Officers.
- SPG 0711 - Inspection and Testing of Signalling

2 Principles

**Bridging or false feeding is normally not permissible**

The bridging of contacts on relays or on any circuit controlling device, which will in any way impair the protection normally provided by the relay or circuit controlling device, must not be done except when absolutely necessary and only in strict accordance with procedures prescribed in this procedure or as specifically determined by the Professional Head Signalling & Control Systems.

False feeding is a form of bridging and the above restrictions similarly apply.

**The principle for the use of temporary bridging always requires that the protection defeated be provided by an effective alternate means.**

Temporary bridging does not include bridging which is hand held and momentarily applied for releasing purposes under prescribed conditions. Procedures specified in PR S 40006 shall be followed for these situations.

Temporary bridging is permitted only in exceptional circumstances where it is necessary to minimise the disruption to rail traffic caused when signalling equipment is damaged, disconnected, or is disarranged. Temporary bridging shall not be connected across any contacts which provide protection for the movement of trains in either of the following cases:

- Where it prevents signalling apparatus from properly returning to a more restrictive position or locking position
- Where it allows signalling apparatus to indicate falsely that it is in a restrictive or locking position when it could actually be in an unprotected permissive or releasing position
- Where it allows unprotected signalling apparatus to operate to a less restrictive or unlocked position when it is not safe to do so

Signalling apparatus which will have temporary bridging applied shall be booked out of use and be disconnected from its power source in order to prevent its operation and to secure it in correspondence with the interlocking and the bridged out position. Signals affected by the temporary bridging shall also be booked out of use except where prescribed in PR S 40009 Section 4.3.2, PR S 40004 or Section 3 of this procedure.
Authorisation of temporary bridging will generally be confined to bridging of closed contacts of trackside signalling apparatus that indicate the locked, fail-safe position of the apparatus. For example, the normal indicating contacts of signals at stop or trainstops in the raised position or the detection contacts of points in their correct position and locked.

The temporary bridging of contacts shall be limited only to the failed or removed apparatus.

Temporary bridging jumper wires shall be connected as close as possible to the apparatus concerned.

Where the Normal detector contacts are temporarily bridged, for example, at an end of points, the circuits that provide the Reverse detection shall be disconnected. Similarly, if the Reverse detector contacts are temporarily bridged, the circuits that provide the Normal detection shall be disconnected. This precaution can also apply to other apparatus such as trainstops and level crossing mechanisms.

Contacts that are temporarily bridged shall be disconnected so that the work does not interfere with the live portion of the circuit.

Temporary bridging should only be utilised for a maximum of 16 weeks. Any temporary bridging requirement for longer than 16 weeks shall be risk assessed by the authorising signal engineer in consultation with the maintenance signal engineer and advice sought from the Principal Engineer Signalling Integrity for determination.

Bridging of contacts of vital signalling relays or control devices shall be led by licensed signalling personnel deemed competent to perform the activity of temporary bridging without supervision.

Where bridging is required to extend beyond one shift the original bridging jumper wires shall be left in place between shifts, to eliminate the risk of reconnection errors.

A register of bridging authority forms issued shall be maintained by the authorising signal engineer and the maintenance signal engineer.

3 Booking protecting signals into use

In order to facilitate train running while temporary bridging is applied, the authorising signal engineer, after due consideration of the associated risks, may permit the booking into use of specific protecting signals. This is on condition that testing requirements in Section 6 have been conducted and point securing equipment such as point-clips, locks and spikes, as applicable, are applied and frequently inspected. The signal engineer involved is to have suitable experience relative to the complexity of the subject matter.

Protecting signals shall not be booked into use which would allow trains to operate over lines where signalling equipment is moved out of correspondence with the interlocking and the bridged out position. Protecting signals shall also not be booked into use where the equipment is disarranged or worked on in a way that the safety of the signalling is impaired. Protecting signals over disarranged facing points which have been secured by alternative means shall not be booked into use without an approved signal engineering deviation. In an emergency the Principal Engineer Signalling Integrity may grant interim approval after discussion with the authorising signal engineer to ensure all the risks are controlled before implementation.

The procedures as specified in PR S 40009 shall be read in conjunction with this procedure and adhered to.
4 Authorisation for Bridging

Temporary bridging may be authorised by an approved circuit design or a temporary bridging form (PR S 40002 FM01 Authority for Temporary Bridging of Contacts) authorised by a signal engineer.

In all cases, the maintenance signal engineer shall be notified of the temporary bridging arrangement.

Temporary bridging granted by an approved circuit design shall be performed in accordance with SPG 0711.

Temporary bridging around contacts in vital signalling circuits constitutes a disconnection of signalling equipment and the respective Network Rules and Procedures are to be observed.

Licensed signalling personnel who are to apply the bridging shall ensure that they have fully explained the details to the authorising signal engineer including the details of the terminal numbers that will be bridged.

The authorising signal engineer shall understand the circumstances requiring the bridging application. They shall discuss bridging arrangements, alternate protection, testing requirements and notification arrangements with the person applying the bridging and with the person removing the bridging to satisfy themselves that the bridging will be applied, removed and tested correctly.

The authorising signal engineer shall ensure while the bridging is applied that the protection defeated will be covered by alternate means and the normal functioning of the equipment will be fully tested before the alternate protection is removed.

Licensed signalling personnel applying the temporary bridging are also to ensure the local signalling personnel responsible for the maintenance of the equipment concerned are made fully aware of the details.

4.1 PR S 40002 FM01 Authority for Temporary Bridging of Contacts

The PR S 40002 FM01 Authority for Temporary Bridging of Contacts form is to be compiled by licensed signalling personnel or a signal engineer. It is to then be checked and signed by the authorising signal engineer when issuing the authority and again when advised that the bridging is removed. A clear and legible copy of diagrams for the circuits to be bridged shall accompany all bridging authority forms; refer to Section 4.2 for circuit diagram requirements.

In an emergency and only when necessary, if the authorising signal engineer cannot reasonably issue an “Authority for Temporary Bridging of Contacts” form, the authorising signal engineer may delegate the issuing of the form to a licensed signalling person who is independent of the work. Licensed signalling personnel shall transcribe the instructions for the bridging as provided by the authorising signal engineer. The name of the authorising signal engineer shall suffice until a signature is obtained.

Any required extension of time for the application of temporary bridging shall be approved first by the authorising signal engineer. The approved bridging authority form shall be updated by licensed signalling personnel for the extension of time.

Each PR S 40002 FM01 issued from a particular office is to be numbered with the next consecutive bridging authority number. The bridging authority number shall be alphanumeric and identify the office from which it is issued.
Licensed signalling personnel are to progressively update the bridging authority form. Entries are to be at the time the actions occur to ensure the form accurately reflects the state of the bridging activity.

A register of bridging authority forms issued shall be maintained by the authorising signal engineer. A copy of the completed form and accompanying diagrams is to be retained on file by the authorising signal engineer and forwarded to the maintenance signal engineer.

Additionally the responsible maintenance signal engineer shall keep a register of all bridging authority forms issued for a given area of responsibility. The maintenance signal engineer is to examine the details on the copy of the completed forms, investigate any matters of concern and, when satisfied, sign and date the copy for retention on file.

Where temporary bridging is to be left unattended or remain on for multiple shifts, a copy of the authorised bridging authority form with circuit diagrams shall be left in the related signalling location. The copy of the temporary bridging form is to be returned to the authorising signal engineer once the temporary bridging is removed.

### 4.2 Circuit Diagrams

Diagrams for the circuits to be bridged shall be in the form of a clear and legible photocopy, scan or electronic print-out. Sketches are not acceptable.

The circuit diagram is to be prepared showing the temporary bridging to be applied and correlation of existing circuits to one clear point of the temporary bridges before applying the bridges.

A copy of each circuit diagram is to be signed by the authorising signal engineer and forwarded to the licensed signalling personnel who will apply the bridging.

The circuit diagram is to be titled “Temporary Bridging for .......... equipment at .......... location on date: ...... & time: ...... in accordance with Bridging Authority No: .........”

Each circuit diagram is to be signed by the licensed signalling personnel who apply the bridging at the time of bridging and also is to be signed by the licensed signalling personnel who remove the bridging at the time of removal.

### 5 Jumper Wires for Temporary Bridging

Where temporary bridging is permitted as prescribed in this procedure, regulation jumper wires are to be used.

Temporary bridging wires used as part of an approved signalling design shall be in accordance with the relevant design.

The regulation jumper wires should not be less than 1.5m long, be flexible, minimum conductor cross Section 1.5 mm², with insulation 0.6/1 kV standard and be a bright colour which is to be orange unless otherwise approved by the signal engineer who authorises the temporary bridging.

Jumper wires are to be registered with the maintenance signal engineer or the signal engineer in charge of the activity. Where preferable, the owner may be the licensed signalling personnel in charge, who retains the numbered jumper wires locked in a box and issues them for particular work, as required, utilising a detailed register and signatures for receipt of issue and return.

Issuing of jumper wires shall be limited to the amount required as authorised on the temporary bridging authority form.
Jumper wires are to be accounted for by the owner and if a jumper wire is lost or missing, the details are to be reported to the maintenance signal engineer. Any jumper wire found that is not associated with authorised temporary bridging is to be forwarded to the maintenance signal engineer advising details of the finding. Details of lost or destroyed jumper wires are to be recorded in their respective register.

Acceptable options for meeting all the requirements above include:-

- Do not keep bridging jumper wires on hand but make them up only as and when required to be used with the approval of the signal engineer and ensuring they meet the identification requirements. Destroy immediately after use, or;
- Keep bridging jumper wires secured in a locked unit in the depot/office and identify each of them by the depot/office name and consecutive number. Keep details in a register with individuals signing each bridging jumper wire in or out when it is issued and when returned, or;
- Identify bridging jumper wires owned by individuals with their name or employee number or some other unique number they select and keep secured in a locked unit/box. The details of jumper wires shall be kept in a register with the signal engineer.

The connection lugs, plugs or clips at each end of the jumper wire shall be insulated as far as practical and applied and held secured so that there is no possibility of them inadvertently connecting across adjacent circuit terminals or of an end coming loose and touching other exposed terminals, equipment case, racks or equipment housings.

Precautions shall be made to ensure jumper wires used for temporary bridging are not interfered with during the time of their application. Should it be necessary to place the bridging jumper wires within closed equipment housings and if the standard jumper wires will not fit then the particular jumper wires involved may be reduced in length on the authority of the authorising signal engineer with the objective of keeping jumper wires at their maximum practical length.

Before use the jumper wires are to be examined to check they are clean and in good condition and when not in use they are to be kept in separate containers or plastic bags, in the custody of the owner who is to keep a check that none are missing. The number of jumper wires retained should be limited and jumper wires no longer required should be destroyed.

In an emergency the authorising signal engineer can approve the making up of an improvised jumper wire for temporary bridging. The emergency jumper wire is to be fitted with an identification label. The authorising signal engineer will write down a description of this jumper wire in the margin of the authorising form. Immediately after the emergency use, the jumper wire is to be destroyed.

6 Testing of Temporary Bridging when Applied

Following the application of temporary bridging in a signalling circuit licensed signalling personnel, after applying the temporary bridge shall carry out a circuit function test of the circuit to ensure that the temporary bridges and all other contacts that are required to remain effective in the circuit do so. Where the circuit originates and or finishes at a remote signal location, it will only be necessary to test that part of the circuit including any contacts to local trackside equipment, between the incoming and outgoing cables where applicable, at the local signal location where the temporary bridging has been applied.

Signals affected by the work shall remain booked out of use until the satisfactory completion of all relevant tests and implementation of alternate protection.
7 Temporary bridging left unattended

When temporary bridging is to be left unattended for some period of time without the presence of licensed signalling personnel, precautions shall be made to ensure the temporary bridging wires are not tampered with by securing of locations or equipment cases.

Any facing points clipped shall be XL locked and spiked to prevent an unauthorised movement of the points causing an out of correspondence with the interlocking and the bridged-out position. Any attempt to manually operate the points using an ESML or EOL facility shall be prevented using Falcon 8 locks to secure the equipment.

Precautions of a similar nature shall be applicable to other apparatus temporarily bridged as necessary.

When any bridging is applied to point detection, the point securing equipment, such as point clips, locks and spikes, shall be subject to frequent inspection. The authorising signal engineer is to determine and document the inspection frequency by risk assessment.

8 Removal of Temporary Bridging

Testing of the entire affected circuits shall be performed upon removal of temporary bridging to ensure all temporary bridging is removed and all contacts are effective in the circuit. This test shall include an apparatus function test (correspondence test and out of correspondence test, as applicable) and wire / null count. Such testing is to be completed before the alternate protection is removed and before the signalling equipment is booked back into use.

Licensed signalling personnel responsible for removing the bridging are to complete the removal advice section of the bridging authority form and immediately return the form to the authorising signal engineer confirming that the bridging has been removed and all subsequent testing completed.

The notification arrangements shall be discussed and agreed at the time of authorisation.

Wherever practical, licensed signalling personnel who apply the bridging will be the same licensed signalling personnel who remove the bridging. If the licensed signalling personnel will not be the same person, arrangements shall be made for the prompt return of jumper wires to the registered owner of the jumper wires.

Licensed signalling personnel who applied the bridging shall follow up the return of the bridges with the licensed signalling personnel responsible for their removal as soon as practical after the planned removal time.

The authorising signal engineer is to pursue advice of the removal of bridging if they have not been notified once the agreed notification time has elapsed.

9 Temporary Bridging for Planned Works

Additional requirements apply for where there is work which is not of a minor nature, such as planned upgrading or project work, and which extends over more than one shift or involves different licensed signalling personnel applying and removing the bridging.

Work Instructions are to be prepared by the signal engineer in charge of the work (typically the Commissioning Engineer) and with a copy of the authorised bridging authority marked as a field copy issued to the respective team leaders involved,
specifying the bridging application and removal details as well as the testing requirements.

For planned works, the signal engineer in charge of the work should provide regulation jumper wires, individually registered and formally issued by and returned to themselves (or their delegate) together with the associated Work Instructions; in such cases the use of jumper wires from other sources for the work shall be forbidden.

**Note:** New Non-Commissioned Equipment

With new signalling equipment, prior to it being commissioned into use, temporary bridging may be utilised to facilitate testing on the authority of the appointed Commissioning Engineer as the circuit controlling device at this stage has not yet been commissioned to provide protection, temporary bridging of its contacts does not come under the requirements of this procedure but under the relevant procedures as prescribed in SPG 0711 for testing and commissioning new and altered works.

### 10 Infrastructure Booking Authority

Where signalling equipment is booked out of use and bridging is applied, the requirements of *Network Procedure NPR 704* is to be followed, with the bridging authority number to be entered in the space provided at Section 4 on the *Infrastructure Booking Authority form (NRF 003)*. The word ‘BRIDGED’ in brackets is to be entered against the affected equipment in the column headed “Infrastructure Equipment details” under Section 3 of the form.

*E.g. ‘No. XYZ points (BRIDGED)’.*

When the signalling equipment is to be restored to use licensed signalling personnel signing the form shall ensure that the bridging has been removed and the signalling is safe to restore to use.

By signing the IBA form licensed signalling personnel certify that the signalling equipment has been tested and is operating safely and correctly and is fit to return to use.

### 11 Non – Vital Signalling Circuits

If it is necessary to avoid significant disruption to services, the contacts of non-vital circuit controlling devices in non-vital circuits, or the contacts of non-vital circuit controlling devices providing non-vital switching in vital signalling circuits, may be temporarily bridged by licensed signalling personnel provided that the non-vital controlling devices and the terminals being bridged are clearly physically separate from the vital signalling equipment.

Where non-vital signalling circuits are physically separate from vital signalling circuits, they may be exempt from these temporary bridging requirements. However, where bridging is to be applied to these circuits the maintenance signal engineer shall have a suitable process to manage the application and removal of bridging.
Appendix A  PR S 40002 FM01 Authority for Temporary Bridging of Contacts

PR S 4002 FM01
Authority for Temporary Bridging of Contacts

Bridging Authority Number

Employee Authorised to Lead Application of Bridging: 

Employee Nominated to Remove Bridging: 

Planned Application Date: 
Planned Application Time: 

Planned Removal Date: 
Planned Removal Time: 

Location: 

Circuits: 

Reason for Bridging: 
Alternate Protection: 

Procedures to be Observed: 

Bridging Details

<table>
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<th>To Contact / Terminal</th>
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If insufficient space, attach a schedule of additional 'Bridging Details' containing the above details

Maintenance signal engineer: 
(Not required if authorising engineer) 
Consulted / advised on: 

Authorising Signal Engineer: 

Authorising Engineer's Signature: 

Date: 

Copies of the form should be sent to the Line Manager at the next available opportunity. Any discrepancies or anomalies should be reported to the authorising signal engineer.

Bridging Application

Note: Only persons competent to perform temporary bridging unsupervised can lead the activity

IBA No.

Person Applying Bridging: 

Signature: 

Time Applied: 

Date Applied: 

Time Extension Authority

Extended Removal: 

Authorising Signal Engineer: 

Date: 

Removal Advice

The 

(insert number of jumper wire(s) for the bridging listed above were removed)

by: 

(Name and Signature) 

at Time: 

Date: 

Authority Completion

Removal advice received from: 

Authorising Signal Engineer: 

Date: 

Maintenance Signal Engineer Review: 

Date: 

Immediately upon completion of the form, a copy is to be forwarded by the authorising signal engineer to the local team manager and to the maintenance signal engineer.

A copy of the completed form is to be retained on file by the local maintenance signal engineer and the authorising signal engineer.

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Date in Force: 24 January 2018
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1  **Introduction**

Licensed signalling personnel must attend to all major incidents such as an accident, derailment, collision, obstruction, or train stopped by other exceptional cause, unless the affected lines where the incident occurred have no signalling provided (i.e. non-signalled yards).

When licenced signalling personnel are called to attend such major incidents, the following procedures must be adopted.

These procedures support and must be carried out in conjunction with the Network Rules and Network Procedures - *NGE 206 Reporting and Responding to a Condition Affecting the Network (CAN), NGE 208 Responding to a Major Incident, NSG 614 Blocking Facilities and NPR 720 Protecting trains.*

2  **Incident Management**

The management of the signalling investigation of a major incident requires the allocation of roles with the authority and responsibility to ensure the correct processes are followed.

Duties of these roles include:

a) Provide initial reporting  
b) Provide protection of the site  
c) Assign an investigating signal engineer  
d) Preservation and collection of perishable evidence  
e) Conduct inspection and examination of incident site  
f) Collection and storage of data  
g) Provision of emergency arrangements  
h) Incident recovery, testing, certification and restoration of signalling  
i) Reporting and recording.

These are further clarified in the following sections.

3  **Initial Reporting**

When a major incident occurs, the first call notifying the incident must be made by signalling personnel in accordance with Network Rule *NGE 206* to the Network Control Officer. Where electric traction supplies are involved, this information is to be included in the notification.

ICON Infrastructure and the maintenance signal engineer are to be immediately notified where there is any reason to believe, that the accident or derailment has been the result of defective signalling.

4  **Protection**

The immediate priorities for all licenced signalling personnel involved in an incident must be the safety of all persons on or about the line and the protection of the train(s) and any adjacent obstructed line(s).
Protect the incident by the replacement of all fixed signals which apply to the obstructed lines to danger (stop) in accordance with Network rule NSG 614 or by protection in accordance with Network procedure NPR 720.

If it is alleged, or there is any reason to believe, that an incident has been the result of signalling being defective or a contributing factor, then the procedures prescribed in PR S 40004 Section 1.6 Signalling Irregularities and Wrong Side Failures must be followed. The equipment involved must not be disturbed or interfered with until the mishap has been fully investigated by an experienced signal engineer (see Section 5), unless directed by the Incident Rail Commander (IRC) or Emergency Services for safety reasons. It is important that consideration be given to the preservation of evidence (see Section 6) if at all possible to assist in the investigation phase.

Protection must be given by placing the signal or signals next in rear at stop or, where this is not possible, by the provision of handsignaller protection. Any initial inspection of suspect signalling equipment carried out by licenced signalling personnel before the arrival of the investigating signal engineer must be done in the presence of a suitable independent witness who holds the relevant safeworking qualifications, such as the Incident Rail Commander, or a person from emergency services.

Where a line is obstructed then the signal routes leading over the obstructed track, plus outer signal routes whose overlap includes the section of obstructed track, plus any points foul of the obstruction or providing trap protection, should be disconnected and maintained at stop (signals) or in a safe position (points), unless other safe and secure arrangements are directed by the investigating signal engineer.

Once the incident area and affected equipment has been established, the extent of protection is to be reviewed to minimise the impact on the network and maximise the use of the signalling system.

5 Assigning an Investigating Signal Engineer

A signal engineer is to attend if it is alleged, or there is any reason to believe, the incident has been the result of signalling being defective or a contributing factor and incidents where extensive damage to signalling equipment has occurred.

The investigating signal engineer is preferably assigned before the incident site is disturbed. The qualifications and competencies held by the investigating signal engineer shall be appropriate to the nature and complexity of the incident and installation. The initial investigating signal engineer in most instances will be the maintenance signal engineer or another signal engineer as determined by the Signal Engineering Manager. The Signal Engineering Manager may delegate this action to ICON Infrastructure. Circumstances regarding the need for an independent investigation must be considered. In cases of serious consequences or implication, the investigating signal engineer may be nominated by the Professional Head Signalling and Control Systems following consultation with the Signal Engineering Manager.

When the role of investigating signal engineer is escalated or allocated to another investigating signal engineer during the investigation, the initial investigating signal engineer is to promptly hand over all information and evidence collected to the new investigating signal engineer.

5.1 Roles of the Investigating Signal Engineer

The investigating signal engineer will carry out the following:

a) Immediately attend the site to take control of the signalling resources and lead the on-site inspection and evidence collection.
b) Liaise with the Incident Rail Commander, emergency services and other engineering discipline officers.

c) Manage the signalling activities and staff attending the site.

d) Conduct inspection and examination of the site.

e) Ensure protection of perishable evidence at the site until collected or recorded in a permanent or retrievable manner.

f) Arrange collection and safeguarding of physical evidence for removal secure storage and later analysis.

g) Carry out testing and certification of the affected signalling.

h) Provide authorisation for restoration of signalling once the site inspection, evidence collection and testing is completed.

i) Lead a joint review of any signalling evidence and/or data relating to an incident with the Incident Rail Commander and other investigating officers to determine root cause.

6 Inspection and Examination

After taking the necessary precautions and making reports as per Sections 3 and 4, a detailed inspection and examination of the scene of the incident must be carried out by licensed signalling personnel.

If there is any allegation, or possible doubt about the integrity of the signalling system, the detailed inspection and examination must be carried out under the guidance of the investigating signal engineer and in the presence of a suitable independent witness who holds the relevant safeworking qualifications, such as the Incident Rail Commander, or a person from emergency services as per procedures prescribed in PR S 40004 Section 1.6.

Relevant evidence should be preserved and prioritised so that perishable evidence is not lost. An example of perishable evidence is sunlight shining directly on a signal lens. Cameras, video recorders, voice recorders and the like as well as notes should be used to preserve evidence. Capturing of evidence must continue where deteriorating equipment conditions continue to be experienced. Damaged or suspected equipment should be safeguarded and labelled to enable reconstruction of arrangements for investigation purposes. The position of all levers, indications on the signal box indicator diagram / screen, and point positions which may be applicable to the circumstances should be noted on arrival.

In addition to the details noted above, particular notes must be made on the inspection of:

- position of all relevant point mechanisms.
- damage to point switches and point detectors.
- state of signals, trainstops.
- any new or recent strike marks on trainstop trip arm face.
- routes that were set at the time of the incident.
- state of the interlocking taking particular note of the correspondence of relays with the position of signals and points.
- condition of control, indication and interlocking relays, wiring, cables and equipment racks.
- the point of detachment / derailment.
Statements from incident witnesses, such as Rail Vehicle Operators or Network Control Officers, must be sourced from the Incident Rail Commanders if not directly obtained.

Other forms of evidence that should be considered may take the form of data logs and replay files for vital and non-vital systems, station and sidings security CCTV footage, train CCTV footage or logging systems. ICON Infrastructure or the IRC may be utilised to obtain such evidence from other areas.

To assist with incident investigation progression, copies of data logs and replay files for vital and non-vital systems must be obtained at the earliest opportunity. Signalling Logs are to be managed as per PR S 40004 Section 1.5 Signalling Logs.

7 Emergency Arrangements
Licenced signalling personnel are to assist with the provision of alternate signalling arrangements to facilitate the safe movement of rail traffic.

8 Incident Recovery
All damage to signalling equipment must be recorded and a full list of material required to make repairs must be prepared. Refer to PR S 40005 for a checklist to capture damaged equipment.

Equipment and resources are to be requested for the efficient and timely restoration of signalling equipment.

Signalling Safeworking Procedures must be followed during restoration activities.

All equipment is to be tested and certified prior to restoration into use by licensed signalling personnel.

9 Reporting and Recording
Procedures outlined in PR S 40004 Section 1.1 Reporting and Recording Failures are to be observed.

The results of inspections and examinations and enquiries must be communicated immediately they are completed to ICON Infrastructure.
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1 Introduction

Signalling personnel shall clearly understand that the object of good maintenance is to prevent failures and provide a high level of system performance and integrity. This is to be done by intelligent anticipation rather than to wait until the failure occurs.

In the case of an accident, emergency or disruptive failure of signalling apparatus, licensed signalling personnel shall attend with all due urgency in order to deal promptly with the situation, and thus minimise train delays.

Licensed signalling personnel are to review the failure management system for incidents on equipment within their area of responsibility that may have been attended by others so as to be aware of any outstanding matters, such as follow-up requirements, temporary repairs, like for like renewal updates and so on.

There are two types of failures as determined by maintenance standards. These are defined as:

- **Functional Failure** - The failure of an item to perform its normal or characteristic functions within specified limits. This failure type generally causes immediate impact on signal operation, subject to the level of available redundancy. Every signalling functional failure should be reported, recorded and analysed so that appropriate measures can be taken to reduce such failures to a minimum.

- **Conditional Failure** - The failure of an item to meet desired quantifiable performance criteria which may be either an output or condition parameter and which indicate that conditional risk is unacceptable. Conditional failures, which do not impact directly on functional failures, shall be recorded and managed using the Sydney Trains defect management system, and ensure the condition does not develop into a functional failure.

1.1 Reporting and Recording Failures

All notifications of signalling failures shall be thoroughly investigated.

Full details of the findings for functional failures shall be reported to the ICON Infrastructure as soon as possible. The ICON Infrastructure representative shall then enter the information into the failure record management system.

The failure record management system entry shall include such details as the date, time, location, effects, symptoms, tests performed and root cause of the failure, affected equipment, defective or damaged component/s, as well as other relevant information. Where repairable items with a unique serial number such as vital signalling relays, rail control server hardware, track circuit receivers/transmitters, CBI equipment and so on have failed, then they shall be recorded with the serial number in the Sydney Trains failure management system so that performance can be tracked once they are returned to service.

**Note** The process for reporting signalling irregularities (including reported alleged irregularities) shall be done in accordance with Section 1.6.2 of this procedure.

Licensed signalling personnel attending failures outside normal working hours shall report the failure details to ICON Infrastructure prior to ceasing duty. For any failure or damage to signalling and/or safeworking communications equipment, the checklist in PR S 40005 can be utilised by the signalling person in charge of the repair work to record the damage to signalling and safeworking equipment for inclusion in the incident report.
1.1.1 Detailed Failure/Incident Report

A detailed failure/incident report shall be compiled by the attending signalling personnel whenever directed by the maintenance signal engineer.

The maintenance signal engineer shall carefully scrutinise the detailed failure/incident report, add any relevant details or comments as required and initiate any corrective or preventative actions.

The detailed failure/incident report shall include details of train delays and other consequences of the failure/incident.

Specific information (as applicable), shall also be included in the report for the certain types of signalling failure as follows:

- Were the points wound over by hand and by whom? (including the time that the crank handle was removed from the emergency switch mechanism lock (ESML) or emergency operating lock (EOL)
- Special working introduced or cancelled.
- What preventative measures were put in place to ensure perishable information is preserved e.g. telemetry logs.
- Name of the Network Control Officer, if it is alleged that equipment has been incorrectly manipulated.
- Identification of work group, if it is alleged that a specific work group is responsible for the failure.
- The time and details of advice provided to ICON Infrastructure, ICON Electrical, Rail Management Centre or other reporting body.
- For multiple failures, a specific list of all items failed, when each item was damaged and a general comment if this was as a consequence of say a derailment or power failure etc.
- The status of indications provided on equipment that may provide assistance in diagnosing the root cause.
- Change of system or telemetry mastership.
- Whether further investigation is to be carried out.
- Any unusual circumstances.
- The suspected cause for a no cause found failure.
- The kilometrage of any civil defect.
- The nature of temporary repairs and the requirements for permanent repair.
- The exact location (relative to a suitable structure) of joints made in multicore cables or single conductors, types of cable routes in use, and the type of cable joint installed.
- In the case of ETCS on-board failures, the details of the train reporting the failure, including train run number, set number, car number and DMI message at the time of failure.

Comments are to be kept concise, while providing full detail of the failure and circumstances. The use of abbreviations and acronyms in reports for well-known items such as ATP, ETCS, CSEE, ESML, EOL, ATRICS, CCTV, and so on is acceptable; however, lesser known abbreviations and acronyms should be avoided unless specifically defined.
1.1.2 No Cause Found Failure Report

Where the cause of a failure is not immediately found, the failure shall be fully investigated. A ‘PR S 40004 FM 01 No Cause Found Failure Report’ (reference Appendix A), or an approved equipment specific equivalent, shall be completed on each occasion unless otherwise instructed by the maintenance signal engineer.

The relevant parts of the No Cause Found Failure Report are to be completed by licensed signalling personnel attending the failure and the follow-up investigator shall complete the Follow Up Investigation section.

Subsequently, the No Cause Found Failure Report is to be forwarded to the maintenance signal engineer for review and file.

1.1.3 Investigating Signal Engineer's Signalling Incident Technical Report

Signal engineers are to submit a technical report for:

- all reports of signal irregularities
- where signalling was at fault or a contributing factor at derailments, collisions and signals past at danger (SPAD)
- failures of interest, signals returned in front of driver (RIFOD) or other incidents on request from the NMD Signals Engineering Manager, Control Systems Operations Manager or the office of the Professional Head Signalling & Control Systems

The PR S 40004 FM 02 Investigating Signal Engineer's - Signalling Incident Technical Report form (reference Appendix B) is to be used for all signal engineer technical reports.

The signal engineer (investigating engineer) shall forward a comprehensive report of the incident to the Professional Head Signalling and Control Systems via Signalling & Control Systems Integrity email (SignallingControlSystemsIntegrity@transport.nsw.gov.au) by the next working day following the incident.

A preliminary copy of the Investigating Signal Engineer's - Signalling Incident Technical Report may be forwarded by the investigating Signal Engineer where additional time is required for compiling a comprehensive report.

The comprehensive report shall contain events and details of the incident, including an extract of the signalling plan, details of the technical investigation conducted, together with test results, copy of circuit book pages (marked up as per PR S 47112 to show circuit testing performed), logs, control system replays, photos, etc. and any rectification measures either completed or proposed (including further investigations if appropriate). The investigating signal engineer or maintenance signal engineer may suggest recommendations including modifications to designs, installation methods, etc.

A copy of the report shall also be forwarded to the maintenance signal engineer where the investigation was conducted by others.

A separate file for each signalling irregularity shall be kept by the maintenance signal engineer. These files shall not be closed until all investigations and inquiries have been completed and fully reported, and all recommendations, corrective and preventative actions have been satisfactorily implemented.
1.2 Failures Caused by Other Disciplines

Where licensed signalling personnel find a defect or failure in signalling apparatus and the cause of which is due to another discipline, they will call the attention of the discipline representative concerned to the defect or failure. The cause of such failures is to be clearly described.

When licensed signalling personnel become aware of another discipline's defects affecting the operation or reliability of signalling equipment, procedures for co-ordinating with these other disciplines shall be followed to ensure the matter receives appropriate attention.

1.3 Failure Analysis

Maintenance signal engineers shall frequently review and update as required, the failure record management system entries for their area and make recommendations as applicable.

The analysis is to target all failure categories, and in particular the following types:

- Repeat and no cause found failures: to ensure these are thoroughly investigated and if required, escalated to a higher level of investigation to determine appropriate courses of action in preventing recurrence. A file is to be retained of these failures.
- Failures caused by vandalism: to determine appropriate measures of security in an attempt to minimise recurrence of these types of failures.
- Failures caused by rail lines or signalling apparatus seldom used: to provide mitigation against the associated risks.
- Failures caused by persons performing work (personnel failures): to ensure the interference caused by workers is addressed to prevent recurrence, and thus not impair the safety and reliability of the signalling system caused by such failures.
- Failures caused by signalling component defects: to determine appropriate measures such to minimise recurrence of these failures. This analysis is to extend to the identification of equipment used at other locations that can be impacted by similar failure modes.

1.4 Network Operational Procedures

When advised to attend to a failure, licensed signalling personnel are to obtain details from the Network Control Officer about the circumstances of the failure and any symptoms or indications that may assist in providing diagnoses of the cause. Licensed signalling personnel shall advise the Network Control Officer of any intended actions that may disrupt the operation of trains; for example, the requirement to disable or book out of use any signalling, or testing that may interfere with signal indications.

Before any signal, points, points lock, control systems equipment or other signalling safeworking equipment in connection therewith is disconnected; signalling personnel shall ensure the observance of Network Rules and Procedures NWT 312 and NPR 704.

When the failure has been rectified and the necessary tests carried out, licensed signalling personnel shall advise the Network Control Officer.

1.5 Signalling Logs

1.5.1 General

Where logging facilities of vital or non-vital systems are available they may be utilised by signalling personnel as a failure diagnosing tool. However, when signalling logs or the
interpretation of logged information are used for the purpose of information or evidence following a serious incident (such as signalling irregularity, derailment, collision, etc), they shall be reviewed by a signal engineer before being passed on to other parties.

Signalling logs refer to electronic system data, logged from either vital or non-vital systems. These systems include SSI, Smartlock, Microlok, Westlock, Westrace, ATRICS, Dupline, IMAC, Kingfisher, level crossing monitors, and ETCS logs downloaded from such equipment as lineside encoder units (LEU), on-board train recorder units (TRU) or ETCS juridical recorder units (JRU). Some event recording systems may incorporate replay and asset monitoring facilities as well as still and video footage. If ATRICS replays are used, the replay log shall be correlated with the ATRICS control systems log.

Note Some of these systems are also governed by their own procedures which shall be referenced in conjunction with this procedure when providing logged information. These include procedures PR S 40028, PR S 40032, PR S 40036, PR S 40038, PR S 40039 and PR S 40050.

1.5.2 Log Information

The log information shall be an unaltered download, separately interpreted and attested by the investigating signal engineer to be a true representation of the actual event.

When a log is provided for operational purposes, it is to include a specific analysis along with accurate commentary to describe the event in plain language.

1.5.3 Verification of Logger System Time

Prior to analysing logger data, it is essential that the logger time is checked against real time to determine the difference.

1.5.4 Verification of Log

To provide an assurance of the log integrity, the critical inputs and outputs used in logged events, supplied as evidence for a serious or major incident, shall be verified by a signal engineer before releasing the information in written form.

1.5.5 Logs Retrieved from Third Parties

Where logs are obtained from third parties, such as ATRICS logs, ETCS Onboard logs, CCTV footage or video and so on, and the log information is to be used as evidence for a serious incident, the investigating signal engineer shall obtain the necessary assurances from the relevant party providing the log that meets the requirements of Sections 1.5.2, 1.5.3 and 1.5.4.

1.6 Signalling Irregularities and Wrong Side Failures

1.6.1 Definition

Signalling irregularities are defined as the failure of a vital signalling unit or subsystem which is contrary to the design requirement, is not fail-safe, and which in combination with other failures or circumstances may bring the system to an unsafe condition (reference ESG 007).

Signalling irregularities include errors to the intended design principle. This can occur at the design stage or during installation, subsequently missed by the required testing, including design integrity testing (principles testing).
Not all signalling irregularities result in immediate failure. Some may remain in the system as latent defects which may later emerge, adversely affecting the safe running of trains.

Predictable, common failure modes such as lamp and LED unit failures on a signal or level crossing, or a trainstop that is falsely in the lowered position due to a mechanical problem, are not deemed signalling irregularities. Additionally, a single broken road boom at a level crossing is not deemed a signalling irregularity, on condition that the level crossing remains in an activated state.

Further, frequent known occurrences of momentary loss of track circuit shunt caused by rail vehicles identified with wheel-to-rail issues (such as DMU or maintenance rail vehicles), and such vehicles were travelling on sections of track identified as contributing to these issues, are not deemed a signalling irregularity. This deeming is subject to the associated risks being prior addressed to a satisfactory level and each occurrence immediately investigated by signalling personnel to ensure the cause is the ‘known’ wheel to rail issue. Consequently, where the cause is found to be different, the failure shall be treated as a signalling irregularity.

1.6.1.1 Examples of Signal Irregularities and Wrong Side Failures

Signalling irregularities may be protected or unprotected within the system design. They vary in the danger they present to trains and people. This is essentially dependent on the level of protection inherently available during the prevailing conditions. Such protection may be afforded by the system’s design or the presence of effective elements of a safe condition. These safe provisions potentially reduce the risk caused by the failure and as such, this type of signalling irregularity is deemed ‘not wrong side’.

For example, a failure of a signal control relay to de-energise may be proved in the track stick circuit, maintaining the signal in rear at stop. The failed signal is returned and maintained at stop by means of the VRR contact in the signal operating circuit. Therefore the signalling irregularity in this case is protected by the system design, thus preventing it becoming a wrong side failure.

A wrong side failure is not protected by the system design, nor has it sufficient effective elements of a safe condition for the particular circumstance; this could directly endanger the safe running of trains or people.

For example, a signal that falsely displays a proceed-indication is a signal irregularity that is deemed a wrong side failure (even if some protection was afforded by the signal in rear indicating a caution aspect).

Examples of signalling irregularities that are deemed wrong side failures:

- Point Locking - If points are released under conditions when they should be locked.
- Point Detection - If point detection is made when the points are not in their correct position.
- Facing Points – If a signal can be cleared over facing points when the points are not locked or correctly detected.
- Signals - If a less restrictive indication is displayed by the signal than is correct for the conditions allowed.
- Trainstop – if a trainstop fails to provide protection and falsely indicates a Normal position.
- Rail Vehicle Detection - If a track circuit or axle counter fails to detect the presence of a rail vehicle.
- Level Crossing Protection - If level crossing protection equipment fails to operate for approaching trains and the protecting signals are not automatically replaced or held at stop such to protect the failure.
  
  Note This example does not pertain to a level crossing having an insignificant amount of lights out, one broken boom or one failed bell/siren, or when in the level crossing is in manual operation.

- Mechanical or Electrical Interlocking - If a release can be incorrectly obtained from the locked position.

- Vital Relays – If a vital signalling relay is falsely energised due to internal or external interference or defect, which subsequently causes a reduction in system safety.

- Electric Locks - If a lock is incorrectly free.

- Dual Control - If the restoration of any one control fails to return the signal to the Stop position/indication.

- ETCS – If an ETCS trainstop fails to provide an appropriate brake intervention to an ETCS fitted train for the restrictive signalling conditions intended.

- ETCS – If an appropriate brake intervention is not received by an ETCS fitted train on approach to an ETCS managed speed restriction such as:
  - high risk turnouts
  - high risk catchpoints
  - reduced overlaps including reduced overlaps approaching a level crossing
  - end of line buffer-stops

- ETCS – If an appropriate brake intervention is not received by an ETCS fitted train where the train exceeds the designated line speed profile (including any ETCS mitigated temporary speed restriction).

Examples of signalling irregularities that are deemed not wrong side failures:

- Signal Indication - If a signal displays an irregular combination of lights that is obviously seen as an invalid indication.

- Trainstop - If a trainstop fails to provide protection (other than a mechanical cause) and the system design provides proving of the trainstop Normal position (track-stick or similar), thus protecting the system.

- Level Crossing Protection - If level crossing protection equipment fails to operate for approaching trains and the system design provides proving of the boom normal position (XNR) causes the protecting signals to be replaced or remain or held at stop such to protect the failure.

  Note This example does not pertain to the level crossing having an insignificant amount of lights out, one broken boom or one failed bell/siren, or when the level crossing is in manual operation.

- Level Crossing Pedestrian Gate - If only one pedestrian gate remains partially open due to a mechanical problem - conditional that the remaining elements of the level crossing have activated correctly and it is evident that trains are approaching.

  Note Refer to Section 1.6.1.2 for examples of effective elements of a safe condition

- Vital Relays – If a vital signalling relay is falsely energised due to internal or external interference or defect, and the system design provides proving of the relay's de-energised position (back contact proving) thus protecting the system.

- Diagram Indications in Mechanical Signalled Areas:
If a signal repeater (on a panel diagram etc) shows stop, or a Distant Signal repeater shows caution, when in fact the signals show a clear indication.

If a track circuit indicator shows clear when the track circuit is occupied.

**Note** In these cases, network rules and procedures protect against this risk.

- **ETCS** - If a correct DMI message is not received by an ETCS fitted train and the outcome causes only minimal risk; for example, loss of announcement into an ETCS area or loss of warning for a low risk speed restriction

  **Note** Failure of ETCS equipment to apply an appropriate brake intervention to an ETCS fitted train is deemed a wrong side failure.

### 1.6.1.2 Effective Elements of a Safe Condition

In some cases of signalling irregularity, where it is clearly evident that the system has failed, there may still remain sufficient effective elements to provide a safe condition.

These safe elements may alert people such as Network Control Officers, drivers, and users at level crossings of the prevailing conditions.

Examples of effective elements of a safe condition include the following:

- A pedestrian gate not closing when required
  
  The possible effective elements may include the following:
  
  - the obvious activation of the level crossing protection
  
  - the detection of the gate not closing (XNR) and protecting signal held at stop

- A signal indication which has an irregular combination of lights that is obviously seen as an invalid indication
  
  The possible effective elements may include the following:
  
  - the driver recognising the irregular signal indication
  
  - the signal in rear correctly indicated the proceed aspect for the signal ahead (for example, caution if the failed signal was at stop)

Maintenance signal engineers, after due consideration of the prevailing consequences, may treat these cases as 'Simple Cases' as prescribed in Section 1.6.4.1

### 1.6.2 Advising Reports of Signalling Irregularities

Licensed signalling personnel who become aware of signalling irregularities shall obtain as much relevant information as they immediately can, establish that the reported situation could constitute an irregularity and relay this information to the maintenance signal engineer.

The maintenance signal engineer shall be verbally notified of all reports of signalling irregularities as soon as possible. If the maintenance signal engineer is not immediately contactable, a voice or text messages is to be left and the ICON Infrastructure notified to arrange further contact.

The details and actual circumstances surrounding the report shall be fully understood by the maintenance signal engineer.

### 1.6.3 Protection of Signalling Irregularities

All reports of signalling irregularity shall be treated as factual and immediately attended to. An immediate assessment shall be done of the situation by licensed signalling personnel to determine the likelihood of a signalling irregularity. Where the nature of the
failure (right-side failure or signalling irregularity) is in doubt, then the failure shall be treated as a signal irregularity.

Signalling equipment suspected of causing an irregularity shall be protected by licensed signalling personnel, by arranging protecting signals to stop.

The suspected signalling equipment shall be only booked out of use (using NRF 003 Infrastructure Booking Authority form) and not initially disturbed or disconnected, unless instructed by the investigating signal engineer.

The immediate failed signal may be disconnected in conjunction with being booked out of use, if it is clearly evident that the cause of irregularity is not within the signal operating circuit or its controlling relay/module.

Where a failed signal is not disconnected (booked out of use only), the protecting signals in the rear of the failed signal shall be booked out of use and disconnected.

The protecting signals in the rear may be restored in the intervening period until the signalling irregularity is rectified on the following conditions:

- The actual cause of the signalling irregularity is positively determined by the investigating signal engineer.
- Rail traffic can safely operate using the signals in accordance with network rules and procedures.
- The failed signal is disconnected in conjunction with being booked out of use.
- The immediate protecting signal is deemed sufficient protection for the signalling irregularity.

Note: The immediate protecting signals shall remain booked out of use until the defect is rectified or addressed.

1.6.3.1 Protection of ETCS Signalling Irregularities

Not all signalling irregularities associated with ETCS equipment are effectively protected by placing signals to stop. For example, where a train’s on-board ETCS equipment is the cause of failure, placing signals at stop may not afford suitable protection from the moving train.

Similarly, ETCS equipment containing static line speed profile that fails to protect against over-speeding, may not be sufficiently protected by placing signals at stop. Likewise, ETCS equipment that fails its intention to announce the entry or exit of an ETCS area may not be sufficiently protected by placing signals at stop.

Licensed signalling personnel who become aware of these situations shall report the matter to the Network Control Officer. If requested by the Network Control Officer, licensed signalling personnel shall disable or book out of use specific signalling as nominated.

However, where the ETCS equipment failure permits a less restrictive signalling condition; such as a failure to apply the required approach control to nominated high risk turnouts, high risk catchpoints, end of line buffer-stops, or reduced overlaps including reduced overlaps approaching level crossings; the protecting signals shall be placed at stop in accordance with Section 1.6.3.

Similarly, protecting signals shall be placed at stop where an ETCS trainstop fails to provide a brake intervention to ETCS fitted trains for the restrictive conditions.
1.6.4 Attending the Investigation

All signalling irregularities shall be immediately investigated whether they result in an unsafe situation or not.

The maintenance signal engineer will be the investigating signal engineer or otherwise delegate an appropriate officer to conduct the investigation. Only signal engineers can conduct investigations of signalling irregularities. Where the maintenance signal engineer is not contactable, the Signal Engineering Manager is to nominate an alternative maintenance signal engineer. The Signal Engineering Manager may delegate this action to ICON Infrastructure.

Circumstances regarding the need for an independent investigation shall be considered by the maintenance signal engineer before nominating the investigating signal engineer.

In cases of serious consequence or implication, the investigation shall be supervised or conducted by an experienced, independent signal engineer nominated by the Professional Head Signalling and Control Systems.

A suitable, independent officer (usually from network operations such as the Incident Rail Commander or a person from emergency services) shall be sought to act as a witness to the investigation in all cases except simple cases.

1.6.4.1 Simple Cases of Signalling Irregularity

In simple cases where there has been no injury or damage, no collision or derailment or near miss, and there are no extraordinary circumstances, and the cause is non-contentious and obvious to the licensed signalling personnel conducting the preliminary examination; it may not be necessary for the investigating signal engineer to attend on site in order to conduct the investigation.

However in this case, the investigating signal engineer is still the person responsible to determine if the signalling system is safe to restore for normal operational use and shall be satisfied that the identified cause of the incident satisfactorily explains the situation before doing so.

For example; a signal is reported to display an irregular combination of lights. The attending licensed signalling person finds the signal lamp case door open and acknowledges this to be the cause of the irregularity. After noting the door and lock condition and any other evidence that might explain why the door was open, and after ensuring there are no other factors involved, the licensed signalling person reports the situation to the maintenance signal engineer. If satisfied the investigation has revealed the true cause and assured the door is properly secured, the signal engineer permits the restoration of the affected signalling. The licensed signalling person informs the Network Control Officer of the findings and provides advice for certification, specifying the signalling that can be booked back into use. The maintenance signal engineer informs the Professional Head Signalling and Control Systems in accordance with Section 1.6.6.

In serious or complex cases, or where the irregularity is a wrong side failure, or where no cause is obvious for a reported irregularity and evidence available does not allow a conclusion that there was no irregularity, a licensed signal engineer shall attend and conduct the investigation on site.

1.6.4.2 Responsibilities of the Investigating Signal Engineer

It is the responsibility of the investigating signal engineer to determine that the signalling system is safe to restore for normal operational use.
The investigating signal engineer shall be satisfied that upon completion, the investigation has been properly and thoroughly conducted.

Where the cause of irregularity is not immediately obvious, the investigating signal engineer shall compile an inspection and test plan as part of the investigation strategy prescribed in ‘Appendix C Guidelines for Irregularity Inspection and Testing to Determine Cause’. This document is to be sourced to provide guidance in relation to the investigation strategy and testing requirements needed to make a sound determination. The investigating signal engineer is to also liaise with senior, experienced signal engineers where the investigation is not straight forward, to ensure the strategy gathers and secures evidence which can identify the causal factors in order to provide a conclusive finding.

If the signalling is likely to be out of use for some time and train services are going to be seriously disrupted, the investigating signal engineer is to consult with the maintenance signal engineer, Signal Engineering Manager or other senior, experienced signal engineers to determine whether there are other permissible means of protection that will ensure a safe situation whilst minimising the disruption.

While testing is being carried out, book out and disconnect any signalling equipment which is subject to interference by the testing work, which may endanger the passage of trains.

A separate file for each signalling irregularity shall be kept by the maintenance signal engineer. These files shall not be closed until all investigations and inquiries have been completed and fully reported, and all recommendations, corrective and preventative actions have been satisfactorily implemented.

A written report as described in Section 1.1.3 shall be submitted.

1.6.4.3 Responsibilities of Licensed Signalling Personnel Assisting with the Investigation

Licensed signalling personnel shall arrange protection of the suspected and protected signalling equipment as prescribed in Section 1.6.3.

Signalling personnel requested to assist with the investigation shall proceed to the site as soon as possible and act upon instructions from the investigating signal engineer.

The events and conditions causing signalling irregularity may be examined and noted by signalling personnel assisting with the investigation, prior to the arrival of the investigating signal engineer, in an attempt to determine cause. However, this shall be done without disturbing equipment or destroying evidence that could prevent a determination of the true cause, unless specifically instructed by the investigating signal engineer.

Care shall be taken when accessing signalling equipment, as movement or vibrations from movement, could release mechanically stuck devices or vary electrical leakage paths or otherwise remove evidence of the cause of a signalling irregularity.

The investigating signal engineer shall be advised of all examinations carried out by signalling personnel.

1.6.5 Certifying Signalling Equipment Following Reports of Signalling Irregularity

Certification of the signalling system can only be made once the investigation has concluded, and either:
• A genuine cause has been determined and the affected apparatus rectified or addressed.

Or

• If the alleged report is proven to be unsubstantiated by thorough testing which has verified the signalling to be working safely in accordance with the signalling design.

In all other cases, the matter shall be escalated to the Professional Head Signalling and Control Systems or another senior, experienced licensed signal engineer.

1.6.6 Advising the Professional Head Signalling and Control Systems

Investigating signal engineers shall promptly advise the Professional Head Signalling and Control Systems of signalling irregularities, where:

• A wrong side failure or other significant incident occurs (derailment, collision or near collision) and the signalling system is suspected to be at fault.
• A recurrence of the irregularity cannot be ruled out and may result in serious consequences.
• An alleged or confirmed irregularity cannot be satisfactorily explained and the equipment is to remain booked out of use.

Deferred notification of a signalling irregularity can be provided verbally by the investigating signal engineer to the Professional Head Signalling and Control Systems on the morning of the next working day following the incident, where:

• The investigation has determined a genuine cause and the affected apparatus rectified or addressed, and certified for operational use.

Or

• The alleged report is proven to be unsubstantiated by thorough testing which has verified the signalling to be working safely in accordance with the signalling design and subsequently restored and certified for operational use.

1.7 Right Side Failures - Action to be Taken

1.7.1 General

Licensed signalling personnel responsible for the attendance of failures will promptly respond to such incidents to restore the system to good working order, thus allow the resumption of rail operations under normal signalled conditions.

The rectification of failures is to be carried out in such a manner that the failure will not reoccur.

During a failure the best possible arrangements, consistent with safety and in accordance with the Network Rules and Network Procedures, and Signalling Safeworking Procedures will be made to minimise delay to traffic.

It may not always be necessary to book out and disconnect signalling apparatus. The risks associated with removal of the normal operation of signals, points and so on shall be assessed and considered in order to maximise the safe use of the signalling system.

However, signalling shall be made to provide protection in any of the following situations:

• A signalling irregularity, until the investigation has determined the cause and the defect subsequently rectified or addressed.
• The safety of the signalling may be impaired by an intervening action (for example, signalling equipment is disarranged or disconnected from the interlocking).
• The signalling equipment is unreliable and may result in signals inadvertently returning to stop on approaching trains.

• The failure condition remains unrectified and routes become unavailable for a considerable amount of time.

• If requested by the Network Control Officer.

Under no circumstances shall signalling personnel cause a signal to display a less restrictive signal indication to a driver or cause a signal to clear by means of manipulation or interference with circuits or input or outputs (I/O) or data or bridging of relay contacts, or other similar actions, except as specifically laid down in these procedures.

When temporary repairs have been made to correct a failure condition they shall also be listed on the incident report within the failure management system by ICON Infrastructure and the maintenance signal engineer informed.

1.7.2 Signalling Equipment Unable to be Promptly Certified

Unnecessary traffic disruption may occur where there is a delay to certification of signalling equipment following failure rectification. Where a failure or incident has a clear and simple cause, signal engineers have the authority to determine and permit the use of alternate testing requirements sufficient to provide an interim assurance of safety to permit restoration of operations. The following process will confirm that the replaced equipment is safe to allow normal or restricted signal operation until full certification is completed.

Signal(s) affected by failed equipment are to remain at stop until the equipment is fit for operational use (refer to Sections 1.7.3 and 1.7.13.1). Formal booking out-of-order of the affected signal(s) is not required.

When prompt certification of signalling equipment is not possible, licensed signalling personnel shall advise the relevant signal engineer. The signal engineer shall assess the consequence of the disruption to rail traffic, the risks associated with deferring prescribed tests and the expected delay to full certification. If appropriate, the signal engineer is to advise field personnel of the alternate testing and reporting requirements, and timeframe for full certification.

The signal engineer shall document all discussions, decisions and proposed actions, including specifically the alternate testing requirements and constraints to operations.

License signalling personnel shall report alternate test results to the signal engineer who shall confirm that results are satisfactory prior to the equipment being restored to use.

Licensed signalling personnel shall advise Network Control that the signalling is ‘fit for use but additional testing will be required at a later time for full certification’.

Full certification testing shall be completed within the time frame set by the Signal Engineer.

1.7.2.1 Worked Example

The following worked example illustrates the application of this process:

a) A defective receiver is identified on an AF track circuit in an automatic section.

b) The affected signals are maintained at stop by disconnection of signal control circuits.

c) The defective receiver is replaced and observed to be operating correctly.
d) Following discussion with Network Control, personnel are unable to access the track as the appropriate level of worksite protection cannot be authorised at this time and, as a result, shunt tests and measurements cannot be conducted as required by MN S 40000.

e) As a consequence, the track cannot be certified or made operational for an extended time and licensed signalling personnel shall contact a licensed Signal Engineer.

f) The Signal Engineer considers:

   i) The disruption to rail traffic due an extended signal failure at this site.

   ii) The testing requirements prescribed in MN S 40000 for the particular situation.

   iii) The operational safety risks associated with the signalling being inoperative for an extended period and alternative methods of train working being implemented.

   iv) The safety risks associated with deferring or using alternate testing procedures to those detailed in MN S 40000.

   v) Train shunt risk factors such as detailed in PR S 40007 Apparatus Seldom Used (Section 3.2 Factors for Consideration) which may be relevant at this site.

   vi) The length of time full certification can be deferred.

g) Upon assessment of these factors and risks, the Signal Engineer advises the licensed signalling personnel to conduct tests to:

   i) Confirm the receiver is correctly installed/wired in circuit.

   ii) Confirm that the receiver input voltage is as per the track circuit history card.

   iii) Confirm the track relay de-energises and energises cleanly when the location track terminals are disconnected and restored.

   iv) Confirm the track relay de-energises correctly for the passage of sufficient number of trains to be indicative of those likely to operate on the line.

   v) Measure the receiver voltage on train shunt and confirm the results are within the allowable levels detailed in PR S 40025 Track Circuits.

   vi) Complete certification testing within a designated time frame.

h) Upon successful test results and confirmation from the Signal Engineer, licensed signalling personnel are to restore and test the signals previously placed to stop. Licensed signalling personnel are to advise Network Control that the track circuit is fit for operational use but will require further testing as soon as possible.

i) Licensed signalling personnel are to complete certification testing when the restriction is removed and within the time frame allowed by the Signal Engineer. If this cannot occur, the Signal Engineer shall again be contacted and advised.
1.7.3 Failure of Signals

Defective signals which have failed right-side shall be made to remain at stop until the apparatus has been restored to correct working order.

Where colour light signals have failed such that they display no lights at all, these shall be treated as an urgent priority. Where delays to rectify such defect are incurred, the higher indications of the signal in rear shall be restricted to indicate the most restrictive proceed-aspect for the running signal (for example, caution or low-speed).

In the case of a signal showing a less restrictive signal indication than conditions should allow, the signal next in rear shall be disconnected and protected by appropriate safeworking procedures until the wrong side failure is investigated by a signal engineer.

1.7.4 Failure of Electric Lever Locks on Signals

When the normal electric lever lock fails on a signal lever, the lever shall be kept in the normal position until the failure has been rectified.

When the normal electric lever lock fails on a Distant Signal lever licensed signalling personnel shall check that the Distant Signal displays a caution indication, and the signal shall be kept at caution until the failure is rectified.

When the normal electric lever lock fails on a signal in the stop position, the signal lever shall be maintained at stop and traffic shall be conducted in accordance with Network Rule and Procedure NSG 608 and NPR 746 for passing that signal at stop.

1.7.5 Failure of Power Operated Points

When points have failed, no attempt shall be made to unlock or move the points other than from the signalling control unless the affected points and protecting signals have been booked out of use.

Emergency switch machine locks (ESML) and emergency operation locks (EOL) may be used by licensed signalling personnel as permitted by the Network Control Officer to manually operate points for the purpose of diagnosing and rectifying a failure. This may be done without booking the affected points and signals out of use.

Where electro-pneumatic points are not fitted with emergency facilities, the point control unit's actuator arrangements may be utilised for this purpose.

In all cases, the Network Control Officer shall be notified first to place the affected signals to stop. Licensed signalling personnel shall be assured that there are no approaching trains before the emergency facilities are used. Upon reinstatement of the emergency facility, the position of the points shall be left in correspondence with the signalling control and interlocking.

Where the point lock mechanism has failed such that it does not effectively lock the points, the affected points and protecting signals shall be booked out of use. The affected points and protecting signals shall also be booked out of use when the point detection is not in correct adjustment or is unreliable (for example, causing signals to inadvertently return to stop on approaching trains). Facing points shall be clipped and SL locked.

Protecting signals may be left operational on failed points only where the following conditions are met:

- the points are not disarranged or disconnected from the interlocking
- the point lock (if applicable) remains in correct adjustment and is secure
• the point detection remains in correct adjustment and working order
• the point switches remain secured in correct position
• the detector indications on the Network Control Officer's diagram correctly show the points in their set position
• any impending work will not cause the points to become disarranged or disconnected from the interlocking

In this case, the points need not be clipped and locked providing licensed signalling personnel remain in attendance. The prevention of point creep, which may cause loss of detection and potential unlocking of points, shall be considered.

Before traffic moves are permitted over power operated facing points which have failed, the requirements of Network Rule NSG 608 shall be observed.

1.7.6 Failure of ESML or EOL Detection

Where there is a failure of detection or there is a missing point handle or key pertaining to an ESML or EOL cabinet which results in severe disruption to trains, a temporary bridging authority to bridge-out the detector contacts of the ESML or EOL may be obtained. The ESML or EOL cabinet including the manual operation facility at the points shall be secured using signalling Falcon 8 locks.

The points’ manual operation facility shall be booked out of use; however the points and signals may be left operational using the signal box controls.

1.7.7 Failure of Plunger Locks or Isolating Relays

A failed plunger lock on electro-pneumatic points or an isolating relay on electric points may be momentarily released as requested by the Network Control Officer to enable the points to be operated from the signal box control. A separate request shall be made by the Network Control Officer for each release.

If the plunger lock or isolating relay is not effectively locking the points, the points shall be deemed defective and the affected points and protecting signals shall be booked out of use. Facing points shall be clipped and SL locked.

1.7.8 Failure of Point Detection

Where the failure is a result of damaged or defective electrical point detection components, which may cause severe train disruption, a temporary bridging authority to bridge-out the failed detector contacts may be obtained to allow the operation of signals leading over the diamond crossings or over the trailing end(s) of the defective points in question.

1.7.9 Failure of Trainstops

A trainstop that falsely indicates a raised position (indicating the trainstop is providing protection when in fact is not), or due to an irregular circuit operation (and not a mechanical problem) is falsely in the lowered position, shall be deemed a signalling irregularity. Similarly, an ETCS trainstop that fails to provide a brake intervention when required to an ETCS fitted train shall be deemed a signalling irregularity. These instances shall be treated in accordance with Section 1.6 of this procedure.

Notwithstanding the above requirements, protecting signals associated with a failed trainstop (including ETCS trainstops) shall be booked out of use during any of the following situations:

• When the trainstop (or ETCS trainstop equipment) is removed.
• When cabling to the trainstop (or ETCS trainstop equipment) is disconnected.
• When the trainstop detection wiring is interfered with.

ETCS trainstops are not suppressed. Where an ETCS trainstop has failed such that it provides an unwarranted brake intervention contrary to the design requirement, the associated signal shall be booked out of use and disconnected or otherwise restricted to a conditional signal aspect (if available) that is commensurate with the ETCS trainstop in the trip position.

Network Control Officers shall be advised of the operational impacts caused by failed trainstops.

1.7.9.1 Failure of a Trainstop to Provide Protection

Where a trainstop has failed such that it no longer provides protection, an attempt to enable the trainstop to the raised position shall be made. Where the trainstop cannot be enabled in the raised position or the integrity of the tripping position maintained, the associated signal shall be booked out of use and a fixed trainstop shall be fitted in place.

If a fixed trainstop is not available, the signal in rear of the failed trainstop shall also be booked out of use to provide in-lieu protection. The Normal contacts of the failed trainstop may be temporarily bridged to alleviate any impact on the interlocking. In such case, a temporary bridging authority shall be obtained for this purpose and the jumper wires installed inside the trainstop where practical. Temporary bridges shall be removed before the signal is booked back into use.

Note An exemption from the above requirements applies for failed trainstops provided with VCSR functionality. Refer to Section 1.7.9.3 below.

1.7.9.2 Failure of Trainstop to Lowered Position

Where a trainstop has failed such that it cannot operate to the lowered position, the trainstop trip arm shall not be manipulated to the lowered position. The trip arm shall remain in the raised position. The requirements for securing the affected signalling out of use and disconnected in accordance with PR S 40008 and PR S 40009, shall apply for trainstops that have failed in this case.

However, a signal that is affected by a trainstop failed in the raised position may be left operational where a proceed-aspect is available from the signal when the trainstop is in the raised position (as provided by the intended circuit design); for example, a low speed or shunt indication.

Note An exemption from the above requirements applies for failed trainstops provided with VCSR functionality. Refer to Section 1.7.9.3 below.

1.7.9.3 Failure of trainstops provided with VCSR functionality

Where a failed trainstop is provided with VCSR functionality, so to facilitate train movements, the trip arm may be placed or left (as the case may be) in the lowered position and the associated signal allowed to operate in accordance with its VCSR function. This permission is subject to meeting the following conditions:

• the trainstop failure is independent of the signal controls failing
• the trainstop detection inputs remain in correspondence with trainstop trip arm position at all times
  NOTE Trainstop reverse detection is required for the affected signals to clear.
• the trainstop Normal contacts shall not be bridged
• the signal controls shall be used to set up route and operate signals
• an assurance is obtained from the network control officer that a train will not depart from the signal in rear (the signal providing in-lieu protection) for any reason including, a cleared subsidiary aspect or verbal authorisation while the signal associated with the failed trainstop is at Stop

Note Where any points (facing or trailing) are in the route affected by the failed trainstop, and the points are required to be operated or the points detection is not present, then the VCSR functionality of the failed trainstop cannot be used. The failure is to be managed in accordance with Sections 1.7.9.1 or 1.7.9.2 as applicable.

In cases where VCSR functionality is being utilised, there is no need to apply temporary bridging and the signal may be left operational.

1.7.10 Trainstop Suppression during Signalling System Failures

Events such as signalling system failures, control system failures, power supply failures and so on can affect signals and retain the trainstops in the raised position. In such cases, network operators may choose to institute manual block working in accordance with the Network Rules and Network Procedures. Subsequently, network operators may request that affected trainstops be suppressed to facilitate this operation.

Note ETCS trainstops are not suppressed.

In these situations trainstops may be suppressed, subject to a signal engineer assessing and mitigating the risks that apply in each situation.

Failed trainstops are not to be suppressed if the disruption to on-time running will be exacerbated by the time lost to apply and later remove the suppression instead of directly attending to the failure.

The Professional Head Signalling and Control Systems or the Signal Engineering Manager shall be advised prior to the commencement of any such arrangement to suppress trainstops.

The associated signal shall be booked out of use before a trainstop is suppressed.

The signal engineer will determine whether to apply temporary bridging or not. If temporary bridging is required, a temporary bridging authority to bridge-out the trainstop Normal contacts shall be obtained. The jumper wires are to be installed inside the trainstop. The temporary bridges shall be removed before the signal is booked back into use.

Trainstops at entry block posts shall not be suppressed.

1.7.11 Failure of ETCS Trackside Equipment

Where ETCS trackside equipment such as LEUs, balises, associated cabling and connections become defective, damaged or missing, and the failure results in providing a more restrictive condition than desired, such as an unwarranted brake intervention or unwarranted DMI message, it may not be necessary to disable or book out of use any signalling, unless requested by the Network Control Officer. However, in cases where the failure causes an ETCS trainstop to provide an unwarranted brake intervention, then the associated signal shall be booked out of use and disconnected, or restricted in accordance with Section 1.7.9 of this procedure.

Where linking of balise groups is provided, the balise group/s in rear provide/s protection for the missing balise in the form of a linking reaction. The linking reaction for a missed balise will initiate to an ETCS fitted train, the correct brake application or provide the
correct DMI warning to the driver (dependant on the design for the risk profile). In these cases, signalling may be left operational.

**Note:** Where ETCS equipment fails to provide the required level of protection, such that it permits a less restrictive signalling condition (Section 1.6.1.1), the failure shall be treated as a signalling irregularity. Refer to Section 1.6.

Refer to PR S 40028 for management of ETCS equipment removed from service due to failure or relocation.

### 1.7.12 Failure of Level Crossing Protection Interlocked Gates or Boom Barriers

In the event of a failure of interlocked boom barriers, or when carrying out repairs to this equipment which may interfere with the interlocking, traffic shall be conducted over the level crossing in accordance with Network Rule and Procedure NGE 218 and NPR 715.

The fixed signals protecting the interlocked level crossing shall be disconnected and the associated Distant Signals or equivalent shall be arranged to be securely maintained at caution, and traffic conducted past the protecting signals in accordance with the applicable network rules and procedures.

Handsignallers are to be allocated in accordance with Network Procedure NPR 715 in event of failure or when work is being carried out which affects the normal operation of the level crossing.

### 1.7.13 Failure of Track Circuits

#### 1.7.13.1 Track Failures General

In the event of the failure of a track circuit no attempt is to be made to clear any of the signals controlled by such track circuit by manipulating the track circuit relay, bridging across the track circuit relay contact terminals, etc.

The signals controlled by the track circuit shall remain at stop until the track circuit is again in working order, and the traffic shall be conducted past them in accordance with Network Rule NSG 608 for passing the signal at stop.

Track and indication locking controlled by a track circuit, which has failed, may be released by licensed signalling personnel only as prescribed in Procedure PR S 40006.

#### 1.7.13.2 Tracks Failing to Shunt

When rails in sections of a track circuit are in such a condition that vehicles cannot be relied upon to shunt the track relay, licensed signalling personnel shall disconnect and book out of order all signals, points or level crossing protection affected by the track concerned until satisfied that a vehicle will properly shunt the track relay.

When the defective track controls the lock on any point lever, the points concerned shall be clipped and locked until such time as an effective shunt has been obtained.

Licensed signalling personnel, when booking the affected equipment out of use, shall include a list of the defective tracks on the NRF 003 Infrastructure Booking Authority form.

In all cases, where doubt regarding the proper shunting of a track circuit exists, signalling personnel shall immediately verbally inform the maintenance signal engineer of the circumstances and any action taken.
1.7.13.3 Broken Rails

Licensed signalling personnel who become aware of a broken rail that is a danger to rail traffic are to arrange for the immediate protecting signal/s to be placed at stop and disconnected, for a handsignaller to be provided and for the attendance of the civil representative.

Where the broken rail and track circuit failure is causing significant delays due to points being inoperable, or more than one signal is held at stop, licensed signalling personnel after receiving assurance from the civil representative and confirmation from the Network Control Officer that the line is fit for traffic, may place a temporary bond around the break and restore the disconnected signal/s.

1.7.14 Failure of Interlocking Relays

In standard relay interlockings if a failure occurs to the interlocking circuits resulting in a failure of a Reverse relay in the case of a signal lever, or a Reverse or Normal relay in the case of a point lever, or release switch lever, traffic shall be conducted in accordance with Network Rule NSG 608 until the failure is rectified.

In route control interlockings should a failure occur of a route reverse lock relays (RLR or RUR) or release switch or point NLR or RLR, traffic shall be conducted in accordance with Network Rule NSG 608 until the failure is rectified.

On no account are any of these relays to be lifted, or unplugged and replaced by a relay in the up position.

1.7.15 Failure of Section Control Relays in Single Line Track Control Sections

In the event of a failure of the section control relays in single line track controlled areas and with pilot working in use, licensed signalling personnel may temporarily bridge out the half pilot staff contacts at each or either end of the section for testing purposes, provided that the starting signals at both ends of the single line section are disconnected and booked out of use. Temporary bridging shall be done in accordance with Procedure PR S 40002.

1.7.16 Failure or Damage to Signalling Cables and wires

When failures are caused by broken or damaged signals or control systems cables and wires, no attempt is to be made to manipulate any relay or equipment affected by the defect. The affected signalling shall be booked out of use until the items are effectively repaired.

The work of repairing or replacing signalling cables and wires is to be done in accordance with Procedure PR S 40012.

1.8 Telemetry Interface

In the event of a failure of a telemetry interface (e.g. Dupline transmitter, IMAC input module and opto-board) and requires replacement, it is critical that the module is configured and wired correctly otherwise incorrect indications may be displayed.

Cables are generally not indexed resulting in the possibility of cables being incorrectly inserted or terminated.

To prevent this occurrence licensed signalling personnel shall ensure any cables that are to be disconnected are firstly labelled and documented on the associated circuit book ensuring correct orientation and positioning can be readily identified.
All dip switches, jumper settings and EPROMS are to be checked and confirmed for correct setting and module version checked prior to replacement of the module.

A correspondence test shall be conducted by licensed signalling personnel ensuring correct indications are displayed at Network Control.

Under no circumstances shall any I/O be falsely manipulated.

### 1.9 Temporary Repairs

Temporary repairs shall only be done where the work does not affect the design principle. The work shall be done in accordance with Procedure PR S 40011.

The testing of temporary repairs shall comply with the requirements prescribed in PR S 47110.

The maintenance signal engineer shall be duly notified of all temporary repairs made. A temporary repairs register shall be kept updated by the Signal Team Manager as a record for this purpose. The maintenance signal engineer shall review the temporary repairs entries to ensure they include any risk mitigation requirements and the prioritisation of permanent repairs. The maintenance signal engineer is to review the register on an ongoing basis to identify any new risks and ensure risks continue to be managed until permanent repairs are completed.

All items utilised for temporary repairs, including wires, cable cores, contacts and other components, shall be suitable for the intended purpose.

Temporary wiring is to be suitably tagged, identifying the particular circuit and associated terminal number.

Under no circumstances are exposed or bare wire ends to be left loose or have the potential to come into contact with live circuits.

Signalling documentation shall indicate the nature of the temporary repair. Additionally, signalling documentation as certified by a signal engineer is to be duly sent for updating as necessary to reflect any permanently changed arrangements.
## Appendix A  Form: No Cause Found Failure Report

<table>
<thead>
<tr>
<th>INITIAL INVESTIGATION</th>
<th>FOLLOW UP INVESTIGATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>SECTION</td>
<td>LOCATION</td>
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<tr>
<td>EQUIPMENT</td>
<td></td>
</tr>
<tr>
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<td>TIME FAILED</td>
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<tr>
<td>OK ON ARRIVAL</td>
<td>CAME OK WHILE TESTING</td>
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<tr>
<td>INTERMITTENT</td>
<td>OK AFTER TRAIN</td>
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<tr>
<td>OK AFTER POINTS WOUND</td>
<td>OTHER (DETAILS BELOW)</td>
</tr>
</tbody>
</table>

### Symptoms of Reported Failure:

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### Details of Equipment Examined:

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### Test Conducted and Results:

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### Note Possible Causes and Any Other Facts That May Be Relevant:

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Provide Copy of History Card if Failure was that of a Track Circuit or Points:

<table>
<thead>
<tr>
<th>SIGNAL ELECTRICIAN'S SIGNATURE</th>
<th>DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>INVESTIGATING SIGNAL ENGINEER'S SIGNATURE</td>
<td>DATE</td>
</tr>
</tbody>
</table>

To the Maintenance Signal Engineer
Appendix B  Form: Investigating Signal Engineer's Signalling Incident Technical Report

☐ PRELIMINARY REPORT  ☐ COMPREHENSIVE REPORT

☐ IRREGULARITY (Reported or Confirmed)  ☐ SIGNAL PASSED AT DANGER (SPAC)
☐ DERAILMENT  ☐ SIGNAL RETURNED IN FACE OF DRIVER (RFOD)
☐ COLLISION  ☐ MAJOR INCIDENT / FAILURE OF INTEREST

INCIDENT TITLE:
DISTRICT:  INCIDENT LOCATION:
DATE OF INCIDENT:  TIME OF INCIDENT:

INCIDENT DESCRIPTION

INCIDENT BACKGROUND
(Reported information, Symptoms, Sequence of Events, Relevant Conditions, Related Equipment History)
SIGNALLING PROTECTION ARRANGEMENTS
(Equipment Booked Out of Use/Disconnected)

LIST OF RESOURCES USED TO GATHER EVIDENCE
(Signalling Logs, Photographs, Signalling Documentation Extracts, CCTV Footage, Observations, Audio Recordings, Witness Reports, Interview Notes, Personnel Assisting Investigation, Test Equipment, etc)¹

¹ Signalling Logs, photographs, etc shall be included as appendices to the report

DETAILED INSPECTION AND TEST STRATEGY
(Consider Apparatus Inspection, Signal Sighting, Apparatus & System Function Test, Interlocking Test, Circuit Test, Insulation Test, Correspondence Test, Track Circuit Test, Design Documentation Review)
TEST RESULTS AND INVESTIGATION CONCLUSION

(Attach extract of signal plan & documentation used to record testing e.g. marked up circuit pages, plans etc.)

ACTION TAKEN

RECOMMENDATION

INVESTIGATING SIGNAL ENGINEER’S NAME:

DATE:

SIGNATURE:

To the Professional Head Signalling and Control Systems
Appendix C  Guidelines for Irregularity Inspection and Testing to Determine Cause

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Appendix C 1 Irregularity Investigation to Determine Cause

Appendix C 1.1 Investigation of Irregularities to Determine Cause

The requirements in relation to the investigation and reporting of accidents and irregularities are covered in maintenance procedures PR S 40003 and PR S 40004.

The purpose of this document is to provide guidelines for investigating signal engineers in the determination of whether there has been a signalling irregularity and if so its technical cause, through inspection and testing of the signalling apparatus. It is not to be considered a definitive or comprehensive procedure.

It is difficult to prescribe particular inspections and tests for irregularity investigations as circumstances can vary greatly and reports may range from anonymous, vague recollections, to specific allegations, to cases where the irregularity occurrence is obvious.

Whatever the case, the investigating signal engineer is accountable for certifying that the signalling involved is safe by signing the equipment back into use.

Investigating engineers shall therefore satisfy themselves that the correct cause has been conclusively identified and rectified or that the integrity of the signalling has been verified.

There is the further requirement that the investigating signal engineer and management determine and correct any deficiency in the signalling or in the management control systems including deficiencies in licensed signalling personnel competency, supervision, and control procedures.

Appendix C 1.2 Securing the Evidence

As with other failures, irregularities may be intermittent or only be evident under a certain set of circumstances which may have changed by the time signal investigation licensed signalling personnel are in attendance.

In some incidents, an irregularity may be alleged but not be independently substantiated, or following an accident the integrity of the signalling may need to be verified and proven not to have been a contributing factor.

It is imperative that the cause of an irregularity be identified and corrected so that trains can resume normal signalled operations with the guaranteed safety provided by the system.

Attention to the protection of the site from further risk and to anyone seriously injured is the first priority. Restoration of the service to minimise disruption will be necessary in most cases although the signalling concerned will be taken out of service. It is usually not practical to isolate and hold captured all factors that might be involved in the incident.

However, it is necessary that the incident circumstances and the signalling concerned be kept as undisturbed as possible until relevant symptoms are noted and inspections and tests are conducted by authorised persons.

Where tests necessarily require the equipment to be interfered with or disturbed, then the investigating signal engineer shall arrange to carry out these tests after carrying out other non-disturbing inspections and tests that may determine the cause or reduce the possibilities by elimination.

Photographs may be useful and all observations, measurements and witness reports should be recorded in writing.
Appendix C 1.3  History of the Apparatus Involved

An examination of the failure, maintenance and operating history of the apparatus concerned may provide useful evidence.

It may be that a defect has been present for some time and has only come to attention under the circumstances of the irregularity incident.

For an irregularity to occur after a previous history of correct operation then something must have changed, such as,

j) a set of operating conditions occur for which deficient signalling design or incorrect installation does not provide protection

k) degradation or catastrophic change occurs in the physical properties of materials or equipment on which the fail-safe operation of vital circuits and equipment are dependent

l) a false feed occurs from one circuit to another

m) a current leakage path falsely qualifies part of the correct selection path in a circuit

n) detection or indicating equipment becomes out of adjustment

o) foreign matter interferes with correct train detection

p) foreign matter or lack of lubrication obstructs gravity return or spring return devices

q) worn or defective bearings or linkages obstruct gravity return or spring return devices or cause lost motion in drive mechanisms or in detection mechanisms

r) worn, loose, bent or fractured mechanical interlocking defeats locking

s) a complete interruption of power supply to protection systems occurs

t) time limit release devices shorten from the time interval stipulated

u) interference from personnel alters adjustment, correspondence

v) damage occurs affecting the integrity of the equipment in the operating environment

Appendix C 1.4  Investigation Strategy

The investigating signal engineer will need to gather the evidence and study the circumstances and details of the alleged irregular incident, accident or derailment.

The investigating signal engineer will need to devise a strategy and plan for investigating the cause. This could change as evidence unfolds or as suspect items are eliminated.

The investigating signal engineer may need to,

Analyse: whether the evidence allows the cause to be localised to the trackside apparatus itself or the controls to, or indications from, the trackside apparatus.

Identify: all the related circuits and equipment items that control and operate the trackside apparatus and provide indications of its operation.
Inspect and Test: those circuits and equipment items to check that they are installed and operate correctly to the specifications, design drawings and to the interlocking and control tables.

Deduce: what omission, interference or other deviation factor could have caused irregular operation of the apparatus or the related circuits and equipment items.

Ascertain: whether those factors are or could have been present at the time of the incident using appropriate inspection and tests together with analysis of witness reports, event recorders and other clues.

Attempt: to reproduce the alleged irregularity.

The investigating signal engineer should develop familiarity with structured analysis methods such as Kepner-Tregoe Problem Analysis techniques and Fault Tree Analysis techniques which could be helpful. Essentially they will need to understand the respective signalling system, its components and the operating environment.

Investigating signal engineers are to seek expert advice and assistance if they are not satisfied that their inspections and tests have successfully determined the true cause or verified the integrity of the signalling.

Appendix C 2 Inspections and Tests

The investigation will involve similar inspections and tests as used in the commissioning of new and altered works and in general maintenance, e.g. general apparatus inspection, circuit testing, apparatus function testing and system function testing.

Similarly, the investigation will seek to verify conformance with the designs, compliance with installation standards and correct adjustment, correspondence, interlocking and control of the trackside apparatus concerned.

The investigating signal engineer is to be conversant with the procedures and typical inspections and tests described in the Specification SPG 0711.5.

The inspections and tests would generally start with a close, critical examination of the operating equipment involved, particularly of the mechanical operation of mechanisms such as relays, looking for signs of damage, interference or irregular behaviour.

Electrical wiring and terminations, and mechanical linkages and connections would be similarly inspected.

Depending on the situation, the investigation might next move to function tests (to the control tables) of the interlocking and controls between the items of trackside apparatus involved, correspondence and adjustment tests of those items, and then delve more deeply into the individual elements of the controls and indications.

Look first, and only when satisfied, proceed to function test, insulation test, circuit test etc.

When a defect is found that conclusively accounts for the problem, and the investigating signal engineer considers that multiple causes would not exist, further testing need not be performed.

Depending on the incident the inspection and tests could typically involve the following.

a) Inspection of the aspects of signals, including level crossing signals.

Inspection of the positions of points, facing point locks, points detectors, semaphore signal arms, level crossing booms, trainstops, releasing switches, operating levers and keys, rotary controllers, relays, etc.
Inspection and tests that the mechanisms operate freely and correctly.

b) Mechanical Interlocking inspections and tests including:
   i) interlocking frames
   ii) trackside equipment e.g. bolt locks, selecters, train bars, facing point
       lockbars,
   iii) keys and locks e.g. E.S.M.L., annett keys and locks,

c) Electro-mechanical Interlocking inspection and tests including:
   i) electric lever locks
   ii) electric releasing switches,

d) Electrical Interlocking and Control tests including
   i) route to route interlocking (signal to signal, signal to points, points to
       points)
   ii) indication locking (correspondence of signal/trainstop with signal normal
       indication relays and correspondence of points switch and lock positions
       with points detection relays).
   iii) track control of signals, trainstops and points
   iv) points detection control of signals and points
   v) approach locking of signals and points
   vi) route holding of points and opposing signals
   vii) release of approach locking, route holding
   viii) proving features such as track sticks, back contacts,

Function testing of signal control circuits is typically performed as follows:
   i) Clear signal,
   ii) Observe signal clear
   iii) Drop first track (lever stick),
   iv) Observe signal/trainstop return to stop
   v) Pick up first track
   vi) Observe signal/trainstop held at stop
   vii) Reclear signal
   viii) Observe signal/trainstop clear
   ix) Drop second track
   x) Observe signal/trainstop return to stop
   xi) Pick up second track
xii) Observe signal/trainstop reclear
xiii) Repeat ix) – xii) for subsequent tracks up to clearance points
xiv) Obstruct interlocked points with gauge
xv) Observe signal/trainstop can't clear
xvi) Remove gauge, allow switch to close
xvii) Observe signal/trainstop clear.

Function testing of approach locking is typically performed as follows.
i) Clear and replace signal to check it is not approach locked
ii) Clear signal
iii) Drop first approach track
iv) Cancel signal
v) Observe approach locking is held
vi) Drop second track
vii) Pick first track
viii) Observe approach locking is held
ix) Repeat vi) – viii) for subsequent tracks.

Function testing of route holding is typically performed as follows:
i) Operate and restore points, to check they are free.
ii) Clear signal
iii) Observe points locked
iv) Drop first track past signal
v) Normalise signal
vi) Observe points still locked
vii) Drop second track
viii) Pick first track
ix) Observe points still locked
x) Repeat vii) - xi) for subsequent tracks up to points clearance.

e) Train Detection tests:
i) track circuits (see attached guidelines)
ii) block joint clearance positions
iii) trains, wheel/surface, light vehicles
iv) rail surface
f) Electrical Insulation/Isolation inspections and tests:

   i) Inspect cable insulation, cable entries, cable clamps, cable troughing, cable joints for signs of damage/deterioration of insulation, water entry, burning,

   ii) Inspect cable terminations, crimps, connections for signs of bare metal, wire strands, looseness, arcing, burning,

   iii) Inspect insulating surfaces for signs of electrical tracking, water, burning, arcing, metallic dust etc.

   iv) Inspect contacts for signs of sustained arcing, sticking, welding etc., and for adequate air gap, proper adjustment, proper clearances.

   v) Close circuit, operate function and check for correct voltage across function.

   Open circuit by removing fuse and check function de-energises and voltage across function goes to zero (if AC circuit in multicore cable check induced voltage is well below de-energise voltage).

   Repeat test but open circuit by removing negative/common terminal instead of fuse.

   Maintain other circuits closed and operating normally during tests to detect any leakage current present.

   vi) Check earth leakage detectors

   vii) Check busbar voltages to earth using voltage-to-earth meters or Fluke meter with 100K ohm shunt. Compare with records.

   viii) Check power supplies are isolated from one another

   ix) Insulation test the circuit to earth and to equipment racks, equipment cases, and cable sheaths where these are insulated from earth.

   x) Insulation test multicore cables core to core, core to sheath, core to earth, sheath to earth.

   Should the investigating signal engineer require further megger testing directly between circuits or directly across open contacts, the method of testing needs to be carefully considered as to the disconnection of semiconductor devices, including power supply units, and the use of temporary bridging around open contacts or around semi-conductor devices removed for the test. The use of temporary bridging shall be strictly controlled by the investigating signal engineer and bridges shall be recorded and recovered immediately after each application.

   xi) Hand trace and examine the circuit wiring. If this could disturb suspect wiring it should be the last test of the circuit or if a number of circuits are to be tested all other tests of all relevant circuits should be performed before the wiring is disturbed.

**Note:**

In the case of internal circuits in a main relay room fitted with earth leakage detection, it may not be necessary to initially insulation test each circuit individually, providing the earth leakage detection is operating
correctly, and proved to be so by the application of a test earth on each busbar and observing the earth leakage detector drop out.

g) Circuit Test to the Wiring Diagrams:
   i) Check equipment for correct type, correct indexing, pin coding etc.
   ii) Close circuit, operate function and check for correct voltage across the function, including correct polarity where relevant.
   iii) Open and close each fuse, contact and link in turn noting the function de-energise and the voltage reduce to zero
   iv) Wire count the complete circuit (s). Null count the terminals on equipment items in the circuit.
   v) Prove contacts are in correct adjustment and operate in correspondence with their operating mechanisms.

h) Security Inspections:
   i) location locks
   ii) signalling equipment locks

i) Signal Inspections:
   If the irregularity involves the passing of a signal at stop or allegedly at clear the investigating engineer should inspect the signal sighting and check the following, among other things:

   sighting distance; focus; lamp filament; lamp voltage; lens condition; lens colour; lampcase lock; lampcase seal from external light; lampcase internal finish in matt black; possibility of confusion with background lighting; possibility of vegetation, structures or vehicles on other lines affecting line of sight; possibility of confusion with other signals or reading through; possibility of reflected phantom indication; possibility of indication being "washed out" with bright incident light; possibility of power supply interruption etc.

   If needed the signal should be observed from the same type of train travelling at the same time of day under the same weather conditions etc.

Appendix C 3 Function Testing Observations

Function testing is testing in which the function is operated through its controls to check that it achieves its specified purpose and includes testing that it will not operate from a safe position if any of the required controls are incorrect or missing.

Investigating signal engineers should ensure that their observations cover all levels of the operation that they need to check when function testing the trackside apparatus, the local controls and indications, intermediate controls and indications, the central controls and indications and the operator's control console and indicator diagram.

There are a number of levels at which signal equipment may be observed to operate/not operate, for example, in the case of a signal:

   j) signal aspects
   k) signal UCR relay
l) signal HR/DR relays  
m) signal repeater on diagram.

There are a number of levels at which controls may be opened and closed in order to observe the operation/non-operation of signalling equipment, for example, in the case of a track circuits:

n) track circuit rail shunt  
o) track circuit relay.  
p) track circuit relay contact.

If, for example, a signal repeater is observed to correctly change status when a track relay circuit fuse is removed, this would not in itself include proof that the signal repeater is in correspondence with the signal control relays or the signal aspects, and would not in itself include proof that the specific track circuit relay contact concerned would put the signal to stop when a train occupied the track circuit.

Investigating signal engineers are to be aware that through correspondence tests may need to be completed in addition to the interlocking and control function tests (at a particular level) between elements which control or indicate the operation of the trackside apparatus.

**Appendix C 4 Examples of Some Tests for Particular Irregularity Incidents**

**Appendix C 4.1 Interlocked Signal alleged Falsely at Clear or at Less Restrictive aspect.**

**Appendix C 4.1.1 Interlocking Test**

All functions interlocked with the signal (as shown on the Locking Table) are to be proved to be so locked by performing interlocking tests with those functions.

**Appendix C 4.1.2 Function Test**

The signal is to be proved to correctly return to stop when each controlling track circuit and point detector function is de-energised.

The signal is to be proved to be correctly approach locked. The first approach track to the signal is to be dropped and the signal returned to stop. Then each approach track is to be dropped in turn up to the signal to ensure the approach locking is not released. The approach locking time limit release is also to be checked.

Lamp proving is to be proved to be effective.

The track stick circuit is to be proved to be effective, also any trainstop VCSR circuit.

Aspect sequence is to be checked.

**Appendix C 4.1.3 Insulation Testing**

The signal light operating circuit and all control and indication circuits for the signal are to be considered for insulation resistance testing.

These include RUR, UCR, LSpR, HR, HDR, DR and ALSR circuits or their equivalents (Relay Interlocking - Reverse relay, NI relay, Control, Caution, Medium, Clear, Approach...
stick etc; Electromechanical Interlocking - N lock, NI lock, LPR, Control etc;) and related repeat relays.

Also included are the signal repeater circuit, and the track stick circuit.

All operating, control, and indication circuits for an associated trainstop are also to be considered.

The controls within the above circuits may also need to be considered for insulation testing eg., detector relays, track relays etc.

Appendix C 4.1.4 Track Shunt Tests

Each track circuit in the approach locking and track control of the signal is to be shunt tested. The track relays and all their track repeat relays are to be observed to correctly operate for these tests, to prove correspondence. As all these relays are unproved, close examination of their operation is required.

Appendix C 4.1.5 Circuit Testing

Where further testing is required, the circuits considered for insulation testing may need to be considered for circuit strap and function testing, wire counting, and bell continuity testing or hand tracing.

Appendix C 4.2 Automatic Signal alleged Falsely at Clear or at Less Restrictive aspect.

Appendix C 4.2.1 Interlocking Test

Not applicable.

Appendix C 4.2.2 Function Test

Each track circuit (and any other function) is to be proved to return the signal to stop.

Lamp proving is to be proved to be effective.

The track stick circuit is to be proved to be effective, also any trainstop VCSR circuit.

Aspect sequence is to be checked.

Appendix C 4.2.3 Insulation Testing

The signal light operating circuit and all control and indicating circuits for the signal are to be considered for insulation resistance testing.

These include:-

LSpR, HR, HDR, DR, circuits or their equivalents.

Also included is the track stick circuit.

All operating, control and indication circuits for an associated trainstop are also to be considered.

The controls within the above circuits may also need to be considered for insulation testing eg. track relays, release switch normal relays etc.
Appendix C 4.2.4 Track Shunt Tests

Each track circuit in the signal route is to be shunt tested and the track relay and any repeat relays are to be observed to operate correctly and in correspondence.

Appendix C 4.2.5 Circuit Testing

Where further testing is required, the circuits considered for insulation testing may need to be considered for circuit strap and function testing, wire counting, and bell continuity testing or hand tracing.

Appendix C 4.3 Points Run Through, or Operated in Front of Train

Appendix C 4.3.1 Interlocking Test

All functions interlocked with the points (as shown on the locking table) are to be proved to be so locked by performing interlocking tests with those functions.

Appendix C 4.3.2 Function Test

Each track circuit that dead locks the points shall be proved to do so.

Where there is route holding between protecting signals and the points, this route holding is to be tested by clearing the signal and dropping the first track circuit and then restoring the signal. Each track up to the points should then be dropped in turn to ensure the route locking is effective.

Any timed release of route locking is to be checked to be functioning correctly.

Appendix C 4.3.3 Insulation Testing

All points operating, control, and indication circuits are to be considered for insulation resistance testing.

These include NLR/RLR, NWR/RWR, NKR/RKR, NWKR/RWK, NLKPR/RLKPR, NWAR, RWAR, WZR, WJR, IR and point motor operating circuits, or the equivalents in other interlockings (Relay Interlocking - Normal and Reverse Relays, Lock Relays, Contactors, Route Sticks etc. Electromechanical Interlocking-LPR's, Contactors, N & R locks, NI - RI locks, etc).

Appendix C 4.3.4 Track Shunt Tests

All local track circuits, and all route holding tracks from a protecting signal to the points are to be shunt tested. The track relays and the track repeat relays are to be observed to correctly operate for these tests, to prove correspondence. As all these relays are unproved, close observation of their operation is required.

Appendix C 4.3.5 Circuit Testing

Where further testing is required, the circuits considered for insulation testing may need to be considered for circuit strap and function testing, wire counting, and bell continuity testing or hand tracing.
Appendix C 5  Guidelines for Testing of Track Circuits in Irregularity Investigations

Appendix C 5.1  Introduction

When a signalling irregularity is reported, it is critical that the testing which follows be completed as quickly as possible, at the same time ensuring that it is sufficiently detailed and comprehensive to identify any possible cause.

The use of a comprehensive checklist as an 'aide-memoire' can ensure that all necessary testing is completed, with minimum wasted effort and time.

This guideline recommends a general series of steps to be followed in investigating an incident believed to involve the false indication of a track circuit as 'clear', while occupied by a train.

Prior to these activities being undertaken, preliminary investigations will have established that there is substantial evidence that an irregularity has in fact occurred, and that it may involve the irregular operation of one or more track circuits.

The procedure's purpose is to check in a logical manner, for anomalies in all parts and operating characteristics of a track circuit.

Caution

Where the incident leading to the investigation is of a serious nature, take care to avoid, as far as possible without compromising safety, making any change which might be considered to alter conditions material to any subsequent investigation.

Appendix C 5.2  Possible Causes

Appendix C 5.2.1  Recent History, Background

Has there been any work carried out recently which might affect the signalling system, or give rise to unusual indications in the course of the work?

Check the recent history of the area concerned, for all activities which might affect the operation of the signalling system. Activities could include routine maintenance, repairs, installation, trackwork etc.

Appendix C 5.2.2  Manipulation

Was the relay held in the energised position by manipulation?

Check the location for signs of entry, the relay for broken seals or other signs of manipulation. Were any persons noticed in or about the relay location at the time of the incident?

If 'yes', record the details, and continue the tests.

Appendix C 5.2.3  Relay Fault

Is there any mechanical defect in the relay which could cause it to remain in an energised position, or for one or more contacts to remain closed with the relay de-energised?

Do a close visual inspection of the relay.
If an obvious fault is found (for instance, relay still being held up with zero volts applied), have it verified, then try to determine the cause of the mechanical fault without disturbing the relay. If it is not possible to accurately determine the cause of the fault, record all that can be seen, then gently remove the relay, taking the utmost care to retain the faulty condition. Return the relay for a full workshop examination and repair. Replace with a new relay and carry out a normal comprehensive track circuit test, as done when a relay is replaced in routine maintenance.

If an apparent fault is found, record the details then continue with this procedure, to identify any other possible cause.

If no definite cause is subsequently found, replace the relay as a precautionary measure, and return the relay for a full workshop examination and repair.

Appendix C 5.2.4 Circuit Error

Is the track circuit, including bonding, wired correctly?

Check that the track circuit is wired according to the circuit book and track insulation plans, and that the drawings themselves are correct.

If an error is found in one or both, record the details and continue with this procedure, to identify any other possible cause.

After completing the other inspections and tests, make the necessary corrections and then carry out a full test of the track circuit's operation.

Appendix C 5.2.5 Circuit Fault

Is there a fault in the track circuit wiring?

Insulation test all track circuit wiring; include tests on relay and feed cables, from each core to earth and to adjacent track circuits' relay and feed cables.

If any faults are found, record the details, and whether they could result in false energisation of the relay. Continue with this procedure, to identify any other possible cause.

After completing the other inspections and tests, return and correct the fault and then carry out a full test of the track circuit's operation.

Appendix C 5.2.6 Adjustment/Sensitivity

Are any track circuit fuses open circuit?

If open-circuit, examine the fuse wire to determine the nature of the failure. Record the details. Retain the defective fuse, and fit a replacement unit.

Is the track circuit incorrectly adjusted, resulting in reduced sensitivity to shunts?

Check all operating voltages. Measure the drop shunt resistance value of the track circuit, at all extremities and at several points evenly spaced along the track circuit. Note the relay control voltage when shunted, for each shunting point.

If any values are out of specified range, record them, and continue the tests.

After completing the other inspections and tests, return and adjust track circuit levels and then carry out a full test of the track circuit's operation.
Appendix C 5.2.7 False Energisation

Appendix C 5.2.7.1 Extraneous feeds

Is the track relay being energised by current from an external source?

Check polarity reversal to adjacent tracks (on DC, 50Hz and J/S tracks). If any error is found, record the details.

After completing the other inspections and tests, and before final retesting, return and correct any phasing error that was found.

Switch off track feed (O/C fuse to feed set or to feed transformer primary) and check that the residual voltage on the track relay is zero or near zero (less than 0.02 volts for double-element AC relay, or a higher voltage but at adjacent track circuit frequency on jointless track circuit).

On an AC track circuit, also remove the local fuse and check that local and control coil voltages are completely zero.

If the relay residual voltage is not zero, then the track relay is subject to current from an external source which shall be identified and corrected.

Check external connections to rails; note particularly the condition of any spark gaps, and record the position of any that are short-circuited. Use a Clancy meter to locate any point where current is entering or leaving the track circuit. Individually clear and replace any extraneous connections found, checking the track relay input each time.

On jointless track, check attenuation of tuned loops between the suspect track and adjacent tracks operating at the same frequency.

In single rail track circuits areas a level of stray signalling current could be expected in the traction rail. Stray current shall not be permitted to cause a residual voltage of greater than 30 percent of the drop away value of the track relay.

On D.C. tracks any residual voltage due to track battery effect shall be less than thirty percent of the drop away voltage of the track relay.

Appendix C 5.2.7.2 Circulating Currents in AC and Audio Frequency Track Circuits

Is there a stray circulating current, able to affect the operation of the relay?

Using an Induction meter, measure the currents in opposite rails of the track circuit and the current between the track circuits (e.g. in the impedance bond neutral connections on double rail A.C. track circuits or in the traction rail opposite the signalling rail blockjoint in single rail track circuits).

If rail currents are unequal, this indicates the presence of stray alternating current in the rails (In single rail track circuit areas the Clancy meter reading will include traction harmonics in the traction rail and this could account for differences between the signalling rail and the traction rail currents). The source may be the suspect track circuit itself.

Disconnect the power supply to the track feed. Measure the rail currents and the current between the track circuits. Restore the track feed power supply connection.

If these currents dropped to zero, the track circuit itself is the source of the circulating current.

This indicates the presence of a resistance (impedance) unbalance in the track circuit, which can render it prone to false energisation by a stray current. The unbalance may be
caused by one or more high resistance rail or bond connections, high resistance mechanical joints, broken rails, defective insulated block joints, defective impedance bonds or low resistance leakage paths to earth.

Examine the track carefully for open-circuit or high-resistance connections or bonds. High resistance rail connections can be checked by measuring the track circuit voltage drop between the rail connection cable and the head of the rail. Good connections for AC and audio frequency track circuits measure less than a few millivolts AC; any connection that measures more than 10 millivolts, or significantly more than the connections adjacent to it, should be regarded as suspect.

For a conclusive test of rails and impedance bond connections on a double rail track circuit, measure simultaneously the traction currents in both sets of sideleads with high current D.C. tong meters; the degree to which traction current is unequally shared indicates the amount of resistance unbalance in the track circuit. Individual checking of each side lead in both sets further determines the equality of the connections.

If the source of the circulating current is external, the current between the track circuits will be unchanged when the feed power supply is disconnected and, in balanced double rail track circuits, the rail currents will each equal about half of the neutral current.

Trace the circulating current to its source, and correct the fault that causes it. On any balanced double rail track circuit in the path of the circulating current, the neutral current will be equal to the difference in the currents in the two rails.

**Appendix C 5.2.8 Fail to Shunt**

If all tests to this stage have identified no cause for the irregular operation of the track, check for conditions leading to a failure of a train or track vehicle to shunt the track.

Was the train involved in the irregularity of short length, and/or consist of very light vehicles?

If the train was one or more light engines only, were they electric or diesel powered?

If it was a light rail vehicle, was it one that had been authorised to work under track block operating conditions, was it travelling at speed?

Inspect the rails of the track circuit, and in particular the rail contact surfaces and surroundings.

Do the wheels appear to adequately clean the rail or do they track only on a narrow width of the rail head.

Is the suspect track circuit itself very short?

Is it infrequently used, or are there long periods without traffic over the track?

Does the rail show signs of recent corrosion on its contact surfaces?

Are there signs of gross contamination on or immediately adjacent to the rail?

These checks may indicate a combination of conditions in which it is likely that all or part of the train could have failed to shunt the track circuit due to the presence of an insulating layer on the rail and/or wheel contact surfaces.

If all other factors have already been eliminated as possible causes, then the final check is to monitor the operation of the track circuit under track and train conditions which reproduce as closely as possible those which existed at the time of the reported irregularity.
Operate the train over the track while monitoring the input to the track relay. If the input reaches values close to, or exceeding, that required to energise the relay, then rail-wheel contact problems may be inferred. If the input stays at very low values while the train is present, then no conclusion can be drawn.

Appendix C 5.3 Rectification

At this stage, when all tests have been completed, check that all temporary disconnections, etc. have been restored. Make arrangements to rectify any faults found in the course of the investigation, which might lead to the irregular operation of a track circuit. Before making any such changes, be certain that the fault is fully documented, photographed, and independently witnessed if necessary.

If no cause has been found for a serious irregularity, obtain approval before making adjustments or rectifying faults which may be considered possible causes or contributory factors.

Appendix C 5.4 Conclusion

If a track circuit irregularity has taken place, then by the conclusion of these tests there should be one or more factors that have been identified as definite or probable causes.

In the case where no factors have been identified, then 'no cause found' is the only conclusion that can be reached. Either the report was based on an error in observation or interpretation, or it was due to some fleeting condition of which no sign remains. The remaining course of action available is to monitor the operation of the track circuit for a period, in an effort to capture any transient condition.

Appendix C 5.5 Track Circuit Investigation Checklist

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Irregularity still on?</td>
</tr>
<tr>
<td></td>
<td>Check reports of any witnesses to incident</td>
</tr>
<tr>
<td></td>
<td>Decide - possible irregularity (Y/N)</td>
</tr>
<tr>
<td></td>
<td>Decide - suspect circuits (Y/N)</td>
</tr>
<tr>
<td></td>
<td>suspect track (Y/N)</td>
</tr>
<tr>
<td>2.</td>
<td>Signs of interference</td>
</tr>
<tr>
<td></td>
<td>with location of equipment?</td>
</tr>
<tr>
<td></td>
<td>with trackside equipment?</td>
</tr>
<tr>
<td></td>
<td>Reports of persons near equipment?</td>
</tr>
<tr>
<td>3.</td>
<td>Signs of defect that could hold relay, now or recently?</td>
</tr>
<tr>
<td></td>
<td>Signs of relay contacts failing to open, now/recently?</td>
</tr>
<tr>
<td></td>
<td>Relay replaced?</td>
</tr>
<tr>
<td>4.</td>
<td>Circuit design correct?</td>
</tr>
<tr>
<td></td>
<td>Circuit wiring and bonding correct to circuit book and track insulation plan?</td>
</tr>
<tr>
<td></td>
<td>Condition of wiring - possible intermittent faults?</td>
</tr>
<tr>
<td>5.</td>
<td>Insulation tests to earth/other cables and wiring correct?</td>
</tr>
<tr>
<td>6.</td>
<td>Operating voltages etc within accepted limits and</td>
</tr>
<tr>
<td>Consistent with history card?</td>
<td></td>
</tr>
<tr>
<td>-----------------------------</td>
<td></td>
</tr>
<tr>
<td>Track drop shunt within specifications?</td>
<td></td>
</tr>
<tr>
<td>7. Relay has 'zero' residual voltage with feed power supply removed?</td>
<td></td>
</tr>
<tr>
<td>Phasing to adjacent tracks correct?</td>
<td></td>
</tr>
<tr>
<td>Insulated joints and bonding OK?</td>
<td></td>
</tr>
<tr>
<td>Spark gaps in good conditions (V greater than 5.0v)?</td>
<td></td>
</tr>
<tr>
<td>No other rail connections</td>
<td></td>
</tr>
<tr>
<td>Rail currents balanced and no sudden increase/decrease?</td>
<td></td>
</tr>
<tr>
<td>Tuned loop rejection value greater than 10?</td>
<td></td>
</tr>
<tr>
<td>Are rail currents unequal?</td>
<td></td>
</tr>
<tr>
<td>Do currents drop to zero with feed power supply removed?</td>
<td></td>
</tr>
<tr>
<td>Check all bonds and sidelead connections OK</td>
<td></td>
</tr>
<tr>
<td>Does difference in rail currents equal bond neutral current?</td>
<td></td>
</tr>
<tr>
<td>Trace circulating current to source, and correct</td>
<td></td>
</tr>
<tr>
<td>8. Check for train failing to shunt -</td>
<td></td>
</tr>
<tr>
<td>Train short</td>
<td></td>
</tr>
<tr>
<td>light weight</td>
<td></td>
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<tr>
<td>authorised for track-block operation</td>
<td></td>
</tr>
<tr>
<td>Train speed over train length prior to incident</td>
<td></td>
</tr>
<tr>
<td>powering or coasting?</td>
<td></td>
</tr>
<tr>
<td>diesel or electric traction?</td>
<td></td>
</tr>
<tr>
<td>Rail contact surfaces clean and polished?</td>
<td></td>
</tr>
<tr>
<td>signs of recent oxide film?</td>
<td></td>
</tr>
<tr>
<td>signs of heavy contamination?</td>
<td></td>
</tr>
<tr>
<td>signs of contaminants at foot of rail?</td>
<td></td>
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<tr>
<td>Track circuit short length?</td>
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</tr>
</tbody>
</table>
Appendix C 6 Guidelines for Testing of ETCS in Signalling Irregularity Investigations

Appendix C 6.1 ETCS Failure Modes

The most common failure mode for ETCS equipment will be where a train receives either an unwarranted warning on the DMI, service brake intervention (SBI) or emergency brake intervention (EBI), while the driver is driving appropriately to signal aspects and speed boards. In most cases, the linking from the last balise group in rear will provide protection for a single missing or damaged balise/balise group in the form of a 'linking reaction', which will either initiate a brake application on the train or provide a DMI message to the driver, depending on the level of risk of the hazard for which the balise group was installed. This is the designed failure mode of ETCS and is not considered to be a signalling irregularity.

An irregularity of ETCS equipment is highly unlikely to occur due to the fail-safe implementation strategy of ETCS, and is even more unlikely to be discovered, as it would need to be associated with a train either passing a signal at danger or over-speeding.

Appendix C 6.2 Possible Causes

Appendix C 6.2.1 Missing or Damaged Balise Group

An irregularity of ETCS could occur if ALL balises in an unlinked balise group are missing or damaged to the extent that they not capable of sending out the default telegram to a train. In this case, all trains operating over the affected area (in the same direction and ETCS operating mode) should receive the same system response.

Check if there have been any track or signalling work carried out recently which might have required either the removal and replacement, or the relocation of one or more balises.

Check the recent history of the area concerned, for all activities which might affect the position or fixing of ETCS balises. Activities could include routine maintenance, repairs, installation, trackwork etc.

Appendix C 6.2.2 On Board ETCS Equipment Failure

An irregularity of ETCS could occur if the onboard ETCS equipment was damaged or non-operational. In this case the symptoms should be experienced by the affected train only, and may occur at any location, not just at the location of an ETCS balise group.

Arrange for the download of logs from the on-board train or juridical recorder units (TRU or JRU).

Appendix C 6.2.3 Alterations to Line Speed

An irregularity of ETCS could occur if alterations to line speed had been made recently, without a corresponding data change to ETCS or possibly alterations to the position of balise groups in the affected area. In this case, all trains operating over the affected area (in the same direction and ETCS operating mode) should receive the same system response.

Appendix C 6.3 Rectification

In the event of an ETCS trackside equipment signalling irregularity, the operation of trains shall be in accordance with the requirements of PR S 40004 – “Failures”.

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An irregularity of the ETCS on-board equipment should receive the same level of attention as other signalling wrong side failures. A train with suspected or confirmed failed ETCS equipment is managed in accordance with the requirements of the Sydney Trains’ Train Operations Manual (TOM).

Appendix C 7 Irregularities and Wrong Side Failures, Types, Factors and Defects

Appendix C 7.1 Irregularity Type

Irregularities which do not result in false proceed or false release.

False proceed signal indication, train ahead.

False proceed signal indication, conflicting route.

False proceed signal indication, points not correctly set and secured.

False warning signal indication, less restrictive.

Facing points released with train present, loss of approach/route holding locking.

Facing points opening with train present, defective points equipment.

Ground frame irregularly released, train approaching.

Trainstop falsely clear.

Level Crossing protection inoperative.

If an ETCS emergency brake intervention (EBI) or service brake intervention (SBI) does not occur when a train passes a signal at stop, which is fitted with an ETCS trainstop.

If an ETCS target speed indication on the DMI and / or an appropriate brake intervention is not received, on the approach to an ETCS managed speed restriction or hazard.

Appendix C 7.2 Factors

Track Circuit Not Detecting Train

out of adjustment

track relay defective

stray/induced currents

contaminated rail surfaces, light rail vehicles

defective, damaged track circuit equipment

open circuit parallel bonds

incorrect polarity reversal, short circuit blockjoint

Circuit Wiring and Contacts Incorrect/Ineffective

Incorrect
faulty design
faulty installation

Ineffective

coupled/induced currents
leakage currents, defective insulation/isolation
contacts not switching
contacts out of adjustment

Relay falsely energised

electrically held
contacts welded
mechanically held
magnetically held (residual magnetism)
timing short

Points Detection Incorrect/Ineffective

out of adjustment
worn
damaged

Signal Lights falsely illuminated, obscure

illumination by external light
lamps burnt out
lights out of focus
loss of power supply
view obstructed
signal out of position
lens broken

Level Crossing Protection Power Supply Failure

defective/exhausted battery
open circuit fuses, wires, high resistance terminations
long term loss of ac supply
switched off
defective battery charger

Mechanisms & Mechanical Equipment
worn
damaged
out of adjustment
obstructed, seized
out of position
lost motion

Mechanical Lockbars, Trainbars, Clearance Bars, Ineffective
worn
damaged
out of position

Electric Locks Ineffective
electrically held
mechanically held
contact out of adjustment

Block Instrument Defective

Trainstop Defective
out of gauge
damaged
obstructed

Mechanical Interlocking Defective

ETCS Equipment Defective
multiple balises missing or damaged
incorrect ETCS data installed
ETCS balise group installed in the incorrect location
ETCS onboard equipment defective or non-operational

Appendix C 7.3 Defect type

Appendix C 7.3.1 Mechanical Defect

Component/assembly dislocated, deformed, damaged, degraded (physical properties), disintegrated, fractured, fatigued, flooded, obstructed, tight, loose, stuck, corroded, worn, welded, overheated, vibration affected,

Equipment out of adjustment, tolerances exceeded,
Faulty equipment design, manufacture, installation, maintenance,

**Appendix C 7.3.2 Optical Defect**

- Signal lens illuminated by external light
- Lens broken
- Lens colour change

**Appendix C 7.3.3 Electrical Defect**

- Circuit incorrectly designed
- Circuit incorrectly wired
- Isolated conducting parts moving into contact
- Leakage currents tracking across contaminated/wet insulating surfaces
- Leakage currents tracking through defective insulation directly between circuits
- Leakage currents to earth through defective arrestors, metallic connections, defective insulation
- Electromagnetic induction/capacitive coupling between alternating current circuits.
- Direct current arcing across switching contacts
- Residual magnetism in magnetic cores
- Circuit adjustment incorrect
- Contact adjustment incorrect
- Contacts welded, struck
- Contaminated rail and/or wheel surfaces preventing correct shunting of track circuits, light rail vehicles.
- Interfering harmonics in track circuits from chopper trains, defective substation supplies, parallel H. V. power lines,
- Battery effect on D.C. track circuits
- High resistances resulting in circulating currents through connected functions, track circuits etc.
- Insulated block joint failure and track circuit polarities not reversed.
- Open circuit parallel bonds in a track circuit
- Loss of power supply to Level Xing lights (open circuit fuse, exhausted/defective battery, defective battery charger, high resistance/broken connections/wires).
- Faulty equipment design, manufacture, installation
- Variation in properties of timing circuit components

**Appendix C 7.3.4 Damage**

Due to power surges, lightning, fire, flood etc
Due to construction, maintenance activity,
Due to accidents
Vandalism
Sabotage

**Appendix C 7.3.5  Personnel Defect**

Design checking deficient
Inspection and testing incorrectly performed
Emergency releases incorrectly given
Work wrongly performed, procedures not followed, substandard
Signal lens door left open allowing external light to illuminate lens
Level crossing test switch left turned on, or emergency switch left turned off.
Accidental damage, interference

**Appendix C 7.3.6  Management Defect**

Faulty or deficient standards
Faulty or deficient procedures
Faulty or deficient training, accreditation
Faulty or deficient supervision, quality control
Engineering Procedure
Signalling and Control Systems

Signalling Safeworking

PR S 40005

Damage to Signalling Equipment including Cables

Version 1.3

Date in Force: 8 March 2019
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Document control

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<td>C. Darmenia</td>
<td>Inclusion of ATP / ETCS</td>
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Summary of changes from previous version

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<th>Chapter</th>
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<tr>
<td>Added ATP equipment to checklist</td>
<td>Appendix A</td>
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1 General Requirements

It is essential that repair of damage to vital signalling equipment and cables is completed to be safe and secure.

Details of incidents of damage involving the replacement, reconnection or readjustment of vital signalling equipment and cables must be reported to the maintenance signal engineer.

The maintenance signal engineer must be satisfied that the matter has received appropriate attention and must instigate corrective action to prevent a recurrence, as required.

The damage of vital signalling equipment including cables and personnel involved, must be recorded in both the Sydney Trains incident and defect management system. The maintenance signal engineer must ensure entries are made, and that damage and defects are managed appropriately.

Repairs must be carried out by licensed signalling personnel in accordance with PR S 40004, PR S 40010, PR S 40011 and PR S 40050 and to the satisfaction of the maintenance signal engineer.

Repairs must be carried out in accordance with the respective Signalling Safewarking Procedures for working on signalling equipment.

The repaired equipment must be tested by licensed signalling personnel to ensure that the function operates correctly and reliably. Signalling cable repairs must be insulation tested.

The Damage to Signalling and Safewarking Equipment Checklist (Refer Appendix A) provides a guide to typical information that needs to be captured for entry in Sydney Trains incident and defects management systems when repairs to damage signalling equipment have been affected.

Full details of the cause of the damage must be provided. Units of plant owned or operated by either Sydney Trains or other parties must be included in the report as well as the name of the operator.

Whenever temporary repairs are made to vital items of signalling equipment including cables then a report of the nature of the repairs is to be made to the maintenance signal engineer for inclusion on the register.

Temporary repairs must be done only where the work does not affect the design principle. Temporary wiring must be suitably tagged, identifying the particular circuit and associated terminal number. All items utilised for temporary repairs, including wires, cable cores, contacts and other components must be suitable for the intended purpose (Refer to PR S 40004).

If a temporary repair has been made, licensed signalling personnel must ensure that permanent repairs are carried out at the earliest opportunity and advise the maintenance signal engineer to update the register.

Where licensed signalling personnel other than the local licensed signalling personnel attend a failure or damage incident and carry out temporary repairs, advice of the incident is to be forwarded to the maintenance signal engineer describing the defect, damage and the temporary repairs carried out.
## Appendix A  
### Damage to Signalling and Safeworking Equipment Checklist

### INCIDENT DETAILS

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<th>Incident</th>
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</thead>
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<tr>
<td>Location:</td>
<td></td>
</tr>
<tr>
<td>Date:</td>
<td>Time:</td>
</tr>
<tr>
<td>Report Compiled by (Name):</td>
<td></td>
</tr>
<tr>
<td>Position:</td>
<td>Location:</td>
</tr>
</tbody>
</table>

### THROUGH SERVICES

- Air Lines
- Cable Troughing (GST)
- GLT
- Cable Pits
- Cable - Multicore
- Cable - Power
- Cable - Communications
- Cable – Telemetry
- Cable - Server
- Aerial Line Wires / Cable
- Line Poles

### POINTS EQUIPMENT

- Channel Iron
- Cranks, Compensators Etc.
- Levers, Frames
- Point Machines
- Derails
- EP Valve Units
- Detectors, Indication Boxes
- Locks (Facing Point, Plunger, Bracket)
- Releasing Switches
- Point Blades
- Extension Irons
- Spreaders, Rods, Etc.
- Clamp Lock Pumps
- Clamp Lock Piston Unit
- Clamp / Claw Lock Mechanism
- ESML / EOL
### EQUIPMENT HOUSINGS
- Termination Boxes / ‘DB’s
- Equipment / Level Crossing Hut
- Location Cases
- Earthing Rods, Mats

### SIGNALLING EQUIPMENT
- Signal Gantries
- Running Signals
- Shunt Signals
- Signal Lights
- Point Indicators
- Train Stops
- Employee Warning Lights
- Buffer Stop Lights
- Notice Boards
- Telephones
- Trackside Monitoring Equipment
- Routers
- Switches
- Modems
- Servers
- Workstation
- Peripherals e.g. Monitor
- Telemetry Systems
- Relays
- CBI

### ATP EQUIPMENT
- ETCS balise junction box
- ETCS balise tail cable
- ETCS balise mounting system
- ETCS balise
- ETCS LEU
- Ethernet Network Switch
<table>
<thead>
<tr>
<th><strong>LEVEL CROSSING EQUIPMENT</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Lights Stand</td>
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<tr>
<td>Lights</td>
</tr>
<tr>
<td>Boom Lights</td>
</tr>
<tr>
<td>Boom Mechanism</td>
</tr>
<tr>
<td>Booms</td>
</tr>
<tr>
<td>Pedestrian Barriers / Lights</td>
</tr>
<tr>
<td>ARMCO Guardrails</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>TRACK CIRCUITS</strong></th>
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</thead>
<tbody>
<tr>
<td>Insulated Joints</td>
</tr>
<tr>
<td>Bootleg Risers</td>
</tr>
<tr>
<td>Matching / Tuning Units</td>
</tr>
<tr>
<td>Track Connection Cables</td>
</tr>
<tr>
<td>Series Bonds, Parallel Bonds</td>
</tr>
<tr>
<td>Feed / Relay Fuses</td>
</tr>
<tr>
<td>Impedance Bonds</td>
</tr>
<tr>
<td>Impedance Bond Sideleads</td>
</tr>
<tr>
<td>Electrolysis Bonds / Cables</td>
</tr>
<tr>
<td>OHWS Spark Gap Connections</td>
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<tr>
<td>Solar feed Units</td>
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PR S 40006

Release of Track Locking or Indication Locking

Version 1.1

Date in Force: 12 January 2018
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<td>M Khan</td>
<td>Updated for new titles and roles and to meet EIS 15/03 section 14 and ASA Standards</td>
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<tr>
<td>Include reference section and introduce principles section</td>
<td>1 &amp; 2</td>
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<tr>
<td>Included procedures for Momentary Bridging and Jumper Wires for Momentary bridging previously in PR S 40002</td>
<td>3 &amp; 3.1</td>
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<tr>
<td>Improved flow by placing general conditions all in one Section</td>
<td>4</td>
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<tr>
<td>Included the requirements for receiving assurance from the Network Control Officer for any train approaching the signal.</td>
<td>4 to 5.8</td>
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<td>Improved wording consistency for releasing conditions</td>
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<tr>
<td>Separate release of Signal Normal Indication (NI) Relays at standard relay interlockings or Signal Route Normal Relays into own sections</td>
<td>5.5 &amp; 5.6</td>
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<tr>
<td>Permission requirement changed to the maintenance signal engineer for release of point lock relays at route control type interlockings</td>
<td>5.8</td>
</tr>
<tr>
<td>Included the requirements for providing releases for CBI and other situations not covered as per EIS 15/03 section 14</td>
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1 Reference documents

The following documents have been referenced in this procedure:

- PR S 40008 - Securing Signalling Apparatus Out of Use
- PR S 40002 – Temporary Bridging of Signalling Circuits
- Network Procedure, NPR 740 Responding to faulty points
- Signals and Signs, NSG 608 Passing signals at STOP
- Network Rule NGE 234, Responsibilities of Signallers
- Network Rule Form NRF 003 Infrastructure Booking Authority (IBA)

2 Principles

The following principles of locking relate to the release of interlockings.

2.1 Approach locking

Approach locking is provided to prevent the alteration of a route in the face of a train that has received a signal indication that the route is cleared for the train. This provides an assurance that all facing points are lying correctly secured for the passage of the train, that trailing points are set for the non-conflicting position (and hence no converging routes can be signalled) and that opposing signals are at stop.

2.2 Route holding

Route holding is provided to prevent the following in the face of a train that has entered a signalled route:

- the alteration of facing points in the overlap to an obstructed overlap
- the unlocking or movement of facing points within the route
- the alteration of trailing points in the route or the overlap
- the clearing of opposing signals

2.3 Indication Locking

Indication locking is provided to ensure all safe conditions are met for train movements (i.e. signals, points or other units operated, or directly affected by such lever, are in the proper position) before allowing a signal or points lever to enter (or relevant relay to indicate) its full position, which can then free the locking for other signals or points.

2.4 Rules and types of releases

Most track and indication locking is designed to be automatically released by the interlocking; however there are occasions where licensed signalling personnel are required to provide a manual release when requested by network controllers.

Under failure conditions or when an incorrect route for an approaching train is set up or when made necessary by the presence of a train which is delayed on a particular section of track, it may be necessary to provide a manual "release" of track and indication locking to reduce train delays.
In these situations the following principles apply:

**INTERLOCKING** between conflicting signals, points, level crossings and each other shall not be released.

At standard relay interlockings, relays such as signal reverse relays, points normal/reverse relays and releasing switch normal relays shall not be released.

At route control interlockings, relays such as route reverse relays, point normal/reverse lock relays and releasing switch normal/reverse lock relays shall not be released; however in exceptional circumstances, the route locking in point lock relay circuits may be released.

**TRACK LOCKING**, either approach locking or route holding, may be released in certain circumstances in accordance with procedures prescribed hereinafter.

**INDICATION LOCKS** on mechanical levers, either signal normal indication locks or points normal or reverse indication locks may be released in certain failure circumstances in accordance with procedures as prescribed hereinafter.

**CAUTION**

In some installations, circuits may combine INTERLOCKING with TRACK LOCKING or TRACK LOCKING with INDICATION LOCKING and care is necessary to ensure that only the specific locking concerned is released in accordance with the respective procedure.

### 2.5 Manual Releases

Manual releases are normally confined to:

- release of approach locking in approach stick relays
- overcoming failure of an NI electric lever lock on a mechanical signal lever
- overcoming failure of a normal or reverse electric lever lock on a mechanical point lever
- overcoming failure of a normal or reverse indication electric lever lock on a mechanical point lever

In exceptional circumstances only, where delays to trains would be otherwise extensive, manual releases may be provided as prescribed to release:

- route holding locking in point lock relay circuits (route control interlockings)
- point lock relays (standard relay interlockings)
- signal normal indication relays (standard relay interlockings)
- signal route normal lock relays (route control interlockings)

Manual releasing methods after observing the prescribed precautions are limited to:

- Manually lifting the electric lever lock on mechanical levers while the lever is moved.
- Momentarily bridging out track circuit contacts in approach stick circuits (via the stick finger) or in point lock relay circuits (route control interlockings). The bridge is to be immediately removed.
• Momentarily energising a signal normal indication relay, a point lock relay (except route control interlockings) and a signal route normal lock relay. The false feed is to be immediately removed.

3 Momentary Bridging (Hand Held) for Releasing

Momentary bridging is the bridging of specific circuit contacts for release of track locking or indication locking. It requires licensed signalling personnel to hand hold the bridge on momentarily for just sufficient time to allow the requested release.

The bridging wire should always be hand held (at least at one end) by licensed signalling personnel giving the release and shall never be left connected.

The release of track locking or indication locking is permitted by licensed signalling personnel in accordance with this procedure after receiving a written request from the Network Control Officer. All details of the request shall be entered on the Infrastructure Booking Authority (IBA) form NRF 003 and signed by both the Network Control Officer and the licensed signalling personnel giving the release.

Licensed signalling personnel with a level of competency able to work without supervision for release of track or indication locking shall lead this work.

3.1 Jumper Wires for Momentary Bridging

Jumper wires and connection methods used for momentary bridging shall be suitable for the application.

Jumper wires and issuing criteria used for momentary bridging are exempt from meeting the temporary bridging requirements in PR S 40002.

Any improvised jumper wires used for momentary bridging shall be destroyed immediately after use.

Where registered jumper wires are used for momentary bridging, these shall be returned to the owner or the designated secured location after use. In this case signatures for receipt of issue, return and reason for issue shall be recorded in the pertinent jumper wire register.

4 General Releasing Conditions

Releases may be given in accordance with this procedure on receipt of a request from the Network Control Officer (NCO). Details of the release request are to be entered on an IBA and signed by both the NCO and licensed signalling personnel.

The NCO is to place signals at stop with blocking facilities applied as a reminder to prevent trains approaching the signals/points involved while a release is being given.

An assurance is to be obtained from the NCO that all approaching trains have come to a stand and will remain so. This assurance is to be recorded on the IBA form by the NCO prior to the release being given.

A separate request and IBA form should be received for each and every release.

4.1 Release of Approach Locking

Release of approach locking requires that the following be observed.
Licensed signalling personnel giving the release shall ensure that:

- The signal(s) involved is at stop with blocking facilities applied and will remain so. This may be achieved by receiving an assurance from the NCO.
- The train stop (where provided) is in the normal (tripping) position. This may be achieved by means such as observing the position of the trainstop arm, observing the position of trainstop proving relays or the NCO observing a red signal repeater on the diagram etc.
- Any train approaching the signal involved has been brought to a stand and will remain so. This is achieved by receiving written assurance from the NCO recorded on the IBA form.

4.2 Release of Route Holding

Release of route holding requires the following precautions to be observed.

Licensed signalling personnel giving the release shall ensure:

- The signal(s) authorising entry or exit to the route is at stop with blocking facilities applied and will remain so. This may achieved by receiving an assurance from the NCO.
- The train stop (where provided) is in the normal (tripping) position. This may be achieved by means such as observing the position of the trainstop arm, observing the position of trainstop proving relays or the NCO observing a red signal repeater on the diagram etc.
- Any train approaching the signal involved or that has entered the route has been brought to a stand and will remain so. This is achieved by receiving written assurance from the NCO recorded on the IBA form.

For points that are route held and are to be operated when released then, prior to the release being given, licensed signalling personnel shall also:

- Ensure that all ends of the points concerned are protected by signals at stop.
- Receive written assurance from the NCO that any trains, which are approaching signals immediately protecting any end of the points concerned, have come to a stand and will remain so.
- Ensure that no train, having passed an immediate protecting signal, is on the approach side of the point ends concerned.
- Ensure that no train or vehicle is foul of any of the point ends concerned.

In any instance where it is intended to by-pass a train with a second train, by releasing converging points that are route held by the first train, then licensed signalling personnel giving the release shall be assured that the driver of the first train is aware that another train will be signalled across the path of his/her train.

5 Provision of releases

This section provides the detailed procedures to be observed for the following specific types of release.
5.1 **Release of Approach Stick Relays**

After receiving a request on an IBA form from the NCO for the release of approach locking in approach stick relay circuits licensed signalling personnel may give the release after ensuring:

- The signal(s) involved is at stop with blocking facilities applied and will remain so. This may achieved by receiving an assurance from the NCO.
- The train stop (where provided) is in the normal (tripping) position. This may be achieved by means such as observing the position of the trainstop arm, observing the position of trainstop proving relays or the NCO observing a red signal repeater on the diagram etc.
- Any train approaching the signal involved has been brought to a stand and will remain so. This is achieved by receiving written assurance from the NCO recorded on the IBA form.

The release shall be given by momentarily bridging the approach stick finger contact on the approach stick relay. The bridge shall be removed immediately.

If the relay does not pick up traffic is to be conducted in accordance with NSG 608 until the situation is rectified.

5.2 **Release of Normal Indication (NI) Lever Locks on Signal levers.**

Signal NI lever locks apply signal Normal Indication locking and generally incorporate approach locking and also, in some cases, route holding locking.

After receiving a request on an IBA form from the NCO for the release of a signal NI lock licensed signalling personnel giving the release shall ensure:

- The signal(s) involved is at stop with blocking facilities applied and will remain so. This may achieved by receiving an assurance from the NCO.
- The train stop (where provided) is in the normal (tripping) position. This may be achieved by means such as observing the position of the trainstop arm, observing the position of trainstop proving relays or the NCO observing a red signal repeater on the diagram etc.
- Any train approaching the signal involved or that has entered the route has been brought to a stand and will remain so. This is achieved by receiving written assurance from the NCO recorded on the IBA form.
- Any train approaching the signal, or on track circuits included in the NI lock circuit, is at a stand and will remain so and is clear of any points in the route ahead of the signal.

The release shall be given by manually lifting the lock while the signal lever is placed to the full normal position.

5.3 **Release of Normal and Reverse Indication Locks on Point Levers**

Normal or Reverse indication locks on point levers apply indication locking and do not incorporate track locking.

Normal Indication (NI) locks and Reverse Indication (RI) locks on point levers may be released when the electric lock has failed to enable the point lever to be placed to the full normal or reverse position in correspondence with the points.
After receiving a request on an IBA form from the NCO for the release, licensed signalling personnel giving the release shall ensure:

- Any train approaching or that has entered the route has been brought to a stand and will remain so. This is achieved by receiving written assurance from the NCO recorded on the IBA form.
- The points are lying in the position corresponding with the position of the point lever and the point switch blades are in their respective fully closed/fully open positions as applicable, and that facing points where provided are securely locked by the point lock.
- The points won't be unlocked or moved prior to giving the release, if necessary by disabling, disconnecting or by clipping and locking the points.

The release shall be given by manually lifting the respective indication lock while the lever is placed fully over by the NCO.

If the points are found to be still out of order after the initial release has been given, the indication lock shall not be released again until the points have been booked out of use, secured by clip and SL locked.

If this is necessary, provided the points have been disconnected and NSG 608 and NPR 740 are in effect, the failed indication lock may then be permanently released to enable the lever to be placed in correspondence with the points position in order to obtain the sequence of the interlocking (when defective points are being manually operated and clipped and locked).

**WARNING**

While the lever is in the Normal Indication (NI) or Reverse Indication (RI) position, no rail traffic shall be allowed to pass over the facing points unless they are properly secured by clip and SL lock.

5.4 Release of Normal and Reverse Locks on Point or FPL Levers.

Normal and Reverse locks on point or facing point lock (F.P.L.) levers incorporate track locking, generally both approach locking and route holding.

Normal and Reverse locks on point or F.P.L. levers may be released when the electric lock is inoperative due to lock failure or approach locking.

After receiving a request on an IBA form from the NCO for the release licensed signalling personnel giving the release shall ensure:

- The protecting signal(s) are at stop with blocking facilities applied and will remain so. This may achieved by receiving an assurance from the NCO.
- The trainstop (where provided) is in the Normal (tripping) position. This may be achieved by means such as observing the position of the trainstop arm, observing the position of trainstop proving relays or the NCO observing a red signal repeater on the diagram etc.
- Any train approaching or that has entered the route has been brought to a stand and will remain so. This is achieved by receiving written assurance from the NCO recorded on the IBA form.
- Ensure that no train is foul of any of the connections worked by the point lever.
• In hybrid installations containing both mechanical and relay interlocking, licensed signalling personnel shall ensure that all relay interlocked functions are non-conflicting.

The release shall be given by manually lifting the electric lock while the lever is moved by the NCO.

If subsequent releases are required, this may be done provided licensed signalling personnel obtain a new IBA and obtain the NCO signature for each request. When this has been done licensed signalling personnel may give a separate release for each lever movement required by the NCO provided all steps above are followed for each release.

As an alternative to releasing the lock each time, the points shall be secured with a clip and SL lock and a handsignaller stationed at them to act under the directions of the NCO in accordance with NSG 608 and NPR 740. When this has been done and the entry prescribed by NGE 234, has been made on the IBA form and signed, the lock may be permanently released or removed until repairs have been affected.

The above procedure may also be used to release track locking (route holding) where a train has passed the outer protecting signal and has come to a stand at the immediate protecting signal provided licensed signalling personnel have been assured on an IBA form that the driver of this train has been informed that another train is to cross their path.

5.5 Release of Signal Normal Indication (NI) Relays at standard relay interlockings

Failure of signal Normal indication relays at standard relay interlockings may be released as follows only if extensive train delays would otherwise occur.

If the failure is due to track locking then a release of the approach stick relay is to be provided.

If the failure is due to another cause then a release may be provided as described below.

After receiving a request on an IBA form from the NCO for the release licensed signalling personnel giving the release shall ensure:

• The signal(s) involved is at stop with blocking facilities applied and will remain so. This may achieved by receiving an assurance from the NCO.

• The trainstop (where provided) is in the normal (tripping) position. This may be achieved by means such as observing the position of the trainstop arm, observing the position of trainstop proving relays or the NCO observing a red signal repeater on the diagram etc.

• Any train approaching the signal involved or that has entered the route has been brought to a stand and will remain so. This is achieved by receiving written assurance from the NCO recorded on the IBA form.

• The signal is electrically disconnected to prevent its operation and booked out of use.

The release shall be given by momentarily energising the NI relay and then immediately removing the false feed.

Traffic shall be conducted past the disconnected signal in accordance with NSG 608.
5.6 Release of Signal Route Normal Relays at Route Control Type Interlockings

Failure of signal Normal Route Lock Relays (signal NLR) at route control relay interlockings may be released as follows only if extensive train delays would otherwise occur.

If the failure is due to track locking then a release of the approach stick relay is to be provided.

If the failure is due to another cause then a release may be provided as described below.

After receiving a request on an IBA form from the NCO for the release licensed signalling personnel giving the release shall ensure:

- The signal(s) involved is at stop with blocking facilities applied and will remain so. This may achieved by receiving an assurance from the NCO.
- The train stop (where provided) is in the normal (tripping) position. This may be achieved by means such as observing the position of the trainstop arm, observing the position of trainstop proving relays or the NCO observing a red signal repeater on the diagram etc.
- Any train approaching the signal involved or that has entered the route has been brought to a stand and will remain so. This is achieved by receiving written assurance from the NCO recorded on the IBA form.
- The signal is electrically disconnected to prevent its operation and booked out of use.

The release shall be given by momentarily energising the NLR relay (after driving the RLR relay down, if necessary) and then immediately removing the false feed.

5.7 Release of Point Lock Relays at Standard Relay Interlockings

Point lock relays in standard relay interlockings apply track locking, generally route holding and in some cases approach locking.

If approach stick relays are provided in the point lock relay circuit and approach locking needs to be released then the respective procedure for releasing approach stick relays shall be followed.

In exceptional circumstances it may be necessary to energise a point lock relay to minimise excessive train delays. The relay may be energised after the precautions below have been followed.

After receiving a request on an IBA form from the NCO for the release licensed signalling personnel giving the release shall ensure:

- The protecting signal(s) are at stop with blocking facilities applied and will remain so. This may achieved by receiving an assurance from the NCO.
- The trainstop (where provided) is in the Normal (tripping) position. This may be achieved by means such as observing the position of the trainstop arm, observing the position of trainstop proving relays or the NCO observing a red signal repeater on the diagram etc.
- Any train approaching or that has entered the route has been brought to a stand and will remain so. This is achieved by receiving written assurance from the NCO recorded on the IBA form.
No train is foul of any of the connections worked by the points lever.

The release shall be given by momentarily energising the point lock relay while the points are operated by the NCO and then immediately removing the false feed.

Where it is necessary to bypass a train occupying route holding track circuits, provided that in addition to the above licensed signalling personnel are assured that the driver of the train to be by-passed is made fully aware of the by-passing movement and a notation to this effect is made on the IBA form by the NCO, licensed signalling personnel may then give the release.

5.8 Release of Point Lock Relays at Route Control Type Interlockings

At Route Control type relay interlockings if a failure occurs in the circuit of a point lock relay, traffic shall be conducted in accordance with NSG 608 until the defect has been rectified, except as set out below.

At these interlockings in addition to track locking, the point lock relay circuits incorporate interlocking functions. Failure of a point lock relay circuit shall not be released except in the following exceptional circumstances:

- a failure of the track locking within the point lock relay circuit, or
- if for other reasons, it is necessary to release the points with the route holding tracks occupied

In these cases where it is ascertained that the failure cannot be rectified quickly to avoid serious train delays, then the release of track locking shall be performed in accordance with the below process for energising the applicable point lock relay. This process allows the point lock relays to be in correspondence with the intended lie of the points once they have been operated to the required position locally, by hand in the case of EP points or wound over in the case of electrically operated points, and have been secured by clip and SL lock by licensed signalling personnel.

Prior to providing the release licensed signalling personnel shall fully explain the:

- specific release details to the NCO
- circumstances to the maintenance signal engineer and obtain permission to perform the release

The following process shall be observed to provide a release of route holding in point lock relay circuits at route control interlockings:

After receiving a request on an IBA form from the NCO for the release licensed signalling personnel giving the release shall ensure:

- The protecting signal(s) are at stop with blocking facilities applied and will remain so. This may achieved by receiving an assurance from the NCO.
- The trainstop (where provided) is in the normal (tripping) position. This may be achieved by means such as observing the position of the trainstop arm, observing the position of trainstop proving relays or the NCO observing a red signal repeater on the diagram etc.
- Any train approaching or that has entered the route has been brought to a stand and will remain so. This is achieved by receiving written assurance from the NCO recorded on the IBA form.
• Any points or releases which interlock with the points concerned are in non conflicting positions.
• No train or vehicle is foul of any of the connections worked by the point lever.

Licensed signalling personnel shall then:

• Instruct the NCO to place the point lever in route control interlockings to the position in correspondence with the current lie of the points and interlocking with blocking facilities applied to the point lever and to the controls of all signals leading over the points.

The release shall be given by:

a) manually operating the points to the intended (opposite) position and secure by clip and SL lock (this will temporarily place the points out of correspondence with the interlocking and point lever);

b) prior to applying the bridge in the point lock relay circuit concerned, check that the correct contact and only that contact applying track locking will be bridged. Once confirmed, momentarily apply the bridge;

c) instruct the NCO to place the point lever to the centre position and observe the points ‘free’ indication;

d) instruct the NCO that after obtaining the point free indication to operate the point lever to the intended position (normal or reverse) in correspondence with the lie of the points;

e) remove the bridge immediately the respective point lock relay picks up, and check that the opposite point lock relay is down

**WARNING**

• no attempt shall be made to operate the point lock relay or the points by operating route set buttons
• no contacts in the point lock relay circuit are to be bridged except those that apply track locking
• point lock relays shall not be lifted or unplugged and replaced by a relay in the up position

Where it is intended to by-pass a train occupying route holding circuits with another train, in addition to the above requirements, the licensed signalling person giving the release shall be assured by the NCO that both train drivers are aware of the intended move. The NCO is to make a notation to this effect on the IBA form then licensed signalling personnel may provide the release.

A separate request, and IBA form shall be completed and a separate release shall be given on each occasion it is necessary to operate the point lock relays and the points.

### 6 Release for Other Situations Including Computer Based Interlockings

Other situations may arise when the signalling interlocking has been locked and may require a release. An example of this is at computer based interlocking where a loss of track circuit input may cause the interlocking to be locked.
In such cases, where the procedures for providing a release are not prescribed, the risks of providing such a release shall be first identified by a signal engineer.

The decision to release the signalling interlocking shall be approved by the Principal Engineer Signalling Integrity.

The principles prescribed in this procedure shall be applied when permission is granted to provide the release.
## Engineering Instruction
**EI S 17/04**
Replacing EI S 16/07

### Approved by:
George Gadzuric, Professional Head Signalling and Control Systems, Sydney Trains

### Date in Force:
28 March 2017

### Date Expires:
27 March 2018

### Authorised by:
Michael Kemmis, Engineering Technical Publications Manager, Sydney Trains

This Engineering Instruction includes urgent engineering information. Adherence to the information in this Instruction is **MANDATORY**.

### Actions for Resumption of Normal Operation of DMU and SUDC Sets

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### Primary Affected Document:
PR S 40007 Apparatus Seldom Used

### Scope

Outside the metropolitan area bounded by Waterfall, Emu Plains and Berowra the following is to be implemented for Diesel Multiple Unit (DMU) Trains and Single Unit Diesel Cars (SUDC) where rail traffic has stopped for a period of 12 hours or more (instead of the normal 72 hours) or where the line has been closed following a significant weather event.

This does not apply to SUDC and DMU sets fitted with functioning track circuit assisters (TCA).
Background

A significant weather event caused the suspension of traffic on the South Coast Line. After the storm damage was repaired, the South Coast Line was reopened for normal traffic on the following day.

The first train to travel the section was a two car DMU set. The DMU set failed to reliably shunt some of the track circuits approaching West Dapto Road level crossing. This resulted in the level crossing protection providing reduced warning time, with the boom gates operating after the train’s passage.

Event logs showed the DMU experienced multiple losses of track shunts, even though an electric train had traversed the same section of line 12 hours earlier (during the line closure period) without any issue.

As a consequence, DMU and SUDC sets are treated as rail traffic that may not reliably operate track circuits when operating over any track circuited lines where:

- there has been no rail traffic operation for 12 hours or more (instead of the normal 72 hours) or,
- the line has been closed following a significant weather event.

Action required:

Where block working has been instituted as a result of SAFE Notice titled "Unreliable Track Circuit Operation" as a consequence of DMU or SUDC sets potentially not reliably operating track circuits after:

- rail traffic has stopped for a period of 12 hours or more (instead of normal 72 hours)

or

- line closure by a significant weather event (regardless of the duration of closure)

a Licensed Signalling Person (Electrical) must observe the track circuit sequence indications on the diagram / indication panel and any generated out of sequence alarms for each DMU or SUDC consist grouping type along the length of section / line that is affected.

Where Licensed Signalling Personnel (Electrical) are required to observe multiple diagrams / indication panels, the certification activities are to be co-ordinated by a single Licensed Signalling Person (Electrical).

Areas not indicated (dark territories) shall be managed by a signal engineer in line with the requirements of Section 3 below.

Certification of the following may be managed in line with Section 3 below:

- where a DMU or SUDC is not scheduled to run within 24 hours after the resumption of normal traffic operations or,
- lesser consist types of DMU or SUDC after certification of a higher consist type.

Line closure by a significant weather event

In addition to the above requirements, conduct a physical observation of specific track circuits affected by the weather event, to determine condition of rail surface to provide an effective track shunt (contaminants, residue, sludge, debris, etc. as a result of flooding, landslide or similar event).
1. Observation of Consist Types for Certification

Where a DMU or SUDC consist of a lesser length is satisfactorily observed to occupy the track circuit indications in correct sequence, it is permissible to apply this acceptance to consists of a greater length.

The following train consist types may be grouped together for certification:

- **Five or Six Car DMU**

  If five or six car DMU is observed to satisfactorily occupy each track circuit in correct sequence across the length of affected section / line, it is permissible to provide an assurance to the network control officer for DMU consists of five cars or greater. However in this example, a three or four car DMU, a two car DMU and a SUDC set will still need to be separately observed for correct operation.

- **Three or Four Car DMU**

  If three or four car DMU is observed to satisfactorily occupy each track circuit in correct sequence across the length of affected section / line, it is permissible to provide an assurance to the network control officer for DMU consists of three cars or greater. However in this example, a two car DMU and a SUDC set will still need to be separately observed for correct operation.

- **Two Car DMU**

  If a two car DMU is observed to satisfactorily occupy each track circuit in correct sequence across the length of affected section / line, it is permissible to provide an assurance to the network control officer for DMU consists of two cars or greater. However in this example, a SUDC set will still need to be separately observed for correct operation.

- **SUDC**

  If a SUDC is observed to satisfactorily occupy each track circuit in correct sequence across the length of affected section / line, it is permissible to provide an assurance to the network control officer for SUDC and DMU consists of two cars or greater.

2. Certification

Where each DMU or SUDC consist type satisfactorily occupies the track circuits in correct sequence along the length of the affected section / line and no out of sequence alarm generated, the co-ordinating Licensed Signalling Person (Electrical) is to provide certification of correct track circuit operation to the network control officer for the reinstatement of normal working for each DMU train consist type, as applicable.

The certification advice is to be provided on an IBA form and must clearly identify:

- The section / line that has been certified for restoration of normal working

- Consist types covered by the certification

Any remaining train consist types not observed, or covered by the above groupings and allowances, are still required to be Manual Block Worked.

If the DMU/SUDC is observed not to occupy the track circuits in correct sequence, or an out of sequence alarm is generated, then Manual Block Working is to remain in place for that portion of section / line. Further testing shall then be managed by a signal engineer in line with the requirements of Section 3 below.
Additionally where the DMU/SUDC failed to meet certification requirements and was the first rail traffic after line opening or period of non use, then the next rail traffic, regardless of the type (including freight, EMU etc.), shall be Manual Block Worked. This rail traffic is to be observed to satisfactorily occupy each track circuit in correct sequence across the length of affected section / line with no out of sequence alarm generated. Failing to achieve a satisfactory result shall require the protecting signals, including any affected level crossing protection to be booked out of use and fully investigated.

Details of the activities and testing are to be duly provided to the maintenance signal engineer where they have not been directly involved.

3. Where a DMU or SUDC is not scheduled to run within 24 hours after the resumption of normal traffic operations or Areas Not Indicated

Signal engineers may reduce the extent of observation detailed in Section 1 above where a risk assessment (done in accordance with procedure PR S 40007 Section 3) has demonstrated that sufficient other trains (such as freight trains) have traversed the affected section / line and provided an adequate contact band along the rail surface such to alleviate the issue of an ineffective track shunt for DMU and SUDC sets.

Prior to certifying track circuit operation, the signal engineer must consider the principles stated in procedure PR S 40007 Seldom Used Apparatus. In particular, reference shall be made to the following sections:

- Section 3 Seldom Used Track Circuits
- Section 3.2 Factors for Consideration
- Section 3.4.2 Testing Adequate Track Shunt after a Period of Non-Use

The certification advice is to be provided on an IBA form and must clearly identify:

- The section / line that has been certified for restoration of normal working
- Consist types covered by the certification

Note: All the requirements in this instruction are additional to the application of the 72 rule referenced in procedure PR S 40007.

Contact

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Engineering Procedure
Signalling and Control Systems

Signalling Safeworking

PR S 40007

Apparatus Seldom Used

Version 1.1

Date in Force: 21 September 2016
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<td>Added section from EAS 15/04 for responsibilities of signalling personnel for commissioned &amp; booked out of order equipment and ASA requirement for points affected by seldom use for a period greater than nine weeks.</td>
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1 Introduction

Signalling apparatus which is rarely or never used due to a change in rail traffic conditions shall be managed in accordance with signalling safeworking procedures, unless special approval is issued to the contrary by the Professional Head Signalling & Control Systems on lines on which traffic is suspended. (Refer to PR S 40017).

Signalling personnel must take every opportunity to inspect the rail surface of track circuits to evaluate the capability of an effective track shunt, particularly at sections of track which are prone to seldom use, such as sidings, refuge lines, crossovers and so on.

Signalling apparatus seldom used that has the potential to impair the safety of the signalling system must be immediately booked out of use including the associated protecting signals.

The maintenance signal engineer must be immediately advised of seldom used signalling that pose a risk to the safety of signalling. The maintenance signal engineer must assess and mitigate the risks associated in such situations to an acceptable level and must retain a register of seldom used apparatus for this purpose. The maintenance signal engineer must liaise with the network operators, with an aim to ensure sufficient trains are tabled through the track circuits and the affected points that are seldom used to maintain the condition of the rail surface.

The reinstatement of signalling affected by apparatus seldom used must be conditional upon the signalling (including points) being tested to ensure that they are in working order. The track circuits must be tested to ensure that they are capable of providing an effective track shunt. Alternatively where the risks associated in such situations are assessed and mitigated by a signal engineer, the specific signalling may remain operational.

1.1 Closed Signal Boxes

Where signalling equipment is worked from a signal box which only opens occasionally, the apparatus shall be specially maintained upon notice being given that the signal box is to be brought into use.

2 Seldom Used Points

Typically, seldom used points are as follows:

- Emergency crossovers
- Power worked double-ended crossover provided for out of course working
- Points at sidings or refuges operated from a remote signal box
- Points at sidings or refuges locally operated from a ground frame or adjacent control panel
- Installed points pending commissioning or removal

Points affected by seldom use for a period greater than nine weeks must be clipped, XL locked and spiked unless otherwise governed by specific requirements as stated or referenced in this signalling safeworking procedure.

Whenever points become seldom used, the risk of poor track shunt over the unused portion of a track circuit must be mitigated, generally by the disconnection and booking out of use - signals and/or points, or otherwise by applying suitable and effective controls as determined by the maintenance signal engineer prescribed in Section 2.4.
Where the points are booked out of service due to seldom use, and before a train is allowed to pass over the seldom used points, licensed signalling personnel must be present to certify the points fit for use prior to inserting the relevant fuses to permit operation of the points as requested, otherwise points must be clipped and SL locked for the intended move.

Except in the case described in Section 2.3, signals booked out of use as part of the risk mitigation strategy, must not be re-connected until adequate shunting of the track is established and the points are certified fit for use.

Where the points are being operated manually in emergency conditions, all the signalled routes reading over them must be booked out of use and disconnected.

Points that are inoperative or have other constraints due to seldom use must be listed at the relevant signalling control location.

Track circuits situated over seldom used points must be included in a Contaminated Rail Register kept by the maintenance signal engineer.

Following any partially commissioned points with/without detection, the Commissioning Engineer is to promptly provide the Network Maintenance licenced signalling personnel the relevant documentation and provide information about equipment status for all equipment booked out of order. In addition, the Signal Asset Engineer must ensure the relevant Network Maintenance licenced signalling personnel are made familiar with the new signalling arrangement brought into use. The Signal Asset Engineer is to arrange post commissioning attendance of licensed signalling personnel for follow up activities for the new signalling arrangement and creating the equipment in the asset register with applicable service schedules.

Note: There may be situations where an approved arrangement is installed that is designed to operate with rusty rails, such as perway sidings and emergency crossovers that are power worked. In these cases, the specific interlocking arrangements provide inherent protection from the risks of rusty rail and such installations may be left fully operational irrespective of the rail shunt condition of the turnout route.

2.1 Emergency Crossovers

Emergency crossovers are operated from an adjacent ground frame or adjacent control panel. On-site attendance provides an adequate control against the risk of a train left foul of points or running lines.

2.1.1 Ground frames released by Releasing Switches

Ground frames released by releasing switches are interlocked with protecting signals. In this case, each end of the emergency crossover must be kept clipped and XL locked in the Normal position.

Licensed signalling personnel are to examine the points in accordance with the Technical Maintenance Plan (TMP) and at intervals prescribed in the document. Where the points are impractical to operate for maintenance purposes, they must be booked out of use and maintained as a minimum requirement, to the items listed in Section 2.7.

Where Safety Critical inspections are performed every 30 days as prescribed in the Technical Maintenance Plan (TMP) and the points are fully operated in either direction, an SL lock can be fitted to the point clip(s) in lieu of the XL lock.
2.1.2 Ground frames released by Duplex Lock or similar arrangement

Ground frames released by duplex lock or similar arrangement do not offer the same protection as provided by a releasing switch. In this case, each end of the emergency crossover must be kept clipped and XL locked in the Normal position.

Licensed signalling personnel are to examine the points in accordance with the TMP and at intervals prescribed in the document. Where the points are impractical to operate for maintenance purposes, they must be booked out of use and maintained as a minimum requirement, to the items listed in Section 2.7.

2.2 Crossovers for Out of Course Working

Some crossovers are provided for out-of-course working. To ensure their readiness and to maintain reliable operation of the track circuit over the points reverse, sufficient trains are to be timetabled through the crossover to clean the rail surfaces. Licensed signalling personnel must check that the rail surfaces on these crossovers are kept clean enough to maintain an effective shunt of the points track circuits involved.

Where inadequate track shunt is evident, the following risk control measures must apply:

2.2.1 Power operated points disconnected

Seldom used power operated points must be booked out of use, disconnected and SL locked in accordance with PR S 40009. This is the preferred arrangement as the points whilst inoperative, can be easily maintained ensuring a desirable level of reliability. The signalled routes reading through the seldom used portion of track are also to be booked out of use and disconnected.

Licensed signalling personnel are to examine the points and associated signalling apparatus in accordance with the TMP and at intervals prescribed in the document.

2.2.2 Power operated points disconnected for an extended period

Where points are booked out of use for an extended period greater than 9 weeks, and the likelihood of restoration is low, the points must be XL locked and spiked in addition to the requirements of Section 2.2.1.

This arrangement does not allow the points to be maintained easily and in most cases it would be impractical to arrange the points to be operated for maintenance purposes. Licensed signalling personnel therefore must perform as a minimum requirement, the inspection items listed in Section 2.7 at intervals prescribed in the TMP.

2.3 Power Worked Points at Sidings or Refuges

A greater level of risk exists where power operated points located at sidings or refuges become seldom used. In this situation, where inadequate track shunt is evident, there is a possibility that power operated points could be operated with a portion of the train foul of the turnout or a portion of the train left foul of the running line. In this case, the points and signalled routes through the turnout must be booked out and disconnected.

The points are to be clipped and XL locked.

These controls require the presence of a qualified person to provide direct observation, ensuring the train is not left foul of the points or the running line prior to restoring the operating facility.

It is preferable to have the shunt signal clear for the train entering into the siding or refuge thus providing an assurance that points within the route are in the correct position and
locked. In this case, licensed signalling personnel are to be present to unclip and reconnect the points to allow the points to be operated to the desired position and resecure the point-clip. The fuse for the protecting shunt signal may then be reinserted to allow the signal to operate over the points.

Upon assuring the train is wholly within the siding or refuge and not left foul of the turnout or the running line, the signal is to be disconnected and points reinstated to the original position, disconnected, clipped and XL locked.

Where licensed signalling personnel are unavailable, trains must be worked into the siding or refuge by a qualified person in accordance with the Network Rules & Procedures.

This arrangement does not allow the points to be maintained easily and in most cases it would be impractical to arrange the points to be operated for maintenance purposes. Therefore, the points must be maintained as a minimum requirement, to the items listed in Section 2.7 at intervals prescribed in the TMP.

**2.4 Power Operated Points Left Operational**

If the seldom used portion of a turnout is part of a run-off and there is no signal move for the turnout, then the points may be left operational.

Power operated points may also be left operational in certain circumstances to facilitate the maintenance of selective overlaps or to maximise the safe use of the signalling system eg; where it may be preferable to leave the route setting functional (with signals disconnected) to ensure points within the route are set in their correct position. These provisions are to be conditional upon a proper risk assessment conducted by the maintenance signal engineer with outcomes determined as an acceptable level of risk.

Factors that maintenance signals engineers should consider when determining the level of acceptable risk are prescribed in Section 3.2.

Maintenance signal engineers must advise the Professional Head Signalling & Control Systems of the determination made to keep points operational and of the associated controls put in place as part of the risk mitigation strategy.

Not withstanding any of the above, licensed signalling personnel must continue to maintain the apparatus in accordance with the TMP and at intervals prescribed in the document unless alternative arrangements are approved by the Professional Head Signalling & Control Systems.

**2.5 Points at Sidings or Refuges Operated by an Adjacent Ground Frame or Control Panel**

Where seldom used points are located at sidings or refuges operated by an adjacent ground frame or an adjacent control panel and the operator can easily observe the clearance point or other end of points, then the ground frame releasing arrangements may be left connected.

Where observation of the clearance point is not easily sighted, then the releasing arrangements are to be disconnected.

Each end of points must be kept clipped and locked in the Normal position.

Licensed signalling personnel are to examine the points in accordance with the TMP and at intervals prescribed in the document. Where the points are impractical to operate for maintenance purposes, they must be booked out of use and maintained as a minimum requirement, to the items listed in Section 2.7.
Where Safety Critical inspections are performed every 30 days as prescribed in the TMP and the points are fully operated in either direction, then an SL lock can be fitted to the point clip(s). In all other cases the points must be locked with an XL lock.

2.6 Installed points pending commissioning or removal

Where points become redundant and not immediately removed or new points are installed in running lines and they are not immediately connected to the interlocking and brought into use, then the signal engineer in charge of the work must ensure that an XL lock and point clip is fitted to the closed switch, and the points are spiked.

Additionally, a minimum of two stretcher bars must be fitted to the points to maintain the open switch in the correct position. Alternatively, the method prescribed in Signal Design Principles ESG 100.14 Section 14.16.2 for securing the open switch can be applied.

Catchpoints and independent switches pending commissioning must be similarly secured and in accordance with ESG 100.14.16.3.

Swing Nose Crossings pending commissioning must be similarly secured and in accordance with ESG 100.14.16.4.

Where the new points are facing points, then they must be detected in accordance with Signal Design Principle ESG 100.14 Section 14.16.5 and in an emergency, a period of 16 weeks without detection is permitted. Points pending removal must retain detection. The loss of detection must place at stop the immediate signals reading over the points.

The above precautions must be completed prior to certifying the line fit for rail traffic.

The maintenance of securing devices of points not connected to the signal interlocking must be created and scheduled into the Sydney Trains maintenance management system at intervals as prescribed in the TMP. The tasks listed in Section 2.7 shall apply as a minimum requirement.

2.7 Where Impractical to Operate Points during Maintenance

Generally, points booked out of use are examined in accordance with the TMP at the intervals prescribed in the document.

However, where it is impractical to operate points for maintenance purposes, the following examination procedure must be followed to ensure a high level of integrity for the signalled routes that remain operational through the points in the Normal position.

In this case, the usual point lock and detection tests may be omitted provided the examinations listed below are performed within the scheduled intervals as prescribed in the TMP. Identified defects are to be repaired or reported for rectification.

Note: Certain other scheduled maintenance activities may also be omitted during the extended period that the points remain booked out of use, provided the reliability and integrity of the working signalling is not jeopardised. For example, insulation testing of detection circuits that affect working signals is still required in accordance with the TMP. Full maintenance service must resume prior to the points being booked back into use.

a) Check the releasing arrangements are securely locked, including manual operating levers locked by special lock or Falcon 8 (as applicable).

b) Check there is no damage to any of the equipment or rodding.

c) Check all fastenings are secure and of the correct type (eg; nyloc nuts).

d) Check the point spikes, point clips and locks are securely fitted.
e) Ensure the point lock is securely plunged or claw lock or spherolock is effectively locking the points.

f) Check the closed switch is securely against the stock rail throughout its entire length and that the backdrive is not moving or flogging during train passage.

g) Ensure the detection mechanism is in its proper position and will detect opening of the closed switch (where applicable, using a 1 mm / 2 mm go/no go or H gauge as described in PR S 40030 Section 3). Trace the rodding and linkages between the detector contact actuator, through the detector rod and to the closed switch to confirm that when the closed switch opens, the correct detector contacts will be operated.

h) Check the stretcher rods securely maintain the open switch in its correct position and provide minimum flange-way clearance.

i) Check there is no evidence of excessive movement or wear of the channel iron route or in the case of power operated points, the point mechanism gearbox is secured to prevent drifting (latched in the case of EP claw lock or EP spherolock points).

j) Check there is no evidence of excessive movement or wear of the perway at the points.

k) Inspect parallel bonds, including the hypalon insulation, the termination to rail and the clips holding the bonds or conduit to sleepers are all in good condition and secure. Where parallel bonds are not visible over their entire length, the continuity of the bonds is to be tested using a suitable tong ammeter.

3 Seldom Used Track Circuits

Licensed signalling personnel should take every opportunity to inspect rail surface, observing for rust or other contaminants that may reduce the effectiveness of a good track shunt, particularly sections of track that are prone to seldom use including sidings, entry/exit points, refuges, branch lines, crossovers etc.

Whenever licensed signalling personnel become aware of rails that are rusty or otherwise contaminated, such that the track circuit would not detect the presence of a train, they must book out of use the affected signals/route controls and points, and immediately advise the maintenance signal engineer of the details. Potential problem sections of track must also be reported.

The maintenance signals engineer must then determine an appropriate strategy for dealing with contaminated rail.

Note: Where installations provide inherent protection from the risks of rusty rail (for example, axle counters), the signalling may be left fully operational irrespective of the track shunt condition.

3.1 Risk Mitigation

Routine maintenance visits may need to be scheduled more frequently where the likelihood of contaminants prevails and a risk assessment has determined this requirement as part of a risk mitigation strategy.

Maintenance signal engineers must maintain a register of contaminated rail for track circuits on their area which are likely to be rusty or contaminated and cause loss of train detection. They are to ensure that the potential for this is minimised by an appropriate mitigation strategy that would protect against the risk factors shown in section 3.2.
Maintenance signal engineers and licensed signalling personnel must be alert for changes in the rolling stock type, service operating frequency and tonnage in their area.

Maintenance signal engineers are to specify any change needed to the general requirement period of 72 hours nominated in Network Rule NGE 220 and advice the Professional Head Signalling & Control System of any more stringent requirements for ensuring track circuits do not fail to detect trains because of rusty rail and/or light weight trains and/or infrequent services.

Where a lesser period or longer are required for specific sections, the maintenance signal engineer is to advise this as an exception to the general requirements. For example, reductions might be to 48 hours for non electrified main line areas and to 24 hours for non electrified branch line areas, longer periods may be due to the provision of impulse track circuits. Once approved, the maintenance signal engineer must arrange to implement these changes with Network Operations.

The decision to ensure the integrity of track circuits relative to the potential loss of track shunt due to contaminated rail needs to be determined on site by a signal engineer.

### 3.2 Factors for Consideration

Relevant factors that must be considered when conducting a risk assessment for allowing the safe use of the signalling system to operate when apparatus is seldom used include:

- **Effectiveness of Track Shunt**
  - type of track circuit used, eg; impulse track circuit
  - loose or light coating of rust that can be easily cleaned
  - random contaminants causing intermittent loss of shunt
  - new or seldom used and heavily rusted rail, causing high likelihood for loss of shunt

- **Location of Contaminated Rail**
  - does the area affect clearance point(s)
  - can a whole train or light engine be undetected
  - does the contamination span the entire track circuit
  - does the contamination span several track circuits
  - is a tuned loop affected

- **Environment and Configuration**
  - does the area involve long straight or tangent track allowing smooth rolling of wheels on rails
  - is the affected area part of a siding or refuge
  - do contaminated turnout rails form part of mainline crossover
  - are all rails in the points contaminated (turnout & straight)
  - are points operated from an adjacent ground frame or adjacent panel
  - do affected track circuits operate level crossing protection equipment
  - is the area prone to high humidity, rainfall, temperature extremes
  - rail susceptibility to rusting due to surrounding environment (eg; air borne contaminants, ocean salt spray)

- **Maintenance/Administrative Controls**
- effective monitoring
- regular grinding
- utilisation of a temporary stop block to reduce risk
- certain signal routes left connected subject to an acceptable level of risk
- the arrangement of more frequent services
- determine if manual safeworking operation would cause a higher risk
- determine if blocking facilities applied to controls in lieu of apparatus disconnection would cause a higher risk

• Rolling Stock
- diesel multiple units (DMU) or single unit diesel cars (SUDC)
- do trains with electric traction operate on the affected line
- is the line normally designated for mixed rail traffic
- do freight trains only operate on the affected line
- do light engines operate on the affected line
- what are the lengths/consists of typical rolling stock
- speed of short light trains
- axle loading and number of axles per train, gross tonnage
- do rail vehicles have tread conditioning from brake shoes or only disk brakes used
- time and frequency between trains
- wheel/rail profile interaction, variance of wheel to rail contact band (especially the risk of "hollow" wheels)
- would changes to the TOC manual provide an acceptable risk
- do rail contaminants come from the type of train

Where adverse conditions exist and/or an infrequent or light weight traffic service runs, measures such as five second slow pick-up track repeat relays or impulse track circuits may be necessary. These options must be discussed with the Professional Head Signalling & Control Systems.

3.3 Application of the 72 hour Rule

The application of the 72 hour rule was designed for main line operations or frequently used lines where the rail head surface was already clean and free of contaminants (bright shiny) and maintained in that condition by the normal timetabled running and where the line was intermittently closed for periods of less than 72 hours.

The application of running one short train over a section of track circuited line once every 72 hours does not allow adequate cleaning of the rail head surface and over an extended period of time, allows a slow build-up of rust and other contaminants to accumulate, resulting in the subsequent intermittent loss of track circuit shunt.

The term "infrequently used lines" appears in a number of safeworking documents. For signalling purposes, "infrequently used lines" when applied to light engines or equivalent, refers to track circuited lines that have had less than the equivalent of six eight car trains or 5,000 tonnes traverse them at or near line speed in a 24 hour period.
The action of a train travelling at or near line speed, especially freight trains, has a "scrubbing effect" on the top of the rail head keeping it free from contaminants and rust. However there is a difference between the behaviour of a light engine & an electric train on the track circuits on "infrequently used lines". The electric train, because of the large traction current drawn, will break down contaminants on the rail head allowing the track circuit to shunt more effectively. This may result in a different safeworking requirement for electric rolling stock as to light engines or similar rail vehicles when applying to a tracked circuited line that comes under the category of an "Infrequently used lines".

3.4 Period of Non Use Affecting Wider Areas

Periods of non use may be instigated by possession work, industrial dispute, storm events, security events or alteration to normal timetables or varied freight operations.

Where rail traffic has stopped operating for periods greater than 72 hours affecting large areas of track circuited lines, suitable arrangements must be put in place by the relevant maintenance signal engineer and Signal Asset Engineer. While maintenance signal engineers are responsible for ensuring that effective mitigation strategies are in place for events that could instigate non use of lines, for possession works the Signal Asset Engineer is to ensure adequate support is provided by the groups responsible for possession planning.

Proper and timely notification, liaising and planning with relevant parties are required to ensure that risks associated with loss of track shunt are managed effectively as to not cause a reduction in signalling integrity.

3.4.1 Track circuits at risk due to possessions

Possessions can cause track circuits to become seldom used within the possession limits and the surrounding area.

Rail lines affected by possessions can be considered as follows:

- **Track circuits directly worked on within the possession area:**
  
  Risks associated with this work are mitigated by the relevant signalling safeworking procedure (eg; rerailing).

- **Track circuits within a possession area, but are clear of track work:**
  
  These track circuits are at risk of not providing effective track shunt if not used for a period of greater than 72 hours.

- **Track circuits outside a possession area, but not used due to an operational variance caused by the possession:**
  
  These track circuits are at risk of not providing effective track shunt if not used for a period of greater than 72 hours.

3.4.2 Testing adequate track shunt after a period of non use

A risk assessment, taking into account factors in Section 3.2, endorsed by the maintenance signal engineer must be arranged to form a strategy for testing and an inspection & test plan following periods of non use - greater than 72 hours.

Testing must provide an assurance of satisfactory track shunt. The method and scope of testing will vary dependant upon the reason for the event, length and track configuration, type of trains operating, weather conditions and the period of non use.

Testing strategies may require re-evaluation if the scope of work or possession arrangements alter throughout the period of non use.
Trains may be block worked through the affected sections until the lines are certified for normal operation.

Certification of the track circuits and subsequent running of train services must not exceed 24 hours from the conclusion of testing.

The following methods may provide an assurance of satisfactory track shunt. Maintenance signal engineers may determine that a combination of these tests is required.

- **Train Shunt Check:**
  
  A Train Shunt Check, as prescribed in *PR S 40025*, conducted over a selected sampling of affected track circuits, can assist to provide a confident assessment of track shunt capability for the affected area before certifying the track circuits into use.
  
  Consideration should be given to the type of track circuits in use, selecting a higher sampling rate from track circuits with a lesser shunting characteristic. Track circuits nominated in a contaminated rail register for the affected area should be included in the sample test.
  
  Consideration should also be given to the relevant factors listed in section 3.2.

- **Competent Person Travelling on a Test Locomotive:**
  
  Utilising a competent person travelling on a test locomotive who is capable of communicating their exact position in reference to track circuit, to a suitably licensed signalling person located in the signal box for the area being observed.
  
  Licensed signalling person is responsible for observing and ensuring that all track indications operate in correspondence as the test locomotive occupies and unoccupies each track circuit within the section of affected track prior to certifying the track circuits into use.
  
  The test must be conducted in a manner that each individual track circuit is clearly differentiated from the next.
  
  The generation of track sequencing alarms (if available) must also be taken into account.

- **Test Locomotive or Tabled Trains Traversing Under Block Working:**
  
  A test locomotive or tabled trains, block worked in accordance with NGE 220, can be used to operate on the affected line(s) with a suitable licensed signalling person observing each affected track circuit indication and ensuring its operation as satisfactory as the locomotive/train traverses the section before certifying the track circuits into use.
  
  The generation of track sequencing alarms (if available) must also be taken into account.
Engineering Procedure
Signalling and Control Systems

Signalling Safeworking

PR S 40008

Securing Signalling Apparatus
Out of Use

Version 2.1

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Disclaimer

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1 **Reference documents**

This procedure shall be read in conjunction with the following documents:

- PR S 40001 – Introduction to Signalling Safeworking Procedures
- PR S 40004 - Failures
- PR S 40009 – Disconnection of Signalling Apparatus
- PR S 40010 - Risks and Controls Associated with Testing and Certifying Equipment
- PR S 40011 - Renewals Work
- PR S 40012 - Repair / Replacement of Signalling Wires
- PR S 40050 – Control Systems
- PR S 47110 - Inspection and Testing of Signalling
- Network Rules and Network Procedures

2 **Introduction**

Signalling apparatus is secured in a safe state or position during degraded modes in order to prevent its operation.

Situations where the signalling integrity has been impaired or may become impaired shall be adequately protected by securing the signalling apparatus out of use.

Securing of signalling equipment generally pertains to the equipment being directly worked on or affected directly by an incident. Additionally, it pertains to the wider array of signalling apparatus that is affected by the work (or incident) as well as the signals assigned for protecting the affected area.

Notwithstanding the above principle maximising the safe use of the signalling system shall be considered when determining the course of action for securing apparatus out of use. This may permit some of the signalling to remain operational. This is described in more detail in Section 3.3.1.

Engineering works performed in track possessions shall meet the same requirements for securing signalling apparatus out of use, as if the work was being performed on running lines.

3 **Requirements for Securing Signalling Apparatus Out of Use**

The methodology used to prevent the operation of signalling shall be relative to the level of protection required. The requirement to book signalling apparatus out of use each time may not always be necessary.

Three methods are used to secure signalling apparatus out of use depending on the level of risk governed by the specific situation. These methods are as follows:

- Applying blocking facilities to signalling controls by the Network Control Officer.
- Disabling of signalling apparatus by licensed signalling personnel.
- Booking signalling apparatus out of use.
Signalling controls may have blocking applied by the Network Control Officer (NCO) to secure signalling apparatus in a safe position so that it will not be operated as part of the safeworking system for the signalled movement of trains.

Signalling apparatus itself may also be disabled by licensed signalling personnel to prevent its operation for the purpose of failure rectification, adjustment or testing activities.

Signalling apparatus is referred to as booked out of use when the NRF 003 Infrastructure Booking Authority (IBA) form is correctly compiled with the NCO and blocking facilities have been applied by the NCO.

Disconnections shall be carried out as described in Procedure PR S 40009.

Any disconnection, reconnection or alteration shall be thoroughly tested as functional before returning the apparatus into service.

The three methods (including their application and limitations) are further described below in Sections 3.1 to 3.3.

3.1 Applying Blocking Facilities to Signalling Controls

NCOs may temporarily apply blocking facilities to signalling controls, thus preventing control of the signalling apparatus. The blocking means can differ depending on the type of signalling control in use; typically they include the following means:

- Enabling virtual blocks on train control workstations, such as ATRICS, SIGVIEW and PHOENIX.
- Applying covers over buttons and switches of conventional panels in order to prevent the operation of signals and routes in the normal position, points in the normal or reverse position, level crossing controls in the lowered position, and so on.
- Applying lever sleeves (or equivalent) over mechanical levers in order to prevent the operation of signal levers from the normal position, points levers from the full normal or reverse position, or point lock levers from the point-locked position, and closing levers in the open or closed position.

Generally in these cases, the NCO makes a documented entry for this purpose. Telephone conversations with the NCO’s shall be made on recorded lines as an additional record of arrangements.

Where signalling apparatus has failed and is subsequently being inspected and tested to rectify a failure or to certify its correct operation, and where such inspection, testing and rectification work will definitely not interfere with the safe operation of the signalling system, then it is sufficient to verbally request the NCO to keep the associated signalling controls in the required position, by applying blocking facilities.

However, this method is not an acceptable level of protection for signalling apparatus that is to be disconnected from the interlocking or where the interlocking apparatus is to be disarranged. This method does not provide a high level of protection as the signalling remains potentially operable. It is suitable only for the immediate protection of a derailment, collision or a failed train, or otherwise for the protection of engineering works where the work does not affect the signalling system.

Where blocking facilities are applied following a major incident, the booking-out arrangements shall be formalised by compilation of an IBA form and the associated apparatus disconnections applied as described in Procedure PR S 40009 as soon as is practicable.
3.2 Disabling of Signalling Apparatus

Licensed signalling personnel can disable signalling apparatus to prevent its operation by removing electrical power or air supply to motors, mechanisms or control devices. This method provides an intermediate level of protection because the trackside apparatus that is disabled from operation still maintains connection to the interlocking. Therefore, the apparatus may not require formal booking out of use and the signals may remain operable.

The NCO shall be advised of all work that secures signalling apparatus using this method and shall be requested to apply blocking facilities to relevant signalling controls.

This method applies only where the trackside apparatus is not disarranged and is safely connected to the interlocking. Additionally, the application of this method is restricted to work that does not interfere with the safe operation of the signalling system and does not impact the on-time running of trains.

Examples of engineering works that may be suited to this type of protection are as follows:

- Inspection and testing of signalling apparatus to rectify a failure.
- Inspection and testing of signalling apparatus to certify its correct operation during periodic or reactive testing.
- Periodic maintenance of signalling apparatus.

When performing signalling maintenance, some work may involve the disconnection of signal lights or level crossing protection equipment (making the equipment inoperable), or the disarrangement of points or other trackside apparatus such as releasing switches and ground frames.

This type of work is permitted using this method only where the disconnection or disarrangement occurs for a very short period of time (less than the time between trains, but not greater than 30 minutes).

This permission is strictly for signalling maintenance of the following tasks:

- Temporary disconnection of signal lights for the purpose of periodic insulation testing.
- Momentary disabling of active level crossing protection equipment using designated switches (for example, emergency and manual override switches) for the purpose of periodic testing and maintenance.
- Minor adjustment of point locks, point detection or individual elements of other trackside apparatus, such as releasing switches and ground frames for the purpose of periodic testing and maintenance.

In these situations, the protecting signals in the rear of the affected apparatus shall be disabled, such that they remain at stop for the duration of the work. The disabling of signals in the rear may be exempted where the responsible signal engineer has assessed all the risks and determined that the work will not endanger the safe running of trains or users at level crossings. This should be documented for each individual occurrence or may be documented to cover the responsible signal engineer's area of responsibility.

Whenever the possibility exists that the work (including inspection and testing) could interfere with the safe operation of the signalling system, the equipment being worked on shall be booked out of use and disconnected in accordance with Section 3.3. Additionally, any signals protecting the work, as well as any other signals or apparatus (such as points, ground frames and track circuits) affected by the work shall also be booked out of use.
Where disabled signalling is to be left unattended by licensed signalling personnel, the affected signalling apparatus shall be booked out of use on IBA form and disconnected.

### 3.3 Booking Signalling Apparatus Out of Use

This is the most secure method of protection. It requires licensed signalling personnel to book out of use signalling apparatus and is a formal agreement between the NCO and licensed signalling personnel.

Signalling apparatus shall be booked out of use in any of the following situations:

- Where disabled signalling apparatus requires the use of hand signallers to facilitate the movement of rail traffic, or the movement of users at level crossings.
- Where signalling apparatus requires total disconnection from the interlocking.
- Where signalling apparatus is disarranged (except for the specific maintenance tasks described in Section 3.2).
- Where the safe operation of the signalling is put at risk by engineering works.
- Where the integrity of the signalling is in doubt.

In these cases, the following approach shall be adopted:

- Reach an understanding with the NCO of the type of work involved, the implications to rail operations and the safeworking requirements to be applied.
- Compile an IBA form in accordance with the Network Rules and Procedures.
- Requesting the NCO to place blocking facilities on the affected signalling controls.
- Protecting signals made to remain at stop by electrical or mechanical disconnection.
- Disconnecting the operation of the trackside apparatus concerned in accordance with PR S 40009 and securing the apparatus in a safe state (example: clip and SL lock points).
- Disconnecting in accordance with PR S 40009 and securing in a safe state, other apparatus that interlocks with the trackside apparatus concerned.

**Note:** Signalling apparatus may not be required to be disconnected in certain situations including major incidents and signalling irregularities. This is done to preserve evidence where the signalling system integrity may be in doubt. In these instances the procedures in PR S 40003, PR S 40004 shall be complied with.

### 3.3.1 Maximising the safe use of the signalling system

Maximising the safe use of the signalling system shall be considered when determining the course of action for securing the apparatus out of use. This may permit some of the signalling apparatus to remain operational.

For example, where points are affected by rail contamination, the route control functionality may be retained while still securing the protecting signals from clearing by booking out and disconnection. This enables all the points in a route to operate as designed and eliminates the human error associated with manually operating points. This can prevent an inadvertent point run-through.

This consideration shall be subject to a risk assessment conducted by a signal engineer and the implementation of an appropriate mitigation to bring any identified risk to an acceptable level. The potential for human error shall be given due consideration during the risk assessment.
The mitigation strategy for situations requiring signalling to remain operational shall be discussed between the signal engineer and another signal engineer before implementing, to ensure all risks are controlled. The signal engineers involved need to have suitable experience relative to the complexity of the subject matter.

Risk assessments shall be documented.

3.3.2 Example of Work requiring Signalling Apparatus to be Booked Out of Use and Disconnected

The example scenario below relates to the rewiring of point detector contacts.

The protecting and affected signal routes (including overlaps) which detect those points shall be booked out of use and disconnected, together with the points.

The detector relay (which is not being interfered) shall be isolated from the work by disconnection of the incoming cable links.

*If the protecting and affected signal routes requiring the detector relay circuit were not disconnected and booked out of use, and the detector circuit was to be wrongly reconnected, then it can cause the signals to be unsafely cleared, perhaps inadvertently.*

When the detector rewiring work is completed, the detector relay and points operation can be reconnected. The work, including the detector circuit shall fully be inspected, tested and certified to be physically and functionally correct. During this time, the affected signals shall remain disconnected. In this particular example, because it could be assured that the detector relay itself, including its contacts were isolated from the work and not interfered, no further testing of the interlocking and controls would be necessary, and the disconnected signals could be reconnected and booked back into use, together with the points.

The signals which have been disconnected shall be operated to ensure they are in working order before being booked back into use. Prior to testing, the NCO shall be informed that the signals are being reconnected for testing purposes only, but are still out of use. A check shall be made that any hand signallers are advised accordingly, and that there are no trains approaching which could be endangered by the signal clearing during the testing.
4 NRF 003 Infrastructure Booking Authority (IBA) form

Licensed signalling personnel shall use an IBA form NRF 003 to book signalling apparatus out of use and back into use in accordance with Network Rule NWT 312 and Network Procedure NPR 704. This is done to achieve an understanding with the NCO of the type of work involved, the implications to rail operations, the safeworking precautions to be applied and that the affected signalling apparatus is properly certified fit for use before being booked back into use.

Licensed signalling personnel shall be responsible for compiling the IBA form with the NCO whenever they are booking out signalling apparatus. Licensed signalling personnel shall provide a description of the purpose the signalling apparatus is booked out of use on the IBA form under the section titled Infrastructure Equipment Details. The physical disconnection of signalling apparatus shall begin only after obtaining the approval of the NCO.

Where signalling apparatus is booked out of use for an extended period (greater than six months) or indefinitely, suitable arrangements shall be made for advertising these details in the Weekly Notice.

Completing and signing the IBA form for restoring signalling apparatus to use, constitutes certification that the interlocking apparatus and signalling apparatus that was disarranged or disconnected or which could have been affected, has been tested and is safe and fit to restore to normal use.

It is imperative that only the licensed signalling personnel directly involved with the certification work complete the IBA form in accordance with the Network Rule and Procedure NWT 312 and NPR 704. An exception to this requirement is where a Commissioning Engineer following the processes described in PR S 47110 Inspection and Testing of Signalling certifies signalling into use.

Where the signal control centre is remote from the work location, the licensed signalling personnel in charge of booking out of and into use of signal apparatus shall contact the NCO in accordance with Network Rule NWT 312 and transcribe the details of the IBA form.

Note: Where work which affects the signalling is carried out under track possession, the signalling apparatus which is to be disconnected from the interlocking and the associated protecting signals and points (which would also normally be disconnected) is still required to be disconnected and booked out of use on the IBA form and in accordance with Network Rule NWT 312.

5 Testing of Signalling Prior to Reinstatement into use

Prior to reinstating disabled or disconnected signalling apparatus back into operational use signalling personnel shall identify and perform the testing in accordance with PR S 40010 and PR S 47110 for the particular situation involved.

In many cases, testing to certify the equipment will involve operating the booked-out apparatus from the signalling control panel. This shall be done with the NCO’s agreement and under strict conditions directed to the licensed signalling personnel. This shall be performed only where it is safe to do so and where there is no possibility of endangering train movements or operators responding to the operation of the apparatus while it is being tested, but still booked out of use. Signalling personnel shall not operate any signalling control for the movement of trains.
Disconnection of Signalling Apparatus

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Document control

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<td>Add Terminology for ATP / ETCS</td>
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<td>Disconnection of ETCS equipment including ETCS trainstops</td>
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1 Reference documents

The following documents are referenced and will need to be read in conjunction with this procedure:

- PR S 40002 – Temporary Bridging of Signalling Circuits
- PR S 40004 – Failures
- PR S 40007 – Apparatus Seldom Used
- PR S 40008 – Securing Signalling Apparatus Out of Use
- PR S 40011 – Renewals Work
- PR S 40016 – Notification of Whereabouts and Liaison with the Network Control Officer.
- PR S 40028 – Automatic Train Protection – Alstom ETCS Trackside
- PR S 40032 – Solid State Interlocking (SSI) and Smartlock 400T
- PR S 40038 – Microlok II Computer Based Interlocking
- PR S 40039 – Westrace Computer Based Interlocking
- Network Rule NWT 312 – Infrastructure Booking Authority
- Network Procedure NPR 704 – Using Infrastructure Booking Authorities
- Network Procedure NPR 715 – Protecting Type F level crossings
- Network Rule NGE 218 – Type F level crossing management

2 Terms and definitions

The following definitions and abbreviations apply in this document:

<table>
<thead>
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<th>Abbreviation</th>
<th>Definition</th>
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<tr>
<td>ATP</td>
<td>Automatic Train Protection</td>
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<tr>
<td>EMR</td>
<td>Master Emergency Arrangements (Emergency Master Relay)</td>
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<tr>
<td>EOL</td>
<td>Emergency Operation Lock</td>
</tr>
<tr>
<td>ESML</td>
<td>Emergency Switch Machine Lock</td>
</tr>
<tr>
<td>ETCS</td>
<td>European Train Control System (type of ATP)</td>
</tr>
<tr>
<td>Facing points</td>
<td>Points with the switch blades facing approaching rail traffic</td>
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<tr>
<td>FPL lever</td>
<td>Facing Point Lock lever on a mechanical frame</td>
</tr>
<tr>
<td>IBA</td>
<td>Infrastructure Booking Authority (Form NRF 003)</td>
</tr>
<tr>
<td>LEU</td>
<td>Lineside Electronic Unit</td>
</tr>
<tr>
<td>LSpR</td>
<td>Low Speed Relay</td>
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<tr>
<td>NCO</td>
<td>Network Control Officer. NCO may be known as a Train Controller for an unattended location, a Signaller for an attended location, or a delegate carrying out some functions of a Train Controller or Signaller.</td>
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<tr>
<td>Qualified Worker</td>
<td>A worker certified as competent to carry out the relevant task.</td>
</tr>
<tr>
<td>UCR</td>
<td>Route Checking Relay</td>
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<tr>
<td>XR</td>
<td>Crossing Control relay</td>
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3 Principles

Whenever it is necessary to disconnect signalling apparatus (mechanical or electrical) the provisions of Network Rule and Procedure NWT 312 and NPR 704 shall be strictly observed.

The physical disconnection of signalling apparatus shall begin only after obtaining the Network Control Officers approval. All involved in the work shall ensure there is a common understanding of who is in charge and responsible for these Safeworking arrangements.

IBA form NRF 003 shall be filled in by licensed signalling personnel and countersigned by the Network Control representative, in accordance with NWT 312 and NPR 704.

The licensed signalling person in charge of the work shall request the NCO to make a suitable permanent record regarding the disconnection of equipment.

When the work involves the disarrangement of permanent way equipment (e.g. where rails, points or crossings are replaced, removed or repaired) the IBA form shall be signed jointly by the Signalling, Network Control and Civil officers in charge.

When it is necessary under the provisions of NWT 312 and NPR 704 for a Handsignaller to be provided in connection with the disarrangement of interlocking apparatus, or disconnection of points, signals, trainstops or level crossing warning systems from the interlocking, such Handsignaller shall be provided and work under the directions of the NCO.

Licensed signalling personnel shall not interfere with the connections until they have assured themselves that any required Handsignaller is in position.

The latest correct signalling documentation shall be sourced when determining the disconnection requirements of signalling circuits and apparatus. This shall include any relevant interim maintenance copy. Where the accuracy of the existing documentation is in doubt then a correlation check of the relevant parts of a circuit shall be performed prior to disconnection or compiling of a disconnection list, as applicable.

The disconnection of relays and devices shall preferably occur within the same location as the relay/device; otherwise two points of disconnection (one on each leg of the relay/device circuit) is required.

When disconnecting licensed signalling personnel should ensure they remove the correct pins, fuses, plug coupler, wire and the like by rechecking names, numbers, racks etc. and avoiding the risk of parallax error.

Signalling apparatus that is disconnected, in conjunction with being booked out of use in accordance with PR S 40008, shall be secured in the relevant disconnected position. For example signals shall be made to display a stop indication with the associated trainstop in the raised (tripping) position, points shall be clipped and locked in the required position and level crossing booms shall be tied up in the raised position.

When the apparatus that had been disconnected is certified back into use, licensed signalling personnel shall sign the IBA form in conjunction with the Network Control representative, and other representative where applicable. They shall also request the NCO to make a suitable permanent record to reflect the return to service of the equipment.

On completion of disconnections and reconnections, a check is to be made with the NCO that only the intended equipment has been affected and that there has not been an inadvertent disconnection or reconnection of other equipment.
Whenever any signalling apparatus is electrically disconnected by the removal of fuses, pins or links and licensed signalling personnel cannot remain in attendance, the points of disconnection shall be securely and clearly labelled and made secure to prevent the possibility of someone inadvertently replacing the fuse or pin or closing the link, preferably using dummy plugs where possible.

If equipment is disconnected to facilitate maintenance works such as insulation testing, fault finding etc. it shall be appropriately tested to ensure it is working correctly after the works. The extent of testing to be performed shall address the risk factors for the particular situation, (e.g. extended period of disuse). If adequate testing is not possible then other risk mitigations shall be documented and agreed with a signal engineer. These mitigations shall ensure the required testing is carried out prior to the equipment being reinstated into use.

3.1 Disconnection from Interlocking

Signalling apparatus is deemed disconnected from the interlocking when the disconnection affects the integrity provided by the interlocking for the safety of train movements.

The opening of circuit terminal links and pins, or the disconnection of electrical power or air supply to trackside apparatus alone does not constitute disconnection from the interlocking.

There is an exception in the case of signal lights and level crossing protection equipment where it shall be deemed disconnected from the interlocking if their indication or operation is disabled.

Note The 'interlocking' is deemed that part of the signalling system which applies the interlocking and track locking between conflicting routes, signals, trainstops, points, level crossing warning systems and which applies track circuit control to the clearance of signals and level crossing warning systems. It includes all the vital control, indication and detection equipment and circuits that provide and prove correspondence between the respective signals, trainstops, points, track circuits and level crossing warning systems and the rest of the interlocking.

4 Disabling Signalling Equipment

When disabling signalling equipment to prevent its operation, in accordance with PR S 40008, the isolation method shall be confined to any of the following:

- removing fuses and disconnecting pins
- unplugging of coded plug couplers and the like
- turning off circuit breakers, isolating switches or air cocks

In general the removal of wires from terminals or relays, or the removal of mechanical equipment should not be warranted. However, where this is absolutely necessary, the reinstatement shall be suitably tested.

5 Disconnection process for Signalling Equipment

The following sections describe the process to correctly disconnect specific signalling equipment.
5.1 Disconnection of Signalling Apparatus at Computer Based Interlocking (CBI) Installations

Where the interlocking system is computer based, then the specific methods for inhibiting (disabling or disconnecting) signalling apparatus for the purpose of signalling safeworking shall be observed in conjunction with the relevant parts of this procedure. In these cases, the following procedures shall be additionally referenced:

- PR S 40032  Solid State Interlocking (SSI) and Smartlock 400T
- PR S 40038  Microlok II Computer Based Interlocking
- PR S 40039  Westrace Computer Based Interlocking

5.2 Disconnection of Signals

Where signals are disconnected in accordance with the principles above they shall continue to display a stop indication consistent with the design requirements; otherwise the protecting signals in the rear shall be booked out of use. Additionally, signals that are manipulated to display a proceed-indication for the purpose of testing shall also have protecting signals in the rear booked out of use.

Any trainstop associated with a signal made inoperable, shall also be made inoperable to prevent its inadvertent operation by removing the motor operating fuse and if electro pneumatically operated by also turning off the air valve.

The following disconnection requirements pertain to situations where the signalling integrity is not in doubt or where the integrity is not affected by the work.

When it is necessary to disconnect a signal to prevent its operation and maintain it at stop, under normal circumstances there is no need to disconnect any associated ETCS equipment, nor is it necessary to prove that the most restrictive balise telegram is being transmitted. The disconnection of the signal control relay circuit for the lowest proceed indication will also prevent ETCS from issuing a proceed telegram, irrespective of the method of connection of the ETCS LEU to the signalling. Refer to Section 5.7 where disconnection of ETCS equipment is required.

Where the signalling integrity is in doubt or affected by the work, a more stringent means of disconnection and protection shall be considered (for example, disabling the higher indications of the protecting signals and the affected signals in the rear and other signals affected by the work).

Removal of power to signal lights constitutes disconnection from the interlocking.

5.2.1 Disconnection of Signals Activated by Control Relays

Signals shall be made to remain at stop by electrically disconnecting both the active (positive) leg and the common (negative) leg of the signal control relay circuit for the first proceed aspect in the sequence (typically the caution HR relay circuit, low speed LSpR relay circuit or shunt control relay). Also, disconnect the active (positive) or common (negative) legs of the signal control relay circuits for the higher indications in the signal.

Where signals provide more than one route, it is permissible to disconnect the affected routes only while still maintaining the functional routes to operate. This shall be accomplished by the disconnection of the applicable signal control relay circuits. On installations where route termination links are provided in the route checking relay (UCR) circuit, these links shall be used to disconnect the route(s) of the signal concerned instead of removing the common signal control circuit fuse. Where separate fuses,
terminals or route links are not provided a signal engineer shall be consulted before disconnecting the required route.

In conjunction with any main line signal being disconnected and maintained at stop, the distant signals or equivalent shall also be arranged to be securely maintained at their correct restrictive indications. The signal immediately in rear shall be maintained at caution, or low speed, as applicable, with the respective lower yellow, lower green or clear relay circuits etc., controlled by the main signal prevented from operating.

The respective control relay circuits for the higher indications of the signal in rear shall be disconnected by manually opening either the active (positive) or common (negative) legs of the circuits. Where the respective higher signal indications of the signal in the rear are double switched by the disconnected control relays for the main line signal and where the integrity of these circuits is not in doubt, then the manual disconnection is unnecessary.

5.2.2 Disconnection of Signals Activated by Mechanical Interlocking (Large Levers)

When it is necessary to disconnect a mechanical signal to prevent the operation of the signal, and maintain the signal in the stop position, the catch rod handle shall be disconnected by removing the pivot pin, and a lever sleeve fitted to the lever. In addition, the signal wire is to be slackened off at the wire adjuster or with the GNR wheel for distant signals where provided.

In conjunction with any main line signal being disconnected and maintained at stop, the distant signals or equivalent shall also be arranged to be securely maintained at their correct restrictive indications i.e., the mechanical distant signal shall be disconnected and maintained at caution.

Signals shall not be operated by hand from the stop position. Should it be necessary to momentarily move the semaphore arm of a stop signal for maintenance, licensed signalling personnel shall ensure there is no train approaching that could accept the signal arm movement as authority to proceed.

5.3 Disconnection of Points

Points are disconnected for the purpose of either disabling their operation or booking out of use.

Where points are disarranged, the points shall be booked out of use and the protecting signals booked out of use. Protecting signals may be left operational when the points are not disarranged.

Following are some typical situations where the points are disarranged:

- point lock is not effective and secure
- point detection is not in proper adjustment
- point switches are not held in their correct position and in proper condition
- critical mechanical connections are not effective and secure
- if points can be incorrectly released

Points that are booked out of use shall also be clipped and SL locked.

Where points are not disarranged and the requirement is only to disable their operation, then it may not be necessary to clip and lock the points unless required by Network Rules, Network Procedures or other factors.
Points that are disabled or booked out of use for an extended period may be affected by unreliable track circuits (which may not provide an effective track shunt) and the requirements of PR S 40007 shall apply.

When booking points out of use, the unavailability of emergency facilities for point manual operation (EOL or ESML) shall be considered if the infrastructure (track, signalling, and overhead wiring) is not fit for use. In such cases, the facility shall be locked with a Falcon 8 lock and the information of the unavailability of the infrastructure shall be stated on the IBA form.

The following disconnection requirements pertain to the different point operating types.

5.3.1 Disconnection of Points – Mechanically Operated

When it is necessary to disconnect mechanical points to prevent their operation the catch rod pivot pins for the FPL lever and the point lever concerned shall be disconnected. Lever sleeves shall be fitted to the FPL lever and the point lever.

The procedures described above render the points inoperative but still safely connected to the interlocking with the points locked in position and the signals detecting and interlocked with the points. In such circumstances, provided the facing points are clipped and SL locked, the signals leading over the points may be left in order.

When it is intended that the points are to be further interfered with, worked on, manually operated or disconnected from the interlocking, then, in addition to the above, the signals protecting the points shall also be disconnected and maintained at stop and the associated distant signals or equivalent (i.e. higher indications of the signals immediately in the rear) are to be disconnected so that these signals are restricted to a caution indication, or low speed, as applicable. Rail traffic moves shall be conducted with the points clipped and SL locked, and with the disconnected signals hand-signalled.

5.3.1.1 Exception

If it is intended to work on the channel iron lead to the points or facing point lock and the points will not be moved during the course of this work it will be permissible to leave the protecting signals in working order provided the following precautions are observed.

a) Book the points and facing point lock out of order on IBA form.

b) The licensed signalling person in charge of the work shall request the NCO to make a suitable permanent record.

c) Disconnect the catchrod of both the point lever and the facing point lock lever so that the levers and the interlocking cannot be moved out of correspondence with the points.

d) Disconnect the plunger of the facing point lock and securely wire the plunger into the plunger casting to securely lock the points.

e) Secure the points with point clip and SL lock.

f) Provided the detection is in order and no attempt will be made to move the points, the signals leading through the points may be left working.

g) This procedure can only be adopted while the site is permanently attended by licensed signalling personnel. If it is required that the protecting signals remain operating while licensed signalling personnel are not in attendance, the points shall also be spiked and XL locked in accordance with the procedures for PR S 40007.
5.3.2 Disconnection of Points - Power Operated

Electrically disconnected points shall be securely and clearly labelled to prevent the possibility of someone inadvertently replacing the fuses, closing links, switching on the power or turning on the air.

The Network Control Officer is to be advised of the circumstances and request blocking facilities be applied to the points lever for the position the points are in.

The method of disconnection of points in computer based interlocking (CBI) areas is described in the following procedures:

- PR S 40032 Solid State Interlocking (SSI) and Smartlock 400T
- PR S 40038 Microlok II Computer Based Interlocking
- PR S 40039 Westrace Computer Based Interlocking

5.3.2.1 Electric – All Types

When it is necessary to electrically disconnect power worked points to prevent their operation, the following arrangements shall apply.

Where the points are electrically operated the local power shall be disconnected from the motor by the removal of the motor operating fuse. The isolating switch shall also be switched to the off position. This shall be carried out for each point end worked from the point lever.

Where point motors are to be turned OFF for an extended time, then prevention of point creep should be considered. This is particularly the case with machines which have external point locks.

5.3.2.1.1 Siemens D84M point machines

Where points powered by Siemens D84M point machines are booked out of use and disconnected, and the detection is still in working order for the purpose of train running, then licensed signalling personnel shall control the process whenever there is a necessity to manually (hand) operate the points.

Licensed signalling personnel shall ensure the points have fully operated to the desired position and additionally check that the dog-clutch has engaged following the manual operation prior to handing back the point detection to the Network Control Officer.

To enforce this requirement, the EOL for the points operated by a Siemens D84M machine shall be locked with a Falcon 8 lock for the period that the points remain booked out of use.

Siemens D84M point machines are required to be power operated on restoration to ensure the mechanism has operated to its full stroke.

5.3.2.2 Electro Pneumatic (EP) Points

5.3.2.2.1 Style E, S and ES control valves units

Where points are electro pneumatically operated and the point motor does not require a continuous air supply to prevent sagging back or switch creep (typically Signal Branch EP), the air supply shall be isolated at all ends of the points concerned. In addition the circuit fuse to the plunger lock valve for each point end is to be removed for points controlled by style ‘E’, ‘S’, and ‘ES’ control valve units.
5.3.2.2 Style E, S and ES modified control valves units

Where points are fitted with modified 'S', 'E' and ES control valve units for “air on” operation, the circuit fuse is to be removed for the points operating solenoid opposite to that which the points are laying, i.e. when the points are disconnected in the Normal position the fuse for the Reverse solenoid (RW) circuit is to be removed, or conversely, the Normal solenoid (NW) fuse is to be removed when the points are disconnected in the Reverse position.

The air supply is not to be isolated as EP Claw Lock points require a continuously air supply to prevent the piston sagging back against the motor latching pin and possible open switch creep.

5.3.2.3 Style T control valves units

Where points are fitted with 'T' control valve units for trailable operations, the circuit fuse for the points operating solenoid opposite to that which the points are laying, i.e. when the points are disconnected in the Normal position the fuse for the Reverse solenoid (RW) circuit is to be removed, or conversely, the Normal solenoid (NW) fuse is to be removed when the points are disconnected in the Reverse position.

The air supply is not to be isolated as losses of air to the relevant pressure detection switch this will fail point detection. As an additional precaution the air slide valve to the side of the motor opposite to that which the points are disconnected may be turned off. It is recommended that where the points are to be booked out of order for an extended period (in excess of 72 hours) this arrangement be implemented.

Removal of the circuit fuse for the cut off valve solenoid (LW) is not recommended as in 'T' control valve unit operation, the cut off solenoid (LW) when de-energised maintains air to the respective side of the point motor for which the points are laying. When the LW solenoid is energised this allows the points to become trailable.

5.3.2.4 Style A control valves units

Where the points are controlled by an ‘A’ valve unit they are to be electrically isolated by the removal of the circuit fuse for the points contactor relay opposite to that which the points are laying i.e. when the points are disconnected in the Normal position the fuse for the Reverse points relay (RWR) circuit is to be removed, or conversely, the Normal points relay (NWR) circuit fuse when the points are disconnected in the Reverse position.

The air supply to the control unit is not to be isolated as losses of air to the relevant pressure detection switch will fail point detection. As an additional precaution the air slide valve to the side of the motor opposite to that which the points are disconnected may be turned off. It is recommended that where the points are to be booked out of order for an extended period (in excess of 72 hours) this arrangement be implemented.

5.3.3 Signals leading over points with detection in working order

The procedures described above render the points inoperative but still safely connected to the interlocking with the points locked in position and the signals detecting and interlocked with the points. In such circumstances the signals leading over the points may be left operating provided that:

- if the electrically disconnected points are to be left unattended or out of use, the facing ends of the points are to be clipped and SL locked and an IBA form is to be completed
- the interlocking of the signals with the points is in proper working order, and will remain so
the point switches, connections and operating mechanisms are in proper adjustment and working order, and will remain so

the electrical detection is in proper adjustment and working order, and will remain so

the point lock is securely plunged and locking the switch hard against the stock rail, with the lock unable to be withdrawn due to the points being electrically (and electro-pneumatically where applicable) disconnected to prevent their operation

no attempt will be made to manually unlock or move the points

the points are to be electrically disconnected for a limited period of time. When points will be out of use for an indefinite period the procedures detailed in PR S 40007 shall be applied

If it is intended that the points are to be further interfered with, worked on, manually operated or disconnected from the interlocking, then, in addition to the above, the signals protecting the points shall also be disconnected and maintained at stop and the associated distant signals or equivalent (i.e. higher indications of the signals immediately in rear) are to be disconnected so that these signals are restricted to a caution indication, or low speed, as applicable. Rail traffic moves shall be conducted with the points clipped and SL locked and with the disconnected signals. The requirements of NWT 312 and NPR 704 shall be observed.

Where ESML/EOL arrangements (Emergency Switch Machine Lock, Annett Key and attached crank handle/Emergency Operating Lock Key) on electric point machines or EOL arrangements on E.P. points are provided for the manual operation of power worked points, the disconnection of the points and the protecting signals is accomplished automatically through use of the ESML or EOL arrangements. Similarly where Plug Connector and Key arrangements are utilised with Style E operated electro-pneumatic points, the affected signals and points are automatically disconnected. The ESML, EOL or Plug Connector and Key arrangements may be utilised during failure conditions and also for testing of point locks and detectors.

Electro-pneumatic points, and particularly those utilising type S, A and T valve units, shall not be blown over by manipulating the valves unless it is assured that the points and affected signals on all lines have been securely disconnected by use of the EOL arrangements, where applicable, or by disconnection of Plug Connectors, (E and ES valves), where applicable, by manual disconnection of the points detector circuit.

5.3.3.1 Disconnection of Points for Work on the Points: Points Detection in Working Order

Where work is to be carried out on power worked points fitted with electrical detection, then, in some cases, the signals leading over one or more of the ends of such points, and over the diamond crossings may be left working if it is safe to do so provided the following precautions are observed.

a) Advise the Network Control Officer of the work to be done and request blocking facilities be applied to the points lever

b) Fill in IBA form. Observe NWT 312 and NPR 704

c) Electrically disconnect the points and turn the power off (electric or electro-pneumatic) to prevent their operation

d) Clip and SL lock the points facing ends which are being worked on or are liable to be affected by the work
e) If the points detection is in working order and will remain so, and if all ends that are or could be affected by the work are clipped and locked, the signals over the points may be left working while licensed signalling personnel are in attendance to ensure the point clips and SL locks are not removed. If licensed signalling personnel cannot remain in attendance and if the integrity of the point lock cannot be relied upon, then the SL lock is to be changed to an XL lock and the points are also to be spiked, or otherwise the signals leading over the points ends and the diamond crossings are to be disconnected and maintained at stop, until the points are restored to use.

f) Where points are booked out of use and are clipped, XL locked and spiked pending removal, the detection, if in order, should be left in circuit and not bridged.

5.3.4 Disconnection of Points for Work on the Points: Points Detection Not in Working Order

5.3.4.1 Normal Case

a) Advise the Network Control Officer of the work to be done and request affected signals to be placed at stop, the point lever placed in the required position and blocking facilities applied to the affected signals and points levers.

b) Fill in IBA form observing NWT 312 and NPR 704.

c) Disconnect and maintain at stop the signals leading over the point ends and the diamond crossings and restrict the signal in the rear to a caution indication (or low speed where applicable).

d) Electrically disconnect the points and turn the power off (electric or electro-pneumatic) to prevent their operation.

e) Clip and SL lock the facing ends of the points.

f) Clip and SL lock the trailing ends of the points.

5.3.4.2 Exceptional Case

In exceptional circumstances where work will affect detection or when the points detection equipment has failed and the time to repair and the traffic delays will be extensive the following may be applied.

With the points lying normal the signals leading over the trailing end, and over the diamond crossings on a middle road, may be allowed to work if it is safe to do so, by remaining connected and by bridging detection and the following precautions are strictly observed:

a) Explain the work to and obtain authorisation on the PR S 40002 FM 001 Authority For Temporary Bridging Of Contacts form from the authorising signal engineer. Ensure to include a photocopy, scan or electronic print-out of the diagrams for the circuits bridged.

The requirements of PR S 40002 shall be observed.

b) The authorising signal engineer shall discuss the bridging arrangements with licensed signalling personnel applying the bridging and removing the bridging.

c) Advise the Network Control Officer of the work to be done and request affected signals to be placed at stop, the point lever placed in the Normal position and blocking facilities applied to the affected signals and points levers.
d) Compile an IBA form, booking the signals leading over the facing ends of the points and the points out of use, including the section relating to bridging of signalling equipment and with the NCO jointly sign the form. 

Observe the requirements of NWT 312 and NPR 704, as applicable.

e) Disconnect and maintain at ‘Stop’ the signals leading over the facing ends of the points and disconnect the mechanical distant signal or restrict the power worked signal in rear to a caution indication (or low speed where applicable).

f) Electrically disconnect the points and turn the power off to prevent their operation. (Mechanical points shall have the catch handle rod of the point lever and the FPL lever disconnected to prevent their movement.)

g) In all cases, clip and SL lock the facing ends of the points.

h) Also clip and SL lock the trailing end points for traffic movements (in addition to the facing end points) if the work is being carried out on the trailing end points, or if the detection is out of order on the trailing end.

i) Disconnect the reverse detector circuit at the same location where the normal contacts are being bridged.

j) Bridge only the affected detection contacts for the position the points are lying using regulation jumper wires, as follows:

i) Using the regulation jumper wires, strap and function test the contacts to be bridged to prove they are the correct contacts and then leave the bridging connected.

ii) Bridge only the detection contacts that are affected (e.g. detector normal contacts or indication box normal contacts or plunger lock normal contacts, as applicable).

iii) Do not bridge out the contacts on points ends that are not affected.

iv) Do not bridge out the ESML/EOL contact.

v) Apply the bridging at the actual detection contacts where the detection is out of order, if practical. If this is not practical apply the bridging at the nearest respective cable terminals to the contacts themselves and open the cable links leading back to the contacts; correspondence shall firstly be proved between the cable terminals and the respective detection contacts.

k) Once the bridging is applied, circuit function test the point detection contacts at the end that is not affected to verify they are still effectively in the detection circuit.

l) Signals leading over the trailing end, and over the diamond crossings on a middle road may then be returned for use.

m) Remain in attendance at the points while the bridging is applied to ensure the points are not unclipped or unlocked, unless this can be otherwise guaranteed.

Restoration

n) Advise the Network Control Officer of the work to be done and request all affected signals to be placed at stop and blocking facilities applied.
o) Remove the applied bridging.

Bridging is to be removed BEFORE:

- the point clips and locks are removed, or
- the points are electrically reconnected, or
- the signals leading over the facing ends are reconnected, or
- reconnecting the reverse detector circuit

p) Operate the points and function test the entire detection circuit through to the signalling control panel to ensure all temporary bridging is removed and all contacts are effective in the circuit. This testing shall include an apparatus function test, correspondence test (and out of correspondence test, as applicable) and wire / null count.

q) All testing is to be completed before the alternate protection is removed and before the signalling equipment is booked back into use.

r) Complete the IBA form and sign into use.

s) Complete the removal advice section of the bridging authority form and immediately return the form to the authorising signal engineer confirming that the bridging has been removed and all subsequent testing completed.

t) Authorising signal engineer completes the ‘Authority for Temporary Bridging of Contacts’ form.

5.3.4.2.1 Facing end detection in order and facing end not affected by the work

If the work does not involve the facing end of points, and the detection is not bridged out on the facing end, and if (after the bridging is applied on the point ends affected by the work) the points normal detection on the facing end is tested and proved to be in working order, then, provided the facing end is clipped and SL locked normal and provided all other aspects of the above procedure are observed, the signals leading over the unaffected facing end of the points in the normal direction may be restored to use, if specifically approved by the authorising signal engineer for the temporary bridging.

5.3.4.2.2 Bridged points detection not permanently attended.

If it is not practical for licensed signalling personnel to remain in attendance all the time that the bridging is left on, then other precautions shall be taken to ensure that the bridging will not be interfered with and points will not be unlocked or moved or restored to use before the bridging is removed and the detection tested. These precautions need to be documented and authorised.

For example, if it cannot be otherwise guaranteed that the points would not be unlocked and if there could be any train movements (including work trains) over ends of the points in a facing direction, then have those points ends XL locked and spiked; if the bridging is to remain on for an extended period, then additionally secure the ESML/EOL cabinet including the manual operation facility at the points with Falcon 8 locks.

Points that have been secured with clips, locks and/or spikes must be frequently inspected to confirm the security of these devices. The authorising engineer shall determine the inspection frequency.

If unable to remain in attendance while the detection is bridged out, then it will be necessary to close and lock signalling apparatus, disconnection boxes and equipment locations in which case the jumper wires may not remain obvious to any uninformed person becoming involved. Where practical leave the jumper wires protruding, or further
disconnect the points near the terminals where the bridging is applied so that to reconnect the points the jumper wires will be noticeable.

5.3.4.2.3 Work requiring clipped and locked points to be unclipped.

Where one end of a crossover set of points is being worked on and the nature of the work necessitates that the points be unclipped at some stage, then such work is to be carried out with the signals on that line (leading up to and over that end of the points) disconnected and booked out of use with Handsignallers provided at the signal(s) for any train movements. The bridging of the points detection on that line shall not be applied unless licensed signalling personnel can ensure that the points will be kept clipped and locked in the non-conflicting (normal) position except for periods when there is no possibility of any train movement (including work trains) up to the points on that line. Licensed signalling personnel are to be in attendance when the points are unlocked or unclipped.

5.3.4.2.4 Testing when points equipment disconnected.

If the planned work involves the renewal of the points wiring or the disconnection and removal of more than one wire from its terminal at the one time, then the procedure PR S 40011 is to be observed with testing of the wiring, points correspondence and out correspondence testing to ensure correct reconnection. If there are mechanical disconnections or track or permanent way adjustments then it will be necessary to perform point lock and detection tests.

5.3.4.2.5 Work on ESMLs or EOLs

Where work is restricted to an ESML or EOL that would cause severe disruption to train operations, a temporary bridging authority to bridge-out the detector contacts of the ESML or EOL may be obtained provided that:

- The points remain in correspondence with the interlocking
- All point end point locks and detection are in correct working order
- The points are not disarranged or worked on in a way that the safety of the signalling is impaired.

The points manual operation facility shall be booked out of use and the ESML or EOL manual operation facility at all affected point ends secured using signalling Falcon 8 locks, however, the points and signals may be left operational using signalling controls.

The requirements of PR S 40002 and Section 5.3.4 above (as applicable) shall be read in conjunction with this procedure and followed. Additionally refer to PR S 40004 for failures.

5.3.4.3 Unplanned Work During a Planned Possession

If during the course of a planned possession it becomes obvious that the points equipment is at risk of damage and requires to be disconnected to protect the equipment or, if otherwise it becomes necessary to be disconnected, then bridging of the detection to maintain signalling on adjacent roads which are not affected by the possession, is only permitted if authorised and carried out in accordance with the requirements of Section 5.3.4.2 above.

5.3.5 Disconnection of Points for Indefinite Period

If it is necessary to disconnect either mechanically or power operated points for an indefinite period, the points shall be spiked, clipped and XL locked in accordance with NWT 312 and NPR 704. Also the requirements in PR S 40007 shall be followed.
5.4 Disconnection of Level Crossing Protection

5.4.1 General

The method of level crossing protection disconnection depends on whether or not the installation has been fitted with EMR arrangements. Where it is necessary to disconnect level crossing protection equipment (i.e. type 'F' warnings lights, bells, half arm booms, pedestrian warning lights, audible alarms, booms and gates), licensed signalling personnel shall first be aware of the different arrangements that apply (i.e. level crossings fitted or not fitted with EMR arrangements).

The removal of power to level crossing protection equipment constitutes disconnection from the interlocking.

5.4.2 Level Crossings not fitted with Master Emergency (EMR) Arrangements

The crossing control (XR) fuse is to be removed. Additionally, where Up Road and Down Road control relays are provided, the circuit fuse for the relevant relay is also to be removed if that circuit is directly affected (i.e. when one or more of the approach track circuits have been disconnected).

Where road half arm boom barriers, pedestrian booms or gates are provided, the motor control fuses for the Up and Down booms and gates are to be removed. Road booms shall be arranged to be tied up clear of the road.

Pedestrian crossing booms are not to be tied up or gates held open.

In single line areas where Up and Down Direction Stick relays are provided, both relay circuit fuses are to be removed.

Where the level crossing is situated in an interlocking and protected by home signals the fixed signals protecting the interlocked level crossing are to be disconnected and maintained at stop and the associated distant signals or equivalent (i.e. higher indications of signals immediately in the rear) are to be disconnected so that these signals are restricted to a caution indication or low speed, as applicable (refer to Sections 5.1 and 5.2).

In addition, hand signallers shall be provided at the level crossing and affected signals, if applicable, in accordance with NWT 312, NPR 704, NGE 218 and NPR 715.

5.4.3 Level Crossings fitted with Master Emergency (EMR) Arrangements

Level crossings that are fitted with level crossing EMR arrangements enable full functionality of the level crossing protection equipment, irrespective of the status of the control circuits, during manual operation by Qualified Workers for emergencies or planned track work. This maximises the availability of warning provided by the level crossing.

Confirm that rail traffic is not approaching or beyond the protecting signal(s) when operating the Master Emergency switch

Operation of the Master Emergency switch will deactivate the level crossing operation in the raised position and cause protecting signal(s) on the approach side of the level crossing (where provided) to be retained at Stop, allowing road and pedestrian traffic to pass. When it becomes necessary to allow rail traffic to pass, the Manual Operating switch shall be used to activate the warning equipment. The signals clear once the level
crossing has been proved in the lowered position and the availability of other conditions such as track circuits clear, route set, etc. being available.

Whenever the Master Emergency arrangements are in use, the Qualified Worker shall remain in attendance at the level crossing.

Level crossings fitted with EMR arrangements when booked out of use need not be disconnected unless the level crossings protection equipment itself is inoperable.

However, use of the Master Emergency switch is not permissible in the situation where the level crossing warning equipment is required to be formally disconnected and booked out of use. Disconnection of the crossing shall be performed in accordance with Section 5.4.2.

If it is necessary to carry out work on a damaged boom or associated equipment, then the boom shall be tied up clear of the road. The associated motor operating fuse removed - in conjunction with turning off the relevant Boom Emergency switch to place the boom out of service. Should damage be more extensive and operation of the Master Emergency switch does not cause the level crossing to cease, the arrangements shown in Section 5.4.2 are to be implemented.

5.4.4 Where Track work affects the Operation of Level Crossing Equipment

It is preferable to have the level crossing operational wherever possible to maximise the safe use of the signalling system.

Where the operation of the level crossing equipment is affected by planned track work, the signal engineer, in consultation with the maintenance signal engineer, shall evaluate the need to maintain the level crossing in an operational state.

In bi-directional areas where track work is conducted on one track only, consideration should be given to obtaining a signal design for bridging out the track control circuits that affect the level crossing, thus permitting the level crossing to operate normally for the unaffected track.

5.5 Disconnection of Electric Locks and Releasing Switches

When disconnecting a Releasing Switch or Electric lever lock to prevent its operation, the operating circuit fuse is to be removed and the common/negative side is also to be manually open-circuited.

A test is then to be made to ensure that the device is inoperative.

5.6 Disconnection of Track Circuits

Track circuits shall be disconnected to prevent the energisation of the track circuit relay/output. Care shall be taken to ensure track circuit relays/outputs are not falsely energised by other track circuits or power sources.

In electrified areas track circuit equipment is to be isolated by open circuiting the cable leads to the track in both the feed and relay end locations to prevent the potential of any traction return current or other extraneous voltages entering the track circuit equipment. This is not required in the case of jointless track circuits or for high voltage impulse track circuits that incorporate an isolating transformer in the trackside termination.

When disconnecting track circuits the circuit fuses controlling the FEED and RELAY are to be removed.
The disconnection of FEED arrangements is as follows:

a) For transformer fed track circuits both AC and DC,
   i) The transformer primary fuse (typical 120v) is to be removed, and
   ii) At least one of the links on the secondary side of the feed transformer to
       track is to be removed.

b) For Jeumont track circuits:
   i) The 120v fuse to the transmitter is to be removed, and
   ii) At least one of the internal links on the outgoing cables to the track is to
       be open circuited. This is not required in the case of high voltage impulse
       track circuits that incorporate an isolating transformer in the trackside
       termination.

c) For Audio Frequency tracks, both the active/positive and common/negative
   needs to be removed. Always remove the common/negative pin or link before
   removing the fuse as this provides a clean disconnection action.
   i) Where the track circuit is fed from a bus bar, the supply pin and fuse
      (typical 24 V) feeding the transmitter is to be removed, or
   ii) Where a separate power supply is provided the 120 V pin and fuse
       feeding the P/S unit is to be removed.

d) For Microtrax Master End, disconnect both links in the Microtrax Track Interface
   panel.

   Note: Do not disconnect the link between the Microtrax circuit module in the
   cardfile and outgoing track connection cable in the location as this will
   cause a selective shutdown of the cardfile due to load mismatching
   on the Microtrax module.

The disconnection of RELAY arrangements are as follows:

a) For both conventional AC and DC track circuits the track side fuse controlling
   the relay is to be removed, the local fuse for an AC vane track relay need not
   be removed.

b) For Jeumont track circuits at least one of the internal links on the incoming
   cables from the track is to be open circuited.

c) For Audio frequency track circuits, both the active/positive and
   common/negative needs to be removed. Always remove the common/negative
   pin or link before removing the fuse as this provides a clean disconnection
   action.
   i) The supply pin and fuse to the receiver is to be removed (typical 24 V)
      or,
   ii) alternatively, if the unit has its own separate power supply, the 120 V pin
      and fuse to the P/S may be removed.

d) For Microtrax Slave End, disconnect both links in the Microtrax Track Interface
   panel.

   Note: Do not disconnect the link between the Microtrax circuit module in the
   cardfile and outgoing track connection cable in the location as this will
cause a selective shutdown of the cardfile due to load mismatching on the Microtrax module.

5.7 Disconnection of ETCS Equipment

Where it is necessary to disconnect or remove an ETCS LEU, this will result in a default (i.e. most restrictive) telegram being sent from any controlled balise attached to that LEU. This will cause a train to receive either an ETCS warning on the DMI or a brake intervention, potentially when the driver is driving appropriately to signal aspects and speed boards.

Where it is necessary to disconnect a failed LEU or balise, there are no specific requirements for the management of the failure until it is rectified, as trains would be expected to continue to obey the more restrictive braking requirements imposed by the failure. The Network Control Officer should be advised to issue a CAN notice if the disconnection is likely to remain in place for a significant period of time.

Note For ETCS equipment that uses current sensing (typically SSI installations); disconnection of the LEU incorrectly will stop the associated signal from displaying an aspect. In this case refer to PR S 40028 for the correct procedures for the disconnection of an LEU which uses current sensing.

5.7.1 ETCS Trainstops

Acceptable methods to ensure that an ETCS trainstop is maintained in the trip condition are:

- remove the transient protection cassette for the applicable controlled balise, or
- power down the associated LEU

The voltage to the ETCS trainstop controlled balise(s) should be tested at the ETCS trackside junction box to ensure that the correct equipment has been disconnected.
Engineering Procedure
Signalling and Control Systems

Signalling Safeworking

PR S 40010

Risks and Controls Associated with Testing and Certifying Equipment

Version 1.3

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Disclaimer

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Document control

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1 Introduction
Having assured a safe, operational signalling installation by certification inspection and testing of new works and alterations, it is essential that this integrity is maintained and is not jeopardised by maintenance work that requires some necessary interference with vital parts of the signalling system.

When performing work on signalling equipment which involves disconnection, disarrangement, disassembly or adjustment, licensed signalling personnel shall take adequate precautions during the work and carry out proper tests at the completion of the work, commensurate with the risk of incorrect reconnection, assembly or adjustment and a resultant irregularity. This includes risks associated with polarity reversal.

2 Reference documents
This procedure should be read in conjunction with the following documents:

- Network Rules and Network Procedures
- SPG 706 - Installation of Trackside Equipment
- PR S 47110 - Inspection and Testing of Signalling
- PR S 40004 - Failures
- PR S 40011 - Renewals Work
- PR S 40012 - Repair/Replacement of Signalling Wires
- PR S 40025 - Track Circuits
- PR S 40028 - Automatic Train Protection – Alstom ETCS Trackside
- PR S 40050 - Control Systems
- MN T 20251 - Turnouts

3 Terms and definitions
The following terms and definitions apply in this document:

- ETCS - European Train Control System (a form of automatic train protection)
- LEU - Lineside Electronic Unit
- promptly - without delay
- duly notified - advice is provided during normal business hours such as Monday to Friday by methods such as phone, email, text message or in person.

4 Assess the Risks, Take Adequate Precautions, Test on Completion
Risk is a measure of probability of the undesired event occurring, multiplied by the severity of the consequences.

Whenever a wire is disconnected from its terminal there may be a risk that it could be reconnected to the wrong terminal.

The risk increases with the circumstances, e.g. are there other terminals close by; are the terminals and the wires labelled; are they correctly labelled; is more than one wire disconnected at the same time; is the period of disconnection brief or extended; will the person who re-connects the wire be a different person to the one who disconnected the wire; is the person involved unfit, tired or under pressure; is complacency likely; is lighting
and access good or poor and awkward; could wrong reconnection lead to an irregularity or would it instantly be detected by a right side failure?

Similarly, if an item of equipment is disconnected or disassembled, or replaced, is there a risk that it could be installed the wrong way around or upside down, and would such wrong assembly be detected by failure or could an irregularity result?

Similarly, if broken wires are repaired there is a risk they could be cross-connected and in certain cases this could cause an irregularity, if undetected.

4.1 Risk Mitigation Requirements for Minor Additions, Alterations or Renewals

Licensed signalling personnel are to assess these risks when disconnecting wiring and when disconnecting or disassembling equipment and are to take adequate precautions to minimise the risk, for example:

- Electrically isolate the live circuitry of affected signalling from the worked-on portion
- Correlate the existing arrangement, which includes apparatus inspection, wire and null count to ensure it reflects the specific as-built design before commencing work
- Ensure the signalling documentation used reflects the latest design
- Secure and insulate unterminated wires, including spare cable cores in such a way that they are unable to make contact with any conductive surface or electrical component
- Not connect wires or equipment pending commissioning to working circuits, and as such shall require two points of connection to take effect
- Not leave connected wires and equipment decommissioned from use, to working circuits or power supplies
- Mark or label the wires and corresponding terminals before connecting or removing.
- Treat metal links as wires, particularly when wire/null counting
- Disconnect and reconnect only one single wire or one cable type (where the individual cores can be easily identified) at a time, where possible
- Mark matching sides of items of equipment including air hoses before disassembly.
- Provide a unique and distinct colour for temporary wiring used on each stage or testing purpose
- Comply with the required standard for the specific location including wires, cable cores, contacts and other items of equipment which will be utilised in new or altered circuits
- Update accordingly, the signalling documentation at the end of each stage
- Ensure personnel are competent for the task
- Comply with the testing and certification requirements of PR S 47110
- Provide adequate lighting and access
- Remove distractions or causes of pressure; apply a methodical and systematic approach and concentrate the mind on the issues involved.
• Maintain proper housekeeping of the work area and ensure the housing and all equipment are made secure when vacated

Most importantly, licensed signalling personnel are to follow up the precautions taken (to eliminate the probability of incorrect reconnection, assembly, repair or replacement) with a series of tests, in accordance with PR S 47110, of the reconnected circuit or item of equipment to ensure it is working correctly. A functional test of the apparatus shall always be included in such testing. Network Rules and Network Procedures are to be followed wherever they apply.

Similarly, when equipment is adjusted, licensed signalling personnel are to assess the risks, take adequate precautions to eliminate the probability of incorrect adjustment and then carry out tests to verify the correct operation of the adjusted equipment.

4.2 Involvement of Signal Engineer for Risk Mitigation Requirements

A signal engineer shall be associated with every signalling addition, alteration or renewal. The level of association shall be dependent upon the risks associated with the work and the authority level of the signalling personnel performing the work, which includes inspection, testing and certification.

Examples of such cases are listed below:

• Signal engineer signs off the scope and authorisation form for a like for like renewal.
• Signal engineer authorises a like for like renewal where the equipment is not exactly identical.
• Signal engineer is advised of rewiring.
• Signal engineer performs inspection and testing of signalling additions or alterations.
• Maintenance signal engineer is consulted when adjustment made beyond specified or expected limits.
• Maintenance signal engineer notified when temporary repairs are effected.
• Commissioning Engineer commissions new or altered signalling.

4.3 Principle Process for Minor Signalling Additions, Alterations and Renewals Work

Where work on vital signalling equipment involves disconnection, disarrangement, disassembly or adjustment, then the principles shall be that:

• The equipment is worked on in accordance with the relevant Network Rules and Procedures and the Signalling Safeworking Procedures.
• Adequate precautions are taken to eliminate the probability of incorrect reconnection, assembly, replacement or adjustment.
• The equipment is tested to function correctly after the work is completed.
• The work is recorded with the relevant documents completed and signed by licensed signalling personnel which shall signify that it has been tested and functions correctly prior to returning the apparatus into service.
• The documents are submitted to the maintenance signal engineer, who actions it appropriately and retains the documented report on file.
Except as provided for in the like for like renewal requirements, details shall be submitted on the following signed documents, which shall constitute certification:

- Relevant maintenance record documents (e.g.: Point history card, monthly returns, insulation test record, track circuit history card, relevant inspection and test form) (if applicable).
- Infrastructure Booking Authority form NRF 003 (if applicable).
- Interlocking certificate, design integrity test certificate (if applicable).
- A specific work instruction as prescribed in PR S 40011 – Renewals Work, or other work instruction (if applicable).
- Certified office copy circuit book, signalling plan, track insulation plan, control table, locking table or working sketch (if applicable).

The maintenance signal engineer shall ensure that reporting and recording procedures are adequate and be satisfied that the work has been properly carried out.

Licensed signalling personnel are to select and perform inspections and tests that will satisfy the certification requirements for the particular work.

A list of various types of inspections and tests used to verify correct physical and functional compliance as described in the following section.

4.3.1 Typical Inspections and Tests to Verify Physical & Functional Compliance

**Documentation Check:**

Verify design analysis sheets - contact analysis, fuse, terminal, rack layouts and relay types to each circuit design sheet. Ensures updated and verified documentation and further, the documentation required to conduct the Null Count.

**Correlation Check:**

Hand trace (verify conductor runs directly i.e. no intermediate connections between two wire termination points) and wire count existing portions of the altered circuit/s sufficiently to verify that the design and the actual circuits are one and the same.

**Apparatus Inspection:**

Verify correct configuration, type, colour, labelling, inscriptions, positioning, clearances, rating, warding/pin coding/indexing, tightness, secureness, lock-up security, damage free, quality workmanship, no loose wires, extraneous items/material removed, temporary wiring/bridging removed, stage work removed.

**Wire Count:**

Verify correct number of conductors on terminals, also tightness and termination workmanship.

**Null Count:**

Verify no conductors on spare terminals.

**Insulation Test:**

Megger test insulation of conductor to earth, frame, cable screen/drain, cable spare conductors.

**Bell Continuity Test:**

Bell/meter test for conductor continuity between wire termination points.

**Hand Trace:**

Verify conductor runs directly (i.e. no intermediate connections) between two wire termination points by hand tracing.
<table>
<thead>
<tr>
<th>Function Test</th>
<th>Description</th>
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| Apparatus Function Test | 1. Test apparatus operates correctly from its local controls and power source and indicates its status correctly to local indications.  
2. Verify apparatus operates its contacts in correct correspondence and adjustment.  
3. Verify mechanisms operate freely and within specified tolerances and in correct adjustment and that lights are correctly illuminated and focused/aligned.  
*(1. Local Operation and Correspondence Test, 2. Contact Proving Test, 3. Adjustment Test)* |
| Contact Proving Test | Test apparatus opens and closes its contacts in correct correspondence and adjustment. |
| Circuit Function Test | Test the circuit function energises and de-energises when its control devices change state and when fuses, links, are removed and replaced. |
| Circuit Strap & Function Test | Test the circuit function is energised and de-energised by the specified contacts of its control devices when those individual contacts open and close; also when fuses, links are removed and replaced. |
| Function Test to Control Tables | Test that functions interlock and/or control one another, in accordance with the control table. |
| Through Circuit Test | Circuit function test the completed circuit over outgoing/incoming cable links and verify correct correspondence. |
| Through System Test | Test correspondence from initial input to final output for controls and indications combined. |
| Track Circuit Shunt Test | Test track relay is dropped away when the track circuit is shunted by a train (Train Shunt Check) or by a fixed shunt of the correct value at a given point along the track (Fixed Shunt Check) or by a fixed shunt at all extremities and the mid point (Fixed Shunt Test). |
| Track Circuit Drop Shunt Test | A variable shunt applied at the receiver/relay end of a track circuit to identify the drop shunt resistance value. |
| Track Circuit Polarity Test | Test for polarity reversal at block joints between adjoining track circuits, at all extremities. |
| Power Supply Polarity Test | Test power supply polarity is correct and has not been reversed when transformers are changed or when wiring is interfered with. |
| Power Supply Isolation Test | Test that power supply busbars are free of earths. Test that power supplies busbars are not interconnected. |
| Aspect Sequence Test | Test to check that signal indications assume the correct colour or position for the various operational sequences and failure conditions. |
| ETCS LEU Input Correspondence Test | Test to check the LEU outputs the correct telegram for each signal aspect input. |
| ETCS Balise Function Test | Test the balise air-gap interface to confirm output telegram is correct to the signal aspect. |
| ETCS Balise Default Telegram Test | Test the balise air-gap interface to confirm the default output telegram is correct. |
**Mechanical Locking Test:** Test mechanical locking (to Locking Table, Locking Diagram, Working Sketch) of interlocking frames, release switch locks, electric locks, releasing keys, Annett locks, pilot man’s locks, half pilot staff locks, bolt locks, bracket locks, mechanical detectors/selectors, emergency operator locks, emergency switch machine locks, point lock detectors, etc.

**Points Correspondence Test:** Test that points detection is obtained at each end of points with all ends of a set of points in the normal position & then reverse. Ensure the relevant detection energises and de-energises whenever each control device in the detection circuit changes state.

**Points Out of Correspondence Test:** This test is usually done in conjunction with a Correspondence Test. Test that points detection is not obtained with one end of a set of points normal & the other end(s) reverse and vice versa, for all combination of ends.

**Point Lock Test:** Test lock fails at correct setting.

**Closed Switch Detection:** Test closed switch breaks detection at the correct setting. Check switch is correctly closed up along the closed switch.

**Open Switch Detection and Switch Openings:** Test open switch breaks detection at the correct setting. Check switch openings are correct along the entire length of the open switch.

## 5 Alterations Not Affecting the Principle of Circuits

Licensed signalling personnel are permitted to perform some alterations work on the signalling system, without the direct involvement of a signal engineer, where the work does not alter the design principle.

The following are the tasks that can be performed by licensed signalling personnel:

- Transfer of a circuit from a defective contact, terminal, cable core or wire to an equivalent spare in order to rectify a failure scenario. The wiring work shall be limited to removing one single wire or cable type at a time. This work shall be treated as a temporary repair in accordance with PR S 40004 Section 1.8.

- Replacement of signalling equipment with an identical type. The like for like renewal requirements in accordance with PR S 40011, PR S 40028 and PR S 40050.

- Replacement of consumable or sub component items, where there is minimal risk of error. These items include pluggable apparatus that are indexed against incorrect insertion. This work may be exempt from meeting the like for like renewal requirements.

The following are examples of consumable or sub component items that may be exempt from the like for like renewal requirements:

- Fuses and terminals
- Power supply units, transformers, capacitors, rectifier units
- Mechanical pins, bushes, fasteners and minor mechanical components such as cranks, rods, economical movements, detector ball joint, extension irons.
- Contacts where fitted with a pluggable wiring loom or individually wired
- Plug-in relays, track circuit transmitters and receivers.
• Trainstop limit switches, motors, older style contact fingers, trip arms, detector arms.
• Electric point motors, capacitors, clutches, mechanisms, older style contact fingers.
• Signal Lamps, signal LED boards, signal lenses.
• Level Crossing booms, lights and bells
• Signalling controls and indications such as push buttons, switches and diagram lights

Where licensed signalling personnel make some alterations which do not affect the principle of the circuits, the maintenance signal engineer shall be duly notified. In addition, licensed signalling personnel shall test the circuit thoroughly each time such an alteration is made, provide a documented report and call the maintenance signal engineer’s attention to the alterations so that they can check them throughout.

In the event of any relocation or alteration in the adjustment being necessary on any working contact, special reference of such alteration should be recorded and be brought to the attention of the maintenance signal engineer.

Resistances, excepting track resistances, which are provided in certain portions of the equipment, should not be altered without authority from the maintenance signal engineer unless absolutely necessary to meet an emergency. In such cases the resistances shall be replaced as soon as normal conditions are restored.

Resistances in track circuits may be altered as required, care being taken to see that the relays are not receiving more energisation than is necessary for their normal operation. A careful check shall be made of the track circuit to ascertain the necessity for the alteration, and, if possible, the cause removed and the resistance restored. The maintenance signal engineer shall be notified of any adjustment or alteration to resistance values in accordance with PR S 40025. The Track History Card shall be updated to record any alteration and a scanned copy or photo sent to the maintenance signal engineer for information.

In an emergency, licensed signalling personnel may transfer a circuit from a defective contact or terminal to an equivalent spare contact or terminal or transfer a circuit from a defective cable core to a spare cable core provided the following procedure is also followed:

• The circuit is tested to prove that the circuit has not been altered in any way.
• The maintenance signal engineer shall be promptly notified of any changes.
• Any rearrangement in vital signalling circuits to the existing wiring between terminals, although there may be no change to the principle of the circuit, and even though the terminals may not be detailed in the existing circuit book, shall constitute a wiring alteration and, other than in emergency, require the prior approval of the maintenance signal engineer.
• Design drawings are required to be brought up to date with any permanent changes; the maintenance signal engineer shall be advised and make suitable arrangements with the Signalling Documentation Manager.
• Adjustment made to vital signalling equipment beyond the specified or expected limits shall be first approved by the maintenance signal engineer before bringing the equipment back into use.
5.1 Renewal of Signalling Equipment

When it is necessary to renew signalling equipment that has become defective or life expired, licensed signalling personnel shall be aware of the risks involved with the work including an assurance that the equipment being replaced is with an identical item.

Where the replacement item is not exactly identical, authorisation from the maintenance signal engineer in accordance with PR S 40011 shall be obtained.

6 Alterations Affecting the Principle of Circuits

Alterations which affect the principle of the circuits shall be carried out only to approve circuit design alterations as authorised by the Professional Head Signalling & Control Systems.

A signal engineer shall be responsible for implementing and commissioning the alteration in accordance with PR S 47110 and hence shall be the "Commissioning Engineer". Testing and certification shall be carried out by the Commissioning Engineer or an independent signal engineer (who did not install any part of the alteration) as nominated and instructed by the Commissioning Engineer.

7 Relocating or Moving Relay Racks

Moving, relocating or temporarily supporting relay racks with operational relays in service should be avoided wherever possible. Whenever it is unavoidable precautions shall be taken to ensure that there is no possibility of irregular operation, otherwise all associated circuits are to be disconnected and booked out of use.

Similarly, when any abnormal activity could tilt or turn upside down vital signalling equipment which relies on gravity return, the work shall not be carried out while the equipment or affected circuits are in operational service.

8 Authority to Interfere with Working Signalling Circuits

Signal engineers and licensed signalling personnel are permitted to interfere with vital signalling equipment and working circuits in the performance of their duties, in accordance with Sydney Trains standards & procedures and as approved by relevant Commissioning Engineers or maintenance signal engineers.

Persons who are not licensed in signalling are not to interfere with operational signalling circuits or equipment, nor do anything that affects or could affect the adjustment of operational signalling equipment. Except as specifically instructed and under direct and close supervision of licensed signalling personnel or signal engineers, who shall take responsibility for the work being performed by the non-licensed person. This work shall include the removal or insertion of fuses, terminal pins and links in operational signalling circuits or equipment in association with booking apparatus out or into use.

Authorised signalling personnel are permitted to perform specific unsupervised work within a live signalling environment. They shall perform work only as prescribed on their Certificate of Competency and Permit to Work. Such work may include the supervision of non-signalling personnel during specific non-invasive tasks such as installation work, cabling, wiring, mechanical and civil works as prescribed on the Permit to Work.

Authorised signalling personnel may also perform or lead testing and certification of signalling apparatus in accordance with their Certificate of Competency and Permit to Work. The affected signalling shall be first booked out of use and disconnected from the interlocking by licenced signalling personnel before the testing work can proceed.
The statement 'direct and close supervision' requires the supervised person to work in reasonable proximity to the supervising person. Reasonable proximity refers to the supervised works being clearly seen and heard within normal hearing and speaking distance given the ambient noise level. All supervised work shall meet these criteria for reasonable proximity. The use of non-licensed/non-authorised signalling personnel to perform similar duties at remote locations where the criteria of reasonable proximity cannot be met, or where it is necessary to use telephones or radios to communicate is strictly forbidden.

Additionally, the work shall be performed by persons competent of doing the work. For example, a relevant trade person shall be required for building, electrical or air conditioning works.

The supervised work shall be commensurate with the licence/authorisation level of the person providing the supervision (see examples below). Suitable instruction shall be provided to the person performing the work to ensure they understand the signalling requirements associated with the work.

**Example 1:** Licensed signalling personnel (*Signal Electrician*) conducting track circuit testing or insulation testing of local equipment tail cables at a signal location, may use a non-licensed person to assist in the removal or insertion of fuses, terminal pins and links in existing operational signalling circuits where it is necessary to complete the work.

**Example 2:** Licensed signalling personnel (*Control Systems Technician*) conducting like for like renewals work at a signalling location, computer room, may use a non-licensed person to assist in the removal or insertion of, operational Control Systems equipment where it is necessary to complete the work.

**Example 3:** Authorised Signalling Personnel (*Signal Electrical Installer*) may supervise another person who is not an Authorised Person to install wiring within a live signalling location within the limits pertaining to the Authorised Signalling Personnel Certificate of Competency and Permit to Work.

**Example 4:** Authorised Signalling Personnel (*Electrical Mechanic*) may supervise another person who is not an Authorised Person to perform works such as maintenance of air conditioning systems, fire protection systems, security systems, building structures, etc. that are well clear of operational signalling equipment within a live signalling location.

The above examples are provisional of:

- The person having the applicable trade and other essential competencies.
- The person having been suitably instructed.
- The work meets the criteria for reasonable proximity.

The practise, where signalling maintenance teams only comprise of a Signal Electrician & a Signal Mechanical person, and the Mechanical Person provides general assistance for electrical testing of signalling (meter readings, holding test leads, observations, etc.), is recognised under these provisions and remains permissible. The level of assistance provided and adequate instructions for each occasion shall be at the discretion of the Signal Electrician who shall take responsibility for the entire work.

### 8.1 New Works and Alterations

Where signalling equipment and/or circuits are disconnected and booked out of use and where the precautions in place together with the inspection and testing activities to be conducted will adequately ensure that only the intended connections, disconnections and adjustments will occur, then non-licensed persons, suitably authorised and experienced, who receive proper instruction, may be used to progress the work on the disconnected
signalling equipment and circuits under a level of supervision commensurate with the attendant risks.

The precautions in place, the inspections and tests to be conducted, and the level of supervision are also required to safeguard against:

- The possibility of inadvertent or mistaken interference with working signalling equipment and circuits in the vicinity that are not disconnected and booked out of use.
- The possibility of wiring connections being made inadvertently or mistakenly to the wrong terminals (and then the correct connections being made with separate wiring) and the incorrect wiring being overlooked and left connected in a situation where it would not necessarily be detected in functional testing of the intended alterations. (When carrying out new work and alterations, any incorrect wiring run or wiring incorrectly terminated is to be removed as soon as it is discovered.)

Licensed signalling personnel or signal engineer in charge of the work is accountable for the work performed by those non-licensed persons and shall ensure the work is performed within the required restrictions.

9 Renewal of Switches, Stockrails or Turnout

A joint inspection by Civil & Signals is required on any turnout where a renewal of the switches, stockrails or turnout is proposed.

A checklist is to be completed and retained by licensed signalling personnel. This checklist is to be attached to documentation forming the scope of work for the project.

Additionally, signalling personnel are authorised to drill switches and stockrails in accordance with SPG 706 Installation of Trackside Equipment - Appendix D.

9.1 Checklist

The checklist for signals requirements for switch, stockrail or whole of turnout renewal works shall be completed for each instance where renewal is carried out affecting switches or stockrails with signal equipment attached. The checklist is to be signed by the responsible civil and signal personnel and will be held by licensed signalling personnel.

For checklist see the track standard MN T 20251 Turnouts, Chapter 2-1 ‘signals requirements for track work affecting points’ and Appendix A ‘checklist for turnout work’.
Engineering Procedure
Signalling and Control Systems

Signalling Safeworking

PR S 40011

Renewals Work

Version 3.0

Date in Force: 8 March 2019
Disclaimer

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Document control

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Summary of changes from previous version

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<td>Major reorganisation of sections</td>
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<td>Update reference numbers for Inspection and Testing of Signalling</td>
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1 Introduction

Whenever vital signalling equipment is renewed or replaced it shall be done in accordance with the applicable Signalling Safeworking Procedures, Inspection and Testing Procedures, Network Rules and Network Procedures.

The restored equipment shall be tested and certified correct before the apparatus is brought back into use.

These procedures aim to ensure there is no alteration to the circuit design and principle, no change of polarity and no unexpected adjustment.

Where there is any modification to the principle of the circuits or interlocking then the work is to be conducted in accordance with PR S 47110.

Signal engineers and licensed signalling personnel shall ensure they comply with the requirements in this procedure as well as the below referenced procedures.

Where the information contained in this procedure and the referenced documents is not fully understood, licensed signalling personnel shall arrange to discuss those issues with a signal engineer.

2 Scope

The precautions prescribed in this procedure are applicable to vital signalling equipment such as relays, electrical apparatus, trackside equipment (including ETCS equipment), and wiring.

3 Reference documents

This procedure should be read in conjunction with the following documents:

- PR S 40001 Introduction to Signalling Maintenance Procedures
- PR S 40008 Securing Signalling Apparatus Out of Use
- PR S 40009 Disconnection of Signalling Apparatus
- PR S 40010 Risks and Controls Associated with Testing and Certifying Equipment
- PR S 40012 Repair or Replacement of Signalling Wires
- PR S 40013 Field Paralleling of Signalling Contacts
- PR S 40024 Vital Signalling Relays
- PR S 40025 Track Circuits
- PR S 40028 ETCS Trackside Equipment
- PR S 40047 Calibration of Tools and Instruments for Signalling Applications
- PR S 40050 Control Systems
- PR S 41604 Alstom ETCS Trackside Maintenance Manual
- PR S 47110 Inspection and Testing of Signalling
4 Renewal of Like Equipment

Like for like renewal refers to the replacement of an item with an identical item. It can also refer to an item that is not identical where it is deemed acceptable by a signal engineer on the following basis:

- The replacement item is of a similar characteristic, footprint
- Where the difference does not diminish the intended design principle

The like for like renewal requirements generally pertain to the renewal of trackside apparatus such as electric point mechanisms, electro-pneumatic point equipment, mechanical points components, signals, trainstops, vital shelf relays, releasing switches, level crossing mechanisms, balises and similar items.

The like for like renewal process aims to mitigate the risks associated with the renewal of equipment. To this extent, the like for like renewal process is mandatory for equipment renewals unless otherwise stated as exempt.

All equipment renewed, as well as any signalling affected by the work shall be tested and certified prior to reinstating such signalling into use. The licensed signalling personnel performing the work shall hold accountability for this certification. This means that licensed signalling personnel are to ensure the equipment renewed is of the correct type and configuration and that no alteration has occurred contrary to design requirement (either the approved design or design variant approved in the like for like renewal authorisation). Additionally, it means that all other signalling affected by the renewal work has been sufficiently tested to ensure there were no impacts caused by the work taken place.

Like for like renewals can be performed by licensed signalling personnel without the appointment of a commissioning engineer.

Where renewal work requires modification to the circuit or interlocking, such that it alters the design principle shall be deemed General Renewals Work and undertaken in accordance with Section 5.1 below.

Refer to Section 13 for like for like renewals.

5 Renewal of Unlike Equipment

Where an item of signalling hardware or software is required to be replaced with an item which is not identical, that is not of the same type, version and not equivalent in all respects then the matter shall be referred to the maintenance signal engineer or the signal engineer in charge of the works who shall determine if the renewal can proceed under the "like for like" process otherwise it shall be deemed "general renewals work".

5.1 General Renewals Work

All renewals work and modifications to existing circuits shall be deemed general renewals work except as provided for within MN S 40000 Signalling Safeworking Procedures such as in Section 13 of this document, PR S 40004, PR S 40012 and PR S 40013.

General renewals work requires supporting documentation including an authorised design, work package, test plans, and work instructions as prescribed in PR S 47110. This work shall be certified by a Commissioning Engineer or a nominated signal engineer.
6 Relay Change - Plug-in Relays

This section shall be read in conjunction with PR S 40024 and PR S 40025 (as applicable). The following precautions apply when replacing plug-in relays.

Plug-in relays may be changed over as traffic conditions permit between trains.

Prior to placing any plug-in relay in service it shall be closely inspected to see that the contacts are aligned correctly and it has not been damaged in transit. The replacement relay shall be checked to be of the same voltage, type, contact configuration, and coding pin index, as the relay being replaced.

The new relay is to be operationally tested in the plug-in relay test panel or automated relay test equipment, prior to placing into service.

Magnetically latched relays shall be driven down before they are placed in circuit.

After changing over, the principal functions controlled by the relay shall be checked to ensure they operate in accordance with the specific circuit design.

If the replaced relay had caused a failure, the change details shall be recorded in Sydney Trains defect and failure management system. Change details for certain plug-in relays (plug-in vane relays, electromechanical or thermal relays, track relays, etc.) shall be recorded as prescribed in PR S 40024 or PR S 40025 as applicable.

7 Relay Change - Shelf Relays

This section applies to all AC and DC shelf relays and is to be read in conjunction with Section 13 and PR S 40024.

Shelf relays that become defective or due for replacement shall be replaced with a relay type of identical configuration to the relay being replaced. Where this is not practical, licensed signalling personnel shall consult with a signal engineer for advice prior to replacing the relay. In this case, the signal engineer shall ensure that the specific circuit design principles have not been altered and that the replacement relay is treated as a "temporary repair" or otherwise, after obtaining approval from the Professional Head Signalling & Control Systems, arrange for the affected circuit documentation to be updated. The maintenance signal engineer is to be duly notified of the temporary repair.

Note: It is permissible to replace a double element AC line relay with a single element type and vice versa provided due care is taken to ensure that local and control coils are correctly bridged in parallel for double element relays.

The replacement relay is to be examined and bench tested for correct operation and checked that it is of the same type and contact configuration as the one to be replaced and as shown in the circuit book prior to placing into service. The relay shall be sealed and the seal shall not be broken.

The replacement of shelf type relays is treated as safety-critical work and shall be carried through by licensed signalling personnel using the utmost care. Transfer to another person part way through is not permitted.

The procedure as prescribed in Section 13 Like for Like Signalling Equipment Renewals shall be strictly followed for the replacement of shelf relays.

Whenever track relays are replaced, licensed signalling personnel shall ensure that the shunt value is within the permissible range of values for the type of track and that the local coil voltage and current and track coil voltage and current are correctly adjusted.
When any DC shelf-mounted relay or DC standard 'B' size plug-in relay is changed the "pick-up", "drop-away" and "working" currents of the new relay shall be tested.

The change details shall be recorded in the form PR S 40024 FM01 by licensed signalling personnel and forwarded to the maintenance signal engineer for recording as prescribed in PR S 40024. The relay records or database shall be updated to reflect the change. Should the replacement be due to a relay failure, then details shall also be recorded in Sydney Trains defect management and failure management systems.

8 Electrical Signalling Equipment Renewal

This section is to be read in conjunction with Section 13. Refer also to Section 8.1 for replacement of transformers.

The following precautions apply to the renewal of electrical signalling apparatus.

- The replacement equipment is firstly to be inspected and tested to be the correct type and in proper working order.
- If contacts are to be replaced they are to be changed one contact at a time by licensed signalling personnel.
- If a contact carrier, circuit controller or other electrical equipment that is to be replaced requires the removal and reconnection of wires, then the work shall be done in accordance with Section 13.
- Care shall be taken when renewing mechanical equipment, including rodding, cranks, etc., to ensure that the operation of such apparatus is not altered by the renewed components. Where the renewal alters the configuration of interlocking equipment, it shall be certified to be accordance with an approved signal design by a signal engineer.
- Adjustments made to vital signalling equipment beyond the specified or expected limits shall be first approved by the maintenance signal engineer or signalling commissioning engineer before bringing the equipment back into use.
- All adjusted equipment shall be tested in situ.

8.1 Transformer Change

When a transformer is changed there is a possibility that the polarity of the output voltage will be reversed due to differences in the internal wiring of the transformers.

When power supply transformers or track circuit transformers are changed, test the polarity before and after the change to ensure that it has not been reversed.

9 Retro-Fitting 84M MkI point machine to MkIII version

A signal engineer shall commission the work for retro-fitting of the electric brake mechanism in a Siemens 84M MkI point machines as part of a conversion to MkIII version.

Only electric brake mechanisms, factory fitted with suitable leads and biased plugs shall be installed.

When the work is complete, the signal engineer shall mark up the relevant circuit diagram (for each end of points converted) with the details of the installation and certification.

The signal engineer shall liaise with the Signal Asset Engineer who shall forward the certified circuit diagram to the Signal Documentation Manager for issue of an updated maintenance copy.
10 **ETCS Equipment Changes**

ETCS equipment renewal pertains to the replacement or temporary removal of LEUs, associated power supplies, ETCS cables, balises, balise tail cables and balise junction boxes. Renewal of these items shall be in accordance with Section 13, as well as with PR S 40028 and PR S 41604.

11 **Rewiring**

The repair, joining or like for like replacement of signalling cables or single wires shall be in accordance with Section 13 and PR S 40012.

The replacement of cables or single wires for new or altered works shall be in accordance with the Inspection and Testing of Signalling procedures (PR S 47110). Precautions when Interfering with Operational Signalling Circuits.

Sections 12.1 to 12.16 prescribe the precautions that shall be adhered to when involved in interfering with existing circuits or when working near existing circuits.

11.1 **Correlation of existing arrangements**

Whenever renewal work involves the disconnection of wiring or the removal of equipment in existing installations, or the installation and connection of new or altered wiring and equipment, then the existing arrangements shall be first correlated to ensure the as-built installation is in accordance with the specific design.

The correlation shall be performed in accordance with PR S 47110 and shall include a null count as necessary.

Where discrepancies are found between the as-built installation and the specific design, the matter shall be referred to the signal maintenance engineer before any disconnection or connection work can proceed in relation to the renewal. Where doubt exists with the discrepancy, a signal engineer shall be required to certify the arrangements and if necessary, confer with the signal design engineer.

11.2 **Isolation from Operational Circuits**

Wires and equipment, de-commissioned from use shall be disconnected from operational signalling circuits or power supplies. Refer to Section 12.12 for information regarding disconnection of equipment removed from use.

New wires installed in preparation for circuit alterations shall remain unconnected to operating circuits and operating power supplies until the circuit is commissioned or formally staged-in.

In both cases, the wire ends shall be insulated and secured in accordance with Section 12.13 to prevent any possible contact with metallic objects, operating circuits and equipment.

The wire ends and equipment shall be suitably identified as “redundant” or “new” (as the case may be); the wires shall be labelled in accordance with Section 12.8.

11.3 **Mixing of Old and New Circuits**

If new wiring is to tap into old circuits none of the new wiring is to be connected into the existing working circuit until commissioning.
11.4 **Loose Wires or Crimps**

Loose wires with exposed conductors or with exposed crimps or lugs etc. shall not be left unterminated near working circuits or equipment. They shall be clearly labelled and have their ends secured and insulated to prevent contact with one another or with any other equipment.

11.5 **Connection or Disconnection from Vital Circuits**

For New Works and Alterations, wires or equipment shall only be connected into, or disconnected from, vital signalling circuits when the affected signalling apparatus is disconnected and formally booked out of use.

11.6 **Interference with Working Circuits, Security of Signalling Locations**

All precautions shall be taken to ensure that working circuits cannot be mistakenly interfered with, accidentally damaged, or shorted out by tools, loose relay nuts, washers, bits of wire, etc.

All vital equipment and locations shall be fitted with locks and be locked when unattended.

Before closing up equipment or locations, persons shall check that everything is in order and properly connected and that nothing has been left loose, foul of standard clearances, or in a potentially unsafe condition.

Only persons who are licensed or are properly instructed and authorised (authorised signalling personnel) by the maintenance signal engineer or Commissioning Engineer are permitted to work without close supervision by licensed signalling personnel in equipment locations and relay rooms.

Only persons who are licensed or closely supervised by licensed signalling personnel are permitted to interfere with existing signalling circuits or equipment.

11.7 **Wiring Not in Use**

In working locations any wiring or equipment which is not in use for signalling shall be distinctively evident as such and shall be clearly and adequately labelled accordingly. It shall be kept isolated from any power supply except as necessary under supervised use.

11.8 **Tagging of Wiring at Termination Points**

At the termination point where new wiring is to be connected to working circuits, or where old wiring is to be disconnected from working circuits, the wire shall be fitted with a tag clearly identifying the circuit and terminal to which it applies and the terminal to which it runs; the other end of any such wire it is to be similarly tagged.

11.9 **Labelling of Stagework**

Wiring to be commissioned or de-commissioned in stages shall be clearly labelled as to what stage it is to be commissioned or de-commissioned. On changeover, the stage labelling shall be removed, the correct labelling applied and the arrangements made obviously permanent.
11.10 Temporary Wiring

Temporary stagework wiring is to be of a distinctive colour with a different colour for each stage.

Temporary wiring for testing purposes is to be of a distinctive colour.

The distinguishing colours for temporary wiring should be documented and displayed in the location concerned.

The use of temporary wiring shall be strictly controlled and shall be removed as soon as it has served its purpose and prior to through testing. All temporary wiring shall be documented for this purpose and records kept by the maintenance signal engineer unless controlled by an approved design.

11.11 Spare Wires

Spare wires in equipment locations shall be properly terminated on spare terminals on termination racks; spare wires within trackside apparatus shall have the ends insulated, if there are no spare terminals available.

11.12 Equipment Not in Use

Equipment not in use and disconnected from the interlocking shall be securely open circuited and labelled accordingly.

It shall not be sufficient to only remove a fuse or open a link or remove a signal lamp etc. i.e. situations where someone could mistakenly insert a fuse or connect a link or insert a lamp etc. and cause a potentially unsafe situation. The equipment shall be securely open circuited in two places where practical, and measures applied to prevent accidental or mistaken connection at both places.

11.13 Insulating the Wire and Equipment Not in Use

Where insulation of unconnected wiring or equipment out of use is required, a secure method shall be used.

Insulating tape or adhesive devices shall not be reused, new insulating tape etc., is required on each occasion. Approved closed and pre-insulated connectors properly crimped to wires shall be used where applicable.

Adhesive insulating tape should not be used directly on prepared conductor ends or on terminal lugs or pins etc., that are intended to be brought into use subsequently, as the adhesive may cause unreliable contact resistance.

The insulation method and application shall be checked to be effective.
11.14 **Test Equipment**
Approved test equipment only shall be connected to signalling circuits and equipment as per PR S 40047.

Test lamps shall not be used as they may provide a significant leakage path for circuit currents.

Test equipment shall be subject to calibration checks taken and recorded at appropriate intervals.

Electrical test instruments shall have insulated probes, etc.

11.15 **Use of Spares or Reuse of Existing Equipment**
Use of spares or reuse of redundant or existing equipment in New and Altered Works shall require the agreement of the maintenance signal engineer.

All spares, redundant or existing wires, cable cores, contacts or other items of equipment which are to be utilised in new circuits or in altered parts of existing circuits shall first be inspected and tested to ensure that:

- They are spare without any connection at any point with other conductors, contacts, power supplies, or other equipment.
- Their condition complies with the required Sydney Trains procedure and Asset Standards Authority standard.
- They are properly insulated without any leak or potential leak of current to or from earth or other circuits.

Special attention shall be paid to ensure that terminals are not connected together by jumper bars or other strapping.

The results of the wire count, bell continuity test and insulation tests of the new circuit or altered parts of existing circuits, inclusive of the spare or reused items, shall be recorded and certified.

11.16 **Interfacing of New and Existing Work**
Where new or altered work is to interface with existing vital signalling, the Commissioning Engineer with the Signal Design Engineer shall together satisfy themselves of the accuracy of existing signalling plans and circuit diagrams to the as-built situation, in consultation with the maintenance signal engineer. If there is reasonable cause to doubt that they are accurate, the existing arrangements which are to be altered to connect with the new arrangement shall be tested and certified.

12 **Like for Like Signalling Equipment Renewals**
This procedure shall be used for like for like renewal of signalling equipment. This shall generally pertain to the renewal of trackside apparatus such as electric points mechanisms, electro-pneumatic point equipment, mechanical point components, signals, trainstops, vital shelf relays, releasing switches, level crossing mechanisms and similar items as well as control system hardware and telemetry equipment.

Examples of electro-pneumatic point equipment include detectors, escapement slides, and plunger lock assemblies.
Where a specific work instruction for the type of renewal is not provided, the signal engineer shall be consulted. The signal engineer shall provide the necessary instruction pertaining to the work to mitigate the associated risks.

The like for like renewals procedure provides signalling personnel performing like for like renewals suitable documentation and ensures that all the required tests and checks have been completed before permitting the equipment to be booked back into service. Refer to Section 14 for a listing of like for like renewal work instructions.

It is not applicable where configuration or design principles are altered, or where significant pre-planning is required. Where renewal work is performed in support of trackwork then PR S 47118 shall apply in conjunction with this section (including relevant work instructions).

Like for like renewals shall also apply where items of equipment are temporarily removed, (involving the removal of wiring/cable that connects the equipment to the interlocking), and later reinstated for use. For example, trainstop temporarily removed from track to allow for track work. In these cases, the work shall be treated as Like for Like.

The following are examples of consumable or sub component items that may be exempted from the like for like renewal requirements:

- Fuses and terminal
- Power supply units, transformers, capacitors, rectifier units
- Mechanical pins, bushes, fasteners and minor mechanical components such as cranks, rods, economical movements, detector ball joints, extension irons
- Contacts where fitted with a pluggable wiring loom or individually wired
- Plug-in relays, track circuit transmitters and receivers
- Trainstop limit switches, motors, older style contact fingers, trip arms, detector arms
- Electric point motors, capacitors, clutches, mechanisms, older style contact fingers
- Signal lamps, signal LED boards, signal lenses
- Level crossing booms, lights and bells
- Signalling controls and indications such as push buttons, switches and diagram lights

Precautions and adequate testing shall apply as per Signalling Safeworking Procedures to ensure that there is no alteration to the circuit, or changes to polarity, operating parameters or settings, configuration or design principle. Additionally, a functional test shall be performed before certifying every case.

Whenever a signalling power supply or related wiring to polarity sensitive equipment, for example, 50 Hz ac track circuits is worked on, care shall be taken to ensure the polarities are not reversed.

Licensed signalling personnel (Signal Electricians or Control Systems Technicians), who satisfy the competency requirements prescribed in Section 13.4, are authorised to perform like for like renewals.

12.1 Authorisations Required by Signal Engineer

A like for like renewal is one where a piece of equipment is replaced with an identical item.
Where the equipment to be installed is not exactly identical as the item being replaced, the difference between the equipment types, the effect on the design principle and the risks associated with the changed configuration shall be assessed. Authorisation for use of this procedure shall be obtained from a signal engineer in these circumstances. Before providing this authorisation, the signal engineer shall ensure that suitable measures are put in place to control these risks.

Some examples where authorisation is required:

- Newer version of a point machine replaces an earlier version.
- Renewal of similar equipment where later versions alter the terminal arrangement.
- Trainstop with enclosed contacts replaces trainstop with open contacts.
- Point machine changed on a triple-end or independent switches (additional out of correspondence test required).
- More than one point machine is changed within the layout.
- Shelf relay replaced by a plug-in relay conversion unit.
- Partial renewal where not all elements are replaced and a subset of the work instruction may be applicable.
- Change of Control Systems workstation model to newer model.
- Network Device model change.
- Renewal of equipment where a formal work instruction does not cater for the particular type of work.

Where the signal engineer authorisation is provided, the Scope of Work and Authorisation form shall include a description of the difference between the equipment types and a listing of any subsequent actions. The subsequent actions can include updating the asset register, marking-up and signing the field certified office copy, submission of the certified office copy for updating and arranging additional training for signalling personnel. Any pending actions following the authorised renewal of equipment not exactly identical shall be promptly closed out.

Additionally, the scope and authorisation page is to be signed by the signal engineer prior to the commencement of work.

In the case of an emergency, the signal engineer shall be contacted by telephone and for verbal agreement to proceed noted on the form. In such cases, the signal engineer shall sign the authorisation at the earliest opportunity.

A signal engineer’s authorisation for like for like renewal can be omitted where the items for renewal are exactly identical and a formal work instruction caters for the particular type of work. A submission of the work package is still required to the authorising signal engineer at the end of the work.

If the like for like package is not authorised by the maintenance signal engineer, the approving signal or delegate shall duly advise the maintenance signal engineer of the work.

12.2 Pre-Authorisation

Signal engineer authorisation may be considered for routine equipment changes, in advance of an event. The pre-authorisation shall be documented by provision of appropriate local procedures attached to the relevant work instruction. The local procedures shall mitigate the additional risks associated with the equipment change. The maintenance signal engineer shall duly sign the authorisation at the earliest opportunity.
Some examples where pre-authorisation may be granted:

- Newer version of equipment replaces an earlier version (including trainstops, point machines, maintenance workstations and peripherals).
- A point machine is changed on a triple-end or at independent switches.
- Shelf relay replaced by a plug-in relay conversion unit.

### 12.3 Work Not Considered Like for Like

Replacements, alterations or renewal work that do not meet the like for like renewal requirements, or any other work that affects the intended signalling design principle or configuration shall proceed only when issued with an approved design. A Commissioning Engineer shall be assigned to lead this work and the work done in accordance with PR S 47110.

The following examples where work shall be treated as an alteration and are **not** considered like for like and an approved design shall be obtained for these works:

- Conversion of Incandescent Signals to LED type.
- The replacement of one LED type signal with a different LED type.
- The replacement of conventionally operated points with Claw Lock or Spherolock type.
- Change of track circuit type
- Installation of repeat relays
- Alterations to software, data, IOS or SOE version

### 12.4 Competency Requirements

Licensed signalling personnel who lead a like for like renewal shall have a level of competency to perform the work without supervision, as defined in MN S 41412, indicated on their current Certificate of Competency for at least the following elements:

**Note:** When performing a like for like renewal, licensed signalling personnel leading the work shall satisfy the minimum licensing requirements stated in PR S 47111 (6.13.5).

**Signalling Safeworking**

- Disconnect Operational Signalling Infrastructure
- Inspect, Test & Certify Operational Signalling Infrastructure for the purpose of Maintenance and following Corrective Action
- Replace, Inspect, Test & Certify Signalling Apparatus where treated as Like for Like Renewal
- Apply Temporary Bridging in accordance with PR S 40002 & PR S 40009
- Change over of Wires & Cables in accordance with PR S 40011 & PR S 40012

**Inspection & Testing**

- Documentation Check
- Correlation Test
- Apparatus Inspection (Relay/Equipment/Wire Analysis)
- Wire/Null Count
• Bell Continuity Test
• Circuit Function Test
• Correspondence & Out of Correspondence Test
• Insulation & Earth Leakage Test
• Power Supply & Polarity Test
• Test Track Circuit, Test Point Lock & Detection, Gauge Trainstop

Signalling Standards, Management Systems & Documentation

• Signal Plans, Track Insulation Plans & Circuit Books

System/Equipment Maintenance/Construction

• A competency for the relevant apparatus being renewed

12.5 Documentation Work Package

The licensed signalling personnel shall create a documentation work package for the work.

The documentation package shall consist of the following:

• Scope of Work and Authorisation page (Appendix A).
• The work instruction for the appropriate equipment type. See Appendix A (one work instruction per asset or see below for multiple assets on a combined work instruction).
• Signalling plan extract (if applicable).
• Circuit diagrams and analysis pages (if applicable).
• Infrastructure Booking Authority (IBA) Form NRF 003.
• Bridging Authority (if applicable) with circuit diagrams.
• Returns and other required certificates (if applicable).

Each page of the package shall be numbered and the total pages shown on the cover.

All work is to follow the procedures in the work instruction, and all testing is to be documented on the work instruction where space is provided, or on the circuit diagram/analysis page, or signalling plan as appropriate.

The inspection and tests stated in the work instructions are detailed in PR S 47114, & PR S 47115, with a summarised explanation appearing in PR S 47113 and PR S 40010.

The work instructions shall be specific to the equipment renewed. Progressive entries shall be made against each completed task by the licensed signalling personnel performing the work.

NOTE

A competency level able to work without supervision, as defined in MN S 41412 shown against the relevant Inspection & Testing list in the Certificate of Competency will enable the person to "perform the test" for work that is treated as Like for Like Renewal.
Where multiple items of equipment are combined on the same work instruction, each task of every equipment item shall be separately and clearly shown. Additionally, every equipment item shall be specifically signed-off to attest its final certification prior to booking the affected signalling into use.

The circuit diagrams and signalling plans shall be printed copies of the authorised issued circuit book or signalling documentation for the area (not hand drawn copies), with care taken to ensure these reflect the latest installed design, including any interim maintenance copies that may apply.

Part circuit diagrams are to be marked with CB and page number or job number if an interim maintenance copy is used.

Disconnection of circuits shall be marked on the circuit diagrams.

12.6 Certification
Following completion of the works, the time of completion shall be noted on the Scope and Authorisation page, the work instruction shall be signed and any other document where testing notations have been made, such as the signalling plan or circuit diagram, shall also be signed.

12.7 Package Finalisation
The completed package shall be forwarded to the Authorising signal engineer for review, actioning the requirements of asset update and filing. A copy of packages for routine maintenance work and signalling support track work shall be forwarded to the maintenance signal engineer.
## 13 Like for Like Instructions

The following table lists the currently available like for like work instructions which are available for download from the Sydney Trains intranet, Signals (S) and Control Systems (CS), and from the internet Signals only.

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Engineering Procedure
Signalling and Control Systems

Signalling Safeworking

PR S 40012

Repair / Replacement of Signalling Wires

Version 2.0

Date in Force: 8 March 2019
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1 Introduction
This document describes the procedure for the emergency renewal, repair and replacement of vital signalling wires and cables and signalling data communication links.

2 Reference Documents
This procedure should be read in conjunction with the following procedures:
PR S 40001 - Introduction to Signalling Safeworking Procedures
PR S 40004 - Failures
PR S 40008 - Securing Signalling Apparatus Out of Use
PR S 40010 - Risks and Controls Associated with Testing and Certifying Equipment
PR S 40011 - Renewals Work
PR S 47110 - Inspection and Testing of Signalling

3 General
As far as practical change over or replace one wire at a time.

Whenever wires are broken, defective or otherwise in need of repair or replacement, extreme care is necessary to ensure that wires are not cross connected or circuits interconnected.

When renewing, repairing or replacing signal wires and cables licenced signalling personnel shall perform adequate testing to ensure the integrity of the repaired wiring as well as the proper function of circuits concerned. Tests shall include pre and post polarity tests where there is any possibility of reversal of power supply wiring or of wiring in polarity sensitive circuits e.g. track circuits, paired detector circuits.

Under the following conditions a signal engineer, or other authorised person able to perform circuit function testing, shall test the repair, renewal or replacement of signalling wires and cable prior to connected apparatus being restored into use.

- When more than one single wire or multicore cable of the same size and type is broken.
- When replacing wires and more than one wire of an existing circuit is to be disconnected prior to the reconnection of replacement wires (does not include track circuit leads).
- If single wire cables are to be replaced by multi-core cables.
- When performing planned rewiring on other than a direct like-for-like basis.

In all cases, the affected signalling and protecting signals shall be booked back into use only by licensed signalling personnel.
3.1 Single Wire Replacement

If a new wire is needed to replace a single broken or defective wire, licensed signalling personnel shall:

a) Advise the Network Controller Officer and book out of use the apparatus controlled by the affected circuit.

b) Identify and label both terminal ends of the broken or defective wire; hand trace where possible; ensure that there are no intermediate terminals or contacts; and ensure the wiring is in accordance with the circuit books. With external cables ensure that the cable does not go through any intermediate location.

c) Run the new wire and prepare ends for changeover. Keep ends clear and insulated from working circuits. Label ends with identity of terminal to which they will be connected.

d) Disconnect the affected circuits.

e) Disconnect the broken or defective wire and immediately connect the new wire, one end at a time. Cut back all ends of the broken or defective wire and carefully remove the wire. If the redundant wire cannot be removed then cut, turn back and insulate all ends securely (including ends at the break) and label with tags as “Defective”.

f) Insulation test the new circuit wire to earth.

g) Test as required.

- If the identity of the terminal ends of the broken wire cannot be established with absolute certainty, then the testing shall be extended to include hand tracing and verifying the existing wiring to the circuit book to one clear series contact, fuse or link each side of the new wire.

or

- Strap and function testing to one clear series contact, fuse or link inclusive each side of the new wire.

[Refer to Figure 1 below regarding the necessity to correctly identify the terminal ends of a defective wire]

h) Re-connect the affected circuit.

i) Advise the signaller and restore the apparatus into use.

j) Promptly advise the signal engineer and certify the repairs by submitting a Detailed Report advising details of the repair. The signal engineer must check and assure themselves that the work was performed correctly.

Throughout the process ensure there is no possibility of there being a disconnected wire with one end loose and uninsulated with the other end connected to, or able to come into contact with, any “live” circuit elements.
Illustration Of Necessity To Correctly Identify The Terminal Ends Of A Defective Wire And Change Over Onto Those Same Terminals

ARC circuit and contact B7 as shown in the circuit book

ARC circuit and contact B7 as it actually is

Suppose ACR circuit has failed and there is no positive voltage on the coil. Suppose in checking back through the circuit as shown in the circuit book the first positive voltage is found on B7 armature and it is checked that there is no continuity between B7 armature and C6 point. Suppose the maintainer assumes that the wire between B7 armature and C6 point is defective, open circuit somewhere along its length, and decides to replace the wire.

Run new wire to replace wire between B7 and C6

Change over at C6 point

Change over at B7 armature (suppose ACR relay picks up)

Strap and function test B7 and C6

At this stage the test seem to indicate that the failure has been rectified, but in fact two separate circuits has been wrongly interconnected. The following inspection and test are also necessary to verify the correct repair.

**EITHER**
Handtrace defective wire end to end

**OR**
Trace and verify wires on the other side of the contact at each point of connection

**OR**
Strap and function test to one contact clear of each point of connection (as shown in the circuit book)

The above precautions apply whether the defective wire is connected to contacts, fuses or links. When carrying out circuit modifications the same potential for wrongly interconnecting circuits exists if contact terminals, fuses or links are wrongly identified.

Figure 1 Necessity to correctly identifying terminal ends of a defective wire
3.2 **Single Wire Repair**

If a signalling failure is traced to a single broken wire or cable. Licensed signalling personnel shall correctly identify the ends of the wire and the circuit to which the wire belongs. If it is obvious that only one wire is broken, licensed signalling personnel shall join the broken wire ends together with a reliable and secure connection otherwise disconnecting the circuit concerned.

Joins in wires shall be properly insulated and licensed signalling personnel shall insulation test to earth when joints are made in external wires.

Licensed signalling personnel shall reconnect and test the circuit and ensure that the failure is rectified.

4 **Track Circuit Wires - Repair, Replacement**

Should two or more track circuit leads to a location be broken or in need of replacement then licensed signalling personnel shall follow the same procedure to that in Sections 3, as applicable, changing over one wire at a time and shall include the following:

- Ensure that wires have not been cross connected.
- Test that the track relay of the track circuit concerned de-energises with a shunt across the rails.
- Carry out a polarity test in accordance with the track insulation plan.
- Shunt test the adjacent track circuit at the location on the lines affected.

Where cut tracks are involved, licensed signalling personnel shall test that a shunt across the rails of the adjacent track circuit removes the voltage from the rails of the cut track.

5 **Multicore Cables - Repair, Replacement**

Should cores in a multicore cable be broken or in need of replacement then licensed signalling personnel shall observe the following requirements.

5.1 **Transfer to a spare cable core**

Should a core of a multicore cable used in a signalling circuit be open circuit or defective then follow the same procedure to that in Section 3, as applicable, and also observe the following:

Replace the cable core concerned with a spare core of the same cable which is not defective, if available.

Identify and open the cable termination link at each end of the defective cable core after verifying the cable core number to the terminal and after verifying that the circuit connected to the cable termination link at each end is the same circuit.

Test the cable core identified to be the defective core. Fit the defective cable core with labels marked "Defective" at both termination ends. Open the respective cable termination link at each end and disconnect the defective cable core from the link terminal. Cut all ends cleanly off, turn back and insulate.
Figure 2 - Transferring a circuit from a defective cable core to spare cable core

Check the circuit book to ensure that the cable is directly connected between the locations housing the cable links and that there are no intermediate terminals.

Continuity test the spare cable core selected using a separate spare cable core or the sheath as a test return wire, and also insulation test the selected spare to earth, to sheath and to other spare cores.

Transfer the circuit wire at each end from the cable termination link for the defective cable core to the cable termination link for the selected spare cable core.

Function test the circuit by opening and closing the link at each end in turn and observing the circuit function energise and de-energise accordingly. Connect a voltmeter across the circuit function and check that the voltage returns from the correct voltage to zero when the circuit is opened.

When more than one cable core is defective and more than one spare cable core is involved, close the cable termination links at each end for each circuit, one cable core at a time, and function test each circuit over the respective cable core and termination links prior to closing the links for the next cable core.

The maintenance signal engineer shall be advised and to arrange for the maintenance documentation to be updated.

5.2 Jointing of broken cores

When repairing broken cores in a multicore cable follow the same procedure to that in Section 3, as applicable, and also observe the following.

Identify and label the cores at the break and at the immediate terminal ends, and identify the circuit to which each cable core belongs.

Open the cable termination links of the defective cores at the immediate terminal ends.

Conduct a continuity test between these corresponding terminations (at each end) to further check that there is no continuity because of the break.

Joint the corresponding ends at the break of each of the cable core and carry out a continuity test on each jointed cable core from the cable termination link to the corresponding cable termination link at the other end.
Carry out an insulation test on the jointed cable cores to earth, to sheath, to one another and to any spare cores in the cable.

Function test each circuit by closing and opening the link at each end in turn and observing the circuit function energise and de-energise accordingly. Connect a voltmeter across the circuit function and check that the voltage returns from the correct voltage to zero when the circuit is opened.

5.3 Replacement with another multicore cable

Where a multicore cable is being replaced with another multicore cable follow the same procedure to that in Section 3 as applicable, and also observe the following.

Where all the cable cores can be clearly identified then the process of changing one wire at a time need not be applied.

Open the cable termination links at the immediate terminal ends of the defective multicore cable. Check that the cable core numbers terminal numbers at each end correspond. Also check that the circuit connected to the corresponding cable link terminals at both ends is the same circuit, and in accordance with the circuit book.

Disconnect the defective multicore cable and connect the replacement multicore cable, each cable core number corresponding to the cable link terminal number the same as the cable replaced.

Carry out a continuity test and an insulation test on the cable.

Function test each circuit by opening and closing the link at each end in turn and observing the circuit function energise and de-energise accordingly. Connect a voltmeter across the circuit function and check that the voltage returns from the correct voltage to zero when the circuit is opened.

Close the cable termination links at each end for each circuit, one cable core at a time, and function test each circuit over the respective cable core and termination links prior to closing the links for the next cable core.

5.4 Additional testing procedure following cable damage

Where multicore cables are damaged there is a risk that the insulation between the conductors may be damaged causing short circuit current flow for a sustained period. This may lead to deformed Q relay contacts.

Where this is the case, in addition to the preceding requirements, a signal engineer shall be notified to consider the potential for sustained (exceeding one hour) short circuit current flow. If the cable is determined to be at risk, additional testing of all relay contacts in the affected circuit(s), on the fuse/supply side of the damaged cable, shall be conducted by either one of the following two methods:

1. Test the affected relays in a Relay Test Panel or Relay Pro to ensure all contacts operate (open and close) in accordance with their configuration type.

   Or

2. Circuit Function Test - functionally operate the affected relays in the circuit to ensure they effectively operate the circuit function as designed.
6 Signalling Data Communication Links

Data communication links are utilised to connect Microlok systems, Solid State Interlocking systems, Dupline, Kingfisher and SCADA telemetries, etc. These links consist of either copper communication type cables or optical fibre conductors.

6.1 Transfer to a spare copper cable pair

When changing over to a spare pair in a copper communication type cable licensed signalling personnel shall conduct an end-to-end continuity test of the replacement pair prior to certifying the operational signalling apparatus back into use.

6.2 Transfer to a spare optical fibre conductor

When changing over to a spare optical fibre conductor licensed signalling personnel shall conduct an end-to-end continuity of the replacement fibre prior to certifying the operational signalling apparatus back into use.

6.3 Replacement of a SCADA G32 Cable

Should a core of a G32 cable used in SCADA 2000 RTU telemetry system become open circuit or defective then replacing the G32 cable will be necessary and the following procedure observed.

a) Perform a continuity test of the new G32 cable.

b) Identify which input and outputs (I/O) are affected by the replacement of the cable

c) Ensure that mastership of the RTU has been swapped to the healthy side and set the mastership to manual.

d) Advise the Network Controller Officer and book out of use the SCADA 2000 RTU controlled by the affected telemetry cable.

e) Identify and label both ends of the broken or defective G32 cable by hand tracing both cables from the IOJ connector, taking note of the affected optoboard, and RTU terminal and confirm against the circuit book.

f) Run the new cable

g) Disconnect the affected cable and mark as faulty.

h) Connect the new cable. Take extra precaution when inserting to IOJ connector ensuring that the pins are lined up properly before pushing the connector in all the way. If the connector is misaligned, there is a risk which may result in bent and shorted out pins.

i) Test the affected I/O by hand tracing and verifying the existing wiring to the circuit book to one clear series, fuse or link on the signalling side of the optoboard and perform a function test for each I/O that was affected by the change. This is required to be done by the relevant licensed signalling personnel.

j) Advise the signaller and certify the operational signalling apparatus back into use.

k) Duly advise the signal engineer by submitting a Detailed Report advising details of the repair. The signal engineer shall check and assure themselves that the work was performed correctly.

Note: Throughout the process ensure there is no possibility of a disconnected wire coming into contact with any “live” circuit elements.
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1 Introduction

Licensed signalling personnel may connect spare contacts of signalling trackside equipment in parallel with existing contacts (of the same type and setting) in a given circuit on the authority of the maintenance signal engineer, provided that the additional wiring is run directly from the terminals of the existing contact in circuit to the terminals of the spare contact, and is not run to or from other circuit terminals. It is not necessary that an approved design be issued for this, however, the maintenance signal engineer must authorise this change and arrange for the circuit books to be updated.

Each additional wire must be correctly beaded for the terminals and labelled ‘PC’ (or otherwise securely labelled as a ‘parallel contact’ wire).

Licensed signalling personnel must test the parallel pair in circuit before allowing the additional contact to be used in service for the running of trains. (eg: with the circuit energised over both contacts closed, check that the adjacent series contact either side of the parallel pair de-energies and re-energises the circuit function when each is opened and closed in turn; then check that it takes both of the parallel contacts to be open before the circuit will de-energise and that either one closed will energise the circuit).

Licensed signalling personnel are to write their name, sign and date the circuit book sheet with the amendment when contacts are paralleled (in red pen). The maintenance signal engineer is to be sent a copy of the “field update” to review and forward to the Signal Documentation Manager for updating of document master. When the parallel contacts are incorporated into the updated “as built” white copy, and these copies are issued to the field, the ‘PC’ labelling (or otherwise) can be removed.

Contacts in parallel can improve reliability by reducing the series contact resistance, and by helping maintain a low resistance under conditions that cause contacts to vibrate.

It can be also advantageous for maintenance if the contacts of trackside apparatus which require cleaning and tension checking are paralleled; if the contact is closed the tension and cleaning could still be checked one contact at a time without the risk of changing signal aspects in the face of trains. (Otherwise such closed contacts are only to be broken during maintenance when there are no trains approaching the signals that would be affected or else they are to be maintained when the contacts are in their open position. Closed normal contacts of train stops or semaphore signals at stop are similarly not to be broken with a train approaching the signal as, although signal aspects would not be changed, approach locking would be applied).

Reliable, low contact resistance is particularly important for input circuits to SSI trackside TFM modules which operate over very low voltages (5 volt) and use a coded circuit current. Loss of voltage or code through high or varying contact resistance can cause the TFM module to shut down.
Engineering Procedure
Signalling and Control Systems

Signalling Safeworking

PR S 40014

Control of Signalling Documentation
Issued to the Field

Version 1.3

Date in Force: 8 March 2019
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1 Introduction

The purpose of this procedure is to set out the responsibilities and requirements for document control of signalling documentation issued to the field.

The signalling documentation referred to in this procedure include:

- Track Plans and Working Sketches, or combined Signalling Plans
- Track Insulation Plans (track bonding plans)
- Circuit Diagrams
- Circuit Books
- Locking Tables,
- Locking Diagrams,
- Lever Nameplates,
- Modification sheets
- Control Tables
- Detailed Site Survey Drawings
- Computer Based Interlocking Data
- Control and Indication panel layouts
- Air System diagrams and air reticulation plans
- Equipment layout diagrams
- Control Systems maps
- Automatic Route Set maps

1.1 ETCS Trackside Data Management

Management of ETCS trackside data shall be in accordance with PR S 40028 Automatic Train Protection – Alstom ETCS Trackside and PR S 45005 ETCS Data Storage and Access.

2 Configuration Control

Other than for like-for-like replacement for maintenance purposes, other specified exceptions, or specially authorised cases, the working signalling equipment and circuits are not to be altered, nor new signalling equipment or circuits commissioned into use, except in accordance with approved designs.

The changes are to be inspected and tested and the design drawings certified by a signal engineer. The masters must be updated and amended drawings issued to replace out of date copies.

3 Document Control

3.1 General

All persons given a controlled copy of a signalling documentation for their work are to treat it as a valuable document entrusted to their care. Such persons are called Copy Holders. Copy Holders may be responsible for one or more copies of the signalling documentation.
All involved with the production, installation, maintenance, and use of signalling documentation have a responsibility for ensuring that the drawings accurately record and correspond to the requirements and to the as-built status, as applicable, and they are to promptly advise any discrepancies and arrange to have them corrected without delay. All copy holders are to ensure that they have the latest version of control documents.

All persons with nominated responsibilities under these procedures are to be able to account for all controlled copies of signalling documentation issued to them and, through them, to their subordinates.

Should the persons with the nominated responsibilities be off duty on sick leave, transfer to other jobs, resign or otherwise be unavailable, the manager of the person is to ensure that those responsibilities are appropriately reassigned and carried out.

Transmittal notices, on standard Memo of Document Exchange forms or equivalent, are to be included with the despatch of signalling documentation and the recipient must acknowledge receipt on the transmittal notice and promptly forward a copy back to the sender.

For project works, the requirements of specification SPG 0703 Signalling Documentation and Drawings are to be complied with as well as Sydney Trains Safety Management System SMS-05-OP-3001 Documentation Control. Where approved Configuration Management Plans (CMP) cover particular signalling documentation then the requirements of the CMP are to be complied with.

### 3.2 Particular Responsibilities: Signal Asset Engineer

The Signal Asset Engineers, for their assigned area, is responsible for:-

a) Liaising with the maintenance signal engineer to determine the quantities and allocation of controlled copies of signalling documentation.

b) Managing the distribution of new and updated controlled signalling documentation, ensuring all superseded copies are destroyed.

c) Maintaining an effective document control register for all field maintenance copies of signalling documentation. Including computer based interlocking data. Recording details of copies destroyed.

Immediately arranging with the Signalling Documentation Manager for changes to the signalling documentation that are necessary for the correction of any discrepancies found in controlled copies of signalling documentation and maintenance changes due to like-for-like repairs, etc., (eg. cable core numbers, contact or terminal numbers changing because of defective cable cores, contacts or terminals, field paralleling of contacts or terminals).

d) Ensuring the availability or temporary retention of issued maintenance copies along with interim maintenance copies and commissioned stage-work copies while project works are in progress.

e) The despatch and receipt of all field issued signalling documentation and computer base interlocking data. This must be supplemented by a transmittal notice.
3.3 **Particular Responsibilities: Maintenance Signal Engineer**

The maintenance signal engineer, for their assigned area, is responsible for:

a) Determining the quantities and allocation of controlled copies of signalling documentation for their assigned area with the Signal Asset Engineer.

b) Issuing all controlled copies to the licensed signalling personnel for distribution to signalling locations and ensuring all redundant signalling documentation are destroyed.

c) Ensuring all issued computer based interlocking data is secured.

d) Ensuring that, (except for like-for-like renewals and repairs, other specified exceptions and specially authorised cases) there are no changes to working signalling equipment and circuits without the approved signal design for the alterations.

e) Maintaining an effective document control register for all the current field maintenance copies (including interim maintenance copies) of signalling documentation. Checking the field copies versions against the master listing every 12 months and whenever needed. Recording details of copies destroyed.

f) Immediately arranging with the Signal Asset Engineer for changes to the signalling documentation that are necessary for the correction of any discrepancies found in controlled copies.

g) Arranging with the Signal Asset Engineer for changes to the signalling documentation arising from maintenance changes due to like-for-like repairs, etc., (eg. cable core numbers, contact or terminal numbers changing because of defective cable cores, contacts or terminals, field paralleling of contacts or terminals).

h) Marking up and signing (preferably in red pen) all controlled copies of signalling documentation with the corrections required, where such drawing correction is the obvious remedy to a discrepancy with the as-built installation, while waiting for updated copies.

i) Booking out of use any vital signalling equipment or circuit which is not in accordance with the signalling documentation if there is any doubt about the integrity of the particular signalling equipment or circuit.

j) Promptly updating the maintenance signal engineer’s office copies of signalling documentation to the latest copies issued and received, and destroying superseded copies.

k) Issuing the amended copies to the licensed signalling personnel responsible as soon as practicable within receipt and following up that they have updated their copies and destroyed the superseded copies.

l) The despatch and receipt of all field issued signalling documentation and computer base interlocking data. This must be supplemented by a transmittal notice.

**Note:** Where new works or alterations are being carried out, refer also to the responsibilities nominated under ‘Project Engineer’ and ‘Commissioning Engineer’.
3.4 Particular Responsibilities: The Project Engineer

Refer also to specification SPG 0703.

The Project Engineer (the person carrying out the role of Engineer In Charge of the installation of the works) is responsible for:

a) Liaising with the Signal Design Engineer and agreeing on the number and distribution of copies of signalling documentation for the construction phase of new and altered works.

b) Maintaining an effective document control register for all copies of signalling documentation (including Modification Instruction Forms) issued to and received by the project staff including those that the Test Engineer has accepted responsibility for.

c) Complying with the practices and procedures set out in standard specifications in relation to signalling documentation (including signal plans and circuit books) for new works and alterations.

d) Ensuring the delivery and receipt of any signalling documentation forwarded from the Project Engineer’s office to the Signal Asset Engineer.

e) Collecting all copies of signalling documentation issued for the project which are no longer in use and are not required by others, and destroying them at the end of the project. Recording details of the copies destroyed.

f) Liaising with the maintenance signal engineer and Signal Asset Engineer and maintaining updated as-built maintenance copies during new and altered works, particularly between stages. Appointing a person with this specific responsibility where needed to minimise the risk of maintenance personnel being misled by signalling documentation no longer accurate.

g) Formally advising the Signal Asset Engineer, maintenance signal engineer and the Signalling Documentation Manager, of any discrepancies noted with the existing signalling documentation.

h) Formally advising the Signal Asset Engineer, and arranging for the current signalling documentation to be amended where there have been changes carried out to the existing signalling system.

i) Requesting the Signalling Documentation Manager to provide listings of signalling documentation issued and not returned for new and altered signalling works on a regular basis and comparing the listings with the Project records and following up any discrepancy with the Signalling Documentation Manager.

j) Collecting and returning to the Signal Asset Engineer all signalling documentation for jobs that have been cancelled, or deferred, or are reprogrammed to a later time because of priority given to other new or altered work which will affect these signalling documentation issued for the original job.

Note: The organisational structures for projects vary and the field person allocated these responsibilities may be designated by titles other than 'Project Engineer'.
3.5  **Particular Responsibilities: The Commissioning Engineer**

The Commissioning Engineer is responsible for:

a) Liaising with the Signal Design Engineer and agreeing on the number and distribution of copies of signalling documentation for the correlation, testing and commissioning phases of new and altered works. Advising the Project Engineer accordingly.

b) Advising the Project Engineer of the distribution of field copies which are the responsibility of the Commissioning Engineer so that the Project Engineer’s document control register can be updated. This advice is to include advice of field copies returned to the Signal Asset Engineer.

c) Ensuring that all copies of signalling documentation that carry certification inspection and testing markings and signatures are archived or scanned in a secured location for permanent retention.

d) Completing the certification of the signalling documentation immediately after commissioning and ensuring they are delivered to and received by the Signal Asset Engineer within one month of the commissioning.

e) Ensuring Interim Maintenance copies are available for maintenance personnel as soon as the work is partially commissioned or commissioned into operational use. Agreeing the number of copies required with the maintenance signal engineer and Signal Asset Engineer.

f) Formally advising the Signal Asset Engineer and Signalling Documentation Manager, of discrepancies noted with the existing signalling documentation.

g) Formally advising the Signal Asset Engineer and Signalling Documentation Manager, and arranging for the current signalling documentation to be amended where there have been changes carried out to the existing signalling system.

3.6  **Particular Responsibilities: The Licensed Signalling Personnel (and Copy Holders Generally)**

Licensed signalling personnel (and Copy Holders generally, as applicable) are responsible for:

a) Maintaining the copies of signalling documentation allocated to their assigned area in a satisfactory condition, ready for use, and updated with the latest amendments.

b) Retaining the signalling documentation, when not in use, in their nominated location and available for reference by licensed signalling personnel for failure attendance, emergencies, etc.

c) Keeping circuit books bound and secure, except when required to insert or remove sheets for authorised amendments.

d) Requesting the maintenance signal engineer to arrange replacement copies of signalling documentation sheets that have become illegible or dilapidated.

e) Advising the maintenance signal engineer in writing of any discrepancies between the signalling documentation and the as built installation.
Marking up and signing (preferably with a red pen) the corrections required to the Copy Holder’s copies of signalling documentation (including signal plans or circuit book sheets), where such drawing correction is the obvious changes to a discrepancy with the as built installation, while waiting for updated copies.

Where the correction alters the as built installation to match the signalling documentation immediately contact the maintenance signal engineer for instruction.

Should the discrepancy bring to notice an imminent risk to the safety of the system, booking the vital signalling equipment concerned out of use until instructions are received.

f) Promptly advising the maintenance signal engineer in writing, of any change needed to details in the signalling documentation because of like-for-like works, e.g. cable core numbers changed, contact numbers changed, or because a relay has had to be changed for one of a different type, or because contacts have been paralleled. Attaching copies of the advice to the Copy Holder’s copies. Marking up and signing (preferably in red pen) the Copy Holder’s copies with the corrections required while waiting for the updated copies. Including the completed PR S 40011 FM 03 Scope of Work Authorisation – Like for Like Work Package.

g) Within one week of receipt of amended signalling documentation, checking the amended documentation for obvious discrepancies. Understanding of what has been changed, replacing the affected documentation with the new copies, inserting and completing associated control pages, destroying superseded copies, and returning the transmittal notices to the maintenance signal engineer.

Advising details of the copies of the signalling documentation that have been updated and the copies of superseded signalling documentation that has been destroyed.

For copies that are kept in locations remote from the depot location, updating those as soon as possible and not later than the next scheduled maintenance visit.

h) When a new or alteration job is installed and commissioned and it is still necessary to retain the existing maintenance signalling documentation. A handwritten field note on the existing signalling documentation control pages describing its status, noting that part has been superseded by job no. “........”, titled “........”, all affected documentation stamped with the job no (as minimum) and referring to any interim maintenance copies purposely left on the site until the existing signalling documentation are updated.

i) Ensuring that copies of signalling documentation, which are superseded by new or amended copies, are destroyed or, if they need to be temporarily retained, binding the superseded sheets together and clearly marking each document as ‘superseded’.

j) Destroying these superseded copies as soon as practical and advising details of the copies destroyed to the maintenance signal engineer. Before destruction, the superseded copies should first be checked for any relevant mark ups and these transferred with signatures to the new copies if the correction has not been made. In such case, written advice of the continuing discrepancy is to be forwarded to the maintenance signal engineer who is to follow it up in writing with Signal Asset Engineer.
k) Reporting the circumstances and returning to the maintenance signal engineer any signalling documentation that are not in use or of unknown origin.

l) Ensuring that uncontrolled copies of signalling documentation are marked ‘Uncontrolled Copy’ and are dated, and that they are destroyed as soon as they have served their purpose.

m) Booking out of use vital signalling equipment, where a discrepancy poses an imminent risk to the safety of the signalling system, until instructions are received from the maintenance signal engineer.
Notification of Whereabouts and Liaison with Network Control Officers

Version 1.1

Date in Force: 21 September 2016
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1 Liaison with Network Control Officers (NCO)

Licensed signalling personnel must regularly liaise with Network Control Officers to determine the status of the operating signalling system, and if problems exist with the signalling equipment, then understand the symptoms and take any necessary action.

Licensed signalling personnel must request the permission of the Network Control Officer before commencing any work that could interfere with the operation of rail traffic.

When communicating the identification of specific signalling assets to the Network Control Officer for any purpose, it is imperative to convey the asset location along with the asset number. This is to avoid confusion where points or signals may have similar numbers at different locations on control panels operated by the same Network Control Officer.

Before departing from a work site where the work interfered with signalling apparatus, licensed signalling personnel must request the Network Control Officer to test the equipment to ensure that it is in proper operating order. Such operational tests are in addition to the precautions, inspections and tests carried out by licensed signalling personnel to ensure the equipment is left in order.

2 Entry into Signal Boxes

Signalling personnel must not enter a signal box or control centre except in the execution of their duties and must not remain longer than is necessary. Network Control Officers must not be disturbed in the performance of their duties.

Signalling personnel must not operate signalling controls for the movement of rail traffic. The Network Control Officer must be requested to operate signalling controls for the purpose of signalling maintenance or testing.

In certain circumstances, licensed signalling personnel may be permitted to operate signalling controls for testing purposes only (and not for the operation of rail traffic). This must be conditional on the affected signalling being booked out of use and an assurance obtained that no rail traffic will enter the test area, and there is no risk of inadvertent operation of signalling for rail traffic, and the Network Control Officer has granted permission by noting an entry in the Train Register Book or equivalent. Signalling personnel must attain an understanding as to which controls may be operated, the extent of the test area and of the agreed time frame for the testing.

The above requirement also applies at ground frames, local panels and closed signal boxes.

Note: Where releasing switches are provided at ground frames and the work will not disarrange or disconnect the equipment from the interlocking, the above requirement for booking signalling apparatus out of use may be dispensed with.
3 Whereabouts of Routine Maintenance Licensed Signalling Personnel

Licensed signalling personnel engaged in routine maintenance activities must remain contactable or otherwise advise of their whereabouts throughout their shift (or after hours if on recall), so that officers from ICON Infrastructure or other relevant parties know how to contact them for signalling failure attendance or other emergencies.

At the commencement and completion of duty, licensed signalling personnel must advise ICON Infrastructure. A group leader may provide the above advice on behalf of individual team members.
Engineering Procedure
Signalling and Control Systems

Signalling Safeworking

PR S 40017

Maintenance Responsibilities and Frequencies

Version 1.2

Date in Force: 8 March 2019
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1 General Responsibilities

Licensed signalling personnel are responsible for effective maintenance of signalling equipment to ensure the availability of the equipment and its reliable operation to safely and efficiently regulate train movements in accordance with its design.

When it is necessary for any work to be carried out on operational signalling equipment that will effect, or may have the capacity to effect the status of the indication displayed by signal/s for an approaching train or the status of signalling equipment indication displayed to the Network Control Officer’s (NCO) panel/s, licensed signalling personnel prior to the work commencing must contact the NCO responsible for the area advising them of the nature of the work to be performed and the equipment that will or maybe effected.

Prior to the removal or disturbance of any signalling apparatus such as ESML handles, relays, fuses, links, switches, or opening working contacts, licensed signalling personnel are to contact the NCO for the affected area/s, including automatic signalled areas, to ensure there are no trains approaching signals that may be affected by the interference of this equipment.

Licensed signalling personnel are responsible for the maintenance of the whole of the electrical and or mechanical signalling equipment, including the circuits and level crossing warning systems where applicable, in accordance with the Signalling Safeworking Procedures, Network Rules and Procedures, Engineering Instructions, maintenance instructions, Technical Maintenance Plans and service schedules, standard practices and procedures and equipment manuals. If due to unavoidable circumstances the required maintenance frequency is missed, records must be suitably endorsed with reasons.

Where maintenance of signalling equipment is performed by separate working groups, then licensed signalling personnel normally responsible for the item of equipment are not responsible for the work of the group, but are to be vigilant and report any defect or maintenance attention required for correction.

For example, where signalling circuits extend over cables or data links which are maintained by staff who do not report to the signal electrician then the signal electrician is not responsible for the maintenance performance by those staff but is required to assure themselves, as far as reasonably practical, that the integrity and reliability of those circuits are not at risk. Any work involving disconnection or re-connection of signalling circuit wires and cables requires the attendance of the signal electrician.

Licensed signalling personnel in charge of persons carrying out work for which licensed signalling personnel in charge do not normally hold accreditation, are to ensure that those persons hold current accreditation and are suitably experienced for the work to be carried out and are to reasonably assure themselves to the best of their ability that the work is carried out correctly and is satisfactorily completed.

Where signal electricians are in charge of mechanical maintenance employees they are also responsible for ensuring that the maintenance of the mechanical equipment is properly carried out.

Licensed signalling personnel are also responsible for the maintenance of communication equipment, excepting where provision is made for specified communications equipment to be maintained by communications technicians.

Licensed signalling personnel in charge of others are also responsible for the direction and supervision of persons placed under their control and in their care, and are to ensure the equipment is effectively and efficiently maintained. They must ensure that their signalling personnel are knowledgeable and competent to perform their duties and they
are to develop the skills and proficiency of their signalling staff. They are to train inexperienced and junior signalling employees as required. They are to ensure that their personnel are aware of safety hazards, that they know the safety precautions and that they practice safe work methods.

Upon being assigned maintenance responsibilities, licensed signalling personnel are to become fully conversant with the equipment and circuits etc. in the area, including the particular condition and maintenance requirements of each item of equipment, and the applicable specifications, equipment manuals, Technical Maintenance Plans and service schedules, instructions, procedures and Network Rules and Procedures. They must familiarise themselves with relevant emergency arrangements.

As far as practicable, they are also to become fully conversant with equipment in adjacent areas, and thus be capable of performing effective service when required to do so in an emergency.

Licensed signalling personnel are required, from time to time, to attend failures or carry out maintenance in other areas. When tracing equipment failures in their area, signalling personnel must, if required, work in adjacent areas to find and rectify the cause. In such cases, the maintenance signal engineer and relevant team manager must be notified as soon as practical.

Licensed signalling personnel must functionally test any signalling that may have been adversely affected by maintenance activities. This requirement extends to the removal or disturbance of any signalling apparatus such as ESML or EOL keys, relays, fuses, links, switches, electrical contacts and so on.

Licensed signalling personnel, when attending equipment fitted with doors, covers, lids etc. are responsible for ensuring that they are left properly secured in position, closed and where applicable, locked.

Licensed signalling personnel must check items of signalling equipment during regular maintenance visits, and whenever there is reasonable cause to suspect that reliable operation of equipment may have been jeopardised (e.g. by construction activities, mechanised track maintenance activities, etc.), and also at other times when the opportunity arises and it is practical and advantageous to do so. Examples of fundamental checks that licensed signalling personnel must be aware of are visual inspection of track circuit parallel bonding, obvious signal sighting obstructions and poor rail surface condition.

To ensure the reliable operation of equipment, it is the responsibility of licensed signalling personnel to keep a lookout for potential failures and potential failure situations so that preventative maintenance can be achieved.

Licensed signalling personnel must report to the maintenance signal engineer any technical or safeworking matter which appears to require attention which is beyond their own means. The urgency of the advice is to be appropriate to the issue.

The maintenance signal engineer is accountable for monitoring all aspects of signalling maintenance. This is achieved by taking into account the asset condition, safety criticality and site specific conditions that may require the asset to receive additional or more frequent maintenance tasks.

Where the safety provided by an asset is impaired, the maintenance signal engineer and licensed signalling personnel must take the necessary action to mitigate such risk associated with the situation or otherwise arrange to book the affected signalling out of use.
2 Maintenance – Frequencies, Reports and Records

In order that maintenance of systems and equipment is carried out in a controlled and programmed manner it is necessary to keep accurate, updated records. Licensed signalling personnel are required to produce and submit returns, reports and test records in accordance with these procedures.

In the event of a train accident in which the integrity of the signalling system may be questioned or thrown under suspicion, the maintenance reports and records form an important documented account, duly attested to the maintainer, of the maintenance of the system concerned.

Detailed records of maintenance, defects repaired and adjustments made are also required to assist in determining the optimum level of maintenance for each type of equipment.

The maintenance actions carried out are to be on the basis that it should ensure that the signalling equipment will operate safety and reliably until the next maintenance visit.

2.1 Maintenance Frequencies

Maintenance signal engineers and team managers are responsible for ensuring the performance of maintenance necessary to meet safety standards and reliability targets.

Maintenance frequencies are set out in Technical Maintenance Plans and Service Schedules. Some assets and areas of the network have Tailored Technical Maintenance Plans and Service Schedules to take account of the particular conditions relevant to that asset or area.

Maintenance frequencies and maintenance tasks are to be in accordance with the Technical Maintenance Plan (TMP) and the associated service schedules or an approved Tailored Technical Maintenance Plan and service schedules where applicable.

Maintenance frequencies and tasks are subject to continuous review. Maintenance signal engineers and signalling personnel should advise the Sydney Trains TMP team of their experience using the TMPs, to provide feedback and suggest improvements.

The TMP maintenance periods are specified intervals for specified maintenance tasks included in the Service Schedules and are based on signalling equipment in fair and reasonable condition in an operating environment of a reasonable standard with a high level of main line passenger and/or freight traffic.

The maintenance signal engineer is to direct that additional or more frequent maintenance be carried out where site specific conditions, (such as road movement, or equipment approaching its life expectancy, etc.) would otherwise cause a reduction in safety integrity or in reliability below requirements.

For non-vital equipment, or on non-passenger lines with low to medium levels of traffic, or on terminating branch passenger lines with a low level of traffic, then, provided the equipment and its operating environment are in reasonable order, the maintenance signal engineer after due deliberation, may apply for a Signal Engineering Deviation to extend the TMP maintenance periods. This does not apply to the frequencies of safety related inspections and tests which are listed in the table of Signalling Safety Tasks under Section 2.2 of this procedure, where a Signal Engineering Deviation or ASA Concession is required. Refer to PR S 40049.

Where approval has been given to extend the maintenance frequencies and or modify the maintenance tasks the maintenance signal engineer will be responsible for regularly
reviewing the conditions to ensure that there are no changes that would affect the maintenance requirements.

Notwithstanding the scheduled maintenance tasks, licensed signalling personnel should be particularly vigilant when attending locations to detect any deficiency in items other than those they are specifically maintaining during that visit. This includes bonding, notice boards, and any changes to track circuit ballast conditions that may have recently occurred. Any defects are to be attended to and not left for the next scheduled visit. Maintenance on such items is to be recorded in the Sydney Trains defect management system.

Details of the planned maintenance schedules and frequencies and the actual preventative and corrective maintenance performed, including safety related tests, must be recorded using Sydney Trains’ maintenance reporting and recording system.

2.2 Management and reporting of Safety related Examinations and Inspection Tasks

2.2.1 Safety Importance

A system of managing and reporting compliance with standards for nominated maintenance tasks has been introduced for defined safety critical signalling assets and components. These assets and components are defined as items whose functional failure or secondary damage resulting from the functional failure, either by itself or as a hidden function in concert with one other failure, will result in the likelihood of an irregularity or significant incident occurring, causing injury to the public or staff.

To manage the known failure modes of these safety critical assets and components the maintenance tasks have been categorised as Safety Critical or Safety Significant tasks and allocated set time periods with appropriate planning latitudes for the maintenance and inspections tasks to be carried out to mitigate the risk of critical failure.

The difference in importance between the tasks allocated to manage these safety critical assets and components is the failure characteristics of the condition being assessed by the examination task.

The failure characteristics of safety critical tasks are generally rapidly developing and adverse following the breach of the defined conditional criteria. There is a significant increase in risk associated with safety critical tasks being extended beyond the specified task period without defined and approved risk mitigation measures in place.

The failure characteristics of safety significant tasks are slower to manifest themselves and are less likely to be adverse following the breach of the defined conditional criteria due to additional system safety barriers.

2.2.2 Safety Critical Task

A safety critical task is one that protects against a wrong side failure mode in a safety related asset or component, such that if a failure were to occur it would have a high probability of causing an outcome of severe consequence.

For example, points are identified as safety critical assets and are allocated safety critical tasks of gauging the gap between switch and stock rails to check the go/no-go settings of the point lock and point detection. These tasks are done to ensure the point lock and point detection settings have not drifted beyond their specified limits.

The risk increases when the safety critical tasks are extended beyond the specified period.
2.2.3 Safety Significant Task

A safety significant task is one that protects against a wrong side failure mode in a safety related asset or component, such that if a failure were to occur it would have a medium to low probability of causing severe consequences. This is enabled by the provision of additional safety barriers such as a quality check on staff performance.

For example, track circuits are identified as safety significant assets and are allocated safety significant tasks of performing a shunt test, zero feed test and polarity test (where applicable). These tasks are done to ensure the track circuit characteristic has not drifted beyond its specified limits, and ensure that it cannot be falsely fed from another source. Another example is the Signal Engineer Level Crossing Inspection.

2.2.4 Management and Reporting Compliance

Safety inspections and tests are recorded with returns to provide verification and record compliance. For Safety Critical and Safety Significant examinations and inspections, returns are to be completed utilising the forms specified in Section 2.2.5. Additionally, a return must be provided following any out of course adjustment or test made between routine maintenance inspections. Returns are to be duly submitted to the maintenance signal engineer. Electronic copies such as scans or photographs are also acceptable. Equivalent forms having, as a minimum, all details of the designated form in Section 2.2.5 are acceptable after approval unless shown otherwise.

The Signalling Technical Maintenance Plan defines preventive maintenance tasks for signalling infrastructure equipment. Each task has planning latitude which reflects the allowed variation around the task due date i.e. an earliest start and a latest finish time. Planning latitudes are 20% for tasks of 42 days or less and 10% for tasks greater than 42 days unless otherwise authorised in the TMP.

Safety Critical and Safety Significant tasks are be prioritised and completed within the defined planning latitude. Tasks that cannot be achieved due to special technical circumstances must be risk assessed by the maintenance signal engineer and the risks appropriately and promptly mitigated. This may include obtaining a Signal Engineering Deviation or ASA Concession in accordance with PR S 40049. Failure to secure prompt, appropriate risk mitigation will require the particular asset to be booked out of use.

When it comes to notice that a Safety Critical or Safety Significant task has exceeded compliance (including the latitude period) due to non-technical circumstances, then immediate action must be taken at the earliest opportunity (within 24 hours of receiving the notice) to satisfactorily complete the task. Failure to achieve satisfactory completion within the stated time frame will require removal of the particular asset from service.

Work orders that become due within the scheduled period and are completed, must be closed off using Sydney Trains' maintenance management system as soon as practical.
2.2.5 Signalling Safety Tasks

The test frequencies for the following Safety Critical Tasks and Safety Significant Tasks are to be as detailed in the approved Signalling Technical Maintenance Plans.

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<td>Checking of 50 Hz ACDR track circuits</td>
<td>PR S 40017 FM 01</td>
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<tr>
<td>Testing of point locks and point detection</td>
<td>PR S 40017 FM 01</td>
</tr>
<tr>
<td>Testing of derail detection</td>
<td>PR S 40017 FM 01</td>
</tr>
<tr>
<td>Testing of selectors and bolt locks</td>
<td>PR S 40017 FM 01</td>
</tr>
<tr>
<td>Testing of unproved electric locks</td>
<td>PR S 40017 FM 01</td>
</tr>
<tr>
<td>Inspection of non-proved vital signalling relays – AC vane and DC shelf types</td>
<td>PR S 40017 FM 01</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Safety Significant Task</th>
<th>Return</th>
</tr>
</thead>
<tbody>
<tr>
<td>Testing of signalling interlockings and mechanical locking items (Signal Engineers inspection)</td>
<td>PR S 40022 FM 01 *</td>
</tr>
<tr>
<td>Inspection of level crossing protection equipment (Signal Engineers inspection)</td>
<td>PR S 40036 FM 02</td>
</tr>
<tr>
<td>Testing of signalling electrical conductor insulation resistance</td>
<td>PR S 40023 FM 01 to FM 06</td>
</tr>
<tr>
<td>Testing of electro-mechanical and thermal type time limit relays</td>
<td>PR S 40024 FM 02 *</td>
</tr>
<tr>
<td>Overhaul of non-proved vital signalling relays – AC vane and DC shelf types</td>
<td>PR S 40024 FM 01 *</td>
</tr>
<tr>
<td>Inspection of parallel bonding</td>
<td>PR S 40017 FM 01</td>
</tr>
<tr>
<td>Track circuit level 3 – including shunt testing, zero feed and polarity testing (2 year test)</td>
<td>PR S 40017 FM 01</td>
</tr>
<tr>
<td>Testing of slip detectors and rainfall detectors</td>
<td>PR S 40017 FM 01</td>
</tr>
<tr>
<td>Testing of ETCS Unlinked or Seldom Used Balises</td>
<td>PR S 40017 FM 01</td>
</tr>
</tbody>
</table>

* Use of an equivalent form is not permitted.

Maintenance records recording safety related tasks are to be arranged such that each critical item is individually signed for and submitted as required or alternatively a separate return listing all related items and signed for collectively, would fulfil the requirements for these returns.

The maintenance signal engineer is to analyse maintenance records regularly for certification and compliance elements and arrange corrective action if required.

Where a Signal Engineering Deviation is being sought for extension of the safety critical tasks of point lock and detection testing, the Points Turnout Checklists (refer Appendix A) are to be completed as part of the risk assessment for the particular points concerned and accompany the Deviation application.
Relay records

Relay records must be prepared and submitted in accordance with PR S 40024 – Vital Signalling Relays.

Battery records

Battery record cards must be kept with the battery/cell in accordance with the procedure laid down herein.

Level Crossing records

Level Crossing maintenance visit sheets must be kept in the level crossing location as defined in PR S 40036 – Level Crossings.

Point maintenance records

Point history cards must be kept in the same signalling location as the local points operating relays/ contactors/ module. For mechanical points, Point history cards are to be kept in the signalling location nearest to the operating levers.

Track circuit records

Track circuit test record cards (track history cards) must be kept near the track relay and track feed as specified in PR S 40025 – Track Circuits.

Insulation Test Records

Insulation test records must be kept by the maintenance signal engineer or maintenance depot and monitored against the program as scheduled in the Sydney Trains maintenance management system.

Signal Engineer Inspection/Test Reports and Certificates

Reports and certificates must be completed and kept by the maintenance signal engineer for the specific inspections or tests required to be carried out by them or their suitably accredited delegate. These include locking test certificates, protected level crossing inspection reports, and signal sighting inspection reports.

2.3 Lines on Which Traffic is Suspended

Should traffic on the line be suspended, maintenance may also be suspended with the approval of the Professional Head, Signalling and Control Systems. Network Operations must be notified in writing that no maintenance is being carried out and that no trains must run until arrangements have been made to carry out the maintenance prior to any train running. Written acknowledgment is required from Network Operations and a notation is to be made in the Train Register Book or equivalent if provided at the controlling signal box or control centre. All signalling equipment on the line is to be collectively booked out of order. A CAN notice is to be sent.
2.4 Trainstop Gauging

The periodic gauging of trainstops is not required. However, it is important to ensure events which may affect the gauge of the trainstop trip arm are considered and thus trigger gauging to be performed as an event driven task.

Whenever trainstops are gauged, a return must be duly submitted to the maintenance signal engineer.

Typical events that require gauging of trainstops are as follows:

- Occurrence of rerailing adjacent to the trainstop
- Renewal of the trainstop
- Reinstatement following temporary removal of the trainstop (i.e. facilitating track work)
- Replacement of the trainstop trip arm
- Renewal or adjustment of a trainstop component affecting the height of the trip arm
- Renewal or refastening of the trainstop mounting
- Where signs or evidence indicates the trip arm is out of gauge (i.e. non-aligned trip marks on trip arm face)
- Where the adjacent track alignment has changed or the rail fixings replaced or adjusted
- Following an incident/ derailment/ irregularity where the gauge of the trainstop is in question
Appendix A  Returns, Checklists and Point History Cards

<table>
<thead>
<tr>
<th>Location:</th>
<th>Location:</th>
<th>Location:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equip. No</td>
<td>Equip. No</td>
<td>Equip. No</td>
</tr>
<tr>
<td>Test Date</td>
<td>Test Date</td>
<td>Test Date</td>
</tr>
<tr>
<td>Adjust</td>
<td>Adjust</td>
<td>Adjust</td>
</tr>
</tbody>
</table>

- **Scheduled**: S
- **Achieved**: A

- **Remarks**: (Advising the details of adjustments)

| Signal Electrician | (Name) | (Signature) |
Points Turnout Checklist

To accompany Signal Engineering Deviation application for proposals to change Point Lock and Detection Testing frequency

Date: ____________________
Location: ____________________ Points No: ____________________

**Turnout Type: Conventional**

1. General turnout condition including timbers or beams and ballast – do not include signalling equipment in this part of the assessment.

<table>
<thead>
<tr>
<th>Condition Rating</th>
<th>V Poor</th>
<th>Poor</th>
<th>Fair</th>
<th>Good</th>
<th>V Good</th>
</tr>
</thead>
<tbody>
<tr>
<td>60kg 1m 8% or 1 in 10% on concrete beam</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○ or</td>
</tr>
<tr>
<td>60kg 1 in 15 on concrete beams</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○ or</td>
</tr>
<tr>
<td>60kg 1 in 8% or 1 in 10% on timber sleepers</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○ or</td>
</tr>
<tr>
<td>60kg 1 in 15 on timber sleepers</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○ or</td>
</tr>
<tr>
<td>53kg 1 in 15 housed</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○ or</td>
</tr>
<tr>
<td>53kg 1 in 8% or 1 in 10% std switch</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○ or</td>
</tr>
<tr>
<td>53kg 1 in 8% or 1 in 10% thick switch</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○ or</td>
</tr>
<tr>
<td>47kg or lighter</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Ballast Condition (Foiled ⇒ Clean)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Ballast Height (Low/Excessive ⇒ Correct)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Is the turnout pumping (High ⇒ negligible)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Has the ballast through the turnout been glued (bonded)</td>
<td>Yes</td>
<td>No</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Super-elevation through the turnout</td>
<td>None</td>
<td>&lt;35mm</td>
<td>&gt;35mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Switch lip condition</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td></td>
</tr>
<tr>
<td>Type of chair</td>
<td>Rail Brace</td>
<td>Pressed Steel</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Switch fit up to stockrail: Normal</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Reverse</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Flange way clearance (behind open switch)</td>
<td>&lt;60mm</td>
<td>&gt;60mm</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Evidence of Flange contact**

<table>
<thead>
<tr>
<th>Normal Switch</th>
<th>NO</th>
<th>YES</th>
<th>Reverse Switch</th>
<th>NO</th>
<th>YES</th>
</tr>
</thead>
<tbody>
<tr>
<td>General level and alignment</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Turnout Geometry</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Drainage</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Gauge</td>
<td>&lt; 1432</td>
<td>1432-1440</td>
<td>&gt; 1440</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turnout switch alignment</td>
<td>within 25 mm of square</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Evidence of stockrail longitudinal movement</td>
<td>○</td>
<td>&gt; 20 mm</td>
<td>10-20 mm</td>
<td>&lt; 10 mm</td>
<td></td>
</tr>
<tr>
<td>Evidence of stockrail lateral movement</td>
<td>○</td>
<td>&lt; 3 mm</td>
<td>&gt; 4 mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heel condition (if not flexible switch)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>
Sydney Trains Engineering Procedure - Signalling and Control Systems  
Points Turnout Checklist  
PR S 40017 FM92

Date: ____________________________  
Location: ____________________________  Points No: ____________________________  

Turnout Type: Conventional  
2. Traffic: Density, type and speed

<table>
<thead>
<tr>
<th>Density: Trains per day</th>
<th>&lt; 5</th>
<th>5 - 20</th>
<th>20 - 50</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 - 100</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100 - 200</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; 200</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type</th>
<th>EMU</th>
<th>XPT or Mixed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Freight</td>
<td>Heavy Haul</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Speed</th>
<th>Straight Route</th>
<th>60 - 90</th>
<th>90 - 120</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&gt; 120 kph</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Turnout Route</th>
<th>&lt; 20 kph</th>
<th>20 - 40</th>
<th>&gt; 40 kph</th>
</tr>
</thead>
</table>

Percentage of trains through turnout route: __________ %  

Line Class: ________________________________________

3. Environment

Approach Conditions:  
- Continuously webbed
- Other turnout
- Rail joint within 3 m of tip

Curvature approaching turnout:  
- None
- > 400 m
- < 400 m

Rising grade approaching turnout:  
- < 1 in 60
- > 1 in 60

Level approaching turnout:  
- __________

Falling grade approaching turnout:  
- < 1 in 60
- > 1 in 60

Locality:  
- Subject to flooding
- Corrosive (coal or mineral traffic)
- Seaboard

Derailment Severity #:  
- 5
- 4
- 3
- 2
- 1

### Derailment severity is defined by the location of the turnout relative to bridges over rivers or roads, embankments, other running lines, building or overbridge supports, frequented public areas.

E.g. a turnout immediately ahead of a bridge could rate "5" (very high) whereas a turnout on a single line in open flat country could rate "1" (very low).
Sydney Trains Engineering Procedure - Signalling and Control Systems

Points Turnout Checklist

**Date: __________________________**

**Location: __________________________ Points No: ___________**

**Turnout Type: Conventional**

4. **Signalling Equipment: Type and condition**

<table>
<thead>
<tr>
<th>Type</th>
<th>Electric</th>
<th>EP</th>
<th>mech</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydraulic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clamp Lock</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Claw Lock</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Back Driver(s)</td>
<td>None</td>
<td>One</td>
<td>Two</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Condition of external equipment</th>
<th>V Poor</th>
<th>Poor</th>
<th>Fair</th>
<th>Good</th>
<th>V Good</th>
</tr>
</thead>
<tbody>
<tr>
<td>V Poor</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poor</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fair</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Good</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V Good</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Condition of mechanism(s)</th>
<th>V Poor</th>
<th>Poor</th>
<th>Fair</th>
<th>Good</th>
<th>V Good</th>
</tr>
</thead>
<tbody>
<tr>
<td>V Poor</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poor</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fair</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Good</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V Good</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Installation Standard**

- Alignment of rodding: Yes
- Electric Switch Machine: Type:

<table>
<thead>
<tr>
<th>Mechanical Drive</th>
<th>Interlock Machine</th>
<th>Ground frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type of extension piece</th>
<th>ball joint</th>
<th>rubber bush</th>
</tr>
</thead>
<tbody>
<tr>
<td>yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>no</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For Mechanical operation only:

- Adjustment remaining on 10x18 crank: < 65 mm
- Escapement between bobbin and cradle: < 10 mm

**Lock and/or Detection Adjustment History**

- Lock and/or detector required adjusted during testing or periodic maintenance at intervals of:
  - < 2 months
  - 2 - 4 months
  - > 4 - 6 months
  - > 6 months

**Lock and/or detection failure history (include only "adjustment" failures)**

- No of failures past 3 months at intervals of: ___________
- No of failures past 12 months: ___________

**Signed:** ____________________

Maintenance Signal Engineer

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Date in Force: 21 September 2016

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Page 3 of 8

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Date in Force: 8 March 2019

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Page 15 of 22

Version 1.2
To accompany Signal Engineering Deviation application for proposals to change Point Lock and Detection Testing frequency

Date: 

Location: Points No: 

**Turnout Type: Tangential**

1. General turnout condition including timbers or beams and ballast: do not include signalling equipment in this part of the assessment.

<table>
<thead>
<tr>
<th>Condition Rating</th>
<th>V Poor</th>
<th>Poor</th>
<th>Fair</th>
<th>Good</th>
<th>V Good</th>
</tr>
</thead>
<tbody>
<tr>
<td>190 - 250 m radius on concrete beams</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○ or</td>
</tr>
<tr>
<td>300 - 600 m radius on concrete beams</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○ or</td>
</tr>
<tr>
<td>1200 m radius on concrete beams</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○ or</td>
</tr>
<tr>
<td>190 - 250 m radius on timber sleepers</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○ or</td>
</tr>
<tr>
<td>300 - 600 m radius on timber sleepers</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○ or</td>
</tr>
<tr>
<td>1200 m radius on timber sleepers</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○ or</td>
</tr>
<tr>
<td>Ballasted Condition (Fouled ⇒ Clean)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Ballast Height (Low/Excessive ⇒ Correct)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Is the turnout pumping (High ⇒ negligible)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Has the ballast through the turnout been glued (bonded)</td>
<td>Yes</td>
<td>No</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Super-elevation through the turnout</td>
<td>None</td>
<td>○ &lt; 35 mm</td>
<td>○ &gt; 35 mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Switch tip condition</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Switch fit up to stockrail</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Normal</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Reverse</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Flangeway clearance (behind open switch)</td>
<td>○ &lt; 60 mm</td>
<td>○ &gt; 60 mm</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evidence of Flange contact</th>
<th>Normal Switch</th>
<th>NO</th>
<th>YES</th>
<th>Reverse Switch</th>
<th>NO</th>
<th>YES</th>
</tr>
</thead>
<tbody>
<tr>
<td>General level and alignment</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td></td>
</tr>
<tr>
<td>Turnout Geometry</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td></td>
</tr>
<tr>
<td>Drainage</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td></td>
</tr>
<tr>
<td>Gauge</td>
<td>○ &lt; 1432</td>
<td>○ 1432-1440</td>
<td>○ &gt; 1440</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turnout switch alignment</td>
<td>○ within 25 mm of square</td>
<td>○ more than 25 mm out of square</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Evidence of stockrail longitudinal movement</td>
<td>○ &gt; 20 mm</td>
<td>○ 10-20 mm</td>
<td>○ &lt; 10 mm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Evidence of stockrail lateral movement</td>
<td>○ ≥ 4 mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Sydney Trains Engineering Form - Signalling and Control Systems
Points Turnout Checklist

PR S.40017 PM92

Date: __________________________

Location: ________________________ Points No: ______________________

Turnout Type: Tangential

<table>
<thead>
<tr>
<th>2. Traffic: Density, type and speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density: Trains per day</td>
</tr>
<tr>
<td>O &lt; 5</td>
</tr>
<tr>
<td>O 5-20</td>
</tr>
<tr>
<td>O 20-50</td>
</tr>
<tr>
<td>O 50-100</td>
</tr>
<tr>
<td>O 100-200</td>
</tr>
<tr>
<td>O &gt; 200</td>
</tr>
<tr>
<td>Type</td>
</tr>
<tr>
<td>O EMU</td>
</tr>
<tr>
<td>O XPT or Mixed</td>
</tr>
<tr>
<td>O Freight</td>
</tr>
<tr>
<td>O Heavy Haul</td>
</tr>
<tr>
<td>Speed</td>
</tr>
<tr>
<td>Straight Route</td>
</tr>
<tr>
<td>O &lt; 60 kph</td>
</tr>
<tr>
<td>O 60-90</td>
</tr>
<tr>
<td>O 90-120</td>
</tr>
<tr>
<td>O &gt; 120 kph</td>
</tr>
<tr>
<td>Turnout Route</td>
</tr>
<tr>
<td>O &lt; 25 kph</td>
</tr>
<tr>
<td>O 25-50</td>
</tr>
<tr>
<td>O &gt; 60-80</td>
</tr>
<tr>
<td>O &gt; 80 kph</td>
</tr>
<tr>
<td>Percentage of trains through turnout route</td>
</tr>
<tr>
<td>Line Class</td>
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3. Environment

<table>
<thead>
<tr>
<th>Approach Conditions</th>
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<tbody>
<tr>
<td>O Continuously welded</td>
</tr>
<tr>
<td>O Other turnouts</td>
</tr>
<tr>
<td>O Rail joint within 3 m of tip</td>
</tr>
<tr>
<td>Curvature approaching turnout</td>
</tr>
<tr>
<td>O none</td>
</tr>
<tr>
<td>O &gt; 400 m</td>
</tr>
<tr>
<td>O &lt; 400 m</td>
</tr>
<tr>
<td>Rising grade approaching turnout</td>
</tr>
<tr>
<td>O &lt; 1 in 60</td>
</tr>
<tr>
<td>O &gt; 1 in 60</td>
</tr>
<tr>
<td>Level approaching turnout</td>
</tr>
<tr>
<td>Failing grade approaching turnout</td>
</tr>
<tr>
<td>O &lt; 1 in 60</td>
</tr>
<tr>
<td>O &gt; 1 in 60</td>
</tr>
<tr>
<td>Locality</td>
</tr>
<tr>
<td>Subject to flooding</td>
</tr>
<tr>
<td>O yes</td>
</tr>
<tr>
<td>O no</td>
</tr>
<tr>
<td>Corrosive (coal and mineral traffic)</td>
</tr>
<tr>
<td>O yes</td>
</tr>
<tr>
<td>O no</td>
</tr>
<tr>
<td>Seaboard</td>
</tr>
<tr>
<td>O yes</td>
</tr>
<tr>
<td>O no</td>
</tr>
<tr>
<td>Derailment Severity ##</td>
</tr>
<tr>
<td>O 5</td>
</tr>
<tr>
<td>O 4</td>
</tr>
<tr>
<td>O 3</td>
</tr>
<tr>
<td>O 2</td>
</tr>
<tr>
<td>O 1</td>
</tr>
</tbody>
</table>

### Derailment severity is defined by the location of the turnout relative to bridges over rivers or roads, embankments, other running lines, building or overbridge supports, frequented public areas.

Eg. a turnout immediately ahead of a bridge could rate "5" whereas a turnout on a single line in open flat country could rate "1".
<table>
<thead>
<tr>
<th>Turnout Type: Tangential</th>
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<tr>
<td>4. Signalling Equipment: Type and condition</td>
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<table>
<thead>
<tr>
<th>Type</th>
<th>Electric</th>
<th>EP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Back Driver(s)</td>
<td>None</td>
<td>One</td>
</tr>
<tr>
<td></td>
<td>One plus spring assist</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Condition of external equipment</th>
<th>Poor</th>
<th>Fair</th>
<th>Good</th>
<th>V Good</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condition of mechanism</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Installation Standard</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alignment of rodding</td>
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OR

<table>
<thead>
<tr>
<th>Electric Switch Machine</th>
<th>Type</th>
<th>Electric</th>
<th>EP</th>
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</thead>
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<td>None</td>
<td>One</td>
<td>Two</td>
</tr>
<tr>
<td></td>
<td>One plus spring assist</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Condition of external equipment</th>
<th>Poor</th>
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<th>Good</th>
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</tr>
<tr>
<td>Alignment of rodding</td>
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Lock and/or Detection Adjustment History

Lock and/or detector required adjusted during testing or periodic maintenance at intervals of

| <2 months | 2 - 4 months | <4 - 6 months | 0 > 6 months |

Lock and/or detection failure history (include only “adjustment” failures)

No of failures past 3 months

No of failures past 12 months

Signed: __________________________

Maintenance Signal Engineer
## Point History Card (EP and Mechanical)

<table>
<thead>
<tr>
<th>Location/Cupboard</th>
<th>Point End</th>
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<table>
<thead>
<tr>
<th>Date</th>
<th>Service Schedule/Activity*</th>
<th>Switch/Tie Opening (mm)</th>
<th>Flushdown Check** (✓/✗)</th>
<th>Point Lock Test** (✓/✗)</th>
<th>Direction Test** (✓/✗)</th>
<th>Adjustment/Maintenance Comments***</th>
<th>Name</th>
<th>Signed</th>
</tr>
</thead>
<tbody>
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* Service Schedule/Activity may be an SS01, SS02, Defect, Failure, Tampering, Rail or Relay, for example.
** ✓ = tested OK, ✗ = adjustment made and retested OK, ✗ = not applicable or not performed. Flangeway Check includes a check of backdrive operation/adjustment (where fitted).
*** Adjustment/Maintenance Comments may be Slack Nor Luck, + Immun sharn. Tight Rev Lock, Splinee Rotated, -shar. Light Nor Det, Heavy Rev Det. Refer to any defects found or fixed. Write PTO when further comments are made on the back.

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Date in Force: 21 September 2016

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Version 1.0
Page 1 of 2
## Additional Comments

<table>
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<th>Service Schedule/Activity*</th>
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</table>
## Location/ Cupboard:

<table>
<thead>
<tr>
<th>Date</th>
<th>Service Schedule Activity</th>
<th>Switch Tip Contact</th>
<th>Flangeway Check</th>
<th>Point Lock Test</th>
<th>Detection Test</th>
<th>Motor Current (Amps)</th>
<th>Adjustment/ Maintenance Comments</th>
<th>Name</th>
<th>Signed</th>
</tr>
</thead>
</table>

**Notes:**

* Service Schedule Activity may be an S501, S502, Defect, Failure, Tampering, Retail or Renewal, for example.

**F** = Tested OK, **A** = adjustment made and retested OK, **N** = not applicable or not performed. Flangeway Check includes a check of backdrive operation or adjustment (where fitted).

**Adjustment/Maintenance Comments** may be: slack nor lock, * trim shim, tight rev lock, spherro robbed, 180th, light nor det, heavy rev det. Refer to any defects found or fixed. Write PTO when further comments are made on the back.

---

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Date in Force: 21 September 2016

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Date in Force: 8 March 2019

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### Additional Comments

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Engineering Procedure
Signalling and Control Systems

Signalling Safeworking

PR S 40019

Cleanliness and Lubrication of Mechanical Signalling Equipment

Version 1.1

Date in Force: 21 September 2016
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<td>1.1</td>
<td>21 September 2016</td>
<td>R. Del Rosario</td>
<td>Updated titles, roles and removed references to Draw Locks</td>
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Summary of changes from previous version

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1 Introduction
All mechanisms and connections must be kept free from dirt and grit to reduce wear and help to reveal defects in their early stages.

1.1 Cleaning
Mechanical signalling equipment and connections, as applicable, are to be cleaned as explained below.

The cleaning should be done by means of knife or scraper and dry brush. After all dirt has been removed, the connections are to be lightly oiled. Any excess oil should be wiped off with a cloth or small brush.

Cotton waste must not be used for applying or removing oil.

On sections where dusty conditions are experienced and in railway yards where various minerals are handled, the foregoing procedure is to be modified to suit circumstances, at the discretion of the maintenance signal engineer. The surface of the connections should be painted with a suitable paint and oil applied only to the joints, pins etc.

All ballast, grit or dust or rubbish accumulating about connections must be moved away, so that the connections work freely. Wet or damp conditions due to ineffective drainage, causing problems with equipment or connections, must be reported to the Civil personnel.

Where required, point chairs are to be cleaned during routine maintenance (as per technical maintenance plan) or failure investigation.

Steel wool must not be used in any area where there is electrical signalling apparatus or circuits.

1.2 Interlocking Machines at Intermediate Sidings
These machines are to be oiled and cleaned by licensed signalling personnel in the same way as the machines in signal boxes.

For this purpose, the lock faces of the Annett locks may be removed but great care must be taken not to interfere with the locking mechanism.

Each time a cover has been removed and replaced the Annett Lock must be carefully tested.
Engineering Procedure
Signalling and Control Systems

Signalling Safeworking

PR S 40020

Security, Fire Protection, Weather Proofing and Cleanliness of Signalling Equipment, Housing and Locations

Version 1.2

Date in Force: 8 March 2019
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<td>R. Del Rosario</td>
<td>Updated to new titles &amp; roles, update to ASA requirement and merge PR S 40015 into document</td>
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<td>1.2</td>
<td>8 March 2019</td>
<td>A. Sozio</td>
<td>Update to include control systems requirements.</td>
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Summary of changes from previous version

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<td>1, 1.3</td>
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1.3 Housekeeping ...............................................................................................................................5
1.4 Fire Prevention ..............................................................................................................................5
1.5 Access ............................................................................................................................................6
1.6 Position of Trackside equipment .................................................................................................6
1 Introduction

Relay rooms, computer rooms, walk-in enclosures and lower floors of signal boxes and apparatus cupboards must be kept clean and tidy. They must be kept locked whenever possible. Spare or surplus material must not be stored in these places, unless it is neatly placed in racks or cupboards provided specially for that purpose. Highly inflammable material must not be stored in these places.

Cleanliness and tidiness of signalling equipment and its surroundings facilitates access and visibility of the equipment for maintenance inspection and work as well as minimising the potential for failure caused by dirt and dust, corrosive conditions, loose objects obstructing or shorting out equipment, fire etc.

The maintenance signal engineer must be advised of any security breach, water ingress or fire or any other significant matter that requires escalation and their attention.

1.1 Security

Where electric locks are in use on interlocking machines, other than electric locks on Distant Signal levers, the doors, in the case of elevated boxes, or trap doors in platform level signal boxes, must be secured by padlock or night latches.

All signalling locations are to be secured by Falcon 4 locks and all field signalling equipment is to be secured by Falcon 8 locks or as otherwise specified in PR S 40048.

All signalling equipment operating mechanisms, relays, contacts, terminals etc, must be housed in equipment units or in cupboards locked by Falcon Series locks as per PR S 40048 Appendix A, to prevent interference by unauthorised persons.

Locking arrangements are to be maintained in good condition and signalling apparatus and locations are to be left securely locked. Before closing up and locking equipment or locations, signalling personnel must check that everything is in order and properly connected and that nothing has been left loose, foul of standard clearances, or in a potentially unsafe condition.

1.2 Prevention of Water Ingress

Licensed signalling personnel are to keep insulating surfaces between electrical terminals clean and free from water to prevent leakage currents.

Licensed signalling personnel are to ensure that signalling locations including relay rooms, cupboards, huts etc, are properly sealed to prevent the ingress of rainwater.

Conduit entries to trackside apparatus near ground level in areas prone to flooding must be sealed with appropriate neutral cure silicon or similar sealants.

During routine maintenance licensed signalling personnel are to look for signs of water leakage and take appropriate corrective action.

During wet weather licensed signalling personnel are to avoid carrying out preventative maintenance which would allow water to enter equipment.

During corrective work, licensed signalling personnel should take measures to protect signalling equipment from the ingress of rainwater.

During wet weather licensed signalling personnel should examine the drainage around electrical apparatus to ensure water does not build up and enter the equipment. Check locations, housings and vulnerable equipment for leaks, and remove any rubbish, cans etc, that have been blown or washed foul of operating equipment, drains, or into V or K crossings near insulated block joints etc.
After heavy rains licensed signalling personnel should check equipment, particularly in vulnerable locations and in areas additionally affected by extreme conditions, clean and dry the equipment as necessary and utilise approved lubricating, penetrating and anti-corrosion sprays where advantageous. Where evidence of water ingress is apparent the equipment must be checked for correct operation.

Semi-sealed components must be inspected to ensure that they are thoroughly dry and not internally contaminated. If there is evidence of foreign matter or moisture within the component, or it is not able to be easily checked, it must be changed out.

Sealed components must be checked to ensure the sealing remains effective.

Where wiring and contacts are not visible, but have been affected by water (such as Nippon point machine contactors and controllers), the apparatus is to be removed, cleaned and dried before replacement.

The lead licensed signalling personnel maintaining an area is responsible for reporting details of any water ingress which affects signalling equipment, to the maintenance signal engineer.

1.3 Housekeeping

Access pathways, ladders and other such items must be maintained in good order, so as to provide adequate access to signalling apparatus and housings. Excess vegetation, rubbish or surplus materials must be removed during maintenance visits.

Vegetation must be kept clear of signalling equipment, signal and communications line wires and must not obstruct the sighting of signals. If obstructions become noticeable to licensed signalling personnel, the obstruction must be removed as soon as possible and if the obstructions become unmanageable the defects to be reported to the team manager and arrangement must be made for removal.

Lighting of relay rooms and cupboards must be maintained in good order to ensure adequate visibility is available.

Licensed signalling personnel are to ensure that signalling locations including relay rooms, computer rooms, cupboards, huts etc, are properly sealed to prevent entry of pests, such as insects and vermin, to control and mitigate risk to signalling equipment.

Conduit entries to trackside apparatus near ground level must be sealed with appropriate neutral cure silicon or similar sealants, to prevent entry of pests, such as insects and vermin.

During routine maintenance licensed signalling personnel are to look for signs of pests, such as insects and vermin and take appropriate corrective action.

Signalling relay rooms, computer rooms, locations, cupboards and equipment (including computer racks and cabinets) must be kept clean and tidy. Covers to cubicles, cable ducts computer racks and cabinets etc. are to be restored into place on completion of works.

1.4 Fire Prevention

It is essential that all licensed signalling personnel should take every precaution for the prevention of fires in or around signalling equipment and signal boxes and any situation considered to be a fire hazard must be reported to the maintenance signal engineer. Inflammable and combustible materials such as paper, wood shavings, scrap timber, spent cleaning material and litter must be cleared from and not be left near any cables,
signal boxes, relay rooms, walk-in enclosures, equipment cupboards, trackside equipment, cables, pits and ducts, airlines and air reticulation equipment.

The underneath portions of elevated relay huts and equipment cupboards must be enclosed to prevent the accumulation of rubbish.

Signalling personnel should always remain vigilant for signs of possible heat sources or damaged equipment (such as heat or smoke affected relays, power supplies, wiring etc.) that may lead to fires and taking the appropriate actions to mitigate the risk.

1.5 Access

Persons who are not required, as part of their normal duties, to examine or work on specific signalling equipment are not permitted entry to signalling locations housing such equipment, except under supervision by licensed signalling personnel or authorised signalling personnel.

Other than in emergencies, licensed signalling personnel who do not belong to the particular maintenance area are not to interfere with equipment on the particular maintenance area unless authorised by the maintenance signal engineer responsible for the area concerned.

1.6 Position of Trackside equipment

Signalling apparatus must not be located so that it fouls the structure gauge unless special dispensation is given by the Professional Head Signalling & Control Systems. Signalling infrastructure is to be installed to the approved specification, details of which are shown in SPG 0705; SPG 0706 and SPG 0708.

Licensed signalling personnel involved in the maintenance of signalling equipment must inspect and report signalling equipment & cable routes which may become foul of the structure gauge.
Inspection and Testing of Signalling Interlockings

Version 1.1

Date in Force: 21 September 2016
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<td>Title</td>
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<td>Included maintenance signal engineer is accountable to retain up to date interlocking test documentation.</td>
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<td>Added inspection, testing &amp; certification for additional mechanical items during periodic testing of mechanical interlockings (EIS 15/03)</td>
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1 **Testing Interlockings**

New or altered signalling interlockings require testing when commissioned and periodically to ensure they comply with the design requirement.

Signalling interlockings may also require testing in the following situations:

- When investigating a signalling irregularity or incident.
- Where there is doubt with the integrity of the interlocking.
- Whenever mechanical locking or associated covers are interfered with.

1.1 **Testing New Works and Alterations**

Requirements for testing and certifying new works and alterations are detailed in Specification SPG 0711 *Inspection and Testing of Signalling*. All changes are to be tested and certified and the tables and plans promptly brought up-to-date.

When new works or alterations are commissioned into use, the Commissioning Engineer must provide the maintenance signal engineer with a copy of the associated locking table or control table, locking diagram and working sketch/signalling plan showing the locking details as commissioned. The Commissioning Engineer is to forward a copy of the Interlocking Test Certificates to the maintenance signal engineer.

The maintenance signal engineer is accountable for retaining the most up-to-date versions of signalling documentation relevant for the purpose of interlocking testing.

1.2 **Periodic Maintenance Interlocking Tests**

Periodic maintenance interlocking tests must be carried out by a signal engineer (refer Section 2) for the primary reason of checking the interlocking and ensuring that it remains in accordance with the design requirement as shown on locking tables or interlocking portion of control tables, the locking diagrams and the working sketches/signalling plans.

Periodic maintenance testing of interlockings is a safety significant task and must be managed in accordance with PR S 40017.

The maintenance signal engineer is responsible for adhering to interlocking test programs as set out in the Technical Maintenance Plan and scheduled by the Sydney Trains maintenance management system. Any defects identified must be appropriately treated to ensure system safety and managed by the Sydney Trains defect management system.

The Signals Engineering Manager is to monitor performance indicators and/or status reports on the interlocking test programme.

1.3 **Mechanical Interlockings**

Inspection, testing and certification of mechanical interlocking apply to mechanical locking items and mechanical interlocking frames. Mechanical locking items and mechanical interlocking frames are subject to wear and tear. The method of testing used is important in identifying any fault or flaw. For example, mechanical locking that may be inappropriately defeated, or where the inscription or indexing of items is impaired or is inappropriate.

Periodic interlocking tests on mechanical locking must be completed and certified on a *PR S 40022 FM01* certificate by a signal engineer (refer Section 2) every two years.
1.3.1 Mechanical Locking Items

The locking tests are performed to ensure that mechanical locking items are effectively operational, safe and secure, and in accordance with Locking Tables, Control Tables, Locking Diagrams and Working Sketches/Signalling Plans.

Mechanical items include Releasing Switch Locks; Annett Keys; Annett locks; Duplex Locks; Half Pilot Staff Locks; Emergency Locks; Bolt Locks; Bracket Locks; Loose Keys; Token Boards; Emergency Switch Machine Locks (ESML); Emergency Operation Locks (EOL); SL and XL locks on points; XL locks, point-clips and point-spikes used on installed points not connected to the interlocking; points with wide cut notch lock slides.

Signalling notice boards are also to be checked as part of the interlocking certification.

1.3.2 Mechanical Interlocking Frames

The locking tests are performed to ensure that mechanical interlocking frames are effectively operational, safe and secure, and in accordance with Locking Tables, Control Tables, Locking Diagrams and Working Sketches/Signalling Plans.

Mechanical interlocking machines as a matter of principle do not contain redundant interlocking.

Mechanical interlocking frames vary in complexity. Interlocking tests on mechanical interlocking frames must be completed and certified by a signal engineer holding the appropriate authority as detailed in Section 2.

1.4 Relay and Route Control Interlockings

Standard Relay and Route Control interlockings, referred collectively as relay interlockings, contain some redundancy for safety spread over the interlocking and control circuits.

Relay and Route Control interlocking integrity may be reduced by mechanical deterioration of electromechanical relays or by the deterioration of circuit and/or equipment insulation through aging, termite or rodent attack, overheating, fire, lightning damage etc or by electrical leakage paths tracking across insulating surfaces.

Defects, mechanical or electrical, which hold a relay falsely energised, are likely to be brought to early attention due to the back proving or cross proving of relays or due to equipment malfunction.

However, defects of a type which result in part of the selection in an interlocking circuit being bridged out may not necessarily come to attention. Earth leakage detection equipment and bus-bar voltage leak to earth tests together with down proving of relays assist in guaranteeing the integrity of a relay interlocking.

Relay and Route Control interlocking integrity may also be reduced by interference to the design configuration.

No person must disconnect or connect wiring in working circuits unless they are licensed in signalling and do so in accordance with the rules and established procedures.

The method of testing used is important in identifying any fault or flaw where the relay locking may be inappropriately defeated.

Relay and Route Control interlockings must be periodically electrically tested in accordance with the locking tables or the interlocking portion of control tables and certified on a PR S 40022 FM01 certificate every five years.
Where the interlocking relays and interlocking circuits fully comprise of:

a) plug-in type vital signalling relays, and

b) P.V.C. insulated and sheathed wires and cables, and

c) double switched external circuits to relays used for interlocking, and

d) reliable earth leakage detection fitted to vital supplies for interlocking circuits,

then they need not be subject to periodic interlocking tests except at the discretion of the maintenance signal engineer.

Periodic tests of mechanical locking associated with relay interlocking areas, (for example, Ground Frames, Releasing Switches, Annett Locks and Keys, E.S.M.L.’s etc), must be tested in accordance with applicable signalling documentation as detailed for Mechanical Locking (refer to Section 1.3), and certified on a PR S 40022 FM01 certificate every two years.

Interlocking tests must be completed and certified by a signal engineer holding the appropriate authority as detailed in Section 2

1.5 Computer Based Interlocking

Computer based interlockings are exempt from periodic interlocking testing. The safety integrity level required of these interlocking provides the necessary safety assurance requirements for the signalling system.

However, validation and testing will be required when commissioning new or altered works, or otherwise in response to a signalling irregularity or incident and certified on a PR S 40022 FM02 certificate.

The following are computer based interlocking systems used:-

- Solid State Interlocking (SSI)
- Microlok II
- Westlock
- Westrace
- Smartlock

Periodic tests of mechanical locking associated with CBI interlocking areas, (for example, Ground Frames, Releasing Switches, Annett Locks and Keys, E.S.M.L.’s etc), must be tested in accordance with applicable signalling documentation as detailed for Mechanical Locking (refer to Section 1.3), and certified on a PR S 40022 FM01 certificate every two years.

Interlocking tests must be completed and certified by a signal engineer holding the appropriate authority as detailed in Section 2

1.6 Interlocking Test Certificates

Interlocking test certificates as per Appendix A must be used in the following situations:

- Certification of related new or altered works
- Certification of periodic interlocking testing
- Certification of interlocking subsequent to a related signalling irregularity or incident
For maintenance testing of mechanical and relay (including route control) interlockings, form PR S 40022 FM01 Mechanical/Relay/Route Control Locking Test Certificate should be used.

For new or altered works of mechanical and relay (including route control) interlockings, where track locking is not required to be included in the testing, form PR S 40022 FM01 Mechanical/Relay/Route Control Locking Test Certificate should be used.

For all other new and altered works, form PR S 40022 FM02 Design Integrity Test Certificate is to be used, which would also encompass the certification electrical testing of relay interlockings, inclusive of track locking.

Copies of the Interlocking Test Certificates are to be kept on file by the maintenance signal engineer.

2 Authority to Test Interlockings

Interlocking testing, including design integrity testing (also known as principles testing), must only be performed by signalling personnel who hold the competency and authority for such testing.

2.1 Interlocking Fitters

Licensed interlocking fitters are permitted to test mechanical interlocking frames and items, following maintenance performed by the interlocking fitter.

2.2 Signal Engineers

Signal engineers are authorised, as part of their accreditation, to perform interlocking tests (including Function Tests to Control Tables and Circuit Design Principles as required) on the following.

- Testing of mechanical interlocking frames of up to eight levers for any purpose.
- Inspection and testing of mechanical interlocking items, releasing devices and notice boards for any purpose.
- Testing of Relay, Route Control and CBI interlockings for the purpose of certifying minor new or altered work where a design integrity tester is not required – does not permit certification of complex new or altered work.
- Testing of all types of interlockings as part of an investigation when done in response to a signalling irregularity or incident or where there is doubt with the integrity of an operating interlocking.

2.3 Full Interlocking Accreditation

Only signal engineers holding full interlocking accreditation and in possession of a Full Locking Certificate are authorised to perform interlocking tests on the following.

- Testing of mechanical interlocking frames, including frames greater than eight levers for any purpose.
- Inspection and testing of mechanical interlocking items, releasing devices and notice boards for any purpose.
- Testing of Relay, Route Control and CBI interlockings for the purpose of certifying minor new or altered work where a design integrity tester is not required – does not permit certification of complex new or altered work.
- Periodical testing of Relay and Route Control interlockings.
Note:

Where the interlocking test is being performed to certify locking following an alteration to a Mechanical Interlocking Frame of greater than eight levers, then two signal engineers holding full interlocking accreditation (Full Locking Certificate) must jointly conduct the test and subsequently both sign the test certificate to certify that the interlocking is correct.

A Design Integrity Test Engineer may substitute one of the two signal engineers holding full interlocking accreditation.

When conducting an interlocking test in this case, one tester must observe the layout plan to ensure the relevant signalling principles are effective during the test eg: (levers pulled do not clear opposing signals, etc).

2.4 Design Integrity Tests

The Design Integrity Test Engineer must be accredited by the Professional Head Signalling & Control Systems to conduct Design Integrity Tests.

Design Integrity Test Engineers are permitted to perform the following interlocking tests:

- Function testing to control tables for the purpose of certifying minor and complex new or altered work.
- Design integrity testing for the purpose of certifying minor and complex new or altered work
- Periodical testing of Relay and Route Control interlockings.
Appendix A  Forms

PR S 40022 FM01
Signal Apparatus –
Mechanical / Relay / Route Control Locking Test Certificate

To be Issued By:

Test Engineer (Name): / / 

To be Issued To:

Maintenance signal engineer (Name): Location:

Purpose:

To certify that * Mechanical / Relay / Route Control Locking is correct

The * Mechanical / Relay / Route Control Locking at

was completed and Certified Correct on / / (Date) at (Time).

* Route / Lever No to are in accordance with

Control / Locking Table Title / No


Test Engineer (Signed): Dated: / /

Received by Signal Engineer (Signed):

* Commissioning / maintenance signal engineer

* Deletes that not required

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Date in Force: 21 September 2016
UNCONTROLLED WHEN PRINTED
Version 1.0
To be Issued By:  
Test Engineer (Name):  
Date:  

To be Issued To:  
Signal Engineer (Name):  
Location:  

* Commissioning / maintenance signal engineer  

Purpose:  
To Certify that Design Integrity is correct  

The Design Integrity Test at __________________________ was completed and Certified Correct  
on ______/_____/______ (Date) at __________________________ (Time), and is in accordance with  

Control Table Title / No __________________________  

Dated: ______/_____/______ and / or  

Design Integrity Test Plan / Title No __________________________  

/ /  
Test Engineer (Signed):  
Dated:  

/ /  
Received by Signal Engineer (Signed):  
Dated:  

* Commissioning / maintenance signal engineer  

[Delete that not required]
Engineering Procedure
Signalling and Control Systems

Signalling Safeworking

PR S 40023

Insulation Inspection and Testing

Version 1.2

Date in Force: 8 March 2019
Disclaimer

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1 Introduction

1.1 Purpose

The purpose of maintenance insulation testing of circuits is to check for the degradation of the insulation of cables and wires and ultimately to determine the requirement for their renewal.

The purpose also is to detect and rectify insulation defects which could potentially result in irregularities due to current leakage cutting out one or more of the control elements of a circuit.

1.2 Concept

Insulation inspections and tests are to be performed to detect the presence of individual earths on conductors, degradation in the insulation of electrical circuits from earth and degradation in the insulation of electrical conductors from one another in multicore cables.

Leakage to earth significant enough to affect the safe and reliable operation of circuits, can occur through two individual earth faults or through the cumulative effects of a number of less significant earth faults - each less significant leakage path to earth adding up in parallel to give a significant total.

The ideal aim is to detect and rectify each single earth fault before a second earth fault develops.

The following methods are used to detect circuit electrical leakage path:

- monitoring of power supply busbars using reliable earth leakage detectors
- measuring of power supply busbars to earth using test instruments
- testing of conductor insulation using test instruments
- function testing of signalling circuits
- visual examination of wiring, cables, terminals, racking, cable routes and equipment for damage and deterioration

Inspect and test for evidence of breakdown or degradation in the insulation of circuits from earth or from one another which may occur due to ageing, cracking, abrasion or other damage to the insulation, ingress of moisture into cables or across insulating surfaces, build up of dirt and grit etc. across insulating surfaces, distortion or movement of components affecting the clearance between metallic conductor parts, terminal lugs or wire strands coming into contact with frames, breakdown of surge arrestors, line wires coming into contact with trees, deposits caused by rotary contact wear, arcing, etc.

1.3 New and Altered Work

The cause of immediate or latent faults may be the result of poor installation practices, which can lead to undesirable electrical contact between wires, between cable cores, between wires and racks or equipment housings, and between wires and terminals.

Testing, either prior to commissioning or as a matter of routine, is no substitute for good installation practice and thorough supervision and management of the installation process.
New and altered work shall be supervised accordingly, be completely insulation tested and the results recorded before the installation is brought into use in accordance with PR S 47110.

1.4 Responsibilities

Licensed signalling personnel are responsible for recording busbar voltage to earth readings, earth leakage detector (ELD) testing and insulation resistance testing of all electrical wiring and equipment in their area of responsibility.

They are responsible for routine inspection of visible wiring and equipment for signs of potential electrical leakage paths and for insulation damage or deterioration. They must report all deterioration to the maintenance signal engineer, including circuits exempt from periodic insulation testing.

Additionally, the cable route shall be observed for any likely damage or degradation, for example, where earth works have taken place in the vicinity of buried cable routes or where trackwork has taken place near cable troughing and pits.

Licensed signalling personnel shall promptly investigate and record all incidents, reports and alarms of earth leakage faults, detailing every occurrence and testing performed on PR S 40023 FM 01 or equivalent (see Appendix A).

On completion of the tests, licensed signalling personnel shall forward results to the maintenance signal engineer for checking. The maintenance signal engineer is accountable for these records including the initiation of any subsequent actions that are derived from the findings.

Licensed signalling personnel shall record busbar voltage leak to earth test results, and earth leakage detector tests on earth leakage test sheet PR S 40023 FM 01 (see Appendix A) provided for the purpose and kept in the equipment location. Separate earth leakage test sheets are to be compiled for all power supplies within the location.

Licensed signalling personnel shall bring to the attention of the maintenance signal engineer any abnormal earth leakage reading or unidentified earth leakage detector fault and the value of all insulation resistance which is less than the minimum required or is showing signs of deterioration, as well as any visual or other evidence indicating abnormal deterioration or damage of insulation. The maintenance signal engineer shall carry out a risk assessment, manage the residual risk and shall advise the Principal Engineer Signalling Integrity of any circumstances.

The Professional Head Signalling & Control Systems shall decide under which conditions the wiring or cabling is to remain in use.

Should the results of inspection or tests of insulation dictate that further special action or testing is required, the Professional Head Signalling & Control Systems shall direct accordingly.

The maintenance signal engineer and team manager shall closely monitor and review the insulation test programme, the defect repair programme and cable renewal programme.

Appropriate performance indicators shall be established to ensure that the maintenance signal engineer and team manager effectively and efficiently monitors insulation testing, rectification of defects and cable renewals in their assigned area of responsibility.

The team manager is to provide performance indicators and/or status reports to the maintenance signal engineer at the agreed frequency.
1.5 Test Equipment

The insulation test instrument used shall be an approved type. A 500 volt test instrument shall be used in all cases. In the case of impulse track circuit tail cables and 415V mains cables, the risk from earth faults is mitigated by other means, and the use of a 1000 volt test instrument is not required.

The approved 500 volt test instruments have a current rating of less than three (3) milliamps and may be used safely on connected DC circuits.

Insulation test equipment shall be checked frequently to ensure that it works correctly. Faulty equipment shall be notified to the Team Manager who will arrange for a replacement during repair and return.

1.6 Test Earths

The test earth used for insulation testing will normally be the main earth bus in the location, or a subsidiary earth bus bonded to the main earth bus.

A check shall be made to prove that a satisfactory test earth is obtained before testing commences, by measuring with the insulation tester between the earth bus and an alternate temporary test earth. The alternate earth may be the ELD Test Earth, GST Galvanised steel troughing or a temporary electrode.

Note: The rail of any track is not to be used as a test earth.

For insulation testing, any earth resistance that registers as a short circuit on the insulation tester (typically less than 10 kΩ) will be a sufficient reference earth for insulation testing.

Where this earth resistance value cannot be obtained with standard earthing arrangements, the circumstances are to be referred to the Professional Head Signalling & Control Systems for resolution.

1.7 Inspection

Before the testing of cables and wires is carried out, wires, cables and cable routes are to be visually examined for damage and deterioration of insulation as far as it is practical, particularly at points where there could be any possibility of disturbance which might cause chafing or mechanical damage to take place. A common area for damage or deterioration on multicore cables is where cables have been stripped back and conductors have been exposed.

Replacement equipment shall be inspected to ensure it is in good order and condition before being placed in service.

At all times when maintaining equipment, licensed signalling personnel are to inspect as far as practical the condition of cable and wire insulation and the condition of insulating material and components comprising the equipment being maintained.

1.8 Conditions For Testing

Insulation tests should be carried out in wet/damp conditions whenever practicable. It is less effective to test external cables during dry or frosty conditions except where arid conditions always apply.
1.9 **Test Frequencies**

Any special tests stipulated by the Professional Head Signalling & Control Systems shall be carried out as instructed and to the frequencies specified in Section 13.

1.10 **Insulation Test Records**

Periodic insulation testing on vital signalling circuits and earth leakage test of signalling busbars shall be recorded on the test sheets provided in Appendix A. Further details on insulation test record requirements are found in *PR S 40017*.

1.11 **Inspection and Testing of Electrical Conductor Insulation**

Wires or cables cores shall not be removed from their terminals for the purpose of insulation testing unless necessary. Where it is necessary, only one wire shall be removed at a time and the reconnection shall be suitably tested. The use of disconnection link or unplugging of coded type plug couplers is the preferred means to conduct this test.

Electronic equipment shall be disconnected before insulation testing to avoid damage caused by the test equipment.

The following are examples of such equipment that may be affected:

- power supplies and power supply filters
- electronic track circuit equipment
- timers and timer relays
- flashing relays
- solid state modules
- ATP / ETCS equipment
- computer based interlocking equipment
- control system equipment
- telemetry equipment
- rectifiers, capacitors, diodes and transistors

1.12 **Testing Complete Circuits**

Regular insulation testing of each external circuit, complete end to end, is not necessary as a general rule.

Should there be reason to believe that the integrity of circuits may be diminished because of undiscovered insulation defects then the maintenance signal engineer shall include complete end-to-end circuit insulation testing as required.

The practice for regular insulation testing shall allow circuits to be divided into internal wiring in locations, main cables between locations, and local tail cables from trackside control equipment locations to trackside apparatus.

The requirements are prescribed as follows.

2 **Power Supply Busbars**

All busbar voltage leakage to earth test readings and ELD test results shall be recorded on *PR S 40023 FM 01* form or equivalent (see Appendix A), and a check shall be made
for any deviation from previous readings. Where a fault was detected but the ELD can be cleared, licensed signalling personnel shall identify the fault by:

- Performing insulation testing on known / suspect circuits
- Arranging with the Network Control Officer to operate various signals and points to present the fault
- In automatic areas, wait for a train movement or simulate a train movement to present the fault
- Inspect field equipment for evidence of water ingress or other defect
- Discuss further investigations or mitigations with the maintenance signal engineer

If the fault is permanently detected the ELD faults shall be thoroughly investigated by isolating circuits.

Electrical safety in regards to earth leakage faults shall be assessed and actioned according to PR S 40042 Sections 4.1 & 5.1.

Where earth leakage detectors are fitted they shall be tested and checked for reliable operation, by the operation of the test switch, on every maintenance visit. Busbar voltage to earth for each leg is to be measured using a Fluke meter fitted with a 100 kΩ shunt resistor (as use of 20 kΩ shunt resistor might trip some ELDs set at low earth leakage sensitivity), with the results recorded on PR S 40023 FM 01 or equivalent (see Appendix A).

Where power supply busbars are not fitted with reliable earth leakage detectors then, on each maintenance visit, the busbar voltage to earth for each leg shall be tested, with the fixed test equipment, where provided, or otherwise with a Fluke meter fitted with a 100 kΩ shunt resistor. Tests shall be performed according to Technical Maintenance Plan and daily at major interlockings where licenced signalling personnel are in attendance. The results are to be recorded on PR S 40023 FM 01 form or equivalent (see Appendix A).

Under no circumstances is an ammeter to be connected between any busbar and earth.

3 Signalling Circuits: Internal

Internal wiring referred to is the vital signalling wiring contained in relay rooms, signal boxes, level crossing huts, walk-in enclosures, equipment location cases and cupboards.

3.1 Internal Wiring - Circuits with Earth Leakage Detectors.

No maintenance insulation testing of internal wiring is required where reliable earth leakage detectors continuously monitor supply busbars that feed the internal wiring.

3.2 Internal Wiring - Circuits without Earth Leakage Detectors.

Where internal wiring is fed from power supply busbars without reliable earth leakage detection, then the internal wiring shall be insulation tested to earth and to frame every four (4) years for installations wired in standard PVC/nylon insulated wire, and every two (2) years for installations wired in other than PVC insulated wire.

3.3 Wiring to Mechanical or Power Interlocking Frames.

Circuit wiring to mechanical or power interlocking frames, annett locks or safeworking instruments in signal boxes is to be treated as stipulated for tail cables in Section 4.
3.4 Method of Testing

For internal wiring and cabling of relay rooms, signal boxes, walk-in-enclosures, equipment location cases, cupboards, and level crossing huts, internal circuits (disconnected at outgoing cable links), shall be tested complete - with all relay contacts closed. Where this is not possible, the internal circuit shall be tested thoroughly by testing all the individual parts when the relay contacts can be closed.

These tests should be carried out only after the circuit to be tested has been disconnected from its power supply at both ends.

The insulation of each circuit should then be tested to earth using the same earth to which the metal of relay racks or location cupboards are connected (where these are earthed).

4 External Cables and wires

A single wire group is defined as the single conductors that are grouped together within the same cable route.

The external main and local tail cables and wires which connect signal boxes, relay rooms, walk-in-enclosures and control equipment location cupboards and cases to one another or to vital signalling operating apparatus shall be tested as follows.

a) Tests on vital signalling circuit wires and cables in an external route shall be applied to cover all of the following:

i) all metallic screen sheaths or bare conductor drain wires in multicore cables - to earth, and to other conductors being tested in the cable

and

ii) all spare conductors in each multicore cable - to screen/drain wire, to earth, to one another, and to any working conductors nominated for testing

and

iii) all spare single core conductors, - to earth and to one another in the same single wire group

and

iv) a minimum of two conductors (three if no screen/drain wire) in each multicore cable, - to earth, to screen/drain and to one another. (Spares count towards this minimum requirement e.g. if there are two (three if no screen/drain wire) or more spares in each multicore cable then the minimum requirement is satisfied by the testing of all spares, as in ii) above)

and

v) a minimum of three single core conductors within a single wire group, in each route connecting between equipment locations or operating apparatus, - to earth and to one another (Spares count towards this minimum requirement e.g. if there are three or more spares in the total number of single wires, then the minimum requirement is satisfied by the testing of all spares in the single wire group, as in iii) above)

and
vi) working conductors to earth, and, in multicore cables-to screen/drain and, in tail cables-to the metal casing/frame of the operating apparatus except where they are protected by reliable earth leakage detection or are connecting control elements which are double switched in the circuit

and

vii) in tail cables and single wires, function test the external operating contact or apparatus to verify there are no core to core insulation defects except where the conductors are double switched in circuit. This is in preference to disconnecting wires from terminals for core to core tests. Where links are provided at both ends, then core to core insulation tests may be carried out instead

Tail cables are cables which are connected directly to trackside operating apparatus (e.g. release switches, annett locks, signals, points, track circuits, trainstops, level crossing lights and booms, and such like) or to mechanical interlocking machines (lever rotary contacts, catchrod contacts, circuit controllers, electric locks, annett locks) or to safeworking instruments (half pilot staff instruments).

If there are less spares then the minimum requirement in a multicore cable and working conductors are required to be disconnected, select from the outer layer of cores and record core numbers. Where some working conductors in the cable are connected directly through to busbars that are monitored by earth leakage detectors, and some are not, then those that are not shall be selected in preference. Where applicable the working conductors of single wire routes shall be similarly selected.

b) Where the cables and wires in the particular route are PVC insulated, PVC sheathed then insulation resistance testing shall be performed every four (4) years to the extent stipulated in a).

c) Where the cables and wires in the particular route are not PVC insulated, PVC sheathed (e.g. non PVC insulated line wires, VIR insulated wires, neoprene cables) then insulation testing shall be performed every two (2) years to the extent stipulated in a).

d) Cables with metallic screen sheaths or bare conductor drain wires earthed via lightning arrestors shall have the arrestors disconnected during tests.

e) The external cables and wires being tested shall be disconnected at the cable links from the internal equipment and wiring.

For external signalling cables and wires to operating apparatus, insulation testing of the metallic screen sheath or internal bare drain wire and of conductors to earth and to the metal structure of the individual trackside apparatus casing, should be done without disconnecting the operating apparatus but while the cables and wires are disconnected at the end remote from the apparatus which they service.(i.e. usually at the control equipment location cupboard, walk - in enclosure or relay room).

Note:

If the Metallic screen sheath of an external multicore cable has a low insulation resistance to earth then, except where reliable earth leakage detectors monitor the circuits, all single switched circuit conductors in the cable are to be insulation tested to screen and earth, and twenty percent of double switched circuit conductors are to be insulation tested to screen and earth.
5 External Power Supply Cables

The metallic screen sheath of twin multicore signalling power cables shall be insulation tested to earth every four years for PVC insulated PVC sheathed cables and every two years for non PVC insulated cables.

Cables with metallic screen sheaths earthed via lightning arrestors shall have the arrestors disconnected during tests.

The conductors of signalling power cables and wires need not be tested where the supply busbars are connected to reliable earth leakage detectors or where residual current devices are fitted.

In other cases, signalling power cables and wires are to be insulation tested each conductor to earth every four years for PVC insulated PVC sheathed cables and every two years for non PVC insulated cables.

When the power cables and wires are being insulation tested they are to be disconnected from the supply and from the equipment, including disconnection from surge protection equipment.

Insulation testing of 120 volt AC power supply mains that only feed isolating transformers for SSI Trackside Functional Modules is not required.

6 Non-Vital Wiring and Equipment

Non-vital wiring and/or equipment connected to non-vital busbars shall have the busbar voltage leak to earth tests carried out on each maintenance visit and the tests results shall be recorded on form PR S 40023 FM 01 or equivalent (see Appendix A).

Non-vital wiring and equipment connected into vital signalling circuits shall be insulation tested every two years to earth, to metal structures, and, if in a multicore cable, to screen/drain wire.

Non-vital signalling wiring and equipment are exempted from periodic insulation testing where non-vital signalling circuits are physically separated from vital signalling circuits or otherwise where associated power supply busbar is monitored by an earth leakage detector.

7 Signal and Train Working Telephone Circuits

Signal and train working telephone circuits are exempt from periodic insulation inspection and testing.

Where testing is performed, insulation test values less than 500 kΩ are considered unsatisfactory.

8 Arrestors

 Arrestors or varistors to earth shall be tested using an ohm-meter or arrestor tester to ensure they are open circuit under normal conditions and will break down / conduct at a specified voltage.

In lightning prone areas tests are to be carried out on each maintenance visit approaching, during, and immediately after, the lightning season.

Arrestor testers are provided for testing the breakdown voltage of arrestors or varistors; these breakdown voltage tests should be conducted every 52 weeks.
9  **Track Circuit Cables**

Track circuit cables from the location to the bootleg riser, bond, or tuning unit, shall be disconnected at each end and each conductor shall be insulation tested to earth. However, where a conductive sheath, screen or drain wire is fitted to the track circuit cable, only the sheath, screen or drain wire needs to be tested to earth. This test to be carried out every four years for PVC insulated PVC sheathed cable and every two years for non PVC insulated cable.

Measures shall be taken to ensure the polarity is not reversed when reconnecting 50 Hz AC, DC and impulse track circuits.

Track circuit cables are exempt from periodic insulation inspection and testing if:

- No combination of feed-end and relay-end of like track circuits that are run in the same cable route
- No more than one relay-end of like track circuits that are run in the same cable route

Track circuits of the same type, but of different frequency or channel are not considered like track circuits

**Note 1:** Where the track circuit exemption condition is not met, and the track circuit cable is not fitted with a conductive sheath, screen or drain wire, or the conductors consist of individual wires; each conductor shall be tested to earth.

**Note 2:** Where the track circuit exemption condition is not met, and the track circuit cable has a conductive sheath, screen or drain wire, the insulation testing requirement can be achieved by testing only the sheath, screen or drain wire, as applicable.

9.1  **Axle Counters**

Insulation testing on cables used for the axle counter system is not required. The signals are monitored by the evaluator and electronic junction box. Insulation faults will be self-revealing.

Note, if insulation testing is to be performed then the wiring or cable shall be isolated at all ends to prevent equipment damage or malfunction.

10  **Computer Based Interlocking Systems (including exemptions to testing requirements)**

Where it is necessary to insulation test wiring or cables (including spares, sheaths, screens or drain wires) directly connected to Computer Based Interlocking (CBI) systems, the cable is to be isolated from the CBI equipment. Failure to isolate may lead to directly or induced faults on input or output interfaces, corruption of data or data links, interlocking equipment shutdown or failure.

See below for specific interlocking type requirements and exemptions.

10.1  **SSI, Westlock and Smartlock Systems**

Following are the specific circuits and items that are exempted from periodic inspection and testing:
• central interlocking cubicle wiring and equipment
• technician’s terminal wiring and equipment
• long distance terminal and data link module wiring and equipment
• data link wiring and cables
• isolation transformers and secondary wiring
• trackside functional modules and associated input/output wiring, including external conductors (including spares, sheaths, screens or drain wires) where directly connected to inputs/outputs of trackside functional modules

Refer to PR S 40032 for additional Insulation testing requirements.

10.2 **Microlok Systems**

Insulation testing is not required on the conductors of tail cables that directly drive signal lamps from Microlok lamp driver cards.

Insulation testing is also not required on Microlok vital output relay circuits, where isolation modules are in use. The circuit on the relay side is the equivalent of being double switched and isolated therefore insulation testing is not required.

50v input circuits shall be protected by an ELD, unless the input is independently driven by an isolated supply. In these cases, insulation testing is not required.

Insulation testing is not required on communication port and card addressing wiring.

On duplicated Microlok systems, insulation testing is required on that portion of the vital relay output between the duplication diodes and relay unless ELDs are fitted to all main 12 v and 50 v power supplies in the location.

Faults on direct drive signal lights and vital output drives will result in a shutdown of the cardfile.

Refer to PR S 40038 for additional Insulation testing requirements.

10.3 **Westrace Systems**

Westrace direct lamp drive circuits are not isolated but need not be insulation tested if a 120 v AC ELD is fitted to the location.

Where isolation transformers are fitted to individual lamp drives, insulation testing is not required.

Westrace vital relay outputs are isolated outputs, however they are fitted with surge protection that may result in a lower resistance to earth. As the outputs are isolated, multiple specific faults are required to create an unsafe situation. As the likelihood is extremely low, insulation testing is not required.

Insulation testing on vital inputs is not required where ELDs are fitted to these supplies (which may be in a different location) or the supply is isolated.

Insulation testing is not required on communications wiring.

Refer to PR S 40039 for additional Insulation testing requirements.
11 ATP Systems

Insulation testing is not required or to be performed on conductors of the following ETCS cables:

- ETCS tail cables (from the LEU to the trackside balise junction box);
- ETCS balise tail cables (from the trackside balise junction box to the balise);
- ETCS ethernet data cables between LEUs.

If required continuity testing may be conducted on these cables with a multimeter.

Refer to PR S 40028 for additional insulation testing requirements.

12 Values of Insulation Resistance

Values between infinity and 10 MΩ, insulation resistance to earth, irrespective of the type or length of cable, should be expected for signalling cables which are free of apparatus, i.e. links disconnected.

Values between 1 MΩ and 10 MΩ, insulation resistance to earth may be expected for terminated cables and wires which are housed in location cupboards and walk-in enclosures.

Values better than 2 MΩ, insulation resistance to earth should be expected for local tail cables tested with the cable disconnected at the location but connected at the trackside apparatus.

Values below 1 MΩ, insulation resistance to earth for complete signalling or safeworking circuits are considered unsatisfactory.

If cable or single-wire insulation values are found at or below 1 MΩ, and if they cannot be replaced promptly, the maintenance signal engineer shall carry out a risk assessment to determine the frequency of testing required to effectively manage the residual risk where working cables or single-wires are left in these conditions.

Where any of the tested conductors are found at or below 1 MΩ, all the conductors within the cable or single-wire group shall be completely tested.

Where the conductive sheaths, screens or drain wires of external cables are tested and found at or below 1 MΩ and the associated busbar is not monitored by a reliable earth leakage detector, the following testing requirements shall apply:

- where all working conductors of the cable are double switched, at least 20% of the cable cores shall be tested
- where any of the working conductors of the cable are not double switched, all the cable cores shall be tested

When no obvious cause can be found and remedied for cables and wires that produce test results of a value less than the minimum expected values specified above, or less than the unsatisfactory values specified above, the details shall be reported immediately to the maintenance signal engineer.

The maintenance signal engineer shall analyse the insulation resistance results and inspect the cables and cable route to determine the risk involved and the urgency and extent of action required. Where all circuits are double switched the risk is less than with single switched circuits.
Immediate action pending renewal could include changing circuits on defective cores to non defective cores, temporary rewiring/recabling, insulation taping of defective sections, protective measures against disturbance, frequent insulation megger testing to monitor degradation, and monitoring busbar voltage to earth readings or installing earth leakage detectors.

Any vital signalling circuit with a conductor with an insulation resistance to earth value of 200 kΩ or less shall be disconnected and booked out of use except where written authority is obtained from Professional Head Signalling & Control Systems to retain the circuit in service under nominated conditions.

12.1 Temperature Dependence of Insulation Resistance Values

The insulation resistance of materials such as PVC is very temperature dependant, with the resistivity of PVC at 40°C being less that one tenth of the value at 20°C. While cables in buried routes are insulated against fluctuations in temperature, cables installed above ground, and especially in GST, may return apparently unacceptable insulation resistance values due to elevated temperatures alone. Where low IR values are measured and it is believed that elevated temperature may be the cause, the temperature of the cable should be estimated, and the equivalent 20°C IR value calculated as specified in PR S 47114.

13 Periodic Inspection and Testing Requirements

The following tables provide an outline of periodic inspection and testing of electrical insulation requirements.

For non vital wiring and/or equipment connected into vital signalling circuits see Section 6.
<table>
<thead>
<tr>
<th>Insulation Type</th>
<th>ELD Fitted</th>
<th>Double Switched in Circuit</th>
<th>Apparatus Function Test/Core to Core</th>
<th>Insulation Test</th>
<th>Test Frequency (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Screen/ Drain Wire</td>
<td>Spare Conductors</td>
</tr>
<tr>
<td>PVC</td>
<td>ELD</td>
<td>D/S</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>PVC</td>
<td>ELD</td>
<td>NOT D/S</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>PVC</td>
<td>NO ELD</td>
<td>D/S</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>PVC</td>
<td>NO ELD</td>
<td>NOT D/S</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>NON PVC</td>
<td>ELD</td>
<td>D/S</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>NON PVC</td>
<td>ELD</td>
<td>NOT D/S</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>NON PVC</td>
<td>NO ELD</td>
<td>D/S</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>NON PVC</td>
<td>NO ELD</td>
<td>NOT D/S</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 1 - Test Frequencies

Note:

Wherever cables are visible they are to be regularly examined. If there are any indicators that cable insulation is deteriorating or defective then more extensive insulation testing than shown above is required.
Table 2 - Test Frequencies

<table>
<thead>
<tr>
<th>External Cables/Wires</th>
<th>Insulation Type</th>
<th>ELD Fitted</th>
<th>Double Switched in Circuit</th>
<th>Apparatus Function Test/Core to Core</th>
<th>Insulation Test</th>
<th>Test Frequency (years)</th>
</tr>
</thead>
<tbody>
<tr>
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<td></td>
<td>Screen/Drain Wire</td>
<td>Spare Conductors</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PVC</td>
<td>ELD</td>
<td>D/S</td>
<td>-</td>
<td>✓</td>
<td>ALL</td>
<td>NIL</td>
</tr>
<tr>
<td>PVC</td>
<td>ELD</td>
<td>NOT D/S</td>
<td>CC</td>
<td>✓</td>
<td>ALL</td>
<td>MIN 2</td>
</tr>
<tr>
<td>PVC</td>
<td>NO ELD</td>
<td>D/S</td>
<td>-</td>
<td>✓</td>
<td>ALL</td>
<td>MIN 2</td>
</tr>
<tr>
<td>PVC</td>
<td>NO ELD</td>
<td>NOT D/S</td>
<td>CC</td>
<td>✓</td>
<td>ALL</td>
<td>ALL</td>
</tr>
<tr>
<td>NON PVC</td>
<td>ELD</td>
<td>D/S</td>
<td>-</td>
<td></td>
<td>ALL</td>
<td>MIN 3</td>
</tr>
<tr>
<td>NON PVC</td>
<td>ELD</td>
<td>NOT D/S</td>
<td>CC</td>
<td></td>
<td>ALL</td>
<td>MIN 3</td>
</tr>
<tr>
<td>NON PVC</td>
<td>NO ELD</td>
<td>D/S</td>
<td>-</td>
<td></td>
<td>ALL</td>
<td>MIN 3</td>
</tr>
<tr>
<td>NON PVC</td>
<td>NO ELD</td>
<td>NOT D/S</td>
<td>CC</td>
<td></td>
<td>ALL</td>
<td>ALL</td>
</tr>
<tr>
<td>PVC</td>
<td>ELD/RCD</td>
<td>-</td>
<td>-</td>
<td>✓</td>
<td>-</td>
<td>NIL</td>
</tr>
<tr>
<td>PVC</td>
<td>NO ELD</td>
<td>-</td>
<td>-</td>
<td>✓</td>
<td>-</td>
<td>ALL</td>
</tr>
<tr>
<td>NON PVC</td>
<td>ELD/RCD</td>
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<td>-</td>
<td>✓</td>
<td>-</td>
<td>NIL</td>
</tr>
<tr>
<td>NON PVC</td>
<td>NO ELD</td>
<td>-</td>
<td>-</td>
<td>✓</td>
<td>-</td>
<td>ALL</td>
</tr>
</tbody>
</table>

**Note:**

*1) CC  Core to core insulation tests of the necessary working conductors in the multicore cable are to be used to verify no core to core insulation breakdown. The links in the locations at each end are to be opened.

*2) Include test of spare conductors to one another and, in multicore cables, to screen/drain wire. Where ever cables are visible they are to be regularly examined. If there are any indicators that cable insulation is deteriorating or defective then more extensive insulation testing than shown above is required.
### Insulation Inspection and Testing

#### Table 3 - Test Frequencies

<table>
<thead>
<tr>
<th>Insulation Type</th>
<th>ELD Fitted</th>
<th>Double Switched in Circuit</th>
<th>Apparatus Function Test/Core to Core</th>
<th>Insulation Test</th>
<th>Test Frequency (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PVC</td>
<td>ELD D/S</td>
<td>-</td>
<td>F/CC</td>
<td>✓ ALL NIL</td>
<td>4</td>
</tr>
<tr>
<td>PVC</td>
<td>ELD NOT D/S</td>
<td>F/CC</td>
<td></td>
<td>✓ ALL MIN 2</td>
<td>4</td>
</tr>
<tr>
<td>PVC</td>
<td>NO ELD D/S</td>
<td>-</td>
<td>F/CC</td>
<td>✓ ALL MIN 2</td>
<td>4</td>
</tr>
<tr>
<td>PVC</td>
<td>NO ELD NOT D/S</td>
<td>F/CC</td>
<td></td>
<td>✓ ALL ALL</td>
<td>4</td>
</tr>
<tr>
<td>PVC</td>
<td>ELD D/S</td>
<td>-</td>
<td></td>
<td>✓ ALL MIN 3</td>
<td>2</td>
</tr>
<tr>
<td>PVC</td>
<td>ELD NOT D/S</td>
<td>F/CC</td>
<td></td>
<td>✓ ALL MIN 3</td>
<td>2</td>
</tr>
<tr>
<td>PVC</td>
<td>NO ELD D/S</td>
<td>-</td>
<td></td>
<td>✓ ALL MIN 3</td>
<td>2</td>
</tr>
<tr>
<td>PVC</td>
<td>NO ELD NOT D/S</td>
<td>F/CC</td>
<td></td>
<td>✓ ALL ALL</td>
<td>2</td>
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</tbody>
</table>

**Note:**

1. F/CC Carry out function tests of external contacts of operating apparatus to verify no core to core insulation breakdown. Core to core insulation tests of all working conductors in the multicore cable may be used instead but not if more than one wire at a time has to be disconnected from its terminal in the apparatus. The links at the location end are to be opened.

2. Include test of spare conductors to one another. Also test spare and working conductors to metal casing/frame of operating apparatus, and in multicore cables, to screen/drain.

Wherever cables are visible they are to be regularly examined. If there are any indicators that cable insulation is deteriorating or defective then more extensive insulation testing is required.
# Appendix A  Forms

## EARTH LEAKAGE AND DETECTOR TEST SHEET

<table>
<thead>
<tr>
<th>Date</th>
<th>Busbar Voltage (*)</th>
<th>Busbar to Earth Voltage (*)</th>
<th>ELD Found (Y/N)</th>
<th>ELD Cleared (Y/N)</th>
<th>ELD Test Function (Y/N)</th>
<th>Investigation Comments</th>
<th>Name</th>
<th>Signed</th>
</tr>
</thead>
<tbody>
<tr>
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</tr>
</tbody>
</table>

*Measure with meter & 100kΩ short resistor fitted

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Version 1.0

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**INSULATION TEST SHEETS: SIGNALLING CIRCUITS**

**NOTE:**
1. Remove all applicable lightning protection and electronic components prior to insulation testing.
2. Ensure the reference earth resistance registers a short circuit on the insulation tester (typically less than 10,000 ohms)
3. Refer to PR S 40023 for test criteria and values

<table>
<thead>
<tr>
<th>CIRCUIT BOOK NAME</th>
<th>CIRCUIT BOOK NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>CB PAGE No.</td>
<td>CIRCUIT No.</td>
</tr>
<tr>
<td>Fuse No.</td>
<td>TERM No.</td>
</tr>
<tr>
<td>LOCATION</td>
<td>SUPPLY</td>
</tr>
<tr>
<td>TEST TO EARTH</td>
<td>RECONNECTION</td>
</tr>
<tr>
<td>CERTIFIED VIN</td>
<td>DATE</td>
</tr>
<tr>
<td>TEST BY</td>
<td>RETEST TO EARTH</td>
</tr>
<tr>
<td>RETEST DATE</td>
<td>RETEST BY</td>
</tr>
</tbody>
</table>

**WEATHER CONDITION:**
- INITIAL TEST: WET / DAMP / DRY
- RE-TEST: WET / DAMP / DRY
  (CIRCLE APPLICABLE OPTION)

**REMARKS:**

**INITIAL TEST & RECONNECTION CERTIFICATION**

- NAME:
- SIGNATURE:
- DESIGNATION:
- DATE:

**SIGNAL ENGINEER REVIEW**

- NAME:
- SIGNATURE:
- DATE:

---

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## INSULATION TEST SHEETS: POWER FEEDERS

### NOTE:
1. Remove all applicable lightning protection and electronic components prior to insulation testing.
2. Ensure the resistance assumes between 50 ohms and 10,000 ohms as a short circuit on the insulation tester (typically less than 10,000 ohms).
3. Refer to PR S 40023 for test criteria and values.

### CIRCUIT BOOK NAME: CIRCUIT BOOK NUMBER:

| Circuit Breaker No. | SUPPLY | CABLE SIZE | CORE No. | LOCATION FROM | LOCATION TO | CONTINUITY | Core to Core | Core to Earth | Core to Sheath | Sheath to Earth | RE-RE Convention | CERTIFIED YR | DATE | TEST BY | RE-TEST BY | RE-TEST BY |
|--------------------|-------|------------|----------|---------------|------------|------------|-------------|---------------|----------------|----------------|----------------|-----------------|-------------|-------|---------|------------|------------|
|                    |       |            |          |               |            |            |             |               |                |                |                 |                |           |         |          |            |            |
|                    |       |            |          |               |            |            |             |               |                |                |                 |                |           |         |          |            |            |
|                    |       |            |          |               |            |            |             |               |                |                |                 |                |           |         |          |            |            |
|                    |       |            |          |               |            |            |             |               |                |                |                 |                |           |         |          |            |            |

### WEATHER CONDITION:
- INITIAL TEST: WET / DAMP / DRY
- RE-TEST: WET / DAMP / DRY
  (CIRCLE APPLICABLE OPTION)

### REMARKS:
- INITIAL TEST & RE-RE CONNECTION CERTIFICATION
- NAME:
- SIGNATURE:
- DESIGNATION:
- DATE:
- RECORD ALL VALUES IN MD
- SHOW “FT” IF FUNCTION TESTED
- IF NOT TESTED PROVIDE DETAILS (DIS, ELT ETC)

### SIGNAL ENGINEER REVIEW
- NAME:
- SIGNATURE:
- DATE:

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### Insulation Test Sheets: Main Cables

**NOTE:**
1. Remove all applicable lightning protection and electronic components prior to insulation testing.
2. Ensure the reference earth resistance registers as a short circuit on the insulation tester (typically less than 10,000 ohms).
3. Refer to PR S 40023 for test criteria and values.

<table>
<thead>
<tr>
<th>CABLE</th>
<th>CIRCUIT BOOK NAME</th>
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**Weather Condition:**
- Initial Test: Wet/Damp/Dry
- Re-Test: Wet/Damp/Dry

(Circle applicable option)

**Remarks:**

**Initial Test & Reconnection Certification**
- Name:
- Signature:
- Designation:
- Date:

**Signal Engineer Review**
- Name:
- Signature:
- Date:

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Date in Force: 8 March 2019
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UNCONTROLLED WHEN PRINTED
## Insulation Test Sheets: Tail Cables

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### Re-Test

### Weather Condition:
- Initial Test: WET / DAMP / DRY
- Re-Test: WET / DAMP / DRY (Circle applicable option)

### Remarks:

### Initial Test & Re-Connection Certification
- Name:
- Signature:
- Designation:
- Date:

* Record all values in MD
* If not tested provide details (Dis, ELD etc)

### Signal Engineer Review
- Name:
- Signature:
- Date:
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WEATHER CONDITION: INITIAL TEST: WET / DAMP / DRY RE-TEST: WET / DAMP / DRY (CIRCLE APPLICABLE OPTION)

REMARKS:

INITIAL TEST & RECONNECTION CERTIFICATION
NAME:
SIGNATURE:
DESIGNATION:
DATE:

* RECORD ALL VALUES IN MJ
* IF NOT TESTED PROVIDE DETAILS (DJ, ELD ETC)

SIGNAL ENGINEER REVIEW
NAME:
SIGNATURE:
DATE:

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Date in Force: October 2016
Engineering Procedure
Signalling and Control Systems

Signalling Safeworking

PR S 40024

Vital Signalling Relays

Version 1.1

Date in Force: 21 September 2016
Disclaimer

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Document control

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<td>16 September 2013</td>
<td>Garry Ware</td>
<td>First issue as a Sydney Trains document, rebranded from previous RailCorp TMG J024</td>
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<td>21 September 2016</td>
<td>Mohammed Khan</td>
<td>Update to Engineering Instructions, mandatory ASA requirements and position titles/roles.</td>
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Summary of changes from previous version

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<td>Inspection of counterbalance nuts and worn roller spindles in vane relays. EI 11/02.</td>
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<td>Updated requirements for Examination of DC Relays, Shelf-Mounted</td>
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<td>Updated Examination of Plug-in Relays for retaining clip to be securing relay in base.</td>
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<td>Updated for Q type relays fitted with grey/white Pertoid (fibreglass) contact operating arms and adjustment cards. EI 04/05 and EI 04/13.</td>
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<td>Adjustment of 50V DC Power Supplies to QTD5 Relays. EIS 16/03</td>
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<td>New section for QXR1 transformer rectifier</td>
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1 Introduction

Vital signalling relays are integral to the safety and reliability of interlockings. Their critical applications include control, indication, locking, operation, detection and timing. The safety assurance aspect of vital signalling relays requires a thorough understanding and management of the various failure modes and associated risks. Persons working on vital signalling relays shall take the necessary precautions when wiring, inspecting and maintaining, replacing, and overhauling.

Vital signalling relays exist in various forms and configurations, but all are categorised as either proved (proved in the de-energised position by the signalling design) or unproved. Unproved relays pose a greater risk, as a wrong side failure associated with these relays may go undetected by the system.

As the proper working of all relays is essential, the following instructions must be most carefully observed. Where licensed signalling personnel are in doubt with the condition of any relay they must report it to the maintenance signal engineer immediately.

1.1 Sealing of Relays

All vital signalling relays supplied by manufacturers and workshops are sealed, and all relays installed in the field that are not presently sealed, must be considered as sealed and not opened.

This seal must not be broken in the field except in exceptional circumstances when directed by a signal engineer. In the event of a defect being observed in a relay the seal must be left intact until the relay is examined by a signal engineer.

1.2 Cyclic Changing and Overhaul of Relays

1.2.1 General Policy

The task for changing and overhauling of all shelf mounted relays and AC vane type plug-in relays is to be treated as a safety significant task in accordance with PR S 40017.

The policy for changing and overhauling all shelf mounted relays and AC vane type plug-in relays is based on two (2) main classifications of relays, "Proved" and "Unproved".

Unproved shelf mounted relays and AC vane type plug-in relays must be changed after 15 years in service and overhauled in the workshops or scrapped.

Relays which are proved to release (proved down/de-energised by another circuit) are not required to be changed on a regular basis but on an "as needed" basis as determined by the maintenance inspections of licenced signalling personnel.

Shelf mounted relays and AC vane type plug-in relays used for cut tracks are to be changed on a 10 year basis.

In the case of all other plug-in relays, (not AC vane type), a regular overhaul period is not laid down.

Samples of plug-in relays, other than AC vane type, from typical installations are to be inspected in detail after 20 years of service life to assess the need for overhaul or replacement of the complete group, or to assess the period to the next sample inspection. The maintenance signal engineer is to define the sample frequency based on a risk assessment. The inspection is to eventually cover all such relays in service over a defined period determined by the risk assessment. This is to be programmed using the Sydney Trains maintenance management system.
This inspection must be carried out in the Rail Equipment Centre, and must be arranged by the signal electrician in conjunction with the signal engineer who must advise the Rail Equipment Centre Manager. The sample relays are to be completely dismantled during the inspection.

The Rail Equipment Centre Manager must obtain a report from the workshops and forward a copy to the Professional Head Signalling & Control Systems. After the inspection report is accepted by the Professional Head Signalling & Control Systems the sample relays that were dismantled for inspection may be discarded.

Shelf mounted Signal Branch type DC relays must not be used. If in service they are to be immediately replaced, preferably with a DN 11 type shelf relay.

1.2.2 Plug in Conversion Units for ACVL Line Relays

Plug-in conversion units, using Q type BRB 930 relays, are available as a replacement for ACVL relays.

Any ACVL relay determined for replacement must be replaced with a Q style plug in conversion unit.

When arranging to replace an in-service ACVL relay with a Q style plug in conversion unit, it will be necessary to survey the circuit book contact analysis sheet to ensure that there are no circuits passing through the ACVL that has a current that exceeds the 3 Ampere rating of the Q relay contact e.g. trainstop motor circuits.

Prior to placing a Q style plug in conversion unit into service, the conversion unit as a whole (complete unit – not just the relay) is to be inspected and compared to the Test Certificate accompanying the relay, that it is the same relay and that the form is signed by the workshop tester and workshop supervisor.

Any straps between the local and the line coil terminals are to be removed and not reinstalled.

Installation and testing is to be in accordance with \textit{PR S 40011 Precautions Associated with Renewals Work}.

Note: Maintenance signal engineer authorisation is required for renewal of shelf relays with plug-in conversion units.

Once an ACVL relay has been replaced with a Q style plug in conversion unit, a "Notice of Installation of Shelf Relay Conversion Unit" is to be completed and returned to the Documentation Manager, Signalling and Control Systems, for updating of the circuit book.

For maintenance purposes, Q style plug in conversion units are to be considered as plug in relays.

1.2.3 Jeumont Schneider Track relays.

This type of relay is to be kept under review until a fault or deterioration rate requires their replacement unless outlined in the applicable TMP.

1.3 Relay Program and Register

The maintenance signal engineer must ensure there is an up to date program for the changing and overhaul of vital signalling relays as required by the general policy detailed above in Section 1.2.1.
The maintenance signal engineer is to maintain an up to date register for the program management, replacement and overhaul of vital signalling relays as required by this procedure. The register must include relevant details of the following relays in service:

- Shelf relays
- VT1 relays
- electro-mechanical & thermal timer relays
- Large plug-in

The register must include details of relays that were replaced due to defect or periodic overhaul.

When a relay has been replaced, newly installed or removed permanently from service, the relay register is to be brought up to date to reflect the change. Details of newly installed or replaced relays including the install date are to be included.

1.4 Type of wire connecting to shelf relays

With detachable top fitted shelf relays, flexible stranded wire (e.g. 7/0.40mm) may be terminated on the detachable top using appropriate insulated crimp lugs. Ensure that bakelite terminal covers are fitted and the lugs on different terminals do not cross one another.

When a shelf relay is not fitted with a detachable top, flexible stranded wire must not be terminated directly onto the relay.

Single strand, stiff wire (e.g. 1/1.70mm) without crimp lugs is to be used on these relays. Where this is required to run to a “Q” type relay or similar which will not accept this wire, an interfacing terminal block must be used.

In cases where flexible, stranded wire has already been terminated directly onto shelf relays the following is required:

a) Ensure that crimp lugs do not touch one another or other terminals.

b) Whenever it is necessary to change the relay or to disconnect then reconnect the wiring for any reason:
   i) Each wire must be labelled with its relay terminal number and
   ii) Each crimp lug must be insulated as it is removed from the relay with either suitable sized plastic tubing which will fit tightly over the crimp lug or with another equally secure product.

2 Placing Signalling Relays into Service

2.1 General

When placing relays in service, particularly shelf relays, care should be taken to ensure that the level of signalling integrity is maintained throughout the work and that no alteration of the principle design occurs without approval. Reference to other engineering requirements must be made, including PR S 40011 for precautionary measures when renewals work is undertaken and applicable work instructions when replacing like for like equipment.

The replacement task of shelf relays must be wholly performed by one person and not transferred to another person part way through the work.
The integrity of all vital signalling relays to be placed into service is paramount particularly as they may be installed in circuits where they are not proved to release when de-energised.

Signalling relays must be handled, transported and stored with care and not in any manner, condition or circumstance that would subject them to damage or deterioration. Relays fitted with an armature securing screw must have it installed during transportation to prevent damage to the relay.

The relays must be stored on racks in enclosed buildings in a clean, dry and non-corrosive environment. They must always be kept in the upright position in case of any undetected foreign matter which has fallen to the bottom of the case moves to a critical position.

Spare refurbished relays with workshop testing dates in excess of that specified below must not be placed into service and must be sent for retesting. The retesting must be carried out using an approved relay go/no-go tester that cycles the relay operation while measuring the contact resistance.

<table>
<thead>
<tr>
<th>Relay Type</th>
<th>Service Life</th>
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<tr>
<td>Q type BRB 930 Relays</td>
<td>Seven (7) Years</td>
</tr>
<tr>
<td>Plug-in AC Relays</td>
<td>Three (3) Years</td>
</tr>
<tr>
<td>DC Shelf Relays</td>
<td>Five (5) Years</td>
</tr>
<tr>
<td>AC Shelf Relays</td>
<td>Three (3) Years</td>
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New “Q” type plug-in relays which have been stored in their original boxes or packaging for periods up to 7 years may be used without being refurbished provided that the relay passes the visual examination specified in Section 9.1 and the operating tests specified in Section 9.2.

Used “Q” type plug-in relays with up to 10 years of service use may be considered for reuse, on condition that the relay passes the visual examination specified in Section 9.19.1 and the operating tests specified in Section 9.2.

Q type plug-in relays with a contact resistance greater than 2 ohms must not be used except in cases of emergency, as a temporary measure, on condition that the resistance is not greater than 7.5 ohms.

Relays which do not pass the inspection and/or test should be forwarded to the maintenance signal engineer as described in Sections 9.1 and 9.2.

Prior to placing any plug-in relay in service it must be closely inspected to see that the contacts are aligned correctly and no foreign matter is attached to the contacts and that it has not been damaged in transit.

When plug-in relays are to be changed, before insertion into the plug-in base, licensed signalling personnel must ensure that the replacement relay is correct to the specific signalling design and has the same voltage, the same contact arrangement by direct examination of the contacts, the contacts are aligned correctly and no foreign matter is attached to the contacts and that the code pins are present in the same indexing locations. The base must be fitted with one set only of five index holes.

Licensed signalling personnel must electrically test the contacts to ensure they are functional and have a resistance of less than 2 ohms when closed. Where relay test panels are provided this facility is to be utilised. In addition to this, all relays which have been unplugged and placed on the floor during installation and testing work should be visually examined before being plugged in again, to ensure that the contacts are aligned correctly and no foreign matter from the floor has become attached to the contacts.

Licensed signalling personnel must check the operation of the relay in circuit and ensure that the functions controlled by it operate correctly.
Immediately prior to any relay being placed in service it must be examined at a bench under full lighting conditions by licensed signalling personnel who are to install the relay. Licensed signalling personnel must also arrange a test circuit to check the relay under operation.

Licensed signalling personnel are to examine the relay under normal electrical operation, observing the energise/de-energise cycle several times to ensure that the mechanical operation is normal, unrestricted but not pounding, and that the relay drops fully away.

Where there is any cause to suspect that the relay is not operating correctly it must be immediately labelled accordingly and sent to the maintenance signal engineer for more detailed testing together with written advice of the problem.

Once the relay has been installed it must be observed to function fully in its operating circuit and must not be certified until licensed signalling personnel are satisfied that it is operating correctly.

The Professional Head Signalling & Control Systems must be promptly advised of all incidents of an unsafe condition whether in use or in storage of a vital signalling relay and must nominate a signal engineer from the Signalling and Control Systems team and, as required, a person from the Rail Equipment Centre, to examine the relay before it is unsealed.

Before placing a shelf-mounted relay in service special care must be taken to remove the armature securing screw provided to prevent damage during transport. The arrangement of terminals vary for different manufacturers of shelf-mounted relays, it is therefore necessary that licensed signalling personnel take special care when replacing a relay by one of a different manufacture to see that the connections are placed on the correct relative terminals and that circuit diagrams are updated for any change in contact numbers. The relay must be examined and bench tested by licensed signalling personnel prior to installation.

Also before placing the shelf-mounted relay in service licensed signalling personnel must remove the nuts on the studs and check that the bottom nut is tightened down. This is to ensure that the pigtail is securely maintained by a tight armature stud or that the carbon pillar is securely maintained in position by a tight point stud. Excessive force must not be applied on the bottom nut as this could cause the stud to fracture.

When a shelf-mounted relay has been replaced licensed signalling personnel changing the relay are responsible for seeing that a thorough test of all circuits passing through the relay to ensure that no incorrect connections have been made and that the circuits are in accordance with the circuit diagrams.

In addition when any DC shelf-mounted relay or DC plug-in track relay or DC standard 'B' size plug-in relay is changed the "pick-up", "drop-away" and "working" currents of the new relay must be tested.

PR S 40024 FM01 Relay Change Form (see Appendix A), must be made out in duplicate by licensed signalling personnel for all shelf relays replaced and these forms must be forwarded to the maintenance signal engineer immediately after the relay or relays have been changed. Licensed signalling personnel must show all relevant particulars on these forms and certify that the circuits through the shelf-mounted relays have been tested and are correct.

2.2 Relay Change Form

In the event of any of the following relay types:-

- Shelf relays
• VT1 relays
• electro-mechanical & thermal timer relays
• Large plug-in

Being tested, installed or removed from service licensed signalling personnel must fill out the relay change form PR S 40024 FM01 (see Appendix A) and forward it to the maintenance signal engineer for recording.

3 Miniature Plug-In Relays BRB Series: Care of/Handling

Cases have occurred where newly installed miniature plug-in signalling relays have failed to operate, and it was found that their contacts were out of adjustment due to distortion of their stationary contact support brackets.

It has been demonstrated that this fault was a result of the relay having been dropped or struck during transport or installation.

Extreme care must be exercised in transporting and handling relays. Any relay which is bumped or dropped should be closely examined and tested, and if need be sent to the workshops for overhaul.

Because of the risk that relays may have been dropped or damaged without knowledge, any relay which is to be placed in service must be visually inspected, then inserted in a relay test unit and observed to operate correctly before being plugged into service.

If there is any sign of damage to the case, or to the relay, or if the operation or the relay is in any way suspect, the relay must not be put into service but sent for overhaul.

4 Large Size (Standard ‘B’ Type) Plug-In-Relays Distorted Contact Carrier

Special note should be taken, by all licensed signalling personnel concerned with the handling and placing into service of large size plug in relays that contacts can become seriously out of adjustment due to rough handling.

Before placing a relay into service it must be carefully examined to see that all contacts, both front and back, make with sufficient over travel and open sufficiently (when applicable). If a relay is suspect or in any way damaged it must be sent to the maintenance signal engineer for inspection.

Large size plug-in relays are particularly prone to maladjustment of contacts due to the alloy casting which carries the coil becoming misaligned at some angle other than 90 degrees relative to the relay base. This is usually caused by the relay being dropped during transit or installation.

When these relays are transported by any means they must be packed with the contact springs vertical and “THIS SIDE UP” labels applied appropriately.

5 Precautions to be Taken when Changing Magnetically Latched Relays

Magnetically latched relays remain in the position to which they were last operated and for this reason special precautions are required to ensure that a relay is “down” before it is plugged into service. Magnetically latched relays are used for the parent relay of the route, point and release lock relays and the procedure for changing these relays is as follows.
5.1 Route NLR and RLR Relays

Prior to unplugging a route NLR or RLR relay licensed signalling personnel must:

a) Gain assurance from the NCO that the signal to which the route lock relay applies is at stop, the route normalised, and that any train which is approaching the signal has been brought to a stand.

b) The magnetically latched relay which is to be placed in service must then be plugged into the magnetically latched relay test base and the indicator lamp observed to ensure that the relay is down.

The relay to be withdrawn from service is then unplugged and the new relay removed from the test base and plugged into service.

Note:

After changing a route NLR relay both the route NLR and RLR may be down. This will be indicated by a steady white light in the button knob controlling the route and the button must be pulled to energise the NLR.

5.2 Point NLR and RLR Relays

Prior to unplugging a point NLR or RLR relay licensed signalling personnel must:

a) Ensure that no trains are standing foul of or passing over or approaching the points concerned.

b) Gain assurance from the NCO that all signals which protect the points concerned are at stop and that any trains which may be approaching those signals have been brought to a stand.

c) The magnetically latched relay which is to be placed in service must then be plugged into the magnetically latched relay test base and the indicator lamp observed to ensure that the relay is down.

d) The relay to be withdrawn from the service is then unplugged and the new relay is removed from the test base and plugged into service.

Note:

After changing a point lock relay both point NLR and RLR relays may be down. This will be indicated by both point position lights extinguished, and the transit light flashing. Under these conditions it will be necessary to move the point lever to the centre position and then to return the lever to its previous position and thereby energises the point lock relay for the position in which the points are laying.

5.3 Release Switch NLR or RLR Relays

Prior to unplugging a release NLR or RLR relay licensed signalling personnel must:

a) Ensure that no trains are standing foul of or passing over or approaching the ground frame points concerned.

b) Gain assurance that all signals which protect the ground frame points are at stop and that any trains which may be approaching those signals have been brought to a stand.
c) The magnetically latched relay which is to be replaced into service must then be plugged into the magnetically latched relay test base and the indicator lamp observed to ensure that the relay is down.

d) The relay to be withdrawn from service is then unplugged and the new relay is removed from the test base and plugged into service.

6 Time Limit Relays (all types)

Time limit relays must be coarsely adjusted and tested in a relay test panel or test bench environment prior to installation.

These relays must be finely adjusted and tested in service to prove their function and to minimise the variance in time between the test and in service supply voltages.

The time limit adjustment must be adjusted as accurately as possible and must be within 10 percent of the specific signalling design.

50 V d.c. busbars powering QTD5 relays must not be in excess of 55 V (dc + ac).
Busbars are to be adjusted between the range of 47.5 V to 55 V (dc + ac).

A record is to be kept of all QTD5 busbar and end location voltages when any adjustment is completed and forwarded to maintenance signal engineer.

If the QTD5 relay busbar cannot be reduced below 55 V (dc + ac) or signalling failures due to voltage supply are experienced, the maintenance signal engineer must be advised and consulted for further instruction.

7 Routine Examinations and Tests

The periodic inspection of unproved DC shelf mounted and AC vane type relays is to be treated as a safety critical task in accordance with PR S 40017.

The periodic inspection of electro-mechanical type and thermal type time limit relays is to be treated as a safety significant task in accordance with PR S 40017.

During periodic inspections of relays, signalling personnel may use devices such as thermal imaging cameras to assist with the detection of unusual heat sources which may cause a reliability or integrity risk. Any identified risks should be reported to the maintenance signal engineer for assessment.

Signalling personnel must take precautions when utilising test instruments on vital signalling relay circuits. The following precautions should be taken into account:

- The preferred method of current measurements is through the use of a tong meter or current clamp, rather than placing a multimeter in current mode in series with the circuit.

- Multimeter ohms and diode-test modes produce a test voltage and present the risk of falsely energising a relay. These modes must not be used without the disconnection of the circuit.

7.1 Examination of AC Relays, Vane all types.

Vane and polyphase AC relays, including contacts, pigtails and terminals, must be inspected periodically for any signs of abnormal conditions.

Examine all non-proved vane AC relays in accordance with the technical maintenance plan and not exceeding 52 weeks.
Particular attention must be paid to the working of the vane and for any indication of the following conditions, by observation through the glass case.

The relay must be observed to operate correctly.

Check for abnormal release operation of a relay, e.g. sluggish, jerky or not falling fully to the stop position may be due to defective bearings, warped bakelite tops, wax or other foreign matter in the bearings, vane obstructions, etc.

Inspect to ensure that the counterbalance nut is secured in place by either a lock nut, locking tab or thread lock compound.

Check that there is no foreign matter or flaking plating or paint inside the relay.

The bottom of vane relay cases must be inspected, looking for signs of a build up of filings. Where evidence of filings exists, a close inspection of the rollers and associated spindle must be undertaken looking for signs of excessive wear.

Check for deposits of wax, varnish or paint on the vane which may indicate overheating of coils or contact with pole faces.

Check for scratches or abrasions on the vane which may indicate that the vane is distorted or that air gap tolerances are incorrect.

Check if the bottom of the vane could be spread due to striking the bottom of the relay case. This condition can first be detected by a mark in the paint of the case bottom. A vane allowed to spread could become jammed between the pole faces.

Check that the vane is central between and clear of pole faces. Vane distortion may be evident from observing the relay in operation.

Check the surface of the vane spindle for any accumulation of dust or discolouration which may be attributed to wear of the bearings.

Where the relay fails any of the inspection criteria listed above then the relay must be removed from service and sent to the Rail Equipment Centre for inspection.

Do not place in service AC vane shelf relays fitted with black coils without coil formers, as some these are suspected of releasing wax from the coils when hot.

If other types of relays in service exhibit evidence of wax deposits then details are to be reported.

Examine all non-proved AC vane shelf relays with black coils without coil formers for the presence of wax coatings and, where noted, check the release operation of the relay. Also examine the contacts for any noticeable presence of wax contamination.

Immediately change out non-proved AC vane shelf relays with black coils without coil formers and with evidence of wax and program those without evidence of wax for priority change-out, and have the maintenance signal engineer scrap this type of relay after removal from service.

Keep on record in the Network Maintenance depot a separate list of each and every non-proved relay circuit function on the section which is fitted with an AC vane shelf relay. This list would include track relays, track indicating relays, signal NI relays, release switch normal relays, detector relays etc.

If correct operation of a relay is in doubt, advise the maintenance signal engineer and change out the relay immediately and label it accordingly. The maintenance signal engineer is to promptly examine the relay as follows:
a) Check that ends of split pins are properly spread.

b) Check that the counter weight lock nut is locking the counter weight and that they have not moved.

c) Examine roller stops for evidence of grooving.

Examine spring type stops for evidence of grooving and ensure that the spring is effective and is not fouled by its bracket when the relay is energised and that they are tight and there is no sign of cracking.

### 7.1.1 Examination of VT1 Relays for Restricted Movement of the Vane

All VT1 relays must be examined as per the technical maintenance plan and in accordance with Section 7.1 above but especially with special attention to the following:

1. Inspection of both left and right hand vane spindle pivot pins looking for any signs of corrosion.

2. With the relay de-energised, ensure the vane is resting against the bottom roller.

3. With the relay energised, ensure the vane is pushing the top roller back. Where this is not the case, the track circuit must be checked for correct set up and adjustment.

4. With the vane operating from energised to de-energised and vice versa, the travel of the vane is to be observed, ensuring a clean pick up and drop away, with no abnormal sound. Where any hesitation in travel of the vane is noted or squeaking is apparent, the relay is to be removed from service and sent to Rail Equipment Centre for inspection.

5. The bottom of the relay case must be inspected for any particulate matter that would indicate the corrosion of the vane spindle.

Where the relay fails any of the inspection criteria listed in 1-5 above, or is contrary to the essential requirements in Section 7.1 above, then the relay must be removed from service and sent to the Rail Equipment Centre for inspection.

Any relays removed from service following a defect detected by inspection are to be reported to the Professional Head Signalling & Control Systems.

### 7.2 Examination of DC Relays, Shelf-Mounted

Licensed signalling personnel are responsible for the inspection of all DC shelf-mounted relays on their section. These relays must be inspected as defined in the technical maintenance plan and not exceeding 52 weeks.

The following is to be part of examination:

- Ensure correct operation, condition of contacts, terminals and pigtails
- Inspect for correct release and ensure the armature is operating freely and drops away promptly when the relay is de-energised – check for defects or wax or foreign matter in the bearings
- Inspect for foreign matter or flaky plating or paint inside the relay
- Ensure end of split pins are properly spread
- Inspect for any other unusual condition
If any unusual condition or if any sluggishness or failure of the armature to drop away promptly is observed, the relay must be replaced immediately and the maintenance signal engineer advised. When making this check due allowance should be made for a slow release relay.

7.3 Examination of Plug-in Relays

Licensed signalling personnel must examine, to the extent practical without removal, all plug-in relays, both Standard ‘B’ size and miniature, as per the technical maintenance plan and not exceeding 52 weeks and whenever the opportunity presents. They must particularly inspect for:

a) Any evidence of overheating such as discoloration or distortion of plastic covers, and burn marks on circuit boards, electronic or electrical components

b) Any signs of the plastic in the covers fouling the contact assembly and are not loose due to warping or cracking.

c) Any signs of contact burning, or pitting of the carbon contacts.

d) Any evidence of melted solder and other particulates across contacts or base of plastic cover.

e) Any signs of displaced or worn carriers.

f) Any signs of rust on plated components or signs of excessive deterioration of the plating.

g) The retaining clip is securing relay in base

h) Any Q type relays found which are fitted with the grey/white Pertoid (fibreglass) contact operating arms and adjustment cards are to be replaced immediately.

Licensed signalling personnel must replace relays if any of these or other defects are detected and advise the maintenance signal engineer.

7.4 Electro-mechanical and Thermal type Time Relays

Electro-mechanical type and thermal type time limit relays must be regularly tested as per the technical maintenance plan and at not more than two years intervals to see that they operate at the specified timing and the necessary details entered on a PR S 40024 FM02 form (see Appendix A) and forwarded to the maintenance signal engineer.

Any relays must be considered defective if the timing varies by more than ten percent of the specified timing.

Defective relays must be sent to the maintenance signal engineer for attention.

Type approved electronic time limit relays, such as QTD4 and QTD5 time limit relays are not required to have their timing function routinely tested.

7.5 QXR1 Transformer/Rectifier

The QXR1 transformer/rectifier unit has been supplied in two forms, earlier type having an input voltage adjustment of up to 115 V a.c. and latter type having an input voltage adjustment of up to 125 V a.c. Whilst the pin code and labelling is identical, the earlier type only has provision for connection to D1 and D2 terminals.
Care must be taken when installing or replacing QXR1 units that the appropriate type is used (i.e. not to use an earlier type where wiring is terminated on the D3 terminal or where the input supply voltage will be in excess of 115 V a.c.).

QXR1 transformer rectifier units are subject to the examination requirements detailed in Section 7.3 above.

7.6 Examination of Suspect Relays, all types

The maintenance signal engineer is to promptly arrange for a relay replaced because of doubtful operation to be examined by a Signal Engineer delegated by the Professional Head Signalling & Control Systems, and the Rail Equipment Centre Manager.

8 Despatch, Transport and Handling of Relays

Relays removed or replaced must be forwarded to the Rail Equipment Centre for overhaul or scrapping with a label detailing the reasons for its removal.

Relays should be handled and transported at all times with care and always be kept in the upright position in case any foreign matter has escaped detection and can move into a critical position to prevent proper operation.

9 Re-Use of Q Type Relays

Before Q Type (BRB930) miniature plug in relays, which have been in service for ten years or less, are considered for reuse in new or altered works, the following procedures of inspection and operating tests must be carried out and the relay must meet all performance criteria.

9.1 Visual Inspection

Visually examine the relay to ensure that:

a) Seals are intact.

b) The cover and base (base of the relay itself) mouldings are not chipped, cracked or warped.

c) Register pins are straight and correctly coded.

d) Plug-in contact fingers are not bent, distorted or burnt and have not lost tension.

e) There is no sign of overheating within the relay.

f) There are no signs of the plastic cover fouling the contact assembly or the assembly being misaligned.

g) Plated components are not corroded and are not showing signs of deterioration.

h) There is no loose or foreign matter inside the cover.

i) The cover is still transparent and there is no internal coating of a rust coloured, metallic or greasy nature.

If the relay has any of the defects listed above or if the seals are broken, the relay is to be returned to the workshops for scrapping or overhaul.

Relays which in all respects pass the visual test must be operationally tested as follows.
9.2 Operating Tests

Place the relay into the miniature relay test set or automated relay test equipment and check.

a) Pick up and drop away values (see Relays Manual)

b) Normal operation i.e. no chatter, excessive hum, slow to pick up or drop away (except where this is a function of the particular relay).

c) Pick up and drop away times (where applicable).

Note: If the relay fails a) or b) it must be scrapped. If the relay fails c) it must be returned to the workshops for scrapping or overhaul.

d) Check the contact resistance of each contact pair in the relay.

If the resistance is greater than 2 ohms the contact may be able to be cleaned by cycle testing the contact at its full rated current. Retest for resistance. If now less than 2 ohms the relay may be re-used. If still more than 2 ohms the relay must be sent to the workshops for mechanical cleaning and service.

Note: A relay with contact resistance readings up to 7.5 ohms may be re-used as a temporary measure if no replacement is available. This relay must be replaced without delay. Such relays must be marked “High resistance contacts, relay to be replaced”.

9.3 Contact Full Current Cleaning

All relays which have had contacts full current cleaned MUST have a permanent label affixed which states

“Nos ........contacts full current cleaned on ................. Signed ..................”.

9.4 Relays with more than Ten Years Use

Any Q type relay removed from service which has been in operational use for more than ten years must, provided it passes visual inspection, be returned to the workshops for overhaul.

9.5 Relays in Service

The above procedure for carrying out visual inspections and operating tests may also be used to test and clean relay contacts which are in service or which have been removed from service with suspected or proven high resistance contacts.

9.6 Alterations requiring spare contacts to be brought into service.

Whenever there are circuit alterations and circuits are connected to spare contacts that have not been in use for some time there is a probability that the contact may be high resistance. Again cycle testing the spare relay contact with its full rated current before it is connected in service may reduce the contact resistance and should be carried out, as required.
## Appendix A  Forms

**PR S 4024 FM01**  
Relay Change Form

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<th>No.</th>
<th>Type</th>
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<th>Location</th>
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I certify that all connections to the relays are correct as per circuit.

---

Name:  

Section:  

Signature:  

Date:
### 2 Yearly Test of Electromechanical or Thermal Timing Relays

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Date:
## Notice of Installation of Shelf Relay Conversion Unit

**To**
Documentation Manager, Signalling and Control Systems

**Cc**

**From**
Signal Engineer

**Date**

**Location**

### Details of Relays changed:

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Name: 

Signature:

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Date in Force: 21 September 2016

UNCONTROLLED WHEN PRINTED

Version 1.1
Engineering Procedure
Signalling and Control Systems

Signalling Safeworking

PR S 40025

Track Circuits

Version 3.0

Date in Force: 10 January 2018
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Document control

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<td>J. Rasborsek / C. Darmenia</td>
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Summary of changes from previous version

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<td>Clarify actions when shunt tests are outside limits</td>
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1 Introduction

Track circuits are a form of rail vehicle detection that relies on the wheel to rail interface and low axle resistance to detect the presence of trains which is an input to the interlocking.

Licensed signalling personnel are responsible for maintaining track circuits for safe and reliable operation.

Licensed signalling personnel shall perform, as a minimum, the periodic inspection, test and maintenance tasks as described in this procedure and at frequencies specified below:

- for 'Safety Critical' and 'Safety Significant' tasks – as stipulated in this procedure
- where not stipulated in this procedure – frequencies as stipulated in the approved Technical Maintenance Plan

Licensed signalling personnel shall make themselves aware of the relevant equipment manuals and specifications for each type of track circuit they are required to maintain.

Additionally, licensed signalling personnel shall be vigilant for potential track circuit problems which may lead to an unsafe condition or track circuit unreliability.

Any condition found with the potential to cause a track circuit to incorrectly indicate an unoccupied state shall be treated as a signalling irregularity and the maintenance signal engineer be promptly notified.

Any condition found with the potential to reduce the reliability of the track circuit shall be actioned immediately if practicable, recorded as a defect with an appropriate priority and where appropriate duly notify the maintenance signal engineer.

2 Reference documents

The following documents are referenced within this procedure:

- PR S 40007 Apparatus Seldom Used
- PR S 40017 Maintenance Responsibilities and Frequencies
- PR S 40023 Insulation Inspection and Testing
- PR S 40026 Rerailing - Precautions to be Taken
- PR S 40027 Traction Return (1500 Vdc)
- PR S 40038 Microlok II Computer Based Interlocking
- PR S 40048 Signalling Locations and Equipment – Security Locks and Keys
- PR S 41500 EBI Track 200 Set-To-Work and Certification
- GL S 43000 EBI Track 200 Digital Receiver
- GL S 43001 EBI Track 200 Digital Transmitter
- Signals Equipment Manual - Relays
3 Terms and definitions

The following definitions apply in this document:

- **TCHC**: track circuit history card (also known as THC)
- **DPU**: pin-point detectors/ data pick-up units
- **HVI**: high voltage impulse
- **AF**: audio frequency
- **TCA**: Track Circuit Assistor
- **promptly**: without delay
- **duly notified**: advice is provided during normal business hours such as Monday to Friday by methods such as phone, email, text message or in person
- **minor adjustment**: up to 10% of normal relay/Rx operating value
- **large adjustment**: greater than 10% of normal relay/Rx operating value

4 Objective of track circuit inspection, testing and maintenance

The objective of inspection, testing and maintenance of track circuits is to find and remove any potential failure condition, and ensure that the track circuit will function safely and reliably until the next scheduled examination.

The following are examples of track circuit components:

- track circuit power supplies
- transmitter/feed units
- receiver/processor units
- trackside units and interfaces
- track circuit resistor and capacitor units
- track circuit relays
- rail surface, track and ballast condition
- impedance bonds
- insulated rail joints
- equipment wiring, track wiring and cabling (including series bonds)
- traction bonds and track circuit parallel bonds
- wiring connections, including rail connections
- lightning protection

The following are examples of specific tasks that pertain to track circuits:

- performing inspection and maintenance of track circuit components
- recording of power supply and track circuit voltages, currents and settings
- performing shunts tests, including Train Shunt Check where applicable
- performing Polarity Tests, where applicable
- performing Open Circuit Feed Tests, where applicable
4.1 **Track circuit test records (Track Circuit History Cards)**

Track circuit test records (TCHC) are used to record test values, adjustments, observations and events. They shall be kept near each track relay and tests shall be recorded in accordance with PR S 40017 and this procedure. To ensure that historical track circuit records are preserved, a copy of test records is to be kept at the maintenance depot and updated at intervals no greater than two years.

Although it is preferable to have one card per track circuit located in the track relay location, it is permissible to have a second card in the track feed location and the test readings recorded separately for each end of the track circuit on the respective card.

Microtrax shall have a separate track circuit history card that is to be maintained at both the Master and Slave ends for the specific measurements at that end.

The track circuit history card provides a past record of the performance of the track circuit. They can highlight variations that need to be investigated. Observation and comparison of values recorded provide a way of detecting trends in performance, allowing problems to be detected before they cause a failure. Progressive variations in readings (e.g. adjusting KRV upward on a CSEE receiver by a small amount each visit) can indicate the deterioration of some component of the track circuit. The causes of these variations shall be investigated and resolved.

When all available lines on a track circuit history card are filled, enter, on the first lines of the new card, the details of the first (full row) test record and last (full row) test record from the old card, including the respective test date. This provides a long term base-line against which to compare changes.

The following shall be treated as a separate track circuit and tests and records carried out and kept accordingly,

- track circuits with a common transmitter;
  - pin-point detectors/data pick-up units (DPUs)
  - both ends of a centre-fed track circuit
  - double-receiver track circuits
- master and slave ends of Microtrax coded track circuits

Samples of the track circuit history cards are included in Appendix A.

4.2 **Track circuit inspection and tests**

The track circuit tests as prescribed in this procedure shall be performed as required during periodic maintenance. Examples of other events that require track circuit testing include the following:-

- in response to an associated failure or incident
- following re-railing or trackwork
- following periods of lack of track use by rail traffic
- whenever track circuit components are interfered with or replaced

4.2.1 **Track circuits failing safety testing criteria**

Track circuits that fail safety testing criteria shall be immediately reported to the relevant signal engineer. In the absence of prompt, effective remedial action, the protecting
signals shall be booked out of use until the cause is rectified. Shunt signals that are not affected by the track circuit may remain in use. Track circuits shall not be left operating for rail traffic in an unsafe condition.

Failure of track circuit safety testing includes:

- Fixed Shunt Test fails to de-energise the track circuit relay/output,
- Fixed Shunt Check fails to de-energise the track circuit relay/output,
- Open Circuit Feed Test ‘acceptable’ value in Table 2 is exceeded
- Train Shunt Check ‘maximum’ value in Table 2 is exceeded; refer to Instructions for Table 2 for values between Acceptable Value and Maximum Value.

Where the relevant signal engineer is not the maintenance signal engineer, then the relevant signal engineer shall duly notify the maintenance signal engineer by the end of the next business day of any authorisation and details.

Refer to Section 4.2.2.1 for actions for track circuits that do not meet Drop Shunt Test limits.

Refer to Section 4.2.4 for track circuits do not meet Polarity Test requirements.

4.2.2 Shunt tests

Shunt testing of track circuits using the prescribed methods is conducted to:

- confirm the shunt sensitivity of a track circuit receiver adjustment (Drop Shunt Test)
- confirm all legs of a track circuit are connected and the track receiver is shunting correctly (Fixed Shunt Test)
- confirm the receiver operates correctly (Fixed Shunt Check)
- confirm a train shunt is effective (Train Shunt Check)

Shunt tests and checks using fixed or variable shunt resistors require two persons, one to apply the shunt resistor and the other to observe the contacts of the track relay.

Additional information and requirements for Microtrax is provided in Section 8.

4.2.2.1 Drop Shunt Test

The drop shunt resistance is the highest value of resistance which, when placed across the rails, will cause the relay to drop away (i.e. become de-energised with all front contacts open).

The drop shunt is used during:

- track circuit set-up and adjustment; to set the track receiver/relay sensitivity to specification
- routine maintenance; to check and confirm receiver/relay sensitivity has not significantly altered due to changes in track condition or equipment deterioration
- track circuit failure or incident investigation; to confirm receiver/relay sensitivity is adjusted according to specification

The drop shunt resistance is measured using a variable resistance device called a shunt box.
When taking the drop shunt measurement, the leads of the shunt box are connected across the rails at the relay/receiver end of the track, set at a high value (at which the relay is energised), and then the resistance is decreased until the relay drops away. The drop shunt is the value of the resistance of the shunt box at which the receiver/relay has dropped and remained de-energised.

The Drop Shunt Test is repeated three times until consistent results are obtained. This result shall then be recorded on the track circuit history card.

The drop shunt value obtained during initial track circuit set-up or subsequent adjustment shall be in accordance with the Set-to-Work and Certification procedure for the relevant track circuit type. The value recorded on the track circuit history card is to be used as the reference value for subsequent track inspections or adjustments.

Table 1 lists the acceptable range of drop shunt resistance for the relevant track circuit types. Track types shown as having a value 'For reference only' do not have a specified range of values and the readings taken are compared to those on the track circuit history card to provide an indication of any changes in the track performance. For the track circuits without a specified range, the minimum drop shunt resistance will always be the 'Fixed Shunt Resistance' of Table 1.

When a drop shunt for a specific track circuit is found to be outside the range or significantly different to the previously recorded value the cause should be investigated. The maintenance signal engineer shall be consulted if the track cannot be restored to normal levels by minor adjustment following the investigation or rectification actions.

4.2.2.2 Fixed Shunt Test

A Fixed Shunt Test is conducted to confirm all sections of a track circuit, when shunted, will effectively de-energise the track relay/output.

This test is carried out by connecting a set-value resistive shunt across the rails at nominated points and observing that the track relay de-energises. The value of the shunt used for this test shall be in accordance with the fixed shunt resistance value for the relevant track circuit type in Table 1.

The nominated shunt shall be applied at the positions specified in the 'Set-to-Work and Certification' procedure for the relevant track circuit. The test points include:

- at the feed/Tx and the relay/Rx ends of all track circuits
- three metres inside the tuned loop at both the transmitter and receiver ends of AF track circuits
- extremities of track circuits in crossovers including parallel or series bonded sections
- mid-point of all track circuits.

Each test point is conducted as a series of three consecutive effective shunts.

The designated receiver/relay input value is measured with the fixed shunt applied at the receiver/relay end and this reading is recorded on the track circuit history card.

This value is checked to be consistent with previous readings to:

- verify the accuracy of the shunt equipment and application
- detect any track circuit changes which may have resulted in a reduced shunting effect at the receiver/relay
### Table 1 – Minimum Shunt Resistance

<table>
<thead>
<tr>
<th>Track Circuit Type</th>
<th>Fixed Shunt Resistance</th>
<th>Drop Shunt Resistance in dry ballast conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>HVI Jeumont Schneider impulse track (Double rail) (1x BRTCA2-Rx)</td>
<td>0.25 ohms</td>
<td>For reference only</td>
</tr>
<tr>
<td>HVI Jeumont Schneider impulse track (Double rail) (2x RVT600-Rx)</td>
<td>0.25 ohms</td>
<td>For reference only</td>
</tr>
<tr>
<td>HVI Jeumont Schneider impulse track (Double rail) (1x RVT600-Rx)</td>
<td>0.5 ohms</td>
<td>For reference only</td>
</tr>
<tr>
<td>HVI Jeumont Schneider impulse track (Single rail) (Normal/TV-TH1)</td>
<td>0.5 ohms</td>
<td>For reference only</td>
</tr>
<tr>
<td>HVI Jeumont Schneider impulse track (Single rail) (TV-THD2 or TV-LV)</td>
<td>0.25 ohms</td>
<td>For reference only</td>
</tr>
<tr>
<td>Single Rail AC resistor fed - Signal Branch</td>
<td>0.25 ohms</td>
<td>For reference only</td>
</tr>
<tr>
<td>Single Rail AC resistor fed – WBS</td>
<td>0.5 ohms</td>
<td>For reference only</td>
</tr>
<tr>
<td>Double Rail AC resonant impedance bonds</td>
<td>0.25 ohms</td>
<td>For reference only</td>
</tr>
<tr>
<td>Double Rail AC AAR standard</td>
<td>0.06 ohms</td>
<td>For reference only</td>
</tr>
<tr>
<td>UM71 (CSEE) audio frequency</td>
<td>0.15 ohms</td>
<td>For reference only</td>
</tr>
<tr>
<td>TI21 audio frequency</td>
<td>0.15 ohms</td>
<td>Nor power: 0.8 – 1.2 ohms Low power: 1.3 – 1.7 ohms</td>
</tr>
<tr>
<td>ET200 audio frequency</td>
<td>0.15 ohms</td>
<td>Nor power: 0.8 – 1.2 ohms Low power: 1.3 – 1.7 ohms</td>
</tr>
<tr>
<td>FS2500 WB&amp;S audio frequency</td>
<td>0.15 ohms</td>
<td>0.8 - 1.2 ohms</td>
</tr>
<tr>
<td>FS2600 WB&amp;S</td>
<td>0.5 ohms</td>
<td>&gt; 0.6 ohms</td>
</tr>
<tr>
<td>USS Microtrax Coded Track</td>
<td>0.25 ohms</td>
<td>0.4 – 0.5 ohms</td>
</tr>
</tbody>
</table>

#### 4.2.2.3 Fixed Shunt Check

The Fixed Shunt Check proves that the track circuit will shunt at a given point along the track, and is usually conducted at the receiver/relay end. The shunt check is carried out by using a fixed shunt resistance across the rails while observing that the track circuit relay/output drops away with the shunt applied.

The value of the fixed shunt resistance used for this test shall be in accordance with the specified resistance for the relevant track circuit type as shown in Table 1.

#### 4.2.2.4 Train Shunt Check

A final test of the correct shunting of a track circuit is the Train Shunt Check, carried out to ensure that there is sufficiently good electrical rail/wheel contact and that a train is effectively detected during its entire passage over the track circuit.

A Train Shunt Check is required where there is doubt about the electrical conductivity of the rail contact surfaces, for example after re-railing or after an extended period of disuse.

For track circuits over points, the Train Shunt Check is to be carried out for all routes through the points.

The check is carried out by continually monitoring the track relay/receiver input voltage at the designated test point, while a train passes over the whole length of the track circuit, and observing that the input voltage does not exceed the acceptable train shunt value.
A train fitted with a functioning TCA (Track Circuit Assistor) cannot be used for train shunt testing unless all TCAs on the vehicle are turned off.

The test points and the acceptable train shunt values for each type of track circuit are given in Table 2.

### Table 2 - Train Shunt and Zero Feed Values

<table>
<thead>
<tr>
<th>Track Circuit Type</th>
<th>Test Point</th>
<th>Unit of Measure (FSM - Frequency Selective Meter)</th>
<th>Acceptable Train Shunt and Zero Feed Value</th>
<th>Maximum Train Shunt Value (with Signal Engineer's approval)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 Hz ac</td>
<td>Control Terminals</td>
<td>V ac</td>
<td>&lt;=10% of D.A. test value</td>
<td>30% of D.A. test value</td>
</tr>
<tr>
<td>CSEE UM71</td>
<td>Receiver R1 &amp; R2 (T1) or M1 &amp; M2 (T2)</td>
<td>mV ac with FSM</td>
<td>&lt;=30 mV</td>
<td>90 mV</td>
</tr>
<tr>
<td>ML TI 21</td>
<td>Input resistor (across 1 ohm) terminals</td>
<td>mV ac with FSM</td>
<td>(mV x GAIN) &lt;=35</td>
<td>(mV x GAIN) 100</td>
</tr>
<tr>
<td>ET200</td>
<td>Receiver terminals TP1 &amp; IP1</td>
<td>mV ac with FSM</td>
<td>&lt;=20% of threshold current</td>
<td>50% of threshold current</td>
</tr>
<tr>
<td>WB&amp;S FS2500</td>
<td>Receiver Monitor</td>
<td>mV ac</td>
<td>&lt;=135 mV</td>
<td>400 mV</td>
</tr>
<tr>
<td>HVI (Jeumont Schneider)</td>
<td>Receiver Terminals</td>
<td>V dc with integrator</td>
<td>&lt;=35 V</td>
<td>100 V</td>
</tr>
<tr>
<td>USS Microtrax coded track circuit</td>
<td>Slave end – track interface panel terminals</td>
<td>mV DC</td>
<td>Within -50 mV to +50 mV pulse. (zero feed test is not possible)</td>
<td>±80 mV pulse.</td>
</tr>
<tr>
<td>WB&amp;S FS2600</td>
<td>Receiver Monitor</td>
<td>mV ac</td>
<td>&lt;=100 mV</td>
<td>500 mV</td>
</tr>
</tbody>
</table>

### Instructions for Table 2

i) The 'Acceptable Train Shunt' is the limit value which can be accepted without consultation and approval by a signal engineer.

ii) Train shunt readings between the 'Acceptable' and 'Maximum' values are only permitted by a signal engineer when it is expected that the train shunt will improve under normal conditions.

Example scenario: new rail is train shunted with a light engine with results above the 'Acceptable' value. Normal services are electric trains which provide a superior shunt. As this traffic is more tolerant to contaminants such as scale, rust and protective surfaces, the signal engineer may allow the higher value based on the normal electric service on the track until retested once some traffic has passed over the rail.
v) When testing shelf relays, the Drop Away (DA) value is the printed value shown on
the manufacturer's or workshop's test label on the relay.

vi) When testing plug-in relays, the nominal drop away value for the type of relay is as
shown in the Relay Equipment Manual.

vii) When testing AC vane relays, supply to the local coils will need to be disconnected
during the check to reduce induced voltage readings.

4.2.3 Open Circuit Feed (Zero Feed) Test

An Open Circuit Feed Test (commonly referred to as a Zero Feed Test) is performed to
ensure that the track circuit relay or receiver is not fed from any other source other than
its own track feed or transmitter. The test is generally required upon initial certification,
where the work could result in a cross connection of track circuit feeds, or where there is
doubt in regards to the integrity of the track circuit. A periodic Zero Feed Test shall be
performed with a scheduled Level Three Inspection, Test and Maintenance. A Zero Feed
Test is not required for Microtrax coded track circuits.

The Zero Feed Test requires the track circuit feed or transmitter power supply to be
temporarily disconnected and, during this time, the relay voltage or receiver input is
measured. The measured value is to be near zero and shall not exceed the 'Acceptable
Train Shunt and Zero Feed' values specified in Table 2. The track relay shall also be
observed to have de-energised.

Note On ac vane relays, supply to the local coil will also need to be disconnected.

4.2.4 Polarity Test

A Polarity Test is performed to ensure polarities across insulated rail joints of like track
circuit types conform to the polarity shown on specific track insulation plan. In most cases
there will be opposite polarity of rail voltages across insulated rail joints. This requirement
avoids an unsafe condition arising caused by a track circuit being fed from an adjacent
track circuit in the event of an insulated rail joint becoming short-circuit.

The existence of like polarities is only acceptable at a track feed to track feed interface, or
where a short-circuited insulated rail joint would result in both adjacent track circuits
becoming de-energised. Polarity reversal does not apply to audio frequency track circuits
as this is managed by minimum frequency separation.

A Polarity Test is performed by checking the rail voltage polarities using a voltmeter (and
pulse integrator where applicable) to ensure that the polarity across all insulated rail joints
between adjacent like track circuits (namely 50 Hz ac to 50 Hz ac, HVI to HVI and
Microtrax to Microtrax) conform to the specific track insulation plan. Also refer to
Section 8.3 for Microtrax.

The WBS FS2600 is technically termed a jointed track circuit that uses frequency
separation similar to AF track circuits. The receivers also look for particular frequencies
for which they can detect known as detection pairs as a check for failure of an insulated
joint. The Polarity Test cannot be checked in the same way as for conventional double
rail 50 Hz AC track circuits. The Polarity Test for the FS2600 track circuit is a check of the
detection pair function. To ensure that insulated joint detection is functioning one or both
of the track circuits is to fail when one of the insulated rail joints is short circuited.

The maintenance signal engineer shall be duly advised of incorrect polarities between
track circuits. The condition of insulated rail joints shall be checked to ensure they are not
liable to breakdown before the situation is corrected.
The maintenance signal engineer shall consult with a signal design engineer as necessary to determine appropriate design solutions and any track insulation reconfiguration shall have an approved signal design.

Following are examples of adjacent track circuits affected by like polarity:

- 50 Hz ac track circuit adjacent to 50 Hz ac track circuit
- High voltage impulse (HVI) track circuit adjacent to HVI track circuit
- Microtrax coded track circuit adjacent to Microtrax coded track circuit
- FS2600 jointed track circuit to FS2600 jointed track circuit (detection pair check)

Licensed signalling personnel are to be aware of the risks to adjacent 50 Hz ac track circuits at boundaries between different power supplies, change of state between Normal and Emergency power supplies or temporary supply arrangements such as generators. Refer to Section 5.6 for precautions for changes to power supplies and the risk this presents to 50 Hz ac track circuits and their polarities.

4.2.5 Inspection of traction bonding

PR S 40027 shall also be referenced for Traction Bonding

Traction bonding includes parallel bonds between rails, tie-in bonds, cross bonds (rail to rail and rail to impedance bond), and traction bonds from rails to section hut or substation busbars.

Licensed signalling personnel shall ensure that; traction bonding is in good condition, open circuit bonds are immediately replaced, high resistance connections are immediately rectified, and deteriorated bonds are programmed for timely renewal.

Licensed signalling personnel shall check the integrity of the traction bond during maintenance visits. Where traction bonds are visible throughout their entire length, an observation may be sufficient to check their integrity. Where traction bonds are buried, the integrity shall be checked using a clamp meter on each parallel leg of the traction bond to ensure they are all carrying equal current.

Traction bonding can be electrically tested in service using DC ammeters on the individual parallel cables. Confirm that parallel cables carry approximately equal DC current (within 10%). Confirm that rails on double rail track circuits carry approximately equal DC current (within 10%).

Traction bonding not associated with track circuits shall also be inspected to ensure it is good condition and the connections are not disconnected or damaged. This is done to prevent (so far as is reasonably practicable) the potential for unsafe voltages that may develop across rail breaks or cable breaks. Traction bonding not associated with track circuits is particularly relevant in yards, rolling stock maintenance centres and at end of line sections.

4.2.6 Inspection of track circuit parallel bonds

Track circuit parallel bonds are used in turnouts to tie-in the portion of track that extends over points to a clearance point on another line with the main portion of the track circuit. In this case the tied-in portion of track circuit relies on the effectiveness of the parallel bonds for its provision of rail vehicle detection.
The inspection of track circuit parallel bonds is to ensure the bonding has not been damaged or removed by track work, vandals or other causes which could result in loss of train detection. This inspection is categorised as 'Safety Significant'.

Inspection and certification of track circuit parallel bonds includes the following tasks:

- inspect the parallel bonds for electrical continuity in accordance with track insulation plan
- inspect the parallel bonds for effective rail connection
- inspect the parallel bonds for sound condition

Track circuit parallel bonds shall be inspected at a frequency not exceeding three months. An exception to this is where parallel bonds are surface run and have hypalon insulation and welded rail connections; the inspection frequency then can be extended to six month intervals.

Results of inspections are to be recorded to enable:

- compliance to Safety Significant task
- assurance of track circuit parallel bond condition
- review of actions and timeframes for proposed defect rectification

Any open circuit parallel bond or high resistance connection found shall be immediately rectified or replaced.

Licensed signalling personnel should take the opportunity to inspect track circuit parallel bonds whenever opportunities arise, for example when working in the vicinity of points.

5  

Precautions associated with track circuits

5.1 Adjusting track circuits

Once commissioned, track circuits do not normally require adjustment unless they have been affected by component degradation/replacement, environmental changes, or engineering works.

Track circuits shall not be adjusted without a full inspection of the track circuit equipment to determine if an equipment or bonding fault or a change in track condition has contributed to the adjustment requirement. An adjustment can only be considered when the root cause of the track level change has been determined and actioned appropriately.

Licensed signalling personnel are permitted to make minor adjustments (up to 10% of normal relay/Rx operating value) when shunt tests do not comply with the requirements of Table 1 and Table 2, when equipment is replaced or the track circuit is sagging due to known causes. Licensed signalling personnel shall duly notify the maintenance signal engineer of the adjustment by the end of the next business day.

When a large adjustment is necessary to rectify a fault or condition to return the track relay/Rx to TCHC normal levels, the cause of the change shall be immediately investigated and where possible rectified. If the cause cannot be identified and large adjustment is still necessary it is to be referred to the relevant signal engineer for consideration and instructions. Large adjustments shall not be made without the authorisation of the signal engineer. Where the relevant signal engineer is not the maintenance signal engineer, then the signal engineer giving authorisation shall duly
notify the maintenance signal engineer by the end of the next business day of the authorisation and details.

Track circuit adjustment and shunt tests are preferably completed in dry ballast conditions. Track circuits adjusted in wet or poor ballast conditions shall be retested when the track has dried out, or the ballast conditions improved, to ensure correct shunting and track circuit performance.

Track circuits are adjusted with all track bonding (rail bonds, series bonds, parallel bonds, impedance bond side leads, etc.) and rail connections in place and in good condition with low resistance.

Track circuit feed voltages shall not be increased to compensate for open circuit or high resistance bonding. In electrified areas, high track feed voltages could increase the probability of circulating currents through traction tie in bonding or earths.

Whenever the track circuit is installed or readjusted:

- measure and record all track circuit parameters on the track history card,
- perform a Fixed Shunt Test and observe the relay pick up and drop away correctly,
- perform a Drop Shunt Test, and
- record the values and reason for the adjustment on the track circuit history card.

Licensed signalling personnel shall regularly monitor the track circuit and the track shall be readjusted immediately the ballast conditions have improved. The maintenance signal engineer shall ensure the timely attention to the readjustment.

The maintenance signal engineer shall be informed of planned works or activities which could change track or ballast conditions and affect the proper adjustment of the track circuit and its ability to operate reliably and safely.

5.2 50 Hz ac track circuits – circulating currents

Fault conditions can cause 50 Hz ac track circuit currents to circulate via traction tie-in bonds or earth paths etc. through other track circuits (or where a fault condition causes ac currents in the dc traction supply) leading to a potentially unsafe condition occurring if a high resistance track circuit condition arises. All cases of open circuit or high resistance rail bonds, series bonds, impedance bond side leads, and their connections, shall be rectified promptly. Emergency jumper bonds, in good condition and correctly applied, should be utilised as required, however, they shall be replaced by permanent bonds as soon as possible.

Any time a significant imbalance in AC rail current is detected outside the limits below, the unbalance shall be immediately reported to the maintenance signal engineer, and the cause found and rectified without delay.

The rail current balance of double rail 50 Hz ac track circuits shall be determined by measuring the signalling current in both rails, at both the feed and relay ends of the track, using an Induction meter. This test is not highly accurate, due to variations induced by traction current harmonics; however the test does give a convenient indication of imbalance in the rail currents. Any difference greater than 0.5 A shall be considered significant.

Measuring rail current balance using a meter that is not 50 Hz frequency selective may not be an accurate indicator because of traction harmonics flowing in the traction rail. Differences between the rail currents measured on an induction meter of greater than
1.25 A on single rail 50 Hz ac track circuits shall be considered significant and should be further investigated including checking other track circuits in the vicinity.

While there should not be any stray 50 Hz currents emanating from balanced double rail track circuits, this is not the case with single rail 50 Hz ac track circuits, where close tie in bonding between the traction rails of parallel tracks provides an alternate low resistance path for stray 50 Hz ac track circuit currents. It may not then be unusual to measure unbalanced 50 Hz currents in single rail track circuits.

The currents measured in each cable of a side lead pair should be within 10% of each other. Uneven current sharing indicates a high resistance side lead or connection. The voltage drop across a side lead connection to rail should be less than 10 mV ac.

A special periodic inspection is required to be scheduled as described in Section 6.1. This inspection is categorised as 'Safety Critical'.

WBS FS2600 track circuits, whilst also susceptible to circulating currents, are exempt from this safety check as the risk is managed through its design. A breakdown of the insulated joint is detected by the detection pairing function and will fail the track circuit.

5.3 Interference/repairs to track circuit wires

Whenever two or more track circuit wires are disconnected and reconnected or repairs are made to two or more broken wires to track circuit equipment ensure that the track relay has picked up and perform a Fixed Shunt Check to ensure that the relay drops away correctly. Where applicable, perform a Polarity Test between the affected track circuit and adjacent track circuits to confirm the polarity has not been altered.

5.4 Contaminated rails

Contamination on the rail surface can prevent a track circuit from shunting when a train is occupying the track circuit.

Where the rail surface condition is in doubt, a Train Shunt Check shall be performed.

Signalling Safeworking Procedure PR S 40007 shall be referenced for matters relating to the management of contaminated rail caused by track circuits seldom used. The register referenced in PR S 40007 shall also be used to record and manage areas that have become otherwise contaminated.

Signalling Safeworking Procedure PR S 40026 shall be referenced for matters relating to the certification of track circuits following a re-railing.

5.4.1 Excessive sanding of the track by locomotives

When excessive sanding of tracks by locomotives occurs in track circuited areas the effective shunting of track circuit by rail traffic can be reduced.

Any case of excessive sanding is to be immediately brought to the attention of the relevant signal engineer, and also to the attention of the relevant Network Control Officer.

Any instances of trains failing to shunt track circuits, intermittently or otherwise due to sand on the rail head, are to be immediately reported to the relevant signal engineer and fully investigated.
Where the relevant signal engineer is not the maintenance signal engineer, then the signal engineer shall duly notify the maintenance signal engineer by the next business day of the details.

Track circuits prone to excessive sanding shall be treated as seldom used track circuits, refer to PR S 40007.

5.4.2 Wheel marks outside the clean contact band

Modern designs of rolling stock wheels and rails have led to a reduction in rolling friction and rail wear. While this has led to greater operating efficiency it has narrowed the clean contact band on the rail head.

Irrespective of wheel or rail wear states, minimum contact band requirements are:

- centre top 10 mm of new or re-profiled rail
- inner 30 mm of top of worn or standard profile rail

When inspecting track circuits licensed signal personnel shall be vigilant for evidence of wheel marks outside the clean contact band on heads of rails or contact bands less than the required minimum. Where wheel marks have been found outside the clean contact band or the contact band is less than the required minimum it shall be duly reported, including evidence such as photos of the rail head, to the maintenance signal engineer for guidance on further testing and actions.

5.5 Inserting UM71 (CSEE) and Jeumont Schneider track circuit receivers

It is crucial that CSEE and Jeumont Schneider track circuit receivers are plugged into their correct rack positions. The misalignment of a receiver by one module space can have unsafe consequences, resulting in the permanent energisation of the track relay.

To prevent this occurrence, licensed signalling personnel shall ensure that these units are replaced into their correct position whenever they are unplugged from their base, and additionally check on all racking used for CSEE and Jeumont-Schneider track circuit equipment, that every vacant module position above and below these units is fitted with obturation fittings and coding plugs.

5.6 Polarity of power supplies

Whenever power supplies or their associated wiring are worked on or when the supply phasing is altered by supply authorities or the location normal or emergency power supply changes state, there is a risk that the polarity of 50 Hz ac track circuits may become swapped, potentially causing an unsafe condition.

Adjacent 50 Hz ac track circuits, fed from different power supplies are mostly at risk. Consequently, the polarities of these adjacent track circuits shall be tested whenever an at-risk event occurs at the power supply level.

Where the feed and relay ends of the same 50 Hz ac track circuit are fed from different power supplies are discovered, these track circuits shall be duly reported to the maintenance signal engineer to arrange for prompt reconfiguration so that they become fed from the same power supply.
Temporary supply arrangements (generators) may not accurately remain in phase with the electrical supply network. The maintenance signal engineer shall be consulted for appropriate mitigations and testing for works involving supply alterations or generators.

6  Safety critical and safety significant tasks

Safety critical and safety significant tasks that apply to track circuits are mandatory. The requirements of PR S 40017 and any applicable Technical Maintenance Plan (TMP) shall also be observed.

In addition to the reporting requirements of PR S 40017, the results shall be recorded on the TCHC. Recording the level of periodic maintenance inspection containing the task for the inspection of parallel bonding or a notation for inspecting parallel bonding on the track circuit history card will suffice for this requirement if a specific area is not provided.

6.1 Safety critical tasks for double rail 50hz ac track circuits

The following schedule of tasks is categorised as 'Safety Critical' and shall be performed at a frequency not exceeding 30 days.

Test double rail 50Hz ac track circuits in electrified areas as follows, and record the results on the Track History Card:

- track relay coil voltage, unoccupied
- current in each rail, relay end, for balance
- current in each rail, feed end, for balance
- current in each cable of impedance bond side lead, up rail, for balance
- current in each cable of impedance bond side lead, down rail, for balance
- voltage drop across each up rail side lead connection
- voltage drop across each down rail side lead connection

The track circuit shall be adjusted so the relay coil voltage reads approximately 50% (under normal working conditions) above the working/compression voltage shown on the relay's workshop label.

The current in each rail at the one location should be equal or within 0.5 A as measured using an induction meter.

Investigate unbalanced (unequal) current readings and advise the maintenance signal engineer without delay.

The currents measured in each cable of a side lead pair of cables should be equal, or within 10%. Uneven current sharing indicates a high resistance side lead or connection.

The voltage drop across a side lead connection to the rail should be less than 10 mV ac.

Investigate changes in values significantly different to previous readings.

6.2 Safety significant tasks track circuits

The safety significant task requirements and frequencies for track circuits with track circuit parallel bonds are detailed in Section 4.2.6 above.
Safety significant tasks that apply for all track circuits are carried out as part of the Level Three Inspection, Test and Maintenance detailed in Section 7.3 below and included:

- test track circuit relay/ receiver input voltage when unoccupied (except double rail 50 Hz ac as these are certified separately)
- perform Fixed Shunt Test
- perform Drop Shunt Test
- perform Polarity Test (as applicable)
- perform Zero Feed Test (as applicable)
- inspection and testing of track circuit parallel bonding

7 Periodic inspection, test and maintenance tasks

7.1 Level one inspection, test and maintenance

The following schedule of tasks shall be performed at a frequency in accordance with the approved Technical Maintenance Plan.

The following tasks shall be performed as part of this scheduled maintenance:

a) examine connections to the rails and the condition of cables for:
   i) track circuit leads (shall include testing to ensure that the voltage drop across all audio frequency track lead connections to rail head be of low resistance, typically less than 10 mV ac)
   ii) track circuit parallel bonds
   iii) series bonds
   iv) mechanical rail joint bonds
   v) electrolysis bonds
   vi) impedance bond side leads
   vii) traction tie-in leads
   viii) emergency jumper bonds

Note: The voltage drop across impedance bond side lead connections to the bond and to the rail shall be checked to be low resistance, ie; less than 10 mV ac.

b) examine connections to air-cored inductors, tuning units, compensating capacitors and their connections

c) examine cable fasteners to rails and sleepers (including clip/cleating arrangements on concrete sleepers)

d) examine insulated rail joints for:
   i) deterioration
   ii) rail burning/burring over
iii) steel scale
iv) clear of ballast and metallic items

Note: Using an induction meter, check the leakage through the insulated joints

e) where an insulated joint between track circuits is in need of repair, check for
correct polarity reversal as a precautionary measure

f) examine point rods, signal wires and debris such as spent drink cans or other
metallic items coming into contact with rails and crossing noses

g) check that traction bonding cables and other cables are clear of, and insulated
from, rails to which they are not bonded

h) check for rusty rails, sand or other contamination which could affect train shunts
(on the contact surface of the rail for the entire length of the tract circuit).

For specific types of audio frequency track circuits (types CSEE, TI-21, ET-200 and
FS2500) and High Voltage Impulse (types Jeumont Schneider Single Rail and Double
Rail) this may be managed by the following process:-

i) Check signal control systems for any recorded “out of sequence” events.
Any recorded events on the affected track circuit will necessitate a full visual
track inspection.

ii) Check if track circuit is active within the maintenance area Contaminated
Rail Register. If the track circuit is listed, additional investigations will be
required as per the requirements of PR S 40007 Section 3 and any
additional instructions from the maintenance signal engineer dealing with
contaminated rail.

iii) If any track circuit components are listed in the Temporary Repair Register
or have outstanding defect listed in the Sydney Trains Defect Management
System then additional inspections will be required.

iv) Examine the track circuit in the vicinity of tuned loops, cable connections,
signals and insulated joints (IRJs) for contamination on the rail head (this
includes sand, rust and other contaminants). Particular attention to be paid
to sidings, yards, infrequently used track, crossovers and equipment in the
vicinity of mechanical signalling equipment (channel iron or signal wire runs).
Any issues found during the examinations of the track circuits shall be
reported to the maintenance signal engineer and arrange to inspect the
whole length of the track circuit. Additional requirement as per PR S 40007
Section 3 shall be observed during inspection of the track.

v) Perform a Train Shunt Check and observe passage of a train over affected
track circuit section. The measurement shall be recorded on the TCHC and
compared with the previous readings. If any reading outside the parameters
as per Table 2 shall be investigated and report it to the maintenance signal
engineer.

vi) If the Train Shunt Check is impractical due to insufficient rail traffic. Physical
examination for contamination of the track and rail contact band shall be
carried out for the entire length of the tract circuit in lieu of the Train Shunt
Check.
i) check that rail fasteners (including Pandrol clips) are clear of fishplate bolts at insulated joints, and clip and chair insulation pads on concrete sleeper track. Check rail fasteners and rail bonds are clear of steel structure on bridges.

j) check the general condition of ballast

k) examine lightning protection equipment

l) record the voltage at the track receiver/relay and check against the last recorded value

m) on 50 Hz ac track circuits, check and record the rail current balance

If the reading shows a variation from the last recorded value which is large enough that it cannot be accounted for by normal variations in ballast conditions, then further investigation and tests shall be carried out. Severe degradation of performance of the track circuit outside normal behaviour or known symptoms of failure shall be duly reported to the maintenance signal engineer who shall arrange an investigation.

7.2 Level two inspection, test and maintenance

In addition to the schedule of tasks listed above, the following schedule of tasks shall be performed (as applicable) at a frequency in accordance with the approved Technical Maintenance Plan.

For the ease of maintenance planning, Level Two Inspection, Test & Maintenance tasks have been divided and packaged with other suitable service schedules of the approved technical maintenance plan.

a) Impedance bonds fitted with removable lids which are installed inside the track below top of sleeper level shall be internally inspected for wear and damage. The set screws securing the yoke to the laminated core and all terminal studs shall be kept tight. The windings shall be examined to ensure that the insulation is not displaced and that the coil leads are not fractured. The bond shall be examined to see that it is clean and dry and the case is not cracked. When replacing the lids of bonds installed in the four foot it is essential that the sealing of the connection inlets and hemp lid packing or gasket will effectively exclude the entry of water or other foreign matter. The set screws or bolts securing the lid shall be kept in good order and the wooden packing, where provided, maintained in position.

b) Impedance bonds installed on the outside of the track (on stands), or otherwise have fixed lids, do not require periodic internal inspection.

c) Jeumont Schneider CIT 1400 impedance bonds can suffer from loose back nuts so particular attention should be given to any loose terminations. The construction of this bond brings out each half of the winding externally for traction connections. To prevent a possible cause for unbalanced traction return a good solid connection shall be maintained between the two centre copper bars. Inspect this connection to ensure that the two bus bars form a good connection.

d) On MJS and ABW 1000 amps per rail impedance bonds, the condition of the connections is to be examined for looseness or any signs of oxidation.

e) On impedance bonds there is an additional box mounted on the rear of the bond containing either capacitors (2000R and 2000RAF) or a transformer (2000P). The lid on the box is to be removed and a check made for any loose or imperfect connections.
f) On resonated bonds the capacitor voltage is to be measured and recorded on the respective impedance bond capacitor history card. Variation in the voltage compared to previous records is to be investigated.

7.3 Level three inspection, test and maintenance

The following schedule of tasks is categorised as Safety Significant. These tasks shall be performed, in addition to the schedule of tasks listed above, at a frequency not exceeding two years.

a) Measure all voltage readings indicated on track circuit history card according to the method prescribed for each track circuit type and record the results on a new line on the card and compare with previous results.

b) Perform a Fixed Shunt Test, with the appropriate resistance value for the type of track circuit concerned (see Table 1), at all extremities of the track circuit including in points turnouts and crossovers and especially where connected by parallel bonding. Record details on the track history card.

c) If the track fails to shunt at the minimum fixed shunt value specified for that type of track circuit, then a Drop Shunt Test shall be conducted to establish the resistance value that is required to shunt the track circuit and the maintenance signal engineer shall be immediately informed. The track circuit shall not be left operating in an unsafe condition.

d) Perform a full visual inspection of complete length of the track circuit for contamination of the track and rail contact band. Check for rusty rails, sand or other contamination which could affect train shunts (on the contact surface of the rail).

e) On compensated track circuit types, record the rail-rail voltage at each capacitor connection and compare with previous results.

f) On 50 Hz ac, high voltage impulse and Microtrax track circuits, perform a polarity test across all insulated rail joints between adjacent track circuits of the same type, including at all extremities where there are turnouts and crossovers. Ensure track polarities conform to the specific track insulation plan.

g) Where adjacent track circuits of the same type are fed from different power supplies, then ensure these supplies are operating on the Normal supply during the polarity test.

h) Advise any discrepancies to the maintenance signal engineer.

i) On all track circuit types except Microtrax, perform a Zero Feed Test.

j) In accordance with PR S 40023, insulation test track circuit leads from the location to the bootleg riser, bond or tuning unit, and record values on the appropriate record, every two years for non PVC insulated cables and every four years for PVC insulated PVC sheathed cables.

If the track circuit readings show variations from the last recorded values which are large enough that they cannot be accounted for by normal variations in ballast condition, then further investigation shall be carried out. Severe degradation of performance of the track circuit outside normal behaviour or known symptoms of failure shall be duly reported to the maintenance signal engineer for investigation.
7.4 Other circumstances requiring testing

Additional inspection, tests and maintenance is required whenever there are events that may cause change which could affect adjustment, polarity, etc and thus impair the safe and reliable operation of track circuit.

- In the case of 50 Hz ac track circuits with shelf relays, when a relay change has been carried out. Perform a Fixed Shunt Check at the relay and measure the relay voltage before and during the fixed shunt check. Compare the values with previous values, the track relay workshop test values, and the normally required values. Assess the need for and carry out readjustment as required.

- Following replacement of equipment items forming part of the track circuit, e.g. power supplies, transformer, resistor unit, impedance bond, insulated rail joint, capacitor unit, transmitter/ feed units, track circuit relays, receiver/ processor units, tuning unit, matching unit, lightning protection, shielding unit, equipment wiring, track wiring, track cabling, wiring connection including rail connections. Perform a Drop Shunt Test at the relay/ receiver-end to determine the value of shunt resistance required to shunt the track circuit. Also perform a Fixed Shunt Check at the relay/ receiver-end and measure the relay/ receiver voltage before and during the fixed shunt check. Compare the values with the previous values, the track relay workshop test values and the normally expected values. Assess the need for and carry out readjustment as required.

- Following track work such as track re-sleepering or reconditioning that has the potential of affecting the adjustment of the track circuit. Perform a Fixed Shunt Check at the relay end and measure the relay/ receiver voltage before and during the fixed shunt check. Compare the values with the previous values, the track relay workshop test values and the normally required values. Assess the need for and carry out readjustment as required.

- Following rerailing work the requirements described in PR S 40026 are also to be observed.

- When track circuit readjustment is required proceed as stipulated in Section 5.1. When a track circuit is readjusted a Drop Shunt Test is also required as well as a Fixed Shunt Test.

- Whenever both track circuit feed wires and relay wires are disconnected and reconnected, perform a Polarity Test between adjacent track circuits requiring polarity reversal.

- Whenever track circuit feed wires or relay wires have been reconnected, or a 50 Hz ac track feed transformer has been changed, the track relay shall be observed to pick up correctly to ensure that there has been no change to the circuit polarity.

- Whenever the polarity of power supply transformers or wiring feeding the track circuits is subject to change, perform a Polarity Test between adjacent track circuits requiring polarity reversal which are fed from different power supplies.

- When investigating no cause found failures or repeat failures, testing shall be performed in accordance with guidelines or as instructed by the maintenance signal engineer or as otherwise deemed required to eliminate any potential cause

- Whenever a track circuit is newly installed, a full suite of tests shall be performed in accordance with the relevant track circuit set-to-work manual

- Following an incident, perform specific tests as directed by the investigating signal engineer

- Following a period of track non-use the additional procedures described in PR S 40007 shall be observed.
8 Microtrax

8.1 Maintenance

The maintenance of Microtrax shall be conducted to relevant Technical Maintenance Plan (TMP) and in conjunction with the maintenance of the associated Microlok II cardfile and power supply as per PR S 40038.

8.2 Shunt tests

Track circuit shunt tests are to be performed as per Section 4.2.2. The track circuit energised condition at each end is indicated by an illuminated red LED on the respective end CPU card which extinguishes when the track is shunted.

The track condition at the Slave end shall be observed for shunting in all instances; the Master end is only observed to shunt when applied at the Master end. With the shunt applied observe the ‘Trk Margin’ display on the CPU card. A zero percent (0%) margin level, shown as a display of ‘0000’, indicates the track is de-energised. The track LED on the CPU card will be extinguished. The shunt shall be left in position for at least 30 seconds to ensure the occupancy indication remains constant.

Note: One of the checks Microtrax performs on the incoming message is to confirm the ‘power’ in each received message approximates that of previous messages. It is possible, when first placing a shunt on the track, for the track circuit to shunt briefly only for it to re-energise on the following messages. The track fails as a result of the difference in power levels in successive received messages when the shunt is first applied. On the provision that the shunt value is high enough that the message at the slave is still valid, the track will then re-energise as the power contained in each subsequent message will be roughly the same, albeit with a lower margin level.

8.2.1 Fixed Shunt Test

Three sets of shunts shall be made at the following points:-

- Master End: Observe both the Master and Slave end CPU card track LEDs.
- Mid-Track: Observe the Slave end CPU card LED. (Mid-Track shunt only required for the initial and subsequent certification and for Level Three Inspection, Test and Maintenance).
- Slave End: Observe the Slave end CPU card LED and ‘Trk Margin’ display.

The value of the fixed shunt resistor is provided in Table 1.

8.2.2 Drop Shunt Test

The Drop Shunt Test is conducted at the Slave end track connections by altering the shunt resistance and monitoring the Margin and the loss of the track circuit LED on the CPU card at the Slave end.

The closeness of the shunt value can be assessed by monitoring the Margin, with track occupancy occurring when the Margin reduces below 100%. The Slave may not register the effectiveness of the shunt for up to 12 seconds due to the duration of time needed to register the loss of message at both ends.

The acceptable drop shunt resistance values are provided in Table 1.
8.2.3 **Train Shunt Check**

The train shunt is checked at the Slave end by observing the level of the Master signal being received by the Slave. This is shown by:

- The maximum and minimum DC voltage on a digital voltmeter measured at the track terminals of the Slave track interface panel.
- The Track Signals LEDs.
- The margin on the CPU card display.

A digital voltmeter on a low Vdc scale set to maximum and minimum recording should be connected to the track terminals in the Slave end track interface panel. The value of the largest maximum or minimum readings (disregarding the negative sign) should not be greater than the Maximum Train Shunt value of Table 2 when the track is shunted by the train.

The Microlok II event log can also be reviewed to identify if any messages were received by the Slave.

8.3 **Polarity**

Microtrax track circuits have a design polarity for each rail. A mismatch of polarity between the Master and Slave will result in a failure of the track circuit through the inability for the Slave to respond to the message from the Master.

Rail polarity shall be checked at each end to comply with the Track Insulation Plan and to confirm adjacent tracks (if present) have opposite polarity.

The terminals of the track interface panel are labelled with the design polarity and should be wired accordingly from the Microlok II.

The track polarity can only be changed by reversing the track cables at the Track Interface Panel.

8.4 **Adjustment**

Adjustment to the track shall only be performed by authorised signalling personnel using a laptop computer loaded with the Microlok II Maintenance Tools and after consultation with the maintenance signal engineer.

The fixed resistor mounted in each end track interface panel is used to achieve the correct drop shunt in the margin range. It is recorded on the track circuit history card and is specific for each track circuit. The fixed resistor shall not be changed unless authorised by signalling engineering personnel of Engineering System Integrity Division.

It is essential that both Master and Slave ends are configured to the same length and have the same value track resistors mounted in the track interface panels.

**Wiring from the Microtrax unit to the track interface panel should not be short-circuited or open-circuited while the Microtrax unit is in operation.**

The Microtrax unit shall be turned OFF at both ends before interfering with this wiring. Failure in doing so will place the Microtrax unit in selective shut down mode.
8.5 Microlok II Application Data Change

Upload of the Microlok II CPU application data can result in a loss of the Microtrax track length settings held in the configuration chip. When the current data is uploaded to a new CPU card the track setting are not affected, but when new version data is loaded, the configurations settings are set to default levels.

In conjunction with any application data upload the following actions are required:

1. Before any data change the track lengths stored in the board configuration and the current margin are to be recorded.
2. After the data change the track length settings are to be confirmed to the correct or entered into the configuration if at default levels
3. The track margin is to be confirmed to be approximately the same as the previous setting
4. A Fixed Shunt Check is to be performed at the end with the data change

When the data change is due to a failed CPU and no visibility of the existing settings is available, the most recent track circuit history card readings are to be used for the track length settings. If necessary, reference is to be made to the settings at the other end of the Microtrax.

9 EBI Track 200 AF track circuit

The ET200 digital transmitter and receiver are installed as an upgrade or replacement for the analogue units on the standard ML/TI21 track circuit. Both the digital receiver and transmitter are compatible with the analogue ML/TI21 track equipment, with the exception of DPUs which shall not be connected to a digital receiver. The digital receiver shall only be used with an ET200 digital transmitter.

There is only one version of the ET200 receiver for use with all four track frequencies. The receiver is assigned its designated frequency during the set up process through use of the specified frequency key.

The receiver set up process requires the use of a **frequency key** to assign frequency and a **set-up key** to carry out the receiver operational threshold adjustment with a specified value of **set-up shunt**.

Guidelines GL S 43000 (ET200 Receiver) and GL S 43001 (ET200 Transmitter) provide information on the installation and operation of the ET200 units.

The maintenance of ET200 receiver fitted track circuits should be conducted in accordance with the TMP for 'Track Circuits - Audio Frequency - ET200'. This has standard jobs common to both ML/TI21 and ET200 track circuits and the tasks specific to each type are indicated accordingly.

Fixed Shunt Test, Drop Shunt Test and set-up shunts are conducted when scheduled in the TMP and as required, refer to Section 4.2.2 and Section 9.3.

Signalling personnel currently accredited in ML/TI21 can attain ET200 accreditation by completing the briefing session and assessment.

Signalling personnel obtain a set-up key by holding level 1 competency in ML/TI21 and being assessed competent after attending the ET200 briefing.

Refer to PR S 40048 for the management of frequency and set-up keys.
9.1 Labelling of ET200 Transmitter and Receiver Plug Cabling

The cable plugs for the transmitter and receiver are not individually coded for each frequency and in some instances can be inserted reversed in the socket. To avoid incorrect plug insertion in a transmitter or receiver, wiring to the plug is to be kept as short as possible and the cables to each plug are to be labelled with the track circuit name and relevant module.

9.2 ET200 Receiver Set-up

The receiver set-up is detailed in the set-to-work and certification procedure PR S 41500 and ET200 guidelines GL S 43000 and GL S 43001.

The ET200 is set up and adjusted using the auto-set operation of the receiver with a designated set-up shunt connected to the rail at the receiver end tuning unit connections of the track circuit. The auto-set calibrates the receiver at this input current level which is then referred to as the threshold current. After set-up, a receiver current level above the threshold will cause the receiver to indicate 'PICK' while current below the threshold will cause the receiver to indicate 'drop'. The receiver output to the track relay is through a track stick circuit (if fitted).

The receiver input current for the track circuit history card is to be read from the receiver display on 'Inow' and then 'AV'. This value is checked against a voltage measurement across terminals TP1 & IP1 taken with a frequency selective meter. The two values shall be confirmed to be approximately the same and any discrepancies investigated. This requirement to check the receiver display against the meter reading applies to receiver current for threshold (on set-up only), unoccupied, fixed shunt and zero feed readings.

The threshold current can only be measured with the set-up shunt connected to the receiver end of the track. When the threshold current is required for subsequent maintenance inspections and no set up is conducted, only the 'Ith' (current threshold) value from the display is required.

9.3 Resetting of ET200 Receivers

A reset of the ET200 receiver threshold using the auto-set operation with set-up shunt is required in the following circumstances:

- When the track is initially certified or recertified.
- When the receiver is replaced.
- When a frequency key is changed.
- When the drop shunt, in dry conditions, is less than 0.8 Ω (1 Ω setup) or 1.3 Ω (1.5 Ω setup) or is significantly different to previous readings (consultation with maintenance signal engineer required). The drop shunt value will go higher in wet ballast conditions and should be rechecked once the ballast has dried.
- When adjusting a sagging track circuit.
- When required in a service schedule of the TMP.
- Upon advice from the maintenance signal engineer.
9.4 Set-up shunt value

The set-up shunt is used in the auto-set adjustment procedure to produce the required receiver threshold current value. This is the value of receiver current at which the receiver will transition between picking and dropping. The receiver should be set up with ballast in a dry condition if possible, as changes in ballast resistance, predominately due to rainfall, can result in an unacceptably over-energised receiver upon the track drying.

Table 3 contains the set-up shunt resistance values for both normal and low power transmitter settings for various track lengths for:

- Standard set-up: tracks with good ballast in dry or damp conditions (column 3)
- Low ballast resistance set-up: Tracks with poor ballast or excessively wet conditions (column 4).

<table>
<thead>
<tr>
<th>Track Length Metres</th>
<th>Transmitter Tuning Unit Power Setting</th>
<th>Standard Receiver Set-up Shunt Value dry/damp/good ballast condition Ω</th>
<th>Low Ballast Resistance Receiver Set-up Shunt Value very wet/poor ballast condition Ω</th>
</tr>
</thead>
<tbody>
<tr>
<td>50-250</td>
<td>Low</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>200-800</td>
<td>Normal</td>
<td>1.0</td>
<td>1.2</td>
</tr>
<tr>
<td>&gt;800</td>
<td>Normal</td>
<td>1.0</td>
<td>1.4</td>
</tr>
</tbody>
</table>

Track circuits set up with other than the standard value of 1.0 Ω/1.5 Ω (normal/low power) shunts will need to be monitored and have the drop shunt re-checked once the track returns to a dry condition. A drop shunt measured below 0.8 Ω requires the receiver to be reset using the standard set-up shunt value.

9.5 Adjustment of sagging tracks

An ET200 track circuits found to be sagging where the unoccupied receiver current is measured to be very close to the recorded threshold current, is to be thoroughly investigated prior to any adjustment in accordance with Section 5.1.

An ET200 assessed to be sagging due to track conditions is to be adjusted in the following manner:

- Confirm that the unoccupied receiver current is approximately the same as the threshold current (Ith).
- Investigate the conditions and operation of the track circuit to identify any external causes for the sagging track. Rectify if possible and recheck track circuit adjustment. If the cause of the track sagging is uncontrollable (e.g. substandard ballast affected by excessively wet conditions) continue as follows:
  1) Fit a shunt box set to 2.9 Ω at the receiver end of the track circuit and reset the receiver using the auto-set operation. Measure and record the new threshold current. (This should result in about 10% decrease to the previously recorded threshold current).
  2) Remove the shunt box and confirm the receiver current is now greater than the threshold current and the receiver picks.
3) Measure and record all readings on the track circuit history card. The drop shunt under these conditions may be greater than 2.9 Ω.

4) Record on the track circuit history card that the re-adjustment of the receiver was to a 2.9 Ω set-up shunt.

5) The track drop shunt should be regularly monitored as the ballast condition improves and the receiver reset if the drop shunt falls below 0.8 Ω.
## Appendix A  Sample Track Circuit History Cards

### 50 Hz A.C. TRACK CIRCUITS

<table>
<thead>
<tr>
<th>50Hz A.C. TRACK CIRCUITS</th>
<th>TRACK CIRCUIT HISTORY CARD</th>
<th>TRACK: __________________________</th>
</tr>
</thead>
<tbody>
<tr>
<td>SINGLE RAIL</td>
<td></td>
<td>LENGTH: ________________________ m</td>
</tr>
<tr>
<td>DOUBLE RAIL</td>
<td></td>
<td>NUMBER OF IMPEDANCE BONDS * __________</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IMPEDANCE BOND TYPE * __________</td>
</tr>
</tbody>
</table>

### TRACK FEED *

<table>
<thead>
<tr>
<th>STORE 37 (100VA)</th>
<th>STORE 45 (200VA)</th>
<th>STORE 47 (200VA)</th>
<th>W.R.E (250VA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VT1</td>
<td>W.B. S.R.</td>
<td>SIG.BCH S.R.</td>
<td>D.R. RESONATED BOND</td>
</tr>
<tr>
<td></td>
<td>0.25Ω</td>
<td>0.25Ω</td>
<td>0.25Ω</td>
</tr>
</tbody>
</table>

### RELAY TYPE *

<table>
<thead>
<tr>
<th>DATE</th>
<th>SERIAL No</th>
<th>P.U. VOLTS</th>
<th>COMPL VOLTS</th>
<th>D.A. VOLTS</th>
</tr>
</thead>
</table>

### TEST SHUNT *

<table>
<thead>
<tr>
<th>DATE</th>
<th>SERIAL No</th>
<th>P.U. VOLTS</th>
<th>COMPL VOLTS</th>
<th>D.A. VOLTS</th>
</tr>
</thead>
</table>

### CHANGE OF RELAYS

<table>
<thead>
<tr>
<th>DATE</th>
<th>SERIAL No</th>
<th>P.U. VOLTS</th>
<th>COMPL VOLTS</th>
<th>D.A. VOLTS</th>
</tr>
</thead>
</table>

### TRACK:

<table>
<thead>
<tr>
<th>DATE</th>
<th>SERIAL No</th>
<th>P.U. VOLTS</th>
<th>COMPL VOLTS</th>
<th>D.A. VOLTS</th>
</tr>
</thead>
</table>

### CHECKS

- [ ] Ballast Condition
- [ ] Service Schedule
- [ ] Dummy or Not
- [ ] Dry/Wet
- [ ] Dummy or Not
- [ ] Service Schedule

### SAMPLE

![Sample Track Circuit History Card](image_url)
## 50Hz A.C. DOUBLE RAIL TRACK CIRCUIT - SAFETY INSPECTION

<table>
<thead>
<tr>
<th>DATE (DD/MM/YY)</th>
<th>FEED END</th>
<th>RELAY END</th>
<th>CHECKS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Maltes Supply Voltage</td>
<td>Field Voltage</td>
<td>Rail Current</td>
</tr>
<tr>
<td></td>
<td>(V)</td>
<td>(V)</td>
<td>(A)</td>
</tr>
<tr>
<td></td>
<td>UP</td>
<td>DN</td>
<td>UP</td>
</tr>
</tbody>
</table>

(1) CHECK RAIL CURRENTS ARE WITHIN ESA.
(2) RECORD VOLTAGE FROM RAIL TO NEUTRAL ON DOUBLE RAIL ELECTRIFIED TRACKS.
*Where applicable:* PLACE CROSS AGAINST APPROVED TYPE.

**Remarks**
- Service Schedule (SS01, SS02, SS03, etc.)
- Name or initials & Signature of Testing Officer

**Sample Table:**

<table>
<thead>
<tr>
<th>TRAM:</th>
<th>Remarks</th>
<th>Tested by</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# UM71 (CSEE) T1 TRACK CIRCUITS

## Track Circuit History Card

<table>
<thead>
<tr>
<th>DATE</th>
<th>Transmitter End</th>
<th>Receiver End</th>
<th>Equipment</th>
<th>Test Date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Remarks:**
- Service Schedule
- Commission
- Last Inspected

---

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Date in Force: 10 January 2018
Prepared using: TP ESI 003 V1.8

UNCONTROLLED WHEN PRINTED

Version 3.0
UM71 (CSEE) T2 TRACK CIRCUITS

CSEE T2 Track Circuits (for ESR)  TRACK CIRCUIT HISTORY CARD

<table>
<thead>
<tr>
<th>DATE</th>
<th>TRANSMITTER END</th>
<th>RECEIVER END</th>
<th>Tests</th>
<th>Remarks</th>
<th>Tested by</th>
</tr>
</thead>
<tbody>
<tr>
<td>DD/MM/YY</td>
<td>Location ID</td>
<td>Location ID</td>
<td>0-150 Shunt Test</td>
<td>Service Schedule</td>
<td>Name (or Initials) &amp; Signature of Testing Officer</td>
</tr>
<tr>
<td>DC Supply</td>
<td>Tx Serial No</td>
<td>DC Supply</td>
<td>Rx Serial No</td>
<td>DCU</td>
<td>Rx Serial No</td>
</tr>
</tbody>
</table>

Any additional information needed (sketch of track, location IDs, equipment positioning, bonds etc)

Impedance Bonds on track:
- Tx end
- Rx end
- Mid point

Impedance:
- Re measured (V/V)
- Test Cap. (F)
- Cap/ohms (V)

CSEE T2 Track Circuits

© Sydney Trains
Date in Force: 10 January 2018
Prepared using: TP ESI 003 V1.8
## WBS FS2500 TRACK CIRCUITS

**WBS FS2500 TRACK CIRCUITS**

**TRACK CIRCUIT HISTORY CARD**

<table>
<thead>
<tr>
<th>Track</th>
<th>Impedance Bonds on track?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Track Length**: __________ m
- **Frequency**: __________ Hz
- **Tx Output Level**: % HI / LO

### Date

<table>
<thead>
<tr>
<th>Location ID:</th>
<th>Transmitter End</th>
<th>Receiver End</th>
<th>Remarks</th>
<th>Tested by</th>
</tr>
</thead>
<tbody>
<tr>
<td>DD/MM/YY</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Transmitter End

- **Location ID**: __________
- **Transmitter**: __________
- **Number**: __________
- **DC Supply**: __________
- **Tx Vols Across T1/T2**: __________
- **PU**: __________
- **Serial Number**: __________
- **Amp Set**: __________
- **Voltage**: __________
- **Amp Set**: __________
- **Voltage**: __________

### Receiver End

- **Location ID**: __________
- **Rx Set**: __________
- **Rx Vols Across T1/T2**: __________
- **Monitor Vols**: __________
- **Rx Set**: __________
- **Rx Vols Across T1/T2**: __________
- **Unoccupied**: __________
- **With short circuit**: __________
- **Zero Feed**: __________

---

**Sample**
### RECEIVER SENSITIVITY ADJUSTMENT TABLE

<table>
<thead>
<tr>
<th>SENS</th>
<th>CONNECT</th>
<th>BRIDGE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A to</td>
<td>B to</td>
</tr>
<tr>
<td>1.65</td>
<td>+45</td>
<td>-5 +15 +15 to -6</td>
</tr>
<tr>
<td>1.60</td>
<td>-45</td>
<td>+15 +45 to -15</td>
</tr>
<tr>
<td>1.55</td>
<td>-45</td>
<td>-5 +25 to -15 +15 to -5</td>
</tr>
<tr>
<td>1.50</td>
<td>-45</td>
<td>+5 +45 to -5</td>
</tr>
<tr>
<td>1.45</td>
<td>-45</td>
<td>+45</td>
</tr>
<tr>
<td>1.40</td>
<td>-45</td>
<td>-5 +15 to -5</td>
</tr>
<tr>
<td>1.35</td>
<td>-45</td>
<td>+5 +45 to -15 -15 to -5</td>
</tr>
<tr>
<td>1.30</td>
<td>-45</td>
<td>-15 +45 to -15</td>
</tr>
<tr>
<td>1.25</td>
<td>-45</td>
<td>-5 +45 to -15 -15 to -5</td>
</tr>
<tr>
<td>1.20</td>
<td>-15</td>
<td>+15 to -6</td>
</tr>
<tr>
<td>1.15</td>
<td>-15</td>
<td>+15 to -5</td>
</tr>
<tr>
<td>1.10</td>
<td>-15</td>
<td>+15 to -5</td>
</tr>
<tr>
<td>1.05</td>
<td>-5</td>
<td>+5</td>
</tr>
<tr>
<td>1.00</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td>0.95</td>
<td>-5</td>
<td>-5</td>
</tr>
<tr>
<td>0.90</td>
<td>+15</td>
<td>+5 -15 to -5</td>
</tr>
<tr>
<td>0.85</td>
<td>+15</td>
<td>-15</td>
</tr>
<tr>
<td>0.80</td>
<td>+15</td>
<td>-5 -15 to -5</td>
</tr>
<tr>
<td>0.75</td>
<td>+45</td>
<td>+5 -45 to -15 +15 to -5</td>
</tr>
<tr>
<td>0.70</td>
<td>+45</td>
<td>+15 -45 to -15</td>
</tr>
<tr>
<td>0.65</td>
<td>+45</td>
<td>-5 -45 to -15 +15 to -5</td>
</tr>
<tr>
<td>0.60</td>
<td>+45</td>
<td>+5 -45 to -5</td>
</tr>
<tr>
<td>0.55</td>
<td>+45</td>
<td>-5 -45 to -5</td>
</tr>
<tr>
<td>0.50</td>
<td>+45</td>
<td>-5 -45 to -6</td>
</tr>
<tr>
<td>0.45</td>
<td>+45</td>
<td>+5 -45 to -15 -15 to -5</td>
</tr>
<tr>
<td>0.40</td>
<td>+45</td>
<td>-15 -45 to -15</td>
</tr>
<tr>
<td>0.35</td>
<td>+45</td>
<td>-5 -45 to -15 -15 to -6</td>
</tr>
</tbody>
</table>

### GUIDE TO Tx OUTPUT LEVEL ADJUSTMENT

<table>
<thead>
<tr>
<th>Nominal Track Circuit Length</th>
<th>Tx Output Level</th>
<th>Output Number</th>
<th>Terminals Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 - 250 m</td>
<td>20%</td>
<td>1 (LO)</td>
<td>1 and 2</td>
</tr>
<tr>
<td>250 - 450 m</td>
<td>40%</td>
<td>2</td>
<td>1 and 3</td>
</tr>
<tr>
<td>450 - 600 m</td>
<td>60%</td>
<td>3</td>
<td>3 and 4</td>
</tr>
<tr>
<td>600 - 750 m</td>
<td>60%</td>
<td>4</td>
<td>2 and 4</td>
</tr>
<tr>
<td>750 - 900 m</td>
<td>100%</td>
<td>5 (Thr)</td>
<td>1 and 4</td>
</tr>
</tbody>
</table>

*The Screen Terminal is Earthed*
JEUMONT SCHNEIDER TRACK CIRCUITS

<table>
<thead>
<tr>
<th>Location ID:</th>
<th>DATE</th>
<th>Power Supply</th>
<th>PSU Serial number</th>
<th>Transmitter END</th>
<th>Location ID:</th>
<th>Receiver END</th>
<th>Remarks</th>
<th>Tested by:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Location ID:</th>
<th>DATE</th>
<th>Power Supply</th>
<th>PSU Serial number</th>
<th>Transmitter END</th>
<th>Location ID:</th>
<th>Receiver END</th>
<th>Remarks</th>
<th>Tested by:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**TRACK CIRCUIT HISTORY CARD**

<table>
<thead>
<tr>
<th>Track Voltage</th>
<th>Rx Voltage</th>
<th>Rx Type</th>
<th>Total Tx Loop Resistance</th>
<th>Test Shunt</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Any additional information needed ( UWJLq, location XYZ, unusual equipment positioning, transition zones, bands, etc.)

**JEUMONT SCHNEIDER Track Circuits**

- DOUBLE RAIL: □
- SINGLE RAIL: □
- TRACK LENGTH: _______ m
- Tx LOOP RESISTANCE: _______ Ω

**Track Circuits**

- Rx TYPE: RVT600
- TOTAL Tx LOOP RESISTANCE: 200 Ω
- TEST SHUNT: 0.50 Ω

[Sample image of the track circuit history card]
### Track Circuit Test Sheet

<table>
<thead>
<tr>
<th>Track:</th>
<th>Location:</th>
<th>Transmitter End</th>
<th>Receiver End</th>
</tr>
</thead>
<tbody>
<tr>
<td>DATE</td>
<td>Location ID</td>
<td>Power Supply</td>
<td>Mains Supply (V)</td>
</tr>
<tr>
<td>COMWAY</td>
<td></td>
<td>Input Serial number</td>
<td>(V)</td>
</tr>
</tbody>
</table>

**Notes:**
- [Sample Track Circuit Test Sheet]
- [Version: April 2003]
- [Stock Code: 1189546]
ML/ABB/ADTRANZ TI 21 TRACK CIRCUITS (ANALOGUE RECEIVER)

<table>
<thead>
<tr>
<th>ML/ABB/ADTRANZ TI 21 TRACK CIRCUITS</th>
<th>TRACK CIRCUIT HISTORY CARD</th>
<th>TRACK:</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRACK LENGTH: __________ m</td>
<td>Any additional information (length of track, location, distances, equipment position, bonds, etc.)</td>
<td></td>
</tr>
<tr>
<td>FREQUENCY: __________ Hz</td>
<td>Impedance Bonds on track?</td>
<td></td>
</tr>
<tr>
<td>Tx OUTPUT LEVEL: __________ HI / LO</td>
<td>Reas. (Y/N)</td>
<td>Tx end</td>
</tr>
<tr>
<td></td>
<td>Rx Cap. [pF]</td>
<td>Rx end</td>
</tr>
<tr>
<td></td>
<td>Cap. [V]</td>
<td>Wor.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DATE</th>
<th>TRANSMITTER END</th>
<th>RECEIVER END</th>
<th>Tests</th>
<th>Remarks</th>
<th>Tested by</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Location ID</td>
<td>Location ID</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tx Serial Number</td>
<td>PSU Serial Number</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>DC Output (Compressed)</td>
<td>Amp Serial Number</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(V)</td>
<td>Amp Gain [mV]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>DC Volts [mV]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(V)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**SAMPLE**

TE21 TC History card 2010; (Page 1/2)  Version: April 2003  Stack code: 1885938
### Track Circuits PR S 40025

**Date in Force:** 10 January 2018  
**Version:** 3.0  
**Prepared using:** TP ESI 003 V1.8

---

**Table:**

<table>
<thead>
<tr>
<th>Date</th>
<th>Transmitter End</th>
<th>CPU (For Tracks with Intermediate Receiver Only)</th>
<th>Receiver End</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>TX Serial No</td>
<td>PSU Serial No, Amp Serial No, Amp Gain (mA)</td>
<td>TX Serial No</td>
</tr>
<tr>
<td></td>
<td>DC Supply (V)</td>
<td>Re Input Current (mA)</td>
<td>DC Supply (V)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Re Input Current (mA)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>T/T2</td>
<td>T/T2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PSU Serial No, Amp Serial No, Amp Gain (mA)</td>
<td>PSU Serial No</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DC Supply (V)</td>
<td>DC Supply (V)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Re Input Current (mA)</td>
<td>Re Input Current (mA)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>T/T2</td>
<td>T/T2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PSU Serial No, Amp Serial No, Amp Gain (mA)</td>
<td>PSU Serial No</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DC Supply (V)</td>
<td>DC Supply (V)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Re Input Current (mA)</td>
<td>Re Input Current (mA)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>T/T2</td>
<td>T/T2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PSU Serial No, Amp Serial No, Amp Gain (mA)</td>
<td>PSU Serial No</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DC Supply (V)</td>
<td>DC Supply (V)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Re Input Current (mA)</td>
<td>Re Input Current (mA)</td>
</tr>
</tbody>
</table>

**Track:**

0.150 Shield Check (OK)  
Ballast Condition (Grounded: Poor/Drained)  
Service schedule (123.00 / 123.20)  
Name or Initials & Signature of Testing Officer

---

**Diagram:**

**Typical Connection for the Gain = 2**

**Gain**

1. Input 1: 1L, 1H  
2. Input 2: 3L, 3H

**Input Wiring**

<table>
<thead>
<tr>
<th>Input</th>
<th>Bridge</th>
<th>Bridge</th>
</tr>
</thead>
<tbody>
<tr>
<td>1L</td>
<td>1H</td>
<td></td>
</tr>
<tr>
<td>3L</td>
<td>3H</td>
<td>1H - 3H</td>
</tr>
<tr>
<td>5L</td>
<td>1H</td>
<td>1H - 3H</td>
</tr>
<tr>
<td>7L</td>
<td>3L</td>
<td>3H - 9H</td>
</tr>
<tr>
<td>9L</td>
<td>1H</td>
<td>1H - 3H</td>
</tr>
<tr>
<td>10L</td>
<td>3L</td>
<td>3L - 9H</td>
</tr>
<tr>
<td>11L</td>
<td>1H</td>
<td>1H - 3H</td>
</tr>
<tr>
<td>12L</td>
<td>3L</td>
<td>3L - 9H</td>
</tr>
<tr>
<td>13L</td>
<td>1H</td>
<td>1H - 3H</td>
</tr>
</tbody>
</table>

---

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Date in Force: 10 January 2018  
Prepared using: TP ESI 003 V1.8  
Version 3.0

UNCONTROLLED WHEN PRINTED  
Page 41 of 49
## TI 21 ET 200 TRACK CIRCUITS (DIGITAL RECEIVER)

**Track Circuit History Card**

<table>
<thead>
<tr>
<th>DATE</th>
<th>TRANSMITTER END</th>
<th>RECEIVER END</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Remarks Service Schedule</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Location ID:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tx No:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tx Design (V)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PSM (V)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TU (V)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PS (V)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Rx (V)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>DC Supply (V)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Set-up (Ohm)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fixed Shunt (Ohm)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fixed Shunt (mA)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fixed Shunt (A)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RX (V)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>DC Supply (V)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Set-up (Ohm)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fixed Shunt (Ohm)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fixed Shunt (mA)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fixed Shunt (A)</td>
<td></td>
</tr>
</tbody>
</table>

*WARNING: IF LIMIT(Tx) & LIMIT(Rx) are installed, around 115V would appear on feed cable & at terminals.*

---

**continued on back**

*Version: September 2013*
## WBS FS2600 TRACK CIRCUITS

### FS2600 TRACK CIRCUITS

- SINGLE RAIL
- DOUBLE RAIL (Using Track Interface Unit with impedance bondtype M25)

<table>
<thead>
<tr>
<th>TX Serial Number</th>
<th>Rx Serial Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tx Output terminals</td>
<td>Rx Sensitivity</td>
</tr>
<tr>
<td>Tx set to double rail = low</td>
<td>Links on configuration</td>
</tr>
</tbody>
</table>

### TRACK CIRCUIT HISTORY CARD

- TRACK LENGTH: ____ m
- CHANNEL: _____

### TRACK:

Any additional information needed (track, location, IDs, distances, equipment positioning, bonds, etc.)

### CHECKS

- Fixed Shunt Test: OK
- Bond/ Rail Connections: OK
- Insulated Joint Detection: OK
- Lightning Protection: OK

### REMARKS

- Ballard Condition: Good
- Service Schedule: (8:00, 8:30, 9:00, 9:30, etc.)
- Tested By: Name or Initial & Signature of Testing Officer

---

**Sample Track Circuit History Card**

[Image of sample track circuit history card]

---

**FS2600 QC History Card 2010, Page 1/2**

**Version: April 2010**

**Track code: 1815920**

---

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Date in Force: 10 January 2018

Prepared using: TP ESI 003 V1.8
## FS2600 Track Circuits

### Track Circuit History Card

<table>
<thead>
<tr>
<th>Date</th>
<th>Transmitter Location</th>
<th>Receiver/Relay End Location</th>
<th>Checks</th>
<th>Remarks</th>
<th>Tested By</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Supply Voltage (DC110V)</td>
<td>Track Voltage</td>
<td>Rf Input Voltage</td>
<td>Monitor Voltage</td>
<td>Drop Shunt</td>
</tr>
<tr>
<td></td>
<td>(85-121V) (V A C)</td>
<td>(3.3-20V)</td>
<td>(V)</td>
<td>(V)</td>
<td>(3-12V)</td>
</tr>
</tbody>
</table>

**SAMPLE**
# MICROTRAX TRACK CIRCUIT

**MICROTRAX TRACK CIRCUIT HISTORY CARD**

<table>
<thead>
<tr>
<th>Date</th>
<th>Comments</th>
<th>Track length setting (’000 ft)</th>
<th>Location 120v</th>
<th>12V Supply Volts</th>
<th>Margin</th>
<th>Drop Shut 0 (slave end only)</th>
<th>0.25Ω Shunt Test</th>
<th>Polarity Check (ok)</th>
<th>Test Equipment Used (Type &amp; Ser. No.)</th>
<th>Ballast condition</th>
<th>Name &amp; Signature</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Comissioned</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Last test</td>
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<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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Date in Force: 10 January 2018
Prepared using: TP ESI 003 V1.8

UNCONTROLLED WHEN PRINTED

Version 3.0
**RESONATED IMPEDANCE BOND CAPACITOR HISTORY CARD**

(The card to be held at the Rx end of the track location (______) TOWN: __________ TRACK: _________)

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![Diagram of track circuit positions]

Version: February 2017  
Code/Sheet: 1866935
## Track Circuits PR S 40025

**DATE**

**IMPEDANCE**

**POSITION ON THE TRACK**

**CAPACITANCE**

**VOLTAGE ON**

**BALLAST**

**NAME & CONDITIONS**

**SIGNATURE**

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**LOCATION**

**TRACK NAME**

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### LOGICAL SAMPLE

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**SAMPLE DIAGRAM**

- **Tx**
- **Near Tx**
- **Mid Track (one or both)**
- **Near Rx**
- **Rx**

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**Version:** February 2017

**Code Stock:** 188698

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Date in Force: 10 January 2018

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UNCONTROLLED WHEN PRINTED
Engineering Procedure
Signalling and Control Systems

Signalling Safeworking

PR S 40026

Rerailing - Precautions to be Taken

Version 2.0

Date in Force: 8 March 2019
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Summary of changes from previous version

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<td>Added Referenced documents section</td>
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<tr>
<td>Expand attendance to where ETCS equipment needs to be moved or removed and where potential to impact operation of level crossing</td>
<td>4</td>
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<td>Include ETCS trainstops and caution that they cannot be suppressed</td>
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<td>Traction return made into general precaution with details moved to PR S 40027</td>
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<td>Added precautions for re-railing related to ETCS balises and cables.</td>
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<td>Add ETCS reference into applicable circumstances restriction</td>
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1 Introduction

When rerailing or during other trackwork activities that involve breaking the rail occurs on track circuited, ETCS areas (including ASDO areas) or in electrified areas, certain precautions shall be taken to ensure all the risks associated with the work are understood and controlled. Generally these precautions include the following:

- Protection of trains.
- Provision of alternative arrangements for traction return.
- Testing and certification of affected track circuits and associated signalling.
- Ensuring an effective track shunt.
- Correct location, installation and certification of ETCS balises.
- Certification of infrastructure for operational use.

2 Scope

This document outlines the general precautions that apply when rerailing, however they are also applicable to many other types of trackworks that may impact traction return, rail vehicle detection systems or ETCS equipment.

3 Reference documents

These precautions shall be read in conjunction with the following referenced documents:

- PR S 40002 Bridging or False Feeding of Signalling Circuits.
- PR S 40008 Booking Signalling Equipment Out of and Into Use.
- PR S 40009 Disconnection of Signalling Apparatus.
- PR S 40011 Renewals Work
- PR S 40025 Track Circuits.
- PR S 40027 Traction Return (1500V DC).
- PR S 40028 Automatic Train Protection – Alstom ETCS Trackside
- PR S 47118 Typical Signal Support Procedures for Trackworks
- MN S 41604 Alstom ETCS Trackside Maintenance Manual

4 Authorisation and Attendance

Planned rerailing work requiring a track possession is carried out in accordance with Network Rules and Network Procedures.

Licensed signalling personnel shall attend whenever there is replacement of rail in the following cases:

- Where the interlocking will be impacted by the work
- At points, in any intermediate location outside an interlocking.
- In plain track areas, where the length of rerailing is six metres or more.
- In single line electrified areas.
- In the vicinity of insulated joints, tuned loops or any other track interface, including short sections of rail in the vicinity of the clearance point between converging tracks.
- Where there is the potential for the operation of a level crossing to be impacted by the work.
- Outside sub-stations and sectioning huts.
- Wherever there is potential for traction bonding or track circuit cabling to be interfered with by the work.
- There is a requirement to move (beyond the permitted tolerance from the designed position) or remove ETCS equipment (such as balises).

When licensed signalling personnel are required to attend re-railing, they shall protect rail traffic and signalling equipment from the work by undertaking the following tasks:

- considering the effects caused on the signalling system by the work
- compiling the infrastructure booking authority
- booking protecting signals out of use
- providing an alternative path for traction return current, as necessary
- disconnecting affected track circuits
- disconnecting associated signalling equipment

At the end of the work, licensed signalling personnel shall reinstate and test the affected ETCS equipment and track circuits. They shall also ensure that the rail surfaces are sufficiently clean to provide an effective track shunt. Associated signalling shall be functionally tested before restoring the signalling back into use.

Where it is not necessary for licensed signalling personnel to attend trackwork (as described in Sections 6.1 and 6.2 of this procedure), Temporary Rail Bonds are authorised by a maintenance signal engineer for use by the Civil Discipline representative in accordance with these procedures. The Civil Discipline representative shall be properly instructed and qualified in the use of the Temporary Rail Bonds. Refer to Section 6 of this procedure for more detail.

## 5 Precautions

### 5.1 Prior to the Commencement of Rerailing Work

#### 5.1.1 Affected Apparatus

Prior to commencement of the rerailing work, an Infrastructure Booking Authority (IBA) NRF 003 (IBA) form shall be compiled by licensed signalling personnel in accordance with PR S 40008 and Network Rule NWT 312 and Network Procedure NPR 704, showing the full particulars of the equipment affected and signed by the Civil and Signalling Discipline representatives. Where the Electrical Discipline is involved, the representative of that discipline shall also sign the form.

The relevant signalling apparatus shall not be disconnected until the IBA form has been signed by the Network Control Officer. Trackwork affecting the track circuit or ETCS equipment shall not commence until authorised by licensed signalling personnel in attendance. This is required to confirm the protecting signals are booked out of use, the relevant signalling apparatus has been disconnected and alternative traction arrangements (as required) have been implemented.
Disconnection of affected signalling and the placement of handsignallers shall be in accordance with PR S 40009 and the Network Rules and Network Procedures, particularly ensuring that:

- Track circuits affected by the rerail are disconnected.
- Handsignallers (where required) are positioned at their posts before the signals protecting the section where the rerailing is to take place are disconnected and maintained at stop.
- Where rerailing occurs on the overlap track circuits, the signal in the rear shall also be booked out of use.
- Trainstops, including ETCS trainstops, provided at protecting and affected signals shall be retained in the tripping position.

To reduce the impact on train services, trainstops affected by the rerailing may be suppressed after consultation with a signal engineer. Prior to implementation, the signal engineer shall risk assess and define limitations of trainstop suppression in consultation with the Network Control Officer or Possession Protection Officer. This shall include the risk of trains inadvertently passing signals at stop. The outcome of the risk assessment shall influence the number of trainstops that can be suppressed.

**CAUTION**

ETCS trainstops are not able to be suppressed.

Trainstops shall only be suppressed for rerailing where handsignallers are positioned at affected signals in accordance with Network Rules and Procedures and the track infrastructure including traction return (where applicable), is in a fit state for rail traffic to enter the worksite.

The signal engineer shall determine whether to apply temporary bridging or not. If temporary bridging is required, a temporary bridging authority to bridge out the trainstop Normal contacts shall be issued. The jumper wires shall be installed inside the trainstop. The temporary bridges shall be removed before the signal is booked back into use. Temporary bridging is to be accordance with PR S 40002.

Trainstops provided at the first approached signal to the area affected by the rerailing work shall be maintained in the trip position. Each individual trainstop (or signal with a trainstop) within the affected area that is suppressed shall have the notation “TRAINSTOP SUPRESSED” on the IBA form for the rerail. The Protection Officer for the rerail is also to be informed for the purpose of train movements through the worksite.

- When rerailing affects the operation of an automatic level crossing, the crossing shall be booked out of use.
  - Level crossing protection shall be disconnected in accordance with PR S 40009 and Network Procedure NPR 715 if not fitted with master emergency, or other similar manual override facilities.
  - Where level crossing protection is disconnected as a result of rerailing, it shall be functionally tested (by operation of each approach track circuits in turn) before the level crossing protection is booked back into use.
  - Where the level crossing is situated in double line automatic areas, and is disconnected in accordance with PR S 40009, the signals approaching the level crossing on the track not affected by the rerailing may be left working if required.
Other trackside signalling equipment affected by the re-railing shall be booked out of use, disconnected and removed clear of the trackwork as necessary, for example, points equipment and ETCS balises.

In bi-directional signalling, the immediate protecting signal in each direction shall be booked out of use and disconnected in conjunction with the track relay of the particular track affected.

Where signals other than the immediate protection signals are affected by the rerailing, and it is impractical to disconnect each signal, then it is sufficient to only book these signals out of use without the requirement to disconnect.

Where Starting signals are not directly affected by the rerailing work, then these signals may be left operational.

5.1.2 Electrified Areas

In 1500V DC electrification areas, before any interference with the rails forming part of the traction return is permitted, adequate provision shall be made for a safe return path for the traction current to the sub-station or section hut. At the same time the signalling equipment shall be safeguarded against damage due to a possible rise in traction return voltage.

5.2 PR S 40027 shall be referenced for information in relation to the precautions and safeguards which apply to traction return.

Newly Installed Rails

The surfaces of newly installed rails are most likely to be contaminated with protective coatings, rust and other contaminants. The surfaces of rails, including the running face, shall be made sufficiently clean along the entire length of track circuit in order to provide an effective track shunt.

Rail surfaces shall be clean for sections of track even as short as two metres (the wheel base of a single bogie) when that section of track is located within 15 metres (a vehicle wheel base) of an insulated rail joint between adjacent track circuits.

When insulated rail joints are renewed, a dangerous situation could arise, for example: a rear bogie of a train could come to stand on the rusty portion of the newly installed rail of an insulated rail joint that may be located just at the clearance point between two converging tracks and not be detected. Similarly, short sections of newly installed rail within a tuned loop, if critically located in respect of a clearance point might also cause problems.

In these cases, licensed signalling personnel shall request the Civil Discipline representative to grind the surface of the rail head that is in contact with the wheels for the full width of the head and along the entire length of the newly installed section of rail to clean off any protective coating, rust or other contamination and provide a shiny metallic surface for good electrical contact with the wheels.

This shall be achieved by the following methods, as applicable:

- Mechanised profile-grinding long sections of newly installed rail. The grinding shall clean any protective coating, rust or other contaminates for the full width of the rail head and along the running face for the entire section of newly installed rail.
- Hand operated rail-grinding short sections of newly installed rail. The grinding shall clean any protective coating, rust or other contaminates for the full width of the rail head and along the running face for the entire section of newly installed rail.
• Utilising the passage of trains or other rolling stock to provide a satisfactory wear band on the rail surface and running face to achieve an effective track shunt. The trains shall not operate on signals until an effective track shunt is obtained.

Following the installation of newly installed rails licensed signalling personnel shall conduct a Train Shunt Check to ensure that a train is effectively detected over the complete length of the track circuit. Trains shall operate under a manual system of safeworking, such as manual block working and not under signals, until an effective track shunt is obtained.

5.2.1 Exemption to Train Shunt Check Requirement

Where the following conditions are applied to each affected track circuit, then it will not be necessary to conduct a Train Shunt Check before restoring the track circuit back into use.

A Train Shunt Check shall be conducted if all the applicable conditions cannot be met.

The time between rail surface cleaning and trains operating over the track circuit shall be taken into consideration before certifying affected track circuits back into use, refer to PR S 40007.

5.2.1.1 Short Section of Newly Installed Rail (Not exceeding 15 metres in length and at a distance greater than 15 metres from any clearance point or adjacent track circuit insulated rail joint or tuned loop)

• No requirement to clean the rail surface
• A satisfactory Fixed Shunt Check is conducted at any point of the newly installed length of rail.

5.2.1.2 Short Section of Newly Installed Rail (Not exceeding 15 metres in length and at a distance of 15 metres or less from any clearance point or adjacent track circuit insulated rail joint or tuned loop)

• The newly installed rail has been ground along its entire length using a hand operated rail profile grinder or mechanised rail profile grinder (track machine)
• Licensed signalling personnel shall perform a visual inspection of the newly installed rail surface to prove the running face and rail surface is clean and a continuous contact band is present prior to the Civil Discipline representatives leaving site
• A satisfactory Fixed Shunt Check is conducted at any point of the newly installed length of rail.
5.2.1.3 Long Section of Newly Installed Rail (exceeding 15 metres in length)

- The newly installed rail has been fully profile-ground by a mechanised rail profile grinder (track machine)
- The grinding has been completed within 72 hours of track circuit certification
- An inspection has shown that the entire length of the newly installed rail (at the wheel contact band) is free of contamination
- For each track circuit, a satisfactory Fixed Shunt Test is conducted in the vicinity of each end and in the centre on the newly installed length of rail.

Licensed signalling personnel are to liaise with the Civil Discipline representative to ensure they are aware of the rail cleaning requirement in these instances.

5.3 Reinstatement Process following Rerailing

When the rerailing work is complete, the other relevant discipline representatives can sign-off their portion of the IBA form to certify their infrastructure. Licensed signalling personnel (when in attendance) shall test the track circuits and ETCS equipment affected by rerailing in accordance with PR S 40025 and PR S 40028 respectfully.

Testing and certification of the track circuits shall be done only after the traction return arrangements have been reinstated.

In particular, the following requirements shall be applied before the work can be certified and the signalling brought back into use:

- Ensure the track relay operates correctly and drops away freely when de-energised. Compare the values with the previous values, the track relay workshop test values and the normally required values. Assess the need for readjustment.
- If track connections have been disturbed or insulated rail joints installed, where polarity testing is applicable, testing shall be carried out to see that the tracks are of correct polarity and comply with the Track Insulation Plan.
- Carry out a Fixed Shunt Check at the relay/receiver end and measure the relay or receiver voltage before and during the Fixed Shunt Check to ensure compliance with the specific requirements and the track relay (or equivalent) is de-energised.
- Carry out a Train Shunt Check to ensure satisfactory shunting of the rails by the train wheels.
- Carry out a Zero Feed test.
- Where rerailing affects parallel bonds, licensed signalling personnel shall ensure that the parallel bonds are correctly and effectively connected after the rerailing and comply with the Track Insulation Plan. The portion of the track circuit connected via the parallel bonds shall be tested to shunt correctly.
- If trainstops have been affected by the rerailing, they shall be regauged and any temporary bridging removed.
- Where ETCS balises are removed due to trackworks, it is important that they are reinstated in exactly the same position. The rectangular balise location ID plate affixed to the sleeper adjacent to the position of the balise, and the circular balise ID plate affixed to the balise (as shown in the diagrams below) are key to this requirement.
Where the work does not require the replacement of sleepers and the balise location ID plate remains in place, the balise can be reinstated by placing it alongside the balise location ID plate.

Where the work requires the removal of a balise and the sleeper (thus the corresponding balise location ID plate as well), then it is important that both are reinstated in exactly the same position. The balise position shall be identified in accordance with the processes described in PR S 40028.

The output of reinstated balises shall be tested in accordance with the ETCS Balise Function Test described in PR S 40028.

All affected signalling shall be observed to be operational prior to being available for use.

The IBA form can then be completed and signed by licensed signalling personnel to certify signalling infrastructure. The IBA form is then provided to the Network Control Officer for sign off. Handsignalers may then be withdrawn. The maintenance signal engineer is to receive a copy of the completed IBA form for retaining on file.

6 Guidelines for the use of Temporary Rail Bonds

(Also refer Network Rule NWT 318)

6.1 Scope

These guidelines set out the circumstances under which temporary rail bonds may be applied to keep track circuits working and maintain traction return currents during trackwork, where it is necessary for the rail to be cut and where licensed signalling personnel are not required to be in attendance. Refer to Section 2 for attendance requirements.

They are designed to assist maintenance signal engineers or their specifically delegated signalling representatives in the determination of the rail bonding requirements, and define the requirements for standard temporary rail bonds.

These guidelines apply to both electrified and non-electrified areas.

Refer to PR S 40004 Section 1.7.10.3 for the requirements of using temporary rail bonds in emergency situations (broken rails) by licensed signalling personnel.

Note: These guidelines do not prevent the use of shorting bonds being used in conjunction with bonding around the break. When used in this configuration the shorting bonds are to be placed across the rails (4 foot) either side of the break.
6.2 Applicable Circumstances

In order to allow particular trackwork to proceed with the minimum disruption to rail traffic which would otherwise affect the operation of signals or ETCS, track circuits may be kept working by the placement of an approved temporary rail bond around the rail break by a suitably instructed Civil Discipline representative in connection with the following work:

- Pulling back for expansion or creeping.
- Welding of rail joints.
- Renewing defective fishplates.
- Replacing a length of rail not more than can be reasonably accommodated between the connections of the standard 6 metre temporary rail bond.

6.3 Applicable Procedures

The conditions laid down in Network Rule NWT 318 regarding the issue of Temporary Rail Bond Approval form NRF 013 are to be adhered to.

Only maintenance signal engineers, the Testing & Commissioning Manager or the delegated licensed signalling person may authorise the use of temporary rail bonds. A separate approval is required for each application of temporary rail bonds. Maintenance signal engineers shall retain a copy of approved NRF 013 forms on file.

6.4 Competence

All duties allocated to the maintenance signal engineer under this procedure equally apply to the Testing & Commissioning Manager and may be performed by a specifically delegated licensed signalling person on their behalf, but may not be further delegated. However, the maintenance signal engineer or Testing & Commissioning Manager shall retain accountability.

The maintenance signal engineer is to ensure that the Civil Discipline representative placing the Temporary Rail Bonds has been suitably instructed and is competent to perform the task. This will necessitate the maintenance signal engineer providing clear instruction and where necessary, practical demonstration on the placing of the Temporary Rail Bonds. For each issue, the maintenance signal engineer is to provide the Civil Representative a simple diagram depicting the placement of Temporary Rail Bonds.

The maintenance signal engineer is to ensure that the Civil Discipline representative installing the Temporary Rail Bonds understands that at start of the work the rail shall not be broken until the bonds are correctly in place and that the bonds are not to be removed until the break has been welded out or permanent bonds installed.

Where traction bonding is concerned, the maintenance signal engineer is to ensure that the skill level required is not beyond the ability of the Civil Discipline representative who will be responsible for installing the Temporary Rail Bonding and there will be minimum risk to personnel or system by the work and bonding methods.
6.5 Control and Issue of Temporary Rail Bonds

6.5.1 Description
Temporary Rail Bonds shall be to an approved design fitted with approved rail clamps. The maximum length of Temporary Rail Bonds shall not exceed 6 metres. (This will generally limit the maximum rail cut to approximately 4.8 metres; however this is only an approximation and is not to be taken as the specified maximum). Temporary Rail Bonds used as shorting bonds shall be limited to 2 metres in length.

6.5.2 Control
Each bond and its associated rail clips are to be uniquely numbered. The maintenance signal engineer shall fix tags showing this number and the inspection date prior to issue, and update or renew the tags on subsequent inspections.

Temporary Rail Bonds shall be inspected by the maintenance signal engineer every six months to assess their condition and effectiveness. Where there is evidence of damage to the cable or rail clips that would impede its effectiveness, then the cable or rail clips shall be repaired or replaced as appropriate. Special attention shall be made where a bond is or may be used in electrified areas.

6.5.3 Register
The maintenance signal engineer shall keep a register specifically for the purpose of managing Temporary Rail Bonds and their issue.

Details to include as a minimum:
- the identification number of bond and clamps,
- bond description (e.g. length, cable size etc.),
- last of inspection date,
- result of inspection (e.g. condition of bond, pass/fail),
- date of issue,
- issue by,
- issued to (e.g. work team),
- personnel briefed in applying Temporary Rail Bonds, including date of briefing.

6.5.4 Issue
The maintenance signal engineer is responsible for the issue of Temporary Rail Bonds, limiting their issue to two 6 metre bonds and two shorting bonds per work team.

The issuance of Temporary Rail Bonds shall be recorded in a register (refer to Section 6.5.3).

Where no evidence of use has been observed between six monthly inspections, such as a request on a Temporary Rail Bond Approval form, consideration should be given to the withdrawal of the issued bonds or otherwise justified and recorded in the register.

When approving the use of temporary rail bonds maintenance signal engineers shall consider the work intended by the Civil Discipline representative, such that it does not alter the energisation of the track relay or receiver; for example, the potential of a track circuit relay becoming over-energised following the replacement of mechanical joints with track closures. Other considerations shall include the adequacy of traction return.
6.6  **Restriction for Use**

When approving the use of temporary rail bonds maintenance signal engineers are to instruct the Civil Discipline representative of the restrictions stated in Sections 6.6.1, 6.6.2 and 6.6.3 as applicable.

6.6.1  **Double Rail A.C. Track Circuit Areas**

In double rail AC track circuit areas, temporary rail bonds can only be placed around the rail break in conjunction with shorting bonds placed across both rails (4 foot) of the line on both sides of the break.

6.6.2  **Electrified areas**

In electrified areas no more than one rail shall be broken at any one time between adjacent traction sub-stations. It is also not permissible to have more than one break in the rail. For example, it is not permissible to break both rails of the same track at the same time, or break a rail in more than one track at the same time or have multiple breaks in the rail between traction substations.

6.6.3  **Non Electrified areas**

In non-electrified areas, no more than one break shall be made in each rail of a track within a Civil Discipline work team's worksite at the same time. It is permissible to have a break in both rails of a track simultaneously, but no other breaks can be made at that time. The work team shall be limited to work on one track at a time.

Where multiple work teams are applying temporary rail bonds, the extent that this can concurrently occur shall be determined by the signal engineer.

6.7  **Special Situations**

Where these guidelines do not address complex situations or where circumstances arise, causing doubt as to whether these guidelines satisfactorily control the risk, the matter shall be referred to the Professional Head Signalling & Control Systems for determination.
Engineering Procedure
Signalling and Control Systems

Signalling Safeworking

PR S 40027

Traction Return (1500V DC)

Version 3.0

Date in Force: 8 March 2019
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<td>C. Darmenia</td>
<td>Inclusion of precautions for track works and other clarifications</td>
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Summary of changes from previous version

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<td>Expand title to include works affecting traction return and clarify application of section</td>
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1 Reference Documents

This document describes the precautions necessary when work is performed that may affect any part of the traction return in 1500V DC electrified areas including but not limited to running lines, sidings, yards, maintenance centres and areas where the risk of traction return may be present. These precautions and associated procedures shall be followed in conjunction with other chapters of the Signalling Safeworking Procedures including:

- PR S 40008 Securing Signalling Apparatus Out of Use.
- PR S 40009 Disconnection of Signalling Apparatus.
- PR S 40025 Track Circuits.
- PR S 40026 Rerailing – Precautions to be taken.
- PR S 40042 Safety Issues for Signalling Personnel

The following Electrical Distribution Procedures listed below shall also be referenced where applicable:

- PR D 78000 Electrical Network Safety Rules.
- PR D 78303 Work on 1500 Volt Negative Equipment Outside Substations.
- PR D 78304 Work on 1500 Volt Negative Equipment Inside Substations.
- PR D 78305 1500 Volt Operating Procedures.
- PR D 78500 Electrical Permits.
- PR D 78501 Electrical Permit to Work.
- PR D 78502 Substation Access Permit.

The requirements of Network Rule NWT 318 Work that affects traction return currents or track circuits shall also be followed.

2 General Requirements for Working with Traction Return Currents

2.1 Principles

Adequate provision for the safe return of traction return current shall be considered and implemented before performing work that affects its path to the substation or section hut.

Multiple traction return paths shall be maintained at all times to ensure that traction return will be available in the event of any path becoming unavailable. See Section 3 for specific minimum requirements during work.

The following types of work have the potential to impact the path of traction return current:

- Re-railing in electrified areas.
- Disconnection of traction bonding including impedance bonds.
- Disconnections of negative return cables at substations and section huts.
Alternative traction return arrangements shall be made to mitigate the risks associated with rail breaks, disconnection of traction bonds or negative return cables. This is done to ensure unsafe voltages do not develop across the breaks.

Prior to any break being made, confirmation is to be obtained that an alternate, suitable capacity, traction return path is functional. This may require the placing of temporary bonding around the break.

Temporary traction bonding is to be direct (rail to rail) and may not be run along the track for any distance unless risk assessed by a signal engineer.

Where the break is to occur on all traction rails or disconnection of all traction cables or a sub-station or section hut is to be completely disconnected, it will be necessary to make suitable alternate arrangements to ensure traction return is provided for and unsafe voltages do not develop.

Similarly, signalling equipment shall be safeguarded against damage caused by the potential rise in traction return voltage.

In many cases, where complete tracks are removed, the alternate arrangements can include isolation of the overhead. Where this is the case, the effects of live overhead that are adjacent to the isolated section shall be considered.

Licensed signalling personnel or Signal Engineers shall provide alternative traction return arrangements as prescribed in this procedure.

### 2.2 Traction Return Provision During Work

Traction currents may flow between the areas either side of a work area. This traction current may be provided for by ensuring sufficient traction rails remain connected throughout the work area as described in Section 3 below.

Where this is not possible suitable alternate traction return arrangements may be provided for by:

- Installing temporary bonding to provide an alternate path for traction return, or
- Laying an additional rail adjacent to the work and bonding this to the remaining traction rails either side of the worksite, or
- Using the existing isolated OHW by rail connecting the OHW at each end of the work area ensuring:
  - The Signals representative signs onto an Electrical Permit to Work, to ensure the OHW rail connections are not removed until the normal rail and bonding is restored,
  - The electrical discipline provides assurance that the OHW will remain continuous during the work,
  - Traction rails at the break are bonded together locally so the OHW rail connection is effective on all traction rails,
  - Not to break any rails until the OHW rail connections are in place.

In all cases, licensed signalling personnel are to monitor and ensure that all temporary arrangements remain in place.
2.3 **Substation or Section Hut Disconnection**

In all cases of complete disconnection of a sub-station, or section hut rail connections, licensed signalling personnel shall sign onto a Substation Access Permit before work commences and shall not sign off the permit until the new cables and connections have been restored and certified. Refer to Section 3.6 Traction Return Connections to Substations and Sectioning Huts for further requirements.

2.4 **Where No Provision for Traction Return is Required**

Where the absence of traction return is assured, then no additional bonding or protection is required to assure safety.

In these cases the absence of traction return is assured by:

- A new railway being constructed where all ends are not connected to a working railway and there is no energised overhead wiring over, or adjacent to, the track, or
- An OHW isolation of an existing railway branch line where the last sub-station is rail connected and an Electrical Permit to Work has been issued to licensed signalling personnel, and there is no electric traction in use between that point and the end of the line, or
- An OHW isolation of a section of line where:
  - The Signals representative has signed onto an Electrical Permit To Work for the area
  - No electric traffic will operate past the site or on adjacent tracks. This includes nearby tracks which are bonded to the isolated section.
  - All traction rails have effective traction tie-in bonds at each end of the section being re-railed, tying all rails together
  - A Signal Engineer authorises that alternate traction return arrangements do not need to be provided.

3 **Precautions When Renewing Traction Bonds or Works Affecting Traction Return**

The following section provides guidance to licensed signalling personnel on the precautions and requirements for traction return management under live conditions. Where this is not possible, suitable alternate traction return arrangements shall be provided.

3.1 **Broken Traction Return Continuity**

If the traction return continuity of both rails in one or more tracks (or the traction rail of a single rail track circuit) at a location is found to have been broken, all rails adjoining the break shall be assumed to be live at traction voltage until it can be established that traction return continuity is maintained through bonding further along the track.
3.2 Protection of Track Circuit Equipment from Traction Current

Where licensed signalling personnel are in attendance, before any interference with rails forming part of the traction return circuit on a track circuited line is permitted, the feed/transmitter and relay/receiver/s of the track circuit shall be disconnected at the outgoing terminals in accordance with Signalling Safeworking Procedure PR S 40009.

This action isolates the equipment from a rise in D.C. traction current and eliminates a source of possible circulating track circuit current.

3.3 Where Electric Trains are to Traverse Broken Rails and Mechanical Joints

For planned trackworks in track circuited areas, where electric trains are to traverse directly over a break in the rail(s) (e.g. mechanical joints, rail closures etc.), the break in the rail shall be sufficiently bonded out with temporary traction bonds and the track circuit booked out of use.

For planned trackworks, where mechanical joints are to remain after the track circuit is booked into use, these are to be bonded in line with construction specifications between rail ends across the joint. Where this is unachievable, multiple temporary traction bonds are required. The security and continuity of each temporary traction bond is to be confirmed prior to booking the track circuit back into use.

Temporary bonds are considered to be a temporary repair and will require regular inspection during maintenance. They shall be managed in accordance with PR S 40004. Temporary bonds should be replaced with a permanent arrangement if the joint is not welded out in a reasonable time period.

Refer to PR S 40026 for the management of temporary rail bonds.

For emergency works (broken rails) in track circuited areas, in compliance with the requirements of Section 3.1 and the requirements in PR S 40004 Section 1.7.10.3, the broken rail shall be sufficiently bonded out with temporary traction bonds.

These requirements are in addition to Section 3.4.

3.4 Minimum Requirements and Exemptions to Providing Alternate Traction Return Arrangements

The requirements stipulated in Sections 3.4.1, 3.4.2 and 3.4.3 are the minimum rail requirements to ensure a low resistance path is provided for the traction return currents.

However circumstances may arise where it is not possible, due to the nature of the work, to provide the minimum rail requirement. Where such circumstances arise, the matter is to be referred to a signal engineer for determination of the traction return current arrangements. The signal engineer is to liaise with the Professional Head Signalling and Control Systems to ensure and agree on the proposed traction return arrangements, this may necessitate temporary track bonding design being issued where a level of complexity exists or as determined by the Professional Head Signalling and Control Systems, in accordance with the principles in Section 2.

3.4.1 Two Traction Rails

Any affected traction rails must have alternative traction return arrangements in place, before being broken. The continuity of the affected traction rail shall be maintained by means of temporary traction bonding around the break and across the four foot or alternative arrangements described in Section 2.2.
3.4.2 Three to Five Traction Rails

Where there are three to five rails in the same corridor that provide the traction return path to a substation or section hut, one traction rail may be broken without providing alternative traction arrangements. Only one rail break is permitted in the same traction rail to prevent any section of rail being isolated from a negative return path.

The following requirements shall be met before the exemption to providing alternate traction arrangements applies:

- Ensure traction bonding in the vicinity (on both sides) of the intended work complies with the specific track insulation plan.
- Ensure traction bonding in the vicinity has sufficient capacity to safely return the additional traction return current.
- The requirements of Section 3.3 are met and any track with live electric traffic must always have at least one effective traction return rail or alternate traction bonding in place.

These conditions shall be validated by physical inspection of the traction arrangements to confirm their condition and compliance.

3.4.3 Six or more Traction Rails

Where there are six or more traction rails in the same corridor that provide the traction return path to a substation or section hut, two traction rails may be broken without providing alternative traction arrangements. Only one rail break is permitted in each of these traction rails to prevent any section of rail being isolated from a negative return path.

The following requirements shall be met before the exemption to providing alternate traction arrangements applies:

- Ensure traction bonding in the vicinity (on both sides) of the intended work complies with the specific track insulation plan.
- Ensure traction bonding in the vicinity has sufficient capacity to safely return the additional traction return current.
- The requirements of Section 3.3 are met and any track with live electric traffic must always have at least one effective traction return rail or alternate traction bonding in place.

These conditions shall be validated by physical inspection of the traction arrangements to confirm their condition and compliance.

3.5 Impedance Bonds (not at Substations or Sectioning Huts)

The same principles apply for disconnection of impedance bonds as apply to breaking traction rails in Section 3.4. Disconnection of impedance bond traction cabling is equivalent to breaking the traction rail these cables connect to.

Before a feed/transmitter or relay/receiver end impedance bond is disconnected, the feed and relay of the track circuit concerned shall be disconnected and temporary bonding connections provided for traction return between the neutral point of the impedance bond of the adjacent track circuit and one of the rails of the track circuit from which the bond is to be disconnected. Where the adjacent track circuit is single rail, the same effect can be obtained by connecting one of the rails to the traction rail of the adjacent single rail track circuit.
3.6 Traction Return Connections to Substations and Sectioning Huts

3.6.1 General

The traction return to substations and sectioning huts is provided by cables connecting directly to the rail in the case of single rail track circuits or non-track circuited lines, or via impedance bonds in the case of double rail track circuits.

Under no circumstances should all the traction return connections from the track to the substation or sectioning hut be broken or disconnected without providing an adequate alternative traction return to the substation or sectioning hut or otherwise obtaining an isolation of the 1500 Volt DC traction by the licensed signalling personnel signing onto a Substation Access Permit.

In all cases of work being carried out at the negative connections at substations or sectioning huts, the Electrical discipline shall be advised prior to the work.

Temporary arrangements shall be confirmed by a signal engineer.

3.6.2 Arrangements for Continuity of Negative Connections

At substations and sectioning switch locations of the 1500V DC overhead supply, multiple parallel cable connections are provided from the traction rail(s) or impedance bond(s) to trackside negative busbar(s). In some cases, there may not be a negative busbar provided. The installed arrangements are to be confirmed to the specific track insulation plan for the area.

It is permissible to temporarily disconnect up to half of the negative return cables from the negative busbar to one rail or impedance bond only, while the OHW for that line remains energised. Licenced signalling personnel are to confirm the continuity and effectiveness of the remaining cables for that line and adjacent lines prior to disconnection.

Where a negative busbar is not provided, a representative from the Electrical discipline shall additionally confirm the continuity and effectiveness of the remaining cables and connections into the substation or section hut.

The location of negative cable connections is indicated by a notice plate, generally attached to the sleepers, the inscription reading "Danger 1500 volt negative, do not break cable".

Care should always be exercised in the maintenance of these connections as a total break in the cables would result in a potential difference of 1500 volts across the break.

The requirements below are additional to the minimum requirements of Section 3.4 and 3.5.

For rerail and other trackworks affecting traction return, the requirements in Section 4 below and PR S 40026 Section 5 shall be referenced prior to the commencement of rerailing or the trackwork.
3.6.2.1 Older Sectioning Hut installations:

Negative cable connections are made to the same rail, on either side of a mechanical joint.

No more than one half of the negative cables for one line can be disconnected at the same time. Where this results in only one cable being left connected, the removed cable should be temporarily connected to the remaining connected side of the mechanical joint.

The negative cables for adjacent lines at that sectioning hut shall remain connected. If this requirement cannot be met, isolation of the 1500V DC traction is to be ensured by the licensed signalling personnel signing onto a Substation Access Permit.

3.6.2.2 Substation and newer Sectioning Hut installations:

Negative cable connections are made to all traction rails.

On multi-track lines, the usual practice is to provide negative busbars on both sides of the tracks, for termination of the rail connections. The substation or sectioning hut location is also used as a traction tie-in location.

For single rail track circuits, no more than one half of the negative cables for one rail can be disconnected at the same time.

For double rail track circuits, where one "mid-track" impedance bond is provided for a line, no more than half of the negative cables to the negative busbar can be disconnected at the same time. Alternatively, no more than the traction cables from one rail to the impedance bond can be disconnected at the same time.

For double rail track circuits, where two "end track" impedance bonds are provided for a line, with insulated rail joints between the impedance bonds, no more than half of the negative cables on one impedance bond to the negative busbar can be disconnected at the same time. Alternatively, no more than the traction cables from one rail to one impedance bond can be disconnected at the same time.

For double rail track circuits, where two "mid track" impedance bonds are provided for a line, with no block joints between the impedance bonds, no more than one impedance bond can be totally disconnected at the same time.

Note – disconnecting the rail connections to one side of the impedance bond for double rail track circuits may unbalance the track circuit and this should be assessed by licensed signalling personnel prior to being undertaken.

If these requirements cannot be met, isolation of the 1500V DC traction is required by licensed signalling personnel signing onto a Substation Access Permit.

4 Trackworks Affecting Traction Return

This section provides requirements and procedures for live traction conditions. They are additional to the minimum requirements of Section 3.4 and 3.5.

When trackworks are occurring past a section hut, care shall be taken so that one negative connection to the rail or impedance bonds is maintained at all times. Refer to Section 3.6 above.

Where negative cable connections are to a single rail, trackworks affecting traction return such as rerailing, shall be done in two stages. The first stage up to one side of the mechanical joint, and when bonding of that portion is complete and the negative cable
connection to the section hut is restored, the remainder of the rerailing may be carried out as the second stage.

In the case of negative cable connections to impedance bonds, the rerailing should be carried out on one rail at a time, with the other rail fully bonded and its negative connection complete via the impedance bond. Refer to Section 3.5 above.

In all cases where rerailing is to be carried out involving the 1500V DC negative rail connection at a sectioning hut or sub-station, the Discipline responsible for the work shall notify ICON Electrical of the work to be performed before rerailing commences. Refer to Section 3.6 above.

In areas where the mechanical joint has been welded out, and there is only the one set of negative connections, the rails shall first be cut so as both connections are not broken simultaneously. Where it is not possible for the rail to be cut, isolation of the 1500V DC traction shall be initially obtained. Refer to Section 3.6 above.

In all cases, where there are negative connections and the entire track is to be removed and replaced, isolation of the 1500V DC traction shall be initially obtained.

For rerail and other trackworks, the requirements in PR S 40026 Section 5 shall be referenced prior to the commencement of rerailing.

5 Traction Bonding in non-track circuited area

Traction bonding in non-track circuited areas in particular in yards, rolling stock maintenance centres and the end of the line sections shall be inspected to ensure it is in good condition and the connections are not disconnected or damaged. The maintenance signal engineer for the area is responsible for ensuring this inspection is provided for and scheduled.

This is done to prevent the potential for unsafe voltages that may develop across rail breaks or cable breaks.

6 Rail Spark Gap Arrestors – Precautions

Certain overhead metal structures to which 1500V DC wiring is attached are provided with a rail spark gap arrestor and a cable connection to the traction return rail.

In cases where a spark gap connection to rail is found to have become broken, or requires disconnection, the overhead structure and the cable connected to it may become live at traction voltage. Refer to PR S 40042 for precautions, actions and management of spark gaps during maintenance activities or programmed works.

During routine examination of track circuits any spark gap connection cables which pass under the rails shall be examined for insulation damage. Damage shall be reported to ICON Electrical for prompt rectification. Necessary interim repairs are to be carried out to ensure that contact to the rails will not occur.
7 Electrolysis Bond Connections

At certain locations indicated on track insulation plans a negative connection is provided to the neutral point of an impedance bond or a special transformer for the purpose of providing a low resistance one way path for "earth" leakage current from adjacent power and telephone cables, gas and water mains. This connection is made through what is known as an electrolysis bond. These connections can also be made to the traction rail of single rail track circuits.

These connections shall be carefully checked and maintained at all times by signalling personnel.

8 Temporary Rail Connection of Overhead Wiring

During any work that requires the 1500V traction supply to be isolated, and except where permanent overhead sectioning/earthing switches have been installed, there will be a requirement to provide temporary rail connections from the overhead wiring to the traction rail to protect personnel from inadvertent energisation of the OHW.

The signal engineer, upon a request for temporary rail connections, shall identify an appropriate connection point by marking a copy of the specific track insulation plan with the location where the temporary connection may be made, and providing this to the Electrical discipline or representative.

Where there is doubt about a correct connection being made licensed signalling personnel should attend to supervise the connection.

No connections shall be made unless the signal engineer has agreed to the connection, or it is on a formally approved track insulation design issued by Signalling and Control Systems Design.

The signal engineer shall ensure that the temporary connections are only made as follows:

- To a trackside 1500 V negative bar, or
- To the traction rail of a single rail track circuit; or
- To the neutral point of an impedance bond of a track circuit, or
- Direct to a rail of an audio frequency track circuit or double rail track circuit, but only if that track circuit is not required to be energised during the work

The connection point shall be a secure point external to any work taking place in the possession to ensure traction return to the substation is not affected.

If the track circuit is to be de-energised in conjunction with this connection, the track circuit shall be booked out of order and disconnected. In this case, care shall be taken to identify any points or other signalling equipment that may be required as operational during the time the connection is made, to avoid disruption to the movement of track machines and trains.

At the completion of the work the Electrical discipline is responsible for the removal of all temporary connections. The signal engineer will arrange for the reconnection and booking in of any affected track circuits.
Engineering Procedure
Signalling and Control Systems

Signalling Safeworking

PR S 40028

Automatic Train Protection – Alstom
ETCS Trackside Equipment

Version 1.0

Date in Force: 8 March 2019
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Document control

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1 Introduction

Automatic Train Protection (ATP) is being implemented across the Sydney Trains maintained network. The type of ATP system that has been adopted is the European Train Control System (ETCS). There are different levels of ETCS these generally being:

- **ETCS Level 0** the ETCS application level used on unfitted or uncommissioned lines.
- **ETCS Level 1** involves continuous supervision of train movement while a non-continuous communication between train and trackside (normally by means of balises). Lineside signals are necessary and train detection is performed by the trackside equipment ETCS Level 1 can be provided in full supervision or Limited Supervision (LS) modes
- **ETCS Level 2** involves continuous supervision of train movement with continuous communication, which is provided by GSM-R, between both the train and trackside. Lineside signals are optional in this case, and train detection is performed by the trackside equipment
- **ETCS Level 3** is also a signalling system that provides continuous train supervision with continuous communication between the train and trackside. There is no need for lineside signals or train detection systems on the trackside other than balises. Commonly referred to as moving block.

2 Scope

This procedure covers the signalling safeworking requirements for ATP associated with the implementation of the ETCS Level 1 (LS), pertaining to trackside equipment only.

ETCS Level 1 LS mode uses the same equipment and architecture as ETCS level 1 Full Supervision (FS) mode but in a different configuration, and provides the following functionality;

- Ceiling Speed Supervision for all Speed Signs;
- Target Speed Monitoring for High Risk Speed Signs, High Risk Turnouts and Deficient Overlaps;
- ETCS Trainstops where no mechanical trainstops are present;
- Buffer Stops and End of Line protection;
- Wrong Running Hazard protection; and
- Automatic Selective Door Operation.

ETCS Level 1 trackside equipment primarily consists of balises mounted on the track, trackside junction boxes, Line-side Electronic Units (LEU) and associated equipment, cabling between the balises and the LEU trackside location, relay room or cabinet, and the interface equipment between the LEU and the signalling system.

A balise group may consist of a combination of 'fixed' or 'fixed' and 'controlled' balises, depending on the application functionality (as listed above). Speed sign supervision will only ever require a fixed balise; however any function which can change state depending
on the state of the signalling system (e.g. ETCS trainstops) will require a controlled balise as part of the balise group.

The LEU reads the signal aspect information (from the signalling interface between the signalling system and the LEU), and selects the appropriate telegram to send to the ‘controlled’ balise.

The message that is interpreted by the on-board system is formed from the aggregate of telegrams received by the train as it passes over the individual balises within a defined balise group. A valid message will only be received if all telegrams are successively received from the balise group.

When a train passes over a balise group, the on-board system reads the message and selects the appropriate traction or braking reaction from the train, as well as the appropriate information to be displayed on the Driver’s display.

2.1 Purpose

The purpose of this document is to specify the Signalling Safeworking requirements for the maintenance, faulting and failure rectification of ETCS L1 LS track mounted and trackside equipment.

2.2 Application

This procedure applies to ATP ETCS L1 LS trackside equipment where Sydney Trains is the Rail Infrastructure Manager (RIM).

3 Reference documents

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### 4 Terms and definitions

The following terms and definitions apply in this document:

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td>ASDO</td>
<td>Automatic Selective Door Operation. An ETCS function that facilitates the safe boarding and alighting of passengers at platforms.</td>
</tr>
<tr>
<td>ASDO Calibration Balise</td>
<td>A balise located within the platform to aid with accurate location information. The balise has an additional ID plate engraved with “ASDO Calibration”.</td>
</tr>
<tr>
<td>ASDO Calibration Balise Marker Plaque</td>
<td>A plaque that is fixed to the vertical face of each platform to facilitate the positioning of ASDO calibration balise.</td>
</tr>
<tr>
<td>ATP</td>
<td>Automatic Train Protection. A safety system that warns of or enforces speed limits and stopping before supervised locations.</td>
</tr>
<tr>
<td>Balise</td>
<td>A transponder on the track that is read by on-board ETCS equipment.</td>
</tr>
<tr>
<td>Balise Group (BG)</td>
<td>One or more closely spaced balises at the same location which combine to send a single telegram to the train.</td>
</tr>
<tr>
<td>Balise ID Plate</td>
<td>An identification name plate fitted to each balise.</td>
</tr>
<tr>
<td>Balise Junction Box</td>
<td>Trackside ETCS Junction Box.</td>
</tr>
<tr>
<td>Balise Location ID Plate</td>
<td>An identification name plate fitted to the track adjacent to each balise.</td>
</tr>
<tr>
<td>Balise Tail Cable</td>
<td>A cable between the balise and the trackside ETCS Junction Box.</td>
</tr>
<tr>
<td>BEPT</td>
<td>Alstom Balise and Encoder Programming Tool.</td>
</tr>
</tbody>
</table>
BMM Big Metal Mass

CAN Warning Condition Affecting the Network

Contact Sensing An interface where the LEU inputs are detected from a relay contact.

Controlled Balise A balise, connected to the signalling system via and LEU, which can send different telegrams based on different signalling inputs.

CRC Cyclic Redundancy Check.

Current Sensing An interface where LEU inputs are detected from an in-line connection with the signal lamp circuit. Also known as ‘Lamp Current Sensing’.

DMI Driver Machine Interface. The ETCS display and control panel in Drivers cabs.

ERA European Railway Agency

ETCS European Train Control System (a specific type of ATP).

ETCS Level 0 (L0) The ETCS application level used on unfitted or uncommissioned lines.

ETCS Level 1 (L1) The ETCS application level that uses balises to send movement authorities to trains, and which is overlaid on the pre-existing signalling system. Note this mode can be further separated into L1 Limited Supervision (LS) and L1 Full Supervision (FS) modes.

ETCS Level 2 (L2) The ETCS application level that uses a radio system to transmit movement authorities to trains, and uses pre-existing signalling system methods to determine trains’ positions.

Eraser The person responsible for the erasing of balise data.

Fixed Balise A balise that can transmit only a predetermined message and is not connected to an LEU.

Gold Key A special LEU configuration key used to de-pair the key pairing configuration on an Alstom LEU i.e. the pairing between the key and the LEU.

Importer The person responsible for importing missions and data from a USB memory stick into the BEPT.

JRU Juridical Recording Unit. A data logger onboard and ETCS fitted train.

LED Light Emitting Diode.

LEU Lineside Electronic Unit or Lineside Encoder Unit. The term LEU is a generic descriptor. Alstom’s LEU product is the Cobalt ‘Micro-Coder’.

LEU Configuration Key An Alstom programmable device which connects to an LEU and contains the LEU configuration data.

Micro-Coder An LEU encoder from Alstom.

LS Limited Supervision Mode. An ETCS solution in which only selected signals and other high risk supervised locations are fitted.
Programmer  The person responsible for the loading of previously compiled data into a Balise or LEU configuration key (the role is called “Programmer” in Alstom documents).


SR  Staff Responsible Mode. An ETCS on-board equipment mode which allows a train to move forwards without a movement authority at up to a preset (National Value) maximum speed.

Tail Cable  A one or two pair cable between the ETCS LEU location and the trackside ETCS Junction Box.

TMP  Technical Maintenance Plan.

Verifier  The person responsible for the testing of the data installed into a Balise or LEU configuration key (the role is called “Verifier” in Alstom documents).

Validator  The person responsible for validating that the testing of the data installed into a Balise or LEU configuration key has been completed correctly (the role is called “Validator” in Alstom documents).

Virtual Balise Cover (VBC)  Balise groups that are programmed to instruct ETCS fitted trains to ignore balises within a defined area.

5  ETCS Failures

Failures of ETCS trackside equipment and the requisite actions to be taken for ensuring the safety of train movements are detailed in PR S 40004.

When a fault report is received, signalling personnel shall determine if the fault is trackside or on-board. Although failures of ETCS onboard equipment are not considered to be signalling failures, if signalling personnel become aware of ETCS onboard issues, such issues shall be reported to ICON Infrastructure as soon as possible. ICON Infrastructure shall advise the relevant onboard maintainer of the information required.

If there is a discrepancy between speed information displayed on the onboard DMI and lineside signals or signs, the lineside signals or signs shall have precedence over the DMI, in accordance with Network Rules NSG 604 "Indicators and Signs” and NSG 606 "Responding to Signals and Signs”.

5.1  ETCS Right Side Failures

The most common failure mode for ETCS trackside equipment will be where a train receives a warning on the Driver / Machine Interface (DMI), a service brake intervention (SBI) or an emergency brake intervention (EBI) applied while the driver is driving appropriately to signal aspects and speed boards. This is considered to be a right side failure.

This failure mode could occur if an ETCS balise is missing, defective or damaged to the extent that it is not capable of sending out a telegram to a train. In this case, the linking from the last balise group in rear will provide protection for the missing balise in the form of a ‘linking reaction’. The linking reaction for a missed balise is either to initiate a brake application on the train or to provide a DMI warning to the driver, depending on the level of risk of the hazard for which the balise was installed.
For right side failures of ETCS trackside equipment, there are no specific requirements for the management of the failure until it is fixed, as the balise linking provides a level of protection for the failure and trains would be expected to continue to obey the more restrictive braking requirements imposed by the failure. The signaller shall be advised of such failures and of the time period expected until the failure is rectified.

5.2 ETCS Wrong Side Failures

A wrong side failure of ETCS equipment is highly unlikely to occur due to the fail-safe implementation strategy of ETCS, and is even more unlikely to be discovered, as it would need to be associated with a train either passing a signal at danger or over-speeding beyond the defined tolerances. In the event of an unprotected wrong side failure of ETCS equipment, a train shall be prevented from operating over the failed equipment by maintaining a signal in rear at stop. A wrong side failure of ETCS equipment shall be treated in accordance with PR S 40004.

5.3 On-Board Log Files

On-board log files are recorded in the on-board juridical event recorder (JRU). On-board log files shall be requested by contacting ICON Infrastructure, who shall make a formal request to the on-board maintainer.

For a significant event (such as a wrong side failure allegation), log files for the train shall be downloaded as a matter of urgency. Low priority events (right side failures) can be downloaded once the train is stabled.

Note: In some cases, further information may be required from the Driver, to confirm the location of an ETCS related incident.

5.4 Trackside Log Files

Trackside log files shall be analysed in accordance with MN S 41604. The requirements of PR S 40004 are applicable.

6 Like For Like Renewals

6.1 General Requirements

Where a balise or a LEU configuration key requires replacement due to failure, then the replacement balise or LEU configuration key shall be installed with the same data as the item replaced.

Installation, verification and validation of the replacement balise or LEU configuration key data shall be done in accordance with the processes described in the MN S 41604 Alstom ETCS Trackside Maintenance Manual and PR S 40011 Renewals Work. Final validation of the balise or LEU configuration key data is to occur at time of installation.

Data version changes for a balise or a LEU configuration key shall not be considered as like for like. When a data version change is required, a full commissioning process shall be followed in accordance with the MN S 41605 Alstom ETCS Trackside Equipment Set to Work, Testing and Commissioning Manual.

Before replacing any equipment, it shall be determined whether or not the ETCS equipment and any associated signalling are required to be booked out of use in
accordance with PR S 40004 and PR S 40008. If required, disconnect the ETCS equipment and any associated signalling, in accordance with PR S 40009.

Like for like activities shall be done in accordance with the work instruction provided in PR S 40011. During track work support activities the work instructions in PR S 47118 for the removal and installation of balises may be substituted in lieu of that in PR S 40011, however, if a balise is required to be programmed then the work instruction in PR S 40011 shall also be adhered too and completed.

Section 15 provides a list of forms that shall be used to record testing and certification activities as referenced in PR S 40011, PR S 47118 and MN S 41604.

6.1.1 Independent Verification and Validation of ETCS Data
Personnel conducting the data verification process shall be independent of the data installation activities. Personnel conducting the data validation process shall be independent of the data installation and data verification activities.

6.2 Balise Like For Like Renewal
For precautions associated with the like for like renewal of balises, see Section 9.2.

Only one balise should be disconnected or re-instated at a time to prevent incorrect reconnection.

Fixed and controlled balises contain default data specific to each balise, in the form of a default telegram stored in its internal memory. A balise shall always have its data erased prior to having data installed.

The requirements for identifying the old balise to be replaced, and identifying the exact location of the new replacement balise vary according to the situation:

- For the replacement of a balise that is currently identifiable on the track, or for planned track works which do not require the removal of sleepers, check the circular balise ID plate (on the existing balise) and the rectangular balise location ID plate (on the sleeper) against the signalling documentation, to ensure that this is the correct balise, and if necessary mark the position of the existing balise in accordance with MN S 41604.

- For the replacement of a balise that is missing, removed or damaged to the extent where its installed location cannot be accurately determined, the distance of the balise, as referenced on the signalling documentation, shall require measuring and marking, prior to installation of the replacement balise.

- For planned track works that require the removal of the sleepers upon which the balise is mounted, or where there is no way of accurately marking the location of the removed balise, the distance of the balise, as referenced on the site certification form, shall require measuring and marking, prior to installation of the replacement balise.

- For ASDO calibration balises at the platform, balise installation shall be aligned to the ASDO platform plaque using the specific laser tool. In case of misalignment between sleeper with balise location ID plate and platform plaque, use of universal beam or other approved fixing shall be considered.

Use of a Vortok Universal Spreader beam or a longitudinal mounting plate in accordance with drawing M05-545 is permitted for temporary repairs and where necessary.
Moving a balise by as little as one sleeper bay can have an undesirable operational impact at some locations.

The replacement balise shall have data installed, verified and validated prior to operational service, in accordance with MN S 41605.

### 6.3 LEU Like For Like Renewal

For precautions associated with the like for like renewal of an LEU, see Section 9.1.

A replacement LEU shall have the same or newer, approved hardware and firmware versions as the LEU being replaced. The replacement LEU shall have the same configuration of blanking plates and port caps as the LEU replaced. Any un-used ports shall be covered.

Data version changes for an LEU shall not be considered as like for like. When a data version change is required, a full commissioning process shall be followed, in accordance with MN S 41605.

The new/replacement LEU shall be un-paired prior to use, using a Gold Key, in accordance with MN S 41604.

**Note.** Data installation is not required for the LEU prior to use. Data configuration is obtained from the LEU configuration key.

Only one LEU shall be removed and replaced at any one time.

The LEU configuration key tether chord shall not be removed from the fixing point when removing the LEU.

### 6.4 LEU Configuration Key Like For Like Renewal

Only one LEU configuration key shall be removed and replaced at any one time within a location or cabinet.

LEU configuration keys contain data specific to each installation.

Any new or replacement LEU configuration key shall have the correct data installed, verified and validated prior to placing into service. Where programmed prior to going on site the key shall be appropriately and securely labelled to ensure it will be matched to the correct location.

A Like for Like replacement of LEU configuration key will not normally require the existing LEU to be de-paired. This is due to the LEU configuration key data being paired with the LEU and not the physical key. Restart the LEU (or reboot it if it was not powered down) to ensure the LEU starts up correctly. If LEU start-up was unsuccessful, prior to de-pairing the existing LEU the checks detailed in MN S 41604 shall be conducted.

**WARNING**

Data on LEU configuration keys can only be overwritten not erased.
7 Periodic Maintenance

Periodic inspections of all ETCS equipment shall be done in accordance with TMP’s.

In some cases, ETCS on-track or trackside equipment pending commissioning (or removal) shall require maintenance, for example installed balises, LEUs and associated equipment for current sensing installations.

7.1 Unlinked or Seldom Used Balises

Where installed ETCS balises are not regularly traversed by ATP fitted rail vehicles during normal train operations, there becomes a risk that these balises may go unchecked by the ETCS system. In these cases, the risk of the ETCS system not providing the intended protection due to balise removal or defect becomes realised.

Seldom used balises are typically located in the following situations:

- The last balise group before buffer stops,
- At the end of a line (in the run off area, past where a train would normally stop),
- Trip balises: stop light, stop sign balise group,
- Balises at unused sidings or passing loops.

There are also some ETCS balise installations which are routinely operated over, however if they were defective or the balises were missing, would not be reported by the train as they are not linked to a balise in rear.

Unlinked balises are typically located in the following situations:

- The transition announcement balise group from a Level 0 to a Level 1 area.
- Yard entry/exit balise groups.
- Temporary Speed Warning (TSW) balise groups.
- Virtual Balise Covers (VBC) balises groups.

The risks associated with seldom used balises and unlinked balises are mitigated by periodic maintenance in accordance with the TMP. The TMP includes a functional test by reading the telegrams using the BEPT to verify that the balise is working.

7.2 Debris

Debris or conductive materials on top of a balise can affect the reception of telegrams by the on-board system. Balises shall be maintained free of debris. This is referenced in MN S 41604.

7.3 Insulation Testing

Insulation testing shall not be performed on the following ETCS cables, as it could damage the cable:

- ETCS tail cables (from the LEU to the trackside balise junction box);
- ETCS balise tail cables (from the trackside balise junction box to the balise);
- ETCS Ethernet data cables between LEUs.
Continuity testing is required during the replacement of cables.

8 Authority Levels

8.1 General

Three independent personnel are required for the installation of ETCS data into a balise or an LEU configuration key. The first to install the data (using the BEPT), the second to verify the installation (also using the BEPT), and the third to validate the installation (using the checksum detailed on the existing Installed Data Form for that installation).

The independence shall relate to the following activities:

- Installation of data using the BEPT;
- Verification of data using the BEPT; and
- Validation of data against the Installed Data Forms for the specific installation.

8.2 ETCS Data Installation

As part of the replacement and data installation for a balise or LEU configuration key, licensed signalling personnel, subject to limitations in Sections 8.3 and 8.4, are permitted to perform the following tasks:

1. Replace failed balises
2. Replace failed LEU modules
3. Replace failed LEU configuration keys
4. Erase data from a previously used balise
5. Import installation missions into a BEPT
6. Load data into balises as detailed on the ETCS Installed Data Form
7. Load data into LEU configuration keys as detailed on the ETCS Installed Data Form.

Licensed signalling personnel shall not install any version of data to a balise or LEU configuration key, for maintenance purposes, other than that which is currently installed, unless directly instructed otherwise by a signal design engineer authorised to do so.

8.3 ETCS Data Verification

As part of the data verification for a balise or LEU configuration key, licensed signalling personnel are permitted to perform the following tasks:

1. Verify the loaded data for balises as detailed on the ETCS Installed Data Form
2. Import verification missions into a BEPT

Signal engineers are additionally permitted to:

- Verify the loaded data for LEU configuration keys as detailed on the ETCS Installed Data Form.
8.4 ETCS Data Validation

As part of the data validation for a balise or LEU configuration key, signal engineers and ICON Infrastructure licensed signalling personnel are permitted to perform the following tasks:

1. Validate the loaded data for balises against the ETCS Installed Data Form;
2. Validate the loaded data for LEU configuration keys against the ETCS Installed Data Form.

Where the data validation was not performed by the responsible maintenance signal engineer, they shall be duly notified by the validator, unless validation was conducted as part of commissioning works.

9 Precautions

9.1 LEUs

There are two types of LEU input interface; current sensing and contact sensing. An LEU may be wired for one type only, or a combination. The circuit book will provide details on how to identify the type of sensing employed for any particular input.

Note: Powering down an LEU which uses either current or contact sensing will not affect the signal lamps or the aspects.

9.1.1 Current Sensing Inputs

LEU fitment at computer based interlockings (SSI, Westrace, Westlock, Smartlock etc.) generally has a current sensing interface. This is achieved using a current loop in series with the signal lamp.

Warning
Incorrect disconnection of current sensing LEU equipment can prevent the associated signal from displaying an aspect, and can damage the LEU.

Any disconnection and reconnection of LEUs or associated interface wiring with a current sensing interface shall be done in accordance with MN S 41604.

Where testing of the signal aspect circuit requires the LEU to be by-passed or isolated, this isolation shall be done in accordance with MN S 41605.

Caution
Failure to follow these procedures may result in damage to the LEU.

9.1.2 De-Pairing of an LEU using a Gold Key

An LEU is paired with its LEU configuration key data at first start-up. Where an LEU containing other data is re-used, the LEU will power up but not function correctly, and will need de-pairing using a Gold Key. De-pairing shall be done in accordance with MN S 41604.
9.2 Balises

A balise group (BG) typically consists of two balises. A single balise is only used in a BG where direction of train movement is not required to be established. Examples of single balise groups include the last balise just before a buffer stop, or a calibration balise (includes ASDO calibration balise).

In rare circumstances the configuration data may not fit within two balises and in such a case, a third balise may be added to the group.

The longitudinal positioning of a balise is critical for the safe and correct operation of the ETCS system. Any balise that is removed and replaced, whether during track work or due to balise failure, shall be replaced within the prescribed tolerance. Engineering approval is required if a balise cannot be placed within the tolerance defines in Table 1 below.

<table>
<thead>
<tr>
<th>ETCS Balise Function</th>
<th>Maximum Longitudinal offset from original design location permitted without Engineering Approval</th>
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</thead>
<tbody>
<tr>
<td>ASDO calibration balise</td>
<td>+/- 350 mm</td>
</tr>
<tr>
<td>All other balises</td>
<td>+/- one sleeper increment (nominal 600 mm).</td>
</tr>
</tbody>
</table>

Table 1

The reinstatement of ETCS balises shall be done in accordance with the Like for Like requirements detailed in Section 6 above.

The order of balises within a group shall not be changed. The removal of more than one balise within the same balise group at the same time shall be avoided, unless it is specifically required by track works.

Two consecutive balise groups shall not be removed from the track, unless the equipment has first been booked out of use in accordance with PR S 40008.

For the reconnection of multiple balises, the certification tasks for one balise shall be completed before commencing the next balise.

In scenarios where an ASDO calibration balise cannot be repaired or installed at the correct location (e.g. rail clips are damaged or sleeper is not fit for installation), the ASDO calibration balise shall be booked out of use in accordance with PR S 40008, removed or muted using the approved metallic cover and re-installed at the next available opportunity. This will ensure that the system is more restrictive which may result in doors on the extremities of a fitted train not being operational in ASDO mode.

Balises may be fitted with an approved mechanical cover to prevent it from being read by trains passing over it. Refer to standard drawing M05-535 for details of an approved cover. Balises shall not be muted by means of the BEPT.
10 Equipment Specific Information

10.1 Temporary Speed Warning Balise
Temporary speed signs are placed on the infrastructure to advise train drivers and track vehicle operators of temporary speed restrictions. They are applied in accordance with Network Rule NSG 604 and Network Procedure NPR 713, and are generally installed by track discipline personnel.

Where a temporary speed restriction exists, ETCS Temporary Speed Warning (TSW) balise groups are provided by the track discipline to reinforce the notice of temporary speed signage.

TSW balise groups consist of a set of two balises placed at the temporary warning sign. The first balise within the group in the direction of travel has a blue Balise ID Plate, and the second has a Yellow Balise ID Plate. Each BG has the same standard programming and does not contain any specific speed information. The driver will receive a standard warning message only, which needs to be acknowledged to avoid a brake application.

10.2 Virtual Balise Cover
The purpose of the Virtual Balise Cover (VBC) function, is to inhibit the onboard system from acting on telegrams received from trackside, thus VBC instructs an ETCS fitted train to ignore any balises within a defined area.

The VBC functionality is used to facilitate the rollout of new trackside ETCS equipment over a line of route where ETCS fitted trains are already operating in an area with commissioned trackside ETCS equipment, and will be removed once the ETCS equipment on that section of line has been commissioned. For further information on VBC functionality refer to PR S 45006.

VBC's orders are sent at every limit of an AMS deployment areas not yet commissioned.

VBC consists of two BGs. Each BG consists of two balises for redundancy. These are installed at the beginning and end of the section to be inhibited. VBC balises can be visually identified by their red coloured Balise ID Plates.

10.3 Ethernet Switch
Siemens model RS900 Ethernet switch is used for optical and copper Ethernet connection where LEU modules are required to be networked, for example where more than 6 LEU inputs are required for functionality, or for 'look ahead' functionality.

The RS900 Ethernet switch does not need to be managed nor configured for ETCS point to point application.

10.4 Big Metal Masses
A Big Metal Mass (BMM) is defined in EGG 1656 "Balise Placement and Metal Mass Assessment Guide". Licensed signalling personnel shall be observant for BMMs in the four foot on ETCS lines. Any new BMM not already managed by a BMM announcement balise group shall be identified as per EGG 1656, reported and managed in accordance with MN S 41604.
A BMM in the four foot of the track can obstruct the ability of the on-board transmission equipment to function correctly. If a BMM is detected, the on-board system might report a malfunction (system failure), resulting in an emergency brake intervention.

Where a BMM is identified, an ETCS balise group consisting of two fixed balises is used to announce the presence of the BMM to the on-board equipment, which then ignores all balise group messages until a second balise group, also consisting of two fixed balises is used to tell the on-board equipment that the BMM has been cleared.

10.5 **ASDO Calibration Balise and Calibration Plaque**

An ASDO calibration balise is installed if the distance between the platform information BG to the stopping point causes the confidence interval to become too large and thereby causing passenger doors on extremities to become unnecessarily inhibited. Some platforms may not need a calibration balise.

An ASDO calibration plaque shall be placed at the platform face to enable accurate re-installation during the asset life cycle. ASDO calibration balises must be maintained in a position accurate to the designed position as shown in Table 1, inclusive of rounding errors, for the life of ASDO.

10.6 **Supply and Management of BEPT tools and Accessories**

Only approved test equipment and accessories shall be used. Complete BEPT kits and individual kit components are available from Sydney Trains Logistics Services. Part numbers are provided in MN S 41604.

Each BEPT and Gold Key has a unique number attached. A record is to be kept of personnel issued with BEPTs and Gold Keys including serial and identifying numbers. For traceability these items shall be included on the minor plant register against an individual or team.

Sydney Trains Logistics Services shall gain approval from the Professional Head Signals & Control Systems (or nominated delegate) prior to the issue of a Gold Key or BEPT regardless whether in a kit or individual form.

A record shall be kept on file by the person responsible for the BEPT where loss or damage has occurred to the following items:

- BEPT G3 Core
- BEPT 'USB Booting Key'
- BEPT (G3) terminal (ALGIZ7)
- LEU configuration key adaptor,

The record is to contain the following information as a minimum.

- Date and name of person making report
- Item serial number/s
- Area responsible for the BEPT (e.g. Network base, business unit, company, etc.)
- Outline of incident including persons involved.

A copy of the record is to be forward to the Principal Engineer Signal Systems.
11 Balise and Encoder Programming and Test Tool (BEPT)

11.1 General Precautions

The Balise and Encoder Programming and Test (BEPT) tool is a ruggedised computer, sealed within a hard case, with a built in ETCS transmitter/receiver, which is used for programming and reading LEUs and balises.

Directions for the use of the BEPT are provided in MN S 41604. Full details of the use of the BEPT are detailed in MN S 41607 BEPT G3 User Manual.

The BEPT shall not be left on top of a balise within the four foot during passage of a train.

The BEPT shall not be opened by the user for any reason. It shall be considered as a sealed unit.

BEPT repairs shall not be undertaken by unauthorised personnel. Faulty BEPTs shall be returned to the manufacturer or authorised agent for repair.

Where a BEPT Core has required the reloading of its software or other faults, then a record shall be kept on file by the person responsible for the BEPT. The record is to contain the following information as a minimum.

- Date
- BEPT serial number
- USB Booting Key serial number
- Area responsible for the BEPT (e.g. Network base, business unit, company, etc)
- Programmer (i.e. person who performed reboot of software)
- Reason for rebooting BEPT or description of issue

A copy of the activity record is to be forwarded to the Principal Engineer Signal Systems.

Balise or LEU configuration key data, or missions shall not be kept stored in the BEPT, as referenced in Section 12 of this procedure.

BEPT calibration is not required.

11.2 BEPT Logins

BEPT users shall log in to the BEPT as per the authority level relevant to the task being undertaken. The relevant BEPT log in profiles for the various tasks is detailed in MN S 41604 and MN S 41605. A full list of user profiles and permissions is provided in MN S 41616.

12 Security of As-Commissioned ETCS Data

The BEPT shall be loaded only with the latest approved trackside configuration data, in accordance with the installed data forms for the specific installation intended for the balises or LEU configuration keys that are to be replaced or tested. The latest data shall be transferred from 'ProjectWise' using the specifically issued USB memory stick, which shall be immediately erased once the data has been loaded in the BEPT.
To minimise security risks, the USB memory stick shall not be used for any purpose other than ATP/ETCS associated tasks.

Once a specific task has been successfully completed using the BEPT, it is essential that all trackside configuration data and missions are deleted, to prevent incorrect data being used for future tasks.

If the CRC is misread by the BEPT during the testing of balise or LEU configuration key data, after ensuring the correct missions had been selected for programming and installed, work shall cease and the BEPT shall be quarantined until it can be ascertained that it is working correctly.

12.1 Management Of Data Files

ETCS L1 data is managed by the Signalling Documentation Section.

ETCS L1 data files include LEU configuration key and balise data files, missions, ETCS Data Release Notes and ETCS Installed Data Forms.

Processes for the management of ETCS data control and configuration within the Sydney Trains network are detailed in PR S 45005 ETCS Data Storage and Access. Data selection decision flowcharts are provided in PR S 45005 to guide maintainers and ICON Infrastructure for various scenarios.

ETCS L1 data files are stored in the 'ETCS L1 Data' folder in the Bentley ProjectWise application.

The 'ETCS L1 Data' folders are further sub-divided into folders for each geographic region, i.e. Central, North, West and Illawarra, as well as a '1 Common Files' folder for standard forms and reference files applicable to all regions and a '2 VBC Generic Data' folder containing a register for virtual balise cover applications.

ETCS Installed Data Forms include information on all of the specific data files for a circuit book area, including file version, checksum, relevant header information, and modification status for the latest version of data installed.

The ability to view and access folders will depend on the rights of the user as detailed in PR S 45005.

12.1.1 Maintenance

Data is copied to the 'Commissioned As-built' folder in ProjectWise by design personnel soon after the data is commissioned.

The signalling maintenance engineer or other authorised persons shall be granted read only access to these files.

![Figure 1 Commissioned As built data folder](image-url)
12.1.2 Interim As-built

The "Interim As-built Sxxxxx – Contact ICON after HHMM DD_MM_YYYY" temporary folder contains data that is either to be commissioned or has recently been commissioned. To issue data to site, data is copied into this folder by design staff.

Project staff will download data from this folder for the purpose of uploading to balises and LEU configuration keys.

![Interim As-built data folder](image)

13 Current and Contact Sensing LEU Installations

Current sensing is a method of interfacing an ETCS LEU to the signalling system typically used with SSI or Westrace installations, where signal lamps are driven directly from TFM outputs. Some isolated installations use a relay interface for signals, and any LEUs associated with these signals will be required to use a contact sensing interface.

Contact sensing is a method of interfacing an ETCS LEU to the signalling system typically used with relay or Microlok installations, where signal lamps are driven over conventional relay contacts. Some isolated Microlok installations use a lamp driver card for signals. No interface has yet been developed for LEUs associated with these signals.

13.1 Effects of Lamp Failure

There are significant differences between the current and contact sensing methods used to interface LEUs with the existing signalling. Contact sensing uses the state of the signal control relays for LEU inputs, whereas current sensing uses the actual signal lamp circuit currents, and hence the reaction to a lamp failure will differ.

13.1.1 Current Sensing

With current sensing, some limited lamp failures that would otherwise operationally permit a driver to proceed past a failed signal (after stopping) will require the driver to select Staff Responsible (SR) mode in order to proceed past the signal, at a capped speed as far as the next balise group. This is not considered a hazard, but may have some operational impact in terms of delays.

An incomplete or invalid aspect will be interpreted by an LEU as an invalid input mask and will result in a default telegram being sent to the train. Should a train pass over a balise group announcing a default telegram, the ETCS response will be defined by the linking reaction sent from the last balise group in rear. For the majority of installations this will be the announcement of trackside failure on the DMI, with no service or emergency brake intervention occurring. If the balise was associated with an ETCS trainstop function, then a default telegram will cause a service brake application.

If a train is in SR mode, then a service brake application will always occur when a default telegram is received.
13.1.2 **Contact Sensing**

Contact sensing is independent of the characteristics of the lamp fitted in the signal.

LEUs using a contact sensing interface will reflect the state of the signal control relays, irrespective of whether the lamp is actually lit.

13.2 **Effect of Variations in LED Lamp Current Draw**

13.2.1 **Current Sensing**

Information on how to set up current sensing inputs for each lamp type is detailed in the MN S 41604.

As LED lamps can degrade during their life cycle, they could cause an LEU which was correctly set up at the time of commissioning, to not sense the current of the lit LED. Also, as LED lamp current characteristics vary between lamps, a replacement LED lamp could have a significantly higher or lower current draw than the LED lamp replaced. For LEUs utilising current sensing, this can also cause an LEU to not sense the current of a lit LED. Adjustments to the lamp proving resistor may be required in these circumstances. Where this is the case, the signal maintenance engineer shall be duly notified for instructions.

13.3 **Removal of an LEU**

For current sensing installations, if an LEU is removed without the bypass terminals first being closed, the aspect on the signal will be extinguished.

The correct use of bypass terminals and associated consequences of use are referenced in MN S 41604.

For contact sensing installations, the removal of an LEU will have no effect on the signal aspect.

14 **Equipment Removed From Service**

Failed balises, LEU power supplies, LEUs and RS900 modems shall be returned to the manufacturer or their authorised agent as required, for warranty assessment and failure analysis.

Equipment suspected of causing a signalling irregularity shall not be disturbed including balise/LEU data or power supply. Refer to PR S 40004.

Failed items which are not returned for analysis (typically those which have a clear cause of failure and which are clearly outside of the manufacturers control such as: lighting strike, voltage surge, physical impact, etc.), shall be destroyed and disposed of in accordance with legislative requirements and corporate policies.

A permanent record (including serial number) shall be kept of all destroyed balises, LEU power supplies, LEUs, LEU configuration keys and RS900 devices.

Where ETCS equipment is relocated (including placed into storage for future use), the description, serial number and location details shall be updated in the permanent record.
A balise, LEU and LEU Configuration Key all contain data specific to a location. Prior to, or immediately after removal; fit an identification tag to the equipment. The tag shall include the following minimum details:

- Balise/LEU ID Nameplate information,
- Balise/LEU Serial number (where legible),
- Reason for removal (e.g. recovered / spare),
- Date, and
- Name.

**Caution**

The tag must remain on the balise/LEU/LEU Configuration Key as long as they contain or are paired with configuration data.

LEU Configuration Key data cannot be erased only overwritten

14.1 **Balise**

Where a balise is recovered for potential re-use, the existing configuration data shall be erased from memory, using a BEPT. Once the data has been erased, each balise shall be appropriately tagged, before being stored.

14.2 **LEU**

Where an LEU is recovered for potential re-use, the LEU shall be immediately de-paired, using a Gold Key. Once the LEU has been de-paired, it shall be appropriately tagged, before being stored.

14.3 **LEU Configuration Key**

Where an LEU configuration key is recovered for potential re-use, additional care must be taken as there is no means of erasing existing data. The LEU configuration key shall be appropriately and securely tagged, before being stored for reuse.

Where an LEU configuration key has either failed or is suspected of failure, it shall be destroyed and disposed of, so that it cannot find its way back into circulation for possible future re-use.

14.4 **BEPT**

Where a BEPT has failed or is suspect, it shall be immediately removed from use. All reports and analysis files shall be downloaded from the BEPT, as detailed within MN S 41605. The BEPT shall be returned to the manufacturer or their agent, for analysis.

Upon receipt of a repaired BEPT from the manufacturer or their authorised agent, the memory shall be cleared of all configuration files, before use.
15 Forms for ETCS L1 Testing

Testing and certification activities shall be recorded on the following forms as applicable:

- PR S 40028 FM01 - Balise Replacement Testing (ETCS M1)
- PR S 40028 FM02 - LEU Replacement Testing (ETCS M2)
- PR S 40028 FM03 - Configuration Key Replacement Testing (ETCS M3)
- PR S 40028 FM04 - ATP Power Supply Maintenance Testing (ETCS M4)

Samples of the above forms are provided in Appendix A.
**Appendix A  Sample Forms**

**PR S 40028 FM01 - Balise Replacement Testing (ETCS M1)**

<table>
<thead>
<tr>
<th>Completed By:</th>
<th>Date:</th>
<th>BEPT Serial No:</th>
<th>Location ID</th>
<th>Signal Name</th>
<th>Signal Name</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**PART A**

<table>
<thead>
<tr>
<th>Description</th>
<th>1st Balise PIG:</th>
<th>2nd Balise PIG:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serial Number / Version (Revision)</td>
<td>V XXXXX</td>
<td>V XXXXX</td>
</tr>
<tr>
<td>Balise ID Plate (on Balise)</td>
<td>WWW XXXXXXXX</td>
<td>WWW XXXXXXXX</td>
</tr>
<tr>
<td>Balise Location ID Plate (on Sleeper)</td>
<td>YYYY Z_T</td>
<td>YYYY Z_T</td>
</tr>
<tr>
<td>Horizontal distance from balise side to rail (in each corner) are equal +/-10mm (direct fixed balises only)</td>
<td>OK</td>
<td>OK</td>
</tr>
<tr>
<td>Vertical distances from top of the balise to highest part of the rail are equal +/-10mm (direct fixed balises only)</td>
<td>OK</td>
<td>OK</td>
</tr>
<tr>
<td>No other cable within 400mm of Balise</td>
<td>OK</td>
<td>OK</td>
</tr>
<tr>
<td>Where Balise Location ID Plate is missing, measure &amp; record distances from As Built SCF reference asset</td>
<td>Asset 1</td>
<td>Asset 1</td>
</tr>
<tr>
<td>Tick &quot;OK&quot; for balise location within permitted tolerance</td>
<td>OK</td>
<td>OK</td>
</tr>
<tr>
<td>(+4600mm for ATP and +/−350mm for ASDO Calibration Balise)</td>
<td>OK</td>
<td>OK</td>
</tr>
<tr>
<td>Mounting Type (circle mounting type):</td>
<td>OK</td>
<td>OK</td>
</tr>
<tr>
<td>(Universal Beam / eClip / FastClip / Direct / Guardrail) installation / ASDO calibration)</td>
<td>OK</td>
<td>OK</td>
</tr>
</tbody>
</table>

**Note:** Other than for necessary track works, only 1 balise should be removed and replaced at any one time.

**PART B**

<table>
<thead>
<tr>
<th>Description</th>
<th>Y/N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Configuration file name including Version (f, v, p)</td>
<td>Y/N</td>
</tr>
<tr>
<td>Programming mission executed successfully (from BEPT)</td>
<td>OK</td>
</tr>
<tr>
<td>Verification mission executed successfully (from BEPT)</td>
<td>OK</td>
</tr>
<tr>
<td>Write CRC (from BEPT)</td>
<td>XXXX XXXX</td>
</tr>
<tr>
<td>Request Validator to confirm CRC and file Version match and record the response</td>
<td>Yes / No</td>
</tr>
<tr>
<td>If match confirmed, write CRC and file Version (f, v, p) from Validator</td>
<td>XXXX XXXX</td>
</tr>
</tbody>
</table>

**PART C**

<table>
<thead>
<tr>
<th>Description</th>
<th>1st Balise</th>
<th>2nd Balise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Balise Telegram Testing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Balise Group ID (NID_BG)</td>
<td>Default</td>
<td>Connected</td>
</tr>
<tr>
<td>Position in Group (N_PIG)</td>
<td>Connected</td>
<td>Connected</td>
</tr>
<tr>
<td>Country Code NID_C</td>
<td>Default</td>
<td>Connected</td>
</tr>
<tr>
<td>M_MCOUNT</td>
<td>Connected</td>
<td>Connected</td>
</tr>
<tr>
<td>Matches Balise ID Plate information</td>
<td>OK</td>
<td>OK</td>
</tr>
</tbody>
</table>

**Note:** For a controlled balise, readings from the BEPT should be taken with the cable disconnected and again with the cable connected.

**PART D**

<table>
<thead>
<tr>
<th>Description</th>
<th>Name</th>
<th>Signature</th>
<th>/</th>
<th>/</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Programmer</em></td>
<td></td>
<td></td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td><em>Verifier</em></td>
<td></td>
<td></td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td><em>Validator</em></td>
<td></td>
<td></td>
<td>/</td>
<td>/</td>
</tr>
</tbody>
</table>

**Note:** *Only required if programming has occurred*
- Maintenance activities - copy of form to be sent to the maintenance signal engineer.
PR S 40028 FM02 - LEU Replacement Testing (ETCS M2)

<table>
<thead>
<tr>
<th>Location ID</th>
<th>Signal Name</th>
<th>LEU ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEU Serial No.</td>
<td>LEU Hardware Version</td>
<td>OK</td>
</tr>
<tr>
<td>1</td>
<td>LEU Configuration Key tether cord length 190mm (+/-10mm)</td>
<td>OK</td>
</tr>
<tr>
<td>2</td>
<td>LEU Configuration Key secured (screws not loose)</td>
<td>OK</td>
</tr>
<tr>
<td>3</td>
<td>LEU Hardware and Software is approved version</td>
<td>OK</td>
</tr>
<tr>
<td>4</td>
<td>LEU Vital Plug Coupler(s) secured (screws not loose)</td>
<td>OK</td>
</tr>
</tbody>
</table>

Tick "OK" for each test or check completed successfully.

NID_BG        N_RIG       M_MCOUNT
Enter values read from BEPT.

<table>
<thead>
<tr>
<th>Proceed Aspects</th>
<th>State (ON/OFF)</th>
<th>Mode</th>
<th>Fault (Yes/No)</th>
<th>Current (mA)</th>
<th>Signal Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lamp 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lamp 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lamp 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lamp 4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lamp 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lamp 6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Check any one (1) proceed aspect. Enter all values shown on BEPT 'Calibration Table Reading' screen.

Note: The above level of testing is only valid where the configuration key has not been altered. Where the configuration key has been altered required testing is recorded on PR S 40028 FM03.

| 5 | Voltage at the outgoing side of the transient protection cassette for approximately 10V a.c. with the cassette installed. | OK |
| 6 | Where two balises are connected to one LEU, or more than two LEUs exist at the location, LEU output to the balise output cable correlated | OK |
| 7 | LEU Clock Set | OK |

Tick "OK" for each test or check completed successfully.

Certified by Name Signature / /
Maintenance Signalling Engineer Name Signature / /

This form is to forwarded to the maintenance signal engineer for review and filing.

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PR S 40028 FM03 - Configuration Key Replacement Testing (ETCS M3)

Completed By:  
Date: / /  
BEPT Serial No:  

<table>
<thead>
<tr>
<th>Location ID</th>
<th>Signal Name</th>
<th>LEU ID</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Configuration file name including Version (\# \# \#):

Program mission executed successfully (from BEPT):

OK [ ]  OK [ ]

Verification mission executed successfully (from BEPT):

OK [ ]  OK [ ]

Write CRC (from BEPT):

XXXX XXXX  XXXX XXXX

Request Validator to confirm CRC and file Version match and record the response:

Yes / No  Yes / No

If match confirmed, write CRC and file Version (\# \# \#) from Validator:

XXXX XXXX  XXXX XXXX  \# \# \#  

Tick "OK" for each test or check completed successfully

ETCS Input Correspondence Testing  
From BEPT

<table>
<thead>
<tr>
<th>Aspect</th>
<th>LEU A</th>
<th>LEU B (Look-Ahead)</th>
<th>NID BG</th>
<th>NID PIG</th>
<th>M_M Count</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 2 3 4 5 6</td>
<td>1 2 3 4 5 6</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Enter "1" or "0" corresponding to a high or low input  
Enter values read from BEPT

Note: All aspects used for the particular location need to be tested and compared with the values shown in the as-built circuit book control table.

Programmer
Name  
Signature  
Verifier
Name  
Signature  
Validator
Name  
Signature  
Maintenance Signalling Engineer
Name  
Signature

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Date in Force: 8 March 2019  
Version 1.0
Page 27 of 28  
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Prepared using: TP ESI 003 V1.8
PR S 40028 FM04 - ATP Power Supply Maintenance Testing (ETCS M4)

<table>
<thead>
<tr>
<th>Location ID</th>
<th>LEU ID</th>
<th>MIPS200 Serial No.</th>
<th>MIPS200 Hardware Ver.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### MIPS200 Power Supply Testing

<table>
<thead>
<tr>
<th>Signal / LEU</th>
<th>Voltage Measured</th>
<th>Acceptable Range</th>
<th>Volts to Earth Active / Positive</th>
<th>Volts to Earth Comm. / Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input 120Vac (No Load)</td>
<td>Vac</td>
<td>96 / 132 Vac</td>
<td>Vac</td>
<td>Vac</td>
</tr>
<tr>
<td>Busbar 120Vac (Lights etc.)</td>
<td>Vac</td>
<td>96 / 132 Vac</td>
<td>Vac</td>
<td>Vac</td>
</tr>
<tr>
<td>PSU 1 Output (No Load)</td>
<td>Vdc</td>
<td>24 Vdc (+/- 0.5%)</td>
<td>Vdc</td>
<td>Vdc</td>
</tr>
<tr>
<td>PSU 1 Output (Loaded)</td>
<td>Vdc</td>
<td>24 Vdc (+/- 0.5%)</td>
<td>Vdc</td>
<td>Vdc</td>
</tr>
<tr>
<td>PSU 2 Output (No Load)</td>
<td>Vdc</td>
<td>24 Vdc (+/- 0.5%)</td>
<td>Vdc</td>
<td>Vdc</td>
</tr>
<tr>
<td>PSU 2 Output (Loaded)</td>
<td>Vdc</td>
<td>24 Vdc (+/- 0.5%)</td>
<td>Vdc</td>
<td>Vdc</td>
</tr>
<tr>
<td>PSU 3 Output (No Load)</td>
<td>Vdc</td>
<td>24 Vdc (+/- 0.5%)</td>
<td>Vdc</td>
<td>Vdc</td>
</tr>
<tr>
<td>PSU 3 Output (Loaded)</td>
<td>Vdc</td>
<td>24 Vdc (+/- 0.5%)</td>
<td>Vdc</td>
<td>Vdc</td>
</tr>
</tbody>
</table>

**NOTE:** In the 24 V circuit, the negative is connected with the earth (design of the equipment).

### Contact Sensing (Toroidal Transformer) Power Supply Testing

<table>
<thead>
<tr>
<th>Transformer ID</th>
<th>Volts (Vac)</th>
<th>Acceptable Range</th>
<th>Current (mA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input 120Vac (No Load primary)</td>
<td>96-132 Vac</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Busbar 120Vac (on load)</td>
<td>96-132 Vac</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transformer Secondary 1 (12Vac)</td>
<td>10.6-15.7 Vac (8.5:1 ±5%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transformer Secondary 2 (12Vac)</td>
<td>10.6-15.7 Vac (8.5:1 ±5%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transformer Current Balance</td>
<td>Currents within 10% (of each other)</td>
<td>OK / Not OK</td>
<td></td>
</tr>
</tbody>
</table>

### Remarks:

<table>
<thead>
<tr>
<th>Tester</th>
<th>Name</th>
<th>Signature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintenance Signalling Engineer</td>
<td>Name</td>
<td>Signature</td>
</tr>
</tbody>
</table>

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Engineering Procedure
Signalling and Control Systems

Signalling Safeworking

PR S 40029

Point Lock Testing – Mechanical

Version 1.1

Date in Force: 21 September 2016
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Document control

<table>
<thead>
<tr>
<th>Version</th>
<th>Date</th>
<th>Author/Prin. Eng</th>
<th>Summary of change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>16 September 2013</td>
<td>Y Bagaric</td>
<td>First issue as a Sydney Trains document</td>
</tr>
<tr>
<td>1.1</td>
<td>21 September 2016</td>
<td>Colin Darmenia</td>
<td>Updated to ASA Standards</td>
</tr>
</tbody>
</table>

Summary of changes from previous version

<table>
<thead>
<tr>
<th>Summary of change</th>
<th>Chapter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terminology change from F.P.L. to Point Locks (consistent with power operated points)</td>
<td>All</td>
</tr>
<tr>
<td>Prerequisites added, Wide Cut Lock Slides added, Derail reference added</td>
<td>1.1, 1.3, 3.0</td>
</tr>
<tr>
<td>Type D point lock adjustment added</td>
<td>2.2</td>
</tr>
</tbody>
</table>
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1 Introduction

Point locks are locking mechanisms that secure switches to stockrails. A locking mechanism may be provided on trailing ends as well as facing ends to facilitate and simplify yard working arrangements.

The mechanical lever in the interlocking machine is designated as the F.P.L. Lever (Facing Point Lock Lever) in accordance to its lever name plate and associated diagrams.

Points referenced in this procedure are layouts operated from a mechanical interlocking frame. Non-interlocked points, including ball lever and throw-over types, or spring switch types such as Thompson, Thornley, or similar, are not covered by this procedure.

Point locks must be periodically maintained and tested to ensure the reliable operation of the points and that with the point lock engaged, the switches are held within specified limits of the running face of the stock rail and to ascertain if the slide chairs in the vicinity of the points rodding have worn, or the stock rails have worn, or the track gauge has varied. The open switch is to also be securely held in the correct position with sufficient rear flangeway clearance. The positions of switch rails, point drives, lock drives and other critical movements are to be correctly detected (where applicable).

Licensed signalling personnel must notify the Civil representative of any undue movement or wear of the track at the points and request rectification of same.

The points must be moved to both normal and reverse positions to confirm the switch rails fit against the stock rail, along its machined length. The open switch must be checked to be securely connected with correct tip opening and flangeway clearance. Adjustments must be made as necessary. The associated point rodding and fastenings must be checked to ensure they are in proper condition.

1.1 Point Adjustment Strategy

The point lock is adjusted to provide a 'go' (engage) setting of 1.6 mm switch opening and a 'no-go' (fail to engage) setting with 3.2 mm switch opening. The switch detection is complementary and should be just made at 3.2 mm and broken at 4.8 mm switch opening (refer to PR S 40030 Point Lock and Detection Testing on Power Operated Points for detection requirements).

These settings ensure that when a switch lock is correctly set within these limits, detector contacts are firmly made and will not ‘bounce’ with train passage over the points.

1.2 Point Record Requirements

Point lock returns must be completed in accordance with PR S 40017 Maintenance Responsibilities and Frequencies for points tested during the maintenance period and copies forwarded to the maintenance signal engineer. Additionally, a return must be provided following any out of course adjustment or test made between routine maintenance inspections. Details of adjustments made must be included in the return.

The Point History Card PR S 40017 FM 03 is to be completed for point maintenance, adjustment, failure investigation or attendance. Record any adjustment or maintenance comments on the Point History Card. Refer to PR S 40017 for details.
1.3 **Prerequisite Tasks**

Prior to point lock or detection testing, licensed signalling personnel must confirm that:

- There is no evidence of excessive movement affecting the correct track gauge, including evidence of any excessive lateral movement of switch and stockrails.
- There are no rail defects on the switch and stock rails such as rail overflow, or rail surface defects that may affect the integrity of the turnout.
- The point lock, detection and drive components are secure, in sound condition and will effectively perform the intended function.
- Switch plates and switch rollers (where fitted) are checked for even loading of switch rails.
- Switch plates and switch rollers (where fitted) are cleared of possible obstructions, cleaned and lubricated to permit uninhibited operation of the switch rails.

Licensed signalling personnel must notify the Civil representative of any undue movement or wear of the track at the points and request and follow up rectification.

1.4 **Safety Arrangements for Points Testing and Adjustments**

In routine testing of point locks and point detection, licensed signalling personnel carrying out the tests must liaise with the Network Control Officer (NCO) so that the testing is conducted without detriment to safety or train working. The NCO is to place affected controlled signals at stop before the testing is allowed to commence. The NCO is to ensure that signals across all ends of points are to remain at stop during gauging activities.

During testing activities, mechanical points are to be operated by means of the lever in the interlocking machine.

Licensed signalling personnel are to remain in direct communication with the NCO during gauging activities.

Where adjustment of point locks or point detection is required, the signals protecting the points are to be disabled or booked out of use, as appropriate, for traffic movements in accordance with *PR S 40008*, Network Rule *NWT 312* and Procedure *NPR 704* before commencing adjustment.

2 **Point Lock Testing General Requirements**

For pre-requisite requirements to point lock testing and adjustment, refer to Section 1.3

The points must be operated to both normal and reverse positions to confirm the switch rails fit firmly against the correct stock rail, along its machined length and as far as possible without switch roll as this will introduce error into the test. The lock plunger travel is to be 200 mm, except in the case of double lock plungers worked by one lever, where the travel is 175 mm. When the lock plunger is withdrawn the clearance between the end of the lock plunger and the slotted lock rod or locking rod block is to be 20 mm. For the point lock detector the lock must enter in the notches with clearance on both sides.

Gauges are inserted between the point switch and the stock rail within 75 mm from the switch tip and in line with the stretcher at the toe of the points.

When gauge testing a point lock the 3.2 mm gauge is used and the lock must be maintained sufficiently tight to ensure that the movement of the F.P.L. lever cannot be completed with the gauge inserted between the point switch and the stock rail.
For reliability the 1.6 mm gauge is used to ensure that the movement of the F.P.L. lever can be fully completed with the gauge inserted between the point switch and the stock rail.

On mechanically operated points fitted with point lock detectors (such as HLM style); in addition to the above requirements the point lock is to enter into the slide notch with sufficient clearance on both sides.

On mechanically operated catchpoints, a fully entered point lock must not permit the open switch to close by less than 100 mm; additionally the point lock must not enter if the open switch is open by less than 100 mm.

The switch must be operated by means of the lever in the interlocking machine. When the point locking mechanism locks the points both ways, each switch must be tested.

Some locations as follows may have special arrangements, such as where a point lock detector is used as a replacement for a wire lock, a wider notch is permitted:

- Lithgow 3.2 mm gauge go, 4.8 mm gauge no go.

Where adjustment is required the signals protecting the points are to be disabled or booked out of use, as appropriate, for traffic movements in accordance with PR S 40008, Network Rule NWT 312 and Procedure NPR 704.

3 Wide Cut Lock Slides

In certain circumstances, where the reliability of mechanical points can be improved by the provision of a wide-cut notch in the point lock-slide, then it may be permissible to implement such arrangement subject to approval by the Professional Head Signalling and Control Systems, and adherence of the requirements in accordance with ESG 100.14 Signal Design Principles – Points and the requirements in Section 3.1 below.

This provision only applies for the following mechanical arrangements:

- The Open switch position on Catchpoints
- The Trailing Only position

The maintenance signal engineer must control a register of all points with a wide cut notch point lock.

Points fitted with wide cut notch point lock slides are to be inspected every two years by a signal engineer as part of the mechanical interlocking inspection to ensure that the integrity of the arrangement is maintained and remain in accordance with the signalling plan or working sketch.

3.1 Requirements for the Provision of a Wide Cut Notch

Where the provision of a Wide-Cut Notch is approved:

a) The allowable cut-out for the wide-cut notch must not exceed 13 mm wider than the respective locking dog, conforming to the requirements of PR S 40030 Section 3.5 for the increase of detector settings.

b) Point Lock Adjustment:
   - For the open switch - the point lock must be adjusted so the lock does not enter with a switch opening of less than 100 mm. (Note the closed switch point lock must be adjusted in accordance with Section 2).
c) The maintenance signal engineer must maintain a register of all points fitted with a Wide-Cut Notch lock-slide for the maintenance area.

d) The affected points must be identified as non-locked points, to Signal Box Operations, for the purpose of yard working. The maintenance signal engineer is to ensure this information is updated and available.

e) The affected points must be identified in the signalling plan or working sketch as having lock slides removed.

Where points with Wide-Cut Notches are reinstated to standard configurations or decommissioned, the maintenance signal engineer is to confirm all actions listed above are updated.

4 Adjustments

4.1 Point Lock

If, during testing under normal operation, the switches do not fit hard up against the correct stockrail with some spring then the points drive may need adjustment.

If, during testing under normal operation, the point lock plunger is tight with the point switch blades fitting hard up against the stock rail then the points may need adjustment.

If, during gauge testing, it is found that the F.P.L. lever can be put fully home with the gauge between the point switch and stock-rail, then adjustment is necessary.

Before adjustment, ensure that there is no movement due to a loose lock casting or movement of stockrail or chairs.

Adjustment must be immediately made as follows:

a) Loosen the two bolts at the joint in the lock rod, sufficiently to allow the disengagement of the serrations. Adjust the lock rod bar accordingly and reengage the serrations at the required new position. Tighten the bolts.

b) If the required adjustment is less than that provided by the serrations, or if the lock rod is of the non-serrated type, shims must be used. These are to be inserted between the switch and the lock rod.

If the extent of the wear is such that a properly adjusted lock cannot be obtained the worn fittings must be replaced. The open switch and rear flangeway must be checked to be secure and have sufficient clearance. Any event causing the rear flangeway clearance to become altered (for example, worn switch rail or bent rodding) must be suitably tested to ensure the clearance is to specification.

4.2 Type D Point Lock Detectors

Mechanical points fitted with a type D point lock are provided with a cross-slide or detection slide. The slides are operated by the point plunger and are connected to an electrical or a mechanical detector. The detector proves the locked position of the type D point lock.
The detector contacts must not make until the point lock plunger has completed two thirds of its stroke. This specification equates to a dimension between 130mm and 140mm of its 200mm stroke towards the locked position.

If, during testing under normal operation, the switches do not fit hard up against the stockrail with some spring then the points drive may need adjustment.

If, during testing under normal operation, the point detector lock is not in the centre of the notch with the point switch blades fitting hard up against the stock-rail then the points may need adjustment.

Before adjustment ensure all fastenings are tight, especially the sleeper and bedplate fixings, and rodding.

Where the travel on the lock slide is insufficient or excessive, adjustment must be immediately made as follows:

a) Loosen the two bolts at the joint in the lock rod, sufficiently to allow the disengagement of the serrations. Adjust the lock rod bar accordingly and re-engage the serrations at the required new position. Tighten the bolts.

b) If the required adjustment is less than that provided by the serrations, or if the lock rod is of the non-serrated type, shims must be used. These are to be inserted between the switch and the lock rod.

c) If the extent of the wear is such that a properly adjusted lock cannot be obtained the worn fittings must be replaced.

d) If the lock is not in the centre of the slide, adjust the lock rod to correctly centre the notch around the lock.

4.3 Siemens (Westinghouse) HLM & HDLM Type Point Lock Detectors

The point lock detection on Siemens (Westinghouse) HLM & HDLM units is not adjustable. By design, the lock detection contacts will not be made until the lock bolt has sufficiently dropped onto the lock bar. During testing, licensed signalling personnel are to confirm the lock bolt, actuator and lock detection contacts operate smoothly with no evidence of wear or damage.

The point lock itself must be set and adjusted as per Section 2 and Section 4.1 of this document.

The adjustment of Westinghouse HLM & HDLM type switch detection must be as per PR S 40030.

5 Point Switch and Derail Detectors on Mechanical Points

The adjustment of point switch detectors and derail detectors is to be in accordance with PR S 40030.
PR S 40030

Point Lock and Detection Testing on Power Operated Points

Version 1.2

Date in Force: 14 February 2017
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1 General Requirements

1.1 Introduction

Point locks are locking mechanisms that secure switches to stockrails. Where a drive system incorporates an integrated lock mechanism, the point lock requirements will apply. Point locks in new installations are provided for facing and trailing points, to facilitate and simplify yard working arrangements.

All point machines must be periodically tested to ensure the reliable operation of the points and that, with the point lock engaged, the switches are held within specified limits of the running face of the stock rail. The open switch is to also be securely held in the correct position with sufficient rear flangeway clearance. The position of switch rails, point drives, lock drives and other critical movements are to be correctly detected.

1.2 Point Adjustment Strategy

Older types of point mechanisms had the detection contacts mechanically interlocked with the point lock such that it was not possible to obtain detection with the lock not plunged. Later point mechanisms may have separate independent lock and detector contacts. For Claw Lock and Spherolock type operating mechanisms, an assurance of locking is determined by the position of the drive bar.

In all cases (except Claw Lock mechanisms – refer to Section 2.2) the point lock is adjusted to provide a 'go' (engage) setting of 1.6 mm switch opening and a 'no-go' (fail to engage) setting with 3.2 mm switch opening. The switch detection is complementary and should be just made at 3.2 mm and broken at 4.8 mm switch opening.

These settings ensure that when a switch lock is correctly set within these limits, detector contacts are firmly made and will not ‘bounce’ with train passage over the points.

1.3 Point Testing Requirements

Point lock returns must be completed in accordance with PR S 40017 - Maintenance Responsibilities and Frequencies for points tested during the maintenance period and copies forwarded to the maintenance signal engineer. Additionally, a return must be provided following any out of course adjustment or test made between routine maintenance inspections.

The Point History Card (PR S 40017 FM 03 and FM04) is to be completed for points maintenance, adjustment, failure investigation or attendance. Record any adjustment or maintenance comments on the Point History Card.

1.3.1 Prerequisite Tasks

Prior to point lock or detection testing, licensed signalling personnel must confirm that:

- There is no evidence of excessive movement affecting the correct track gauge, including evidence of any excessive lateral movement of switch and stockrails.
- There are no rail defects on the switch and stock rails such as rail overflow, or rail surface defects that may affect the integrity of the turnout.
- The point lock, detection and drive components are secure, in sound condition and will effectively perform the intended function.
- Switch plates and switch rollers (where fitted) are checked for even loading of switch rails.
Switch plates and switch rollers (where fitted) are cleared of possible obstructions, cleaned and lubricated to permit uninhibited operation of the switch rails.

The backdrive equipment (where fitted) is checked for correct operation.

Licensed signalling personnel must notify the Civil representative of any undue movement or wear of the track at the points and request and follow up rectification.

1.4 Safety Arrangements for Points Testing and Adjustments

In routine testing of point locks and point detection, licensed signalling personnel carrying out the tests must liaise with the Network Control Officer (NCO) so that the testing is conducted without detriment to safety or train working. The NCO is to place affected controlled signals at stop before the testing is allowed to commence.

During testing and adjustment activities, electric motor operated points must preferably be operated by hand using the applicable ESML handle (and maintenance handle where provided) or the EOL key and hand throw lever for point machines so equipped. Signals protecting the points concerned must first be placed at stop and approaching trains brought to a stand before the ESML or EOL keys are taken.

For electro pneumatic points, where Plug Connector and Key or manual actuator arrangements for Style E or ES points are used, or where EOL arrangements are used, the signals protecting the points concerned must first be placed at stop and approaching trains brought to a stand before the Plug Connector is disconnected or the EOL switch or EOL key is operated.

Where power operated points are being tested using the points control lever, the NCO is to ensure that signals across all ends of points are to remain at stop during gauging activities. Licensed signalling personnel are to remain in direct communication with the NCO during gauging activities. Where the ESML, EOL or Plug Connector and Key arrangements are not being used and adjustment is required, the signals protecting the points are to be disabled or booked out of use, as appropriate, for traffic movements in accordance with PR S 40008, Network Rule NWT 312 and Procedure NPR 704 before commencing adjustment.

2 Point Lock Testing and Adjustment

For pre-requisite requirements to point lock testing and adjustment, refer to Section 1.3.

The points must be operated to both normal and reverse positions to confirm the switch rails fit firmly against the correct stock rail, along its machined length, without switch roll. For conventional type mechanisms, the point lock must fully enter and withdraw from the notch freely and with sufficient clearance. For Claw Lock or Spherolock mechanisms, the lock must engage and release smoothly.

The open switch must be checked to be securely connected with correct tip opening and flangeway clearance. Any event causing the rear flangeway clearance to become altered (for example, worn switch rail, loose backdrive nuts, bent rodding) must be suitably tested to ensure the clearance is to specification. Adjustments are to be made as necessary.

2.1 Conventional Type Mechanisms

The point lock must be tested in accordance with the procedure laid down for the particular type of point machine in the Point Equipment Manuals. Avoid switch roll as far as possible as this will introduce error into the test.
The point lock test must be carried out using in turn gauges for openings of 3.2 mm and 1.6 mm between the stockrail running face and the switch at a position approximately, and not more than, 75 mm back from the tip of a conventional type of switch. For tangential type switch rails, the test position must be in line with the drive rod connection.

The lock must not enter with a switch opening of 3.2 mm, but must enter with a switch opening of 1.6 mm.

Ideally, on those machines with the locking notch approximately 3.2 mm wider than the locking dog, the locking dog should be centred in the notch with the switch closed against the stockrail. This situation will avoid lock wear and tight locks on both locking and non-locking sides and will comply with the go, no-go figures specified above.

The point lock on single bladed catchpoints and independent points in the open position, where Sections 2.1.1 or 2.1.2 do not apply, is not to enter with a switch opening of less than 100 mm. Additionally, the locking dog is to be centred in the lock slide. Point lock adjustment in the closed position is to be gauged as mentioned above.

2.1.1 Provision for Removal of Lock-Slides

In certain circumstances, where the reliability of trailing only points can be improved by the removal of the point lock slides, then it may be permissible to implement such arrangement subject to approval of the Professional Head Signalling & Control Systems and adherence of the requirements in accordance with ESG 100.14 Signal Design Principles – Points and the requirements listed in Section 2.1.3 below.

This provision only applies for the following arrangements:

- Trailing only points (both directions) operated by a combined electric switch machine.

2.1.2 Provision for a Wide-Cut Lock-Slide

In certain circumstances, where the reliability of points can be improved by the provision of a wide-cut notch in the point lock-slide, then it may be permissible to implement such arrangement subject to approval of the Professional Head Signalling & Control Systems and adherence of the requirements in accordance with ESG 100.14 Signal Design Principles – Points and the requirements listed in Section 2.1.3 below.

This provision only applies for the following arrangements:

- The open switch on catchpoints operated by combined electric switch machines
- The open switch on catchpoints operated by Signal Branch EP assemblies
- The trailing only position operated by Signal Branch EP assemblies

This permits a coarser adjustment of the detection as referenced in Section 3.5.

2.1.3 Requirements for Removal of Lock-Slides or Provision of a Wide-Cut Lock-Slide

i) Where the removal of Lock-Slides is approved for trailing only points operated by combined electric switch machines:

a) The unused guideways on both sides of the machine are to be plugged to prevent entry of dust and grit.

b) The maintenance signal engineer must maintain a register of switch machines with lock-slides removed for the maintenance area.
c) The affected points must be identified as non-locked points, to Signal Box Operations, for the purpose of yard working. The maintenance signal engineer is to ensure this information is updated and available.

d) The affected points must be identified in the signalling plan or working sketch as having lock slides removed.

ii) Where the provision of a Wide-Cut Notch is approved for the open switch on a catchpoint operated by combined electric switch machine:

a) The allowable cut-out for the wide-cut notch must not exceed 13 mm wider than the respective locking dog, conforming to the requirements of Section 3.5 for the increase of detector settings.

b) Point Lock Adjustment:
   - The open switch point lock is to be typically adjusted to be in the centre of the notch, but in any case, the lock must not enter with a switch opening of less than 100 mm. *(Note the closed switch point lock must be adjusted in accordance with Section 1.2).*

c) The lock-slide must be stamped "Wide Cut Notch" together with the applicable point end number - all in 6 mm letters.

d) The stamped text must be adjacent to the wide-cut notch on one side of the slide and on the top and bottom face at the end between the elongated slot and second hole.

e) An additional set of lines must be inscribed on the opposite face corresponding to the new wide-cut notch and the old marks must be stamped with a cross.

f) The wide-cut notch must be machined at an engineering machining facility.

g) Installation of modified lock-slides must be controlled by the maintenance signal engineer and certified on installation by a signal engineer.

h) The maintenance signal engineer must maintain a register of all point machines fitted with a wide-cut notch lock-slide for the maintenance area.

i) The maintenance signal engineer, as part of the 2 yearly mechanical interlocking inspection, must inspect the lock-slides of points with wide-cut notches to ensure the integrity of the arrangement is maintained and that the inscriptions are in accordance with the signal plan or working sketch.

j) The lock-slide with a wide-cut notch must always belong to its respective point-end at the specified location, or otherwise when made redundant, must be destroyed.

iii) Where the provision of a Wide-Cut Notch is approved for an open-switch catchpoint or for the trailing only position of points operated by Signal Branch EP assemblies:

a) The allowable cut-out for the wide-cut notch must not exceed 13 mm wider than the respective locking dog, conforming to the requirements of Section 3.5 for the increase of detector settings.

b) Point Lock Adjustment:
   - For the open switch - the point lock must be adjusted so the lock does not enter with a switch opening of less than 100 mm. *(Note the closed switch point lock must be adjusted in accordance with Section 1.2).*

   - For the trailing only switch – the point lock must be adjusted so the lock does not enter with a switch opening of 6.4 mm or more. *(Note the Facing switch point lock must be adjusted in accordance with Section 1.2).*
c) The maintenance signal engineer must maintain a register of all Signal Branch EP points fitted with a Wide-Cut Notch lock-slide for the maintenance area.

d) The affected points must be identified as non-locked points, to Signal Box Operations, for the purpose of yard working. The maintenance signal engineer is to ensure this information is updated and available.

e) The affected points must be identified in the signalling plan or working sketch as having lock slides removed.

- Where points with Lock-Slides removed or Wide-Cut Notches are decommissioned or reinstated to standard configurations, the maintenance signal engineer is to confirm all actions listed above are updated.

2.2 Claw Lock Mechanisms

Where points are driven and locked by claw lock assemblies, the point lock test must be conducted using a no-go obstruction gauge of 4.8 mm placed between the stock rail running face and the switch in line with the operating bar. The lock must enter with a 'go' obstruction gauge of 3.2 mm. This requirement applies to tangential and conventional switch rails.

Full details of this method of point lock adjustment are provided in TMG E1341 Claw Lock Mechanism – Safety and Functional Tests - Routine Maintenance.

2.3 Spherolock Mechanisms

Where points are driven and locked by Spherolock assemblies, the point lock test must be conducted using a no-go obstruction gauge of 3.2 mm placed between the stock rail running face and the switch in line with the drive rod. The lock must enter with a 'go' obstruction gauge of 1.6 mm.

Full details of this method of point lock adjustment are provided in inspection and maintenance manual MN S 41347 Spherolock NG Standard Gauge (Switch Device and Swingnose Crossing).

3 Detection of Switches

The prerequisite tasks defined in Section 1.3 must be performed prior to testing and adjustment of point detection.

3.1 Actions requiring Detection Adjustment

Where any of the following actions have occurred, it will be necessary to check and if required, re-adjust the detection contacts separately by slackening the point lock and applying the process detailed in Section 3.2 of this procedure.

a) There is some doubt as to the correct adjustment of the detector contacts.

b) The lock rod, points rods, or detection rodding has been disturbed to effect repair through damage or replaced through component wear.

c) The detection rodding/slides have been re-adjusted.

d) For the initial point lock and detection adjustment, where the points have been renewed, reconditioned or the points machine, detection slides or associated components have been replaced.

e) A failure of the points detection has occurred because of light contact adjustment.

f) Where civil work has been performed on the points that has the potential to effect the adjustment.
Adjustment of the points switch spring or the point lock by altering the lock adjusting rod, slides and or cranks will not require a separate check of the points detection contacts if the detector adjustment was not altered.

Note:

For points where the lock slides have been removed, it will be necessary to check the detector contacts as detailed in Section 3.2 below.

### 3.2 Setting of Detection contacts

The standard setting for points detection is expressed as detector contacts “just made at 3.2 mm” and “visibly open at 4.8 mm”.

This means that the detection contacts will be electrically made (not necessarily fully compressed) at a 3.2 mm switch opening.

“Visibly open at 4.8 mm” means that, at a 4.8 mm switch opening, detector contacts of the type which can be seen are to be clearly broken (i.e. by not less than 1 mm) even though the contact drive may not have fully completed its stroke.

Confirm that the detector contacts tested are actuated by the detector rod connected to the closed switch. Trace the rodding and linkages between the detector contact actuator, through the detector rod and to the closed switch to confirm that when the closed switch opens, the correct detector contacts will be operated.

For sealed micro-switch contacts, at a 4.8 mm switch opening the detector normal (or reverse) contacts are to be fully opened with the respective R-NI (or N-RI) contacts made, this can be checked using the 4.8 mm gauge with a multimeter set to volts or ohms as appropriate connected across the normal contacts then across the R-NI contacts, or across the reverse contacts then across the N-RI contacts, as the case may be. (N.B. ohm setting only to be used in isolated sections of a double cut circuit).

For semi-sealed contacts such as those in some Westinghouse (Siemens) point machines and detectors, where the contacts cannot be clearly seen, the contact must be electrically open at a 4.8 mm switch opening, and this can be checked with a multimeter set to volts or ohms as appropriate. (N.B. ohm setting only to be used in isolated sections of a double cut circuit).

Detector contacts are not to be adjusted to be broken at a switch opening of 3.2 mm or less. With track vibration such fine adjustment could lead to ‘bobbing’ detection failures and/or excessive wear and flats on rollers within detector mechanisms causing irregularities if not identified and corrected during routine maintenance.

Particular attention should be given to Westinghouse (Siemens) M70, and M3A machines to ensure that flats have not developed on the roller in the contact drive cam follower or on the roller on the detector slide. On these machines adjustment of the segments and cams on the contact drive is not to be carried out on-site as a maintenance task and, if such adjustment is required, the complete assembly must be removed and adjusted under workshop conditions.

Switch detection on single bladed catchpoints and independent points in the open position is to be broken with a switch opening of less than 95 mm. This shall be checked on initial setup or where components affecting detection of the open switch are replaced or adjusted. For routine maintenance inspections, confirmation of the integrity of detector rods, slides, linkages and fastenings is adequate to meet the requirement (i.e. detection does not need to be routinely gauged for the open switch).

Licensed signalling personnel are to use gauges for openings of 3.2 mm and 4.8 mm between the stockrail running face and the switch (at a position approximately, and not
more than, 75 mm from the tip) to test for correct detection adjustments. This requirement applies to tangential and conventional switch rails.

3.3 Machines with Interlocked Point Locking and Detection (M3A, M70 and HW)

In points machines with detection interlocked with the point lock, detection cannot be obtained unless there is correct correspondence between the point lock in the locked position and the points switch in the closed position, i.e. the points must be locked before the detection can be made due to the mechanical design of the points mechanism.

Testing is to be performed by first slackening (floating) the point lock adjustment. The point detector contacts must be then checked to open and close in accordance with Section 3.2 of this document. The point lock must then be readjusted as per Section 2.1 of this document.

When the point lock is being checked with the 3.2 mm gauge inserted between the switch and stockrail and the lock does not enter (i.e. points unlocked) the detector contacts are to be visually inspected to ensure they are open. Where the contacts cannot be clearly seen they are to be electrically checked with a multimeter set to volts or ohms (as appropriate).

Where the methods described in Section 3.3.1 and Section 3.3.2 cannot be performed or the integrity of these methods cannot be guaranteed due to rail wear, or a component affecting detection has been replaced, the above method is to be used to perform detection testing.

3.3.1 Westinghouse (Siemens) M3A and M70 Type

For routine maintenance testing of detection on Westinghouse (Siemens) M3A or M70 points with visual sighting of the detector actuator roller, testing can be achieved by confirming the proximity of the detector actuator roller relative to the detector slide notch. After initial setup testing (by slackening the lock, and adjusting the detector slide as per Section 3.2 of this document) and prior approval of the maintenance signal engineer, a 1 mm 'go' and 2 mm 'no-go' gauge may be used between the detector actuator roller and detector slide notch to confirm detection adjustment. Additionally, the point detector contacts must be checked to be open while the point lock is obstructed with a 3.2 mm gauge inserted between the switch and stock rail.

3.3.2 GEC HW Type

For routine maintenance testing of detection on GEC HW type points, after initial setup testing (by slackening the lock, and adjusting the detector slide as per Section 3.2 of this document) and prior approval by the maintenance signal engineer, a 3.2 mm and 4.8 mm H-gauge may be used to test detection settings, without slackening point lock adjustment as follows:

- For the short detector rod, the adjustment nuts on the switchrail side of the drop lug are loosened and the H-gauge is inserted between the drop lug and the two adjustment nuts on the point machine side of the drop lug.

- For the long detector rod, adjustment nuts on the machine side of the drop lug are loosened and the H-gauge is inserted between the drop lug and the two adjustment nuts on the switchrail side of the drop lug.

The H-gauge effectively simulates moving the detector slides 3.2 mm and 4.8 mm without moving the switchrail.
3.4 Westinghouse (Siemens) 84M & HM Detectors

A common semi-sealed contact block with contacts that are able to be inspected is in use in these detectors.

Closed switch detection testing on initial setup must first be performed using gauges inserted between the switch tip and stockrail. This is a functional test to prove the correct detector slide will actuate the correct detector contact. Closed switch detector contacts are to be electrically made with 3.2 mm switch tip opening and electrically open at 4.8 mm switch tip opening.

If the open switch detection or operating bar detection is not made with a 4.8 mm gauge inserted at the switch tip, this will mask the correct function of the closed switch detection. To prevent this, the Claw Lock or Spherolock point lock adjustment may need to be temporarily slackened (floated) to allow the locking mechanism to complete its travel and open switch detection (or operating bar detection) to be made.

Detection testing during final certification and routine maintenance is by using a 1 mm ‘go’ and 2 mm ‘no-go’ gauge inserted between the switch roller and the slide notch, with the switch closed hard against the stockrail with no or minimal switch roll. Check that the slide notch tested is for the detector slide connected to the closed switch. Confirm that when the closed switch opens, the gap between the switch roller and slide notch will close up. Trace the rodding and linkages between the detector contact actuator, through the detector rod and to the closed switch to confirm that when the closed switch opens, the correct detector contacts will be operated.

For switch detection on single bladed catchpoints and independent points in the open position, in addition to confirmation of the integrity of detector rods, slides, linkages and fastenings, a visual inspection of at least a 5 mm gap between the effective detector slide notch and switch roller will ensure reliability while still satisfying the requirements of Section 3.5.

To ensure sufficient angular freedom of the detector rods from the detector slides, a 0.25 mm feeler gauge may be used on adjustment, without impacting the integrity of 1 mm ‘go’ and 2 mm ‘no-go’ adjustment. Ensure that convex (thin) spherical washers are installed against the detector slide, with the concave (thick) spherical washers against the lock nuts.

Full details of this method of detection adjustment are provided in TMG E1341 Claw Lock Mechanism – Safety and Functional Tests - Routine Maintenance.

3.5 Increase of Detection Settings on Trailing-Only Points

On trailing points with the approval of the signal maintenance engineer it may be permissible to increase the detection limit from 4.8 mm up to 6.4 mm under certain circumstances as follows:

a) This increased limit is necessary to avoid failures and delays to traffic.

b) There is no signalled move through the trailing points in the facing direction.

c) There is no reversing move where part of the train would set back through the points in a facing direction.

d) The condition causing the inability to obtain reliable detection at the lower limits is to receive attention to correct the problem.

e) The arrangement is duly updated in the relevant Signal Plan or Working Sketch.
i) Where an adjustment is for a period greater than 3 months and no more than 6 months, then it is sufficient to apply a temporary note to the local and district office copies of the documents.

ii) Adjustments for a period of 3 months or less are exempt from this requirement.

f) A record is kept of such arrangements and continually monitored by the maintenance signal engineer.

4 Back Drive detectors
Backdrive detectors, where fitted should be adjusted to be broken at approximately 6.4 mm switch opening (at the backdrive detector) and be made with a switch opening of 4.8 mm (at the backdrive detector).

5 Lock Coverage and Detection of Operating Bars (Claw Lock and Spherolock)
When point mechanisms are used that require the operating bar to be maintained in position to guarantee the lock is maintained, this operating bar is detected in position.

Point operating bar detection is tested to ensure adequate point lock coverage is achieved at the moment detection of the point operating bar is just made. Open switch detector contacts are to be broken when the open switch gap is less than 95 mm. This is a minimum requirement, and the measurements for lock coverage must also be complied with.

Testing and certification of the operating bar detection is required on initial setup, or whenever there is any change that may affect the position of the open switch, open switch detection or operating bar detection. Periodic testing is not required.

To test for adequate lock coverage on Claw Lock points, as the operating bar moves towards the fully locked position, detection must not be made until the minimum prescribed lock coverage is achieved.

As the locking mechanism is not visible on Spherolock points, to confirm the normal point lock coverage the following applies. Move the points to the reverse position. Measure the prescribed minimum lock coverage from the normal side edge of the yellow locking tube and mark the black inner tube (ensure marking will not cause damage to the locking tube lip seal or the inner tube). Slowly move the operating bar towards the normal position, detection must not be made until the yellow locking tube has covered the mark. Repeat the process for the reverse point lock.

Refer to TMG E1341 Claw Lock Mechanism – Safety and Functional Tests - Routine Maintenance for further information regarding these point types.

5.1 EP Points
In EP Claw Lock and Spherolock points, where the open switch detector is used to prove the position of the operating bar to ensure adequate lock coverage, a minimum of 20 mm point lock coverage must be provided.

5.2 EP Catchpoints and Independent Switches
Where EP Claw Lock or Spherolock catchpoints or independent switches are provided with a separate detector (typically U5A) on the operating bar to ensure adequate lock coverage, a minimum of 30 mm point lock coverage must be provided.
5.3 EP Claw Lock fitted with Micro Switches

Where EP Claw Lock point motors are fitted with micro switches that prove the position of the motor/operating bar to ensure adequate lock coverage, a minimum of 30 mm point lock coverage shall be provided for the normal or reverse positions, or the closed switch for catchpoints.

For periodic testing of EP point motors fitted with micro switches, a 1 mm ‘go’ and 2 mm ‘no-go’ gauge is inserted between the micro switch and actuator head.

5.4 84M Type Machines

These machines incorporate operating bar detection. A minimum of 20 mm point lock coverage must be provided for the normal or reverse positions, or the closed switch of catchpoints and independent switches.

6 Locking of Operating Bars

Where HLM style point lock detectors are used to secure operating bars, the lock is to be adjusted to operate in the centre of the notch provided.

For EP swing nose crossings, the operating bar locking cannot be tested by the use of gauge blocks. Refer to Section 7 of this document.

7 Swing Nose Crossings

The purpose of a HLM point lock detector when fitted to an EP swing nose crossing is to lock the claw lock operating bar at the extremities of its 180 mm travel. Ensure that the HLM lock enters each notch centrally with equal clearance on either side. The detector contacts must not make until the point lock bolt/dog has dropped into the notch.

It may be impractical to achieve the minimum 20 mm claw lock coverage on swing nose crossings, however the maximum achievable lock coverage must be provided.

The switch detection settings for swing nose crossings are identical to its locking mechanism specification.

8 Removal of Interlocking Ball from D84M Point Machines

The interlocking ball on D84M point machines fitted with a Fortress Lock ensure that the EOL key can only be released from the machine when the points are placed in the Normal position.

To facilitate operational flexibility, the interlocking ball from D84M series point machines fitted with a Fortress Lock may be removed. This will allow the Fortress key to also be released from the point machine and restored to the EOL cabinet, with the points lying reverse. With the interlocking also placed in the reverse position, reverse detection can be obtained.

The interlocking ball can be removed upon agreement from the Signal Box Operations Manager. Once the Interlocking Ball is removed the signal engineer is to field mark-up the signalling plan and provide this information to Signal Design. A label must be installed inside the EOL Cabinet with the instruction "POINTS CAN BE RESTORED IN EITHER NORMAL OR REVERSE POSITION". This arrangement is to be checked against the signalling plan during mechanical interlocking tests.
9 Derails & Crowders

Derails must be detected in both the derail and clear positions.

The derail must be detected to be in the derail position only when it is in position to reliably derail a train.

The derail must be detected to be in the clear position only when it is in a position that it will not impede the safe passage of a train.

Crowders are used only with Westinghouse (Siemens) D150 and Western-Hayes Cullen HB type derails and are discussed in Section 9.1 below.

9.1 Westinghouse D150/ C150 & Western-Hayes Cullen HB Derails and Crowders

The derail must be detected to be in the derail position only when the inside corner of the derail nose is above the rail head clear of the running face. It must also be confirmed that the derail is resting on the railhead when detected in the derail position.

The derail must be detected to be in the clear position only when the derail block is within 10 mm of the end stops.

The crowder is not detected separately and its operation must be checked to ensure that when the derail is detected to be in the derail position the crowder is firmly closed against the railhead; and that when the derail is detected to be in the clear position the crowder is sufficiently clear of the railhead that it will not be struck by the wheel flange of a passing train. The drive linkage between the derail and the crowder is critical to its safe operation and its components must be closely examined to ensure its integrity.

9.2 Mechanical Derails

The derail must be detected to be in the derail position only when within 20 mm of resting on top of the rail head.

The derail must be detected to be in the clear position only when within 15 mm of its final position, resting on the sleeper.
Engineering Procedure
Signalling and Control Systems

Signalling Safeworking

PR S 40031

Maintenance of Signal Sighting and Signals

Version 1.2

Date in Force: 21 September 2016
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Document control

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Summary of changes from previous version

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<tr>
<td>Added section for Treating Issues Associated with Excessive LED Signal Brightness as per EIS 02/10</td>
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<td>Inclusion of requirements of ASA section 22.2.5 in regards to maintenance of mechanical signals</td>
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1 Scope and Application

This document defines the procedures and tests to be followed when carrying out signal and sign checks, supply voltage checks and other maintenance activities on colour light and mechanical signals, signs and their support structures.

Signage referred to in this document must include all signs viewed by train drivers and level crossing users as part of the safeworking and operating systems of the railway. Signage may be passive, retro-reflective or active types such as LED.

2 Introduction

It is essential that signals give an unmistakable indication to train drivers and that running signals display the optimal indication from the lens systems and that the applicable driver's view of the indication is as long and continuous as practical.

Signals must be inspected by licensed signalling personnel as part of their normal duties when visiting sites or walking through the section on regular maintenance visits.

Licensed signalling personnel are responsible for the maintenance of electrical signals and must ensure that any defect or damage to the signal that affects or potentially affects the visibility and correct observation of the signal is attended to immediately and promptly rectified.

The interior of all lamp cases must be checked to be painted matt black to minimise reflection of any external light.

The matt black paint on the hoods and on the front of backgrounds must be checked to be in good condition and be such that there can be no reflection of external lights. Repainting should be carried out using matt black exterior enamel paint.

Licensed signalling personnel are to regularly examine the colour light signal lamp case doors to ensure that they fit neatly closed to prevent external light entry and that the securing devices or locks are in good condition and are effectively securing the doors closed. Before they leave the signal they must check that the doors are securely closed and locked.

The back of a colour light signal must not be opened with a train approaching, or if the back is already open it must be closed to prevent a false aspect being displayed to the driver.

3 Sighting Check

At all times when in the vicinity of signals, licensed signalling personnel are to note the visibility of the signal lights and be vigilant for any condition that could be detrimental to signal sighting by train drivers or, in the case of level crossing signals, by road users.

Any growth of trees or shrubs or new construction or any change of background or lighting conditions (whether on or off the rail corridor) which may affect the sighting of signals must be reported and acted on promptly. In difficult cases where the signal indication cannot be distinguished due to sunlight shining directly onto the lenses, the maintenance signal engineer must be notified to provide an appropriate solution. Any configuration change in this regard must be approved by the Professional Head Signalling and Control Systems.

Active level crossings require a similar action to ensure that road and pedestrian users receive good sighting of the level crossing lights and signs. Licensed signalling personnel...
must check the signal focus and intensity as part of their maintenance visit. This will necessitate viewing the signals from a distance of approximately 100 metres (or the maximum sighting distance if less than 100 m) on all approaches to the crossing.

For passive type level crossings, similar action is required to ensure that road and pedestrian users receive good visibility of the level crossing warning signs. Any defects found by the licensed signalling personnel should be reported to relevant engineering discipline.

All running signals must be regularly checked from the drivers cab by the maintenance signal engineer or delegated competent representative for correct focusing and optimum light intensity. This inspection must preferably be done in collaboration with a lead train crewing representative, providing an opportunity to obtain their perspective whilst enabling effective liaison.

Running signals must be checked every 26 weeks on passenger main lines and 52 weeks on non-passenger lines.

The lights displayed by mechanical signals must be checked after nightfall while colour light signals should be checked during daylight.

Maintenance signal engineers (or delegated representatives) are to assess and determine those signals which may be subject to phantom indications. This may require an inspection from a train 90 minutes after dawn and 90 minutes before dusk.

Where a false proceed indication is possible from sunlight, arrangements must be made to have anti-phantom filters fitted to the lens units concerned.

Where a Signal Sighting Committee is formed to review the sighting of a signal due to a SPAD or other sighting issues, then the committee must use the Signal Sighting Checklist to assist in the completion of the Signal Sighting Form. (Signal Sighting Checklist and Forms are included in Standard Forms SPG 0711.7).

## 4 Signs

Signs referred to in this section pertain to signage as shown on a Signalling Plan or Working Sketch.

Signs must be inspected periodically in accordance with the signalling technical maintenance plan to ensure the wording remains in accordance with the signalling design.

Signs must be regularly cleaned and inspected for: damage, legibility and clear sighting.

Signs must be cleaned with water and mild detergent. Cleaning products that contain abrasives or solvents must not be used. Where it is found that cleaning cannot re-instate legibility at the required viewing distance, the signage must be replaced.

Signs must be checked for colour fade and retro-reflective signs must be checked during both day and night conditions. Where it is found that the legibility or retro-reflectivity has significantly diminished (worn off), the sign must be replaced.

Where signage has been subjected to graffiti attack, an approved graffiti removal product may be used. If the graffiti removal product cannot reinstate legibility at the required viewing distance, the signage must be replaced.

Where signage is regularly subjected to graffiti attack, an approved graffiti protective coating may be applied.
5 Lenses

Lenses must be regularly cleaned. Since many lenses are made of plastic, water with soap or mild detergent only must be used as a cleaning agent. Cleaning products which contain abrasives or solvents must never be used.

Plastic lenses are easily scratched and care needs to be taken during cleaning, installation or transport activities. When transporting LED light modules or lenses, they must be appropriately packaged or wrapped against damage.

Lenses must be inspected to ensure that they are not cracked, damaged or faded, such that they may impair the optimum light intensity or appear as another colour. For example, red appearing as amber or green appearing as yellow.

Where a lens has been subjected to graffiti attack, a Signal Technical Section approved graffiti removal product may be used.

Where lenses are regularly subjected to graffiti attack, a Signal Technical Section approved graffiti protective coating may be applied.

5.1 Incandescent Lenses

Outer lenses of colour light signals must be checked to be intact to ensure that phantom indications are not possible from external light reflecting back through the coloured lens.

If there are partially or completely missing outer lenses, these must either be replaced immediately or the coloured lens or roundel be removed or securely covered with dark non-reflective material and the lamp must be removed and the respective controlling relay disconnected.

On running signals, the indications more restrictive than the defective indication may be left working. For example, if the outer lens for a full clear green indication is defective then the medium and caution indications may be left working, but if the outer lens for the most restrictive proceed indication (caution or low speed as applicable) is defective then the running signal must be retained at stop. The signal indications (clear or medium) or the signal (if the caution or low speed indications are affected) must be booked out of use and an entry made in the train register book by the signaller. Particulars of temporary repairs must be included in the failure report.

These immediate measures concerning partially missing outer lenses are not normally necessary in the case of the signal red aspect where phantom indications would be a safe side condition.

In all cases, broken and damaged lens units must be attended to as soon as possible and partially or completely missing outer lens units must be replaced within 24 hours.

Wherever outer lenses are replaced, they must be replaced by the same type and care must be taken to ensure that spreadlight lenses and deflecting sectors are correctly oriented.

6 Incandescent Lamps/Lamp Changing

Where both filaments of a lamp have failed or where no aspect is displayed, the defect must be reported in accordance with the failure reporting procedures and the defect promptly rectified.

Care must be taken to ensure that any lamp used is the correct type by checking that the voltage, wattage and filament arrangement are suitable for the circuit in which they are to be used.
Multi-filament lamps (SL 35 type) must be a good fit in the holder and properly seated with the main filament at the focal point of the lens. Multi-filament lamps must be inserted in the holder so that the main filament is normally illuminated. It must also be checked that on breaking the main filament circuit, that the auxiliary filament is illuminated.

When replaced, new lamps must be observed to light up before being left in service.

New lamps must be kept in their wrapping and stored in a dry place until they are put into service, to prevent any damage or deterioration due to corrosion.

To obtain maximum life from a lamp it is necessary to adjust the lamp voltage as near as possible to the minimum voltage shown below. The lamp voltage must be measured across the terminals of the lamp holder.

Level crossing light voltages are to be measured using an approved meter of a type which can measure the maximum voltage with the level crossing operating with the charger turned off.

Signal lamp voltages are to be checked on installation and whenever lamps are changed or at intervals not exceeding that specified in the TMP.

<table>
<thead>
<tr>
<th>Lamp Rating</th>
<th>Maximum</th>
<th>Minimum</th>
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<tr>
<td></td>
<td>Voltage</td>
<td>Voltage</td>
</tr>
<tr>
<td>10 Volt 5 Watt</td>
<td>9.7 v</td>
<td>9.4 v</td>
</tr>
<tr>
<td>10 Volt 11 Watt</td>
<td>9.7 v</td>
<td>9.4 v</td>
</tr>
<tr>
<td>10 Volt 13/3.5 Watt</td>
<td>9.7 v</td>
<td>9.4 v</td>
</tr>
<tr>
<td>10 Volt 18 Watt</td>
<td>9.5 v</td>
<td>9.0 v</td>
</tr>
<tr>
<td>10 Volt 18/3.5 Watt</td>
<td>9.5 v</td>
<td>9.0 v</td>
</tr>
<tr>
<td>10 Volt 25 Watt (Level crossings)</td>
<td>9.7 v</td>
<td>9.4 v</td>
</tr>
<tr>
<td>12 Volt 2/2 Watt</td>
<td>10.7 v</td>
<td>9.0 v</td>
</tr>
<tr>
<td>12 Volt 24/24 Watt</td>
<td>11.7 v / 11.5 v*</td>
<td>11.3 v / 11.1 v*</td>
</tr>
<tr>
<td>12 Volt 24/24 Watt (Subsidiary and Marker lights)</td>
<td>10.7 v / 11.3 v*</td>
<td>10.2 v / 11.1 v*</td>
</tr>
<tr>
<td>12 Volt 36 Watt</td>
<td>11.2 v</td>
<td>10.7 v</td>
</tr>
<tr>
<td>12 Volt 36 Watt (Subsidiary lights only)</td>
<td>10.1 v</td>
<td>9.5 v</td>
</tr>
<tr>
<td>120 Volt 15 Watt</td>
<td>Bus Bar Volt</td>
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<tr>
<td>130 Volt 60 Watt</td>
<td>Bus Bar Volt</td>
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* applies where separate voltage taps are not provided for the main and auxiliary filaments and the auxiliary filament is not subject to the voltage drop across the filament changeover relay coils.

+ applies to SSI installations only.

7 LED Signals

Where individual LEDs have failed or where no aspect is displayed, the defect must be reported in accordance with the failure reporting procedures and the defect promptly rectified.

LED modules must display no less than 50% of the applicable individual LEDs contained within the module or otherwise they must be promptly replaced.
LED modules that display between 50% and 75% of the applicable individual LEDs contained within a module must be managed for change-out.

LED modules for level crossing must display no less than 75% of the applicable individual LEDs contained within the module or otherwise they must be promptly replaced.

Care must be taken to ensure that any replacement LED module is the correct type by checking that the voltage, colour and model are suitable for the circuit in which they are to be used, and that any conditioning resistors fitted within the signal head are also re-fitted correctly.

Whenever a LED module is changed or wiring has been altered, the voltage at the LED module must be checked.

When a LED module is replaced or wiring has been altered and circuit proving is employed in that circuit, the current must be checked and the proving circuit must be checked for functionality by breaking the circuit to the lit LED module. Aldridge type LED modules used with QSR3 circuit proving relays must be checked by testing according to the published guidelines for Aldridge LED modules.

Replacement LED modules must be checked for defective LEDs as well as intensity and colour compatibility with other lights in that signal.

7.1 Treating Issues Associated with Excessive LED Signal Brightness

LED signals provide a superior visual output as compared to older style incandescent lamp signals. At night, some LED signals cause drivers a discomfort, due to the excessive brightness emitted, especially where signals are located at stopping platforms or surrounded by low ambient light.

To reduce the excessive brightness from LED mainline signals, the following options are to be adopted:

1. Tilting the signal head downward by 5 degrees, by aiming the signal at a point 50 metres from the signal at sleeper level, and 2 metres out from the running rail.

2. Fitting a reducing filter inside the LED module, between the outer lens cover and the internal lens unit. The filter is a disk of Shinkolite neutral grey, 80% transmission. This option may not be possible with some designs of signal head.

In either case, the visibility of the signals should be rechecked in full daylight, to ensure that the sighting is still acceptable.

Signalling Personnel in the course of their relevant duties, are to observe LED mainline signals for excessive brightness and correct focus, and arrange corrective actions as necessary.

Note: Where corrective actions still do not achieve satisfactory attenuation in LED signal brightness, maintenance signal engineers are to liaise with a subject matter expert from Signalling & Control Systems for further advice on the matter.

8 Mechanical Signals

The cleaning of lower quadrant mechanical signals must be attended to by licensed signalling personnel. It is essential that a thoroughly efficient light be maintained in all signals. Licensed signalling personnel must rectify all cases of dirty lamps, dirty lenses and spectacles.
Signal lamps are to be focused for the driver’s view. If, when adjusting the focus, an obstruction is observed it is to be removed. If it is not practicable to remove the obstruction, the facts must be reported for further action.

The signal operating structure, including its signal wire length and supports, must be periodically inspected to ensure the signal arm movement is not restricted by corrosion or any obstacle which may impact the signal's ability to display a stop indication.

Signal stay wires and associated mechanical items must be checked to ensure they remain clear of the structure gauge.

The back-spectacle must be adjusted to enable the back-light to be seen only when the signal arm is horizontal.

Signal arms, particularly the enamelled type, must be kept clean and bright. Any grime should be removed as necessary by the application of cleaning compound and water.

Licensed signalling personnel must observe the working of electrical repeaters within their area of responsibility, and at once arrange suitably licensed signalling personnel to rectify any defects or irregularities which they themselves cannot rectify.

9 Signal Post and Gantry – Structural

The structural integrity of signal posts, including the condition of all equipment fitted to signal posts, must be examined by signalling personnel on a regular basis.

The structural integrity of signal gantries, including the structure components, fixed ladders, signal cages, walkways (handrails and grating) and foundations are examined by the Civil Structures Managers / Bridges Examiners discipline.

The structural integrity of signal mounting brackets must be examined by licensed signalling personnel on a regular basis.

For full details and guidelines on structural inspection of signal posts and gantries, including level crossing posts, warning light posts, guard indicator posts and associated equipment, reference must be made to MN S 41590 Signal Structures – Examination and Maintenance.

Maintenance frequencies must be in accordance with the relevant Technical Maintenance Plan (TMP).

10 Inspections Forms

Inspection forms, included in Appendix A of this procedure, are only required to be compiled as an exception where an inspection has initiated a rectification action of the signal structure.
Appendix A  Forms: Signal Structure Inspection Forms

Tools required:
As required under the TMP

Instructions:
Insert detail of: Location, Signal or Reference No., Structure or Signal Type, Inspector's Name, Date of Inspection, approximate Structure Age, in the appropriate section of the form for the structure inspected.
Assess each component listed below, and tick the applicable box.
A tick in the NO box indicates further action is required. Briefly describe the problem and the planned action to resolve the problem and photograph where required.
A tick in the YES box indicates no further action or remedial action has been carried out on the spot, such as tightening of loose bolts or patch painting surface corrosion.

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Date in Force: 21 September 2016
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Version 1.0
<table>
<thead>
<tr>
<th>Location:</th>
<th>COMPONENT</th>
<th>TEST INSPECTION</th>
<th>COMMENTS</th>
<th>TICK FOR YES</th>
<th>TICK FOR NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONCRETE SUPPORT FOUNDATION STRUCTURE</td>
<td>Is the exposed structure free of visible significant cracks &gt;0.3mm, rust stained cracks and spalling.</td>
<td>Does the structure appear in good general condition, i.e., not significantly damaged, misaligned or undamaged.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CONCRETE LADDER BASE PAD</td>
<td>Is the concrete pad free of visible significant cracks &gt;0.3mm, trip hazards and spalling.</td>
<td>Does the concrete pad appear in good general condition, i.e., not significantly damaged, misaligned or undamaged.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STEEL POST</td>
<td>Is the post visibly free of severe pitting, i.e., a structural defect.</td>
<td>Are the exposed portions of the base plate hold down bolts threads and nuts in good condition, i.e., not cracked and showing no signs of severe pitting/corrosion.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>POST MOUNTED EQUIPMENT</td>
<td>Are equipment mounting bolts/nuts/brackets in good condition, and obviously not loose, bent or broken.</td>
<td>Are equipment mounting bolts/nuts/brackets free of severe pitting/corrosion.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STEEL ACCESS Ladders</td>
<td>Is the ladder, including safety hoop and ladder cage (where fitted) and associated fixing bolts/nuts/brackets in good general condition, i.e., not loose and no visible cracks.</td>
<td>Is the ladder, including safety hoop and ladder cage (where fitted) and associated fixing bolts/nuts/brackets free of severe pitting/corrosion.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STEEL WORKING PLATFORMS</td>
<td>Are the Working Platforms and associated safety rails, toe grip, safety chain with lock (or swivel bar), fixing bolts, U bolts, etc. in good condition, i.e., not loose and stable.</td>
<td>Are the Working Platforms and associated safety rails, toe grip, safety chain with lock (or swivel bar), fixing bolts, U bolts etc. free of visible cracks, severe pitting/corrosion, rusting or broken sections.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Structural assessment and advice associated with structures must be carried out by suitably qualified persons.
Tools required:
As required under the TMP.

Instructions:
Insert detail of: Location, Signal or Reference No., Structure or Signal Type, Inspector’s Name, Date of Inspection, approximate Structure Age, in the appropriate section of the form for the structure inspected.
Assess each component listed below, and tick the applicable box.
A tick in the NO box indicates further action is required. Briefly describe the problem and the planned action to resolve the problem and photograph where required.
A tick in the YES box indicates no further action or remedial action has been carried out on the spot, such as tightening of loose bolts or patch painting surface corrosion.
### Sydney Trains Engineering Form — Signalling and Control Systems

#### General Cage Mounted Sign Equipment Structural Assessment Record

<table>
<thead>
<tr>
<th>Location:</th>
<th>Signal or Reference No:</th>
<th>Structure or Signal Type:</th>
<th>Inspected by:</th>
<th>Date:</th>
<th>Structure Age:</th>
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</thead>
<tbody>
<tr>
<td><strong>COMPONENT</strong></td>
<td><strong>TEST INSPECTION</strong></td>
<td><strong>COMMENTS</strong></td>
<td><strong>TICK FOR YES</strong></td>
<td><strong>TICK FOR NO</strong></td>
<td></td>
</tr>
<tr>
<td>SIGNAL CAGE and LADDER</td>
<td>Is the signal cage fully screened.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>If the answer is NO, arrange to have the cage screened.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Is the cage ladder and associated bolts/bolts free of severe pitting/corrosion.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SIGNAL EQUIPMENT MOUNTING</td>
<td>Are bolt/nuts associated with equipment mounted from the cage in good condition, and obviously not loose.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Are the bolts/nuts free of severe pitting/corrosion.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BACKING BOARD</td>
<td>Is the backing board background painted surface in good condition.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>If the answer is NO, arrange to have repainted (flat black).</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LANYARD ATTACHMENT RING (where fitted)</td>
<td>Is the stainless steel ring and mounting bolt/nut in excellent condition and fixed securely i.e. not loose, no visible cracks, no signs of surface corrosion.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>If the answer is NO, photograph and obtain advice.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Note: The only maintenance option for the stainless steel ring and mounting bolt/nut is replacement with new items.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MISCELLANEOUS EQUIPMENT</td>
<td>Is the identified equipment in good condition and fixed securely i.e. not loose, no visible cracks, no signs of severe pitting/corrosion.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>If the answer is NO, photograph and obtain advice.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note: Structural assessment and advice associated with signal cages must be carried out by suitably qualified person.*

---

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Date in Force: 21 September 2016

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Version 1.0
Engineering Procedure
Signalling and Control Systems

Signalling Safeworking

PR S 40032

Solid State Interlocking (SSI) and Smartlock 400T

Version 2.2

Date in Force: 8 March 2019
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### Document control

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<td>16 September 2013</td>
<td>Y Bargaric</td>
<td>First issue as a Sydney Trains document</td>
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<td>2.0</td>
<td>1 July 2015</td>
<td>Colin Darmenia</td>
<td>Inclusion of Smartlock requirements</td>
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<tr>
<td>2.1</td>
<td>September 2016</td>
<td>R. Del Rosario</td>
<td>Updated to new titles &amp; roles and ASA mandatory requirement</td>
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<tr>
<td>2.2</td>
<td>8 March 2019</td>
<td>C. Darmenia</td>
<td>Inclusion of ATP / ETCS</td>
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### Summary of changes from previous version

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<td>Include ATP abbreviations used in this document</td>
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<tr>
<td>Include disconnection requirements on signals with associated ETCS equipment.</td>
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</tr>
<tr>
<td>Precautions for disconnection of ETCS Equipment associated with TFM lamp circuits</td>
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### 7.2 Panel Processors

### 7.3 TICC

### 7.4 Support System

## 8. Points Modules Controlled by SSI

### 8.1 Output Interface Failures

### 8.2 Input Interface Failures

### 8.3 Complete Module Failure

### 8.4 Points Motor drive Output

### 8.5 Slow Operation

## 9. Signal Modules Controlled by SSI

### 9.1 Output Interface Failures

### 9.2 Input interface Failures

### 9.3 Complete Module Failure

## 10. Signal and Point Modules controlled by Smartlock 400T

### 10.1 SSI

### 10.2 Smartlock 400T System

## 11. Support System

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#### 8.3.2 Technicians Terminal PC Logger SSI

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#### 8.3.4 Data Link Line Measurements

### 8.4 Installed Software Record

### 8.5 Spares

#### 8.5.1 SSI Spares

#### 8.5.2 Smartlock 400T System Spares

### 8.6 Insulation Testing
1 Introduction

The safeworking procedure hitherto applicable to SSI includes procedures for the Smartlock 400T System. The configuration of Smartlock 400T retains and uses the same Trackside Functional Modules (TFM) and trackside communications links that are used with SSI and is compatible with operational interfaces like ATRICS. Standard SSI safeworking procedures for the SSI field equipment are relevant for Smartlock 400T system.

1.1 SSI

SSI employs microelectronic technology to maintain the integrity of the railway signalling, and for the transmission of safety data to the line-side. Microprocessors and programmable devices are installed within the interlocking, and within points and signal modules which control ground signalling equipment. The software programs resident within these devices are fixed and protected. The overall system is of modular design: all modules are plug coupled, and first line fault rectification is limited to the exchange of modules.

SSI is made up of two main groups of equipment; the central interlocking that contains the main processing units and the trackside functional modules. The two groups of equipment are linked by a dedicated communications bearer enabling the interlocking to be located a great distance from the trackside modules it controls. This allows control of a large area from a central point where a number of interlockings are co-located.

SSI incorporates a system of automatic fault monitoring. Faults to line-side equipment, such as signal lamp failures and loss of point detection are detected by the diagnostic system and an appropriate fault message provided to the technician’s terminal and an audible alarm raised. SSI module failures are also detected and similarly reported. In addition a system logger is provided which records all messages sent to and from the interlocking. This log is available for analysis as required.

1.2 Smartlock 400T System

The Smartlock 400T System (SML400T) is a computer-based interlocking (CBI) system designed as a successor to Solid State Interlocking (SSI). The main elements of a typical Smartlock 400T System are the CIXL, TICC and Support system.

The Central Interlocking (CIXL) is at the heart of the SML400T and is based on a "2oo3 Platform", which is a general-purpose safety computer for railway signalling and control applications and is responsible for the safe execution of all interlocking logic and the issue of correct commands to trackside equipment. The CIXL provides direct interfaces to ATRICS. The CIXL is configured with three USB Keys (flash drives), one for each computing channel, loaded with the specific application data and the interlocking software. Additionally, each computing channel has its own identity device. The information (scheme name, CIXL identity and VIXL data version) is loaded from the identity devices and is checked against the USB key content.

The TICC contains one pair of Gateways (GWs) and their associated Front Ends (FEs) (with 2 FE cassettes per FE Rack) per VIXL, together forming what are referred to as Trackside Functional Module Gateways (TFMGWs) for the VIXL. The FEs handle the interface between the CIXL cubicle and the GWs and conduct the polling as the bus master, whilst the GWs act as protocol converters between the TFM data links and the CIXL. The FEs are fully duplicated internally with Normal and Reserve cassettes. The TICC also contains a pair of SSI communications modules (either Data Link Modules (DLMs) or Long Distance Terminals (LDTs)) for each pair of GWs, which provide the
communications with the TFMs at trackside (where the signals are received by further DLMs and LDTs respectively, which then relay the data to and from the TFMs).

Support system provides diagnostic functionalities such as monitoring, alarm management, event log management, user access management, configuration facilities and facility to apply Signal Technician Controls.

SML400T Operations and Maintenance Manual should be referred for any further details on the procedures, guidance and instructions.
# Glossary

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>Two-out-of-Two channel configuration, i.e. 2 channels available from 2 fitted channels.</td>
</tr>
<tr>
<td>2003</td>
<td>The 2003 term indicates: - Either normal operation of the Platform with reduced availability, i.e. 2 channels available from 3 fitted channels; Or normal operation of the Platform with full availability, i.e. equivalent and interchangeable with the term 3003.</td>
</tr>
<tr>
<td>ATP</td>
<td>Automatic Train Protection</td>
</tr>
<tr>
<td>CISR</td>
<td>Central Interlocking Status Record</td>
</tr>
<tr>
<td>CIXL</td>
<td>Central Interlocking (central computer used within Smartlock 400T system and based on the standard 2003 platform)</td>
</tr>
<tr>
<td>DLI</td>
<td>Data Link Interrogator</td>
</tr>
<tr>
<td>DLM</td>
<td>Data Link Module</td>
</tr>
<tr>
<td>DLTG</td>
<td>Data Link Telegram Generator</td>
</tr>
<tr>
<td>EAU</td>
<td>Ethernet Adaptation Unit</td>
</tr>
<tr>
<td>ESD</td>
<td>Electrostatic Discharge</td>
</tr>
<tr>
<td>ETCS</td>
<td>European Train Control System</td>
</tr>
<tr>
<td>FE</td>
<td>Front End (part of the TFMGW connected to the CIXL)</td>
</tr>
<tr>
<td>GW</td>
<td>Gateway (part of the TFMGW connected to the TDL)</td>
</tr>
<tr>
<td>HMI</td>
<td>Human Machine Interface</td>
</tr>
<tr>
<td>HSCU</td>
<td>High Speed Communications Unit</td>
</tr>
<tr>
<td>IDNET</td>
<td>Internal Data Network</td>
</tr>
<tr>
<td>IMNET</td>
<td>Internal Maintenance Network</td>
</tr>
<tr>
<td>IXL</td>
<td>Interlocking</td>
</tr>
<tr>
<td>KVM</td>
<td>Keyboard Video Mouse</td>
</tr>
<tr>
<td>LDT</td>
<td>Long Distance Terminal</td>
</tr>
<tr>
<td>LEU</td>
<td>Lineside Electronic Unit</td>
</tr>
<tr>
<td>LRU</td>
<td>Line Replaceable Unit</td>
</tr>
<tr>
<td>MM</td>
<td>Memory Module</td>
</tr>
<tr>
<td>MPM</td>
<td>MultiProcessor Module</td>
</tr>
<tr>
<td>MPU</td>
<td>Main Processing Unit</td>
</tr>
<tr>
<td>NVRAM</td>
<td>Non-Volatile Random Access Memory</td>
</tr>
<tr>
<td>NTP</td>
<td>Network Time Protocol</td>
</tr>
<tr>
<td>PM</td>
<td>Points Module</td>
</tr>
<tr>
<td>PPM</td>
<td>Panel Processor Module</td>
</tr>
<tr>
<td>PSU</td>
<td>Power Supply Unit</td>
</tr>
<tr>
<td>REDMAN</td>
<td>Redundancy Management</td>
</tr>
<tr>
<td>SM</td>
<td>Signal Module</td>
</tr>
<tr>
<td>SML400T</td>
<td>Smartlock 400T System</td>
</tr>
<tr>
<td>SSI</td>
<td>Solid State Interlocking</td>
</tr>
<tr>
<td>SSER</td>
<td>Support Server</td>
</tr>
<tr>
<td>SSYS</td>
<td>Support System</td>
</tr>
<tr>
<td>TDL</td>
<td>Track Side Datalink</td>
</tr>
<tr>
<td>TFM</td>
<td>Trackside Functional Module</td>
</tr>
<tr>
<td>TFMGW</td>
<td>TFM GateWay</td>
</tr>
<tr>
<td>TICC</td>
<td>Trackside Interface Communication Cubicle</td>
</tr>
<tr>
<td>TT</td>
<td>Technicians Terminal</td>
</tr>
<tr>
<td>USB</td>
<td>Universal Serial Bus</td>
</tr>
<tr>
<td>VIXL</td>
<td>Virtual Interlocking</td>
</tr>
<tr>
<td>XAU</td>
<td>eXtended Adaptation Unit</td>
</tr>
</tbody>
</table>
3 Types of Module/Cubicles

SSI utilises the following modules:

<table>
<thead>
<tr>
<th>Module/Controller Module</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MultiProcessor Module</td>
<td>MkII &amp; MkIII</td>
</tr>
<tr>
<td>Memory Module</td>
<td>MkII &amp; MkIII</td>
</tr>
<tr>
<td>Panel Processor Module</td>
<td>MkII</td>
</tr>
<tr>
<td>Long Distance Terminal</td>
<td>MkII</td>
</tr>
<tr>
<td>Data Link Module</td>
<td>MkII, MkIII &amp; MkIIIA</td>
</tr>
<tr>
<td>Signal Module</td>
<td>MkII &amp; MkIIIA</td>
</tr>
<tr>
<td>Points Module</td>
<td>MkII &amp; MkIIIA</td>
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Smartlock 400T System comprises of the following:

<table>
<thead>
<tr>
<th>Cubicle</th>
<th>Subsystem</th>
<th>Subcomponents/details</th>
</tr>
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<tbody>
<tr>
<td>CIXL Cubicle</td>
<td>I/O Sub system</td>
<td>XAU, EAU, I/O PSU</td>
</tr>
<tr>
<td>Computing Subsystem</td>
<td>MPU, HSCU, REDMAN, Channel PSU, USB keys A/B/C with IXL Application data</td>
<td></td>
</tr>
<tr>
<td>Maintenance panel</td>
<td>ID plugs for computing channels</td>
<td></td>
</tr>
<tr>
<td>Fan Units</td>
<td>Above and below the computing channels</td>
<td></td>
</tr>
<tr>
<td>Switches and Fuses Panel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I/O Panel</td>
<td>Plugs and connectors</td>
<td></td>
</tr>
<tr>
<td>Main inlet panel</td>
<td>Segregated power input from UPS</td>
<td></td>
</tr>
<tr>
<td>Main Power Supply unit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TICC Cubicle</td>
<td>TFM Gateway</td>
<td>Front End, FE rack PSU</td>
</tr>
<tr>
<td>Gateway, Gateway configuration Key, Gateway PSU</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LDTs</td>
<td>MKII</td>
<td></td>
</tr>
<tr>
<td>Gateway Switches and Fuses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D - Sockets</td>
<td>To connect FE and GW's</td>
<td></td>
</tr>
<tr>
<td>I/O Sockets</td>
<td>Plugs and connectors</td>
<td></td>
</tr>
<tr>
<td>Power inlet panel</td>
<td>Segregated power input from UPS</td>
<td></td>
</tr>
<tr>
<td>Power Distribution Rail</td>
<td>MCBs for LDTs</td>
<td></td>
</tr>
<tr>
<td>Support System Cubicle</td>
<td>Support Servers</td>
<td>Industrial PC servers</td>
</tr>
<tr>
<td>KVM Switch</td>
<td>Keyboard, Video, Monitor</td>
<td></td>
</tr>
<tr>
<td>Client Gateways</td>
<td>Local client gateway PCs, Remote client</td>
<td></td>
</tr>
<tr>
<td>Time server</td>
<td>GPS clock</td>
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</tr>
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<td>LAN Switches</td>
<td>IDNET, IMNET</td>
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<td>Power Strips</td>
<td>Power outlets for SSYS Equipment</td>
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4 Procedures

4.1 General

The procedures given hereunder are those specific to SSI and successive technology such as Smartlock 400T Systems.

4.1.1 SSI

The procedures given for SSI are supplementary to other procedures contained within SSI specific manuals which must be obeyed where relevant.

All SSI modules are fitted with 50 way or 75 way plug couplers fitted with coding pins. It is therefore not possible to connect the incorrect type of SSI module to the fixed wiring when exchanging modules. The connectors are secured by two hand operated retaining bolts and care must be exercised when removing/replacing these connectors to ensure that the bolts are unscrewed and screwed evenly or damage to the connector may result.

4.1.2 Smartlock 400T System

The procedures given for Smartlock 400T are supplementary to other procedures contained within SML400T Operation and Maintenance Manual which must be obeyed where relevant.

Within the Smartlock 400T system, many of the connections to the TICC and CIXL are fitted with EDAC 516 Series 38 way plugs. These require polarisation via a code pin within the connector to ensure that incorrect connections are not made accidentally. Should it be required to replace a faulty cable, the polarisation techniques mentioned in the SML400T Operations and Maintenance Manual shall be used.

4.2 Modules and Line Replacement Units

4.2.1 SSI Module Seals

With the exception of memory modules, all other modules supplied by their manufacturers are factory sealed. These seals shall not under any circumstances be broken in the field by maintenance staff.

Memory modules are sealed by the Signal Design team or an accredited Design Office.

Modules with broken seals or no seal fitted on are not to be used. Non-sealed modules are to be reported to the Signalling and Control Systems Manager for investigation.

4.2.2 Smartlock 400T Line Replacement Units

Smartlock 400T LRUs must not be opened, repaired or modified on site, but must be returned to the manufacturer. In the event of a failure of any of the LRUs, spare LRUs provided by the manufacturer shall only be used to replace the defective units in accordance with procedures in section 7.3.
4.3 SSI Module and Smartlock 400T Line Replacement Unit Handling

4.3.1 SSI Modules

The integrity of SSI modules being placed into service is safety critical. All modules must be handled, transported and stored with care, and not in any manner, condition or circumstance that would subject them to damage or deterioration. SSI modules must be stored on racks in enclosed buildings or locations in a clean, dry non corrosive environment below 60°C.

Solid State Interlocking equipment contains electronic components that may be damaged by misuse. No SSI module is to be disconnected unless its power has been turned off first.

4.3.2 Smartlock 400T LRUs

Spare LRUs and any other components of the Smartlock 400T System should be handled with care and stored in a non-condensing environment and at a temperature between 0 and +45°C.

4.4 Trackside Functional Module – Go / No-Go Testing

A Go / No-Go Tester is provided to enable a PM or SM to be functionally tested before being installed, for example as a replacement for a failed module. The Go / No-Go Tester causes the contents of the TFM’s NVRAM to be updated. This sets the interlocking identity to zero, thus enabling modules taken from one interlocking to be re-installed in another.

**Note:** In the event of a signalling irregularity or an alleged signalling irregularity, the associated point or signal modules must not be tested using a TFM tester as this will erase the contents of the memory.

All modules shall be tested on the TFM Go / No-Go Tester before being put into operational use or being placed into the local spares holding.

4.5 SSI Module and SSI Central Interlocking Operation

When it is necessary to remove interlocking or diagnostic multi-processor modules, or panel processor modules from the interlocking cubicle they shall be removed complete with their associated memory module, and replaced by new units which are also fitted with the appropriate memory module. Faulty or suspect MPMs and PPMs shall be promptly returned to the manufacturers, accompanied by the appropriate documentation as detailed in Section 7.10.1, unless there is a need to retain the unit for further investigation.

**Note:** During major failure situations with limited spare programmed Memory Modules, it is permissible to re-use Memory Modules that were not in-service during the original failure.
4.5.1 SSI Central Interlocking

4.5.1.1 MPMs

When a MPM needs to be changed from an operational interlocking, the following steps must be taken to ensure the entire interlocking is not shut down in error;

- The MPM to be changed is identified,
- Use the Technician’s Terminal to ‘disable’ the MPM via the Command Menu. This will force the interlocking into a “2 from 2” mode using the remaining MPMs to carry out the interlocking functions.
- Once the Technician’s Terminal message confirms the MPM is ‘disabled’. Turn off the MPM by using the power switch at the rear of the unit. The wiring plug couplers are then removed.
- Check the replacement MPM’s configuration to confirm MPM and MM comply with the hardware, fixed programs and site specific data requirements of the Installed SSI software record as per sections 8.4 before installation.
- Check that the seals are intact and the power switch is off.
- Install the replacement MPM. Connect the plug couplers. Turn on by the power switch on the rear of the unit.
- The MPM will then become operational without further intervention.
- Do not turn on any other MPM for at least one minute. This step only applies when turning on 2 or more MPMs to start an interlocking.
- Do not disable, turn off or remove any other MPM for at least 10 minutes.

4.5.1.2 Starting the Central Interlocking

If two or more replacement MPMs or MMs are installed or a prolonged shutdown has occurred then the Central Interlocking will have to be started from the Technician’s Terminal.

a) Replace the MPMs as per section 4.5.1.1.

b) List the Technician’s Controls and check them against the Technician’s Terminal Control Log Book.

c) Update and confirm that the Technician’s Controls are in accordance with the Technician’s Terminal Control Log Book.

d) Wait until the MPM’s have been running for at least 4 minutes so that the interlocking timeout has elapsed. During this period on a panel controlled system the panel indication for “normal working failed” will be FLASHING and for a VDU controlled system there will be an “interlocking timing out” alarm.

e) After this 4 minute timeout period on a panel controlled system the panel indication for “normal working failed” will be ON and for a VDU controlled system the “interlocking disable” alarm will be set.

f) Perform the “Start Interlocking” command. There will be a prompt to enter further technician’s controls or verify that there are no more to be added. Following this response the interlocking will commence its start-up process.

g) When normal operation is resumed the "normal working failed" indication on a panel controlled system will turn off and the “interlocking disabled” alarm will clear on a VDU controlled system.
h) For each set of points;
   i) Arrange for the signaller to “key points” from the centre position to the last known position and return to the point key centre position to regain the ‘points free’ indication.
   ii) Then, arrange for the signaller to “key points” from the centre position to the last known position and return to the point key centre position to regain point detection.

Note: Disabled points need to be managed in accordance with section 6.3.2.1 and 6.3.2.3.

4.5.1.3 PPMs

When a PPM needs to be changed from an operational interlocking, the following steps need to be taken;

- The PPM is turned off by the power switch at the rear of the PPM.
- Check the replacement PPM’s configuration in accordance with section 8.4 before being installed.
- Check the seals are intact and the power switch is off.
- Install the PPM and connect the plug coupler. Turn on the power switch at the rear of the unit.
- The PPM will then become operational without further intervention.

4.5.1.4 Technician’s Terminal and PC Logger

The Technician’s Terminal provides the facilities for licensed signalling personnel to access and control up to six SSI Central Interlockings. The Technician’s Terminal is connected to each Diagnostic MPM and this processes all fault and diagnostic information. Each Diagnostic MPM will send a message to the Technician’s Terminal for;

- the occurrence of a fault,
- the clearance of a fault,
- the occurrence and clearance of an intermittent fault.

Each fault has an alarm status that is repeated on the Signalman’s Control Panel;

- Critical. There will be an immediate effect on train movements,
- Non Critical. There will be no immediate effect on train movements but there will be intervention required before further system degradation occurs that could affect train movements.

Access to the facilities of the Technician’s Terminal is by password. The Signal Engineer is responsible for the password and for changing it if this becomes necessary. Licensed signalling personnel may be requested to enter their name, location and purpose by the system.

The Technician’s Terminal can be remotely accessed by a PC in another location via a modem and telephone line to gain information on faults and to monitor system activity. This facility may be used before proceeding to site, or to assist in providing immediate advice to the attending licensed signalling personnel. During a remote access session, local terminal access is disabled and fault printer records the access details.

The technicians terminal fault printer generates records of all faults, all accesses to the Technician’s Terminal, controls applied and other associated information. The hard copy
output from the printer shall be retained and held on site in the technicians terminal records file.

Generally hard copies are to be held for a minimum of six months. Records relating to incidents should be kept for seven years.

The PC logger records:

- all changes of state of the SSI,
- all faults as they occur and are cleared,
- all Technician’s Controls as they are applied and removed.
- This data can be downloaded and used to generate a log of operations of the SSI.

4.6 Smartlock 400T System Operation

The procedures discussed below are the key operation, start up and shut down procedures for each of the SML400T subsystems. The SML400T Operation and Maintenance Manual should be referred for further details.

4.6.1 Operation

The CI XL has duplicated main PSUs. If necessary, the CI XL can operate with only one working main PSU. However the other main PSU should be returned to operational use as soon as practically possible. This situation can arise due to a fault in one of the main PSUs or a fault in one of the UPSs. It should be noted that switching off both I/O groups will cause the CI XL to shut down and hence should be avoided.

During operation of CI XL, the USB Memory Devices must not be removed from an operational computing channel. If a device is accidentally removed from an operational channel, the channel must be restarted once the USB Memory Device has been reinserted, within the following 24 hours to avoid a potential channel shut down.

Once a USB key is inserted into its MPU it must be considered as captive to the MPU and must remain inserted, even when the MPU is removed and returned for repair.

The USB keys are labelled with month and year in which they are programmed. Due to a limitation on guaranteed memory retention of the USB keys, operational USBs and spare USBs shall be refreshed, within 8 years of the date of programming as per the TMP.

4.6.2 Start up

The Smartlock 400T System start-up procedure must be carried out in accordance with the SML400T Operations and Maintenance Manual.

Before starting up, ensure that the correct USB key is inserted into the lowest USB port of the MPU of each Computing Channel. Ensure that correct Identity Devices are plugged into the CI XL front panel. The correctness of the USB keys/Identity devices can be established by verifying the labels provided on the devices against the CISR. Ensure USB/ID plug programmed for a particular channel is plugged in to the channel for which it was programmed. Plugging-in wrong USB/Identity devices will result in display of error code on the CI XL following full boot up procedure.

The two modes of start-up procedures are:

1. Controlled start up:
   During controlled start up procedure, the following sequence shall be applied:
a) Start the support system by switching on the circuit breakers at the rear of the support system cubicle. This will power up the KVM and Network switches. The boot up of the SSER software takes between 5 and 10 minutes. Switch on the GPS clock/time server. Ensure that at least one server of each pair (e.g. SSER1A, SSER1B) has reached the point where booting has progressed to reach the “active” state. If the Client Gateway computer mounted within the Support System Cubicle is not powered up at this time, start its boot sequence by operating its internal power switch and proceed immediately to the next step.

b) Start the CIXL boot sequence by ensuring that all the computing channels are powered up at the same time (achieved by switching on Computing Channels before switching on I/O Group switches A and B). Ensure that the cubicle fans have started.

c) Start the TICC (can commence start up while the CIXL is booting) by switching on the circuit breakers on the main inlet panel then power up the FE, GWs and LDTs/DLMs.

d) Synchronise the CIXL time from the Support system.

If there was no modification of the data configuration on the USB sticks and ID devices, and if the CIXL was powered off for less than 5h59min, also if at least one of the Support Server is up and running then the system will perform a warm start.

Compare the list of Technician’s Controls in the Support System’s restrictions list against the list of Technicians controls in the signed paper copy of the currently applied Technician’s controls as per form PR S 40032 FM02 (see Appendix A) and reapply any missing controls.

**Note:** The VIXL will be online approximately 7 minutes after CIXL power on, this includes the CIXL boot-up time of 3 minutes and the VIXL timeout of 4 minutes.

If the data configuration on the USB sticks and ID devices has been modified or if the CIXL was powered off for more than 5h59min, then the system will perform a cold start.

The CIXL will also perform a cold start if both of the Support Servers are down during the CIXL start up.

**Note:** If the Support server was online during the cold start, the VIXL will be ready to accept technicians command approximately 7 minutes after CIXL power on, this includes the CIXL boot-up time of 3 minutes and the VIXL timeout of 4 minutes.

If the support server also restarts during the CIXL start-up the technician control shall only be applied after the support server is online which takes approximately 10 minutes, by this time the CIXL boot time and the VIXL time out of 7 minutes would have completed and the VIXL will be ready to accept technician commands.

Following a cold start the previous Technician’s controls will have to be reapplied and all the VIXLs placed into the Online mode. A signed paper copy record of the currently applied Technician’s controls as per form PR S 40032 FM02 (see Appendix A) shall be kept.

2. **Uncontrolled start up:**

This start-up is usually associated with restoration of the power supply following a prolonged shutdown. If the support system was also powered off due to the prolonged shut down, then the CIXL will perform a cold start if the CIXL boots up before the SSYS. In this situation the VIXLs will start in the Offline state. All the Technician’s controls will need to be re-applied. A paper copy record of the currently applied Technician’s controls as per form PR S 40032 FM02 (see
Appendix A) shall be kept. A VIXL shall be enabled to online status as applicable only after applying all the technician controls.

Note: Disabled points need to be managed in accordance with section 6.3.2.2 and 6.3.2.3.

4.6.3 Shut down

The Smartlock 400T System shut down procedure must be carried out in accordance with the SML400T Operations and Maintenance Manual.

Shutting down the CIXL or TICC will disable all the VIXLs and communications to the field equipment. This shut down will affect train operations. Ensure correct authorisation has been obtained.

Shutting down the Support System will not affect the normal train operation but will prevent logging of signalling events. Ensure a record of Technician controls on the Support System’s restrictions list is obtained before CIXL shut down.

4.6.3.1 To shutdown a CIXL cubicle:

1. Ensure that USB keys and identity devices are present in the CIXL, the CIXL cannot reboot without a valid set of USB keys and identity devices installed.
2. Power off I/O groups A and B through the front panel switches, this will power off the CIXL.
4. Power off the circuit breakers (CB1 and CB2) on the main inlet panel at the rear of the cubicle.

Note: To make a data change in the CIXL by replacing the USBs and ID devices and where no other subsystem is affected, it is permissible to shut down the CIXL while leaving the rest of the system powered and operational.

Failing to follow the correct order could result in an error being detected by the CIXL, causing its security fuses to rupture and preventing a CIXL restart. Leaving a single Computing Channel powered with the other two powered off or failed will result in a security fuse rupturing in this channel.

4.6.3.2 To shutdown a TICC cubicle:

1. Turn off all the LDTs using the MCBs on the rear Power Distribution Rail
2. Turn off all the Gateway Modules using the eight switches in the centre of the power tray at the lower front of the cubicle.
3. Turn off the AC/DC converters in the power tray by using the circuit breakers on each side of the power tray.
4. Turn off all the installed Front Ends by switching off the circuit breakers adjacent to the Front End PSU modules.
5. Power off the two circuit breakers on the main inlet panel at the rear of the cubicle.

4.6.3.3 To shut down a support system cubicle:

1. Shut down Client Gateway PC. The Remote Client loses its functionality when Client Gateway is shut down.
2. Shut down all Support Servers.
3. Turn off the NTP Time Server.

4. Turn off the console display.

5. Turn off the two circuit breakers on the main inlet panel at the rear of the cubicle.

4.6.4 Support System Technician's Terminal and access

Access to the facilities of the Technician’s Terminal is done by logging into the HMI with appropriate user rights and a password. Licensed signalling personnel will be assigned with “Technician” log in rights and the Responsible Signal Engineer is assigned “SSysAdmins” rights. SSysAdmins log in access to the HMI is required to change a password.

The installation of any external applications or the modification of the existing installed application on the SSYS environment shall be forbidden without obtaining approval.

4.7 Trackside Modules

Before removing the plug coupler that attaches a trackside module to the fixed wiring, it must have its power removed as outlined in Sections 4.7.1 and 4.7.2.

When installing a trackside module the module retaining screws and plug coupler must be secured before restoring power.

4.7.1 Data Link Modules

When it is necessary to remove operational DLMs from a working system, care must be exercised to ensure that disruption to transmissions, with the loss of data by associated TFMAs, does not occur. Under normal circumstances removal of any one DLM will have no effect on the operation of the signalling as the data link transmission system is duplicated. A DLM must be powered down by removing its BX supply fuse or NX disconnect pin.

Faulty or suspect DLMs shall be promptly returned to the manufacturers, accompanied by the appropriate documentation as detailed in Section 7.10 unless there is a need to retain the unit for further investigation.

4.7.2 Points and Signal Modules

When it is necessary to remove operational point or signal modules from a working installation they must first be powered down by removing the appropriate module 110V NX disconnect pin. All modules being placed into service shall have first been confirmed operational by being satisfactorily tested on the TFM Go / NoGo Tester referred to in Section 4.4.

There is a 9 to 12 second initialisation period before a module comes on line after the application of its 110V ac supply.

Points will not show detection status to the signaller when a Points Module (PM) is replaced or powered off and on. The signaller is to be contacted and requested to key the points to the last known position so that detection is restored when a PM is powered on.

If it becomes necessary to transfer point and signal modules from one SSI interlocking or VIXL to another, these modules must, before re-installation, be tested on the TFM Go / NoGo Tester in order to erase their old interlocking identity number as detailed in Section 4.4.

Faulty or suspect modules shall be promptly returned to the manufacturers accompanied by the appropriate documentation as detailed in Section 7.10 unless there is a need to retain the unit for further investigation.
5 Responsibility in the Event of an Irregularity

5.1 Licensed Signalling Personnel

The first duty is protection of the line in accordance with Procedure PR S 40004 Failures.

a) Incident reporting, inspections and examinations shall also be carried out in accordance with Procedure PR S 40004 Failures.

The Technician's Terminal fault print out or Alarm screen print out should be examined for evidence of equipment failure or malfunction.

b) Current system activity, particularly telegram data to and from the trackside, should be monitored using the facilities provided for this purpose on the Technician's Terminal or Support System. All unexpected activity shall be recorded in the Technician's Terminal Controls Log Record Book or another book provided for the purpose.

c) Evidence of system operation during the incident is recorded on the system logger. The attending licensed signalling person is solely responsible for ensuring that the logger is not touched or tampered with in any manner, prior to the arrival of the investigating Signal Engineer.

d) The indications displayed on all relevant trackside SSI modules and interlocking modules/LRUs shall be recorded, along with their associated serial numbers. It may be necessary for these modules to be removed later for investigation.

5.2 Signal Engineer

5.2.1 Log Analysis

A Signal Engineer is responsible for investigating the incident in accordance with Procedure PR S 40004 Failures. In the event of an irregularity being detected in the transmitted data messages then the site will be protected in accordance with Procedure PR S 40004 Failures. The Signal Engineer will determine whether the interlocking shall be stopped via the Technician's Terminal for an SSI or Support System for a Smartlock 400T system. They shall examine the signalling control tables and data listings and give appropriate instructions for any further action to be taken.

The log analysis shall form part of the Incident Report.

5.2.1.1 SSI

The Signal Engineer shall copy the relevant data message file from the SSI Technician's Terminal PC system logger to a virus free medium, and then, using the analysis program, analyse the data bits in the messages to check on what controls and indications were sent to and from the line-side during the time of the incident.

5.2.1.2 Smartlock 400T System

The Signal Engineer shall copy the data files by creating a Backup of recorded events on the Support System by closing the file into which the events are being recorded. An export of the backup file is to be performed to create permanent copy of the files that are needed for incident investigation. The relevant log and event data files shall be transferred from the support system to a data storage device (through a USB port).

The Offline replay HMI can be used for diagnosis or incident investigation by replaying all the relevant events. Ensure that the USB memory stick is free from viruses or malicious
software; it is strongly recommended that the USB should be subjected to a virus scan on 
a network computer before inserting in to Smartlock 400T subsystems.

5.2.2 Testing

The Technician’s Terminal or Support System may be used to test the conditions leading 
up to an incident by the application of track circuit occupancy via the Technician controls. 
The logger will be recording all system activity and can be later analysed and compared 
with the original incident log.

5.2.3 Removal of Equipment

SSI modules suspected of mal-operation shall be initially subjected to functional tests in 
situ. These tests shall simulate, as accurately as possible, the events leading to the 
irregularity, and module behaviour shall be observed and recorded. If the incident 
warrants, the module in question shall be removed and returned to the appropriate third 
line facility for a detailed examination. Full details shall be recorded of any module so 
removed.

TFM modules under investigation that are connected to SSI or Smartlock 400T must not 
be placed in a TFM Go / NoGo tester as it can destroy the history of the module’s 
operation.

6 Protection of the Line

6.1 SSI Technician's Controls

Facilities are provided within the SSI Technician's Terminal to allow the application and 
removal of restrictive controls to the interlocking. The following technician's controls are 
provided from the Command Menu – option 6 from the Main Menu:

0 – Return to Main Menu
1 – Aspect disconnect
2 – Temporary approach control
3 – Track circuit occupy
4 – Route bar
5 – Points disable
6 – Start interlocking
7 – Stop interlocking
8 – Disable MPM
9 – Select interlocking

The application and removal of these controls must be done as per Section 6.3. All 
controls applied must be recorded on Technician’s Terminal Controls Log book.

A book of forms PR S 40032 FM02 (see Appendix A) shall be used as the “Technician’s 
Terminal Controls Log”.

When a SSI has been stopped and switched off, then restarted, any Technician’s 
Controls that were applicable may have been lost. In this instance the Licensed Signalling 
Personnel must check and reapply any Technician’s Controls that have been lost that are
shown in the Technician’s Terminal Controls Log Record Book before starting the interlocking.

Facilities are also provided within the Technician's Terminal for the interlocking to be stopped or re-started for emergencies. The "Stop Interlocking" command will cause all signals to revert to stop, and route setting will no longer be possible.

6.2 Smartlock 400T Support system Technician's Controls

Technician controls for the Smartlock 400T system can only be executed from the local client workstation by logging-in under technician profile, user name and password. The procedure to apply a Technician's Control is the same for all command types.

Support System Operations Manual should be referred for any further details on the procedures and instructions.

There are 9 types of Technician’s Controls.

- Track section - Allows application and removal of a forced track section occupy command on any Track Section driven by the CIXL.
- Signal - Allows application/removal of Aspect disconnect and application/removal of Temporary Approach control for a Signal driven by the CIXL
- Route- When applied this control allows a portion of the track to be prevented from being part of any route requested by the CIXL
- Points - Any of the points driven by the CIXL can be disabled (normal or reverse) by the application of this control, removal of the control restores normal operation of the point
- VIXL- Start- Starts a VIXL, from offline to online mode.
- VIXL- Stop- Stops a VIXL, putting it into offline mode.
- CIXL- Stop CIXL Channel A/B/C - Allows a single CIXL channel to be stopped from the Support System.
- CIXL - Forbid CIXL Education - Application prevents automatic CIXL Education, once a newly powered on channel is ready, on a given CIXL
- CIXL - Allow CIXL Education - Application allows automatic CIXL Education, if it was previously forbidden, on a given CIXL

A book of forms PR S 40032 FM02 (see Appendix A) shall be used as the "Technician’s Terminal Controls Log". Following shutdown or start up the Technician’s Controls that were applied may have been lost. Procedure discussed in section 4.6.2 addresses this situation.

6.3 Disconnections

When it is required to disconnect signalling apparatus, the necessary safe working procedures shall be strictly observed as stipulated in PR S 40009 Disconnection of Signalling Apparatus.

6.3.1 Disconnection of Signals

The following action should be taken in order to place any signal controlled by an SSI signal module to its most restrictive aspect. When it is required to disconnect a signal controlled from an SSI signal module in order to place it at stop and prevent it from clearing, the signal shall be at stop with no route set from it, then a 'route bar' shall be applied from the Technician's Terminal in the case of an SSI and from the SSYS in case of Smartlock 400T System.
If the Technician's Terminal / SSYS is not available then:

a) For a running signal with a trainstop, the signal train stop motor fuse shall be removed and the trainstop reverse indication into the module shall be opened at the external cable link. This places the trainstop and the signal at stop. This method is also to be used if it is required to disconnect the trainstop itself or if authority is obtained to suppress the trainstop in failure conditions.

b) If trainstop control of the signal is not provided then the signal "A" track circuit shall be disconnected to force the signal to be retained at stop. It should be remembered that this may cause other signals to be returned to stop and associated points to be track locked.

c) If methods a) and b) are not practical, the signal module can be forced to adopt the "red retaining" mode of operation by removal and replacement of the link in the NX (current path) return from the signal head. On removal of the external cable link the module "output interface" indication will be extinguished. After a period of at least 5 seconds the link should be re-inserted and confirmation obtained that a red aspect is displayed.

Fuses to the signal's aspects other than red shall then be removed.

Note When it is necessary to disconnect an SSI signal to prevent its operation and maintain it at stop, there is no need to disconnect any associated ETCS equipment, as the implementation of any of the above methods to place a signal to its most restrictive aspect will also prevent ETCS from issuing a 'proceed' telegram due to the use of current sensing of the signal aspects. Hence no additional disconnection of any ETCS equipment is necessary under normal circumstances.

To return the signal module to normal operation it is necessary to power down the module and then power up. All functions provided by the module will obviously be lost whilst the power is off.

Note It must be appreciated that a main power supply interruption will also re-initialise the module and thus reinstate its output interface removing the "red retaining" feature. In this event if the signal is then cleared, the red lights will extinguish and the signal will be blacked out.

6.3.2 Disconnection of Points

When it is necessary to electrically disconnect a set of points controlled from an SSI points module in order to prevent their operation, then in addition to the requirements prescribed in PR S 40009 Disconnection of Signalling Apparatus, it is preferable that the points shall also be disabled via the Technician's Terminal in case of an SSI and via SSYS in case of Smartlock 400T system as described herein, after communicating with the Signaller.

6.3.2.1 Points controlled by SSI

To 'book out' a set of points normal, a points disable normal technicians control is used. A points disable reverse technician's control is used to 'book out' a set of points reverse.

When technician’s controls for points disable normal are applied, the points identity number is used and the following is applicable;

- if the set of points are lying in the normal position they will remain in the normal position and be disabled from moving from the normal position until the points disable command is removed, or
• if the set of points are lying in the reverse position they will remain in the reverse position until such times as they are driven normal by either the signaller or a route call. Once the set of points are lying in the normal position they will remain in the normal position and be disabled from moving from the normal position until the disable command is removed.

The same philosophy is applicable to disabling in the reverse position. The number 64 is added to the points identity number to disable the points in the reverse position.

6.3.2.2 Points controlled by Smartlock 400T System

As with SSI, a Point Disable can be applied in the position other than that in which they are currently lying. They can, under these circumstances, still be moved towards the position in which they have been “disabled”, but cannot then be moved away from it. The selection of the point is by choosing the correct point number rather than choosing points identity number.

To ‘book out’ a set of points normal from Support System, the sequence listed below is to be followed

• Log-in to the local client workstation by typing user name and password assigned to the Technicians.
• Navigate to the ‘Technicians Controls’ menu
• Select ‘Points’ and select ‘Disable Point Normal’ option
• Select the point that needs to be ‘booked out’ from the trackside mimic and follow on screen commands to execute the action

The same philosophy is applicable to disabling in the reverse position

6.3.2.3 SSI and Smartlock 400T System

The procedure below is applicable to SSI system and Smartlock 400T System

Note: The action of disabling points may result in the loss of detection in the event of a power failure at the controlling point module. The following joint intervention will be required by the licensed signalling personnel and the Signaller to restore the points detection and the disable control. The licensed signalling personnel must remove the disable control from the points, then the Signaller must remove their block on the points key and centre the points control key, then restore it to the same position as the points are lying to restore point detection. The Signaller must then reapply their block on the points key and the licensed signalling personnel must then reapply the points disable command.

Where ESML arrangements (Emergency Switch Machine Lock, Annett Key and attached crank handle) on electric points machines or EOL or plug connector arrangements on E.P. points machines are provided for the manual operation of power worked points, the disconnection of the points and the protecting signals is accomplished through use of ESML, EOL or plug connector arrangements.

When the ESML, EOL or plug connector arrangements are utilised during failure conditions or for the testing (only) of facing point locks and detectors, then it will not be necessary to disable the points from the Technician’s Terminal or Support System.

ESML, EOL or plug connector arrangements are not to be restored while trains are approaching or moving over the points.

Following ESML or EOL operation, the points control will need to be operated from the control panel to correspond with the point position in order to re-establish the detection and control. The points control may then be reinstated to the centre position.

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Note: In the case where there is loss of detection only, the points module will attempt to re-drive the points to the last controlled position. This operation is limited by a time-out feature of approximately 8-9 seconds.

6.3.3 Disconnection of ETCS Equipment

ETCS fitment to SSI, Westrace, Westlock and Smartlock 400T installations typically uses a method of interface called “current sensing” (also known as “lamp sensing”) of signal lamps to provide an input to the LEU. The LEU current sensor is placed directly in series with the TFM output circuit to the signal lamp and monitors the actual current drawn by the lamp.

These installations can be recognised by the absence of the toroidal transformer and resistor holders associated with the contact sensing method of LEU connection, and the presence of bypass terminals, which are normally located close to the TFM rather than at the LEU, as shown in Figure 1 below.

![Figure 1 Current Sensing Arrangement](image)

With current sensing installations, special precautions must be adhered to when replacing an LEU, the LEU by-pass terminals, or the LEU isolation terminals, to prevent signal aspects being affected. These are detailed in the Alstom ETCS Trackside Maintenance Manual.

7 Failures SSI and Smartlock 400T System

7.1 General

Many modules or LRUs have site or interlocking specific software or hardware and as such replacement of these items requires a configuration check against the approved design documentation to ensure correct operation of the interlocking.

7.1.1 SSI

The SSI System maintenance and fault finding manual contains the detailed procedures for dealing with faults to the SSI system and equipment. The information given in this section outlines the module failure modes and key actions required.

It is not desirable to install a spare of an older type to effect repairs, but permissible where no suitable spares are available. In these instances the module installed is to be tagged for replacement with a correct type of module as soon as is practical.
7.1.2 Smartlock 400T System

The SML400T CBI System Maintenance and Operations manual contains the detailed procedures for dealing with faults occurring in the CBI system. Spare LRUs provided by the manufacturer for the installed baseline shall be used in the event of replacing faulty LRUs.

7.2 SSI System

The SSI System cubicle incorporates duplicated panel processor modules and triplicated interlocking multi-processor modules. One PPM failure and/or one interlocking MPM failure will therefore have no effect on the operation of the signalling.

The Diagnostic MPM is not duplicated and failure of this module results in loss of all diagnostics and technicians terminal facilities.

7.2.1 Interlocking MPM

Where a MPM is to be replaced it is imperative that the status of the MM is checked before powering on the MPM. The MMs in use MUST have the same date, version etc as detailed on the software record located on the inside of the rear door of the interlocking cubicle. If this does not occur a MPM with the incorrect MM may have its safety fuse blown, or, possibly shut down the entire interlocking.

7.2.1.1 Failure of one MPM

Failure of one MPM has no operational effect on the interlocking. This will be indicated to the signaller by a non-critical alarm and the licensed signalling personnel will receive an error message on the technician’s terminal printout.

The interlocking will operate in “2 from 2” mode, meaning there must be correlation between the two remaining MPMs at all times. This situation will persist until a serviceable module is installed in place of the faulty equipment.

Section 4.5.1.1 details the replacement procedure. “2 from 3” mode of operation will then be resumed.

7.2.1.2 Failure of two or three MPMs

Failure of two or more MPMs results in a total shut-down of the interlocking. This may be indicated to the signaller by a critical alarm with all panel indications frozen.

All signals will revert to stop.

This failure will persist until the faulty MPMs have been replaced. Section 4.5.1.1 details the procedure.

The Central Interlocking will then need to be started. Section 4.5.1.2 details the procedure.

7.2.2 Panel Processors

Failure of a single PPM will have no operational effect and result in a non-critical alarm to the signaller. However in exceptional cases a single faulty PPM can result in the loss of the Technician’s controls functionality.

Failure of both PPMs will result in loss of communication between the signalling control panel and the interlocking.
All panel indications will be extinguished and this failure will be indicated by an audible and visual alarm on the signaller's panel. The interlocking will continue to function normally with routes that are already set remaining so with signals cleared as appropriate, and trains will be moving in response to the signalling. It will not be possible to set any further routes.

These failures will persist until a serviceable PPM is installed with correct MM in place of the faulty equipment.

7.3 Smartlock 400T System

The Smartlock 400T System is developed as a redundant duplicated architecture for full system availability.

Spare LRUs must be available and ready prior to any replacement. The LRUs must be brought to ambient temperature of the operational environment, after unpacking from original sealed packaging and before powering up. This is to prevent any adverse effect to the performance of the LRUs, when unpacked and powered up.

When removing or handling of any CIXL LRUs, ensure that an electrostatic discharge (ESD) wrist strap is connected to the ESD Bonding Point on the left hand side of the Cubicle; this wristband MUST be worn on the wrist of personnel prior to the removal and handling of any CIXL LRUs.

Replacement of any of the LRUs/components of the Smartlock 400T shall be carried out in accordance with the SML400T Operations and Maintenance Manual.

7.3.1 CIXL

In the event of internal failure the CIXL can change seamlessly, and without any intervention by operators, to a 2oo2 operation (whilst at the same time isolating the failed module) from 2oo3 operation.

Note: Normal mode of operation of the CIXL is 3-out-of-3 with all computing channels powered on and running. In this mode the CIXL manages all the functions common to all VIXLs.

The LRUs that can be replaced are:

- CIXL I/O Subsystem LRU: This includes duplicated redundant input/output blocks A and B, each of which contains XAU, EAU or I/O PSU;
- CIXL Computing Subsystem LRU: This includes three redundant channels A, B and C, which implement the 2oo3 architecture. Each channel contains MPU, HSCU & REDMAN, Channel PSU, Preprogramed USB Key; Preprogramed Identity Device plugged to the Maintenance Panel one each for the computing Sub System channels A, B and C
- CIXL Fan Units;
- CIXL Front Panel Fuses;
- CIXL Main Power Supply duplicated.

When a CIXL Computing channel LRU (either the MPU, HSCU or REDMAN) needs to be changed, it is necessary to replace all the three LRUs (MPU, HSCU and REDMAN) in the computing channel together. The USB key inserted into its MPU must be considered as captive to the MPU and must remain inserted, even when the MPU is removed and returned for repair. While replacing the faulty MPU with the spare MPU ensure that the preprogramed USB key is for the correct channel and matches the CISR configuration.
Note: Each MPU of the Computing Channel is allocated a particular USB key and will only work with the correct USB key inserted.

The approximate time needed for the replacement of any of the above LRUs is expected to be less than 30 minutes. Failure report forms provided in Appendix A must be filled as applicable.

In the case of one computing channel being restarted, the education of this channel will automatically be performed. It is recommended that replacing a computing channel be performed during off peak hours for the area controlled by the Smartlock 400T.

VIXL error mode is an abnormal state entered due internal error in the application data for a VIXL. Once a VIXL has entered error mode, the only way to exit this state is to force a CIXL cold start. SML400T Operations and Maintenance Manual shall be referred for further details.

7.3.2 TICC

The redundant architecture is achieved by a pair of TFM gateways (each gateway formed by combination of FEs, GWs and their power supplies), a pair of LDTs or DLMs and duplicated power supplies.

The LRUs that can be replaced are:
- FE cassette;
- FE AC/DC Converter (one for each FE cassette);
- Gateway module;
- Gateway Configuration Key (or Configuration device);
- DLM;
- LDT;
- Gateway Power Fuse of the Gateway module;
- Gateway PSU (A or B);
- Gateway protecting fuse in the power tray;
- Cable connecting the Gateway plug called “MODEM” to the TICC;
- Cable connecting the Gateway plug called “TFM” to the TICC.

The programming label of a Front End and Gateway Configuration Keys must match with the details in the CISR report.

The approximate time needed for the replacement of any of the above LRUs is expected to be less than 30 minutes.

7.3.3 Support System

The SSYS components that can be either repaired or replaced are:
- All components of the Support system Cubicle
  - Redundant Support Server (hardware and software)
  - Rackmount SSys Client / Client Gateway (hardware and software)
  - GPS clock
  - KVM switch
  - Network devices
The local SSYS Clients / Client Gateways;
The remote SSYS Clients;
Printers

Remote Client is connected to the client gateway through the protected IMNet switch. The remote client shall only be connected to the designated port in the IMNet switch.

While two client gateways are provided only one client gateway is operational and functioning as the maintenance terminal and is connected to the three monitors. If required the second spare client gateway PC can be connected to the monitors 2 and 3 by swapping the video cable from the operational client gateway PC to provide the maintenance terminal.

A virtual LAN has been configured within the ports of the IMNet switch connecting the Remote client and the client gateway port 2, this is to restrict the remote client from accessing the other part of the Smartlock network. Also the port designated for the remote client is configured with the port security this prevents any other devices to be connected to the Ethernet cable in the electrician's office which is designated for connecting the remote client provided by manufacturer. Ensure that the configured spare IMNet switch only is used while replacing the IMNet switch that is connected to the Remote client.

The only authorised connections to the IMNet are the ones provided by the applicable specific approved circuit design describing the links between the IMNet switch and the subsystems connected. No other links shall be authorised.

7.4 Points Modules Controlled by SSI

Failure of point equipment connected to the module such as loss of detection, or failure to drive are detected by the diagnostic system and alarmed via the Technician’s Terminal. Failures to points module themselves are also diagnosed and fall into 5 categories:

7.4.1 Output Interface Failures

Points modules can control two sets of points, known as X and Y and will disable outputs to either of these in the event of a fault occurring. A critical alarm will be given to the Signaller and the Technician’s Terminal will report "Points Module nn output interface". The points concerned will continue to be detected, but it will not be possible to move them from the signaller's panel.

This failure will persist until the points module is powered down and rebooted

7.4.2 Input Interface Failures

All inputs, both point detection and general purpose are detected by a duplicated processor system within the module. If the processors disagree on the state of an input then an input interface fault is declared and the input concerned is set to its most restrictive state. A critical alarm will be given to the signaller and the Technician’s Terminal will report "Points Module nn input interface".

This failure will persist until the points module is powered down and rebooted. The licensed signalling personnel should check the external circuits connecting to the points module for high resistance or bouncing contacts as these can cause this type of fault.

7.4.3 Complete Module Failure

In the event of a complete module failure, known as a "shutdown" a critical alarm will be given to the signalman and the Technician’s Terminal will report "no reply from TFM nn
both links”. The points will remain locked in their last set position, the interlocking will have lost detection and this will indicate to the signaller in the usual way. If a module fails to receive data on both data links A & B it will cease all transmissions. This is detected by the interlocking as the same as a module shutdown.

When the interlocking detects a module shutdown condition it immediately puts all input functions associated with that module to their most restrictive state, and retains this state until normal communications with the affected module are resumed.

This failure will persist until failed module is powered down and replaced by a new module.

7.4.4 Points Motor drive Output

The points module motor drive outputs failure modes include permanently ON and permanently OFF as they are not safety critical outputs. If a motor drive output fails in the permanently ON state then a fault message will appear on the Technicians Terminal and the ESMLR will remain energised. Loss of points detection will occur due to the back proving of the detection circuit through of the ESMLR down.

This fault will persist until the points module is changed.

7.4.5 Slow Operation

Slow points detection can occur due to back proving of the points control relays in the detection circuit. In this case points detection will only be achieved after the points module 8 second time out for motor control has elapsed.

7.5 Signal Modules Controlled by SSI

Failure of signalling equipment connected to the module, such as lamp failures, are detected by the diagnostic system and alarmed via the Technician’s Terminal. Failures to signal modules themselves are also diagnosed and fall into three categories:

7.5.1 Output Interface Failures

In the event of a fault occurring in the signal module output circuitry the module will disable its outputs and apply a "red retaining" feed to selected outputs, generally the red lamp(s) of its associated signals. A critical alarm will be given to the signaller and the Technician’s Terminal will report “Signal Module nn output interface”. Current proving, and other inputs, will continue to be transmitted to the interlocking, but it will not be possible to clear the signal from the signaller's panel.

This failure will persist until the signal module is powered down and rebooted. The licensed signalling personnel should check the external circuits to ensure that there is no voltage showing on outputs that are de-energised, and that there are no high resistance connections in the current sensing leg of any external circuits.

7.5.2 Input interface Failures

All inputs are detected by a duplicated processor system within the module. If the processors disagree on the state of an input then an input interface fault is declared and the input concerned is set to its most restrictive state. A critical alarm will be given to the signaller and the Technician’s Terminal will report "Signal Module nn input interface”.

This failure will persist until the signal module is powered down and rebooted. The licensed signalling personnel should check the external circuits connecting to the signal module for high resistance or bouncing contacts as these can cause this type of fault.
7.5.3 Complete Module Failure

In the event of a complete module failure, known as a "shutdown" a critical alarm will be given to the signaller and Technician’s Terminal will report “No reply from TFM nn both links”. Any signal controlled by the failed module will be displaying a red (or most restrictive) aspect.

If a module fails to receive data on both data links A and B, it will cease all transmissions. This is detected by the interlocking as the same as a module shutdown. When the interlocking detects a module shutdown condition it immediately puts all input functions associated with that module to their most restrictive state and retains this state until normal communications with the affected module are resumed.

This failure will persist until failed module is powered down and replaced by a new module.

7.6 Signal and Point Modules controlled by Smartlock 400T

The failure modes of the Signal and Point TFMs applicable to SSI as described in 7.4 and 7.5 are relevant to SML400T system. Critical alarms are given to the Signaller by the CIXL similar to SSI. The Support system’s Alarm banner and Alarm viewer should be referred to for the complete details of the alarms associated with Signals and Points as per SML400T Operations and Maintenance Manual.

7.7 Data Link

Data link modules interface between the interlocking and the points and signal modules. The data link transmission system is duplicated, and under normal circumstances a failure to either link A or link B will have no effect on system operation, but will be detected by the diagnostics and a non-critical alarm will be given to the signaller.

In some cases an intermittent fault on one data link can affect system operation if the other data link is disturbed. If a data link becomes unstable it may be necessary to turn it off by powering down the appropriate DLM at the central interlocking in case of SSI and TICC in case of Smartlock 400T. Then find and repair the fault in the data link before restoring it to service.

Failures due to data link cable faults or data link bearer systems are also diagnosed and alarmed, and a printout is available to the technician indicating the position of the fault.

Failure of both data links results in the SSI interlocking/Smartlock VIXL losing communications with all or some of its points and signal modules. Such failures are potentially serious and could cause the interlocking to be completely inoperative.

Diverse routes are generally adopted for the two transmission systems and thus complete failure to both links simultaneously is very rare.

Lightning protection is provided by surge protection units. These are installed at every location containing data link modules. Failure of these units is likely to affect many locations attached to the same data link.

7.8 SSI Technicians Terminal and PC Logger

Should the technician’s terminal and / or the PC Logger fail the interlocking will continue to operate normally and the Signaller will receive a critical alarm. In this scenario the interlocking will not be able to be stopped or have any further Technician’s controls applied to, or removed from it. The logging function will also cease and the fault list in the buffer will be lost.
The PC logger functionality is critical for incident investigations. Failures of the PC logger must be dealt with promptly.

### 7.9 Smartlock 400T Support System

The diagnostic functionalities of the Smartlock 400T Support System generate alarms indicating faults or events. Should the support system fail, the interlocking will continue to operate normally and the Signaller will receive Technician Terminal alarm. Technician functionalities such as interlocking mode controls to start/stop a VIXL and application/removal of temporary controls will not be possible. In addition the CIXL cannot be started following an uncontrolled shut down.

Critical alarms shall be analysed and corrective actions taken at the earliest. The facility exists to deactivate audible alarms. Smartlock 400T Support System audible alarms shall only be suppressed by the Responsible Signal Engineer. The audible alarms shall not unnecessarily be left deactivated. The Responsible Signal Engineer shall risk assess the suppression of the audible alarms prior to deactivating.

### 7.10 Reporting

#### 7.10.1 SSI

General failure reporting requirements are detailed in Procedure PR S 40004 Failures. In addition a Solid State Interlocking Equipment Failure Report PR S 40032 FM01 (See Appendix A) must be completed with the appropriate information associated for each failure at an SSI installation. This form shall be signed and attached to the associated failure report form, and a copy attached to the faulty SSI module.

#### 7.10.2 Smartlock 400T System

Smartlock 400T system equipment fault report forms need to be filled in for each of the components of the system namely CIXL, TICC and Support system. In each case the Smartlock 400T Main Failure Report should also be filled in. Where it is required to report failure of Signal Module and Point Module, (SSI external equipment) that is connected to Smartlock 400T then item 3 in the failure form PR S 40032 FM01 (See Appendix A) should be used. To report the failure of the DLM and the LDT, that is connected to the TICC, the failure form PR S 40032 FM05 (See Appendix A) should be used. A copy of the required forms is to be attached to the defective LRU or module.

### 7.11 Track Circuits

SSIs and SML400T do not allow for conventional methods to manually release route holding or approach locking. Track circuit failures will need to be rectified and affected traffic operated under the rules and regulations.

### 7.12 Faulting and Maintenance Manuals

Documents are provided which specify the detailed procedures for fault finding and maintenance. These documents shall be referred to as required.
8 Maintenance

8.1 Use of Test Equipment

Test equipment specifically designed for SSI use is provided, and shall be operated in accordance with the manufacturer's instructions. The procedure associated with the equipment discussed in section 8.1.1 is applicable to Smartlock 400T.

Unauthorised development or use of other special diagnostic or test equipment is forbidden for SSI and its successive technologies such as Smartlock 400T.

List of equipment and tools that are authorised for use with Smartlock 400T systems are listed in the section 8.1.3.2.

The types of test equipment provided are detailed in the following subsections;

8.1.1 Data Link Telegram Generator

This portable test unit simulates data link transmission from an interlocking and is designed for testing TFMs installed in locations before an installation is commissioned.

Data Link Telegram Generators are only to be issued for use of Signal Engineers authorised by Signalling and Control Systems Manager.

Use of this equipment on working installations is strictly forbidden.

Unauthorised use could cause unsafe behaviour of the interlocking. It is critical that DLTG units are stored securely away from working installations and are only issued for use to suitably accredited Signal Engineers.

8.1.2 Data Link Interrogator

This portable test unit which is receive only, is used to monitor data link messages sent to or from the interlocking. It is attached to special test points provided in each location or bungalow where TFMs and DLMs are installed. DLIs are provided to licensed signalling personnel to assist in first line maintenance. Some DLIs also provide an output to trigger an oscilloscope when used in observing messages on the data link during second line maintenance. This enables only data from specific modules to be analysed from the constant stream of data passing between the interlocking and TFMs.

8.1.3 Conventional test equipment

8.1.3.1 SSI

Low input impedance test equipment could bypass input circuits for points and signal modules during testing. That is, the test equipment could be used to ‘bridge’ an input, resulting in a less restrictive input and therefore potentially an unsafe output.

Therefore:

- Digital multimeters (DMM) with an input impedance of less than 100kΩ shall NOT be used with SSI equipment.
- Fluke 114, 116, 117 and 289 DMMs have a LoZ (low AC impedance) mode for voltage measurements. This setting is NOT to be used in fault finding on SSI inputs.
- 20kΩ shunts must NOT be used on DMMs when fault finding on SSI inputs.

Sometimes Digital Storage Oscilloscopes are required to carry out conventional measurements. Mains powered and mains earthed oscilloscopes can be used providing
that they have floating isolated input channels. Oscilloscopes that do not have floating, isolated input channels must not be directly connected to a data link as this will earth one leg and could cause the data link to fail.

8.1.3.2 Smartlock 400T System

A Digital multimeter, type Fluke 77 series, or similar is to be used for checking the integrity of fuses. When it is necessary to use a standard SSI Datalink Interrogator, the SM4825 cable can be used to connect the interrogator to the TICC test ports. When the SSI Datalink Interrogator is to be connected to equipment other than the TICC then procedure in 8.1.2 should be followed. There is no requirement for any other types of equipment for Smartlock 400T.

8.2 Power Supplies

All SSI equipment operates from the signalling 120V ac supply. Normal and emergency primary supplies are provided, with automatic change-over controlled by a static switch, mechanical ECO or GGI (inverter).

The Smartlock 400T system operates from a dual signalling 120V ac supply. Two segregated UPS units are connected to the Signalling 120V ac power supply system via isolation transformers (used to restrict the voltage to the nominal operating range). These two UPS provide power to the Smartlock 400T subsystems in order to fulfil the availability requirements. The UPS powers the Smartlock 400T via the automatic transfer switch which toggles to the main power supply automatically in the event of loss of UPS supply.

8.2.1 Testing the UPS Change-over Function

8.2.1.1 SSI

Correct operation of the static switch or GGI shall be tested on every maintenance visit and at least every 12 weeks by failing the normal supply and observing that the load is taken by the emergency supply with no effect on the SSI or associated signalling equipment. On restoration of the normal supply the static switch will automatically change back to this supply. A record of all such tests shall be maintained. The mechanical block contactor on the normal supply input to the static switch or GGI must be inspected to confirm that the contactor de-energises when the normal supply is failed.

8.2.1.2 Smartlock 400T System

The change-over test is to be performed in accordance with the UPS Operations and Maintenance Manual. A record of all such tests shall be maintained. Maintenance personnel shall ensure that the Automatic Transfer Switch is always in UPS mode at the end of any maintenance activity. The Technical Maintenance Plan schedule should be adhered.

8.2.2 Maintenance By-Pass Switch

8.2.2.1 SSI

The static switch and GGI have a three position switch fitted to the unit to allow maintenance whilst the load is being directly supplied from either of the two sources. This should be left in the ‘auto’ position for the GGI and the ‘normal’ position for the static switch.

8.2.2.2 Smartlock 400T System

In order to facilitate the maintenance activities for the SML UPS system an automatic transfer switch is provided. The two position Manual/Automatic transfer switch should be
rotated to ‘Bypass’ position for the Smartlock 400T system to continue normal operation. This switch shall be restored to UPS position on completion of the maintenance activity.

8.3 Rostered Maintenance Visits

Solid state interlocking equipment consists of a number of sealed modules requiring no maintenance and therefore routine maintenance in SSI areas will continue to be dominated by conventional signalling equipment.

The Smartlock 400T CBI system consists of a number of modules requiring no maintenance and therefore routine maintenance in SML400T CBI areas will continue to be dominated by conventional signalling equipment. The Technical Maintenance Plan schedule should be adhered.

8.3.1 Peripheral Equipment

8.3.1.1 SSI

The SSI Technician’s Terminal incorporates peripheral equipment such as printers, PC Logger and remote dial in modems which require maintenance in accordance with the manufacturer's recommendations. The Responsible Signal Engineer shall program maintenance accordingly.

8.3.1.2 Smartlock 400T System

The system includes peripheral equipment such as printers, local client PC, Remote server/client that are connected via an Ethernet port. An Off-line replay system is also provided to enable playback and detailed analysis of events. Maintenance has to be carried out in accordance with the recommendations stated in manufacturer's Technical Maintenance Plan. The Responsible Signal Engineer shall program maintenance accordingly.

8.3.2 Technicians Terminal PC Logger SSI

In order to prove that the logging feature is working correctly, the logging dialog is inspected to confirm correct time, date and log file updates have occurred. This test shall be carried out in accordance with the TMP.

8.3.3 Smartlock 400T Support system

In order to ensure the correct operation of the Support servers and the Support system client's hardware and software, checks shall be carried out in accordance with the SML400T Operations and Maintenance Manual and the schedule specified in Technical and Maintenance Plan.

8.3.4 Data Link Line Measurements

8.3.4.1 SSI

The SSI diagnostic system is designed to raise alarms when significant faults in the data link occur. However it is useful to check line levels as this will enable deterioration in the transmission line, or data link modules to be detected at an earlier stage and it will provide records on which to base future judgements on the line.

Line measurements should be taken and recorded. Generally this is done at the control centre, using a digital storage oscilloscope, with a data link interrogator providing the trigger source. Full details of the procedures for line measurements are given in the appropriate manuals.
The event logs shall be checked to confirm that no telegrams are being lost on either data link.

8.3.4.2 Smartlock 400T System

The Support system provides several diagnostic features that include monitoring of communication between the cubicles and communication over the data link networks. Any faults detected will result in the generation of alarms. Refer to the manufacturer’s manual for the list of alarms generated and their meanings. Generic line measurement procedures applicable to SSI are relevant to Smartlock 400T CBI also.

8.4 Installed Software Record

8.4.1.1 SSI

Each SSI Central Interlocking has an 'Installed SSI Software Record' which details compatible hardware type and version as well as fixed program and site specific data identification.

The site copy is securely attached to the inside of each central interlocking cubicle rear door. The Installed SSI Software Record is provided and maintained by Signal Design or an accredited Design Office.

8.4.1.2 Smartlock 400T System

The Smartlock 400T design workstation generates a Central Interlocking Status Record-CISR that encompasses all the information giving details of the software and their versions. The hardware configuration is identified by the Smartlock 400T product baseline.

A site copy is to be securely attached to the inside of the central interlocking cubicle rear door. The Central Interlocking Status Record is provided and maintained by Signal Design or an accredited Design Office.

8.5 Spares

It is important to ensure that any spare module provided is of the correct type for the system. Full details of module types and compatibilities are included in the installed software records referred to in section 8.4.

8.5.1 SSI Spares

All spare modules shall be tested and stored in accordance with Section 4.3.1.

The following should be used as a guide when selecting an appropriate SSI module to replace a failed unit:

- MPM. Use the same brand, type (MkII or MkIII), Mod State (Ver). This is critical where internal data links are used.
- MM. Ensure the same type and configuration as per the installed system records.
- PPM. The preference is for the same brand. They are all MkII
- DLM. The preference is for the same brand. They are all interchangeable.
- LDT. There is only one type currently approved for use.
- SM. They must be the same brand and it is desirable for the same type (MkII or MkIIIA). It is permissible to upgrade from a MkII to a MkIIIA, unless the particular TFM is labelled as ‘MkII only’.

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8.5.2 Smartlock 400T System Spares

The Smartlock 400T CBI is supplied with spare LRUs for the CIXL and the TICC. Spare USB sticks are provided, pre-installed with the application and application data, and is identified by a label that will match the CISR number Eg. SM-2014-01. All spare modules shall be stored in accordance with Section 4.3.2. All configurable components are provided with labels and match with the details in the CISR report.

Only manufacturer supplied spares shall be used.

- TICC - Ensure the correct preprogramed spare unit for the particular Front End is used. The programming labels on the front of the spare and front of the failed unit should be same.
- TICC – Ensure correct GW configuration device, that has been specifically programmed for the same TFM network, is used when replacing the GW module
- TICC – Spare DLMs/LDTs used for SSI can be used with Smartlock 400T.
- TICC – Ensure cables with correct polarised coded plugs are used for interconnection between the ports of SML 400T cubicles.
- SSYS – Ensure Support Server is scrutinised as per the manufacturer check list stated in Operation and Maintenance manual.
- Ensure spare fuses of correct rating.

Ensure USBs and programmed ID plugs shall be refreshed within 8 years of the date of programming.

8.6 Insulation Testing

SSI and Smartlock 400T equipment is not to be insulation tested.

Insulation testing is only undertaken on fixed wiring in a location or wiring to trackside apparatus. This equipment is to be powered off and disconnected from the fixed wiring prior to insulation testing taking place.

Refer to PR S 40023 Insulation Inspection and Testing for more detailed information and exemptions to testing requirements. The same exemptions for SSI wiring associated with the MPM, DMPM, PPM and DLM equipment shall similarly also apply to Smartlock 400T with the wiring associated with the CIXL, TICC and System Server.
## Appendix A Forms

**Transport Sydney Trains**

**PR S 40032 FM01**  
SSI Equipment Failure Report

<table>
<thead>
<tr>
<th>Report No.</th>
<th>Control Centre</th>
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<table>
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<th>District:</th>
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<table>
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<tr>
<th>What Interlocking is equipment connected to:</th>
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Please complete all relevant sections by ticking appropriate boxes and answering appropriate questions. Append one copy to any failed equipment returned to the manufacturer and forward another copy and append to the Failure Report Form.

### 1. TIME

<table>
<thead>
<tr>
<th>Time of Failure:</th>
<th>Date of Failure:</th>
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<th>Tech. Terminal Fault Printout:</th>
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### 2. DESCRIPTION (INTERNAL EQUIPMENT)  
(Tick the appropriate box)

What piece of equipment failed:

- Panel Processor Module
- Multi Processor Module
- Diagnostic Processor Module

Other (Specify):  

### 3. DESCRIPTION (EXTERNAL EQUIPMENT)

What piece of equipment failed:

- **Signal Module**
  - At what system address:  
  - Manufacturer:  
  - What type(s) of Signal does the module drive:  
  - Which indications were alight on arrival at site:  
    - Power  
    - System  
    - Rx Data  
    - Outputs

- **Points Module**
  - At what system address:  
  - Manufacturer:  
  - What type(s) of Signal does the module drive:  
    - Air Points  
    - what type of point machine:  
  - Which indications were alight on arrival at site:  
    - Power  
    - System  
    - Rx Data  
    - Points X  
    - Points Y
<table>
<thead>
<tr>
<th><strong>Data Link Module</strong></th>
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</thead>
<tbody>
<tr>
<td>At which location:</td>
</tr>
<tr>
<td>Which Data Link (A or B):</td>
</tr>
<tr>
<td>Manufacturer:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Long Distance Terminal</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>At which location:</td>
</tr>
<tr>
<td>Which Data Link (A or B):</td>
</tr>
<tr>
<td>Manufacturer:</td>
</tr>
</tbody>
</table>

Which indications were alight on arrival at site:

- [ ] System
- [ ] Data from SSI
- [ ] Data to SSI
- [ ] Data to PCM
- [ ] PCM Tx Clock
- [ ] PCM Rx Clock
- [ ] PCM Rx Line
- [ ] Power

4. **HOW WAS THE FAULT RESTORED?**

- [ ] Module recovered on its own
- [ ] Module recovered after being powered down then up

Module replaced with the spare, serial numbers below

Failed Module Serial No.: ___________________________ Replacement Module Serial No.: ___________________________

5. **OTHER INFORMATION**

DC Electrified Area: [ ] YES [ ] NO

Weather conditions at time of failure (e.g. dry, wet, hot, lightning):

Other comments (e.g. power failure or interruption etc.):

Signed: ___________________________

Date:__/__/_________
### Technician Terminal Controls Log

<table>
<thead>
<tr>
<th>TIME &amp; DATE</th>
<th>CONTROL APPLIED</th>
<th>BY WHOM</th>
<th>REASON FOR CONTROL</th>
<th>CONTROL REMOVED</th>
<th>BY WHOM</th>
<th>TIME &amp; DATE</th>
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</thead>
<tbody>
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</table>

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UNCONTROLLED WHEN PRINTED
PR S 40032 FM03
Smartlock 400T Main Failure Report

Author:  
Signature:  

Date & Time:  
Location:  

Identification of the installation
Installation name:  
Location of failure:  

Failure effect
Impact on Railways operation:

Support System Indications
Alarm data & time:

Alarm Code name:
Screen shot attached:  
□ YES  □ NO

Comments

SML-400T equipment involved in failure

<table>
<thead>
<tr>
<th>Subsystem/Equipment</th>
<th>Failure?</th>
<th>Form attached</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIXL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TICC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Support System / Network</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Repair time

Arrival time:  
Date & time of fault clearance:  

Active repair time:  

**PR S 40032 FM04**

**Smartlock 400T CIXL Failure Report**

<table>
<thead>
<tr>
<th>Date &amp; Time:</th>
<th>CIXL Name:</th>
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</thead>
</table>

### Failed Items

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Serial Number</th>
<th>Mod</th>
<th>Symptom (If relevant)</th>
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<tbody>
<tr>
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</table>

### Failed Items Location

Identify Failed LRU location: (Circle of highlight)

![Diagram of Smartlock 400T](image)

### Replacement fitted

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Serial Number</th>
<th>Mod</th>
<th>Symptom (If relevant)</th>
</tr>
</thead>
<tbody>
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</tbody>
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Version 1.0
## Smartlock 400T TICC Failure Report

**Date & Time:**

**TICC Name:**

### Failed Items

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Serial Number</th>
<th>Mod</th>
<th>Symptom (If relevant)</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>

### Failed Items Location

Identify Failed LRU location: (circle of highlight)

![Diagram of Smartlock 400T TICC](image)

### Replacement fitted

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Serial Number</th>
<th>Mod</th>
<th>Symptom (If relevant)</th>
</tr>
</thead>
<tbody>
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Page 1 of 1
Version 1.0
**Smartlock 400T Support System Failure Report**

<table>
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<th>Date &amp; Time:</th>
<th>Cubicle Name:</th>
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**Failed Items**

<table>
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<tr>
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<th>Serial Number</th>
<th>Mod</th>
<th>Symptom (if relevant)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
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</tbody>
</table>

**Failed Items Location**

Identify Failed LRU location:

![Diagram of Smartlock 400T system]

**Replacement fitted**

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Serial Number</th>
<th>Mod</th>
<th>Symptom (if relevant)</th>
</tr>
</thead>
<tbody>
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</table>
Engineering Procedure
Signalling and Control Systems

Signalling Safeworking

PR S 40034

Temporary Storage and Despatch of Staffs and Operational Keys

Version 1.1

Date in Force: 21 September 2016
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<td>21 September 2016</td>
<td>R. Del Rosario</td>
<td>Updated to mandatory ASA requirements and title &amp; roles. Remove reference to Electric Train Staff.</td>
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<table>
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<th>Chapter</th>
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<tr>
<td>Updated section 1 to ASA section 34. Key listing updated and added keys to be used for maintenance purpose only</td>
<td>1</td>
</tr>
<tr>
<td>Remove reference to Electric Train Staff</td>
<td>1, 2 &amp; 2.1</td>
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2 Despatch of Keys or Staffs for Repairs or Alterations or Cancellation ..................4
  2.1 Return of Keys or Staffs to Territory ..................................................5
Appendix A Form: Operational Safeworking Keys or Staffs Sent for Repairs or Alterations or Cancellation ..................................................6
1 Temporary Removal Of Use

When any of the operational safeworking keys or staffs listed below are taken temporarily out of use, they must be kept in a safe, or other appropriate secure facility under the control of the maintenance signal engineer:

a) 1/2 Pilot Staffs
b) Bank Engine Keys
c) Shunting Keys
d) Annett Keys
e) Guards Keys
f) Closing Keys
g) Token Board Keys
h) ESML keys/handles or EOL Keys
i) XYZ keys
j) Fortress Keys on signalling apparatus
k) Level Crossing Emergency Operation Keys

Signalling personnel are permitted to use these keys for maintenance purposes but not for train operations.

Items listed above must be clearly labelled giving full particulars and kept locked inside the maintenance signal engineer’s safe, or appropriate lock-up area.

The maintenance signal engineer must keep records containing the particulars of all the items listed above. These records must be kept in the maintenance signal engineer’s office. Care must be exercised to ensure that these records are kept up to date and the movements of the items correctly recorded.

2 Despatch of Keys or Staffs for Repairs or Alterations or Cancellation

When despatching operational safeworking keys or staffs for repairs or alterations or cancellation, the details must be entered on the PR S 40034 FM 01 Operational Safeworking Keys or Staffs Sent for Repairs or Alterations or Cancellation form (reference Appendix A), which must be forwarded immediately by secure means to the maintenance signal engineer.

PR S 40034 FM 01 form must be used in conjunction with forwarding/returning keys or staffs for repairs or alterations or cancellation.

Note

Care shall be taken when completing the PR S 40034 FM 01 form to ensure that inscriptions are recorded as is. No abbreviations shall be used unless these also appear on the staff.

Where licenced signalling personnel do not deliver the keys or staffs, then they are to be sent in a locked metal despatch box. A Falcon 4 or SWI padlock must be used to lock
the despatch box. In the event of the despatch box being returned to the maintenance
signal engineer without a lock the maintenance signal engineer must rectify this matter.

The maintenance signal engineer upon receipt of the PR S 40034 FM 01 form, must
check and confirm the operational safeworking keys or staffs received reflect the PR S
40034 FM 01 form.

Once verified, the maintenance signal engineer must fill in the appropriate section of the
PR S 40034 FM 01 form and forward the form with the locked metal despatch box to the
Signal Interlocking Fitter (or representative) or Manager, Rail Equipment Centre (REC).

The maintenance signal engineer must investigate the cause of any undue delay with
return of operational safeworking keys or staffs.

2.1 Return of Keys or Staffs to Territory

When keys or staffs are replaced or repaired by the Rail Equipment Centre (REC) or
Signal Interlocking Fitter (or representative) they are to despatch the keys or staffs
together with the PR S 40034 FM 01 form in a Falcon 4 or SWI padlocked metal
despatch box addressed to the maintenance signal engineer and send a separate written
advise and provide telephone advice.

Where a receipt is not acknowledged by the maintenance signal engineer within seven
days, the Manager Rail Equipment Centre (REC) or Signal Interlocking Fitter (or
representative) must investigate the cause of the delay.

The maintenance signal engineer must check the new or repaired keys or staffs for
correct inscription, number and gauge using a test gauge. If correct, the keys or staffs
must be forwarded to licensed signalling personnel in the locked metal despatch box
together with the PR S 40034 FM 01 form.

Licensed signalling personnel must acknowledge receipt, and must complete and return
the PR S 40034 FM 01 form to the maintenance signal engineer. The maintenance
signal engineer is to keep a copy of the form on file.
Appendix A  Form: Operational Safeworking Keys or Staffs Sent for Repairs or Alterations or Cancellation

<table>
<thead>
<tr>
<th>Key/s No/s:</th>
<th>Section:</th>
<th>Inscription:</th>
</tr>
</thead>
</table>

The above key/s have been forwarded to the maintenance signal engineer for repairs.

**FROM**

Signal Electrician: ____________________________
Signed: ____________________________
Dated: ____________________________

**TO**

Maintenance Signal Engineer

Please arrange to repair / replace the above mentioned key/s.
Cost Code: ____________________________

**FROM**

Maintenance Signal Engineer: ____________________________
Signed: ____________________________
Dated: ____________________________

**TO**

Manager REC / Signal Interlocking Fitter

The above key/s have been repaired / replaced and forwarded to the maintenance signal engineer.

**FROM**

Manager REC / Signal Interlocking Fitter: ____________________________
Signed: ____________________________
Dated: ____________________________

**TO**

Maintenance Signal Engineer

The above key/s have been inspected and forwarded to the Signal Electrician a

**FROM**

Maintenance Signal Engineer: ____________________________
Signed: ____________________________
Dated: ____________________________

**TO**

Signal Electrician

Key/s No.: ____________________________ have been replaced on section: ____________________________ at ____________________________ hours

**FROM**

Signal Electrician: ____________________________
Signed: ____________________________
Dated: ____________________________

**TO**

Maintenance Signal Engineer
Engineering Procedure
Signalling and Control Systems

Signalling Safeworking

PR S 40035

Use of XL Keys, Master Keys and Staffs

Version 1.1

Date in Force: 21 September 2016
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<td>21 September 2016</td>
<td>R. Del Rosario</td>
<td>Updated to mandatory ASA requirements and title &amp; roles. Remove section 3 and relocate to PRS 40007.</td>
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Summary of changes from previous version

<table>
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<th>Chapter</th>
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<tbody>
<tr>
<td>Remove section 3 - non commissioned points and relocated to PRS40007 section 2.6</td>
<td>3</td>
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   2.1 Seldom Used Equipment .......................................................................................................... 4  
   2.2 Approval .................................................................................................................................... 4  
   2.3 Transferring Possession ........................................................................................................... 4
1 Master Keys and Master Staffs

1.1 General

All Master Keys and Master Staffs are effectively withdrawn from use.

The lead Interlocking Fitter may retain a Master Key for sole use within a workshop environment.

1.2 Exception

Under emergency situations, the Interlocking Fitter may be instructed to use their Master Key, as authorised by a Signal Engineer. Alternatively, if authorised by the maintenance signal engineer, the Annett Lock or face plate may be removed under strict adherence to procedures laid out in PR S 40006, PR S 40008 and PR S 40009.

2 Issue of XL Keys

This procedure only governs the issue of XL keys to signalling personnel where the key is required for signalling infrastructure work.

2.1 Seldom Used Equipment

The use of XL lock for seldom used equipment and signalling apparatus booked out of use are prescribed in PR S 40007 and PR S 40009.

2.2 Approval

XL keys used for signalling installation, maintenance, or renewal purposes must only be issued to maintenance signal engineers by the Professional Head Signalling & Control Systems.

The maintenance signal engineer issued with an XL key is responsible for its safe custody, and except in the case provided for transfer, must not allow the XL key out of their possession.

The Professional Head Signalling & Control Systems must maintain a record of XL keys issued to maintenance signal engineers and hold in safe keeping XL keys returned by signalling personnel.

2.3 Transferring Possession

In order to facilitate work during alterations or renewals, the maintenance signal engineer may transfer their XL key to a person who is licensed to perform signalling safeworking work for Sydney Trains, holds a current Certificate of Competency and an appropriate Permit to Work for the intended use of the XL key. This person is not permitted to further transfer the XL key to another person or party. The transfer of XL key must only be done by the maintenance signal engineer.

A receipt must be obtained each time an XL key is transferred.

The maintenance signal engineer must maintain a record, specifying the nature of the work and the period that the XL Key will be required. The maintenance signal engineer must arrange for the XL Key to be returned to them at the expiration of the period.
The Professional Head Signalling & Control Systems is to be advised when a permanent change in the maintenance signal engineer position occurs requiring a transfer of the XL key custodian,
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<th>Chapter</th>
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<tbody>
<tr>
<td>Added reference for treatment of failures &amp; irregularities of level crossing as per PR S 40004 &amp; disconnection as per PR S 40009.</td>
<td>1</td>
</tr>
<tr>
<td>Remove reference of maintenance of Level Crossing LED lights and relocate reference to PRS 40031 – Maintenance of Signal Sighting and Signals section 7.</td>
<td>2</td>
</tr>
<tr>
<td>Added where daily test is performed by licensed signalling personnel they are to report results to ICON Infrastructure who will record the test results.</td>
<td>3.1</td>
</tr>
<tr>
<td>Added fault or warning conditions to be cleared before leaving the level crossing site and any lights replaced or re-adjusted the level crossing should be operated for sufficient time to confirm level crossing monitor working correctly.</td>
<td>3.1.3</td>
</tr>
<tr>
<td>Updated maintenance visit sheet and added signal engineer's form</td>
<td>Appendix A &amp; B</td>
</tr>
</tbody>
</table>
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**Appendix B** Form: Signal Engineers Level Crossing Inspection ........................................ 10
1 Introduction

Level crossing protection systems and level crossing mechanisms must be installed and maintained in accordance with Signal Design Principles, the Level Crossing Equipment Manuals, and these Signalling Safeworking Procedures.

Treatment of failure and irregularity of level crossings is to be carried out in accordance with PR S 40004. For the disconnection of level crossing equipment, refer to PR S 40009.

2 Maintenance and Inspection

The moving parts of boom gates and half boom barriers including pedestrian boom gates, swing gates and emergency gates must be kept clean, adequately lubricated and checked for efficient operation at each scheduled maintenance visit by licensed signalling personnel. Boom gates and half boom barriers are to be balanced when installed and the balance must not be altered unless an alteration has been made to the booms or fittings, or as determined from maintenance inspection or incident investigation.

In the case of AC electric type gate mechanism particular attention must be given to the magnetic brake and the armature must be adjusted as necessary to compensate for brake shoe wear. The friction drive or clutch must also be checked and adjusted as necessary.

Where automatic half boom barriers are provided, licensed signalling personnel are to observe for correct operation of the mechanism and check the operating time. All cases where the descending or ascending times are considered excessive they must be reported to the maintenance signal engineer for investigation.

It is essential that good visibility of the lights and signs is available to road users. Licensed signalling personnel must check the signal focus and intensity of lights as part of their maintenance visit. This will necessitate viewing signals and signs from a distance of approximately 100 metres (or the maximum sighting distance if less than 100m) on all road approaches to the level crossing.

Where the sighting of lights is affected by direct sunlight shining on the lens, then these must be investigated thoroughly and the maintenance signal engineer notified to provide an appropriate solution. Any configuration change in this regard must be approved by the Professional Head Signalling & Control Systems.

The operation and focus of Type "F" flashing lights must be checked regularly, the lenses and reflectors kept clean and replaced when scratched or tarnished, and lamps replaced as necessary. The voltage on each of the lamps must be checked under operating conditions (with the mains power supply isolated) to meet the recommended value at intervals not exceeding six months, refer to PR S 40031 for more information.

Where the lights are of the LED type, maintenance of these lights is to be in accordance with PR S 40031 section 7.

Signalling personnel must notify the local road authority of situations where road signs at level crossings positioned outside the railway boundary are obscured, missing, or damaged. Any such report should be recorded and the maintenance signal engineer advised.

A level crossing location maintenance visit sheet must be kept in each level crossing location/cupboard. Tests and observations carried out each maintenance visit and events...
related to level crossing protection equipment are to be recorded on the PR S 40036 FM 01 form (reference Appendix A).

2.1 Additional Inspections

Licensed signalling personnel are to be vigilant when travelling in the vicinity of level crossings, or when performing nearby maintenance duties to observe for damage or vandalism that may affect the safe operation of the level crossing protection equipment including lights, bells, and booms/gates (where applicable).

Further to maintenance by licensed signalling personnel, maintenance signal engineers must periodically inspect each active level crossing to ensure the following:

- Level crossing protection equipment performs in accordance with its design requirement. (For example, approach warning time checked by train activation or log review)
- Level crossing configuration is effective for the specific circumstances. (For example, a change in road approach visibility or pedestrian usage)

The Signal Engineer Level Crossing Inspection Form PR S 40036 FM 02 (reference Appendix B) is to be used to record the inspection results.

This inspection must be scheduled at no less than the following intervals for level crossings fitted with:

- Lights and Bells (no Booms/Gates), not Remotely Monitored and Tested – 3 monthly
- Lights and Bells (no Booms/Gates), Remotely Monitored and Tested – 6 monthly
- Lights, Bells and Booms/Gates, not Remotely Monitored and Tested – 6 monthly
- Lights, Bells and Booms/Gates, Remotely Monitored and Tested – 12 monthly

2.2 Upper Quadrant Signal Mechanisms Used to Operate Pedestrian Boom Barriers

Upper quadrant signal mechanisms on pedestrian boom barriers are to be used in the normal direction of rotation only, i.e. looking from the back (hold clear end) of the motor, rotation clockwise to lift and anti-clockwise to drop.

Note: If the direction of rotation is changed from the normal direction, the uni-directional ratchet wheel has to be reversed and this alters the relationship between wheel, motor shaft, pawl and pawl pivot. The result is a tendency of the pawl to be pulled toward the ratchet wheel with load on the mechanism and failure of the hold clear mechanism to release even though the hold clear coils are open circuit.

2.3 Pedestrian Swing Gates

Maintenance of pedestrians swing gates is to be done in accordance with the tasks and frequencies as prescribed in the applicable technical maintenance plan.

This includes checking of emergency exit gate facility operation and maintenance tasks.

At approximately 5 years depending on rail traffic density, it is recommended that the motor/gearbox assembly be removed and returned to the manufacturer for service.

2.4 Cantilevered Flashing Light Signal Posts

Where level crossing cantilevered flashing light signal posts are installed, a suitable maintenance contractor must be engaged to rectify such lights as they become defective.
The contractor must be qualified in the use of appropriate lifting equipment and the protection of their own work within the road environment.

The maintenance requirements are as follow:

- The lights are to be inspected from the ground only.
- Cleaning of these lights is to be on an ‘as needed basis’ as a result of inspection from the ground.
- Structural maintenance is the responsibility of Sydney Trains Bridges and Structures Engineers.

The work must be carried out under the supervision of licensed signalling personnel who must disconnect the links in the local terminal box or in the location prior to permitting the contractor’s access.

Following the work, licensed signalling personnel must reconnect the links and perform a voltage leak to earth test of the relevant supply to confirm the wiring integrity. A function test of the affected light must also be conducted.

3 Investigating Reports of Power Supply Failure

Licensed signalling personnel must immediately investigate any report of defect associated with the level crossing power supply (as either indicated by an extinguished PSI lights, or an alarm generated by the remote monitoring device - where fitted).

3.1 Daily Level Crossing Operation Test

A daily level crossing operation test is required at active level crossings. This test is performed by licensed signalling personnel or Qualified Workers in accordance with NPR 716 – On-site testing of Type F level crossings and NGE218 – Type F level crossing management.

This test must consist of a two minute load test checking for the correct operation of all lights, bells and boom barriers or gates as applicable. This test is initiated by operation of the Test Switch (refer to section 3.1.2 if test switch not fitted). PSI lights must be observed to be ON at the conclusion of the test.

Where this test is performed by licensed signalling personnel, on the conclusion of the testing they are to report to ICON Infrastructure the results of the above tests, defects identified and confirm the PSI lights were observed to be on. ICON Infrastructure is to record the test results.

A level crossing operation test must also be performed by licensed signalling personnel during scheduled maintenance visits or whenever investigating reports of defective level crossing equipment (including power supply).

3.1.1 Level Crossings fitted with Remote Monitoring and Testing.

Where level crossings are fitted with remote monitoring and testing, and these devices are operating effectively, then there is no requirement for a daily test. Licensed signalling personnel are still required to perform the required tests in accordance with the technical maintenance plan or when investigating reports of defects associated with the level crossing protection equipment.

Where the remote monitor/tester is not operating correctly, a daily test must be performed as described in section 3.1 until the remote monitor is again functional.
3.1.2 Level Crossings not fitted with Test Switches

At some level crossings where a remote monitor/tester is fitted, a test switch may not be installed. In these cases, it is important for licensed signalling personnel to first isolate the mains supply to the battery charger before activating the level crossing for the operation test. The Manual Operation Switch must be used to activate the level crossing for two minutes.

PSI lights located inside the equipment location must be observed to indicate normal supply during this test.

3.1.3 Reinstatement

Fault or warning conditions, detected by a level crossing monitor must be cleared before leaving the level crossing site.

Whenever level crossing lights are replaced or re-adjusted, the level crossing must be operated for sufficient time to confirm that the level crossing monitor’s lamp detection system (where fitted) is working correctly (see Section 4).

Before leaving the level crossing licensed signalling personnel are to ensure that the level crossing is fully operational and that nothing has been left switched off, disconnected or unlocked including battery chargers, power supplies, test switches, emergency switches and manual operating switches. All equipment, switch boxes and equipment housings are to be left secured.

Fault and warning indications displayed by the level crossing monitor or remotely reported by the level crossing monitor are to be investigated and rectified with appropriate urgency.

4 Remote Level Crossing Monitors

The level crossing monitor system has a facility to prevent false alarms being reported to its control centre when maintenance is carried out. The fault reset button is to be pressed and held until the LOGIC led starts to flash (about 5 seconds) in order to temporarily disable reporting of alarms and warnings. At the completion of maintenance activities all fault and warning conditions brought up by any of the maintenance actions must be cleared and then the fault reset button pressed to resume normal operation.

The maintenance disable does time out (nominally 45 minutes) and any alarms and warnings that have not been cleared will be reported to the control centre.

All fault and warning conditions detected by the level crossing monitor are latched and must be cleared by maintenance staff in accordance with the level crossing monitor equipment manual.

Fault and warnings will not clear until the level crossing monitor has detected that the actual fault or warning condition has been rectified. For example, all lamps must operate for at least 20 seconds after a failed lamp has been replaced to clear a lamp fault.

If the level crossing lamps are replaced or re-adjusted then the crossing should be operated for 30 seconds to confirm that the level crossing monitor’s lamp detection is working correctly. If a lamp fault or warning occurs then the lamp learn procedure is to be carried out in accordance with the level crossing monitor equipment manual.
### Appendix A  Form: Level Crossing Location Maintenance Visit Sheet

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**Note:** Enter any additional comments on the back page of this form.

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Version 1.0
Appendix B  Form: Signal Engineers Level Crossing Inspection

| Location: | | |
|-----------|--------------------------|
| Date      | Train Warning Time* (sec)  | U.P. / D.O.M.  | Boom Descend Time (sec) | Boom Ascend Time (sec) | Road, Ped and Train Signage OK (Y) | Lights and Focus OK (Y) | Bells and Tone Generators OK (Y) | Bell Timer Adjustment OK (Y) | Emergency Keys, Switches and Locks OK (Y) | L/Ring Phone OK (Y) | Audit of Maintenance Performed (Y) | Comments | Name | Signature** |
|           |                          | SS / CS       | SS / CS                | SS / CS                | SS / CS                | SS / CS                | SS / CS                | SS / CS                | SS / CS                | SS / CS                | SS / CS                | |
|           |                          |               |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        | |
|           |                          |               |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        | |
|           |                          |               |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        | |
|           |                          |               |                        |                        |                        |                        |                        |                        |                        |                        |                        |                        | |

*Train Warning Time* is performed by timing from activation until train reaches crossing. Analysis of Cerberus logs may suffice. Compare against the specific signal design.

**Signature** confirms the level crossing equipment performs in accordance with its intended design requirement and the configuration is effective for the specific circumstances.

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Version 1.0
Engineering Procedure
Signalling and Control Systems

Signalling Safeworking

PR S 40038

Microlok II Computer Based Interlocking

Version 1.1

Date in Force: 21 September 2016
Disclaimer

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Document control

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<td>B. Howell</td>
<td>Updated to EIS 15/03 requirements and title &amp; roles.</td>
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Summary of changes from previous version

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<td>New section to clarify test tools and equipment requirements</td>
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<td>Changes in the requirements for maintenance signal engineer &amp; licensed signalling personnel for loading and replacement of CPU and Object Controller module.</td>
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1 Scope
The following instructions relate only to Ansaldo STS (formerly Union Switch & Signal) Microlok II cardfile and Object Controller equipment.

2 References
Many Microlok II installations have site specific maintenance instructions, which need to be referenced before conducting maintenance activities. They also contain important information relating to power supply setup, communications links and operating environments.

The Microlok II documentation is contained in the following manufacturer manuals:
- SM 6800A – Microlok II Integrated Vital Interlocking, Coded Track Circuit, and Non-vital Code Line Controller – System Description
- SM 6800B – Microlok II Integrated Vital Interlocking, Coded Track Circuit, and Non-vital Code Line Controller – Hardware Installation
- SM 9494 – Microlok Object Controller, Installation and Operation Manual
- SM 6470A – Microtrax Coded Track Circuit
- SM 6470B – Microtrax Coded Track Circuit System Hardware Installation and Configuration

Where Microtrax Coded Track Circuit boards are housed within the Microlok II cardfile, refer to PR S 40025 for details of track circuit adjustment.

Where there is conflict between this document and the Ansaldo STS documents, this document will take precedence. Discrepancies should be reported to the Professional Head Signalling & Control Systems.

3 Repair
Field repairs are not to be carried out on any Microlok II plug-in modules, track interface module, or Object Controller unit. These items must be returned to the manufacturer, or their agent, for repair.

4 Handling and Storage
Boards and modules must be handled, transported and stored with care and not subjected to damage or deterioration.

The boards and modules must be stored on racks in enclosed housings in a clean, dry and non-corrosive environment below 60º C.

Anti-static protection handing procedures must be applied when handling boards and modules.

5 Tools and Test Equipment
Tools and test equipment used on Microlok based interlocking systems must be Sydney Trains approved or otherwise deemed acceptable by and in conjunction with the
manufacturer. For example, only the correct tool will be used to remove and insert
EPROMs and EEPROMs from circuit boards, or only specified devices will be used for
monitoring or interrogating interlocking data.

Conventional test equipment such as multimeters, data loggers, chart recorders and
oscilloscopes are to be used only where they do not pose a risk to the functional safety of
the system.

Inappropriate use of test equipment and test leads can effectively bridge-out or bypass
safety functions, resulting in a less restrictive input and consequently, an unsafe output.
Test equipment can also potentially force an output to produce a less restrictive situation.

The following restrictions apply for the use of conventional test equipment:

- Test equipment must have an input impedance of 1 MΩ or greater for the voltage
  measurement.

  Note 1: Multimeters which have a low ac impedance (LoZ) mode for voltage
  measurements (for example, Fluke 289) are not to be used for fault finding when in this
  mode.

  Note 2: External shunts are not to be fitted to test equipment when fault finding.

- Multimeter current mode must not be used when testing. Current measurements
  must be performed using a tong meter or current clamp.

- Multimeter ohms and diode-test modes produce a test voltage and present the
  risk of the test voltage turning ON an input or output. These modes must not be
  used without the disconnection of the circuit.

- Test equipment inputs must be floating; not referenced to a common potential.

- Multi-channel test equipment must have all channels isolated from each other.

- Test equipment lead probes must be chosen and applied such to minimise the
  likelihood of probes causing a short-circuit across an input.

Third party devices such as USB sticks must be free of viruses or malicious software
before inserting into signalling computers such as maintenance workstations. Installation
of software that is authorised and in accordance with type approval requirements is only
permitted on signalling computers.

6 Equipment Specific Issues

6.1 General

The equipment contains a Real Time Clock. The Real Time Clock is not used for any
safety critical functions. The Clock is only used for event and error logging. Refer to
Section 6.4 for the handling of the synchronisation process with Eastern Standard and
Eastern Summer (Daylight savings) time.

The indicator LEDs provided on the equipment are not fail safe. The LEDs provide
diagnostic information and aid. The passive state of an indicator LED is not sufficient as
the sole information for a safety critical test.

Application data has logic to check that the application data is correct for the particular
equipment location. If the application data is not correct for the particular location then
application logic will perform a “kill” function, which will put the equipment into CPS
shutdown. The correct application data and/or settings must be installed before the CPS
shutdown can be successfully cleared.
The Microlok II Development System and Microlok Object Controller Network Adapter Advanced Tools, provide maintenance facilities and facilities to alter safety critical data and settings.

As part of the replacement of a CPU module or Object Controller, signal engineers are permitted to:

- Upload the executive as detailed on the Installed Data Form.
- Upload the application as detailed on the Installed Data Form.
- Check and set any adjustable items as per the site specific maintenance procedure.
- Upload object controller network configuration files for the ‘COM1’, ‘COM2’ and ‘Web Tool Ethernet’ ports as detailed on the Installed Data Form
- Program new EPROM serial dongle to replace a damaged or lost EPROM serial dongle as detailed on the Installed Data Form

Maintenance signal engineers must not, unless it is under the direction of an accredited Signal Designer:

- Alter adjustable configuration items to a value other than that detailed in the site specific maintenance manual.
- Upload the executive other than that detailed on the Installed Data Form.
- Upload an application other than that detailed on the Installed Data Form.
- Upload the Network Configuration files for an Object Controller other than that detailed on the Installed Data Form.

Licensed signalling personnel are permitted to:

- Replace failed CPU and Object Controllers with pre-programmed spares as detailed on the Installed Data Form.
- Replace other modules that have failed.

6.2 Microlok II Cardfile

The indications on the module front panel LEDs are based on the external wiring plugged into the board, and not the board position. If the external connectors are swapped between modules of the same type then the LEDs on the modules will have swapped meanings.

If signal lights are directly driven by the Microlok II, licensed signalling personnel must pay special attention to all terminations and associated bleed resistor mounted in the signal head. Licensed signalling personnel should ensure that these terminals and connections are tight, properly mounted, and that faults are unlikely to occur. This requirement is because an open circuit in either the signal LED light or resistor legs has a significant risk of causing the Microlok II to reset and ultimately enter CPS shutdown. If it is necessary to disconnect or work on the resistor or signal LED light terminations, the pins or Elsafe module for that particular signal LED light in the location must be removed first. An open circuit on the cable to the signal terminations will produce a lamp out (which results in a flashing front panel LED on the Vital Lamp Driver Module), and will not initiate a reset or failure of the Microlok II.

A Microlok II cardfile is not to be put into operational service with any disabled Vital Lamp Driver modules (LP16) or Microtrax Coded Track Boards.
6.3 Object controller

Object Controller specific issues:

- Keys are provided on input and output connectors to prevent incorrect connection of the connectors – if the keys are broken the plug or Object Controller must be replaced.
- The connector keys can be damaged by excessive force. Check the correct keying before plugging in.
- The input/output connectors are colour coded. The colours are to be matched.
- Wiring is controlled to prevent the possibility of swapping connectors with another Object Controller. If the wiring is found to be loose or uncontrolled in a way that may permit swapping of connectors then it must be repaired.
- A Dongle is provided to verify that the application data in the Object Controller is correct for the specific location.
- The Dongle is labelled and securely attached to the rack. Loss of the label or non-secure connection to the location must be repaired.
- The Dongle securing point is such that it can only plug into one Object Controller. Dongle securing that permits it to be plugged into multiple Object Controllers must be repaired.
- The Object Controller is labelled to identify application CRC, Executive version, model number and IP addresses. Arrange for any unlabelled Object Controllers to have the correct label fitted.
- Verification of the correct dongle plugged into the Object Controller is determined by comparing the Dongle label, Object Controller label, the application data information obtained via the WebTool and the Installed Data Form in the Circuit Book.

6.4 Eastern Standard and Eastern Daylight Time

All Microlok equipment clocks are to be set to Eastern Standard Time (EST).

Usually the equipment time is set using a PC/laptop computers time as the reference. The PC/laptop time is to be checked and corrected to Eastern Standard Time prior to setting the time. This is usually done after the downloading of logs.

Station LED clocks, Mobile phones with automatic update enabled and the computer network time can be used as a time reference.

All CPU cardfiles that form one system should be set using the same time reference. For example, from the one PC/laptops time. A time mismatch between CPU cards will cause a mismatch in event logs.

If the installation is configured with a CLOCK MASTER then only Microloks configured as CLOCK MASTER need to have their time checked and set.

The Microlok CPU clocks do not have their times adjusted due to Daylight Saving time changes.
6.5 Powering Down of equipment

**Microlok II equipment must be powered down using the B12 fuse or switch (if provided). N12 connections to the equipment must not be disconnected without the equipment being powered down first.**

**Do not remove or replace any modules or the Vital Cutoff Relay (VCOR) with the Microlok II equipment powered.**

7 Elsafe Modules

Elsafe modules have been provided that have a base with test points, and a plug in module. Coloured tags (called T-bars) that clip into the base and match the front cover colour of the module have been provided to ensure that the correct type of Elsafe module is plugged into the base. It is important that the correct types of module are used for each circuit.

The use of yellow 50V immunisation modules type 216640 has been discontinued due to undesirable failure modes in some configurations. Type 216643 is now used instead.

Type 216643 Elsafe module is approved as a direct maintenance replacement for the type 216640 Elsafe module.

Faulty or failed type 216640 modules are to be replaced with a type 216643 module. In an emergency an existing failed type 216640 module may be replaced with another type 216640 module for a short period until a type 216643 module is obtained. Faulty or failed type 216643 modules can only be replaced with type 216643 modules.

8 Maintenance

Scheduled maintenance is carried out as per the Technical Maintenance Plan schedule.

A copy of the system event log and system error log is to be downloaded and kept on a maintenance PC. These logs are to be reviewed for abnormal occurrences and, where Microtrax exist, to confirm the track circuit shunting effectiveness. Any abnormal occurrences are to be investigated and the maintenance signal engineer advised.

**Note:** The above task can be performed remotely.

Microlok equipment clock date and time is to be checked and corrected if necessary to Eastern Standard Time.

Confirm that the User data log is operating and holds the expected duration for either the internal memory or the add-on PCMCIA memory card.

Perform a voltage balance to Earth test for a DC bus as follows:

a) Measure the DC voltage with a 100K shunt connected to the multimeter input.

b) Measure and record the DC voltages: Bus voltage, Bus positive to earth and Bus negative to earth. Note: Polarity of the voltages is ignored.

c) Investigate and correct the cause of any Bus to Earth voltage greater than 10% of the bus voltage. Bus to Earth voltages should be similar. Differences of more
than 5% of the Bus voltage between positive and negative voltages to earth also indicate that an earth leak is present.

All power supplies associated with the Microlok (that don't have an Earth Leakage Detector (ELD) fitted) are to be tested for Voltage Balance to Earth. These typically include: B12 and B50. Sometimes B15, 5V, +12V and -12V are also provided.

Perform a Microlok battery load test as follows:

a) Advise the Network Control Officer (NCO) of the expected alarm.
b) Connect a DMM set to measure DC voltage across the B12 bus.
c) Set the meter for min/max recording and display the minimum value.
d) Turn off the battery chargers.
e) Monitor the B12 voltage for up to 5 minutes.
f) If the B12 minimum voltage drops below 12.0 volts within 5 minutes then turn on the battery chargers.
g) After 5 minutes turn on the battery chargers.

Batteries that do not maintain the B12 supply above 12.0 volts for at least 5 minutes are to be replaced.

Perform an AC ripple voltage test on B12 supply as follows:

a) Connect a True RMS DMM set to measure AC voltage across the B12 bus.
b) Set the meter for min/max recording and display the maximum value.
c) Monitor the B12 voltage for at least 10 seconds.
d) If the maximum recorded value is greater than 250mVAC then investigate and correct the cause of the AC ripple voltage.

**Note:** An acceptable alternative is to measure DC voltage using **fast** min/max. The difference between minimum and maximum recorded values is to be less than 0.5 VDC.

Perform a functional check of the VCOR relay as follows:

a) Arrange access to shutdown the Microlok cardfile.
b) Measure voltage drop across each used contact. Replace relay if the voltage drop is greater than 0.5VDC.
c) Remove the B12 fuse for the VCOR supply to the first OUT16 module whilst observing the VCOR relay.
d) Monitor the operation of the VCOR relay (and any repeat relays) for two shutdown and re-start cycles.
e) Replace any VCOR (or repeat) relay if it does not drop away and pick up cleanly then retest.
f) Restore the removed fuse.
g) Perform a CPS reset if required and check that the Microlok starts operating correctly.

Note: An acceptable alternative test is to remove the B15 fuse for the VCOR supply to a LAMP16 module.

Signal lights directly driven by the Microlok II must be checked to confirm that:

a) Lamp currents for signal lights fed from B15 power supplies are greater than 1.22A.

b) Lamp currents for signal lights fed from B12 power supplies are greater than 1.5A.

The different lamps current values are set because, when the battery is supplying the load, the B12 supply voltage drops as the battery discharges. An increased margin is needed in this case for the lamp currents as they will reduce with some models of LED signals.

Microtrax coded track modules installed in the Microlok cardfile are maintained in accordance with site specific maintenance instructions and PR S 40025.

9 Insulation Testing

Care is to be taken that wiring connected directly to the Microlok II or Object Controller is not insulation tested whilst the modules or connectors are plugged in. Testing must be carried out on wiring isolated by the removal of connectors, modules, fuses, links, relays or by the de-energisation of relays.

Refer to PR S 40023 for more detailed information and exemptions to insulation inspection and testing requirements.

10 Analysis of Error Codes

Any errors from the logs that indicate a possible safety related problem are to be referred immediately to the maintenance signals engineer and the Professional Head Signalling and Control Systems. Reliability related codes are to be referred to the maintenance signals engineer for action.

11 System Failure and Initialisation

11.1 Initialisation

All N12 connections to a Microlok II cardfile or Object Controller must be connected prior to power on.

The Microlok II cardfile or Object Controller is to be powered up by installing the B12 fuse or turning on the switch (if provided).

Refer to the site specific maintenance manual for any particular procedures for the location.

Normal or reverse point detection is required to initialise the internal points lock relay functions.

Microlok application data initialises its internal points lock relays based on the point detection at start-up.
If both internal points lock relays (NLR and RLR) become de-energised during operation they can be re-initialised by the points being keyed centre (on the NCO’s panel) for at least 15 seconds. The internal points lock relays will then be set based on detection of the points.

In some installations, the internal lock relays may be forced to initialise in the normal state if the points are not detected.

### 11.2 CPS Shutdown

A CPS (Conditional Power Supply) shutdown, which must be cleared by maintenance action, occurs when the equipment has repeatedly detected critical errors (typically more than 5 in less than 1 minute of operating time).

CPS shutdown is indicated by the CPS LED not lit on Object Controller or Cardfile PSU. The status can also be checked by the diagnostic applications.

If CPS shutdown has occurred then:

a) Clear the CPS shutdown.

   - **Microlok II cardfile:** CPS is cleared by CPU front panel toggle switches or Development System Reset Microlok II command.
   - **Object Controller:** CPS is cleared by the WebTool, Network Diagnostic Tool, Reset Unit command.

b) If the system does not recover then carry out the necessary fault finding activities to find and correct the failure. Note that as well as the modules, the fault could be due to power supply to the modules, or external wiring faults being detected by the Microlok II or Object Controller.

c) After the fault has been cleared, collect the following information and provide it to the maintenance signals engineer for investigation:
   
i) A copy of the system event log and user event log
   
ii) Power supply voltages
   
iii) Details of any power disruption, or storm activity at the time
   
iv) Any other information that could be relevant.

d) Check that the Microlok equipment clock time is correct.

### 12 Pre-Programmed Spares and Data Management

The management, distribution and version control of Microlok data CDROM(s) issued and installed in the field is to be in accordance with PR S 40014.

CDROM Microlok programming data is only to be kept in storage locations managed by and detailed in the signalling documentation register.

Superseded CDROMs are to be returned to the maintenance signal engineer following commissioning of data changes. Version control of CDROMs is to be achieved by correlating the CDROM version number to the Installed Data Form available in the “Interim Maintenance” or “As Built” Circuit Book.

The supply of pre-programmed CPU and Object Controller spares (along with other critical spares) is to be considered by the Commissioning Engineer of a resignalling
project. The Commissioning Engineer, or nominated representative, is to liaise with the
relevant Signal Asset Engineer and maintenance signal engineer to determine spares
requirements based on system redundancy.

In an operational interlocking, the maintenance signal engineer is to determine the
requirement for pre-programmed spares, considering system redundancy, operational
criticality and any previous incidents at that interlocking.

Pre-programmed spares are to be appropriately labelled to ensure version control. Pre-
programmed Microlok CPU and Object Controller spares are to be labelled with their
version number, checksum, application image CRC, executive version, executive CRC
and date of interrogation/programming. Spare, pre-programmed Microlok CPU or Object
Controllers must be energised and interrogated to confirm the values provided on the
Installed Data Form every 5 (five) years.

Other pre-programmed spares related to Microlok interlockings must be managed with a
similar process, using labelled spares, defined by the maintenance signal engineer.

13 Replacement of a Microlok II CPU Module

13.1 Licensed Signalling Personnel

In the event of a CPU module failure, the replacement pre-programmed CPU module
must be checked to be configured with the correct executive software version AND
correct application data for the location. The pre-programmed CPU module version
control label information must match the circuit book verification sheet for file size, date,
checksum and version number. Use the circuit book or maintenance manual to confirm
the CPU board programming jumpers/links are set to the non-programming position.

Use the Microlok Development II Software tool to check that the installed Application
CRC and the Executive Version and CRC match the details in the circuit book.

Test the correct operation of the CPU module by confirming that no errors or warnings
have been recorded in the event log during the first five minutes of operation.

The maintenance signal engineer must be notified of the CPU module replacement.

13.2 Signal Engineers

In the event of a CPU module failure, the replacement CPU module must be configured
with the correct executive software version AND correct application data for the location.
A copy of the current application data AND executive software versions for each installed
Microlok II cardfile has been issued on CDROM for use by signal engineers. Details on
how to upload data are contained in the Manufacturers Manuals and on the Maintenance
CD.

The CPU Module Flash programming voltage is normally set to 5V.

Upload the executive and application data for the cardfile then check the Application CRC
and the Executive Version and CRC against the details of the Installed Data form in the
circuit book.

Check and set any adjustable items as per the site specific maintenance procedure.

On completion of programming, use the circuit book information to verify the CPU board
programming links are returned to the normal operating positions.

Test the correct operation of the CPU module by confirming that no errors or warnings
have been recorded in the event log during the first five minutes of operation.
Where another signal engineer has carried out the replacement, the maintenance signals engineer is to be notified.

For pre-programmed modules follow Section 13.1 above.

### 13.3 Retrieval of Logs from Removed CPU Modules

If retrieval of the logs is required after a CPU module is removed from the cardfile, then this must be carried out within 4 hours as the back-up power will discharge and the logs will not be able to be recovered. Whenever possible, logs must be retrieved before the CPU is removed from the cardfile.

### 14 Replacement of Modules

Modules are not generally to be removed and replaced unless fault finding.

Power down the cardfile as per Section 6.5 Powering down of equipment.

Licensed signalling personnel must touch earthed metalwork with both hands before replacing any modules or preferably use an earth strap.

Modules are to be checked for physical condition prior to installation or use. Modules that are not in good physical condition or have loose parts are not to be used. They must be treated as defective.

The original module should be restored prior to further testing if a replacement module did not correct the fault.

All modules must be plugged in and fully secured by top and bottom screws prior to powering on a Microlok II cardfile for operational use.

After any module has been removed or changed, the inputs and outputs to that module should be checked for correct operation by exercising a sample of each function and observing the correct operation of the indication LEDs provided on the panel face.

Defective modules are to be tagged with the date, defect, and location and returned for repair in accordance with the procedures required by the manufacturer.

### 15 Replacement of an Object Controller

The Object Controller is replaced as a single unit. The replacement Object Controller must be properly configured prior to being put into operational use. This configuration is to be performed by a signal engineer.

Where another signal engineer has carried out the replacement of an object controller, the maintenance signals engineer is to be notified.

Detailed procedures are provided on the Maintenance CD and in the Ansaldo STS Object Controller manuals. Section 15.1 below describes the process for configuring a replacement Object Controller.

Labelling is provided on the Object Controller for the Application CRC, Executive version and network IP addresses for the Ethernet ports (COM1, COM2, WEB TOOL). These labels are normally attached to the replacement Object Controller during the configuration process, prior to the installation.

Installation of a replacement Object Controller requires several steps as described below.
1. Turn off the existing Object Controller by operating the power switch at the back of the unit. Disconnect the power connection, all input connectors and all output connectors from the back of the Object Controller. Disconnect the Ethernet cables and EEPROM dongle from the front.

2. Install the new Object Controller and configure it in as per Section 15.1 Configuration of a replacement Object Controller.

3. Ensure that the same input connectors, output connectors, network cables and EEPROM dongle that were attached to the faulty unit are also re-connected to the replacement unit. The EEPROM dongle must be secured onto the front DB9 socket by fastening the screws on the plug.

4. After the replacement of the unit, power on and function test a sample input/output from each input and output connector.

5. Check that the Object Controller clock is set to the correct time. Use the WebTool / Network Diagnostic Tool, ‘Set Clock’ link to check the Object Controller system time. If the system time is incorrect then set the time from the computer’s time. Ensure the computer time is correct for Eastern Standard Time (not daylight savings) before applying its time to the Object Controllers system time.

6. Arrange for the replacement Object Controller to have a label fitted that matches the original unit and Circuit Book. Labels typically show details of the application CRC, Executive version, model number and IP addresses.

   **Note:** The WAGO connectors used for the inputs and outputs can be snapped apart. Care must be taken when disconnecting and re-connecting these connectors. The assembly provides wiring and connector keying.

   Defective Object Controller units are to be tagged with the date, defect and location. Return the defective unit for repair in accordance with the procedures required by the manufacturer.

### 15.1 Configuration of a replacement Object Controller

Replacement Object Controller units must have the correct Executive, Application data and network configuration files uploaded by the signal engineer. A controlled copy of the approved configuration data is provided on the Maintenance CD.

The configuration details must be checked against those shown on the Installed Data Form in the Circuit Book.

Configuration of the Object Controller can be performed remotely via the network, locally or offsite.

Three Ethernet network ports are provided with the Object Controller, COM1 and COM2 ports are for signalling. They may have identical IP addresses and network configuration files for redundancy. The third port is the WebTool diagnostic port. Each port has its own Network Configuration File and is configured separately. However, the network configuration file name for all ports is identical; the filename for all ports is ‘niacfg.ini’. Ensure the correct ‘niacfg.ini’ file is used for the port.

**Incorrect uploading of network configuration files for the WEB TOOL Ethernet port can fail the Object Controller.**

**Confirm the correct file and process prior to performing this action.**
SM9494 Microlok Object Controller Installation and Operation Manual details the processes.

Notes: Only one un-configured Object Controller can be turned on and connected to a network. An un-configured Object Controller WebTool port has a factory default IP address. Conflicts in the configuration process will arise if multiple Object Controllers, with identical factory default IP addresses, are connected to the network.

Only the Object Controller Ethernet port being configured is to be connected until all ports have been configured.

Notebook/Laptop computers need a straight network cable and Auto-Negotiation set on the network port or a crossover network cable for direct connection to the Object Controller.

15.2 Replacement of the Object Controller EEPROM Dongle

Confirm that the Object Controller EEPROM dongle is faulty and requires replacement by the following steps:

1. Check the label on the EEPROM Dongle to ensure that it is for the correct Object Controller unit.

2. Check that the EEPROM Dongle is plugged in correctly and securely connected to the Object Controller.

3. Review the System event log to identify the reason CPS has remained in shutdown mode:

4. If an entry Configuration warning – saved configuration unusable is found when the Object Controller was last started then the dongle is not connected, faulty or has never been programmed. Corrective action is to program a replacement dongle.

5. If an entry Configuration warning – wrong application or executive for saved configuration is found when the Object Controller was last started then the dongle is for a different application or executive. Corrective action is to configure the Object Controller to match the dongle and the Installed Data Form in the Circuit Book.

The AnsaldoSTS Microlok Object Controller EEPROM Dongle Update Procedure has instructions on how to program an EEPROM dongle for site specific application data.

Note: An adjustable system configuration parameter needs to be changed during the EEPROM dongle Application data writing stage. The adjustable parameter to change is Board Configuration, IN6.OUT6 board. Disable then enable the first board.

Ensure the following when replacing an EEPROM dongle:

- The maintenance signals engineer is informed of any EEPROM dongle replacements and agrees to the verification arrangements.

- The Configuration of the Object Controller is done as per Section 15.1 Configuration of a replacement Object Controller.

- Verification by an independent accredited person is done to confirm that the Object Controller is configured in accordance with the Installed Data Form in the Circuit Book.
• The Write Enabler is removed once the replacement EEPROM dongle has been programmed.
• The EEPROM dongle attachment to the rack is to be checked as per the Object Controller specific issues in Section 6.3.
• Arrange for a label to be applied to the EEPROM dongle.

15.3 Reconnection of a disconnected Object Controller EEPROM Dongle

The Object Controller requires an EEPROM dongle that matches its application configuration to start from power on or reset otherwise CPS will be disabled.

Disconnected dongles must be reconnected to the correct Object Controller. Each EEPROM dongle has a label indicating which Object Controller it connects to. Ensure that the EEPROM dongle is reconnected to the Object Controller shown on the dongle label. Correct operation is to be verified by restarting the Object Controller under controlled conditions.

Report the reconnection of a disconnected Object Controller EEPROM dongle to the maintenance signals engineer.

16 Failure Reporting

It is important that all failures and problems with the Microlok II are carefully recorded so that an accurate assessment can be made of the reliability of the system.

Information to be recorded as part of a failure report includes:

• Fault observed
• Error codes reported in the error log
• Faulty modules/items replaced
• Possible contributing factors to the fault
• CPS resets performed

Failure reporting is as per the normal signals failure reporting procedure in accordance with PR S 40004.

17 Protection of the Line

17.1 Disconnections

When it is required to disconnect signalling apparatus, the necessary Network Rules, and Network Procedures, as well as the disconnection philosophy as stipulated in PR S 40009 must be strictly observed.

Five alternative arrangements have been implemented for Disconnections as part of installations.

a) Using a CBI Workstation
b) Using Blocking pins
c) Using the Relay interface
d) Using Lamp Driver Outputs

e) Microtrax Coded Track Circuit

17.2 CBI Workstation

Where a CBI workstation is provided, facilities are available for licensed signalling personnel to block and unblock signal routes, points in the normal or reverse position and track circuits. The blocks are applied within the vital Microlok application data and prevent the clearing of a signal route, or movement of points. Blocking a track circuit forces it to an occupied state and would prevent the operation of functions that the track circuit controls.

Before applying the block, ensure that:

a) points are in the correct lie,

b) affected routes are normalised, and auto-reclear is not set.

Ensure that when a block is applied or removed that the appropriate indication confirming the action is received, and that records are kept of the application and removal of the block.

It is essential that any failures of the CBI workstation be promptly attended to, to ensure its availability to apply and remove vital blocks.

Blocks are applied through the CBI workstation where the workstation is an integral part of the installation.

17.3 Blocking Pins

At certain locations, blocking pins are provided to permit the disabling of routes and points.

Before applying the block, ensure that:

a) points are in the correct lie,

b) affected routes are normalised, and auto-reclear is not set.

When disabling a route or points using these facilities, always test that the blocking is effective by attempting to operate the function and observing that it fails to operate.

Similarly, when inserting a pin, or operating a switch to remove a block, always test that the function is again operable.

A register of removed blocking pins is to be kept at the location.

17.4 Relay interface

In cases where the Microlok controls signalling equipment via relay interface circuits, PR S 40009 is applied with the following clarifications:

a) A disconnect terminal on the positive side of the circuit is considered equivalent to the fuse.

b) If it is a duplicated system then the disconnect terminals for both systems are to be operated.
c) Some duplicated systems have plug in diode modules provided on the positive side of the circuit. The diode modules are also provided for disconnection purposes. Care is required to ensure they are plugged in correctly as they can be forced in with the incorrect orientation.

d) If no positive disconnect terminal or individual fuse has been provided then remove, tag, and securely insulate the Relay coil positive as the alternative to removing the fuse.

This method is provided because:

i) The disconnect procedure requires two breaks in the circuit.

ii) Just removing the negative pin may also expose the system to shutdowns due to noise.

17.5 Lamp Driver Outputs.

Some installations of Microlok have the Boolean application logic arranged so that the cold lamp proving of the yellow and green lamps will prevent the signal clearing up if these lamps are not present. This permits the holding of a signal at stop by the removal of the pins or Elsafe modules feeding the higher aspects.

Subsidiary aspects are disconnected by the removal of the pins or Elsafe modules feeding the lights.

A listing of the removed pins or Elsafe modules is to be provided in each location.

Pins or Elsafe modules must always be completely removed for a disconnection.

If the disconnections are to be left unattended, tape or isolation blue plug is to be applied over the links and the disconnections clearly labelled to prevent inadvertent reconnection. An Elsafe Blue Maintenance flags can also be used to identify the disconnection.

Ensure a lever sleeve is applied to the lever on the panel (or a non vital route block for a VDU based system).

Each aspect is to be function tested after reconnection.

17.6 Microtrax Coded Track Circuit

Microtrax coded track circuits can be housed within a Microlok II cardfile.

The Microtrax track interface panel has a set of links for isolating the track circuit bonding to the track interface panel.

Disconnection of Microtrax coded track circuits is achieved by disconnecting both links in the Microtrax track interface panel. The Microtrax track circuit is to be isolated at both the Master and Slave ends.

It is not practical to perform the disconnection when the Microtrax coded track circuit module is installed in a Microlok II cardfile. Disconnecting the links between the Microtrax track circuit module in the cardfile and outgoing track connection cable to the Microtrak track interface panel will cause a selective shutdown of the cardfile due to load mismatching on the Microtrax module. The Microlok must be turned off at both ends (Master & Slave) before interfering with this wiring.
18 Security of Microlok II Software

Under no circumstances is any Microlok II maintenance and configuration software to be copied onto third party machines or supplied to unauthorised personnel.

Only authorised Signal Design personnel are permitted to make application data changes in accordance with the relevant procedures.

19 Security of write enabler for Object Controller dongle

A write enabler allows an Object Controller dongle to be configured for site specific application data. Its use is part of the process for controlling the alteration of site specific application data.

Signal Design Engineers use a write enabler to make changes to the site specific configurations. Write enablers are to be kept securely by the Design team to prevent unauthorised use. Use of the write enabler on-site is to be controlled by a register.

Signal Engineers may use a write enabler to replace a dongle that has been confirmed as faulty. The write enabler is to be kept in a secure location to prevent unauthorised use.

The Professional Head Signalling & Control Systems is responsible for the registration and issue of write enablers to Signal Design, Maintenance and Control System Engineers.

20 Diagnostic Workstations

Diagnostic workstations may utilise the communications network used for the safety critical communications by Microlok II and Object controller equipment.

The diagnostic workstation network connection must be disconnected from the safety critical communications network while it is not in use. An exception to this is when fully duplicated systems are used. In this case one diagnostic workstation may be left connected.
Engineering Procedure
Signalling and Control Systems

Signalling Safeworking

PR S 40039

Westrace Computer Based Interlocking

Version 2.0

Date in Force: 29 January 2019
Disclaimer

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Document control

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Part A Westrace
1 Introduction

The following instructions relate to Westrace computer based interlocking equipment. A Westrace card file can be considered as having the equivalent function as a rack of relays, with the interlocking logic programmed in Boolean.

1.1 Scope

Westrace can be configured in various ways from a single card file interfacing to standard relay circuits, to a series of distributed card files connected with vital serial communication links, and direct lamp driver modules.

Some installations use the Westrace only as the central interlocking with the interface to external equipment using conventional relays.

Westrace can operate from a local control panel via a panel multiplexer or can operate from a remote control centre.

Where a Siemens (Westinghouse) S2 system provides the interface to the Westrace it can be considered as equivalent to a non-vital relay panel and telemetry system.

1.2 References

The Westrace and S2 systems are detailed in the following Siemens publications:

- Westrace First Line Maintenance Manual
- Westrace System Overview Manual

The maintenance procedures detailed in these manuals must be followed.

The Westrace First Line Maintenance Manual - Wyong is specifically tailored to the Westrace installation at Wyong. Other installations have a generic First Line Maintenance Manual with an attached supplement for each particular installation.

2 Westrace Procedures

2.1 General

Where there is a conflict between this document and the two Siemens manuals listed in 1.2, this document is to take precedence. The procedures given hereunder are those specific to Westrace. They are supplementary to other procedures contained within this manual, which are to be followed where relevant.

2.2 Module Handling and Storage

The integrity of Westrace modules being placed into service is paramount. All modules must be handled, transported and stored with care, and not in any manner, condition or circumstance that would subject them to damage or deterioration. The boards and modules must be stored on racks in enclosed housings in a clean, dry and non-corrosive environment below 60°C. The Anti-Static Protection handling procedures listed in the Maintenance Manual are to be followed when handling the modules.
3 Responsibility in the Event of an Irregularity

3.1 Licensed Signalling Personnel

Licensed signalling personnel first duty is protection of the line in accordance with Procedure PR S 40004 and Section 4 herein.

Incident reporting, inspections and examinations must also be carried out in accordance with PR S 40004.

The technician event log stored on the PC (or PCs if more than one) should be examined for evidence of equipment failure or malfunction. The PC based Diagnostic Module (DM) Technician Interface or Moviola PC should be used to determine the errors listed by the Diagnostic Module(s).

All unexpected activities are to be recorded in the Westrace log book provided for the purpose at each location where Westrace is used.

Evidence of system operation during the incident is recorded on the Westrace DM PC Logging Package or Moviola PC. Licensed signalling personnel are solely responsible for ensuring that the logger is not touched or tampered with in any manner, prior to the arrival of a Signal Engineer.

The indications displayed on all Westrace modules, must be recorded, along with their associated serial numbers. It may be necessary for these modules to be removed later for investigation. Ensure that all of the panel indications, S2 indications, relevant relay positions, field equipment etc are also recorded as they may provide valuable information.

3.2 Signal Engineer

3.2.1 Log Analysis

A Signal Engineer is responsible for investigating the incident.

The Signal Engineer must copy the relevant log files from all the event loggers to a storage device, and then, using the edit/view program, analyse the event data to check what events occurred in the Westrace interlocking during the time of the incident.

An incident report is to be produced from the analysis. In the event of an irregularity being detected the Professional Head Signalling & Control Systems is to be contacted immediately. The signalling control tables and application data listings will be examined by accredited design personnel and appropriate instructions for any further action will be given. The Configuration Check Sub System (CCSS) software may be used to download the application data to do a Configuration Check of the Application Data.

3.2.2 Removal of Equipment

Westrace modules suspected of mal-operation must be initially subjected to functional tests in-situ. These tests are to simulate, as accurately as possible, the events leading to the irregularity, and module behaviour is to be observed and recorded. If the incident warrants, the module in question is to be removed and returned to Siemens for a detailed examination. Full details shall be recorded of any modules removed.
4 Protection of the Line

4.1 Disconnections

When it is required to disconnect signalling apparatus, the necessary safeworking procedures must be strictly observed as stipulated in PR S 40009.

4.1.1 Disconnection of Signals

Signals operated by Westrace can be controlled using BRB Q style relays via a Vital Relay Output Module (VROM) or they may be directly driven from a Vital Lamp Output Modules (VLOM).

a) For Signals using BRB Q style relays use the conventional method for disconnecting the signal and placing at stop.

b) For Signals Controlled by a VLOM use the following method for disconnecting the signal and placing it at stop:

Westrace interlockings will have the Boolean application logic arranged so that the cold lamp proving of the yellow and green lamps will prevent the signal clearing up if both these lamps are not present.

This allows the holding of a signal at stop by the removal of the pins feeding the higher aspects. Where this method of disconnection is used, a listing of the pins that need to be removed is to be provided in each location, for the signals fed from that location. Pins must always be completely removed.

When disconnected, and the location is to be left unattended, blue blanking pins or tape is to be applied over the links and the disconnection’s clearly labelled to prevent inadvertent reconnection.

Ensure a lever sleeve is applied to the lever on the panel (or a non vital route block for a VDU based system).

When reconnecting, test that the higher aspects function and cancel the error messages that indicate the lamps were out.

4.1.2 Disconnection of Points

All Westrace systems use conventional BRB Q relay based interface circuits for points operation and detection. The disconnection of the points is the same as a conventional relay based interlocking.
5 Failures

The Westrace First Line Maintenance Manual contains detailed procedures for dealing with faults within the Westrace equipment. The information given in this section outlines the module failure modes and principal actions required.

5.1 Panel Processors

Failure of both S2 panel processors or WestCad will result in loss of communication between the signalling panel and the Westrace interlocking.

Panel indications may freeze. This failure should be indicated by an audible and visual alarm on the signaller's panel.

The Westrace interlocking will continue to function normally. Routes that are already set will remain set with signals cleared as appropriate, and trains will be moving in response to the signalling. It will not be possible to set or cancel any routes.

This failure will persist until a serviceable panel processor(s) is installed in place of the faulty equipment.

5.2 Failure of Westrace

All signals will remain at stop and all points will remain in their current position. This situation will persist until serviceable modules are installed in place of the faulty equipment.

When a Westrace interlocking is first switched on after successful repair there is approximately 28 seconds to start up followed by a 2 minute application data delay before normal working can be resumed.

5.3 Reporting

The failure reporting requirements are detailed in PR S 40004.

A further Westrace Equipment Failure Report Form, as detailed in the Westinghouse First Line Maintenance Manual, must be completed with the appropriate information associated for each failure at the Westrace installation. This form must be signed and attached to the associated Failure Report Form.

A copy of this Westrace Equipment Failure Report is to be sent to the maintenance signal engineer.

Siemens Melbourne must be sent a copy of the Westrace Equipment Failure Report as specified in the maintenance manual.

5.4 Track Circuits

Westrace interlockings do not allow for conventional methods to manually release route holding or approach locking.

Track circuit failures will need to be rectified and affected traffic operated under the appropriate Safeworking Unit procedures.
6 Maintenance Policy

6.1 Test Equipment

6.1.1 Use of Special Westrace Test Equipment

Test equipment specifically designed for Westrace is provided, and must be operated in accordance with the manufacturers instructions.

6.1.2 Westrace GO/NO-GO tester

This is provided to enable Westrace system modules to be functionally tested before being installed, for example as a replacement for a failed module.

All modules are to be tested on the GO/NO-GO tester before being installed on a working installation.

The GO/NO GO tester does not fully test all functions of all modules. It is possible although unlikely for a module to work correctly in the tester but fail to operate in a Westrace system.

When a module is suspected of having failed, test it in the Westrace GO/NO GO tester to confirm the fault before sending for repair in accordance with Section 3. If the module is not initially proven defective in the Westrace Go-No Go Test Unit, then the module is to be left operating continuously for 7 days in the test unit. If no errors occur then it may be returned to service, otherwise return for repair with details of the errors.

6.1.3 Conventional Test Equipment

Tools and test equipment used on Westrace computer based interlocking systems must be Sydney Trains approved or otherwise deemed acceptable by and in conjunction with the manufacturer. For example, only the correct tool will be used to remove and insert EPROMs and EEPROMs from circuit boards, or only specified devices will be used for monitoring or interrogating interlocking data.

Conventional test equipment such as multimeters, data loggers, chart recorders and oscilloscopes are to be used only where they do not pose a risk to the functional safety of the system.

Inappropriate use of test equipment and test leads can effectively bridge-out or bypass safety functions, resulting in a less restrictive input and consequently, an unsafe output. Test equipment can also potentially force an output to produce a less restrictive situation.

The following restrictions apply for the use of conventional test equipment:

- Test equipment must have an input impedance of 1 MΩ or greater for the voltage measurement.

Note 1: Multimeters which have a low ac impedance (LoZ) mode for voltage measurements (for example, Fluke 289) are not to be used for fault finding when in this mode.

Note 2: External shunts are not to be fitted to test equipment when fault finding.

- Multimeter current mode must not be used when testing. Current measurements must be performed using a long meter or current clamp.
- Multimeter ohms and diode-test modes produce a test voltage and present the risk of the test voltage turning ON an input or output. These modes must not be used without the disconnection of the circuit.
• Test equipment inputs must be floating; not referenced to a common potential.
• Multi-channel test equipment must have all channels isolated from each other.
• Test equipment lead probes must be chosen and applied such to minimise the likelihood of probes causing a short-circuit across an input.

Third party devices such as USB sticks must be free of viruses or malicious software before inserting into signalling computers such as maintenance workstations. Installation of software that is authorised and in accordance with type approval requirements is only permitted on signalling computers.

6.2 Exchange of Modules

6.2.1 Repair

Field repairs are not to be carried out on any vital Westrace modules. These items must be returned to Siemens Melbourne, or their agent, for repair. The NVC module and the S2 modules although non-vital are not to be repaired in the field. These modules must also be returned to Siemens Melbourne, or their agent, for repair.

6.2.2 Removal of Modules

DO NOT remove any modules for routine maintenance unless a failure has occurred and there has been a need to replace a Westrace module. Always power off the Westrace and follow the Anti-Static Protection handling procedures listed in the Maintenance Manual before removing or inserting any modules.

Should any module be replaced as being initially considered faulty, and the fault not be rectified by the replacement module, the original module should be returned to the card file, prior to further testing.

Any time a module is removed and replaced, inspect the module for damage and ensure the backplane connectors are not loose or damaged. As a general rule, modules should not be removed or replaced unless fault finding.

After any module is replaced, the inputs or outputs of that module are to be checked for correct operation. For VROM modules, ensure that the procedure (First Line Maintenance Manual Section 6.2.2) for testing the VROM outputs for short circuits is carried out.

After changing a lamp driver module, the lamp voltages for the lamps operated by the module are to be checked and adjusted if necessary. In the case of other modules, ensure the Westrace system as a whole is functional by coming out of reset with no errors. Full details of tests are provided in the first line maintenance manual.

6.3 Failure of HVLC Module

In the event of a HVLC module failure, the Application Data EPROMs must be removed from the defective module and inserted into the new module. Ensure that the Anti-Static Protection procedures are followed as specified in the First Line Maintenance Manual.

Only remove and install one EPROM at a time. Take care to ensure they are inserted into the correct place and that the notch position is correct (i.e. not installed backwards). Ensure that EPROMs are not damaged during changing. Use the supplied EPROM removal and insertion tools. Ensure that the Configuration DIP switch on the new module is adjusted to be the same as the configuration documentation in the circuit book. After startup of the Westrace a check of the configuration should be made using the Diagnostic Module Technician Terminal Interface to confirm that the Westrace has been configured as specified by the documentation.
It is not necessary to re-check the application logic EPROMS using the ICS software as any EPROM errors will result in failure of the Westrace system.

6.4 Failure of EPROMs

Westrace Application Data EPROMs are vital EPROMs as they contain the interlocking data. Spare Application data EPROMs must be registered and kept in a secured place under strict version control by the maintenance signal engineer and in accordance with the manufacturer’s recommendations.

The maintenance signal engineer is to attend and supervise the installation of replacement EPROMs.

Care must be taken that the correct EPROM is installed by checking the details shown on the labels, and ensuring that they are identical with the failed EPROMs and the circuit book documentation. The correct version number, date and checksum must be verified.

After installation, ensure the system comes out of reset and that no errors occur.

An EPROM change report is to be made to the Professional Head Signalling & Control Systems at the same time as a replacement EPROM is requested. The defective EPROM from site is to be labelled “DEFECTIVE” on the underside and on the topside (the version details are to remain visible) and is to be returned to the Professional Head Signalling & Control Systems for cancellation. Under no circumstances are vital EPROMs to be duplicated by maintenance staff.

6.5 Application Logic Changes

Application Logic changes can only be done by a suitably accredited supplier. Upgrade of version numbers, etc must only be done in conjunction with a full design integrity test, and will require updating of the Configuration DIP switch on the HVLC module and documentation.

6.6 Failure Log

Licensed signalling personnel are to maintain a log of Westrace module failures and Westrace system shutdowns for future analysis of reliability and as a record of the age of the installed modules.

This record should be on the attached Westrace failure form and an entry should be made in the Westrace log book kept on-site with the Westrace interlocking and is additional to the normal SIGCOM failure report.

6.7 Insulation Testing

Care is to be taken that wiring connected directly to the Westrace is not insulation tested. However, testing must be carried out on wiring which can be isolated from the Westrace by the removal of plugs, fuses, links or by the de-energisation or removal of relays.

Refer to PR S 40023 for more detailed information and exemptions to testing requirements.
6.8 Monthly Maintenance

Every month the following tasks are to be conducted:

a) Check event logger or Moviola by viewing the log and confirm that the logger is operating correctly. Any errors are to be noted and their causes determined and resolved. The PC time/date and the DM module time/date are to be checked and adjusted as required.

Error codes are provided with explanations in the first line maintenance manual. All critical errors and errors that may indicate a possible safety related problem are to be referred immediately to the Professional Head Signalling & Control Systems by the maintenance signal engineer.

Reliability related codes are to be referred to the maintenance signal engineer. Codes that reflect a failure rectified by licensed signalling personnel (eg. lamp out) need not be referred.

b) For areas with cold standby Westrace interlockings:

Ensure all routes are cancelled and points are normalised while the Westrace is operating from the 'A' side.

Power up ‘B’ side Westrace and switch to ‘B’ side and also switch event logger PC to ‘B’ side. Confirm that the Westrace ‘B’ system and the event logger is operating correctly. This confirmation is done by clearing some signals and confirming that the event changes are in the event log file. The error log file is to be checked to confirm that no errors are present with the ‘B’ system.

When correct operation has been achieved from the ‘B’ side the Westrace system and the event log PC are to be switched back to the ‘A’ side. The system is then to be checked to see that the Westrace system is now correctly operating on the ‘A’ side. The ‘B’ side is then to be switched off.

c) Record the Westrace 24V battery supply and check the charger for correct operation.

6.9 Every 3 Months

Every 3 months the following tasks are to be conducted:

a) Ensure all modules are firmly home in the cardfile.

b) Visually check all wiring terminations and plugs for looseness or defective connections and rectify as necessary. If necessary, confirm tightness by a gentle wire pull.

c) Delete all event log files older than 4 weeks.

6.10 Equipment Records

6.10.1 Hardware Records

Each Westrace interlocking area must have a database containing the detailed records of all Westrace equipment associated with the area. This record should contain all module serial numbers and operating days for each module as well as information on module failures and stocks of spare modules.
6.10.2 **Software Records**

All Westrace interlockings must have proper maintained documentation for the Application data configurations and of the Westrace vital application logic currently in use.

Under no circumstances the Application data configuration and Westrace vital application logic to be copied onto third party machines or supplied to unauthorised personnel.

6.11 **Spares**

The level of spares holdings is determined by the type and number of installed modules.

Full lists of the spares provided for the control centre are to be made available and maintained at the appropriate storage facility.

It is important to ensure that any spare module installed is of the correct version for the system.

Spare modules should be tested every two years to ensure the spares remain viable. All spare modules must be fully tested and certified as operational before being placed into the stock of spares. Spare modules are to be appropriately stored in a secured place, in their protective envelopes. Further requirements for the handling and storage of modules and cards are detailed in Section 2.2.

On receipt of a new spare module or a repaired module, test the module in the Westrace Go-No Go Test Unit provided before storage. Label the module envelope with the date of the test and whom it was performed by.

7 **S2 Panel Processor**

The S2 forms the non-vital part of the Westrace system. A failure of both sides of the S2 will result in loss of controls and loss of indications for the entire interlocking.

All faulty modules are to be returned to the manufacturers for repair.

All failures of the S2 are to be recorded and a copy of the failure report sent to the Professional Head Signalling & Control Systems. The standard equipment failure report form and associated procedures are to be utilised.

8 **Glossary of Terms - Abbreviations**

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>VPIM</td>
<td>Vital Parallel Input Card</td>
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<tr>
<td>VROM</td>
<td>Vital Relay Output Module</td>
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<tr>
<td>VLOM</td>
<td>Vital Lamp Output Module</td>
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<tr>
<td>HVLC</td>
<td>Hot standby Vital Logic Card</td>
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<tr>
<td>HVLM</td>
<td>Hot standby Vital Logic Module</td>
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<tr>
<td>DM</td>
<td>Diagnostic Module</td>
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<tr>
<td>ICS</td>
<td>Integrated Configuration System</td>
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<tr>
<td>S2</td>
<td>System 2 Telemetry system capable of panel processing (Westinghouse)</td>
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<tr>
<td>EPROM</td>
<td>Erasable Programmable Read Only Memory</td>
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</table>
Part B Westrace II
9 Introduction

The following instructions relate to Westrace MkII computer based interlocking (CBI) equipment. A Westrace MkII introduces a number of enhancements to Westrace. The card file can be considered as having the equivalent function as a rack of relays, with the interlocking logic programmed in Boolean.

The Westrace MkII is a safety critical system. Any maintenance of the Westrace MkII equipment that does not confirm with the requirements of the Westrace MkII First Line Maintenance could compromise safety. Do not modify a Westrace MkII Installation except under direction of a competent Westrace designer.

9.1 Scope

Westrace MkII can be configured in various ways from a single card file interfacing to standard relay circuits, to a series of distributed card files connected with vital ethernet communication links, and direct lamp driver modules.

Some installations use the Westrace MkII only as the central interlocking with the interface to external equipment using conventional relays.

Westrace MkII can operate from a local control panel or can operate from a remote control centre.

9.2 References

The Westrace MkII is detailed in the following Siemens publications:

- Westrace MkII First Line Maintenance Manual (WRTOFLDR)
- Installation Check System (ICS) for Westrace MKII (WRTDICS)
- Westrace MkII System Overview Manual (WRTOOVDR)

The maintenance procedures detailed in these manuals must be followed.

10 Westrace MkII Procedures

10.1 General

Where there is a conflict between this document and the Siemens manuals listed in 1.2, this document is to take precedence. The procedures given hereunder are those specific to Westrace MkII. They are supplementary to other procedures contained within this manual, which are to be followed where relevant. For procedures relating to the original Westrace interlocking refer to Part A.

10.2 Module Handling and Storage

The integrity of Westrace MkII modules being placed into service is paramount. All modules must be handled, transported and stored with care, and not in any manner, condition or circumstance that would subject them to damage or deterioration. The modules, back planes and associated equipment must be stored on racks off the floor in a clean, dry and non-corrosive environment below 60° C. Additionally, Westrace MkII modules and cards in storage must not be in close proximity to magnets.

The Anti-Static Protection handling procedures listed in the Maintenance Manual are to be followed when handling the modules.
10.3 Cyber Security Requirements

All work on Westrace MkII equipment must comply with TfNSW Procedure T HR SC 01000 SP Section 20.2 (Cyber Security). Where the procedure is not specific, the following applies:

d) Only approved corporate devices with up to date virus protection are to be used to connect to the Westrace MkII or the physical network that the Westrace MkII resides.

e) Devices connected to the Westrace MkII or network where the Westrace MkII resides must not be connected to other networks (Eg. Corporate WANs, 4G Networks, Wireless hotspots).

f) Third party devices such as USB sticks must be free of viruses or malicious software before being inserted into signalling computers such as maintenance workstations.

g) Installation of software that is "checked and approved" and in accordance with type approval requirements is only permitted.

11 Responsibility in the Event of an Irregularity

11.1 Licensed Signalling Personnel

Licensed signalling personnel first duty is protection of the line in accordance with Procedure PR S 40004 and Section 4 herein.

Incident reporting, inspections and examinations must also be carried out in accordance with PR S 40004.

The technician event log stored on the MoviolaW Diagnostics PC (or PCs if more than one) should be examined for evidence of equipment failure or malfunction.

All unexpected activities are to be recorded in a log book provided for the purpose at each location where Westrace MkII is used.

Evidence of system operation during the incident is recorded on the MoviolaW PC. Licensed signalling personnel are solely responsible for ensuring that the logger is not touched or tampered with in any manner, prior to the arrival of a Signal Engineer.

The indications displayed on all failed Westrace MkII modules, must be recorded, along with their associated serial numbers (This information is located on the side of the module and therefore only available once the module has been removed from the housing). It may be necessary for these modules to be removed later for investigation. Ensure that all of the panel indications relevant relay positions, field equipment etc. are also recorded as they may provide valuable information.

11.2 Signal Engineer

11.2.1 Log Analysis

A Signal Engineer is responsible for investigating the incident.

The Signal Engineer must copy the relevant log files from all the event loggers to a storage device and then, using the edit/view program, analyse the event data to check what events occurred in the Westrace MkII interlocking during the time of the incident. When saving log files the filename should include the starting date and time of the saved log to facilitate replay.
An incident report is to be produced from the analysis. In the event of an irregularity being detected the Professional Head Signalling & Control Systems is to be contacted immediately. The signalling control tables and application data listings will be examined by accredited design personnel and appropriate instructions for any further action will be given. The Installation Check System (ICS) software may be used to download the application data to do a Configuration Check of the Application Data.

11.2.2 Removal of Equipment

Westrace MkII modules suspected of mal-operation must be initially subjected to functional tests in-situ. These tests are to simulate, as accurately as possible, the events leading to the irregularity, and module behaviour is to be observed and recorded. If the incident warrants, the module in question is to be removed and returned to Siemens for a detailed examination. Full details shall be recorded of any modules removed.

12 Protection of the Line

12.1 Disconnections

When it is required to disconnect signalling apparatus, the necessary safeworking procedures must be strictly observed as stipulated in PR S 40009.

12.1.1 Disconnection of Signals

Signals operated by Westrace MkII can be controlled using BRB Q style relays via Output Modules (ROM50 / ROM12) or they may be directly driven from Lamp Output Modules (LOM).

h) For Signals using BRB Q style relays use the conventional method for disconnecting the signal and placing at stop (or disconnecting higher aspects).

i) For Signals Controlled by a LOM use the following method for disconnecting the signal and placing it at stop (or disconnecting higher aspects):

Westrace MkII interlockings will have the Boolean application logic arranged so that the current lamp proving of the yellow and green lamps will prevent the signal clearing up if these lamps are not present.

This allows the holding of a signal at stop or booking out higher aspects by the removal of the pins or surge arrestor units feeding the higher aspects. Pins must always be completely removed.

Where signals provide more than one route, it is permissible to disconnect the affected routes only while still maintaining the functional routes to operate on installations where route termination links are provided.

When disconnected, and the location is to be left unattended, coloured blanking pins or tape is to be applied over the links and the disconnections clearly labelled to prevent inadvertent reconnection.

When reconnecting, test that the higher aspects function and cancel the error messages that indicate the lamps were out.
12.1.2 Disconnection of Points

All Westrace MkII systems use conventional BRB Q relay based interface circuits for points operation and detection. The disconnection of the points is the same as a conventional relay based interlocking.

13 Failures

The Westrace MkII First Line Maintenance Manual contains detailed procedures for dealing with faults within the Westrace equipment. The information given in this section outlines the module failure modes and principal actions required.

NOTE: All Westrace MkII equipment (housings, backplanes, modules, and I/O connectors) are vital components and should not be modified. Any faulty equipment must be returned to Siemens for repair.

Refer to the process described in the Westrace MkII First Line Maintenance Manual (WRTOFLDR).

13.1 Failure of Westrace MkII

All signals associated with a failed card will remain at stop and all points associated with a failed card will remain in their current position. This situation will persist until serviceable modules are installed in place of the faulty equipment.

When a Westrace MkII interlocking is first switched on after successful repair there is approximately 39 seconds to start up followed by a application data delay (typically configured as 2 minutes) before normal working can be resumed. Refer to PM Startup, Section 3.2.9 of the Westrace MkII First Line Maintenance Manual for details.

13.2 Reporting

The failure reporting requirements are detailed in PR S 40004.

A further Westrace MkII Equipment Fault Report Form (available in the Westrace MkII First Line Maintenance Manual Appendix C) must be completed with the appropriate information associated for each failure at the Westrace MkII installation. This form must be signed and attached to the associated Failure Report Form.

A copy of the Westrace MkII Equipment Failure Report is to be sent to the maintenance signal engineer.

Siemens Melbourne must be sent a copy of the Westrace MkII Equipment Failure Report as specified in the Westrace MkII First Line Maintenance Manual.

13.3 Track Circuits

Westrace interlockings, as a result of performing most locking functions within the internal application logic, do not allow for conventional methods to manually release route holding or approach locking.

Track circuit failures will need to be rectified and affected traffic operated under the appropriate Safeworking Unit procedures.
14 Maintenance Policy

14.1 Test Equipment

Tools and test equipment used on Westrace MkII computer based interlocking systems must be Sydney Trains approved or otherwise deemed acceptable by and in conjunction with the manufacturer.

Note Westrace MkII equipment contains some magnetically sensitive components. No magnets are to be placed in close proximity to the Westrace MkII sub-frame, for example magnetic attachment clips for multimeters.

Test equipment such as multimeters, data loggers, chart recorders and oscilloscopes are to be used only where they do not pose a risk to the functional safety of the system.

Inappropriate use of test equipment and test leads can effectively bridge-out or bypass safety functions, resulting in a less restrictive input and consequently, an unsafe output. Test equipment can also potentially force an output to produce a less restrictive situation.

The following restrictions apply for the use of conventional test equipment:

- Test equipment must have an input impedance of 1 MΩ or greater for the voltage measurement.

Note 1: Multimeters which have a low ac impedance (LoZ) mode for voltage measurements (for example, Fluke 289) are not to be used for fault finding when in this mode.

Note 2: External shunts are not to be fitted to test equipment when fault finding.

- Multimeter current mode must not be used when testing. Current measurements must be performed using a tong meter or current clamp.
- Multimeter ohms and diode-test modes produce a test voltage and present the risk of the test voltage turning ON an input or output. These modes must not be used without the disconnection of the circuit.
- Test equipment inputs must be floating; not referenced to a common potential.
- Multi-channel test equipment must have all channels isolated from each other.
- Test equipment lead probes must be chosen and applied such to minimise the likelihood of probes causing a short-circuit across an input.

14.2 Exchange of Modules

14.2.1 Repair

Field repairs are not to be carried out on any Westrace MkII equipment. All Westrace MkII equipment (housings, backplanes, modules, and I/O connectors) are vital components and should not be modified. Any faulty equipment must be returned to Siemens for repair.

Refer to the process described in the Westrace MkII first line maintenance manual (WRTOFLM).
14.2.2 Replacement of Processor Module (PM)

The Westrace MkII Processor Module (PM) is the logic processor for a Westrace MkII installation. Replacement of a Westrace MkII PM will result in the loss of functionality associated with the inputs and outputs at that installation.

A Westrace MkII PM can be removed from a housing without the need to power off the entire Westrace.

Replacement of a Westrace MkII PM should be accompanied by confirmation of the data versions and checksums on the front panel display against the current installation data records.

A hot standby installation is capable of running on a single PM card. If only one PM of a hot-standby pair is running, do not restart the Westrace MkII from the previously non-running PM. The PM contains non-volatile set-reset (SR) latches that can be used to store certain logic states which are not reset when power to the module is removed, for details refer to 6.2.2.1 below and Westrace MkII First Line Maintenance Manual Section 4.3.3.4

14.2.2.1 Non-Volatile Memory

The Westrace MkII Processor Module contains latches that can be used to store the logic state of a function similar to a magnetically latched relay coil.

SR (Set-Reset) Latches are controlled by separate inputs (mnemonics) for setting and resetting the state of the latch (similar to a magnetically latched relay). Like a magnetically latched relay, Westrace MkII SR Latches are non-volatile and maintain their state when the PM is unpowered.

Typical usage includes retaining blocking and barring functions when the Westrace MkII power is removed.

Unlike the Westrace MkII application data which is stored on the PM Backplane, the state of SR Latches are stored on the PM card itself. As a result, a previously in-service PM card configured with SR Latches that is returned to the shelf may have SR-Latch states set in its non-volatile memory.

To mitigate the risk of installing a PM with existing SR Latches set into a new installation, the Westrace MkII will reset the non-volatile memory within a PM card in the following scenarios:

- When the PM detects that the application data installed on the connected PM backplane is different to the version and checksum of the last PM backplane it was inserted into (e.g. the Westrace MkII application data is updated in an installation);
- When a fault is detected with the stored SR Latch states;
- When a different PM is inserted (The serial number of that last seated PM is stored on the PM backplane and compared against when a PM is inserted)

Hot-Standby PM installations present an additional risk. An active hot-standby PM will constantly update the SR Latch states in its inactive partner; however, if the inactive PM is not installed or not powered, that PM may not contain the latest SR Latch states. Restarting the interlocking from the previously inactive PM could result in the Westrace MkII operating with an older set of SR Latch states. Procedural checks are to be performed to ensure the railway will operate with the intended SR latch values.
14.2.3 Backplane and Housing Replacement

Prior to the removal and replacement of housings and backplanes, the Westrace MkII housing must be powered off.

Anti-static procedures must be followed when handling PM Backplanes.

14.2.3.1 Replacement of a Westrace MkII Housing Backplane

Prior to removal of a Westrace MkII Housing Backplane, all installed modules must be unseated from the Westrace MkII housing, SMB terminators and power connectors removed from the rear of the housing, and the Housing Backplane Shield removed.

The housing and installation address links on the replacement Westrace MkII Housing Backplane must be configured as per the installation documentation. Refer to the installation circuit book.

All Input / Output and Processor modules must be returned to their original position within the housing.

Replacement of a housing backplane does not necessitate the removal of I/O connectors or the PM backplane.

Refer to Westrace MkII First Line Maintenance Manual Section 4.6.

14.2.3.2 Replacement of a Westrace MkII Processor Module Backplane

Prior to removal of a Westrace MkII PM Backplane, the PM card must be unseated from the Westrace MkII housing, all connected cables from the PM Backplane disconnected and the PM Backplane shield removed.

The replacement PM Backplane configuration links LK1 and LK2 need to be soldered as per the installation documentation. Refer to the installation circuit book.

As the Westrace MkII PM Backplane contains the installation’s application data, following the replacement of a PM Backplane the application data must be re-uploaded using the data upload and check procedure set out in Section 4 of the Installation Check System manual. A baseline check of the current installed data must be performed prior to data being uploaded to the Westrace MkII, refer to Section 6.3 Application Logic Changes (Data Loading).

Refer to Westrace MkII First Line Maintenance Manual Section 4.4.

14.2.3.3 Replacement of a Westrace MkII Housing

Replacement of a Westrace MkII Housing involves the removal of all cards, backplanes and I/O Connectors.

The procedures for the replacement of a Westrace MkII Housing Backplane and PM Backplane must be followed.

All I/O must be corresponded prior to a return to service.

14.2.3.4 Input / Output Connector Replacement

A correspondence test of the I/O associated with a module whose I/O connector is disconnected is required in any scenario where multiple module I/O connectors are disconnected simultaneously.
14.2.4 Removal of Modules

**DO NOT** remove any modules for routine maintenance unless a failure has occurred and there has been a need to replace a Westrace MkII module. Westrace MkII allows hot swap module replacement and therefore the entire housing does not need to be powered down to replace a failed module. Follow the Anti-Static Protection handling procedures listed in the Maintenance Manual before removing or inserting any modules.

Should any module be replaced as being initially considered faulty, and the fault not be rectified by the replacement module, the original module should be returned to the card file, prior to further testing. When investigating potentially faulty processor modules (PM), be aware of the potential issues regarding non-volatile memory (refer to 6.2.2.1 Non-Volatile Memory).

Any time a module is removed and replaced, inspect the module for damage and ensure the backplane connectors are not loose or damaged. As a general rule, modules should not be removed or replaced unless fault finding.

After any module is replaced, the inputs or outputs of that module are to be checked for correct operation.

After changing a lamp output module (LOM), the lamp voltages for the lamps operated by the module are to be checked and adjusted if necessary. In the case of other modules, ensure the Westrace MkII system as a whole is functional by coming out of reset with no errors. Full details of tests are provided in the Westrace MkII First Line Maintenance Manual (WRTOFLDR).

14.3 Application Logic Changes (Data Loading)

Application Logic changes can only be done by a suitably accredited supplier. Upgrade of version numbers, etc. must only be done in conjunction with a full design integrity test.

All data uploads should follow the procedure as set out in Section 4 of the Installation Check System manual.

Prior to a change of data, a baseline check must be performed to identify the currently installed version.

Following the data upload and subsequent download and comparison of the installed data to the target data, the installation check forms must be produced, printed and signed by the person performing the data update, along with a competent second person to witness the update and returned to the document management system as a record of the data change.

If a new release of data is to be loaded, a copy of the existing data must be on hand to restore the system to its previous state in the event of an issue.

14.4 Failure Log

Licensed signalling personnel are to maintain a log of Westrace module failures and Westrace system shutdowns for future analysis of reliability and as a record of the age of the installed modules.

This record should be on the attached Westrace MkII failure form and an entry should be made in the Westrace MkII log book kept on-site with the Westrace MkII interlocking and is additional to the normal EAM incident report.
14.5 Insulation Testing

Wiring that is connected directly to the Westrace must not be insulation tested. Other wiring may be insulation tested as normal provided it is first disconnected from the Westrace by the removal of plugs, fuses, and/or links or by the de-energisation or removal of relays.

Refer to PR S 40023 for more detailed information and exemptions to testing requirements.

14.6 Maintenance

Carry out maintenance as per TMP.

14.7 Equipment Records

14.7.1 Hardware Records

Each Westrace MkII interlocking area must have a database containing the detailed records of all Westrace MkII equipment associated with the area. This record should contain all module serial numbers and operating days for each module as well as information on module failures and stocks of spare modules.

14.7.2 Software Records

All Westrace MkII interlockings must have proper maintained documentation for the Application data configurations and of the Westrace MkII vital application logic currently in use.

Under no circumstances is the Application data configuration and Westrace MkII vital application logic to be copied onto third party machines or supplied to unauthorised personnel.

14.8 Spares

Full lists of the spares provided for the control centre are to be maintained at the appropriate storage facility.

It is important to ensure that any spare module is of the correct model and version for the system prior to placing into service.

Spare modules are to be appropriately stored in a secured place, in their protective envelopes. Further requirements for the handling and storage of modules and cards are detailed in Section 2.2.

15 Glossary of Terms - Abbreviations

- CBI: Computer Based Interlocking
- ICS: Installation Check System
- I/O: Input and Output
- LOM: Westrace MkII Lamp Output Module
- PM: Westrace MkII Processor Module
- ROM: Westrace MkII Relay Output Module
- MKII: Second Generation of Westrace Interlocking
Signalling Safeworking

PR S 40040

Use of Radio Transmitters Near Electronic Signalling Systems

Version 1.1

Date in Force: 21 September 2016
Disclaimer

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1 **Introduction**

This instruction applies to the use of GRN, handheld and CB radios, mobile phones, Wi-Fi enabled devices, the Automated Train Protection (ATP) programming and test equipment as well as any other type of radio transmitter being used near all types of vital or non-vital electronic signalling systems including electronic power supplies and change over units.

2 **Background**

Radio transmitting devices such as handheld radios, cordless phones, mobile phones, Wi-Fi enabled devices, test equipment and the like, emit electromagnetic energy that can interfere with electronic signalling and test equipment.

The purpose of this procedure is to minimise the likelihood of interference and the subsequent consequence of any interference on signalling electronic systems without loosing the benefits that these devices give.

3 **Precaution**

The readings displayed on test equipment can be affected (and in error) when used in close proximity to a radio transmitting device. Tong or clamp meter current measurements are made by detecting electromagnetic fields and will be more significantly affected.

Measurements for certification of signalling equipment are not to be made within the minimum distances nominated in this procedure.

4 **Procedure**

The following limits apply to the use of these types of devices when in close proximity to signalling electronic systems. The devices are not to be operated within the minimum distances nominated between the transmitting equipment and Signalling equipment.

4.1 **Mobile and Cordless Telephones**

Mobile telephones automatically adjust their transmitting power level to suit their mode of operation. When in stand-by mode their power level is high so that calls can be received. This is also the case when establishing a call. Handsets reduce to the minimum power required during a call. Cordless telephones have the same distance limitations;

<table>
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<th>Minimum Distance</th>
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<tr>
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<td>3 m</td>
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<tr>
<td>Making a call</td>
<td>3 m</td>
</tr>
<tr>
<td>Once call is established</td>
<td>1 m</td>
</tr>
</tbody>
</table>

4.2 **GRN, Handheld and CB Radios**

For all GRN, Handheld and CB radios, the minimum distance is 3 m.
4.3 **Wi-Fi Enabled Devices**

Wi-Fi enabled devices are to be kept a minimum distance of 1 m from signalling equipment.

4.4 **ATP Programming and Test Equipment**

ATP programming and test equipment are to be kept a minimum distance of 1 m from signalling equipment.

4.5 **Other Transmitting Devices not listed**

Where other known transmitting devices are being used, the minimum distance is 3 m.
Engineering Procedure
Signalling and Control Systems

Signalling Safeworking

PR S 40042

Safety Issues for Signalling Personnel

Version 2.1

Date in Force: 8 March 2019
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1 Introduction

Sydney Trains has a Safety Management System (SMS), which details Sydney Trains’ policy, processes and procedures for a safe work environment. The documents are held in the SMS area of the Sydney Trains intranet.

General electrical installations are covered by SMS Element 06 Work Health Safety - Electrical Safety guides and instructions.

This procedure highlights safety issues that are specific to the signalling system. This procedure:

- Alerts personnel to the typical issues and hazards that are particular to the signalling system.
- Identifies issues that personnel working on the signalling system need to consider for their own safety and the safety of others.
- Details actions signalling personnel must take to protect themselves.

A number of issues maybe common sense, however they need to be considered when performing work on the signalling system.

2 Basic Safe Work Principles

The basic principles for working safely are to assess hazards and then remove them, or implement mitigation measures to reduce the risk of those hazards by:

a) Setting up a safe work area.

b) Preventing the work from causing a hazard for others, e.g. signalling safety hazards due to the work, or other people nearby.

c) Managing the electrical hazards by:

   i) Isolation and proven de-energised as applicable and/or

   ii) Temporary use of insulation or covers to prevent the hazards of electric shock and flash burns due to accidental short circuits and/or

   iii) Use of a safety observer.

d) Managing the physical hazards due to operation of equipment by disconnection, isolation, or physical disabling of equipment.

e) Training personnel in First Aid to render assistance.

3 Electrical Work

All work on signalling electrical systems is to be carried out by, or under the direct supervision of, persons trained and accredited to do so.

PR S 40001 Introduction to Signalling Maintenance Procedures details the accreditation and authorisation of personnel.

The term electrical work in the context of the signalling systems refers to any changes to wiring, including connection or disconnection of fuses or links on open terminal blocks, or the removal or installation of un-insulated wires and lugs on terminations, or jointing and termination of cables irrespective of working voltage.
The term *electrical work* does not include: the closing or opening of switches, or the removal or replacement of fuses or link pins in fully enclosed (SAK type) terminal blocks, or use of a meter to measure voltage, or the use of a current tong or current clamp.

A test to prove that the circuit is de-energised is required before work commences. Any wiring changes or re-termination of signalling AC circuits at any voltage must be carried out with the circuit isolated and proven de-energised by use of a meter. Section 4.8.1 details the test method.

The methods of isolation are detailed in PR S 40008 Booking Equipment Out of Use and PR S 40009 Disconnection of Signalling Apparatus.

Work that requires touching of wires or wiring but is unlikely to risk contact with potentials above the limits of 25VAC or 60VDC is not considered *electrical work*. If it is likely that contact with potentials above the limits of 25VAC or 60VDC can occur then it is considered to be *electrical work*. Exposed terminals, or exposed conductors, with potentials above the limits of 25VAC or 60VDC are considered to represent a likely risk of contact.

The voltage limits have been set based on PELV values that do not require protection against direct contact as per Section 1.5.7 of AS 3000:2007 *Wiring Rules*.

Some examples for hand tracing of wires in a relay room are:

a) Hand tracing of wires near exposed stud terminals for 120VAC circuits requires protection by an insulating cover against direct contact with the terminals or is considered to be *electrical work* and requires isolation.

b) Hand tracing of wires near SAK fuses and terminals for 120VAC circuits is not considered to be *electrical work* but should include in the pre-work brief that the test points on the SAKC10 terminals and the front bussing on SAK4 terminals do not comply with touch proof requirements and a possible risk of direct contact with potentials above 25VAC or 60VDC exists.

Adjacent circuits (particularly those below the work area) that have exposed terminals must be insulated or isolated prior to work.

A number of hazards exist within the signalling electrical system. These hazards and associated controls are:

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Control Measure</th>
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<tbody>
<tr>
<td>Electric shock due to contact with live terminals</td>
<td>Work in accordance with the SMS and guidance provided by Sections 3, 4, 5, 7, 8, 9, 10, 11 and 21 of this procedure.</td>
</tr>
<tr>
<td>Electric shock due to stored electrical charge</td>
<td>Work in accordance with the SMS and guidance provided by Sections 5.3, 9.4 and 9.5 of this procedure.</td>
</tr>
<tr>
<td>Arc, blast and flash injuries</td>
<td>Work in accordance with the SMS and guidance provided by Sections 3, 4, 5, 8 and 9 of this procedure.</td>
</tr>
<tr>
<td>Physical injury from equipment operation</td>
<td>Work in accordance with the SMS and guidance provided by Sections 4.4 and 13 of this procedure.</td>
</tr>
<tr>
<td>Toxic substances and gases from secondary batteries</td>
<td>Work in accordance with the SMS and guidance provided by Section 5.2 of this procedure.</td>
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4 **Signalling Electrical System - AC Power**

Signalling electrical system power distribution generally conforms to the Isolation Transformers (IT) system of earthing (unearthed) as detailed in IEC 60364 *Electrical*
Installations in Buildings. This system uses isolation transformers to provide an AC power supply system that does not rely on earth connections for safety of people or property.

The basis for the alignment of the signalling power supply to the IT system of earthing is:

a) By maintaining high impedance to earth, any fault currents to earth are limited. This in turn prevents false operation of signalling safety equipment, and allows power to be maintained whilst faults are found and corrected.

b) By maintaining a high impedance to earth, body shock currents due to contact with live conductors are limited.

c) The use of an earth leakage detector (known as a permanent insulation monitor in the standard) with the IT system allows detection and subsequent correction of any compromised insulation prior to a hazardous situation occurring.

At supply points to the signalling electrical system, equipment on the supply side of the signalling supply step-down or isolating transformers is excluded from these instructions. These transformers are subject to SMS Element 06 Risk Management, OHS Risk Management: Electrical Safety guides and instructions.

4.1 Earth Leakage Faults

The use of Earth Leakage Detectors (ELDs) allows detection of any compromised insulation prior to or when a potentially hazardous situation occurs.

If a short circuit earth fault occurs on one leg of the 120VAC signalling power supply then contact with the other leg can result in an electric shock that could harm a person.

If two faults occur on one signalling AC power supply then it is possible for a “touch potential” to exist between the case of one faulty item of equipment and earth that exceeds the internationally accepted limit of 50VAC.

For example, if a fault occurs where Nx120 is short circuit to earth at a location, and then a second fault occurs in a train stop with Bx120 short circuit to the train stop case, the fuse may not “blow”, and a person touching the particular train stop case may receive an electric shock.

As a result of the potential signalling safety hazard and the electrical safety hazard for personal that work on the signalling equipment it is necessary to rectify the causes of ELD alarms as a high priority.

4.1.1 Assessment

Licensed signalling personnel must assess each AC ELD fault to determine if an immediate Signalling safety hazard or electrical safety hazard exists. If the fault causes a measured voltage of more than:

- 75 volts from either leg of the supply to earth for a 120V supply; or
- 80% of the nominal voltage for extended voltage supplies
  E.g. 332 volts on a 415 volt supply,

then the AC power supply is to be considered as hazardous. Voltages are measured using a 100KΩ shunt across the multimeter.

Higher voltages to earth may be acceptable in some cases. Such cases should be submitted to the Professional Head Signalling & Control Systems for consideration.
4.1.2 Actions

If the signalling AC power supply is considered hazardous based on the assessment then treat all exposed terminals and field equipment as potentially the source of a serious electric shock and the fault must be found and isolated or corrected. If the fault is unable to be found or isolated then advise the maintenance signal engineer. Action must then be taken to manage the hazard until it can be rectified.

If the earth fault results in an assessment that it is not hazardous then the earth fault is to be addressed as part of routine maintenance, with a priority equal to other routine safety critical maintenance tasks. The earth fault must be monitored at least weekly until corrected. Regular monitoring is required to confirm that a second fault has not occurred.

Report any items of external equipment (not equipment installed within locations as it is inherently connected to the location earth) that have had faults to exposed metalwork to the Professional Head Signalling & Control Systems to determine appropriate equipment design changes to prevent re-occurrence.

4.2 Power Supplies without ELDs

A number of older locations do not have ELDs fitted to the 120VAC supply.

Some power supplies like the secondary of SSI isolation transformers do not have ELDs fitted.

Prior to working in locations that do not have ELDs fitted, where it is possible to come in contact with exposed terminals, a check of the voltage between both Bx and Nx to earth of the supply is required using a 100KΩ shunt across the multimeter.

If the measured voltage is more than:

- 75 volts from either leg of the supply to earth for a 120 volt supply

then the AC power supply must be considered as hazardous.

Higher voltages to earth may be acceptable in some cases:

- The 110 volt supply for SSI TFMs may have up to 100 volts from either leg of the supply to earth before being considered hazardous due to inherent imbalances.
- Other cases should be submitted to the Professional Head Signalling & Control Systems for consideration.

If the signalling AC power supply is considered hazardous based on the assessment then treat all exposed terminals and field equipment as potentially the source of a serious electric shock. Find and isolate or correct the fault. If the fault is unable to be found or isolated then advise the maintenance signal engineer. Action must then be taken to manage the hazard until it can be rectified.

If the earth fault results in an assessment that it is not hazardous then the earth fault is to be addressed as part of routine maintenance, with a priority equal to other routine safety critical maintenance tasks. The earth fault must be monitored at least weekly until corrected. Regular monitoring confirms that a second fault has not occurred.

Report any items of external equipment (not equipment installed within locations as it is inherently connected to the location earth) that have had faults to exposed metalwork to the Professional Head Signalling & Control Systems to determine appropriate equipment design changes to prevent re-occurrence.
4.3 Independent Power Supplies

The two independent power supplies provided at power locations may have the same or different phasing, meaning that if the two independent supplies were connected together, then voltages of up to twice the supply voltage could occur between different parts of the circuit.

If testing requires the commons / Nxs to be temporarily connected to test phasing then:

a) Ensure no other work is being done on either power supply.
b) Apply a temporary connection between Nxs by approved controlled bridge/s.
c) Use test equipment rated for the maximum potential voltages. This is not normally a problem with standard test equipment for 120V, but may not be rated for voltages that could occur at higher supply voltages.
d) Remove the temporary connection between Nxs.
e) Test independence of supplies (if appropriate) after the removal of the bridge/s, by measuring voltage between the Bx of one supply and the Nx of the other supply and then Nx to Nx to confirm the voltages are below 30V. A 100KΩ shunt is not required across the multimeter for this measurement.

4.4 Emergency Change-Over Contactors

Emergency Change Over contactors (ECO) as well as operating with high force and speed have two independent sources of power supply. Isolation of both supplies to the ECO requires the booking out of use of a large quantity of signalling equipment, and this is to be avoided if possible.

Work within an ECO cabinet using block contactors may only be carried out when:

a) one incoming supply is isolated and proven de-energised by use of a meter, and
b) the remaining supply terminals are insulated by insulating barriers or covers to control the risk of flash burns due to accidental short circuits.

or

or

c) both supplies are isolated and proven de-energised by use of a meter.

Work within an ECO cabinet using bar contactors may only be carried out when:

a) one incoming supply is isolated and proven de-energised by use of a meter, and
b) the remaining supply terminals are insulated by insulating barriers or covers to control the risk of flash burns due to accidental short circuits, and
c) a barrier or physical separation is fitted to protect against harm due to operation of the contactor, or
d) both supplies are isolated and proven de-energised by use of a meter.

4.5 Testing, Adjustment or Fault Finding – AC Circuits

Signalling testing, adjustment and fault finding on circuits or mains at a nominal 120V that are protected by fuse or circuit breaker rated at:

- more than 25 amps require control measures to be in place to prevent short circuit faults whilst testing without isolation. Safety glasses and long sleeves are to be worn to protect against the risk of flash burns.
- up to 25 amps is permitted without isolation.
Adjustment and fault finding on AC circuits at voltages more than the nominal 120V is not permitted without isolation. However, voltage measurement with a meter and current measurement with a current clamp or tong meter is permitted without isolation.

Current clamps or tong meters are to be used for current measurements in circuits that are protected by a fuse or circuit breaker rated at more than 10A.

4.6 SSI Points Modules

SSI points modules use 140VAC for the motor outputs. The 140VAC is fed from an isolation transformer via the ESML contacts to the points module.

The 140VAC circuits for SSI points modules are limited and do not represent a significantly different hazard to the normal 120VAC installation.

The 140VAC circuits for the SSI points modules should be treated as per the normal 120VAC circuits.

4.7 Work on Electrical Supply Transformers

Power isolating transformers provide power to the signalling system and form one of the interfaces to the electrical discipline.

Electrical work on and adjustment of electrical supply power isolating transformers must be in accordance with SMS Element 06 Work Health Safety - Electrical Safety guides and instructions. This will require a “Low Voltage Access Permit” to be issued by the electrical discipline.

4.8 Isolation of Power Mains

Isolation of the signalling power mains is by:

a) Opening the supply-side circuit breaker or isolator (which isolates both legs of the circuit).

b) Securing the operating lever in the open position by affixing a tie through the holes provided for this purpose. The tie may be the same used to affix the label (see following).

c) Identifying the circuit breaker or isolator as having been deliberately isolated by attaching a label or danger tag showing the name of the person who affixed the tag, the date and the reason for the isolation.

d) Testing that the power mains are “dead” as close as practical to the actual work location to confirm that the power is off.

4.8.1 Test for De-energisation

A test for de-energisation consists of using a multimeter on AC voltage (with a 100KΩ shunt across the multimeter) to check:

- A live circuit has voltage to prove that the meter works.

Then:

a) Bx to Nx has no voltage (<1VAC on meter).

b) Bx to Earth has no voltage (<1VAC on meter).

c) Nx to Earth has no voltage (<1VAC on meter).

The earth for the test is the nearest metalwork bonded to earth. If no metalwork is nearby then one probe is pushed into the ground (dirt, not concrete or floor covering).
4.8.2 Work Carried out by the person doing the isolation

If the work to be carried out is being done by the person who does the isolation, then no further action is required.

4.8.3 Work Carried out by persons other than the person doing the isolation

If the work is to be carried out by persons other than the person who will be isolating and restoring the circuit, then before commencement of any work, licensed signalling personnel or signal engineer in charge must:

- Isolate, identify and test de-energisation of the circuit as per 4.8 and 4.8.1 above.
- Complete a “LOW VOLTAGE ACCESS PERMIT” which is available as Stock code 1886910.
- The permit number must be of the form “SIGNALS/ggggg/xx/ymmdd/n” where “ggggg” identifies the work area issuing the permit, “xx” is the initials of the person issuing the permit, “ymmdd” is the date the permit is issued in year, month, day, and “n” is a sequence number for the day (1 to 9). For example SIGNALS/strath/pz/060116/1.
- A separate danger tag is applied to the circuit breaker or isolator and a separate permit issued for each work group.
- If multiple isolations are required and work could be done so that the permits can be progressively handed back then the issue of multiple danger tags and permits is preferred. The additional danger tags can be tied to the first tag.

While the work is ongoing the permit holder must comply with the instructions printed on the reverse of the permit. The key instructions include:

a) The work description on the permit. This fully describes the work to be carried out. No work may be carried out on or near the isolated equipment other than that specified on the permit.

b) The low voltage equipment that is covered by the permit. Persons carrying out the work must understand which low voltage equipment is covered by the permit and is safe to work on or near. All other exposed equipment must be treated as live.

c) Warnings for persons carrying out the work:
   i) not to allow any part of their bodies, clothes, tools or materials they may be using or carrying, to come within the electrical safe working distances of any exposed equipment, other than the isolated equipment in the electrically safe work area, and
   ii) not to pass over or under work area markers, safety fences or other barriers.

d) Adequate work process controls to ensure that persons do not work beyond the limits of the electrically safe work area.

e) Precautions required prior to the permit being returned. Before returning the permit all persons and material are to be clear of all low voltage equipment for which the permit was issued, and have been instructed to treat the equipment as live.

On completion of the work:

f) The permit holder and the work party sign off the work as being complete and return the “Low Voltage Access Permit” form to the signalling person in charge.

g) The signalling person in charge countersigns the form, removes the danger tag for that permit, and restores the power when all danger tags have been removed.
4.8.4 Lost Permits

If a permit has been lost while the work is still in progress then a duplicate permit is to be issued and all personnel must re-sign. The duplicate must be endorsed “Replacement for lost permit”.

If a permit has been lost after the work has been completed, but before returning it to the signalling person in charge, then written confirmation from each workgroup is required that they have completed their work to confirm that the permit is no longer required. This is to be done on the duplicate copy.

4.8.5 Unknown Danger Tags

If a danger tag is found and its reason for being in place is unclear or unknown then the danger tag may need to be overridden.

To override a danger tag, the maintenance signal engineer and Signal Asset Engineer must consult and confirm that the danger tag is not valid as:

- There is no work occurring where the isolation has taken place, and
- The circuit is safe to be re-energised.

The maintenance signal engineer and Signal Asset Engineer can then jointly authorise the removal of an unknown danger tag.

4.9 AC Power Maintenance Activities

4.9.1 Testing of Earth Leakage Detectors

All ELDs must be tested by operation of the push button provided on the device to confirm that the device, alarms and indications function correctly. These intervals are specified in the Technical Maintenance Plan Service Schedules.

4.9.2 Enclosure of Equipment

All equipment operating at voltages above 120V nominal must have the protective enclosures in position and correctly secured at all times. Covers may be removed for testing purposes only, or when the equipment has been isolated to permit work to take place.

Where work is undertaken within an enclosure where only partial isolation has occurred, then all live parts are to be temporarily enclosed before work commences. These arrangements are to be approved by a maintenance signal engineer.

All covers are to be reinstated if the location is to be left unattended.

4.9.3 Testing of Protective Enclosure Earthing

All power supply equipment operating at voltages above 120V nominal are housed within a protective cover, where any metal components are earthed.

The Technical Maintenance Plan and/or Service Schedules must include two yearly tests to ensure that the resistance from these metal covers and enclosures to the main earth busbar does not exceed 2Ω. This test should be aligned with the power supply insulation test.
5 Signalling DC Circuits

Signalling DC circuits are unearthed.

The reason for maintaining earth free circuits is to prevent false operation of signalling safety equipment due to a single earth fault. A secondary benefit is the reduced risk of electric shock by contact with one live conductor.

5.1 Earth Leakage Faults

The use of ELDs allows detection of any compromised insulation prior to or when a hazardous situation occurs.

As a result of the potential significant signalling safety hazard and the potentially minor electrical safety hazard for personnel that work on the signalling equipment it is necessary to rectify causes of ELD faults as a high priority.

5.1.1 Assessment

Licensed signalling personnel must assess each DC ELD fault to determine if an immediate signalling safety hazard or electrical safety hazard exists. If the fault causes a measured voltage of more than:

- 40 volts from either leg of the supply to earth for a 50 volt supply; or
- 80% of the nominal voltage for extended voltage supplies
  e.g. 56 volts on a 70 volt supply

then the DC power supply must be considered as hazardous.

Earth faults need to be responded to in accordance with the assessment to address the system safety hazard. 50VDC unfiltered supplies may just exceed the internationally accepted limits for touch potentials whereas 12VDC and 24VDC supplies do not.

5.1.2 Actions

If the signalling DC power supply is considered hazardous based on the assessment then treat all exposed terminals and field equipment as potentially the source of a minor electric shock. The fault must be found and isolated or corrected. If the fault is unable to be found or isolated then advise the maintenance signal engineer. Action must then be taken to manage the hazard until it can be rectified.

If the earth fault results in an assessment that it is not hazardous then the earth fault is to be addressed as part of routine maintenance, with a priority equal to other routine safety critical maintenance tasks. The earth fault must be monitored at least weekly until corrected. Regular monitoring is required to confirm that a second fault has not occurred.

Report any items of external equipment (not equipment installed within locations as it has a connection to the location earth) that have faults to exposed metalwork to the Professional Head Signalling & Control Systems to determine appropriate equipment design changes to prevent re-occurrence.

5.2 Secondary Batteries

DC battery installations are used at various locations at voltages up to 120 volts.

Always follow the manufacturer’s recommended procedures and safety instructions when handling or maintaining secondary batteries. Hazards include highly corrosive electrolytes, the capacity to generate very high currents through accidental short-circuits and the ability to generate highly explosive gases. Should a metal watchband or other
jewellery accidentally short-circuit one or more cells, they can weld to the electrical terminals and quickly become hot enough to cause third degree burns or worse to the wearer.

Disposal of batteries must be in strict accordance with the Environmental guidelines or instructions.

Towards the end of a charge cycle or under overcharge conditions, electrolysis within a cell may cause amounts of hydrogen and oxygen to be generated.

The design of battery installations includes the provision of ventilation and the use of explosion-proof caps if vented cells are used.

Ventilation is important to prevent the build-up of explosive gases around batteries. An explosion may occur if a spark is introduced to a combination of hydrogen and oxygen in a confined area. The explosion can have sufficient force to shatter the case of the cell and violently scatter electrolyte over the surroundings.

Vented batteries should not be used or if in use they should be identified and be planned for replacement in the medium term.

5.2.1 Safety Precautions with Secondary Batteries

The following precautions should be followed when installing, maintaining or recharging lead-acid or nickel-cadmium batteries;

a) use safety glasses and insulated tools.
b) do not wear metallic wristbands.
c) ensure there is adequate ventilation prior to starting work on or near batteries.
d) ensure that suitable fire fighting equipment is available. It may be in the vehicle.
e) ensure that non-sealed batteries have explosion-proof cell caps fitted to all cells, and kept closed on all except the one cell that is being maintained.
f) ensure ample clean water and an eyebath are available to treat a spill or splash to skin or especially eyes. Battery electrolytes are harmful – when handling wear protective clothing and eyewear. In the event of contact with skin or clothing wash immediately with running water and obtain immediate medical attention.
g) do not carry cigarettes, burning materials or sources of ignition such as mobile phones in the vicinity of open cells, or cells without explosion-proof caps.
h) when recharging batteries off-line ensure the area is well-ventilated and away from equipment or machines that produce sparks or flame.
i) use distilled water only for topping up of all cells.
j) battery terminals and wiring to the initial protection devices (e.g. fuse or circuit breaker) must not be left exposed or in a condition that allows accidental short circuiting of the battery output.
k) batteries and individual cells can exceed 20kg in mass. Manual handling precautions must be taken.

5.2.2 Vented Cell Batteries

*Australian Standard AS2676.1:1992 Guide to installation, maintenance, testing and replacement of secondary batteries in buildings - Vented cells* applies to battery installations of greater than 24V nominal and 10Ah capacity. The standard recommends:
a) Personal Protective Equipment – the minimum is face shield or goggles for water
top up and acid resistant clothing and gloves.

b) Safety Signs: “Danger – Risk of Battery Explosion” on access doors and Electrolyte
Burns emergency information in the room.

c) Water supply: Disposable sterile eye irrigators as minimum.

d) Precautions during installation and during maintenance that include PPE and
general safety information.

e) Fire Fighting: Equipment for fighting electrical fires to be in the room.

Level crossing battery installations use vented cells and are below the 24V nominal and
do not need to comply with the Australian Standard recommendations.

Telemetry 24V no break supply battery installations should comply with the Australian
Standard recommendation.

50V no break supply battery installations must comply with the Australian Standard
recommendation.

Eye wash facilities are to be provided for all installations of 100Ah or more. The presence
and operation of the eyewash is to be checked prior to any work being done on or near
the batteries.

5.2.3 Sealed Cell Batteries

*Australian Standard AS2676.2:1992 Guide to installation, maintenance, testing and
replacement of secondary batteries in buildings – Sealed cells* applies to battery
installations of greater than 24V nominal and 10Ah capacity. The standard recommends:

a) Personal Protective Equipment (PPE) – face shield or goggles and insulated tools.

b) Safety Signs: Restricted access and caution signs.

c) Precautions during installation and during maintenance that include PPE and
general safety information.

d) Fire Fighting: Equipment for fighting electrical fires to be provided for installation.

Microlok II installation batteries are 12V and do not need to comply with the Australian
Standard recommendations.

Telemetry 24V no break supply battery installations should comply with the Australian
Standard recommendations.

50V no break supply battery installations must comply with the Australian Standard
recommendations.

Battery installations for UPS or GGIs must comply with the Australian Standard
recommendations.

5.3 Capacitors

A capacitor’s stored energy charge may remain for a long time after the power has been
isolated or disconnected. The presence of capacitors must be considered before working
on DC circuits or equipment. Circuits are to be proven de-energised before work is
carried out.

The preferred method of disconnection in these cases is to disconnect the power to the
supply first and then disconnect the load afterwards. This will normally discharge any
capacitors.
5.4  **Electrical Work on DC Circuits**

Normally wiring changes on signalling DC circuits at any voltage must be carried out with the circuit isolated and de-energised. The risks that these measures control are:

- a) electric shock,
- b) flash burn,
- c) false energisation of an in-service circuit,
- d) confusing signalling indications resulting from random energisation and de-energisation of circuits ‘downstream’ from the one being worked on.
- e) accidental tripping of circuit protection upstream of the circuit being worked on, causing failures of multiple items of equipment.
- f) damage to equipment due to intermittent or repeated disconnection and reconnection.

Re-termination of individual wires protected by a fuse of 4A or less, with a working voltage of 50VDC nominal or less using insulated tools without isolation should be avoided. It is however permitted after a site specific risk assessment has been completed.

The methods of isolation are detailed in PR S 40008 *Booking Equipment Out of Use* and PR S 40009 *Disconnection of Signalling Apparatus*.

5.5  **Testing, Adjustment or Fault Finding – DC Circuits**

Signalling testing, adjustment and fault finding on circuits or mains that are protected by fuse or circuit breaker rated at:

- **more than 25 amps** requires control measures to prevent short circuit faults whilst testing without isolation. Safety glasses and long sleeves are to be worn to protect against the risk of flash burns.
- **less than 25 amps** is permitted without isolation.

Current Clamps or Tong meters are to be used for current measurements for circuits that are protected by a fuse or circuit breaker rated at more than 10A (or meter rating).

5.6  **SSI Points Modules**

SSI Points modules use 120VDC for their valve outputs.

The 120VDC circuits from the SSI points modules must be de-energised before any electrical work.

The 120VDC circuits are normally limited to the NWRO, RWRO resistors, and NWR, RWR relays.

6  **Signalling Compressed Air System**

Equipment operated by compressed air moves with both speed and force. A control measure must be put in place to prevent operation of equipment when work is being carried out on or near compressed air powered equipment. This may require isolation of the air supply to the particular item of equipment.

Australian Standard AS 4343:2014 *Pressure equipment – Hazard levels* is used to determine the hazard levels of the compressed air system. The calculated hazard level for the signalling compressed air system general pipe work is hazard level E (negligible...
hazard). The calculated hazard level for the air receivers depends on their size. The hazard level is typically hazard level C (low hazard) for receivers less than 3,000 litres capacity. Hazard level B (medium hazard) applies for receivers of more than 3,000 litres capacity.

Australian Standard AS 3788:2006 *Pressure equipment – In-service inspection* requires inspections for compressed air containing vessels based on the working pressure and volume.

Compressed air containing vessels used in the signalling compressed air system like:

- Air receivers of 150 litres or more in regulated air system
- Air receivers or siphons of 300 litres or more used in the air line or unregulated air systems

must be registered with SafeWork NSW as pressure vessels and are subject to regular inspections.

Any maintenance or alterations to air receivers must comply with Australian Standard AS 3788:2006 *Pressure equipment – In-service inspection*.

A number of hazards exist within the signalling compressed air system. These include:

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Cause</th>
<th>Control measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foreign objects in eyes.</td>
<td>Compressed air travels at high speeds with great force, which can blow dust, grit, etc into eyes.</td>
<td>Safety Glasses. Ensure exhaust air and leaking air is directed away from people and objects it may reflect off.</td>
</tr>
<tr>
<td>Compressed air itself</td>
<td>High-pressure compressed air directed at the skin may break the skin and enter the blood stream.</td>
<td>Ensure exhaust air and leaking air is directed away from people and objects it may reflect off.</td>
</tr>
<tr>
<td>Noise</td>
<td>Compressors and exhaust air can be produce loud noise.</td>
<td>Hearing protection as required.</td>
</tr>
<tr>
<td>Burst or leaking hoses or connections</td>
<td>Damaged, or worn hoses and connections can fail resulting major air leaks blowing dust, grit, etc.</td>
<td>Inspections of hoses and connections. Use of correctly rated hoses and fittings.</td>
</tr>
<tr>
<td>Explosion of pressure vessels</td>
<td>Pressure vessels may explode if the structure is weakened, or if they are operated at more than the rated pressure, or if the vessel is heated.</td>
<td>Work that may heat or cause physical contact with the air receiver is not to be carried out without approval of the maintenance signal engineer or supervisor. Inspections of the pressure vessels as per AS 3788.</td>
</tr>
<tr>
<td>Compressed air released from pressure relief valves</td>
<td>Pressure relief valves may vent exhaust air at any time.</td>
<td>Work is not to be done near pressure relief valves without protection against exhaust air.</td>
</tr>
<tr>
<td>Air filter bowl breakage</td>
<td>Physical damage causing broken glass, and compressed air leak.</td>
<td>Vigilance and care when working near Air filter bowls.</td>
</tr>
<tr>
<td>Hazard</td>
<td>Cause</td>
<td>Control measure</td>
</tr>
<tr>
<td>------------------------------</td>
<td>----------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Equipment movement</td>
<td>Equipment operated by compressed air moves with both speed and force.</td>
<td>Prevent operation of equipment when work is being carried out on or near compressed air powered equipment. This may require isolation of the air supply to the particular item of equipment.</td>
</tr>
</tbody>
</table>

7 Touch Potentials on Metalwork

Under conditions where earth faults have occurred, transferred earth potentials due to a conductive path from one site to another could exist, which may then allow the touch potential limits to be exceeded.

Potential hazards and their control measures are listed below. The control measures are listed so that they can be verified as being in place.

<table>
<thead>
<tr>
<th>Electric shock hazard from:</th>
<th>Control Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Galvanised Steel Troughing between equipment locations.</td>
<td>Two insulated joints in the Galvanised Steel Troughing between any signalling locations so that the touch potential across any insulated joint will not exceed the limits.</td>
</tr>
<tr>
<td>Cable ladders between equipment locations</td>
<td>Two insulated joints in the Cable ladders between any signalling locations so that the touch potential across any insulated joint will not exceed the limits.</td>
</tr>
<tr>
<td>Metallic pipes for Air Lines or cables between equipment locations.</td>
<td>Two insulated joints in the Air Lines between any signalling locations so that the touch potential across any insulated joint will not exceed the limits.</td>
</tr>
<tr>
<td>Metallic cable sheaths, or protective layers.</td>
<td>Provide Arrestors to earth from metallic cable sheaths at one end only. The end to have the arrestors installed will be the end of the cable furthest away from the power supply distribution point or at the location if the cable goes to trackside equipment.</td>
</tr>
<tr>
<td>Metallic cable sheaths or protective layers for Telecommunications cables.</td>
<td>Sheath is connected through and not earthed at Signalling Locations.</td>
</tr>
<tr>
<td>Metal fences.</td>
<td>Two insulated Sections in the metal fencing between any Signalling locations if the fence is within 2 meters of the location at both locations so that the touch potential across any insulated joint will not exceed the limits.</td>
</tr>
<tr>
<td>Multiple earth faults on the Signalling AC power</td>
<td>Maintain the signalling AC power as earth free.</td>
</tr>
<tr>
<td>Touch Potential on metal work in power rooms</td>
<td>Earth bonding of metal work to power earth.</td>
</tr>
<tr>
<td>Fallen Power lines</td>
<td>Visual inspection prior to entering location.</td>
</tr>
<tr>
<td>Overhead Wiring (OHW) structures</td>
<td>OHW Structures may become live due to insulator failures on the Overhead Wiring. The Electrical Discipline carries out inspections and tests on the OHW structures. OHW structures without spark gap connections should not be touched unnecessarily.</td>
</tr>
</tbody>
</table>
Electric shock hazard from: | Control Measure
--- | ---
Touch potential between rails and nearby earthed equipment | Awareness that touching rail (or rail connected equipment) and earthed metal work (or conductors) can cause an electric shock due to voltages in the electric traction return path. Limit the amount of earthed equipment that is within touching distance of the nearest rail.

8 Traction Return

Traction return cables can carry current of up to 4,000 amps, and form part of the 1500 volt traction supply ‘circuit’ for electric trains. Under certain circumstances the full traction supply voltage can appear across a break in the traction return path – it is therefore critical to maintain the traction return path in an unbroken state.

Traction return cables include all series, parallel and tie-in bonding cables.

Before any interference with traction return cables, the requirements detailed in PR S 40027 Traction Return (1500VDC) must be followed to ensure an adequate traction return path is provided.

8.1 Spark Gap Connections

Some nominated steel structures supporting 1500 volt equipment are connected to a traction return rail through a rail spark gap and rail bond.

The rail spark gap device, normally bolted to the structure, is fitted with a brass or copper spark gap capsule. These capsules are normally open circuit and are designed to short circuit (failed state) in the event of failure of the 1500 volt insulation on the structure. This will then connect the structure to the return rail and initiate a trip of the traction supply circuit breaker in the substation. Some spark gaps such as the Mark 2 (Ferraz Unit) and Mark 3 (DEHN dome shaped capsule) automatically reset or restore to open circuit, but many in service today, namely Mark 1, once short circuited remain shorted until replaced.

Maintenance of rail spark gaps (including replacement) is an Electrical Discipline responsibility, although signalling personnel provide the point of attachment to the correct traction rail. Broken or disconnected spark gaps found by licensed signal personnel must be reported to ICON Electrical immediately stating that the spark gap needs to be repaired.

Shorted (i.e. failed) rail spark gaps can cause failure of track circuits, contribute to electrolysis problems and may even lead to a loss of rail vehicle detection.

Rail spark gaps may fail:
   a) Due to lightning or a transient condition
   b) Because the OHW structure is live, or was momentarily live
   c) Because of train overloads or train defects
   d) Due to traction return defects.

If a structure becomes live and the rail spark gap has failed, the traction supply circuit breaker in the substation would normally have tripped, however, there have been instances where the breaker has not tripped which may result in high voltage potentials and current flow at the spark gap.
8.1.1 Hazards Associated with Spark Gaps

1. Removal of a failed spark gap unit or rail connection may create a hazard if an OHW structure is live. That is, 1500V DC could be present between the OHW structure and the rail connection cable when the spark gap unit is removed or between the rail connection cable and the rail if the rail connection is removed.

   Warning: The structure and the rail bond must not be touched at the same time as there may be significant voltages present.

2. Significant current may be flowing from the traction return system via the rail spark gap connection, which may present an arcing hazard when disconnected.

   Warning: When removing spark gap cables, safety glasses designed for protecting eyes to exposure of arc flashes must be worn.

8.1.2 Removal of Failed Spark Gaps

Failed rail spark gaps that have been identified as the cause of a signalling failure may be safely disconnected by licensed signalling personnel provided that they remove the cable from the failed rail spark gap capsule end (at the structure) in the following manner:

- First check for signs of high current flow such as heating of the cable and terminals or melted insulation. This may indicate the breakdown of an overhead insulator and the cable must not be handled and ICON Electrical advised immediately.
- Measure the rail to structure voltage. If less than 50V DC it is safe to continue with removal provided the process below is followed. Otherwise the spark gap cable is not to be removed by signalling personnel and shall be reported to ICON Electrical for removal by electrical discipline personnel.
  - The cable is to be removed using an insulated tool and wearing appropriate insulated gloves while avoiding contact between the structure and cable.
  - Appropriate safety glasses must be worn as arcing may occur as the cable is removed. There may also be significant heat generated in the cable and this needs to be safely managed also by wearing appropriate gloves.
  - When removing the cable from the capsule it must be removed quickly and without hesitation as there may be an arc drawn as it is removed. See diagram 1 below.

   Warning: As there could potentially be up to 1500V between the removed cable and the structure the person removing the spark gap cable must not make contact between the structure and the cable at the same time.

Note: The spark gap cable at the capsule is removed rather than the rail connection as there is less voltage difference between the structure and the earth compared to the rail and earth and also so that when reconnecting, electrical personnel are not required to confirm with the signal engineer the correct traction rail.

- The bond cable end removed at the capsule must be insulated to prevent stray traction current entering the earth and causing electrolysis problems and also to prevent others being exposed to the cable.

Note: At stations, bridges or other locations where the public can access spark gap cables, the disconnected cable must be appropriately insulated to prevent the risk of inadvertent exposure to the uninsulated cable and associated structure.
• Immediately advise ICON Electrical that the failed spark gap needs to be replaced and the spark gap cable is to be reconnected.

![Diagram 1 – Methods of removing rail cable]

8.1.3 Planned Work

For planned work that affects spark gap cables, disconnection and reconnection at the rail connections for rail spark gap cables for re-railing and new work is permitted provided that licensed signalling personnel test with a tong meter to confirm less than 0.1A DC current is flowing in the connection and there is less than 50V DC between structure and rail prior to performing the disconnection. Where these readings are not achieved the process for failed spark gaps above is to be followed.

9 Test Equipment

Faulty, incorrectly rated or poorly designed test equipment can pose a danger to the user due to electric shock or flash burns due to short circuits.

9.1 Test Leads

Test leads must be in good condition, which is indicated by, being clean, without any cracked or broken insulation.

Only test leads complying with IEC cat III 600V are to be used.

Some older test equipment like TFAs, Integrators, and 100KΩ shunts did not have safety sockets (shrouded) and required the shrouds to be cut off the test equipment end of the test leads. The change to the use of safety sockets (shrouded) on these products has been made.

The use of IEC cat III 600V test leads with the shrouds removed is no longer permitted. Older TFAs, Integrators, and 100KΩ shunts that do not have safety sockets are to be phased out as new test equipment is purchased.

9.2 Test Equipment Rating

Test equipment for direct connection to the signalling system must be rated for IEC Over voltage III at 600V as a minimum due to the potential risk of over voltages due to surges. Newer meters are marked “600V CAT III” to indicate that they comply.
9.3 **Current Measurements**

Current clamps or tong meters are to be used for current measurements on circuits that are protected by a fuse or circuit breaker rated at more than 10A.

9.4 **Megger and Bell Megger**

Both the megger tester and bell megger tester products produce voltages sufficient to cause an uncomfortable, but not harmful, electric shock.

Approved meggers are current limited to 3mA short-circuit output, which is significantly below the value of DC current that may be hazardous.

The most likely risk arises from the sudden involuntary movement made when the shock is felt, which could result in minor muscle strain or bruising from coming into violent contact with a fixed object.

Care is required to avoid contact with probes while using Meggers.

Cable cores and sheathes tested on long cable runs can hold a charge for a number of minutes after Megger testing. So either discharge cable conductors after megger testing or avoid contact for at least 5 minutes.

9.5 **Integrators for Jeumont Track Circuits**

The Jeumont Schneider integrator functions by charging a capacitor up to the peak pulse voltage present. A high impedance digital multimeter reads the peak pulse voltage, held on the capacitor. The value measured can be as high as 550 volts. To maintain a steady reading, the capacitor discharge time is a couple of seconds. If the integrator is unplugged before the capacitor has had time to discharge, contact with the output pins can deliver a painful, but not harmful shock.

The polarity switch on the integrator is a three-position switch, with the centre position provided to give a fast discharge of the capacitor between measurements. The integrator also provides a ‘bypass’ function to make it unnecessary to unplug the integrator to make direct circuit voltage measurements.

The following precautions will eliminate the possibility of suffering a shock:

1. Use the ‘bypass’ function to make direct voltage readings without integration,
2. Place the polarity switch to the centre ‘discharge’ position before unplugging the integrator.

9.6 **Insulated Tools, Insulating Covers, Mats and Gloves**

Tools are not considered to be insulated unless they have been manufactured to meet a relevant standard. The use of electrical tape is not considered sufficient for a tool to be considered insulated.

Insulated tools are typically rated for 1000V and been manufactured to meet EN60900:2004 *Live Working. Hand Tools for use up to 1000Vac and 1500Vdc.*

Insulating covers must comply with Australian Standard AS/NZS 4202:1994 *Insulating covers for electrical purposes* or similar international standard.

Insulating mats must comply with Australian Standard AS/NZS 2978:1995 *Insulating mats for electrical purposes* or similar international standard.
Insulation gloves must be rated for voltages up to 650V and comply with Australian Standard AS/NZS 2225:1994 Insulating gloves for electrical purposes or similar international standard.

10 Impulse Track Circuits - Precautions

In some parts of impulse track circuit arrangements, there are voltages present, which may be of sufficient magnitude and energy to present a risk of electric shock.

On single rail impulse track circuits, the repetitive ‘high’ pulse may exceed 120 volts at the rail. More importantly, on all Jeumont-Schneider track circuits, the wiring between transmitter and matching transformer or impedance bond, and between impedance bond or matching transformer and receiver, carries repetitive impulse voltages typically of between 400 and 600 volts.

Some parts of Jeumont-Schneider track circuit wiring have open stud terminals, in particular impedance bonds, matching transformers, adjustable resistors and capacitors.

Persons doing work on this equipment must either use insulated tools or, where practical, disconnect supply from the transmitter before performing electrical work.

A significant shock can be experienced from a single live terminal, if some other part of the person’s body is making good contact with earth.

Personnel should avoid touching across both rails or across both sides of a block joint at the same time.

11 Resonated Impedance Bonds

The voltages across the resonating capacitors inside the capacitor boxes mounted on some impedance bonds for audio frequency track circuits, and 50Hz track circuits can exceed 400VAC. The terminals within the capacitor box are an electrical shock hazard.

The protective cover for the capacitor box is to be kept in-place except whilst testing, adjusting or repairing the capacitor box.

Signal personnel making adjustments to the capacitor setting or repairs must use insulated tools, or apply a short across the capacitors or, where practical, disconnect supply from the track circuit transmitter before performing electrical work.

12 Fibre Optics and Lasers

Only fibre optic modems and equipment that does not exceed hazard level 1 as per AS 2211.2:2004 Laser Safety Part 2 Safety of optical fibre communications systems are used as part of the signalling system itself.

Fibre optic test equipment should not exceed the limits of a class 1 laser. If it is necessary to use test equipment that exceeds the limits of a class 1 laser then the particular issues need to be considered in a specific risk assessment.

Australian Standard AS/NZS 2211.2:2004 Laser Safety Part 2 Safety of optical fibre communications systems includes Section D6 Recommended working practices, which includes the following recommendations:

a) Do not stare at fibre ends or fibre optic connectors with unprotected eyes.

b) Do not point fibre ends or fibre optic connectors at people’s faces.

c) End caps should always be fitted to unused connectors or patch leads.
d) Unterminated fibre ends must be covered when not worked on. They should not be readily visible and sharp ends should not be exposed.

e) Fibre cut offs should be collected and disposed of in an approved container.

13 Equipment Hazards

Equipment Hazards not addressed in other Sections include:

| Burns: | In some cases resistors are operated at temperatures above 55° Celsius, which can cause a burn. This is commonly the case with track resistors in AC track circuits, especially of the double-rail variety. |
| Operation of Surge Protection equipment | If lightning activity is occurring in the vicinity (visible strikes in the sky) then do not touch or remain in close proximity of the surge protection equipment (i.e. < 1m) |
| Cuts: | Cuts due to broken glass from signal lens and globes. Handling fibre optic cables and wire strands. |
| Eye damage: | Due to intense light from fibre optic modems, or electrical shorts. Looking directly into a signal light at close range. |
| Mechanical: | Pinch points exist in points, point machines, train stops, ground frames, level crossing boom mechanisms, electro-mechanical frames, mechanical signals, and crimping tools. Mechanical equipment that uses a ratchet should have a release mechanism. Personnel should be made aware of the release mechanisms and how to use them. |
| Hydraulic power: | Hydraulic power units are capable of producing large forces. Beware of pinch points etc near hydraulic powered units. |
| Acoustic shock: | Audible test equipment on communications lines with Dupline telemetry equipment connected can cause acoustic shock. Do not listen while connecting. |
| Smoke inhalation and burns: | If smoke is observed coming from equipment then: comply with SMS Incident Response; isolate power to equipment and prepare fire-fighting equipment before opening equipment covers or enclosures. |

14 Hazardous Materials

The following hazardous materials can also be found in parts of the signalling system;

- Asbestos can be found in:
  a) Some track and level crossing resistors,
  b) CSEE SI units manufactured prior to September 1987. (The asbestos is well protected and should not be disturbed.)
  c) Used in old cable troughing, and slab type signal huts.
  d) Tape on cables made before 1960.
  e) Lagging on exhaust pipes for motor generator sets.
  f) Type J impedance bond gasket material.

A number of standards, procedures and safe work method statements exist as part of the SMS for asbestos.

- Lead was used as a sheath in older communications cables and lead based paint has been used on air-lines and on older equipment. Ensure appropriate PPE is used when handling lead contaminated equipment.
• Hydraulic fluid used in JAH train stops, and hydraulic point operating mechanisms may be a hazardous substance. Avoid direct contact and comply with MSDS control measures.

• Rocol and other materials used to lubricate point switch chairs may be a hazardous substance. Avoid direct contact and comply with MSDS control measures.

• Welding charges used for rail bonding etc, are hazardous substances. Avoid direct contact and comply with MSDS control measures.

• PVC plasticiser can leak from the ends of a nylon jacketed wire leaving an oily residue. The substance is not toxic, but contact with skin, mouth and particularly eyes is to be avoided. Where contact occurs, wash off with soap and water as soon as practical.

• ETCS Eurobalises degrade over time due to UV exposure. Loose fibres can form on the Eurobalise surface. The fibres do not pose any known health risk but may cause skin irritations. Other pollutants in the rail corridor also accumulate on the Eurobalise. Appropriate Personal Protective Equipment (PPE) must be used when handling old Eurobalises, namely the use of work gloves and long sleeved shirts.

15 Rail Drilling

The SMS has safe work methods statements for rail drilling that is necessary for some rail bonding activities. Rail drilling machines are clearly not light, non-powered hand tools.

Only personnel that have been instructed in the use of Rail Drilling machines are permitted to use the machines. In these cases it must be ensured that:

• the appropriate Personal Protective Equipment (PPE) must be worn, including safety glasses and work gloves.

• hair and loose items of clothing and jewellery are not caught up in moving parts.

• the rail drilling machine is correctly and securely fitted to the rail prior to starting the motor.

• the machine must be switched off prior to changing drills or re-fuelling.

Excessive rail drilling can weaken the rail and cause a hazardous situation. Ensure that the rail is only drilled with approved size drills in the specified locations.

16 Cadwelding

The SMS has safe work methods statements for Cadwelding. Only personnel that have been instructed in the use of Cadweld products are permitted to use the product.

Safety issues that must be considered include:

a) checking the installation guide and MSDS details before use.

b) using the appropriate Personal Protective Equipment (PPE) including safety glasses, and heavy canvas gloves with leather palms.

c) using extended igniters - this is preferred type.

d) removal or protection of fire hazards in the immediate vicinity of the welding.

e) confirmation that this process is permitted during a Fire Ban.

f) checking that the site has adequate ventilation for the fumes generated by the process.

g) not using worn broken equipment – this is not permitted.
h) use of material in good condition only.
i) checking that the mould and material is dry before use.
j) ensuring that the starting material is not accidentally ignited from cigarettes or other sources of ignition.
k) ensuring direct eye contact with the flash from the ignition of the starting material is avoided

l) ensuring contact with hot material is avoided.

17 Working at Heights

Work on signal gantries and on main line signal heads is considered working at heights.

Therefore work on equipment in these locations must be performed in accordance with the SMS Element 06 Work Health Safety Risk Management: Manage Risks Working at Heights procedure.

18 Confined or Restricted Spaces

The SMS has procedures for identifying and working within confined spaces. These also cover restricted spaces.

Cable pits more than 1 metre deep are considered to be a confined space.

Areas under some old signal boxes may be a confined space and need to be evaluated in accordance with the procedures prior to entry.

19 Excavations

The SMS has guidelines for excavations and earthworks.

These activities typically only occur in signals construction activities.

20 Manual Handling

The SMS has procedures for manual handling. A number of signalling equipment items are both heavy and awkward to lift. These include: Impedance bonds, train stops, point machines, larger transformers, power supplies, batteries, and signal heads.

Mechanical lifting devices should be used to reduce manual handling hazards, e.g. a Train Stop Lifter.

21 Work in Old Signalling Locations

In older style signalling relay rooms and location huts dating from before the introduction of BRB-style relays, most equipment operates at 120VAC, with almost all wiring on open stud terminals with narrow aisle-ways between the rows of equipment.

Hazards to be considered are:

a) inadvertent contact with live terminals, especially while reaching into the restricted space above shelf relays and when bending to reach terminals close to the floor of the location.

b) contact from metallic wristbands, jewellery and keys to live terminals that can cause flash burns.
c) Contact with metallic toolboxes and un-insulated tools.

22 Mechanical Lever Frames

Mechanical frames were designed and built at a time when Work Health and Safety for the maintainer was not as carefully considered.

Counterbalances, lever tails, and the area beneath frames all contain significant hazards for personnel who perform work or are in close proximity to mechanical frames.

Head protection should be worn when working underneath a mechanical lever frame.

Signal wires and channel iron runs from mechanical frames to equipment can cause hazards due to their presence and movement.

23 ETCS Equipment

ETCS on-board antennas generate electromagnetic radiation that can be harmful to personnel who are required to work in close proximity to, or underneath an ETCS fitted train.

Suitable precautions need been taken prior to accessing the underside of an ETCS fitted train carriage.
Engineering Procedure
Signalling and Control Systems

Signalling Safeworking

PR S 40044

General Signalling Maintenance
Management, Administration and
Supervision Responsibilities

Version 1.2

Date in Force: 8 March 2019
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1 Introduction

This document sets out general signalling maintenance management, administration and supervision responsibilities to be covered. The responsibilities and authority for specific positions will be determined by Sydney Trains based on Engineering Authority as set out in Signalling Procedures and position descriptions.

This is applicable to the following roles:-

- Maintenance signal engineers
- Maintenance Control Systems Engineers
- Specialist Supervisor Control Systems
- Commissioning Engineers
- Asset Engineers
- Team Manager Signals
- Team Leader Signals
- Work Group Leader Signals

1.1 General Responsibilities

- Responsibility for the safe reliable and efficient day-to-day running of the maintenance area, including the maintenance, installation and renewal of all signalling and nominated communications systems and equipment.
- Responsibility for the supervision, welfare, safety and discipline of subordinate personnel.
- Responsibility for appropriate environmental protection from signalling equipment and activities on the maintenance area.
- Responsibility for maintaining an up to date Asset Register of signalling equipment on the maintenance area.

1.2 Duties

The activities associated with the responsibilities listed below are to be assigned to competent and accredited personnel, as applicable.

The responsibilities must include:

a) The planning and control of a system of programmed maintenance and renewals and regular testing and inspection of systems and equipment ensuring that the specified frequencies, laid down programmes, standards and practices are adhered to by all personnel involved

b) The supervision, welfare, safety, training and discipline of subordinate personnel.

c) Compliance with applicable Work Health Safety requirements.

d) Compliance with applicable Environment Protection requirements.

e) In emergency situations, additional responsibility on the person's own judgement, in the best interest of the public and Sydney Trains and in accordance with stipulated procedures.

f) Giving immediate attention to any report of a signalling or level crossing irregularity, derailment or accident, and carrying out a thorough examination to
determine and rectify the cause. Assessing the risk of such an irregularity being repeated or occurring elsewhere and following up with actions to prevent such an occurrence. Responsibility for the proper investigation of irregularities and the certification of the signalling as safe to be restored to use.

g) Performing inspections to:

primarily

i) monitor the condition of the equipment throughout the maintenance area in order to determine priority based programs and budgets for renewal, repair or rehabilitation.

ii) monitor the standard of maintenance throughout the maintenance area in order to direct any required corrective actions and to plan for improvement.

iii) monitor the level of compliance throughout the maintenance area with required procedures, Engineering Instructions and Advices, TMPs, SOIs etc. in order to direct any required corrective actions and/or recommend improvements to the procedures etc.

and secondly

iv) to monitor the cost-effectiveness of maintenance in order to direct any required corrective actions and to plan for improvements.

v) to monitor the efficiency and effectiveness of the signalling system in meeting the operational requirements in order to correct deficiencies and propose improvements.

vi) to communicate directly with personnel in their work environment and to give them the opportunity to directly raise issues and receive feedback on matters affecting them.

vii) to communicate directly with local operations and other discipline personnel who are serviced by or provide services to the signalling discipline.

h) The preparation and approval of estimates for maintenance and renewal work for recommendation to controlling officers for inclusion in the annual budget, ensuring the material requirements are standard stores items where possible and where plant or other discipline services are required that the necessary costs are included. The control of expenditure to meet budget allocations and maintenance requirements. The approval and control of overtime for subordinate personnel.

i) Organising and/or controlling a program of planned renewals and new works to ensure that the authorised works are executed within the specified authority by the effective use of labour, materials and plant, by scheduling the work effectively, progressing the work, monitoring expenditure and bringing to the immediate attention of controlling officers any changes which may result in over spending.

j) Identifying renewal or modification requirements and inputting to and reviewing tender specifications prepared by project groups for new or altered works affecting the maintenance area; liaison and co-ordination with the project group during the project; preparation of defect lists and acceptance of the completed signalling work.

k) Planning and controlling the allotted activities of subordinates, ensuring all maintenance personnel conform to the Signalling Safeworking Procedures, Standards, Specifications, and carry out established procedures correctly, and preparing and maintaining appropriate personnel position description.
l) Being familiar with the maintenance area and the systems, equipment and all the maintenance procedures relative thereto, and ensuring that these procedures are properly carried out. Controlling this by a system of reports and inspections and by directly observing personnel performing duties on safety related equipment so that equipment and systems are properly maintained, installed and kept in a satisfactory condition.

m) Organising the development and training of maintenance personnel including the examination of personnel for competency, interviewing personnel and trainees and recommending or approving appointment. Participating on personnel examination boards, in mentor systems and counselling sessions.

n) Evaluation of signalling personnel for authorisation and licensing according to MN S 41412 – “Process for Signals and Control Systems Personnel – Authorisations & Licensing”.

o) Signalling safeworking breaches or incidents by signalling personnel accessed according to MN S 41418 – “Signalling Safeworking Breaches”.

p) Issue Permit to Work according to PR S 41419 - “Authority to Work on Sydney Trains Signalling Infrastructure – Permit to Work”.

q) Ensuring personnel are issued with the proper documentation relevant to the performance of their duties and that this is kept updated. Controlling this with an appropriate document control system and by carrying out audits. Ensuring that important messages in new or changed documentation are communicated to and understood by all personnel who need to know through discussion with their supervising officers.

r) A constant review of work practices to improve safety, reliability and economy.

s) Through effective labour management and in conjunction with other personnel, proposing area manning revisions including the approval of maintenance and installation work schedules. Seeking opportunities to reduce costs and authorising overtime for work which cannot be performed during normal working hours. Making relief arrangements for the supervisors and maintenance personnel and, in particular rosters, for emergencies. With the support of controlling officers contributing to the high morale and good efficiency among all subordinate personnel.

t) Paying particular attention to all equipment failures with the objective of:

i) ascertaining if there was there any undue delay in rectifying the fault.

ii) determining the cause of the fault and any action necessary to prevent a recurrence.

iii) identifying any trend or pattern of repetitive faults.

iv) reducing the incidence of failures, and making recommendations to controlling officers for improvements in the design, maintenance, servicing or repair of the apparatus or equipment in question.

u) Maintaining a high standard of “housekeeping” including but not limited to, a regular survey of

i) safety equipment and clothing, ladders and safety belts.

ii) tools, plant and equipment.

iii) meters and test equipment.
iv) justified spare material.
v) depots and work areas for cleanliness and tidy appearance.
w) The clean up of material released and unserviceable and its appropriate disposal.
x) Keeping a specific record of all temporary repairs made and ensuring that permanent repairs are carried out without undue delay.
y) Identifying and maintaining a register of sections of line which are likely to have rust build up and cause loss of train detection. Ensuring that the potential for this is minimised and that if it is likely to occur it will be detected and protected against. Being alert for changes in the type, frequency and tonnage of traffic over the lines.
z) Whenever a complaint has been received concerning the focusing of a signal nominating licensed signalling personnel to inspect the signal reported and to have it adjusted accordingly.

aa) Maintenance of the asset register of signalling equipment on the maintenance area.

bb) Maintaining maintenance records of maintenance support equipment, tools, vehicles and plant requiring maintenance, including calibration.

cc) Liaison with the personnel of other engineering and operating disciplines on the maintenance area.

dd) Arranging as necessary and/or attending communication and co-ordination meetings with other disciplines, other personnel and internal and external parties as appropriate to ensure good co-operation, effective planning and the application of appropriate standards and procedures. Preparing agendas and minutes, as required.

ee) In conjunction with other disciplines, if appropriate, making arrangements for track possessions, the requisitioning of plant or material which may be necessary, and the transport of personnel to work sites.

ff) Determining methods and procedures for putting into practice fire precautions in the accommodation allotted to depots, in equipment rooms, stores, premises and for line side equipment. The periodical inspection of plant and equipment to eliminate avoidable hazards and accidents. Providing for safe custody of Sydney Trains property including materials, machines and small tools.

gg) Administering the maintenance area, its assets and resources, in accordance with the approved policies and procedures.

hh) Preparing returns, assessments, and reports, as required by controlling officers, relating to the current state of affairs on the maintenance area.

ii) Investigating third party proposals, as required, for their possible effect on the existing signalling system.
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<td>Scope of surveillance inspections must include every signal relay room and location</td>
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<td>Inclusion of EIS15/03 section 15 requirements for the ability of signalling personnel to carry surveillance inspections after prerequisites met.</td>
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<tr>
<td>Remove reference to electric train staff</td>
<td>5</td>
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<tr>
<td>Corrected reference for signal sighting (front of train) inspections dot point D as per PRS 40031 section 3 and ASA section 22.1</td>
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1 Introduction

Surveillance inspections by experienced maintenance signal engineers form part of the regime for assuring the safety integrity and reliability of the signalling system.

2 Objectives of Surveillance Inspections

The intention of surveillance inspections is to meet the primary and secondary objectives as listed below. The primary objectives are directed towards signalling safety, reliability and technical capability. The secondary objectives are directed towards signalling operation efficiency, sustainability and its environmental impact. Additionally, it provides an opportunity for effective stakeholder relations and continual improvement.

Primary Objectives:

- Monitor the standard of maintenance throughout the maintenance area in order to direct any required corrective actions (which may be directed at the asset or the maintainer's technical capability), and to plan for improvement.
- Monitor the condition of signalling assets throughout the maintenance area in order to determine priority based programs for repair, renewal, or redesign.
- Monitor the level of compliance throughout the maintenance area with relevant procedures and practices, technical maintenance plans, engineering instructions, etc, in order to direct any required corrective actions and/or recommendations for improvement to the procedures, etc.

Secondary Objectives:

- Monitor the efficiency and effectiveness of maintenance in order to direct any required corrective actions and to plan for improvements.
- Monitor the efficiency and effectiveness of the signalling system in meeting the operational requirements in order to correct deficiencies and propose improvements.
- Monitor any adverse environmental impact caused by signalling infrastructure
- Communicate directly with signalling personnel in their work environment and to give them the opportunity to directly raise issues and receive feed back on matters affecting them.
- Communicate directly with local operations and other stakeholders who are serviced by or provide services to the signalling discipline.

3 Scheduling and Conducting Surveillance Inspections

Surveillance inspections must be performed by experienced maintenance signal engineers and be scheduled on an annual basis. The scheduling is to be arranged such that an adequate inspection sample is conducted of no less than 20% of the maintenance area, eventually covering the whole area over a five year period.

While it may not be practical for surveillance inspections to cover every single item of equipment on the maintenance area every five years, the scope of inspections and observations must include every signal relay room and location to adequately achieve the objectives listed above. The inspections are to include in-depth examination and tests of judiciously selected items and activities from selected areas of aging or brand new installations, or where signalling equipment is out of the way or awkward to access or maintain, or where it may be missed or not performed well by inexperienced signalling
personnel, or has a poor performance history. The inspections must include checks of point locks and detector adjustments, point and track circuit history card records and level crossing test records.

It is important that dedicated surveillance inspections are scheduled annually and are conducted by experienced maintenance signal engineers. However, there are many other opportunities where maintenance signal engineers can capitalise on fulfilling the scope of surveillance inspections. These opportunities may include: mechanical interlocking testing, signal sighting inspections, level crossing inspections, site integrity meetings, practical completion inspections, failure follow-up investigations, irregularity investigations, asset condition inspections and general observations of work being performed by signalling personnel.

Signalling personnel may carry out surveillance inspections on behalf of the maintenance signal engineer. However, they must have first gained suitable experience and the confidence of the maintenance signal engineer by accompanying them during previous surveillance inspections. This does not negate the requirement for the maintenance signal engineer to personally conduct periodic surveillance inspections.

4 Notes of Inspection and Action Requirements

The surveillance inspections must be recorded and the results of the inspections are to be documented and retained on file. The documentation must provide objective evidence of the performance of the inspection. Documented outcomes could be ‘Notes of Inspection’ issued with action requirements (which should be priority based and time scaled where appropriate), training programmes to improve competency, arrangements for increased supervision, adjustments to rosters, local instructions to correct deficiencies, renewal programs, recommendations for changes to procedures, etc.

The Sydney Trains defect management system must be used to manage defects raised for corrective action, and to prioritise and program work to accepted timeframes.

Surveillance inspections provide a vital opportunity to assess a person's competence and compliance with signalling procedures. The most effective way to know if people understand their work and ensure they comply is to observe them doing the work or otherwise by asking them to demonstrate how they would do the work. Maintenance signal engineers must take every opportunity to be satisfied with the competence and compliance of signalling persons (including supervisors) for work performed within their area of responsibility.

Maintenance signal engineers must record occasions where they have directly observed personnel performing signalling related tasks. These must include safety critical and safety significant tasks.

The surveillance inspections must also monitor environmental safety aspects.

5 Other Specific Signal Engineer Inspections and Tests

In addition to the surveillance inspections, there are a number of other specifically nominated inspections and tests required to be carried out by the maintenance signal engineer.

These inspections and tests are:

a) Mechanical Locking/Interlocking tests, conducted every two years (PR S 40022).
b) Relay Interlocking tests (where required), conducted every five years (PR S 40022).

c) Active Level Crossing Protection inspections and tests, conducted at frequencies stated in PR S 40036.

d) Signal sighting (front of train) inspection of running signals, conducted every 26 weeks on passenger main lines and 52 weeks on non-passenger lines in accordance with PR S 40031.
Guidelines for the Safe Use of Temporary Recording, Monitoring and Logging Equipment on Signalling Systems

Version 1.1

Date in Force: 21 September 2016
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<td>Banana plugs or other types of probes intended for temporary unattended connections must be risk assess and approved by maintenance signal engineer</td>
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1 Introduction

When installing and using any type of recording, monitoring and logging equipment (herein known recording equipment), it is imperative that the signalling systems’ safety, integrity, reliability and availability are maintained at all times.

Reasons for connecting this type of equipment to the signalling system include:

a) fault finding and identification of intermittent failures
b) tracking of high resistance relay contacts
c) short term logging/counting of relay operations
d) track sequencing

The types of equipment that this document applies to include:

a) Chart Recorders
b) Logic Analysers
c) Event Recorders
d) Oscilloscopes
e) PC Based recording/monitoring equipment

2 Equipment Selection

2.1 General

All equipment that is intended for monitoring, recording or logging of signalling circuits must have been approved for use by the Professional Head Signalling and Control Systems.

When selecting recording equipment for connection to the signalling system, the requirements outlined below must be adhered to.

If recording equipment is required to be used that does not meet these requirements, or if it is unknown if the requirements are met, then approved third party isolation and/or signal conditioning devices may be used to interface the equipment to the signalling system.

2.2 Input Isolation

The equipment must not allow cross coupling of signalling circuits through common negative or earth returns. This means that each input to the monitoring equipment must meet or exceed following galvanic isolation requirements:

- $1000 \, V_{\text{peak}}$ input channel to device power supply isolation
- $1000 \, V_{\text{peak}}$ input channel to earth isolation
- $1000 \, V_{\text{peak}}$ input channel to output isolation
- $1000 \, V_{\text{peak}}$ input channel to input channel isolation

The device that provides the electrical isolation must not fail under any conditions in a manner that provides an electrical connection of less than 2 megohms at 500 volts between the signalling circuit and the indication circuit.
2.3 Input Impedance

For direct connection to signalling circuits for voltage type measurements, a 500 volt rated resistor must be provided in each leg of the input circuit of the monitoring device. The two resistors must have the same value. The value of the resistors must be such that when one of the resistors and any other internal active component of the recording device is shorted out, the leakage current drawn is less than that which is required to maintain energised the relay of the signalling circuit being monitored.

The table below lists typical values for various signalling circuits.

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<td>12 Volt DC</td>
<td>8 milliamperes DC</td>
</tr>
<tr>
<td>50 Volt DC</td>
<td>5 milliamperes DC</td>
</tr>
<tr>
<td>120 Volt AC</td>
<td>4 milliamperes AC</td>
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3 Equipment Installation

Before any installation work is commenced, a complete circuit diagram of the recording equipment connections (both power and I/O) must be drawn up and approved for use by the maintenance signal engineer. This approval will remain valid for a maximum period of four weeks before it expires.

If there is a requirement to still have the recording equipment connected after this time, then a review of the original failure conditions and an assessment of the investigation procedures is to be made before any further approvals are given.

To ensure that the integrity of signalling system is not compromised with the connection of the recording equipment, all wiring to the recording equipment must be independently checked for correct installation. Assurance must also be made that no signalling functions are by-passed by the recording equipment and its wiring.

Two marked up copies of the affected signalling circuits must be made. One copy is to be left on site and the second copy left at the maintenance signal engineer’s office. These circuits are to be removed from site when the recording equipment is disconnected and removed.

3.1 Wiring Standards

Wiring to the monitoring equipment is to be done to at least to the same standard as that of vital stage work wiring. The wire used must have a minimum insulation rating of 0.6/1kV and temperature rating of V75.

At all times, there is to be minimal disruption to the existing signalling circuit wiring.

In general, the wiring must be a highly visible colour and must contrast sufficiently so that it cannot be mistaken for existing wiring. More importantly, it must not be black in colour nor be of the same colour as any existing or planned future stage work wiring for that site.

All recording equipment power supply circuits and wiring to voltage free contacts from signalling power supplies are to be protected with a suitably rated fuse to no more than 4 amperes.

3.2 Connections and Terminations

If the person is to remain in attendance 100% of the time then temporary connections to the signalling circuits are permitted using recording equipment approved for such temporary connection (eg. Fluke Meter probes on the back of a miniature plug-in relay).
For installations where the recording equipment is to be left unattended, all wiring and connections must be properly identified, lugged and terminated. If connections cannot be terminated by any standard means or if it is required to tap into a signalling circuit where no spare connection is available, then the proposed method of connection must be approved before hand by the maintenance signal engineer.

An approved method for temporarily connecting recording equipment leads to existing wiring in the back of BRB miniature plug-in relays is by the insertion of wire that is crimped with a Q-style crimp which has had the locking loop and locating tag cut off. Once placed in the back of the relay, the temporary wiring is then to be securely fastened with a cable tie or other similar means to the adjacent wiring harness.

Banana plugs or other types of probes intended for temporary unattended connections must be risk assessed and approved by the maintenance signal engineer. These types of connections are to be properly secured and electrically isolated so that the temporary connections cannot be dislodged and potentially interfere with live working signalling circuits.

Alligator clips or other types of connections that could become dislodged are not permitted to be used for temporary unattended connection.

Temporary wire must be clearly labelled with the number of the relay and the contact to which it is connected.

4 Special Circumstances

The special circumstances listed below have been identified as a result of specific cases that have arisen in the past. These cases are by no means the only ones that this document can be applied to. If a need or situation arises that is not clearly covered by this document, then further clarification is to be sought from the Professional Head Signalling and Control Systems.

4.1 Track Circuits

Under no circumstances will the feed/transmitter and the relay/receiver of the same track circuit be fed into channels of the same recording device.

This stipulation is to prevent the possibility of electrically bypassing the presence of a train on a track circuit and applies even if all other isolation requirements mentioned above are adhered to.

4.2 CBI Interface Circuitry

Special consideration needs to be made when wiring to CBI interface circuitry. The wiring must not allow for the induction of electrical noise onto sensitive CBI inputs.

Independent or duplicated data busses and communication channels must not be cross-coupled through the recording device’s signal channel returns or via any earthing connections.

4.3 Current Measurement

Alterations to existing wiring, for the purpose of inserting current shunts are not permitted for measuring current in signalling circuits. Insertion of a shunt by plugging in across an existing disconnection link (e.g. Klippon SAKC10) is permissible.
The disconnection and reconnection of a wire from a terminal for the purposes of passing that wire through a Hall Effect type transducer or similar device is permissible if carried out by licensed signalling personnel.

4.4 Test Lamps

Under no circumstances must a Test Lamp be used on signalling circuits. The input impedance of the lamp is too low and can cause wrong-side failures by false feeding or bridging out vital logic circuits if used incorrectly.

5 Usage and Maintenance

Regular weekly maintenance visits must be carried out on installed recording equipment. Maintenance tasks must include, but not be limited to the following:

a) confirmation of the integrity of the wiring, connections and terminations of the recording equipment
b) inspection of recording equipment to ensure continued correct operation
c) downloading or extraction of any stored log information (if required).
Engineering Procedure
Signalling and Control Systems

Signalling Safeworking Procedure

PR S 40047

Calibration of Tools and Instruments for Signalling Applications

Version 1.3

Date in Force: 07 January 2019
Disclaimer

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<td>14 February 2017</td>
<td>R. Del Rosario</td>
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<td>07 January 2019</td>
<td>E Pace</td>
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1 Introduction

This document describes the calibration requirements of tools and test equipment used in the maintenance, testing, installation and commissioning of signalling equipment on the Sydney Trains network. The following applicable documents are referred to and these documents take precedence in case of any conflict arises.

2 Applicable Documents

<table>
<thead>
<tr>
<th>Document</th>
<th>Description</th>
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<tr>
<td>Sydney Trains SMS-16-GD-3106</td>
<td>Guide to Plant Equipment and Workplace Inspections</td>
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<tr>
<td>BMS-033-PR-002</td>
<td>Control and Monitoring and Measuring Equipment</td>
</tr>
<tr>
<td>Sydney Trains SMS-16-OP-3110</td>
<td>Calibrate Inspection, Testing and Monitoring Equipment</td>
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</table>

3 Multimeters approved for use with signalling infrastructure

Some multimeters with dedicated AC mV and/or DC mV measurement modes have input circuitry which can conduct under overload and which can interfere with the behaviour of the circuits being measured. Such multimeters are not approved for use on the Sydney Trains signalling infrastructure and are listed below. Also listed below are multimeters that are approved for use.

<table>
<thead>
<tr>
<th>Multimeters not approved for use</th>
<th>Multimeters approved for use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fluke 27 II</td>
<td>Fluke 27</td>
</tr>
<tr>
<td>Fluke 28 II</td>
<td>Fluke 70</td>
</tr>
<tr>
<td>Fluke 83 V</td>
<td>Fluke 76</td>
</tr>
<tr>
<td>Fluke 87 V</td>
<td>Fluke 83</td>
</tr>
<tr>
<td>Fluke 175</td>
<td>Fluke 83 III</td>
</tr>
<tr>
<td>Fluke 177</td>
<td>Fluke 85</td>
</tr>
<tr>
<td>Fluke 179</td>
<td>Fluke 85 III</td>
</tr>
<tr>
<td>Fluke 287</td>
<td>Fluke 87</td>
</tr>
<tr>
<td>Fluke 289</td>
<td>Fluke 87 III</td>
</tr>
<tr>
<td>Fluke 1587 Insulation Multimeter (can only be used as an insulation resistance tester)</td>
<td>Fluke 87 IV</td>
</tr>
<tr>
<td></td>
<td>Fluke 89</td>
</tr>
<tr>
<td></td>
<td>Fluke 89 IV</td>
</tr>
<tr>
<td></td>
<td>Fluke 187</td>
</tr>
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<td></td>
<td>Fluke 189</td>
</tr>
<tr>
<td></td>
<td>Fluke 287/NUC</td>
</tr>
</tbody>
</table>

Only multimeters approved for use by the Professional Head Signalling and Control Systems are to be used on Sydney Trains signalling infrastructure. Meters not listed above may be approved for use by contacting the Principal Engineer Signal Systems.
4 Notes on Calibration

Where a particular item of equipment or test application is not listed in Section 8, it is to be referred to the Professional Head Signalling and Control Systems for determination, and any required action that may arise from such determination. Under no circumstances is the equipment to be used on operational signalling equipment/systems until approval has been obtained for its use.

Calibration requirements are related to specific tasks being performed. An instrument used for multiple applications needs to be calibrated only to the highest standard required, and only on the measurement ranges applicable.

Sydney Trains requirements regarding the maintenance, inspection, testing, calibrating and monitoring of Sydney Trains work practices, plant, equipment, and workplaces are provided in SMS-16-SP-3076 “Inspection Testing, Calibration and Monitoring”.

Calibration of test equipment used for signalling applications is to be carried out at a minimum to the frequency and accuracy shown in Section 8.

Where a manufacturer guarantees that an instrument will exceed the accuracy stated in Section 8 without recalibration, for the life of the instrument or for longer intervals than stated, then the calibration frequency may be amended accordingly. A copy of the manufacturer guarantee, endorsed by the Principal Engineer Signalling Systems, is to be kept on file.

5 Calibration Standard/Specification

Test equipment is to be calibrated to manufacturer’s specification, unless specified otherwise in Section 8. A minimum specification is provided to cater for the typical use in signalling applications which generally can tolerate a wider accuracy range without any risk of signalling operational reliability and integrity.

6 Extended Calibration Intervals

Extended calibration intervals for approved test equipment are provided and have been determined by analysis of historical records of calibration and adjustment requirements. These extended intervals are only applicable for the brand and specific model listed.

7 Equipment Failing Manufacturer’s Calibration Specification

Test equipment is calibrated to manufacturer’s specification as detailed in the calibration frequency in Section 8. When test equipment fails a scheduled calibration to the manufacturer’s specification a detailed report is to be produced listing the specific functions and range which failed with the tolerance shown and the measured variation to the tolerance. The test equipment owner is to review the variation and assess against the minimum accuracy for Sydney Trains application.

Where the test equipment is within the minimum accuracy for Sydney Trains application no further action is required other than the test equipment is to be readjusted and recalibrated to the manufacturer’s specification and new calibration certificate issues.

Where the test equipment is beyond the minimum accuracy for Sydney Trains application, the asset owner must assess whether a retesting of equipment certified with this test equipment is necessary. This determination should be conducted with consultation to signalling engineering personnel to ensure any signalling operational risks are correctly addressed.
## 8 Calibration Requirements for Monitoring & Measuring Equipment Used for Signalling Work

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<th></th>
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<tbody>
<tr>
<td>1</td>
<td>Multimeter (see section 3)</td>
<td>General checking and fault finding</td>
<td>Manuf. Spec</td>
<td>All</td>
<td>N/A</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Certification tests – signal lamps and power supplies</td>
<td>Manuf. Spec</td>
<td>AC volts 0-12 AC volts 0-120 DC volts 0-20</td>
<td>± 0.1 @ 50Hz ± 1 @ 50Hz ± 0.1 volts</td>
<td>3 Y</td>
<td>Note 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Certification tests – track circuits</td>
<td>Manuf. Spec</td>
<td>AC mA 0-300 AC mV 0-300 AC V 0-3 AC V 0-200 DC V 0-10 DC V 0-500</td>
<td>± 5mA @2KHz ± 5 @ 2KHz ± 0.1 @ 50Hz ± 1 @ 50Hz ± 0.1 ± 5</td>
<td>3 Y</td>
<td>Note 1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Tong / Clamp Ammeters AC and DC (Kyoritsu, and other approved models)</td>
<td>General checking and fault finding</td>
<td>Manuf. Spec</td>
<td>All</td>
<td>N/A</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Certification Testing</td>
<td>Manuf. Spec</td>
<td>AC A 0-10 AC A 0-100 DC A 0-10 DC A 100 DC V</td>
<td>± 0.1 @ 50Hz ± 1 @ 50Hz ± 0.1 @ 50Hz</td>
<td>2 Y</td>
<td></td>
<td></td>
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<tr>
<td>3</td>
<td>Insulation Resistance Tester – ‘Megger’</td>
<td>Measure insulation resistance</td>
<td>Manuf. Spec</td>
<td>Meg Ohms Output volts Output current into short cct</td>
<td>-0 @ 1MΩ 500/0 @ 1MΩ &lt;3mA</td>
<td>2 Y</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Track circuit Pulse Integrator</td>
<td>General checking and fault finding</td>
<td>Sydney Trains</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td></td>
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<tr>
<td>5</td>
<td>TFA – Track Circuit Frequency Adaptor</td>
<td>General checking and fault finding</td>
<td>Sydney Trains</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
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<tr>
<td></td>
<td>Periodic Maintenance checks</td>
<td>Sydney Trains</td>
<td>AC V 0-2 AC V 0-20 AC V 0-20</td>
<td>± 0.1 @ 1.7kHz ± 1 @ 2kHz ± 1 @ 2.3kHz</td>
<td>2 Y</td>
<td></td>
<td></td>
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<tr>
<td>6</td>
<td>FSM – Frequency Selective Meter</td>
<td>General checking and fault finding</td>
<td>Sydney Trains</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td></td>
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<tr>
<td></td>
<td>Periodic maintenance checks / Certification tests</td>
<td>Sydney Trains</td>
<td>AC V 0-2, 20, 200 AC V 0-2, 20, 200 AC V 0-2, 20, 200 AC V 0-2, 20, 200</td>
<td>± 0.1 @ 1.7kHz ± 1 @ 2kHz ± 1 @ 2.3kHz</td>
<td>2 Y</td>
<td>Tests for all ranges</td>
<td></td>
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<td>7</td>
<td>Track Shunt Tester – DN2000</td>
<td>Certification testing</td>
<td>Sydney Trains</td>
<td>N/A</td>
<td>-0 / -5%</td>
<td>4 Y</td>
<td>Note 2</td>
</tr>
<tr>
<td>8</td>
<td>Combination Insulation &amp; Continuity Test Set</td>
<td>Measure insulation resistance</td>
<td>Manuf. Spec</td>
<td>Meg Ohms Output volts Output current into short cct</td>
<td>-0 @ 60MΩ 500 / 0 @ 1MΩ &lt;3mA</td>
<td>4 Y</td>
<td></td>
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<td>9</td>
<td>Continuity (Bell Test) Set</td>
<td>Continuity</td>
<td>Manuf. Spec</td>
<td>Maximum Ohms</td>
<td>100 / +0</td>
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<td>10</td>
<td>‘Clancy’ Rail Current Meter</td>
<td>General checking and fault finding</td>
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<td>All</td>
<td>N/A</td>
<td>N/A</td>
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<tr>
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<td>Periodic and certification testing</td>
<td>Sydney Trains</td>
<td>AC A 0-5 AC A 0-55</td>
<td>± 0.2 @ 50Hz ± 0.5 @ 50Hz</td>
<td>4 Y</td>
<td>Note 3</td>
<td></td>
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<td>11</td>
<td>‘Ras Coil’ Rail Current Transformer</td>
<td>General checking and fault finding</td>
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<td>N/A</td>
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<td>Periodic and certification testing</td>
<td>Sydney Trains</td>
<td>AC A 0-5 AC A 0-5</td>
<td>± 0.2 @ 50Hz ± 0.2 @ 2kHz</td>
<td>4 Y</td>
<td>Note 3</td>
<td></td>
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<td>12</td>
<td>Chart Recorder - Analogue</td>
<td>System monitoring</td>
<td>Manuf. Spec</td>
<td>All</td>
<td>Manufacturer’s Specification</td>
<td>N/A</td>
<td>Manuf. Recom.</td>
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<tr>
<td>13</td>
<td>Chart Recorder - Digital</td>
<td>Event monitoring</td>
<td>Manuf. Spec</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>Manuf. Recom.</td>
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<tr>
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<tr>
<td>14</td>
<td>Oscilloscope</td>
<td>General testing and fault finding</td>
<td>Manuf. Spec</td>
<td>All</td>
<td>N/A</td>
<td>N/A</td>
<td></td>
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<tr>
<td>15</td>
<td>Oscilloscope / Meter Combination</td>
<td>General testing and fault finding</td>
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<td>all</td>
<td>N/A</td>
<td>N/A</td>
<td>Manuf. Recom.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Measure critical levels</td>
<td>Manuf. Spec</td>
<td>all</td>
<td>Manufacturer’s Specification</td>
<td>N/A</td>
<td></td>
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<tr>
<td>16</td>
<td>Lightning Arrestor Tester</td>
<td>Test arrestors &amp; varistors</td>
<td>Sydney Trains Limiting volts Low scale High scale</td>
<td>± 20 V ±50 V</td>
<td>4Y Note 4</td>
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<td>17</td>
<td>Points Gauge</td>
<td>Check points adjustment</td>
<td>Sydney Trains thickness</td>
<td>+ 0mm</td>
<td>N/A</td>
<td>1 Y</td>
<td>Inspect for damage</td>
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<td>18</td>
<td>Trainstop Gauge</td>
<td>Check trainstop arm adjustment</td>
<td>Sydney Trains dimensions</td>
<td>± 10mm (M04-022 – Trainstop Gauge for Setting Stoparm)</td>
<td>1 Y Inspect for damage</td>
<td></td>
<td></td>
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<td>19</td>
<td>Annett Key Gauge</td>
<td>Check Annett lock warding</td>
<td>Sydney Trains</td>
<td>N/A</td>
<td>N/A</td>
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<td>Torque wrench</td>
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<td>Manuf. Spec Torque -Nm</td>
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<td>Manuf. Spec Manuf. Spec</td>
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<td>Measuring Wheel</td>
<td></td>
<td>Manuf. Spec meters</td>
<td>± 2%</td>
<td>1 Y Inspect for wheel wear</td>
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<td>23</td>
<td>Crimping Tool</td>
<td></td>
<td>Manuf. Spec Tension test on sample crimps</td>
<td>Sigs Std Spec 707</td>
<td>1 W Note 5</td>
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Note 1: Extended calibration interval of 3 years for approved brands of equipment (as listed in the table) determined by historical calibration analysis and adjustment requirements. All other meters, calibration period is 2 years or as determined by the recommendation of the Manufacturer.

Note 2: When using Track Shunt Tester whenever there is a doubt always check resistance value with a calibrated meter. However proper calibration check is performed by passing 1A current and measuring voltage drops.

Note 3: Calibrate rail current devices at centre top of 53 kg rail length greater than 1 metre, with test current injected between ends, on neutral axis.

Note 4: Calibrate arrestor tester using standard devices as reference.

Note 5: Proper functioning of crimping tools can be detected by calibration checks. Each week (or after 40 hours of usage) 10 sample crimps with wire tail 150-200mm must be prepared with specified wires and specified terminal lugs and tested for tensile strength. Pass/fail criteria is 100% pass. If the crimped terminal connections fails during tensile tests, crimping tool, terminal lugs and wires must be further inspected and appropriate action need to be taken.

Manuf. Spec: Manufacture’s specifications (Always refer to Manufacturer’s specifications unless specified in PR S 40047 safeworking procedure)

Manuf. Rec: Manufacturer’s recommendations
Engineering Procedure
Signalling and Control Systems

Signalling Safeworking

PR S 40048

Signalling Locations and Equipment – Security Locks and Keys

Version 1.2

Date in Force: 8 March 2019
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<td>First issue as a Sydney Trains document, rebranded from previous RailCorp TMG J048</td>
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<td>R. Del Rosario</td>
<td>Updated to mandatory ASA &amp; EIS requirements and title &amp; roles. See summary of changes below</td>
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<td>1.2</td>
<td>8 March 2019</td>
<td>A. Sozio</td>
<td>Inclusion of Control Systems requirements</td>
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Summary of changes from previous version

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1 Introduction

This procedure describes the issue and use of signalling security keys and locks used to secure signal infrastructure throughout the Sydney Trains rail network.

This procedure only governs the issuance of keys used for the purpose of signalling infrastructure work (not for operational purposes).

2 Definitions

Central Key Controller: The Senior Signals Mechanical Engineer within Signalling & Control Systems, delegated to approve Key Controllers and control the bulk issue of keys issued to the Key Controller.

Key Controller: The person responsible for the control of the Key Pool, for the issue of keys to a Key Holder and to maintain such records.

Central Key Pool: The stock of keys held by the Central Key Controller to service requests for stock from Key Controllers.

Key Pool: The stock of keys held by the Key Controller.

Key Holder: The person authorised to be in possession of any signalling security key.

Keys Types: As listed in Appendix B

3 Old Series Signalling Security Keys

Typically, these keys are not in general use and will therefore only be issued on a needs basis to signalling personnel as defined in Table 1.

<table>
<thead>
<tr>
<th>Key</th>
<th>Signal Engineer</th>
<th>Signal Electrician</th>
<th>Signals Mechanical</th>
<th>Signals Ancillary</th>
<th>Signals Authorised Person</th>
</tr>
</thead>
<tbody>
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<td>Best 7</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Best 8</td>
<td>N/A</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Yale 6</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Yale 9</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Yale R</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>SWI old</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>SWI new</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Staff old</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Staff new</td>
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<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>PIM</td>
<td>Yes</td>
<td>Yes</td>
<td>Interlocking Fitter only</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Corbin old</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Corbin new</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

Table 1 - Old Series Signalling and Safeworking Keys
4 **SL Keys**

SL keys are still in general use and may be issued to signalling personnel as defined in Table 2.

<table>
<thead>
<tr>
<th>Key</th>
<th>Signal Engineer</th>
<th>Signal Electrician</th>
<th>Signals Mechanical</th>
<th>Signals Ancillary</th>
<th>Signals Authorised Person</th>
</tr>
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<tbody>
<tr>
<td>SL</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

Table 2 - SL Keys

5 **ET200 Track Circuit Set-Up and Configuration Keys**

ET200 set-up keys must only be issued to signalling personnel listed in RG S 41415 with level 1 competency in ML/TI21 and assessed competent by the Principal Engineer Signal Systems after attending the ET200 briefing.

The issued ET200 set-up key must only be used in the Sydney Trains network.

ET200 configuration keys are frequency selective and allocated to specific track circuits according to the signal design. Configuration keys are available as a stock item.

6 **Falcon Series Signalling Security Keys**

The Falcon series is the current lock and key system used for signalling in Sydney Trains rail network. Note: Falcon locks and keys may be in use on other rail networks in NSW.

Falcon keys may only be issued to personnel as defined in Table 3.

<table>
<thead>
<tr>
<th>Falcon Series Number</th>
<th>Authorised Key Holder</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Professional Head Signalling and Control Systems</td>
</tr>
<tr>
<td>2</td>
<td>Signal Engineer</td>
</tr>
<tr>
<td>4</td>
<td>Signal Electrician</td>
</tr>
<tr>
<td></td>
<td>Signal Engineer</td>
</tr>
<tr>
<td></td>
<td>Control Systems Engineers</td>
</tr>
<tr>
<td></td>
<td>Control Systems Technician</td>
</tr>
<tr>
<td></td>
<td>Licensed Signals Mechanical</td>
</tr>
<tr>
<td></td>
<td>Licensed Signals Ancillary</td>
</tr>
<tr>
<td></td>
<td>Signals Authorised Person</td>
</tr>
<tr>
<td>6</td>
<td>No longer in use</td>
</tr>
<tr>
<td>7</td>
<td>Not issued by Signals Discipline</td>
</tr>
<tr>
<td>8</td>
<td>Sydney Trains Apprentice Electrical Mechanic (from second year)</td>
</tr>
<tr>
<td>10</td>
<td>No longer in use</td>
</tr>
<tr>
<td>12</td>
<td>No longer in use</td>
</tr>
<tr>
<td>14</td>
<td>Operational Technology personnel authorised Major Works personnel</td>
</tr>
<tr>
<td>15</td>
<td>Operational Technology personnel authorised Major Works personnel</td>
</tr>
<tr>
<td>16</td>
<td>Operational Technology personnel authorised Major Works personnel</td>
</tr>
<tr>
<td>Falcon Series Number</td>
<td>Authorised Key Holder</td>
</tr>
<tr>
<td>---------------------</td>
<td>---------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>17</td>
<td>Operational Technology personnel listed in RG S 41415 as an Authorised Person</td>
</tr>
<tr>
<td>20</td>
<td>Operational Technology personnel, authorised Major Works personnel</td>
</tr>
<tr>
<td>22</td>
<td>Personnel as approved by Electrical Engineering Manager</td>
</tr>
</tbody>
</table>

Table 3 – Falcon Series Keys

6.1 Series Hierarchy

The Falcon keying system is an interchangeable core type with a restricted key broaching.

The Falcon series has a hierarchy as outlined in Appendix A and has the capability of being extended by adding further locks and/or keys as required. Presently, the system has twenty five (25) locks and keys. Any additions or re-assigning locks or keys within the hierarchy must be approved by the Professional Head Signalling & Control Systems.

6.2 Core Configuration Authority

The configuration of Falcon interchangeable cores must be performed by the Sydney Trains Locksmith. Where this is not achievable, then the configuration must be performed by a qualified external locksmith who is member of the Master Locksmiths Association, with close supervision from a Signal Engineer to ensure the security of the pinning charts is maintained.

6.3 Key Cutting and Numbering

The Sydney Trains Locksmith must hold all key blanks and arrange for the cutting and numbering of all keys, ensuring that the allocation of numbers is unique.

Each key must be stamped with the key number, a unique allocation number and “TfNSW DO NOT COPY”.

6.4 The Locktech Security Keying System

An approved alternate supply of cylinder cores and keys has been arranged through Locktech Industries. There is a slight difference in the key profile between the Falcon and Locktech keys. The Locktech cores can be pinned the same as the Falcon system and can be opened by either a Falcon or a Locktech key. The Locktech keys cannot be used to open locks fitted with Falcon cores.
7 Signalling Security Keys - Control Process

7.1 Key Controllers

The listing of Key Controllers is defined in Table 4. The delegation of officers must be approved by the Professional Head Signalling & Control Systems.

<table>
<thead>
<tr>
<th>Series Number</th>
<th>Business Group</th>
<th>Key Controller</th>
</tr>
</thead>
<tbody>
<tr>
<td>1, 2, 4 and SL</td>
<td>Engineering System Integrity – Signals &amp; Control Systems</td>
<td>Senior Signalling Mechanical Engineer</td>
</tr>
<tr>
<td>2, 4, 8, 18 and SL</td>
<td>Network Maintenance Division</td>
<td>Maintenance signal engineers, Operational Technology Manager Control &amp; Co-ordination Manager</td>
</tr>
<tr>
<td>4, 8 and SL</td>
<td>Network Maintenance Division</td>
<td>Test &amp; Commissioning Manager or his/her delegate</td>
</tr>
<tr>
<td>7</td>
<td>Network Operations</td>
<td>Not controlled by Signalling</td>
</tr>
<tr>
<td>14, 15, 16, 17, 20 and 21</td>
<td>Operational Technology</td>
<td>Not controlled by Signalling</td>
</tr>
<tr>
<td>22</td>
<td>Engineering &amp; System Integrity - Electrical</td>
<td>Delegated Electrical Officer</td>
</tr>
<tr>
<td>ET200 set-up key</td>
<td>Engineering System Integrity – Signals &amp; Control Systems</td>
<td>Principal Engineer Signal Systems</td>
</tr>
</tbody>
</table>

Table 4  - Approved Key Controllers

7.2 Supply of Keys

The Central Key Controller is required to maintain a Key Pool to meet expected demand.

The Sydney Trains Locksmith is to supply keys for the Central Key Pool upon request from the Central Key Controller. ET200 set-up keys must only be ordered by the allocated Key Controller.

The Key Controller must maintain a Key Pool to meet the expected demand.

The Central Key Controller must supply keys for the Key Pool upon request from Key Controllers.

The Sydney Trains Locksmith must maintain comprehensive records of:

- All requests for the supply of keys and locks.
- Key blanks in stock.
- Keys issued to or returned by the Central Key Controller.
7.3 **Key Pool Storage**

Key Pools are to be stored in a safe, or in a secure cabinet. Access to the key pool should be restricted to the Key Controller and no more than one other person nominated by them. Storing the keys on a rack of hooks, or in a multi-compartment case within the safe or cabinet should simplify the process of finding the relevant keys. If the Key Controller is not the custodian of the key for the safe then a lockable cashbox or something similar is to be used to store the keys within the safe.

The Sydney Trains Locksmith must secure all blanks and cut keys in a safe or secure cabinet.

7.4 **Issuance Control**

Signalling personnel listed in RG S 41415 who hold a current Sydney Trains Permit to Work may make application to the Key Controller for the issue of appropriate security keys required for the work in accordance with this procedure.

The issue of security keys must be recorded with details of the individual concerned (position, location, contact details, employer, project, key number, etc.) and date of issue.

Issued keys may be retained by the Key Holder subject to the provisions prescribed in 7.5.

7.5 **Return of Issued Keys**

Key Holders must return their signalling security keys to their respective Key Controller when there is no longer justification for the person to have those keys, or where a person ceases carrying out work for Sydney Trains or where a Sydney Trains Permit to Work expires or is revoked.

Sydney Trains employees exiting from the organisation must also return their signalling keys to the Key Controller. A new issue of keys must be provided in accordance within the provisions stated in 7.4.

The Key Controller must conduct a review of records every 2 years.

7.6 **Maintenance of Records**

Databases shall be used to record and control the supply, issue, transfer, maintenance and return of signalling security keys.

The maintenance of records shall be the responsibility of the Central Key Controller and the Key Controllers nominated in section 7.1.

When signalling personnel transfer to another Sydney Trains position or depot location, and they are authorised to retain their signalling keys, then their key record shall be transferred with them.

7.7 **Key Holder Responsibilities**

The responsibility for the proper use and care of keys lies with the individual key holder. Keys are not to be lent, copied or defaced and any damaged or broken keys shall be immediately returned to the appropriate Key Controller for replacement.
7.7.1 Improper Use

Improper use of signalling security keys will be dealt with under TMG G1418 – Signalling Safeworking Breaches. Improper use would include:

- Use of a key without appropriate authorisation
- Use of a key to unlock infrastructure and fail to make it secure before leaving the site
- Failing to adequately secure keys against theft or loss
- Allowing issued keys to be used by unauthorised persons
- Use of a key when not engaged to undertake work for Sydney Trains

7.7.2 Stolen or Lost Keys

Key Holders shall report all keys that are lost or stolen. The report shall be in the form of a Statutory Declaration detailing the circumstances of the loss. This report shall be sent to the issuing Key Controller and a copy forwarded to the Key Holder's controlling officer.

8 Authorisation to Authorised Engineering Organisation (AEO)

The Professional Head Signalling & Control Systems may authorise another AEO to hold an allocation of signalling security keys for signalling works. The AEO must appoint a Key Holder and maintain records of signalling keys.

9 Dual Access Locations

Dual access to signalling, communication and electrical equipment locations shall be provided on a needs basis to persons where the work required to be done, is performed within their respective area of authority.

Dual access to communication locations shall be provided by installation of a Falcon No.17 lock. The provision of these locks shall be jointly approved by the Professional Head Signalling & Control Systems and the Operational Technology Manager. Issue of Falcon No.17 keys to Communications & Control Systems personnel shall be approved by the Operational Technology Manager. Signalling personnel may gain access to these locations using a Falcon No.4 key.

Dual access to electrical locations shall be provided by installation of a Falcon No.22 lock. The provision of these locks shall be jointly approved Professional Head Signalling & Control Systems and the Electrical Engineering Manager. Issue of Falcon No.22 keys to Electrical Discipline personnel shall be approved by the Electrical Engineering Manager. Signalling personnel may gain access to these locations using a Falcon No.4 key.

Note: Non-signalling personnel shall only enter a signalling location if authorised by the maintenance signal engineer or Commissioning Engineer in accordance with MN S 41412 – Process for Signal and Control Systems Personnel Authorisations & Licensing.

Keys shall be issued by the respective Key Controller.
10 Access to Communication Locations
The Key Controller in Major Works Division shall nominate personnel to the Program Delivery, Operational Technology Manager for authorisation to gain access to communications facilities for the purpose of cable locating, cable jointing and other similar roles.

The Program Delivery, Operational Technology Manager shall authorise the Key Controller in Major Works Division to issue the required Falcon keys as deemed necessary for the work.

11 Signal Box Security
11.1 Operational Areas
Falcon No.7 locks are no longer fitted to the operational areas of existing Signal Boxes. The locks to these areas are the responsibility of operational managers.

11.2 Underside of Mechanical Signal Boxes
Falcon No.7 locks are no longer fitted to the underside of mechanical Signal Boxes. This access shall now be secured with a Falcon No.4 lock.

11.3 Major Signal Boxes
Major Signal Boxes (Control Centres) are fitted with propriety card type security access systems. The maintenance of these systems is the responsibility of Building Service managers. The maintenance signal engineer, or his delegated representative, shall ensure only authorised signalling personnel have access to signalling rooms within these buildings.

12 Emergency Access to Signal Locations
An emergency Falcon No.4 key shall be kept at the Network Maintenance Division Operations Centre (ICON Infrastructure) for emergency access to signal locations.
# Appendix A  Falcon Key Hierarchy

<table>
<thead>
<tr>
<th>LOCK</th>
<th>No.</th>
<th>KEY</th>
<th>OPENS LOCKS</th>
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</thead>
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<td>1</td>
<td>MASTER</td>
<td>1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 20A 21 22 23 24 25</td>
</tr>
<tr>
<td>2</td>
<td>DISTRICT SECURITY</td>
<td>2</td>
<td>SUB-MASTER D.E.</td>
</tr>
<tr>
<td>3</td>
<td>PROJECT SECURITY</td>
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<td>NOT REQUIRED</td>
</tr>
<tr>
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<td>RELAY ROOM</td>
<td>4</td>
<td>SUB-MAST MAIN ELECT</td>
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<td>RELAY ROOM</td>
<td>4</td>
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</tr>
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<td>PROJECT SECURITY 2</td>
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<td>NOT REQUIRED</td>
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<td>U/S SIGNAL BOXES</td>
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</tr>
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<td>OPERATIONS (SIG BOXES)</td>
<td>7</td>
<td>OPERATIONS</td>
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<td>PADLOCK (STEL replacement)</td>
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</tr>
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<td>ELECTRICIANS/SECTMANS DEPOT</td>
<td>10</td>
<td>NOT REQUIRED</td>
</tr>
<tr>
<td>11</td>
<td>AMENITIES (RESTRICTED)</td>
<td>11</td>
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</tr>
<tr>
<td>12</td>
<td>AMENITIES (GENERAL)</td>
<td>12</td>
<td>NOT REQUIRED</td>
</tr>
<tr>
<td>13</td>
<td>PROJECT STORES</td>
<td>13</td>
<td>NOT REQUIRED</td>
</tr>
<tr>
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<td>COMMS-CITYRAIL</td>
<td>14</td>
<td>COMMS-CITYRAIL</td>
</tr>
<tr>
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<td>15</td>
<td>COMMS-CITYRAIL</td>
</tr>
<tr>
<td>16</td>
<td>COMMS-SPARE</td>
<td>16</td>
<td>COMMS-SPARE</td>
</tr>
<tr>
<td>17</td>
<td>COMMS-JOINT ACCESS</td>
<td>17</td>
<td>COMMS-JOINT ACCESS</td>
</tr>
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<td>18</td>
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<td>COMMS-CITYRAIL NOT FOR ISSUE</td>
</tr>
<tr>
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<td>SPARE</td>
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<td>SPARE</td>
</tr>
<tr>
<td>20</td>
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<td>20</td>
<td>SPARE ON LOAN TRAIN RADIO</td>
</tr>
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<td>20A</td>
<td>COMMS-TRAIN RADIO</td>
<td>20A</td>
<td>TRAIN RADIO</td>
</tr>
<tr>
<td>21</td>
<td>COMMS-CITYRAIL</td>
<td>21</td>
<td>COMMS-CITYRAIL FOR USE BY TELSTRA</td>
</tr>
<tr>
<td>22</td>
<td>ELECTRICAL (R SERIES)</td>
<td>22</td>
<td>ELECTRICAL (R)</td>
</tr>
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<td>ELECTRICAL</td>
</tr>
<tr>
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### Appendix B  Key Types

#### In General Use

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#### Not in General Use

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<tr>
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<td>Numbered</td>
</tr>
<tr>
<td>Yale 9</td>
<td>Numbered</td>
</tr>
<tr>
<td>Yale R</td>
<td>Numbered</td>
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</table>
### Not in General Use (cont’d)

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<th>Key Type</th>
<th>Details</th>
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</tr>
<tr>
<td>Corbin New</td>
<td>Not Numbered</td>
</tr>
<tr>
<td>Corbin Old</td>
<td>Not Numbered</td>
</tr>
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<td>SWI New - ABLOY</td>
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<td>SWI Old</td>
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<td>PIM</td>
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Engineering Procedure
Signalling and Control Systems

Signalling Safeworking

PR S 40049

Signal Engineering Deviations

Version 1.1

Date in Force: 24 October 2016
Disclaimer

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Document control

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<th>Date</th>
<th>Author/ Prin. Eng.</th>
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<td>Colin Darmenia</td>
<td>First issue as a Sydney Trains document including additional process requirements, removal of ASA responsible items and rebranded from previous Sydney Trains TMG J049.</td>
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<td>1.1</td>
<td>24 October 2016</td>
<td>Rhoel Del Rosario</td>
<td>Updated for new titles, roles and deviation management</td>
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Summary of changes from previous version

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<td>Change to title and additional requirements for deviation management</td>
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<td>Updated for new titles and roles</td>
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1 Introduction

Engineering Authority for the Sydney Trains Signalling Discipline is held by the Professional Head Signalling and Control Systems. Signals Competency Standards and Procedures, Signalling Safeworking Procedures, Technical Maintenance Plans and Signalling Equipment Specifications provide the processes required to design, supply, install and maintain signalling infrastructure, ensuring a safe and reliable system.

Unless a Signalling Engineering deviation (previously known as a waiver) or Concession is granted, or an approved design is issued, variation from the specified standard or procedure must not be permitted.

1.1 Scope

This document sets out the Sydney Trains Signalling Discipline requirement for the submission, evaluation and approval of variations from Sydney Trains Signals Competency Standards and Procedures, Signalling Safeworking Procedures and Signalling Technical Maintenance Plans.

An Asset Standard Authority (ASA) Concession is required for variation from documents under its control. The process to request a concession and the application form is available on the ASA internet site.

Concession requests against Signalling Discipline requirements from within Sydney Trains require the endorsement of the Professional Head Signalling & Control Systems and are required to be lodged via Signalling & Control Systems Integrity.

1.2 Purpose

The purpose of this document is to specify the requirement to:

a) Determine and evaluate the initial need to vary from current Sydney Trains Signal Competency Standards and Procedures, Signalling Safeworking Procedures and Signalling Technical Maintenance Plans.

b) Assess all the risks associated with the variation, apply mitigating risk controls/conditions and identify persons responsible for actioning risk controls.

c) Appraise deviation requests at the recommendation stage.

d) Approve or decline deviation requests.

This will ensure that all the safety and technical risks associated with the variation are satisfactorily identified, mitigated and managed throughout the valid period of the deviation prior to granting approval for the deviation.
2 Approval Process for Signalling Design

Approval for the issue of new or altered signalling design, including vital data, electrical and mechanical designs, are to be in accordance with the design approval process described in the Signal Engineering Standards, particularly SPG 0711 and SPG 0703.

Where specific variation is required for a particular situation, e.g.: a variation from standard design for the installation of a signal base, then this can be arranged as a design approval by due consideration and endorsement from the relevant signal project engineer and subsequent approval from the Professional Head Signalling & Control Systems or delegated subject matter expert.

The process for temporary cable routes is described in specification SPG 0705.

3 Definitions

The following defined terms are used throughout this procedure:

**Signal Engineering Deviation.** An approved variation from Sydney Trains Signalling Safeworking Procedures, Signals Competencies or Signalling Technical Maintenance Plans.

**Signalling Safeworking Procedures.** Refers to the suite of Sydney Trains Signalling Safeworking Procedures, including Competency Procedures and any other applicable signalling procedure or instruction that is required for proper maintenance and asset management of the signalling system.

**Requesting Officer.** A person who identifies and proposes a temporary variation of an item or matter that does not, or will not comply with Sydney Trains Signalling Safeworking Procedures, Signal Technical Maintenance Plans or Signal Competencies.

The Requesting Officer must be a Signal Engineer listed in RG S 41415 or a person with the appropriate signal engineering authority.

**Risk Control Officer.** A suitable person identified as having responsibility for actioning risk mitigation control(s) as addressed in the deviation submission.

**Sponsor.** Typically a licensed Sydney Trains Signal Engineer at managerial level associated with the request who must provide comment and endorsement on the signal engineering deviation submission.

**Reviewing Officer.** A subject matter expert with delegated authority from Sydney Trains Engineering and System Integrity Division, Signalling & Control Systems, who is responsible for evaluating the deviation request prior to submission for approval.

**Approving Officer.** The Sydney Trains Professional Head Signalling & Control Systems.

4 Deviation Categories

Deviations are defined into three fundamental elements that permit acceptance of a non-compliant signalling item or matter. Deviation categories are as follows:

a) Signalling safeworking & maintenance (Manual MN S 40000).

b) Signalling Technical Maintenance Plans.

c) Competency of signalling personnel to work on Sydney Trains signalling infrastructure (TMG A1412, RG S 41415, TMG A1419 & PR S 40001/40010).
5 Deviation Evaluation and Submission

The Requesting Officer must submit a PR S 40049 FM 01 Signal Engineering Deviation Request for Approval form (refer to Appendix A), requesting a deviation in response to an identified variation to a non-compliant signalling item or matter.

The submission must include an evaluation of the deviation request and a safety and technical risk assessment of the variation, which must be submitted with the PR S 40049 FM 01 form. The risk assessment must identify all risks associated with the variation and specify the controls necessary to manage such risks.

A Risk Control Officer must be identified to action each of the risk controls.

Where the deviation is complex, or involves a high level of risk, then a Sponsor must be arranged to provide comment on the deviation request. The provision of a Sponsor may also be requested by the Professional Head Signalling & Control Systems. The Sponsor, if satisfied that all the requirements have been met, must endorse the deviation request. Typically, the Sponsor must be a licensed Sydney Trains Signal Engineer at managerial level associated with the request.

Affected stakeholders must be notified of the pending deviation request and additionally provide comment on the submission.

The PR S 40049 FM 01 form, including all supporting documentation, must be forwarded to the Principal Engineer Signalling Integrity.

6 Deviation Registration

Once a deviation request is received, the Principal Engineer Signalling Integrity must:

a) Register the request.

b) Assign the deviation to an appropriate Reviewing Officer

7 Deviation Review

The Reviewing Officer must ensure the reason for deviation, detail of variation, identification of risks, specification of controls and conditions (including operating circumstances) are clearly compiled on the PR S 40049 FM 01 form, including all supporting material, photos, calculations, drawings and any other correspondence necessary to demonstrate adequate management of all identified risks.

The Reviewing Officer must evaluate the need for the deviation, review the safety and technical risk assessment and ensure all associated risks are mitigated by suitable controls and conditions necessary to manage the risks and that a Risk Control Officer has been allocated to action each of the risk controls.

Risks associated with any temporary variation of a non-compliant signalling item or matter may be judged to be acceptable, either by implementing suitable controls to manage the risk or by assessing local operating conditions of that signalling infrastructure to be less rigorous than those assumed by the formal procedure.

The Reviewing Officer must ensure all affected stakeholders have been identified, notified and had the opportunity to provide comment. Their comments must be taken into account during the review phase. The Reviewing Officer may liaise with the Requesting Officer, Sponsor or affected stakeholders to establish a clear understanding of the key elements of the deviation request.
The Reviewing Officer must provide comment (including any additional controls and mitigations) where necessary and either recommend (if satisfied that all the requirements have been met) or not recommend the deviation request, then forward the submission to the Professional Head Signalling & Control Systems for determination.

8 Deviation Approval
The Approving Officer must examine the presented evidence including any recommendations or concerns raised by the Reviewing Officer and judge that all significant risks have been identified and adequately addressed in the proposed conditions of the deviation.

The Approving Officer may mandate additional controls and mitigations to address concerns they have deemed as not adequately controlled.

Once satisfied, the Approving Officer can approve the deviation.

Once approved, the PR S 40049 FM 01 form must be returned to the Principal Engineer Signalling Integrity along with all supporting documentation.

9 Deviation Rejection
Deviations not approved by the Approving Officer must have comments explaining the reasons for rejection and then returned to the Principal Engineer Signalling Integrity for final processing.

10 Deviation Advice and Distribution
If a deviation request is approved, the Principal Engineer Signalling Integrity must:

a) Update the deviation register to note the approval.

b) Advise and provide a copy of the approved PR S 40049 FM 01 form to the Requesting Officer, Sponsor (as applicable) and affected stakeholders.

If a deviation request is rejected, the Principal Engineer Signalling Integrity must:

a) Update the deviation register to note the rejection.

b) Contact or arrange the Reviewing Officer (subject matter expert) to contact and advise the Requesting Officer of the details for the deviation rejection and where appropriate, recommend alternate arrangements.

The Requesting Officer may re-submit the deviation request where they are able to demonstrate, to the satisfaction of the Reviewing Officer, that an alternate approach or provision of additional risk controls would address the reasons / concerns stated in the original deviation’s rejection.

11 Deviation Management
The Risk Control Officer is responsible for actioning and maintaining their assigned risk mitigation control(s) as detailed in the deviation submission. This will require monitoring of the controls and mitigations to ensure they remain in place and valid for the risk.

Risk Control Officers are to immediately re-establish any control or mitigation that has lapsed and advise the Requesting Officer of the event.
Requesting Officers are to periodically review deviations to ensure controls and mitigations are being maintained and determine if the deviation is still valid or required.

Requesting Officers are responsible for ensuring deviation provisions are maintained and do not exceed the expiry date.

Request for any extension to a deviation period must be made in a timely manner prior to the expiry date with due consideration of the impacts or additional risks imposed by the extension.

Failure to meet all stipulated deviation approval requirements will render the deviation invalid.

Where current deviations are no longer required, notification is to be made to the Principal Engineer Signalling Integrity to have the deviation withdrawn.

12 Continuation of Responsibilities and Accountabilities

To ensure continual compliance with this procedure and the currency of the individual deviation, where a role holding continuing accountability or responsibility for a deviation is to be vacated, the incumbent is to ensure a suitable replacement is to be assigned and briefed on the role and its responsibilities.

The Principal Engineer Signalling Integrity and pertinent stakeholders must be notified of any changes to roles holding accountability or responsibility.

The change is to be noted on the deviation approval and in the deviations register.

13 Deviation Periodic Review

The Professional Head Signalling & Control Systems is to ensure an annual review is conducted of all issued deviations to determine status and risk. The review is to assess the requirement to update any process or standard relating to a particular deviation. All deviations which are determined to be no longer required are to be withdrawn.
Appendix A  Form

PR S 40049 FM01
Signal Engineering Deviations Request for Approval

Deviations Number:
(Allocated by Principal Engineer Signalling Integrity)

START DATE:

EXPIRY DATE:

REQUESTED BY:

Deviation Category
☐ Signalling Safeworking & Maintenance
☐ Signalling Technical
   Maintenance Plans
☐ Competency Signalling Personnel to work on Sydney
   Trains Signalling Infrastructure

RELEVANT STANDARD/PROCEDURE:

TERRITORY OR PROJECT:

LOCATION:

EQUIPMENT AFFECTED:
(All applicable)

VARIATION DESCRIPTION:

VARIATION DETAILS:
Disclaimer

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Sydney Trains makes no warranties, express or implied, that compliance with the contents of this document shall be sufficient to ensure safe systems or work or operation.

Document control

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1 Scope

The following procedure relates to Control Systems equipment and provides guidance to ensure a high availability is maintained.

As a reminder, and to ensure consistency throughout the safeworking procedures, the principles and actions in these procedures apply to signals and Control Systems equipment. Wherever there is a reference to a signal engineer, or maintenance signal engineer, the actions as applicable will also apply to the Control Systems engineer for control systems equipment only. Likewise, reference to licensed signalling personnel applies to Control Systems technicians for control systems equipment.

Refer to GL S 41551 Signalling, Communication and Control Systems existing interface diagrams’ for interface boundaries.

When it is required to disconnect control systems apparatus, the necessary Network Rules, and Network Procedures, as well as the disconnection philosophy as stipulated in PR S 40008 Securing Signalling apparatus out of use must be strictly observed.

2 References

The following signalling safeworking procedures are also applicable and shall be referenced in conjunction with this procedure.

- PR S 40001 Introduction to Signalling Safeworking Procedure
- PR S 40004 Failures
- PR S 40005 Damage to signalling equipment including cables
- PR S 40008 Securing Signalling apparatus out of use
- PR S 40010 Risks and controls testing and certify equipment
- PR S 40011 Renewals work
- PR S 40012 Repair Replacement of Signalling Wires
- PR S 40014 Control of signalling documentation Issued to the field
- PR S 40016 Notification of Whereabouts and Liaison with Network Controllers
- PR S 40017 Maintenance Responsibilities and Frequencies
- PR S 40023 Insulation Inspection and Testing
- PR S 40044 General signalling maintenance management, administration and supervision responsibilities
- PR S 40048 Signalling locations and equipment - Security Locks and keys

Many Control Systems installations have site specific maintenance instructions typically outlined within the product manuals, which need to be referenced before conducting maintenance activities. They also contain important information relating to power supply setup, general setup, communications links and operating environments etc.

Where there is conflict between this document and the manufacturer’s documents, this document will take precedence. Discrepancies should be reported to the Professional Head Signalling & Control Systems.
3 Security

3.1 Management and Use of Portable USB Storage Drives

There are two major threats associated with the use of portable USB storage devices, which include data loss and providing a conduit for transferring malware into a network. If either of these threats are executed, there is a potential of disrupting the rail network.

Data loss

The large storage capacity of portable USB storage devices relative to their small size and low cost means that using them for data storage without adequate operational and logical controls can pose a serious threat to information, including:

Confidentiality – If a portable USB storage device is lost, sensitive information that is stored on the portable device may be misused to gain unauthorised access to the operational Signals and Control Systems environment.

Integrity – Information within the operational Signals and Control Systems environment could be replaced with unauthorised information.

Availability - The operational Signals and Control Systems environment could be compromised leading to a disruption of rail operations.

Malware infections

The use of portable USB storage devices has the potential of transferring malware into the operational environment potentially disrupting the operational rail network. This is not limited to malware introduced by a storage device but can include infections introduced by other means such as rogue USB firmware or from mobile devices.

All portable USB storage devices that are to be used within the operational Signals and Control Systems environment shall be:

1. Authorised by:
   a) Control Systems Operations Manager for use by Control Systems maintenance personnel, or
   b) Control Systems Design Manager for use by all other personnel,
   c) Maintenance Signal Engineer for use by signalling maintenance personnel

2. Purchased from a reputable supplier of known integrity. Any other USB device shall be treated as suspicious.

3. Used only when there is no other option such as a network file transfer.


5. Physically controlled and monitored by owners of the authorised devices. Authorised personnel shall ensure:
   a) A register of the portable USB storage devices is maintained, containing:
      o Who used it
      o When was it used
      n Time and date taken
      n Time and date planned to be returned
      n Time and date returned
      o What it was used for
b) Devices are stored securely

c) Devices are returned to the secure location by the planned date and time.

d) Devices are scanned for malware prior to connection and use within the operational Control Systems environment. Any system used for scanning shall:
   - Have corporate Antivirus installed with up-to-date virus definitions
   - Scan devices upon connection.

e) Devices are formatted in full before and after each use. Quick formatting shall not be used. The system used to format devices shall be the same as the system used for scanning.

f) Devices are securely disposed of, i.e. data is erased using a secure delete utility

Multiple registers may exist, as long each register has an owner and is stored with its corresponding secured USB storage devices.

### 3.2 Security of Control Systems Software

Under no circumstances is any Control Systems maintenance and configuration software to be copied onto third party machines or supplied to unauthorised personnel.

Only authorised Control Systems Design personnel are permitted to make application data changes, configuration changes and software changes in accordance with the relevant procedures.

### 3.3 Control Systems Workstations and Servers

At no time shall any workstation or server associated with the control system be connected to any external network and must not be used for anything other than its intended purpose. This also includes the installation of unauthorised software or applications on any of the Control Systems workstations.

### 3.4 Security of Network Peripheral

Under no circumstances shall unauthorised network device, workstation, or server be connected to the Control System wide area network or local area network.

Only authorised Control Systems personnel are permitted to make network configuration and software changes in accordance with the relevant procedures.
4 System Maintenance

Licensed signalling personnel are responsible for the safe and reliable operation of their systems.

As a minimum, licensed signalling personnel shall perform the periodic inspection, test and maintenance tasks as stipulated in the approved Technical Maintenance Plans and Manufacturers manuals.

Additionally, licensed signalling personnel shall be vigilant for potential equipment problems whenever the opportunity permits.

Control Systems inspection, test and maintenance requirements include five specific tasks:

- Examination of all Control System components, as applicable including: power supplies, transmitters, receivers, network switches, workstations, servers and peripherals.
- Recording of power supply voltages and settings
- Data and software logging
- Dip switch setting and
- Address logging

Licensed signalling personnel shall make themselves aware of the relevant equipment manuals and specifications for each type of equipment which they are required to maintain.

4.1 Control Systems Equipment Examination

The objective of testing and examining Control Systems is to find and remove any potential failure condition, and ensure a high availability of all control systems equipment infrastructure and associated systems.

Any condition found with the potential to reduce the reliability of any item of Control Systems equipment shall be actioned immediately if practicable, or otherwise brought to the notice of the relevant Maintenance Control Systems Engineer and rectified as soon as possible.

Control Systems personnel must touch earthed metalwork with both hands before replacing any rack mounted equipment or preferably use an earth strap.

Equipment that is not in good physical condition or has loose parts must not be used; it must be treated as defective.

All modules, cardfiles or pluggable equipment must be firmly (but carefully) pushed into position and fully secured (ensure use of securing screws or clasps if provided) and an operational check is to be performed to ensure the equipment is working as per design.

4.2 Defective equipment

Any condition found with the potential to cause a failure shall be actioned immediately, and the Maintenance Control Systems Engineer notified accordingly.

Defective equipment shall be tagged with the date, defect, and location and returned for repair in accordance with the procedures required by the manufacturer.

The original module should be restored prior to further testing if a replacement module did not correct the fault.
After any equipment has been removed or changed, the inputs and outputs to that equipment shall be checked for correct operation by exercising a sample of each function and observing the correct operation of any indication LEDs provided on the panel face.

4.3 Insulation Testing

Care is to be taken that wiring connected directly to any Control Systems equipment is not insulation tested whilst the modules or connectors are plugged in. Testing must be carried out on wiring isolated by the removal of connectors, plug coupler, fuses and links.

Please refer to PR S 40023 Insulation Inspection and Testing for further information regarding the requirements for insulation inspection and testing requirements.

4.4 Repair

Field repairs are not to be carried out on any Control Systems products including plug-in modules, cardfile(s), modems, switches, servers, workstations or any other computer peripherals. These items must be returned to the manufacturer, or their agent, for repair.

All reasonable attempts are to be made to remove any sensitive information on equipment being sent to the manufacturer for repair.

Note for hard drives follow procedure IS-SGD-70125 for secure destruction.

4.5 Analysis of Application and System Logs

Any errors from the logs that indicate a possible system or reliability related problem are to be referred immediately to the relevant Maintenance Control Systems Engineer for action.

5 Handling and Storage

Boards and modules must be handled, transported and stored with care and not subjected to damage or deterioration.

The boards and modules must be stored on racks in enclosed housings in a clean, dry and non-corrosive environment below 60°C.

Anti-static protection handling procedures must be applied when handling boards and modules.

6 Tools and Test Equipment

Tools and test equipment used on Control Systems must be Sydney Trains approved or otherwise deemed acceptable by and in conjunction with the manufacturer. For example, only specified devices will be used for monitoring or interrogating a server.

Conventional test equipment such as multimeters and oscilloscopes are to be used only where they do not pose a risk to the functional safety of the system.

Inappropriate use of test equipment and test leads can potentially bridge-out or bypass safety functions, resulting in a false input and consequently, an unsafe output. Test equipment can also potentially force an output to produce a less restrictive situation.

Testing shall be carried out in accordance with SPG 0711.4 Inspection and Testing Procedures.
7 Control Systems Work Instructions

As a general requirement:

a) Any equipment must be properly configured prior to being put into operational use.

b) The Maintenance Control Systems Engineer is to be notified of any replacement of any Control Systems equipment.

c) If retrieval of the logs is required after a system is removed, then this must be carried out prior to removal from service.

d) Any defective equipment is to be tagged with the date, defect and location. Defective equipment shall be returned for repair in accordance with the procedures required by the manufacturer.

7.1 Replacement of a Control Systems Domain Controller

A domain controller shall be replaced as a single unit.

This configuration change is to be performed by a Control Systems Engineer or Control Systems Technician.

When restoring a domain controller from a full backup image, there are several potential issues that may arise when restoring this way:-

1. Restoration of the relative identifier (RID) master can result in the corruption of the active directory database

2. Restoration of the schema master (SID) can result in orphaned objects

Therefore, as long as there is a working domain controller in the infrastructure, you shall recover from domain controller failure by building a server from base; promote the newly configured server to a domain controller, and allowing Active Directory replication to update it to the current state.

Detailed step by step procedures for the replacement of domain controllers servers are provided within PR S 40011 FMXX – PR S 40011 FMXX

7.2 Replacement of a Control Systems Server

A Server shall be replaced as a single unit.

This configuration change is to be performed by a Control Systems Engineer or Control Systems Technician.

Where applicable, where the server is a dual sided system that all software applications and telemetry systems is to be switched to the operational server and arbitration set to manual as applicable to the system requirements.

Detailed step by step procedures for the replacement of the relevant control system servers are provided within PR S 40011 FMXX – PR S 40011 FMXX.
7.3 Replacement of a Control Systems Operator or Maintenance Workstation

This configuration change is to be performed by a Control Systems Engineer or Control Systems Technician.

Where applicable, and available, ensure that the operator has taken control and has full functionality of the workstation prior to replacing or reconfiguring the workstation.

Detailed procedures for the replacement of the relevant operator or maintenance workstations are provided within PR S 40011 FMXX – PR S 40011 FMXX.

7.4 Replacement of a Telemetry System in automatic areas

Telemetry Systems shall be replaced as a singular or as multiple modules (provided they have been labelled and the order of reinstallation can be confirmed).

This configuration change may be performed by licenced personnel.

Where applicable where the telemetry system is dual sided, that the side not affected of the change is master, and depending on system requirements, the system is set to auto or manual.

NOTE: The modems for a Dupline telemetry system is required to be the same version for both the master and slave.

A detailed procedure for the replacement of a Dupline, Kingfisher and IMAC telemetry system is provided within PR S 40011 FMXX.

7.5 Replacement of a Control Systems Network devices (Hard Wired Non-Vital System)

This configuration change shall be performed by licenced personnel.

Where applicable where the network system is dual sided, that the side not affected of is to be confirmed healthy prior to disconnecting the link. A detailed procedure for the replacement of a Routers, Switches and Firewalls is provided within PR S 40011 FMXX.

7.6 Replacement of a Control Systems Cable (G32, Ethernet, Fibre, Copper)

Control Systems cables must be carefully removed and re-installed (where required) ensuring any other cabling and equipment is not adversely impacted/damaged prior to being put into operational use.

Cable replacement shall be performed by a Control Systems Engineer or Control Systems Technician.

A detailed procedure for the replacement of a G32 cables is provided within PR S 40011 FMXX. This instruction may be used for other cable replacement applications.

Defective cable/s are to be to be removed from site and disposed of in an approved manner.

Please refer to PR S 40012 for further information in replacing a G32 cable.
7.7 Replacement of Tunnel Management System

This configuration change may be performed by a Control Systems Engineer or Control Systems Technician.

A detailed procedure for the replacement of a Tunnel Management System is provided within PR S 40011 FMXX.

7.8 Replacement of OSS

This configuration change may be performed by a Control Systems Engineer or Control Systems Technician.

Where applicable, where the server is a dual sided system that all software applications to be switched to the operational server before shutting down the server.

A detailed procedure for the replacement of an OSS is provided within PR S 40011 FMXX.

8 Equipment Specific Issues

8.1 General

The indicator LEDs provided on the equipment are not fail safe. The LEDs provide diagnostic information and aid. The passive state of an indicator LED is not sufficient as the sole information for a critical test.

As part of the replacement of a Server or Workstation a Control Systems Engineer or Control Systems Technician is permitted to:

- Re-image the new device.
- Check and set any adjustable items as per the maintenance manual.
- Remove and install equipment as detailed on an approved design (for new or renewal works).

Licensed Control Systems personnel are permitted to:

- Replace failed Network Switches, KVMs, Telemetry units with pre-programmed spares as detailed on an approved design and peripheral equipment.

8.2 Plug couplers/ Connectors/ USB connections

The indications on module/cardfile front panel LEDs are based on the external wiring plugged into the module/board, and not the board position. If the external connectors are swapped between modules of the same type then the LEDs on the modules will have swapped meanings.

Licensed Signalling personnel must be vigilant during the process of disconnection and reconnection of any plug coupler or connector. Labelling of disconnected cables, couplers and connectors must be undertaken to control the risk of incorrect insertion.

Cable connector pins must be checked for damage (bent pins) prior to insertion. Plug couplers must be carefully installed ensuring alignment with the coupler and orientation prior to insertion.

Prior to returning to operation a check must be performed ensuring the correct bits are active.
8.3 Network Switches (Network Peripherals)

The replacement of a Core Network Switch must be performed by a Control Systems Engineer in conjunction with ESI Signalling & Control Systems IDC team.

Note: Replacing a Core Network Switch affects multiple control panels.

8.4 Power Supplies

Some power supply units have dip switches that can be toggled between varying output voltages. A check to ensure the correct output voltage must be undertaken prior to bringing into service.

Power supplies that are either hot swappable, or have a mains cable can be replaced by a Control Systems Technician.

If the power supply has screw terminals, than a licensed signal electrician is required to assist with the disconnection of the power supply before replacing the power supply.

All cables must be labelled prior to disconnection and re-connected ensuring correct polarity.

8.5 Workstations

Some workstations may be large/bulky with uneven distribution of weight and positioned in enclosed difficult to reach areas. There may be WHS issues associated with the equipment's removal and re-installation.

8.6 Peripherals

8.6.1 Monitors

When installing new monitors, a check to ensure the correct screen setting must be undertaken. A check to ensure correct:

a) Screen resolution
b) Colour mapping, and
c) Alignment.

8.6.2 Keyboard, Mouse

Prior to any equipment installations the network controller must be informed of any disruption to their working area and the expected time to complete restoration.

Cable connector pins must be checked for damage (bent pins) prior to insertion. Plug couplers must be carefully installed ensuring alignment with the coupler and orientation prior to insertion.

8.7 Eastern Standard and Eastern Daylight Time

All Control Systems equipment (enabled systems) clocks are to be set to Eastern Standard Time (EST) and must sync to the Sydney Trains system servers.

8.8 Powering Down of equipment

Control Systems equipment must be powered down as detailed by their specific product manual/maintenance manuals.
9 Software and Data Management

The management, distribution and version control of Control Systems software, firmware and data issued and installed in the field is to be in accordance with the system management process.

Control Systems software and data is only to be kept in storage locations managed by and detailed in the system management process, and relevant build documentation.

The supply of pre-programmed Servers, Network Switches, Workstations, along with other critical spares is to be considered by the Commissioning Engineer of a re-signalling project. The Commissioning Engineer, or nominated representative, is to liaise with the relevant Control Systems Asset Engineer and Maintenance Control Systems Engineer to determine spares requirements based on requirements.

In an operational control system, the Maintenance Control Systems Engineer is to determine the requirement for pre-programmed spares, considering system redundancy, operational criticality and any previous incidents at that interlocking.

Pre-programmed spares are to be appropriately labelled to ensure version control and to ensure they stored appropriately.

10 Failure Reporting

It is important that all failures and problems with any Control Systems product is carefully recorded so that an accurate assessment can be made of the reliability of the system.

Information to be recorded as part of a failure report includes:

- Fault observed
- Error codes reported in any error log(s)
- Faulty modules/items replaced
- Possible contributing factors to the fault

Failure reporting is as per the normal signalling failure reporting procedure in accordance with PR S 40004.