Sydney Trains

Engineering System Integrity

Engineering Manual

Signalling and Control Systems

Signalling Safeworking

MN S 40000

Signalling Safeworking Procedures

Version 2.4

Date in Force: 20 October 2023

Approved by:	Professional Head Signalling and Control Systems Engineering System Integrity	Authorised by:	Engineering Technical Publications Manager System Integrity

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Document control

Version	Date	Author/Prin. Eng.	Summary of change
1.0	16 September 2013	Y Bagaric	First issue as a Sydney Trains document
1.1	29 November 2013	Y Bagaric	Updated Document Number for Failures
1.2	3 March 2015	M Albrecht	Withdraw 40037 Microtrax and Update documents 40025, 40031 & J048
1.3	2 July 2015	C Darmenia	Update 40032 and replace J049 with 40049
1.4	1 July 2016	R Del Rosario	Title changes & remove 40015, 40018, 40033, 40037, 40041 & 40043
1.5	21 October 2016	C Darmenia	Update 40004, 40023 and 40049
1.6	20 February 2017	C Darmenia	Update 40010, 40011, 40026, 40030 & 40047
1.7	5 July 2017	C Darmenia	Update 40003, 40008 and remove 40021
1.8	10 January 2018	C Darmenia	Update 40025 and 40027
1.9	24 January 2018	C Darmenia	Update 40002 (title change), 40006 and 40009
1.10	1 March 2019	A Sozio	Update 40001, 40004, 40005, 40008, 40010, 40011, 40012, 40014, 40020, 40044, 40048 to meet Control Systems changes. Added 40050. Capture Updates to 40039 and 40047
2.0	8 March 2019	C. Darmenia	New 40028 and update 40004, 40005, 40009, 40010, 40011, 40012, 40014, 40017, 40023, 40026, 40032, 40042 for ATP. Reformat Table. Update 40027
2.1	17 December 2020	C. Darmenia	Update 40004, 40005, 40008, 40009, 40026, 40028 for ASDO, ATP and Control Systems. Capture previous updates to 40013, 40016, 40019 and 40022. Correct 40048 version
2.2	27 June 2022	C. De Sousa	Added docs to Index, updated summary of change table, updated title of PR S 40001, updated index description, updated Prof Head's name
2.3	14 February 2023	Paul Zammit	Update index for changed procedure titles
2.4	20 October 2023	Paul Zammit	Update index for changed procedure titles

Summary of changes from previous version

Summary of change	Section
Update PR S 40004 V3.0 to V3.1	
Update PR S 40005 V1.3 to V1.4	
Update PR S 40008 V2.1 to V2.2	
Update PR S 40009 V1.2 to V1.3	
Update PR S 40013 V1.1 to V1.2 issue date 9 March 2020	
Update PR S 40016 V1.1 to V1.2 issue date 9 March 2020	
Update PR S 40019 V1.1 to V1.2 issue date 9 March 2020	
Update PR S 40022 V1.1 to V1.2 issue date 9 March 2020	
Update PR S 40026 V2.0 to V2.1	
Update PR S 40028 V1.0 to V2.0 and title change	
PR S 40048 correct version number to V1.2 for issue date of 8 March 2019	
Added PR S 40051 and PR S 40052 to Index	
Update index for changed procedure titles: *PR S 40003 Derailments, Collisions and Major Incidents* *PR S 40006 Manual Release of Interlockings* *PR S 40007 Seldom Used Signalling Equipment*	
Update index for changed procedure titles: PR S 40016 *Liaison with Signallers & ICON Infrastructure, and Authority to Operate Signalling Controls*	

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1 Index

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 details the safeworking and safety critical maintenance requirements to be followed when dealing with the various situations as listed below:

Applies to			Document No	Title
Sig Elec & Sig Eng'r	CS Tech & CS Eng'r	Mechanical & Ancillary		
✓	✓	✓	PR S 40001	Introduction to Signalling Safeworking Procedures
✓			PR S 40002	Temporary Bridging of Signalling Circuits
✓	✓	✓	PR S 40003	Derailments, Collisions and Major Incidents
✓	✓	✓	PR S 40004	Failures
✓	✓	✓	PR S 40005	Damage to Signalling Equipment Including Cables
✓			PR S 40006	Manual Release of Interlockings
✓		✓	PR S 40007	Seldom Used Signalling Equipment
✓	✓	✓	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 40012	Repair/Replacement of Signalling Wires
✓			PR S 40013	Field Paralleling of Signalling Contacts
✓	✓		PR S 40014	Control of Signalling Documentation Issued to the Field
✓	✓	✓	PR S 40016	Liaison with Signallers & ICON Infrastructure, and Authority to Operate Signalling Controls
✓	✓	✓	PR S 40017	Maintenance Responsibilities and Frequencies
✓		✓	PR S 40019	Cleanliness and Lubrication of Mechanical Signalling Equipment
✓	✓	✓	PR S 40020	Security, Fire Protection, Weather Proofing and Cleanliness of Signalling Equipment, Housings and Locations
✓			PR S 40022	Inspection and Testing of Signalling Interlockings
✓			PR S 40023	Insulation Inspection and Testing
✓			PR S 40024	Vital Signalling Relays

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Applies to			Document No	Title
Sig Elec & Sig Eng'r	CS Tech & CS Eng'r	Mechanical & Ancillary		
✓			PR S 40025	Track Circuits
✓			PR S 40026	Re-railing - Precautions to be Taken
✓			PR S 40027	Traction Return (1500V DC)
✓			PR S 40028	ETCS L1 - Alstom Trackside Equipment
✓		✓	PR S 40029	Point Lock Testing - Mechanical
✓		✓	PR S 40030	Point Lock and Detection Testing on Power Operated Points
✓		✓	PR S 40031	Maintenance of Signal Sighting and Signals
✓			PR S 40032	Solid State Interlocking (SSI) and Smartlock 400T
✓		✓	PR S 40034	Temporary Storage and Despatch of Staffs and Operational Keys
✓		✓	PR S 40035	Use of XL Keys, Master Keys and Staffs
✓		✓	PR S 40036	Level Crossings
✓			PR S 40038	Microlok II Computer Based Interlocking
✓			PR S 40039	Westrace Computer Based Interlocking
✓	✓	✓	PR S 40040	Use of Radio Transmitters Near Electronic Signalling Systems
✓	✓	✓	PR S 40042	Safety Issues for Signalling Personnel
✓	✓		PR S 40044	General Signalling Maintenance Management, Administration and Supervision Responsibilities
✓			PR S 40045	Surveillance Inspections
✓	✓		PR S 40046	Guidelines for the Safe Use of Temporary Recording, Monitoring and Logging Equipment on Signalling Systems
✓	✓	✓	PR S 40047	Calibration of Tools and Instruments for Signalling Applications
✓	✓	✓	PR S 40048	Signalling Locations and Equipment – Security Locks and Keys
✓	✓		PR S 40049	Signal Engineering Deviations
✓	✓		PR S 40050	Control Systems
✓			PR S 40051	Axle Counters
✓			PR S 40052	WSP 2G Computer Based Interlocking

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Engineering System Integrity

Engineering Procedure

Signalling and Control Systems

Signalling Safeworking

PR S 40001

Introduction to Signalling Safeworking Procedures

Version 3.0

Date in Force: 20 October 2023

Approved by:	Professional Head Signalling and Control Systems Engineering System Integrity	Authorised by:	Engineering Technical Publications Manager System Integrity

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Document control

Version	Date	Author	Summary of change
1.0	16 September 2013	K Bush	First issue as a Sydney Trains document
1.1	21 September 2016	R Del Rosario	Updated for new titles and roles and review to mandatory ASA requirements
1.2	8 March 2019	A Sozio	Updated for new titles and roles in line with Control Systems personnel
1.3	15 July 2021	Ian Maydew C Darmenia	Updated to include axle counter requirements
2.0	13 April 2023	Paul Zammit Mohammed Khan	Define role of Regional Signal Engineer Remove redundant requirements
3.0	20 October 2023	Paul Zammit Mohammed Khan	Add Reference section Update document references

Summary of changes from previous version

Summary of change	Section
Add "Reference" section (all other sections moved down in order).	1
Update document reference from GL S 41551 to IA S 09001	1 5
Replaced *Asset Management Branch* with *Transport* in regard to engineering principles, standards, etc.	7.1

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Table of Contents

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1 Reference documents

This procedure shall be read in conjunction with the following documents:

Signalling Safeworking Procedures

- *PR S 40002 Temporary Bridging of Signalling Circuits*
- *PR S 40004 Failures*
- *PR S 40006 Manual Release of Interlockings*
- *PR S 40011 Renewals Work*
- *PR S 40014 Control of Signalling Documentation Issued to the Field*
- *PR S 40044 General Signalling Maintenance Management, Administration and Supervision Responsibilities*
- *PR S 40047 Calibration of Tools and Instruments for Signalling Applications*

Inspection and Testing Procedures

- *PR S 47110 Inspection and Testing of Signalling: Introduction*
- *PR S 47111 Inspection and Testing of Signalling: Roles, Responsibilities and Authorities*

Training and Competency Documents

- *MN S 41412 Process for Signals and Control Systems Personnel Authorisations and Licensing*
- *RG S 41415 Signalling Personnel – Licensing and Authorisation Status*

Transport Standards

- *T HR ST 07111 ST Mandatory requirements for New or Altered Signalling*

Interface Agreements

- *IA S 09001 Signals, Operational Technology and Control Systems*

2 Introduction

Signalling safeworking procedures are owned and operated by Sydney Trains as the operator and maintainer rail infrastructure manager (RIM) for the Sydney Trains rail network.

These procedures enable Sydney Trains to meet its obligations in accordance with the Rail Safety National Law, as published by the Office of the National Rail Safety Regulator (ONRSR).

3 Purpose

The purpose of signalling safeworking procedures is to prescribe to signalling personnel the essential requirements, standard practices and instructions, that ensure the signalling system performs reliably and with integrity; thus, allowing rail traffic to operate safely and reliably on the network.

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4 Scope

The signalling safeworking procedures prescribe the requirements for work that can affect the safe operation and reliability of the signalling system, inclusive of all its subsystems and components. The scope extends to include any impacts caused to rail traffic and users at level crossings when the system is worked-on by signalling personnel.

For the most part, the signalling safeworking procedures do not include the onboard portions pertaining to the automatic train protection or the automatic selective door operation systems.

The signalling safeworking procedures do not include matters relating to worksite protection.

5 Application

For the purpose of these signalling safeworking procedures, the term 'signalling' shall encompass any work associated with both signalling and train control systems (known as control systems, and in some cases, train management systems). This requirement is irrespective of whether the signalling work is being conducted by such persons directly employed by Sydney Trains, engaged by Sydney Trains or engaged by other entities to work on the Sydney Trains network. Such entities include project delivery RIMs, Technically Assured Organisations (TAO) and service providers.

The principles and requirements in these procedures apply to both signalling and control systems equipment. Wherever there is a reference to a signal engineer or a maintenance signal engineer, the requirements (as applicable) shall also apply to the control systems engineer for control systems equipment. Similarly, the reference to licensed signalling personnel shall apply to control systems technicians for control systems equipment. See *IA S 09001 Signals, Operational Technology and Control Systems* existing interface diagrams for interface boundaries.

Signalling safeworking procedures shall be read in conjunction with other documents, such as engineering instructions and advices, inspection and testing procedures, control systems procedures, other Sydney Trains engineering procedures, transport standards, maintenance manuals and so on, as applicable.

Signalling safeworking procedures shall also be read in conjunction with network rules and procedures. Such documents provide instruction for work that affects the operation of signalling to ensure the work is carried out safely. The signalling safeworking procedures are intended to complement such requirements and are in no way meant to supersede them.

6 Requirements for signalling personnel

Signalling personnel shall comply with signalling safeworking procedures, and the relevant network rules and procedures as applicable.

Signalling personnel shall have access to signalling safeworking procedures and familiarise themselves with the requirements, including any associated or referenced standards. They shall keep up to date with any changes that apply, including any engineering instructions and advices that are published from time to time. Signalling personnel shall gain an understanding of the principle intent of the changes.

Users of the signalling safeworking procedures shall promptly advise the Engineering Technical Publications Manager of any perceived omission, error, ambiguity, inconsistency or lack of clarity with the procedures, as well as recommending suggestions for improvement.

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7 Roles and responsibilities of signalling personnel

For the purpose of signalling safeworking procedures, the term 'licensed signalling personnel' shall refer 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, and so on. Unless otherwise stipulated, these roles mean such duty holders are trained, qualified, competent and licensed to perform the specific tasks referred in the context of the procedures.

Additionally, the term 'authorised signalling personnel' shall refer to persons trained, qualified competent and authorised to perform specific signalling works within an operational signalling environment without supervision.

All personnel shall act and perform signalling work only within their delegated area of authority as prescribed by their certificate of competency and signalling permit to work. Persons who are not competent and suitably licensed shall not interfere with operational signalling equipment. Additionally, persons who are not licensed or authorised shall 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 shall 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.*

7.1 Professional Head Signalling and Control Systems

The Professional Head Signalling and 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 Transport for NSW and Sydney Trains engineering principles, standards, specifications, manuals, instructions and guidelines.

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

7.2 Principal Engineer Signalling Integrity

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

7.3 Signal Engineering Manager

The Signal Engineering Manager is the senior signal engineer within Network Maintenance Division. The position is responsible for the safety and integrity of the signalling infrastructure within the Sydney Trains infrastructure network to meet all relevant standards and procedures.

Unless otherwise stipulated, the engineer may delegate various tasks specified to them in these procedures to the maintenance signal engineer within their area of responsibilities. However, in doing so, this does not dispense with the responsibilities. A document stating the responsibilities delegated to others in accordance with these signalling safeworking procedures shall be kept by the Signal Engineering Manager to ensure all persons clearly understand their delegated responsibilities.

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7.4 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 Operations 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, this does not dispense with the responsibilities. A document stating the responsibilities delegated to others in accordance with these signalling safeworking procedures shall be kept by the Control Systems Operations Manager to ensure all persons clearly understand their delegated responsibilities.

7.5 Regional signal engineer

The regional signal engineer is the senior signal engineer within the network maintenance region. The regional signal engineer oversees the functions allocated to associated maintenance signal engineers to ensure a consistent application of requirements and continuous improvement.

The position is responsible for managing the integrity and reliability of signalling assets within the region. Such responsibilities include representation for projects, engineering initiatives and incident recoveries, advocating issued engineering instructions and advices to signalling personnel within their region.

Additionally, the regional signal engineer manages any local reliability projects, analyses failure data and trends, oversees and monitors assurance and compliance activities, provides feedback for type approval assessment, reviews safe-work instructions, technical maintenance plans and signalling safeworking procedures, and provides recommendations.

7.6 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.

The maintenance signal engineer may delegate various tasks specified to them in these procedures to licensed signalling personnel within their area of responsibilities. However, in doing so, this does not dispense with the responsibilities. A document stating the responsibilities delegated to others in accordance with these signalling safeworking procedures shall 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.

7.7 Signal asset engineer

The 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 engineers is responsible for the following tasks:

- Managing project interface coordination plans.
- Reviewing delivery of new and altered signalling works.

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- Notifying maintenance signalling personnel of any changes to signalling infrastructure.
- Arranging for post commissioning attendance and activities.
- Managing the control of approved design documentation.
- Managing configuration control process and configuration management changes and manage and ensure signalling asset registers reflect the installation.
- Managing configuration management (update documentation and databases) to ensure records accurately reflect existing assets.
- Interfacing with the network base production planner, or otherwise ensure that maintenance scheduled tasks (MST) are correctly setup or removed, as applicable when new assets are commissioned or removed.

7.8 Commissioning engineer

The commission engineer role is defined in *PR S 47111 Inspection & Testing of Signalling: Roles, Responsibilities and Authorities*.

7.9 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 signalling 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 personnel shall be assessed as competent by an approved process for the intended work and shall only perform signalling work within their delegated area of authority. The different licensing levels are described in detail in *MN S 41412 Process for Signalling and Control Systems Personnel Authorisations and Licensing*.

7.10 Authorised signalling personnel

Authorised signalling personnel are persons who are not licensed but are authorised and deemed 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 and signalling permit to work. Such work shall not interfere with operational signalling equipment.

Authorised signalling personnel may perform or lead testing and certification of signalling in accordance with their delegated area of authority and signalling permit to work. The affected signalling shall be booked out of use and disconnected from operation by a licensed signalling person before the testing work can proceed.

There are different authorisation levels for authorised signalling personnel, these are described in detail in MN S 41412.

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8 Basic signalling safeworking requirements

The requirements for specific situations and equipment types are prescribed in the relevant sections of signalling safeworking procedures.

The following list highlights some of the basic requirements for when maintaining the signalling system:

- The installed signalling system and its components shall be maintained to prevent signalling system failures and associated train delays, and to ensure the safety and reliability afforded by the system is maintained throughout its operational life.
- Failed signalling equipment shall be attended and restored for operational use without undue delay.
- Details of signalling maintenance, signalling failures and signalling irregularities shall be recorded and analysed to determine any corrective action necessary, and to ensure signalling safety and reliability levels are maintained.
- Only licensed signalling personnel, using governed practices, test equipment, tools, materials and equipment can maintain the operational signalling system or its components. Test equipment and tools in use to be in proper working order.
- Persons who are not licensed or authorised do not have access to signalling equipment and enclosures except under the supervision of a licensed or authorised signalling personnel, or otherwise as permitted in accordance with stipulated conditions.
- Only licensed signalling personnel or persons directly supervised by licensed signalling personnel can disconnect or connect to the operational signalling system equipment and circuits.
- The movement of trains shall be adequately protected when any maintenance action or other interference impairs or could impair the protection afforded by the signalling system or affect the safety of the line.
- Where the interlocking is disarranged or vital signalling equipment is disconnected from the interlocking, is disassembled or has safety critical adjustments altered, its safe operation shall be certified fit before restoring the signalling for operational use.
- Signalling equipment which has failed in an unsafe manner shall be taken out of service and the affected train movements immediately protected.

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

  Subject to the former, should the signalling equipment be defective in any manner, such that it potentially endangers rail operations or users at level crossings, it shall be immediately repaired or replaced if practical. If it cannot be immediately repaired or replaced, its operation shall be discontinued, and the rail operations protected. Details shall be immediately reported to ICON Infrastructure and relevant signal engineers as applicable.
- When any function of the signalling system affecting traffic operations is taken out of service, the signaller shall be advised.
- Manual releases of the interlocking shall be given only as prescribed.
- Axle counter resets shall be done only as prescribed.
- Temporary bridging of contacts or circuits shall be carried out only as prescribed.

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- Trainstops shall be manually lowered or suppressed for operational purposes only as prescribed.
- Where locking facilities are normally provided, the signalling equipment shall be kept locked to prevent unauthorised interference.
- Alterations or additions to the configuration of the signalling system or its components shall not be made unless authorised in accordance with requirements.
- Whenever the signalling system requires additions or modifications, then the requirements of *T HR SC 07111 ST Mandatory requirements for New or Altered Signalling*, *PR S 47110 Inspection and Testing of Signalling: Introduction* and signalling safeworking procedures shall be observed.
- Prior consultation with the Professional Head Signalling and Control Systems is required before any aspect of the operational signalling system, vital or non-vital, that could affect the safety 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 and Control Systems is not required for like for like renewals where the equipment is replaced with an exactly identical item or otherwise allowed in the *PR S 40011 Renewals Work*. Signal engineers are delegated to make determinations whether renewal work can be treated as a like for like renewal where items are not exactly identical. Like for Like Renewal determinations and work shall be in accordance with PR S 40011.
- Signalling plans, diagrams and circuit books for operating and maintenance use shall be available to those who need them to carry out their duties and be maintained up to date.
- Off-site repair and overhaul of vital signalling equipment shall 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.
- Temporary repairs of vital signalling equipment shall be done to an acceptable and safe standard, and procedures shall 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.
- Malicious damage or interference to vital signalling equipment or circuits shall be reported promptly to the maintenance signal engineer or ICON Infrastructure.
- Test equipment for measuring signalling system safety and reliability parameters shall be calibrated where required to verify acceptance/rejection criteria.

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Engineering System Integrity

Engineering Procedure

Signalling and Control Systems

PR S 40002

Temporary Bridging of Signalling Circuits

Version 3.0

Date in Force: 10 November 2022

Approved by:	Professional Head Signalling and Control Systems Engineering System Integrity	Authorised by:	Engineering Technical Publications Manager System Integrity

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1.0	16 September 2013	Y Bagaric	First issue as a Sydney Trains document
2.0	24 January 2018	C Darmenia	Restructured procedure, updated to new titles and roles and updated to mandatory ASA requirements
3.0	10 November 2022	Paul Zammit/Mohammed Khan	Update complete procedure to clarify, streamline and improve requirements

Summary of changes from previous version

Summary of change	Section
Update content to Asset Standards Style Manual	All
Reorder and add new sections and paragraphs to streamline the sequence and requirements in line with the logical process of temporary bridging	All
Clarify existing requirements to remove ambiguity	All
Update references to related procedures and forms - active forms are now separated from procedure (not part of an appendix)	1
Introduce requirements for temporary bridging of ESML/EOL, half pilot staffs, blocking key releases or other such releasing devices	2, 5.2, 5.3
Limit option for the storage and registering of jumper wires to a locked box	4.1
Clarify requirements for accounting of all jumper wires whenever jumper wires are returned to the person delegated with their safekeeping	4.1, 9
Create new section titled '*Booking equipment out of use*'	5
Brought forward the section titled '*Infrastructure booking authority*', so it is read before the application of temporary bridging	5.1
Define separate requirements for booking-out and disconnecting of equipment with temporary bridging applied, as well as for booking-out and disconnecting the protecting signals	5.2, 5.3
Clarify provision of permitting protecting signals to operate while temporary bridging is applied, including level crossings, ESML/EOL, half pilot staffs, blocking key releases or other such releasing devices	5.3
Add new section titled '*Application of temporary bridging*' to incorporate temporary bridging authority requirements (including testing requirements) from PR S 40009	6
Define testing requirements when applying and removing temporary bridges	7, 9
Introduce requirements for trailing points which have detection temporarily bridged so to be (in addition to facing points) XL locked and spiked where temporary bridging is left unattended. Additionally, EOL/ESML cabinets are locked with Falcon 8 locks during such unattendance.	8
Clarify '*special requirements*' for project works complex trackwork support and complex renewals works	10
Add '*signal engineer involved with the work*' for managing suitable process when temporary bridging applied to non-vital circuits	11

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Table of Contents

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1 Reference documents

This procedure shall be read in conjunction with the following documents:

Signalling Safeworking Procedures

- *PR S 40004 Failures*
- *PR S 40006 Release of Track Locking or Indication Locking*
- *PR S 40007 Apparatus Seldom Used*
- *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*

Signalling Safeworking Forms

- *PR S 40002 FM01 Authority for Temporary Bridging of Contacts*
- *Network Rules and Procedures*
- *NPR 704 Using Infrastructure Booking Authorities*
- *NRF 003 Infrastructure Booking Authority (IBA)*

Transport Standards

- *SPG 0711 3 Inspection and Testing Principles*
- *SPG 0711.4 Inspection and Testing Procedures*

2 Principles and rules for temporary bridging

WARNING
Bridging or false feeding is permissible only by exception

Temporary bridging is permitted only in circumstances where it is necessary to minimise the disruption to rail traffic or users of level crossings, caused when signalling equipment becomes damaged, disconnected, or disarranged.

Temporary bridging shall be done only in accordance with these procedures or otherwise as specifically determined by the Principal Engineer Signalling Integrity.

False feeding or the over-adjustment of contacts is a form of bridging and the requirements of this procedure similarly apply.

Note:
Temporary bridging does not include bridging which is hand held and momentarily applied for the purpose of providing a release. The procedures prescribed in *PR S 40006 Release of Track Locking or Indication Locking* shall be followed for these situations.

The application of temporary bridging shall always require that the protection defeated is provided by an effective alternative means. Additionally, that adequate testing is conducted to satisfactorily prove the effectiveness of those contacts intended to remain unbridged in the circuit.

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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 equipment from properly returning to a more restrictive position or locking position.
- Where it allows unprotected signalling equipment to operate to a less restrictive or unlocked position when it is not safe to do so.

Temporary bridging shall generally be confined to the bridging of closed contacts of trackside signalling equipment that indicate the locked, fail-safe position of the equipment. For example, the Normal or Reverse detection contacts of points, the Normal detection contacts of trainstops, the Normal detection contacts of level crossing boom/gate mechanisms, the Normal detection of ESML/EOL, half pilot staffs, blocking key releases or other such releasing devices, or the Normal Indicating contacts of signals.

Temporary bridging shall not be applied for the purpose of suppressing an ETCS trainstop function.

Temporary bridging shall also not be applied to the trainstop of a signal that protects a series of suppressed trainstops (typically this is the signal immediately leading towards the first suppressed trainstop). The trainstop at such protecting signal shall remain in the raised position.

The temporary bridging of circuits/contacts shall be limited only to the failed or removed equipment, or where the work will cause an unacceptable impact to train running.

Signalling equipment associated with temporary bridging shall be booked out of use and disconnected as applicable, in accordance with Section 5.

The jumper wires used for temporary bridging shall be connected as close as possible to the equipment concerned without them being disturbed by the work. In many cases, this may be the closest equipment housing. The bridging authority form and accompanying circuit diagram shall reflect this arrangement.

The portion of circuit that directly leads to contacts that are temporarily bridged shall be disconnected so that the work does not interfere with the live portion of the circuit. This disconnection shall be shown on the accompanying circuit diagram.

Where the Normal detection contacts are temporarily bridged (for example, at an end of points), the circuit that provides the Reverse detection shall be disconnected. Similarly, if the Reverse detection contacts are temporarily bridged, the circuit that provides the Normal detection shall be disconnected. This precaution also applies to other equipment, such as trainstops and level crossing mechanisms (as applicable). This disconnection shall be shown on the accompanying circuit diagram. See Section 6 for further information.

The duration that temporary bridging is applied should be limited to 16 weeks. However, any temporary bridging that is required for a longer period shall be assessed by the authorising signal engineer in consultation with the maintenance signal engineer, and a determination sought from the Principal Engineer Signalling Integrity.

The application of temporary bridging shall be led by licensed signalling personnel deemed competent to perform such activity without the requirement for supervision.

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3 Authorisation for temporary bridging

Temporary bridging may be authorised by either an approved circuit design or a temporary bridging authority form *PR S 40002 FM01 Authority for Temporary Bridging of Contacts*. The approval of this form is granted by the authorising signal engineer.

See Section 10 for special requirements, where temporary bridging is authorised by an approved circuit design.

In both cases, the maintenance signal engineer shall be notified of the temporary bridging arrangements. The maintenance signal engineer shall then advise the maintenance team responsible for the equipment, making them aware of the temporary bridging details.

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

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

3.1 Authority for the application of temporary bridging

The PR S 40002 FM01 form shall be compiled by the licensed signalling person requesting the application for temporary bridging. The form shall then be checked and signed by the authorising signal engineer when issuing the authority and again when closing-out the form once the temporary bridging is removed. A clear and legible copy of diagrams for the circuits to be bridged shall accompany PR S 40002 FM01 forms. See Section 3.2 for circuit diagram requirements.

Any required extension of time for the application of temporary bridging shall be first approved by the authorising signal engineer. The PR S 40002 FM01 form shall be updated for the extension of time.

Each PR S 40002 FM01 form issued shall be numbered with the next consecutive temporary bridging authority number. The temporary bridging authority number shall be alphanumeric and identify the office from which it is issued.

In an emergency, where the authorising signal engineer cannot reasonably issue a PR S 40002 FM01 form, the authorising signal engineer may delegate the issuing of the form to a licensed signalling person who is independent of the work. The instructions shall be transcribed for the temporary bridging as provided by the authorising signal engineer. The name of the authorising signal engineer shall suffice on the form until a signature is obtained.

The PR S 40002 FM01 form shall be progressively updated as the work progresses. Entries shall be made at the time the actions occur so to ensure the form accurately reflects the status of the temporary bridging activity.

Where the temporary bridging is left unattended or remains active over multiple shifts, a copy of the PR S 40002 FM01 form with circuit diagrams attached shall be left in the related signalling location until the temporary bridging is removed.

The maintenance signal engineer shall keep a register of issued PR S 40002 FM01 forms associated with their area of responsibility, irrespective of whether the temporary bridging authority was granted by them or another authorising signal engineer. This is to ensure that

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the maintenance signal engineer remains aware of any active temporary bridging authorities within their area of control.

A register of PR S 40002 FM01 forms shall also be kept by the authorising signal engineer, as issued by them.

At the end of the temporary bridging authority, the completed PR S 40002 FM01 form and accompanying circuit diagrams shall be returned to the authorising signal engineer who shall examine the details for completeness. Once satisfied, the authorising signal engineer shall sign and date the form and retain a copy on file. A duplicate copy shall then be forwarded to the maintenance signal engineer.

Upon receipt of the form, the maintenance signal engineer shall examine the details ensuring completeness and investigate any matters of concern. Once satisfied, the maintenance signal engineer shall sign and date their copy and retain it on file. Another copy of this form containing the maintenance signal engineer's signature may be sent to the authorising signal engineer upon request.

3.2 Circuit diagrams

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

The circuit diagram shall 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.

The disconnection of terminals in accordance with Section 2 shall be shown on the circuit diagram.

The circuit diagram shall be titled:

'Temporary Bridging for ………… equipment at ………… location on date: ……. & time: …… in accordance with Temporary Bridging Authority No: ……….'

The circuit diagrams shall be signed by the authorising signal engineer and shall accompany the associated PR S 40002 FM01 form.

The circuit diagrams shall be additionally signed by the licensed signalling person who applies the temporary bridging at the time of bridging and signed by the licensed signalling person who removes the bridging at the time of removal.

4 Jumper wires for temporary bridging

Jumper wires used for temporary bridging, when authorised by the PR S 40002 FM01 form shall be as follows:

- The conductor length is not less than 1.5 m long (see Section 6 for exception).
- The conductor is flexible (multi-stranded) with a minimum conductor cross-section of 1.5 mm2.
- The conductor insulation is rated at 0.6/1 kV standard and the colour is of bright orange unless otherwise approved by the authorising signal engineer bridging.

Note:
Wires used for temporary bridging when done as part of an approved signalling design, are in accordance with the specific design.

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The connecting lugs, plugs or clips at each end of the jumper wire shall be insulated (as far as practicable) and suitable for the application. When applied, the jumper wires shall be secured so that there is no possibility of an inadvertent connection across adjacent circuit terminals and no possibility of the wires-ends becoming loose.

4.1 Security of jumper wires

Jumper wires shall be registered and secured in a locked box when not in use.

Each jumper wire shall be accordingly labelled and uniquely identified using the depot or office name and a consecutive number. The details of such wires shall be recorded in a register. Each jumper wire shall be duly signed-out as issued and subsequently signed-in when returned, in accordance with the associated temporary bridging authority.

The locked box and register shall be held by the maintenance signal engineer, commissioning engineer or other signal engineer, as relevant. Such engineers may delegate the responsibility of the locked box containing jumper wires and register to relevant signalling team leaders; however, the accountability for the locked box and jumper wires remains with the relevant signal engineer.

Issuing of jumper wires shall be limited to the amount shown on the PR S 40002 FM01 form.

All jumper wires shall be accounted for by the person responsible for the jumper wire locked box, and if a jumper wire is lost or missing, then the details shall be reported to the maintenance signal engineer, commissioning engineer or other signal engineer, as relevant. Any jumper wire found not associated with a temporary bridging authority shall be forwarded to the relevant signal engineer advising details of the finding. Details of lost or destroyed jumper wires shall be recorded in the register.

Before use, the jumper wires shall be examined to ensure that they are clean and in good condition. When not in use on-site, the jumper wires shall be kept in a separate container away from tools and equipment and retained in the custody of the person responsible for their safekeeping during the work. A regular check shall be made to ensure that none are missing.

In an emergency, the authorising signal engineer may 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 shall write down a description of this jumper wire in the margin of the PR S 40002 FM01 form. Immediately after use, the emergency jumper wire shall be destroyed.

5 Booking equipment out of use

The signaller shall be advised of the work and the temporary bridging arrangements, and accordingly be requested to place at stop, the signals immediately protecting the equipment affected by the temporary bridging.

In the case of points intended for temporary bridging, the signaller shall also be requested to place the associated points control in the position that corresponds with the lay of the points, such that the points will not be inadvertently called by the route setting (including any automatic route setting or auto-normalisation).

Additionally, the signaller shall be requested to apply a block to such signal and point controls.

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5.1 Infrastructure booking authority

Where signalling equipment is booked out of use and temporary bridging is applied, the requirements of network procedure *NPR 704 Using Infrastructure Booking Authorities* shall apply. The temporary bridging authority number shall be entered in the space provided at Section 4 of form *NRF 003 Infrastructure Booking Authority* (IBA). The word 'BRIDGED' in brackets shall be entered against the affected equipment in the column headed "Infrastructure Equipment Details" under Section 3 of the form. For example, 'No. XYZ points (BRIDGED)'.

By fulfilling the NRF 003 form, licensed signalling personnel are certifying that the temporary bridging has been removed, the affected signalling equipment has been tested and is operating safely and correctly, and that the affected signalling is fit for operational use.

5.2 Equipment where temporary bridging is applied

The signalling equipment intended to have temporary bridging applied shall be booked out of use and disconnected in accordance with *PR S 40008 Securing Signalling Apparatus Out of Use* and *PR S 40009 Disconnection of Signalling Apparatus*. This is to prevent its operation and to secure the equipment in correspondence with the interlocking and the bridged-out position.

Where facing-end points have temporary bridging applied, the facing-end being worked-on, as well as any corresponding facing-ends, shall be clipped and SL locked.

Where trailing-end points have temporary bridging applied, the trailing end being worked-on, as well as any corresponding facing-ends, shall be clipped and SL locked.

Where temporary bridging is applied to ESML/EOL, half pilot staffs, blocking releases or other such releasing devices, the facility cabinet shall be secured using a signalling Falcon 8 lock.

5.3 Protecting signals

The signals immediately protecting the equipment where temporary bridging is applied shall be booked out of use and disconnected in accordance with PR S 40008 and PR S 40009.

However, to facilitate train running while the temporary bridging is applied, the authorising signal engineer, after due consideration of the associated risks, may permit the booking into use specific protecting signals. These are typically the signals leading over the trailing-ends of points and over the diamond-crossings on a middle road, or the home signals that are interlocked with level crossings. It may also apply to the protecting signals in other circumstances, such as where temporary bridging is applied to ESML/EOL, half pilot staffs, blocking releases or other such releasing devices.

The permission for protecting signals to operate is based on the following conditions:

- The testing requirements stated in Section 7 have been successfully performed.
- For points being worked-on, that point-clips, locks and spikes (as applicable) are applied and occasionally inspected.
- For level crossings mechanisms being worked-on, a qualified worker is assigned to manually control the crossing in accordance with the network rules and procedures (and remains at the crossing location).
- For ESML/EOL, half pilot staffs, blocking releases or other such releasing devices, that the facility cabinet is secured using a Falcon 8 lock.

- The signal engineer making the determination has suitable experience relative to the complexity of the subject matter.

Where the work involves the facing-end of points and the detection is temporarily bridged, the protecting signals that immediately lead towards such facing-ends shall remain booked out of use for the duration that the temporary bridging is applied. An exception applies where a determination to allow such protecting signals to operate has been granted by the Principal Engineer Signalling Integrity.

Additionally, 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 such a way that the safety afforded by the signalling is impaired.

6 Application of temporary bridging

Licensed signalling personnel who apply the temporary bridging shall ensure that they have fully understood the details explained to them by the authorising signal engineer, including the details of the circuit terminals or contacts that will be bridged.

The following procedure shall be followed where the detection circuit/contacts of signalling equipment are intended to be temporarily bridged.

- Correlate the portion of circuit between the cable terminals or respective detection contacts to one clear point of the intended temporary bridges. This is to ensure that only the intended portion of circuit/contacts are being bridged-out. This is done in accordance with the accompanying circuit diagram and done prior to applying the temporary bridging.
- Disconnect the portion of detection circuit that directly leads to contacts that are having the temporary bridging applied so that the work does not interfere with the live portion of the circuit. This is done in accordance with the accompanying circuit diagram and done prior to applying the temporary bridging.
- Disconnect the detection circuit that is opposite to the detection circuit/contacts intended to have temporary bridging applied (for example, disconnect the Reverse detection links where the Normal detection circuit is being temporarily bridged). This is done in accordance with the accompanying circuit diagram and done prior to applying the temporary bridging.
- Apply the jumper wires in accordance with the temporary bridging authority and accompanying circuit diagram. The detection circuit/contacts being temporary bridged shall be in direct correspondence with the actual position the equipment is in (for example, points Normal detection circuit/contacts temporarily bridged apply where the points are lying in the normal position).
- Do not bridge-out the circuit/contacts on the ends of equipment (for example, the corresponding-ends of points) that is not affected by the work.

Licensed signalling personnel shall remain in attendance on-site where points have temporary bridging applied. This is to ensure that the points are not moved for the purpose of train running, thus causing an out of correspondence with the interlocking and the bridged-out position. An exception to this rule applies in Section 8.

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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 jumper wires within closed-equipment, and if the regulation jumper wires will not fit, then the jumper wires involved may be reduced in length on the authority of the authorising signal engineer with the objective to keep the jumper wires at their maximum practical length. These jumper wires shall be duly labelled as being shorter than the regulation length.

The same jumper wires used for the temporary bridging shall remain in place for the duration that the temporary bridging is applied to the equipment. This requirement shall pertain irrespective of who applies the jumper wires, or other factors such as a change of shift and so on. This is to eliminate the risk of reconnection errors.

7 Testing of temporary bridging when applied

Following the application of temporary bridging (after applying the temporary bridges), test the circuit to ensure that the temporary bridges are effective, and that all other contacts in the circuit not intended to be bridged-out remain effective. The testing in this case shall include the following tests:

- Using the temporary bridging jumper wires, strap and function test the bridged portion of circuit to prove that the temporary bridge is effective and then leave the temporary bridge connected.
- Once the bridging is applied, circuit function test the effective (non-bridged) equipment contacts in the detection circuit for the position in lay (for example, the Normal detection circuit). This test applies to all equipment contacts that are intended to remain effective in the detection circuit. These contacts will include any trackside detection components at the same-end where the temporary bridging is applied, and at corresponding-ends of equipment, as applicable. The circuit function test shall be verified at the signalling control panel.

8 Temporary bridging left unattended

When temporary bridging is left unattended without the presence of licensed signalling personnel, precautions shall be made to ensure the jumper wires are not tampered. This shall be done by securing the signalling locations and equipment, as the case may be.

Any associated points that are clipped (as prescribed in Section 5.2) shall be additionally XL locked and spiked to prevent 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 at the ESML/EOL cabinet, and at the point's manual operation facility. Any ESML or EOL facility locked with a Falcon lock shall be booked out of use and accordingly stated on the NRF 003 form. Controls of a similar nature (the use of Falcon 8 locks) shall apply to other equipment that is temporarily bridged, such as half pilot staffs, blocking releases or other such releasing devices, as necessary.

When temporary bridging is applied to the point detection, the point securing equipment, such as point clips, locks and spikes, shall be frequently inspected. The authorising signal engineer shall determine the frequency and inspection requirements by assessing the situation and documenting such determination. Guidance for such determination can be sought by referencing *PR S 40007 Apparatus Seldom Used*. The maintenance signal engineer shall be advised of any such determination.

9 Removal of temporary bridging

Where practicable, the person who applies the temporary bridging shall be the same person who subsequently removes the bridging.

Any protecting signal booked into use during the application of temporary bridging shall again be made to be booked out of use, until all tests are satisfactorily complete.

Once the temporary bridging is removed, testing of the entire affected circuits shall be performed. This is to ensure all temporary bridging is removed and that all contacts in the detection circuit (including the contacts in any corresponding-ends of equipment) are effective in the circuit. The testing in this case shall include the following tests:

- Conduct a wire/null count on the equipment where temporary bridging was applied.
- Circuit function test the equipment contacts in the detection circuit for the position in lay (for example, the Normal detection circuit). This test applies to all equipment contacts in the detection circuit. These contacts will include any trackside detection components at the same-end where the temporary bridging was applied and at corresponding-ends of equipment, as applicable. The circuit function test shall be verified at the signalling control panel.
- Operate the equipment to the opposite side and circuit function test the equipment contacts in the detection circuit for the position in lay (for example, the Reverse detection circuit). This test applies to all equipment contacts in the detection circuit. These contacts will include any trackside detection components at the same end where the temporary bridging was applied and at corresponding-ends of equipment, as applicable. The circuit function test shall be verified at the signalling control panel.
- Conduct an out of correspondence test if more than one end exists: for example, at multi-ended points or Sydney-side and Country-side level crossing boom/gate mechanisms.

Following the jumper wire removal and the satisfactory completion of all tests, the protection afforded by the signalling can be removed and the signalling equipment booked back into use in accordance with NPR 704. Then complete the removal advice section in the PR S 40002 FM01 form and return the form to the authorising signal engineer, confirming that the bridging has been removed and all subsequent testing is complete.

The notification arrangements shall be discussed and agreed at the time of authorisation. The authorising signal engineer shall pursue advice of the temporary bridging removal where due notification exceeds the agreed notification time.

The jumper wires used for the temporary bridging shall be returned to the point of issue and signed-in as soon as practicable after the planned removal time. The person delegated to hold the jumper wire locked box (in accordance with Section 4.1) shall then conduct a count of such contents and account for every jumper wire. Any discrepancies shall be immediately actioned and duly reported to the authorising engineer or maintenance signal engineer.

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10 Special requirements for project or complex works

Special requirements apply where the work is complex or not of a minor nature. For example, project work, or complex trackwork support or complex renewals work. This is particularly relevant where the application of temporary bridging extends for a duration greater than one shift, involves different personnel applying and removing the temporary bridging, or the work involves the temporary bridging of multiple equipment.

In such cases, work instructions shall be prepared that specifically stipulate the application of temporary bridging. Work instructions are subsequently approved by the commissioning engineer or other signal engineer involved with the work. The work instructions shall be attached to the approved PR S 40002 FM01 form (marked as a field copy) together with the accompanying circuit diagram (if not depicted by an approved signalling design). Such documents shall be issued to the respective team leaders involved, specifying the bridging application and removal details, as well as the testing requirements.

For project work, or complex trackwork support or complex renewals work, the authorising signal engineer (typically the commissioning engineer or other signal engineer involved with the work) shall generally provide the regulation jumper wires. The jumper wires shall be formally issued by them and accordingly returned together with the associated documentation. The maintenance signal engineer shall be involved in accordance with Section 3 and Section 3.1. Where the authority for temporary bridging forms part of an approved signalling design, the jumper wires shall be in accordance with the relevant design and project requirements. Otherwise, the jumper wires shall be in accordance with Section 4.

Where temporary bridging is applied in accordance with an approved signal design that is specific for the new or altered work, such bridging may be exempt from using a PR S 40002 FM01 form. In these cases, the application and removal of the temporary bridging is done in accordance with *SPG 0711.3 Inspection and Testing Principles* and *SPG 0711.4 Inspection and Testing Procedures*, and project procedures. However, the temporary bridging principles, rules and notification requirements stated in this procedure still apply.

Where new signalling equipment is installed, but is not yet commissioned, temporary bridging utilised to facilitate testing on the authority of the commissioning engineer may be exempt from these temporary bridging requirements. This is on condition that no part of the operational signalling or railway operation is adversely impacted by such bridging. The testing for the application and removal of these temporary bridges shall comply with SPG 0711.3 and SPG 0711.4.

11 Non-vital signalling circuits

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 temporally bridged provided that the non-vital controlling devices and the terminals being bridged are clearly physically separate from the vital signalling equipment.

In these cases, the temporary bridging of such non-vital contacts may be exempt from temporary bridging requirements. However, where temporary bridging is applied to these circuits, the maintenance signal engineer or signal engineer involved with the work shall have a suitable process to manage the application and subsequent removal of the bridging.

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Engineering System Integrity

Engineering Procedure

Signalling and Control Systems

Signalling Safeworking

PR S 40003

Derailments, Collisions and Major Incidents

Version 3.0

Date in Force: 31 October 2022

Approved by:	Professional Head Signalling and Control Systems Engineering System Integrity	Authorised by:	Engineering Technical Publications Manager System Integrity

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Document control

Version	Date	Author/Prin. Eng.	Summary of change
1.0	16 September 2013	Y Bagaric	First issue as a Sydney Trains document
2.0	1 July 2016	Colin Darmenia	Complete revision
2.1	5 July 2017	Mohammed Khan/Colin Darmenia	Update procedures for managing investigations from Beverly Hills Fire Investigation
2.2	15 July 2021	Ian Maydew/Colin Darmenia	Update to include axle counter requirements
3.0	31 October 2022	Paul Zammit/Mohammed Khan	Minor requirement updates Clarify and re-order content Update to Asset Standards Style Manual

Summary of changes from previous version

Summary of change	Section
Title changed to better reflect content	Cover
Update content to clarify requirements (to read better)	All
Update content to Asset Standards Style Manual	All
Reorder sections to read in logical sequence	All
Add "Reference document" section (all subsequent sections thus incremented)	1
Updated "Introduction" section to include the '*provision of traction return*' to the requirement of attendance of major incidents (in accordance with TfNSW standard)	2
Added "Initial inspection" section to separate such requirements from previous Section 5 '*Protecting the incident*'. Subsequently, Section 8 referred to as '*Detailed inspection*'	6

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Table of Contents

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1 Reference documents

This procedure shall be read in conjunction with the following documents:

Signalling Safeworking Procedures

- *PR S 40004 Failures*
- *PR S 40005 Damage to Signalling Equipment including Cables*
- *PR S 40008 Securing Signalling Apparatus Out of Use*
- *PR S 40009 Disconnection of Signalling Apparatus*

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*
- *NPR 720 Protecting Trains*

2 Introduction

Licensed signalling personnel shall immediately attend to major incidents, such as derailments and collisions unless the affected lines where the incident occurred has no signalling provided and contains no provision of traction return.

When licenced signalling personnel are called to attend such incidents, the procedures herewith shall be followed.

3 Incident management

The management of investigating a major incident from a signalling perspective requires the allocation of specific roles, each having the appropriate authority and responsibility to undertake the processes correctly.

Duties of signalling investigation roles include:

- Providing initial notification.
- Protecting the incident.
- Initial inspection.
- Assigning the investigating signal engineer.
- Conducting the investigation including detailed inspection.
- Gathering and preserving perishable evidence.
- Collecting and storing data, video footage and other forms of evidence.
- Providing alternate arrangements.
- Incident recovery, testing, certifying and restoring the signalling.
- Reporting and recording.

The aforementioned duties are prescribed in Section 4 through to Section 11.

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4 Initial notification

When a major incident occurs, the first call made by signalling personnel shall be to the signaller notifying of the incident. This shall be done in accordance with network rule NGE 206 Reporting and Responding to a Condition Affecting the Network (CAN). Where electric traction supplies are involved, such information shall be stated in the notification.

ICON Infrastructure and the maintenance signal engineer shall be immediately notified where there is any reason to suspect that the incident was caused (in any way) by the signalling.

5 Protecting the incident

The immediate priority when attending an incident shall be the safety of persons on or about the line. This can be achieved by communicating with the signaller to ensure that rail traffic in the vicinity of the incident has been brought to a stand and associated controlled signals are placed at stop with blocks applied.

The next priority is the protection of trains and users of level crossings (where applicable) from the incident. This shall include any adjacent line where the likelihood of obstruction exists, caused by the incident. The protection shall be achieved by booking out of use and disconnecting the signals that immediately lead toward the obstructed lines in accordance with *PR S 40008 Securing Signalling Apparatus Out of Use* and *PR S 40009 Disconnection of Signalling Apparatus*. The signaller shall be requested to apply blocks to such signal controls.

Where the integrity of such signals is in doubt, the signals in the rear shall be booked out of use and disconnected for the protection. In these cases, the signals in doubt shall not be interfered with nor disconnected until instructed by the investigating signal engineer.

Any signals that are in the rear of those signals immediately protecting an overlap that is obstructed by the incident shall also be booked out of use and disconnected. Additionally, any points that are foul of the obstruction or provide flank protection, as well as any other affected equipment, including active level crossing protection shall also be booked out of use and disconnected.

The disconnection of signalling equipment, including the securing of points shall only proceed where it is clearly evident that the equipment was not causal of the incident. In any case, the investigation signal engineer shall be first consulted.

Once the initial protection of the incident area and affected equipment has been established, the extent of protection shall be reviewed in conjunction with the signaller or incident rail commander, and the investigating signal engineer. This is to minimise the impact on the operating network and maximise the safe use of the signalling system.

6 Initial inspection

During the initial inspection, where allegations or suspicions deem the signalling system as a causal factor to the incident, the situation shall be treated as a signalling irregularity. The procedures prescribed in *PR S 40004 Failures* shall be followed. The equipment involved shall not be disturbed or interfered with until the incident has been fully investigated by the investigating signal engineer, unless otherwise directed for safety reasons by the incident rail commander or emergency services.

The preservation of evidence, particularly perishable evidence shall be duly considered. See Section 8 for further information regarding gathering of evidence.

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Any initial inspection of signalling equipment before the arrival of the investigating signal engineer shall be done in the presence of a suitable independent witness, such as the incident rail commander or delegated emergency services personnel.

7 Assigning the investigating signal engineer

Where the signalling is alleged or suspected of being causal to the incident, or where extensive damage to signalling equipment has occurred, a licensed signal engineer delegated as the investigating signal engineer shall be assigned to attend so to control and investigate the signalling elements of the incident.

The investigating signal engineer should be assigned before the incident site is disturbed.

The competence of the investigating signal engineer shall be appropriate to the nature and complexity of the incident and the signalling installation. The investigating signal engineer will typically be the maintenance signal engineer or other signal engineer as nominated by the Signals Engineering Manager. The Signals Engineering Manager may delegate the action of assignment to ICON Infrastructure. However, in cases of serious consequences or implication, the Professional Head Signalling and Control Systems shall nominate the investigating signal engineer following consultation with the Signals Engineering Manager.

In all cases, circumstances regarding the need for an independent investigation shall be taken into account.

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

7.1 Investigating signal engineer tasks

The investigating signal engineer shall carry out the following tasks:

- Immediately attend the site, and take control of the signalling resources.
- Ensure the protection afforded by the signalling is adequate.
- Liaise with the incident rail commander, emergency services personnel, and other engineering discipline personnel, as required.
- Manage the provision of alternate signalling arrangements.
- Lead and conduct the signalling investigation, including inspection and provide regular notification updates.
- Control the evidence gathering to ensure preservation of perishable evidence.
- Control the collection and safeguarding of physical evidence for removal, secure storage, and later analysis.
- Manage the signalling activities and eventual recovery works.
- Carry out the testing and certification of the affected signalling.
- Provide authorisation for the restoration of signalling.
- Lead a joint review of any signalling evidence related to the incident to determine root cause. This is done in collaboration with the incident rail commander and other investigating personnel.

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8 Detailed inspection

After taking the necessary precautions and providing the initial notifications, a detailed inspection and examination of the incident shall be carried out.

During the detailed inspection, where the signalling is alleged or suspected of being causal to the incident, or where doubt exits with the integrity of the signalling system, the situation shall be treated as a signalling irregularity in accordance with PR S 40004. In such case, the detailed inspection and examination shall be carried out under the guidance of the investigating signal engineer. The investigation shall be done in the presence of a suitable independent witness, such as the incident rail commander or delegated emergency services personnel.

Perishable evidence shall be prioritised and preserved (where practicable) so that the evidence is not lost. An example of perishable evidence is sunlight shining directly on a signal lens, or a contaminated rail surface. Equipment such as cameras, video recorders, voice recorders, as well as documented notes shall be used where available to capture perishable evidence.

The position and indication of applicable signalling controls (including levers and switches) and control system indications (including signal box diagrams) shall be noted on arrival.

The gathering of evidence shall continue where deteriorating equipment conditions are experienced. Damaged or suspected equipment shall be safeguarded where possible, and accordingly labelled to enable reconstruction of arrangements for investigation purposes.

Additionally, notes shall be made of the following observations, as relevant:

- The position of point layouts and mechanisms, including point lock (FPL) and point detectors.
- Any damage to point switches and points equipment.
- The state, indication, and position of signals and trainstops.
- The state of active level crossing protection equipment.
- Any fresh strike marks on trainstops trip arm face.
- Any signalled routes set at the time of the incident.
- The point of detachment or derailment (noting any rail and sleeper marks or damage).
- The state of the interlocking, including correspondence check of associated relays or outputs with the position of signals and points.
- The condition of control, indication and interlocking relays, wiring, cables, and equipment racks.
- The indication and condition of rail vehicle detection systems.

Statements from witnesses (such as from rail vehicle operators and signallers) shall be sourced from the incident rail commander where such statements cannot be directly obtained.

Other forms of evidence can include data logs (for example, from vital and non-vital systems and from trains), replay files, CCTV footage (for example, from stations, level crossings, and trains). ICON Infrastructure or the incident rail commander can be utilised to obtain such evidence.

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To assist with the progress of incident investigation, copies of data logs and replay files shall be obtained at the earliest opportunity. The expiry time relating to the retention of log files required for evidence, shall be taken into account, so not to lose access to such log files. Signalling logs shall be managed in accordance with PR S 40004.

9 Alternate arrangements

The provision of alternate signalling arrangements (as necessary) shall be made to facilitate the safe movement of rail traffic until final restoration of the signalling is complete. This work shall be coordinated by the investigating signal engineer or the maintenance signal engineer.

10 Incident recovery

Damaged signalling equipment shall be identified and documented with a full materials list prepared in order to effect repairs. The checklist contained in *PR S 40005 Damage to Signalling Equipment including Cables* shall be used to identify damaged equipment, where significant.

Replacement equipment and resources shall be requested in a timely manner to enable the efficient recovery of the incident.

The restoration works, including the disconnection of any affected signalling equipment shall be fully tested and certified prior to booking such equipment back into use.

11 Reporting and recording

The reporting and recording procedures outlined in PR S 40004 shall be followed.

The result of the investigation, including inspections and notable enquiries shall be promptly communicated to ICON Infrastructure as they are completed.

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Engineering System Integrity

Engineering Procedure

Signalling and Control Systems

Signalling Safeworking

PR S 40004

Failures

Version 5.1

Date in Force: 26 September 2023

Approved by:	Professional Head Signalling and Control Systems Engineering System Integrity	Authorised by:	Engineering Technical Publications Manager System Integrity

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Document control

Version	Date	Author	Summary of change
1.0	28 November 2013	Y Bagaric	First issue as Sydney Trains document
2.0	21 September 2013	C Darmenia	Major Review
2.1	24 October 2016	C Darmenia	Clarify when a technical report is required
2.2	1 March 2019	A Sozio	Updated to include Control Systems requirements
3.0	8 March 2019	C Darmenia	Inclusion of ATP (ETCS L1) Requirements and update for EA S 17-01 V2.0 enhancements to signalling irregularities and trainstop failures
3.1	17 December 2020	Colin Darmenia	Implementation of ASDO
4.0	26 May 2022	Ian Maydew C Darmenia	Updated to include axle counter requirements & WSP 2G
5.0	13 April 2023	Paul Zammit Mohammed Khan	Update requirements pertaining to signalling irregularities Other minor updates
5.1	26 September 2023	Paul Zammit Mohammed Khan	Content updates regarding signalling irregularities, and clarifications.

Summary of changes from previous version

Summary of change	Section
Swap sections: *Reference Documentation* (1) and *Introduction* (2).	1 2
Clarify signalling irregularity definition and sources that constitute a signalling irregularity, including signalling design causes.	5
Reinstate missing dot point (3rd dot point).	5.2.1
Clarify example for vital relay in 'wrong side' failure situations.	5.1.2.1
Clarify example for vital relay in 'not wrong side' failure situations.	5.1.2.2
Clarify example for pedestrian crossing in 'not wrong side' failure situations.	5.1.2.2
Permit non-vital blocking as a form of disconnection in certain circumstances.	5.3
Permit making signalling operable during signalling irregularity investigation where risk is negligible in certain circumstances.	5.3

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Amend 3rd dot point to imply requirement only applies where the signalling equipment becomes intolerably unreliable, as deemed by the signaller.	6
Added requirements for ESML or EOL when temporary bridging is applied	6.3.2
Amend 4th dot point to imply signaller assurance only necessary where applicable.	6.4.3
New requirements for half-pilot staffs and releasing devices when temporary bridging is applied (Section 6.13 is a new section, former Section 6.13 becomes 6.14).	6.13

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Table of Contents

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1 Reference documents

This procedure shall be read in conjunction with the following documents:

Signalling Safeworking Procedures

- *PR S 40002 Temporary Bridging of Signalling Circuits*
- *PR S 40005 Damage to Signalling Equipment including Cables*
- *PR S 40006 Manual Release of Interlockings*
- *PR S 40007 Seldom Used Signalling Equipment*
- *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 40012 Repair/Replacement of Signalling Wires*
- *PR S 40025 Track Circuits*
- *PR S 40028 ETCS L1 – Alstom Trackside Equipment*
- *PR S 40032 Solid State Interlocking (SSI) and Smartlock 400T*
- *PR S 40036 Level Crossings*
- *PR S 40038 Microlok II Computer Based Interlocking*
- *PR S 40039 Westrace Computer Based Interlocking*
- *PR S 40050 Control Systems*
- *PR S 40051 Axle Counters*
- *PR S 40052 WSP 2G Computer Based Interlocking*

Signalling Safeworking Forms

- *PR S 40004 FM01 No Cause Found Failure Report*
- *PR S 40004 FM02 Investigating Signal Engineer's Signalling Incident Technical Report*

Inspection and Testing Procedures

- *PR S 47110 Inspection and Testing of Signalling: Introduction*
- *PR S 47112 Inspection and Testing of Signalling: Plans, Programs, Documentation and Packages*
- *PR S 47115 Inspection and Testing of Signalling: Typical Inspections and Tests for Signalling Apparatus*

Network Rules and Procedures

- *NGE 206 Reporting and responding to a Condition Affecting the Network (CAN)*
- *NRF 003 Infrastructure Booking Authority (IBA)*
- *NSG 608 Passing signals at STOP*
- *NWT 312 Infrastructure Booking Authority*
- *NPR 704 Using Infrastructure Booking Authorities*
- *NGE 218 Type F level crossing management*

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- *NPR 715 Protecting Type F level crossings*
- *NPR 746 Authorising rail traffic to pass an absolute signal at STOP*

Transport Standards

- *TS TOC 1 Train Operating Conditions (TOC) Manual – General Instructions*

2 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 shall 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.

3 Failure reporting, recording and analysis

All notifications of signalling failures shall be thoroughly investigated.

Full details of the findings for functional failures shall be reported to ICON Infrastructure representative 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, alarms, tests performed and root cause of the failure, affected equipment, defective or damaged components, system resets, 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) is done in accordance with Section 5.2.

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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 Damage to Signalling Equipment including Cables* 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.

3.1 Detailed failure/incident reports

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 signaller 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 European train control system (ETCS) onboard failures, the details of the train reporting the failure, including train run number, set number, car number and driver machine interface (DMI) message at the time of failure.

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- In the case of automatic selective door operation (ASDO) failures, in addition to details for ETCS, details of direction of travel, number of cars in consist, doors affected and position of lead car in relation to car marker.
- Was an axle counter section reset attempted/undertaken (including the type of reset, time that the attempt was made and by whom).

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 ASDO, ATP, ETCS, CSEE, ESML, EOL, ATRICS, CCTV and so on is acceptable; however, lesser known abbreviations and acronyms should be avoided unless specifically defined.

3.1.1 No cause found failure report

Where the cause of a failure is not immediately found, the failure shall be fully investigated. *PR S 40004 FM01 No Cause Found Failure Report* form or an approved equipment-specific equivalent, shall be completed on each occasion unless otherwise instructed by the maintenance signal engineer.

The relevant parts of form PR S 40004 FM01 shall be completed by licensed signalling personnel attending the failure and the follow-up investigator shall complete the *Follow Up Investigation* section.

Subsequently, form PR S 40004 FM01 shall be forwarded to the maintenance signal engineer for review and file.

3.1.2 Investigating signal engineer's signalling incident technical report

Signal engineers shall submit a technical report for the following:

- 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 Principal Engineer Signalling Integrity, Signals Engineering Manager, or Control Systems Operations Manager.

The *PR S 40004 FM02 Investigating Signal Engineer's Signalling Incident Technical Report* form shall be used for all signal engineer technical reports.

The investigating signal engineer shall forward a comprehensive report of the incident to the Principal Engineer Signalling Integrity using the following email address: SignallingControlSystemsIntegrity@transport.nsw.gov.au.

The report shall be submitted by the next working day following the incident.

A preliminary copy of the 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 Inspection and Testing of Signalling: Plans, Programs, Documentation and Packages* 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 and so on.

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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.

3.2 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 shall 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.

3.3 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 shall 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.

3.4 Network operational procedures

When advised to attend to a failure, licensed signalling personnel are to obtain details from the signaller about the circumstances of the failure and any symptoms or indications that may assist in providing diagnoses of the cause. The signaller shall be advised 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 *NWT 312 Infrastructure Booking Authority* and *NPR 704 Using Infrastructure Booking Authorities.*

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When the failure has been rectified and the necessary tests carried out, the signaller shall be advised.

4 Signalling logs

Where logging facilities of vital or non-vital systems are available, they may be utilised 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 Solid State Interlocking (SSI), Smartlock, Microlok, Wayside Standard Platform 2nd Generation (WSP 2G), Westlock, Westrace, Advanced Train Running Information and Control System (ATRICS), Dupline, IMAC, Kingfisher, level crossing monitors, and ETCS logs downloaded from such equipment as lineside electronic 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.

4.1 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.

4.2 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.

4.3 Verification of logs

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.

4.4 Evidence retrieved from other parties

Where evidence, such as logs, replays and footage are obtained from other parties, such as from ATRICS, ETCS onboard, closed circuit television (CCTV), front of train (FOT), video files, audio files and the like, and such information is to be used as evidence for a serious incident, the investigating signal engineer shall obtain the necessary assurances from the relevant party to ensure the information meets the requirements of Sections 4.1, 4.2 and 4.3.

5 Signalling irregularities and wrong side failures

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 causes a less restrictive condition or other unsafe condition.

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Not all signalling irregularities are immediately evident or obvious in nature, and not all arise from signalling failures. Even innocuous defects that remain latent in the system can give rise at a later time to cause a less restrictive condition or other unsafe condition, especially if unfavourable circumstances were to prevail.

Signalling irregularities can emanate from various sources initiated at any stage during the asset life cycle.

Some signalling irregularities can result from defects which inadvertently enter the system through errors, omissions or deficiencies made at the design stage, and subsequently missed by the design verification and validation.

Signalling irregularities can also result at other asset life cycle stages, occurring during or after the system is worked-on (usually contrary to requirements). Such works include construction, integration, renewals, trackwork support, periodic maintenance and incident recovery. For example, an unsafe situation can be caused by a deficiency in the testing, or ineffective signalling protection for a disarranged condition, or from inappropriate or incomplete work practices.

Therefore, any defect that has the potential to defeat the intended design principle, cause a less restrictive condition, or adversely affect the safe running of trains is deemed a signalling irregularity (which may be either ‘wrong side’ or ‘not wrong side').

Section 5.1 provides guidance for identifying signal irregularities from right-side failures, while Section 5.2 specifies the treatment and signalling protection requirements to make the situation safe, as well as requirements for the ensuing investigation, certification and reporting.

5.1 Identifying signalling irregularities

Signalling irregularities vary in the level of danger they present to trains and people. The outcome is essentially dependent on the level of inherent protection present during the prevailing conditions. Such protection can be afforded by the system's design or the presence of effective elements of a safe condition. Safe elements can potentially reduce the risk caused by the situation and as such, signalling irregularities are categorised as either ‘wrong side’ or ‘not wrong side’.

A wrong side failure is neither protected by the system design, nor has sufficient effective elements of a safe condition for the circumstances.

In some failure situations, the effective elements of a safe condition may allow the situation to be deemed ‘not a signalling irregularity’, as outlined in Section 5.1.3.

5.1.1 Predictable, common failures

Predictable, common failure modes are not deemed signalling irregularities where the inherent system design or implementation of administrative systems of safeworking effectively provide for safe mitigation of the failure.

The following situational examples are not deemed signalling irregularities:

- Signal lamp or LED unit failures.
- A trainstop that is falsely in the lowered position due to a mechanical problem (not an electrical problem).
- A level crossing having an insignificant amount of lights out, broken booms or gates obstructed by vandals, or one failed bell or siren, or when the level crossing is in manual operation.

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This deeming is on condition that the remaining elements of the level crossing have activated correctly (remaining effective elements of a safe condition are sufficient) and as such, is clearly apparent that trains are approaching; otherwise, the situation shall be treated as a signalling irregularity.

Note:
The implementation of a 'Condition Affecting the Network' (CAN) warning order may provide an additional layer of protection for the situation.

- Where a data pick-up unit (DPU) momentarily fails to detect the presence of a rail vehicle and no early release of conditions that cause an unsafe situation.

  The situation shall be immediately attended to confirm such cause.

  If the loss of track shunt duration is more than momentary (greater than seven seconds) or the early release of conditions causes an unsafe situation, then the failure shall be treated as a signalling irregularity.

- Where a momentary loss of rail vehicle detection on a track circuit section is caused by a rail vehicle pre-identified as having wheel-to-rail profile issues (such as with diesel multiple units or maintenance rail vehicles not fitted with functional track circuit actuators), and such loss of rail vehicle detection occurred on rail lines accordingly identified in *TS TOC 1 Train Operating Conditions (TOC) Manual – General Instructions.*

Note:
The effective elements of a safe condition in this case are provided by the pre-determined implementation of 'Manual Block Working'.

The situation shall be immediately attended to confirm such cause.

If the loss of detection situation does not involve such known rail vehicles and pre-identified rail lines, or the loss of rail vehicle detection duration is more than momentary (greater than seven seconds), then the situation shall be treated as a signalling irregularity.

- Where a loss of rail vehicle detection on an axle counter track section is caused by a rail vehicle pre-identified as having incompatible wheel-profile or wheel-dimensions with an axle counter wheel sensor (as with some maintenance rail vehicles), and such incompatibility is accordingly identified in the TOC Manual.

Note:
The effective elements of a safe condition in this case are provided by the pre-determined implementation of 'Manual Block Working'.

If the non-detected situation does not involve such known rail vehicles and pre-identified rail lines, then the situation shall be treated as a signalling irregularity.

In some cases, the wheel to sensor incompatibility can result in a miscount of the axle counter track section, placing the section in a 'disturbed' (occupied) state. This situation is not deemed a signalling irregularity.

5.1.2 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'.

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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).

5.1.2.1 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.
- Signal: if a less restrictive aspect is displayed by the signal than is correct for the conditions.
- 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.
- Axle counter unconditional reset: if an unconditional reset is enabled without the Unconditional Reset Enable (URE) function being applied by the signaller where the URE is provided.
- Level crossing protection: if level crossing protection fails to operate for approaching trains and the protecting signals are not automatically replaced or held at stop such to protect the failure.

  However, if only one pedestrian gate remains partially open due to a gate mechanical problem, then conditional that the remaining elements of the level crossing have activated correctly, and it is evident that trains are approaching, then this is a signalling irregularity deemed not wrong side.

Note:
This example does not pertain to a level crossing having an insignificant amount of lights out, broken booms or gates obstructed by vandals, or one failed bell or 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 an in-service vital signalling relay is found to have a defect that causes (or could cause) any of the following conditions:
  - the relay is prevented from de-energising when intended; see Section 5.1.2.2 for an exception to the wrong side deeming for relays falsely energised
  - the relay contacts falsely indicate an energised or de-energised state
  - the relay causes a less restrictive condition or other unsafe condition.
- Electric lock: if a lock is incorrectly free.

- Dual control: if the restoration of any one control fails to return the signal to stop.
- ETCS trainstop: if an ETCS trainstop fails to provide an appropriate brake intervention to an ETCS fitted train for the conditions intended.
- ETCS target speed monitoring: if an appropriate brake intervention is not received by an ETCS fitted train on approach to an ETCS supervised speed restriction such as the following:
  - high risk turnouts
  - high risk catchpoints
  - reduced overlaps, including reduced overlap approaching a level crossing
  - end of line buffer stops.
- ETCS ceiling speed supervision: 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).
- ETCS function: if operational (commissioned) balises are not read by trains due to a VBC function.
- ASDO function: if the release of off-platform doors is enabled by the ASDO system.

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

- Signal: if a signal displays an irregular combination of lights that is obviously seen as an invalid aspect (also known as an illegal signal 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 fails to operate for approaching trains and the system design provides proving of the boom normal position (XNR) and this feature causes the protecting signals to be replaced or held at stop such to protect the failure. See next dot point for pedestrian crossing.

Note:
This example does not pertain to the level crossing having an insignificant amount of lights out, broken booms or gates obstructed by vandals, or one failed bell or siren, or when the level crossing is in manual operation.

- Level crossing pedestrian crossing: if a pedestrian crossing fails to operate for approaching trains and the system design provides proving of the pedestrian gate/boom normal position (XNR) and this feature causes the protecting signals to be replaced or held at stop such to protect the failure.

  Alternatively, if only one pedestrian gate remains partially open due to a gate mechanical problem, conditional that the remaining elements of the level crossing have activated correctly, and it is evident that trains are approaching.

Note:
See Section 5.1.3 for examples of effective elements of a safe condition.

- Vital relay: if an in-service vital signalling relay is found to have a defect that causes (or could cause) it to be falsely energised, but the system design proves the relay in the de-energised position (back contact proving) and this subsequently prevents a less restrictive condition or other unsafe condition from occurring.
- ETCS DMI message: 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.

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5.1.3 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 signallers, 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 5.4.1.

5.2 Treating reports of signalling irregularity

Some incident reports are instantly identifiable as a signalling irregularity, having a low or no likelihood of being caused by a right-side failure. Other such reports can appear less obvious as to whether the situation is a signalling irregularity or in fact, a right-side failure. In any case, all such reports shall be treated as factual and immediately attended.

It is imperative that every incident is properly identified as to whether the situation constitutes a signalling irregularity or a right-side failure, and is accordingly treated, protected, and investigated.

Where an incident is identified as a signalling irregularity, the situation shall be immediately treated as a signalling irregularity.

In other cases, to minimise disruption, licensed signalling personnel may objectively decide from the symptoms whether the situation could constitute a right-side failure; otherwise, the situation shall be treated as a signalling irregularity.

Where symptoms are such that a decision is made of a right-side cause being most probable, an immediate assessment of the situation shall be undertaken. The assessment process alleviates the incident from being initially treated as a signalling irregularity, thus minimising the signalling protection required. The assessment shall be prioritised and initiated expediently.

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Typical examples of symptoms that may impel an assessment over treatment of a signalling irregularity, include the following:

WARNING
These examples are indictive only. Every case shall be decided on its own situational merit.

- No train in area or no train past the protecting signal, signaller diagram or workstation showing signal green indication with other simultaneous indications being conflicting (for example, red track indication, points non-determinant indication or transit indication).

  Consider the symptoms: Would one or two simultaneous faults be needed to cause such incident? Could the fault be in the vital locking (such as CBI data) or the non-vital indication (such as a KR relay)?

- Signal aspect two reds, trainstop down, low speed territory.

  Consider the situational conditions: Was the signal meant to be clear at the time of report? Was the trainstop meant to be down? What was the signal aspect in the rear? Was the situation more restrictive or less restrictive?

- Signal aspect two reds, trainstop down, no train ahead.

  Consider the situational conditions: Was the signal meant to be clear at the time of report? Was the trainstop meant to be down? Is the signal controlled or automatic? Where was the train ahead at the time of report? Was the situation more restrictive or less restrictive?

- Signal in the rear displaying a higher aspect than warranted for the signal ahead condition (for example, signal in the rear full clear, signal ahead at stop).

  Consider the situational conditions: Was the signal ahead (signal with the stop aspect) cleared at the time the driver sighted the signal in the rear? Was the signal ahead replaced or returned to stop by failure after the train passed the signal in the rear? Could the driver simultaneously (or closely) sight both signals? Are the symptoms/evidence increasingly suggesting the situation is less restrictive for the conditions ahead?

- Train *reversing*, *out of sequencing* or *divide* alarms, and no early release of conditions that causes an unsafe situation.

  Consider the portion of occupation: Which track circuit energised? Was the energised track circuit occupied only within the tuned loop. Was any portion of the energised track circuit occupied clear of the tuned loop?

  If a train occupies any part of a track that is clear of the tuned loop, and such track circuit is energised, then the incident is treated as a signalling irregularity.

  If the early release of conditions causes an unsafe situation, then the incident is treated as a signalling irregularity.

- DPU track energises whilst train occupying track, and no early release of conditions that causes an unsafe situation.

  Consider the duration of occupation and conditions: If the DPU track falsely energises for a period of seven seconds or less, then the incident is treated as a right-side failure but is promptly investigated to ensure the cause is pre-known.

  If the DPU track falsely energises for a period greater than seven seconds, then the incident is treated as a signalling irregularity.

  If the early release of conditions causes an unsafe situation (irrespective of the duration of false energisation), then the incident is treated as a signalling irregularity.

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Any incident having a likely potential to cause an unsafe situation involving a level crossing shall be immediately treated as a signalling irregularity. For example, where a level crossing, under the circumstances fails to operate correctly or deactivates incorrectly.

The decision to assess the situation over treating the incident as a signalling irregularity shall be an outcome of a risk based decision, taking into account probability and consequence.

ICON Infrastructure shall judiciously concur with the assessment decision and assist in terms of the assessment's on-going progress. The progressive evidence shall determine whether the situational treatment can remain as a right-side failure or otherwise be treated as a signalling irregularity.

The assessment shall be performed promptly and non-invasively, using as many resources as practicable. Such resources include critical information from signallers and other key persons including driver and guard accounts, as well as from systems like replays and log files, CCTV footage, FOT footage and so on, as applicable.

Where the assessment begins to cause doubt as to the likelihood of a right-side failure (the assessor becomes less in favour with the decision) or the situation is in fact determined to be a signalling irregularity (even if the cause is unknown), the incident shall be on-treated as a signal irregularity.

5.2.1 Maintenance signal engineer involvement

The maintenance signal engineer shall be immediately advised upon reaching any of the following outcomes:

- Where an incident is initially deemed a signalling irregularity.
- Where the evidence is unable to substantiate the situation being treated as a right-side failure, or the evidence supports the situation being a signalling irregularity.
- Where no cause is found during the assessment.

When contact with the maintenance signal engineer is unsuccessful, the next relevant signal engineer shall be contacted to act as the investigating signal engineer.

In such case, the maintenance signal engineer or regional signal engineer shall be duly informed of the situation.

Following the assessment, maintenance signal engineers shall duly review all situations where such treatments were applied. They shall undertake a review of each assessment (as relevant) on the same business day as the incident or otherwise (if not on normal duty), the next normal business day.

This review is required to ensure the maintenance signal engineer is satisfied with the evidence gathered, that nothing was overlooked, and that such determinations were made in accordance with the principles stated in this procedure. The review shall take into account whether all available resources were used in the course of the assessment, and that the incident was in fact a right-side failure (and not a signalling irregularity). The review shall also search for related repeat failures and previous no cause found failures, or patterns of inappropriate or insufficient assessments and so on. Any concerns shall be raised by the maintenance signal engineer to the regional signal engineer and the Signals Engineering Manager who shall take the necessary action. Maintenance signal engineers shall action local issues as required.

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5.3 Protecting signalling irregularities

Signalling equipment suspected of causing a signalling irregularity shall be protected. This is generally achieved by disconnecting the protecting signal so to be retained at stop or by restricting its higher aspect if acceptable for the prevailing circumstances, as applicable and if practicable.

Additionally, if any other affected signalling, such as points or level crossings are at risk of causing an unsafe situation, then such signalling shall be disconnected in conjunction with the protecting signal.

Where the safe movement of trains can be adequately administered by Qualified Workers and Handsignallers, as applicable in accordance with the network rules and procedures (such as CAN warning, manual operation of level crossings using EMR facilities, manual operation of points including clipping and locking, and so on), then this may alleviate the need to disconnect the additionally affected signalling.

The signalling protection shall remain effective until the defect is rectified or addressed, or the risk emanating from the signalling irregularity is deemed negligible (no unsafe situation for trains or users at level crossings).

Notwithstanding the aforementioned requirements, any signalling suspected of causing a signalling irregularity shall be booked out of use only, using form *NRF 003 Infrastructure Booking Authority (IBA)*. The equipment shall not be initially disturbed or disconnected until instructed by the investigating signal engineer.

Further, where a signal is suspected of causing the irregularity, such signal shall not be used as the protecting signal. However, the investigating signal engineer may permit such signal to be disconnected and used as the protecting signal if it is evident that the cause of the irregularity is not within the signal operating circuit, its controlling relay/module or associated interlocking data.

Where a suspected signal is not disconnected, the signal in the rear of the failed signal shall be disconnected and made to be the protecting signal in lieu of the suspected signal.

Disconnection allowances

The aforementioned disconnection requirements may be achieved by requesting the signaller to apply a non-vital block to the protecting signal in certain circumstances, as follows:

- For initial signalling protection of a signalling irregularity prior to attending on site.
- Where the signalling irregularity symptoms appeared for only a short period (for example, less than 60 seconds) and are not repeated within the same incident.

  This determination is made by the investigating signal engineer.
- Where the risk impact caused by the signalling irregularity is minimal, and an actual unsafe situation for trains or users at level crossings has not occurred.

  This determination is made by the investigating signal engineer.

In some cases, where the risk is deemed negligible (no unsafe situation for trains or users at level crossings) and not expected to give rise, the investigating signal engineer may determine to make the signalling operable while the investigation is still in progress.

An example of this situation is where evidence supports a momentary loss of track circuit shunt that has self-rectified and not repeated within the same incident. In this case, the risk becomes negligible and the signalling protection would no longer provide value, rather, can act to adversely impact the efficient running of trains.

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5.3.1 Protecting 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 onboard ETCS equipment is the cause of failure, placing signals at stop may not afford suitable signalling 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.

When licensed signalling personnel become aware of these situations, they shall report the matter to the signaller. If requested by the signaller, the impacted signalling equipment or function shall be accordingly booked out of use and disconnected, as appropriate for the situation.

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 5.3.

Where an ETCS trainstop fails to provide a brake intervention to ETCS fitted trains for the restrictive conditions intended by the design, the protecting signals in the rear of a failed ETCS trainstop and at the failed ETCS trainstop shall be placed at stop.

Incidents where ASDO has enabled the doors to be released off the usable platform area shall be protected by the application of metal covers or by removing the associated ASDO reference balises.

5.4 Attending the investigation

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

The maintenance signal engineer shall 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 Principal Engineer Signalling Integrity.

A person shall be engaged to act as a witness to a signalling irregularity investigation. The witness shall be a suitable person who is independent of an engineering discipline and not involved in the cause of the incident. Such witnesses can be sought from network operations, station operations, safety, environment quality and risk (SEQR), emergency services, and the like. A witness is not required for simple cases, as defined in Section 5.4.1.

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5.4.1 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.

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.

An example of a simple case signalling irregularity

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 signaller of the findings and provides advice for certification, specifying the signalling that can be booked back into use. The maintenance signal engineer informs the Principal Engineer Signalling Integrity in accordance with Section 5.6.

5.4.2 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 A. This document provides 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, the Signal Engineering Manager or other senior and experienced signal engineers to determine whether there are other permissible means of signalling protection that will ensure a safe situation whilst minimising the disruption.

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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 3.1.2 shall be submitted.

5.4.3 Responsibilities of licensed signalling personnel assisting with the investigation

Licensed signalling personnel shall arrange signalling protection of the suspected and affected signalling equipment as prescribed in Section 5.3.

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.

5.5 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 Principal Engineer Signalling Integrity or another senior, experienced licensed signal engineer.

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5.6 Advising the Principal Engineer Signalling Integrity

Investigating signal engineers shall promptly advise the Principal Engineer Signalling Integrity 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 Principal Engineer Signalling Integrity 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.

6 Right-side failures (fail safe)

All signalling functional failures shall be duly attended and subsequently reported, recorded and analysed so that trends can be identified, and appropriate measures taken to minimise the occurrence of failures.

The rectification of failures shall be carried out to restore the signalling in good working order, allowing for the resumption of rail operations under normal signalled conditions, with aim to prevent the failure from reoccurring.

During a failure, the best possible arrangements consistent with safety and in accordance with the network rules and network procedures and signalling safeworking procedures shall be made to minimise delays to rail traffic, as well as to road and pedestrian traffic where level crossings apply.

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 protection shall be provided in any of the following situations:

- A signalling irregularity, until the investigation has determined the cause and the defect subsequently rectified or addressed.
- Where the safety of the signalling may be impaired by an intervening action (for example, signalling equipment is disarranged or disconnected from the interlocking).
- Where the signalling equipment becomes intolerably unreliable, as deemed by the signaller (for example, signals inadvertently returning to stop in front of driver).
- Where the failure condition remains unrectified, and routes become unavailable for a considerable amount of time.
- If requested by the signaller.

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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.

6.1 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.

Signals affected by failed equipment are to remain at stop until the equipment is fit for operational use. See Section 6.2 and Section 6.7 for further information. Formal booking out-of-order of the affected signals 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.

The signaller shall be advised when the signalling is available for operational use; however, is pending additional testing, and thus scheduled at a later time for full certification.

Full certification testing shall be completed within the time frame set by the signal engineer.

An example where signalling equipment is unable to be promptly certified

The situation described herein pertains to a defective receiver identified on an audio frequency track circuit in an automatic section.

The following worked example prescribes a process for where the signalling is unable to be promptly certified:

- The affected signals are maintained at stop by disconnection of signal control circuits.
- The defective receiver is replaced and observed to be operating correctly.
- Following discussion with the signaller, 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 signalling safeworking procedures.

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- 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.
- The signal engineer considers the following:
  - the disruption to rail traffic due an extended signal failure at this site
  - the testing requirements prescribed in signalling safeworking procedures for the particular situation
  - the operational safety risks associated with the signalling being inoperative for an extended period and alternative methods of train working being implemented
  - the safety risks associated with deferring or using alternate testing procedures to those detailed in signalling safeworking procedures
  - train shunt risk factors such as detailed in *PR S 40007 Seldom Used Signalling Equipment* which may be relevant at this site
  - the length of time full certification can be deferred.
- Upon assessment of these factors and risks, the Signal Engineer advises the licensed signalling personnel to conduct tests to:
  - confirm the receiver is correctly installed/wired in circuit
  - confirm that the receiver input voltage is as per the track circuit history card
  - confirm the track relay de-energises and energises cleanly when the location track terminals are disconnected and restored
  - 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
  - measure the receiver voltage on train shunt and confirm the results are within the allowable levels detailed in *PR S 40025 Track Circuits*
  - complete certification testing within a designated time frame.
- Upon successful test results and confirmation from the signal engineer, licensed signalling personnel shall restore and test the signals previously placed to stop. Licensed signalling personnel are to advise the signaller that the track circuit is fit for operational use but will require further testing as soon as possible.
- Licensed signalling personnel shall 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.

6.2 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.

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6.2.1 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 *NSG 608 Passing signals at STOP* and *NPR 746 Authorising rail traffic to pass an absolute signal at STOP*.

6.3 Failure of 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.

ESMLs and EOLs may be used by licensed signalling personnel as permitted by the signaller 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 EOL facilities, the point control unit actuator arrangements may be utilised for this purpose.

In all cases, the signaller shall be notified first to place the affected signals to stop, and they provide assurance that no trains are approaching before the ESML or EOL 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 signaller'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.

Rail traffic is permitted to move over the facing points which have failed in accordance with NSG 608.

6.3.1 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 in accordance with *PR S 40002 Temporary Bridging of Signalling Circuits*.

6.3.2 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 in accordance with PR S 40002.

When temporary bridging is applied to the ESML or EOL circuit, the ESML or EOL cabinet shall be locked with a Falcon 8 lock.

Where point handles or keys are damaged, the maintenance signal engineer shall control the repair or replacement of such items to ensure the integrity of the ESML or EOL is maintained.

Where temporary bridging is applied to ESML or EOL circuits because point handles or keys go missing, a proper search shall be made. Additionally, the associated points manual-operation facility shall be locked with a Falcon 8 lock. This is done to prevent a found point handle or key from operating the points while the temporary bridging is applied.

See Section 6.13 for information regarding half pilot staffs and releasing devices.

6.3.3 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 signaller to enable the points to be operated from the signal box control. A separate request shall be made by the signaller 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.

6.4 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 5 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.

Signallers shall be advised of the operational impacts caused by failed trainstops.

6.4.1 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 signalling 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. See Section 6.4.3 for further information.

6.4.2 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 Securing Signalling Apparatus Out of Use* and *PR S 40009 Disconnection of Signalling Apparatus*, 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. See Section 6.4.3 for further information.

6.4.3 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.

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This permission is subject to meeting the following conditions:

- The trainstop failure is independent of the signal controls failing.
- The trainstop inputs (to the interlocking) remain in correspondence with trainstop trip-arm position at all times.
- The failed trainstop has no application of temporary bridging.
- Where applicable, an assurance is obtained from the signaller that:
  - only the signalling controls will be used to set the routes involved
  - no subsidiary signal (if any) will be cleared for the signal in the rear while the signal ahead, associated with the failed trainstop is at stop
  - no verbal authorisation will be issued to a train to pass the signal in the rear at stop while the signal ahead, associated with the failed trainstop is at stop
  - any points in the route nominally protected by the failed trainstop will not be operated once the train has departed the signal in the rear until the train has traversed both routes.

Where points are in the route affected by the failed trainstop and the points are required to be operated, or the points detection has failed, then the VCSR functionality of the failed trainstop shall not be used. The failure is instead managed in accordance with Section 6.4.1 or 6.4.2, 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.

6.4.4 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, signallers 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 Signal Engineering Manager shall be advised for agreement 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.

6.5 Failure of ETCS trackside equipment

Where ETCS trackside equipment such as lineside electronic units (LEU), ETCS 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 signaller.

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 6.4 of this procedure.

Where linking of balise groups is provided, the balise group in rear provides protection in the form of a linking reaction. The linking reaction for an ETCS fitted train are:

- For a missed balise, a service-brake application is initiated and a DMI warning provided to the driver (dependant on the design for the risk profile).
- For a balise group re-installed in the wrong order, an emergency-brake application is initiated and a DMI warning provided to the driver.

In these cases, signalling may be left operational and managed in accordance with *NGE 206 Reporting and responding to a Condition Affecting the Network (CAN).*

Where ETCS equipment fails to provide the required level of protection, such that it permits a less restrictive signalling condition, the failure shall be treated as a signalling irregularity. See Section 5 for further information.

See *PR S 40028 ETCS L1 – Alstom Trackside Equipment* for management of ETCS equipment removed from service due to failure or relocation.

6.5.1 ASDO trackside equipment

Where trackside equipment becomes defective, damaged or missing causing the on-board system to operate in a degraded mode, such as where some doors do not open or no doors open at a platform, it will not be necessary to disable or book out of use the defective equipment, unless requested by the signaller.

A braking reaction is not normally associated with ASDO balises except in the event that a message consistency error is detected from both balise in a group, in which case there would be a service-brake reaction. To prevent a service-brake application when a balise group message consistency error is detected for ASDO balise groups the service-brake command is inhibited when only one balise in a group has failed and the other balise is properly decoded.

The following two examples are considered right-side failures:

- Single balise in the balise group is missing or failed. This will provide a DMI failure message to be displayed.
- Both balises in the balise group are missing or failed (referring to all ASDO balises along a platform). As ASDO Balises are unlinked this failure would not necessarily provide a DMI failure message to be displayed and depending on failure mode, may cause a service braking reaction.

In an emergency where the balise location ID plate (sleeper plate) is missing, it is permitted to use the ADSO reference balise marker plaque in conjunction with the balise ID plates to determine the position of the ASDO reference balise and the other balise in the ASDO balise group. The other balise in group shall be placed on the correct side and not closer than 2.3 m to the ASDO reference balise by reference to the signalling plan or balise plan. See PR S 40028 for further information.

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In an emergency where the ADSO Reference Balise marker plaque is missing, it is permitted to use the platform limit marker plaque and site certification form (SCF) to determine the position of the balise reference marker plaque for the restoration of the ASDO balise group. See PR S 40028 for further information.

6.6 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 *NGE 218 Type F level crossing management* and *NPR 715 Protecting Type F level crossings*.

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.

Qualified Workers and Handsignallers, as applicable are provided in accordance with NPR 715 in the event of failure or when work is being carried out which affects the normal operation of the level crossing.

6.7 Failure of track circuits

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 NSG 608.

Track and indication locking controlled by track circuits which has failed, may be released in accordance with *PR S 40006 Manual Release of Interlockings*.

6.7.1 Broken rails

Licensed signalling personnel, who become aware of a broken rail that poses danger to rail traffic shall arrange for the immediate protecting signal to be placed at stop, booked out of use and disconnected. A Qualified Worker and Handsignaller, as well as the civil representative shall also be arranged.

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 signaller that the line is fit for traffic, may place a temporary bond around the break and booking the signals into use.

The temporary bonds used shall be of an approved type.

6.8 Failure of axle counters

In the event of an axle counter track section failure no attempt shall be made to clear any of the signals controlled by such track sections. For example, no attempt shall be made to manipulate the track section relay or bridge across the track section relay contact terminals or manipulate track section inputs to the interlocking (other than what is prescribed in *PR S 40051 Axle Counters*).

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The signals controlled by the affected track section shall remain in the stop position until the track section is certified in working order. The signaller shall be advised that rail traffic is be managed in accordance with the network rules and procedures.

Track and indication locking controlled by an affected track section, which has failed, may be released by only as prescribed in PR S 40006.

Signalling personnel shall arrange to attend the site as soon as practicable to effect repairs and certify the affected track section for use.

Axle counters track section resets, when necessary, shall be done in accordance with PR S 40051.

6.9 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 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 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.

6.10 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, the half pilot staff contacts at each or either end of the section may be temporarily bridged 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 PR S 40002.

6.11 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 shall be done in accordance with *PR S 40012 Repair/Replacement of Signalling Wires*.

6.12 Failure of telemetry interfaces

In the event of a failure of a telemetry interface (for example, 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.

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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 ensuring correct indications are displayed at the control centre.

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

6.13 Failure of half pilot staffs and releasing devices

Where there is a failure of detection pertaining to half pilot staffs, signal key switches, XYZ maintenance releases, releasing switches, blocking key releases, and other such releasing devices which result in severe disruption to trains, a temporary bridging authority to bridge-out the detector contacts of the device may be obtained in accordance with PR S 40002.

When temporary bridging is applied to such circuits, the releasing device cabinet shall be locked with a Falcon 8 lock. For half pilot staffs, the corresponding half-pilot staff (at the opposite end) shall also be locked with a Falcon 8 lock.

Where staffs or keys are damaged, the maintenance signal engineer shall control the repair or replacement of such items to ensure the integrity of the releasing device is maintained.

Where temporary bridging is applied because staffs or keys go missing, a proper search shall be made. Additionally, any associated operation facility shall be locked with a Falcon 8 lock, or otherwise secured. This is required to prevent a found key from operating the equipment while the temporary bridging is applied.

See Section 6.3.2 for information regarding ESML or EOL detection.

6.14 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 *PR S 40011 Renewals Work*.

The testing of temporary repairs shall comply with the requirements prescribed in *PR S 47110 Inspection and Testing of Signalling: Introduction*.

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 shall 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 shall be duly sent for updating as necessary to reflect any permanently changed arrangements.

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Appendix A Guidelines for Irregularity Inspection and Testing to Determine Cause

Table of Contents

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Appendix A 1 Irregularity Investigation to Determine Cause

Appendix A 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 A 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 shall be necessary in most cases although the signalling concerned shall 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.

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Appendix A 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:

a. a set of operating conditions occur for which deficient signalling design or incorrect installation does not provide protection.
b. 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.
c. a false feed occurs from one circuit to another.
d. a current leakage path falsely qualifies part of the correct selection path in a circuit.
e. detection or indicating equipment becomes out of adjustment.
f. foreign matter interferes with correct train detection.
g. foreign matter or lack of lubrication obstructs gravity return or spring return devices.
h. worn or defective bearings or linkages obstruct gravity return or spring return devices or cause lost motion in drive mechanisms or in detection mechanisms.
i. worn, loose, bent or fractured mechanical interlocking defeats locking.
j. a complete interruption of power supply to protection systems occurs.
k. time limit release devices shorten from the time interval stipulated.
l. interference from personnel alters adjustment, correspondence.
m. damage occurs affecting the integrity of the equipment in the operating environment.

Appendix A 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.

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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 A 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; for example, 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 PR S 47115 *Inspection and Testing of Signalling: Typical Inspections and Tests for Signalling Apparatus*.

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.

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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:
    i. 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.
    ii. Inspection and tests that the mechanisms operate freely and correctly.
b. Mechanical Interlocking inspections and tests including:
    i. interlocking frames
    ii. trackside equipment; for example, bolt locks, selectors, train bars, facing point lock-bars
    iii. keys and locks; for example, 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. Re-clear 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 re-clear

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 Section Appendix A 5)

ii. axle counters (see attached guidelines Section Appendix A 6)

iii. block joint clearance positions

iv. trains, wheel/surface, light vehicles

v. 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 semi-conductor 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.

   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 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.

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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; lamp-case lock; lamp-case seal from external light; lamp-case 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 A 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:

a. signal aspects
b. signal UCR relay
c. signal HR/DR relays
d. 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:

a. track circuit rail shunt
b. track circuit relay
c. 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 A 4 Examples of Some Tests for Particular Irregularity Incidents

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

Appendix A 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 A 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 A 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 e.g., detector relays, track relays etc.

Appendix A 4.1.4 Track Circuit 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.

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Appendix A 4.1.5 Axle Counter Track Section Occupancy Tests

Each axle counter track section in the approach locking and track control of the signal is to be tested to ensure it indicates occupied if the wheel sensor is disturbed. Any track section relay/s 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.

Where track relays are not provided, observation of correct track section operation shall be observed via:

- the associated LED indications on the corresponding evaluator board.
- diagnostic indications via laptop interface.

Appendix A 4.1.6 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 A 4.2 Automatic Signal alleged Falsely at Clear or at Less Restrictive aspect.

Appendix A 4.2.1 Interlocking Test

Not applicable.

Appendix A 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 A 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, for example, track relays, release switch normal relays etc.

Appendix A 4.2.4 Track Circuit 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.

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Appendix A 4.2.5 Axle Counter Track Section Occupancy Tests

Each axle counter track section in the signal route is to be tested to ensure it indicates occupied if the wheel sensor is disturbed. Any track section relay/s 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.

Where track relays are not provided, observation of correct track section operation shall be observed via:

- the associated LED indications on the corresponding evaluator board.
- diagnostic indications via laptop interface.

Appendix A 4.2.6 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 A 4.3 Points Run Through, or Operated in Front of Train

Appendix A 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 A 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 A 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/RWKR, 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 A 4.3.4 Track Circuit 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.

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Appendix A 4.3.5 Axle Counter Track Section Occupancy Tests

All local axle counter track sections, and all route holding track sections from a protecting signal to the points are to be tested. The track section 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.

Where track relays are not provided, observation of correct track section operation shall be observed via:

- the associated LED indications on the corresponding evaluator board.
- diagnostic indications via laptop interface.

Appendix A 4.3.6 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 A 5 Guidelines for Testing of Track Circuits in Irregularity Investigations

Appendix A 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 A 5.2 Possible Causes

Appendix A 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.

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Appendix A 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 A 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 A 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 A 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.

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Appendix A 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 A 5.2.7 False Energisation

Appendix A.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 D.C., 50 Hz 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 A.C. relay, or a higher voltage but at adjacent track circuit frequency on jointless track circuit).

On an A.C. 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 circuit 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.

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Appendix A.5.2.7.2 Circulating Currents in A.C. 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 (for example, in the impedance bond neutral connections on double rail A.C. track circuits or in the traction rail opposite the signalling rail block-joint 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 A.C. and audio frequency track circuits measure less than a few millivolts A.C.; 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 side-leads 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 shall 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 shall be equal to the difference in the currents in the two rails.

Appendix A 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 A 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 A 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.

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Appendix A 5.5 Track Circuit Investigation Checklist

1.	Irregularity still on?	[ ]
	Check reports of any witnesses to incident	[ ]
	Decide - possible irregularity (Y/N)	[ ]
	Decide - suspect circuits (Y/N)	[ ]
	suspect track (Y/N)	[ ]
2.	Signs of interference	[ ]
	with location of equipment?	[ ]
	with trackside equipment?	[ ]
	Reports of persons near equipment?	[ ]
3.	Signs of defect that could hold relay, now or recently?	[ ]
	Signs of relay contacts failing to open, now/recently?	[ ]
	Relay replaced?	[ ]
4.	Circuit design correct?	[ ]
	Circuit wiring and bonding correct to circuit book	
	and track insulation plan?	[ ]
	Condition of wiring - possible intermittent faults?	[ ]
5.	Insulation tests to earth/other cables and wiring correct?	[ ]
6.	Operating voltages etc within accepted limits and	
	consistent with history card?	[ ]
	Track drop shunt within specifications?	[ ]
7.	Relay has 'zero' residual voltage with feed power supply removed?	[ ]
	Phasing to adjacent tracks correct?	[ ]
	Insulated joints and bonding OK?	[ ]
	Spark gaps in good conditions (V greater than 5.0v)?	[ ]
	No other rail connections	[ ]
	Rail currents balanced and no sudden increase/decrease?	[ ]
	Tuned loop rejection value greater than 10?	[ ]
	Are rail currents unequal?	[ ]
	Do currents drop to zero with feed power supply removed?	[ ]
	Check all bonds and side-lead connections OK	[ ]
	Does difference in rail currents equal bond neutral current?	[ ]
	Trace circulating current to source, and correct	[ ]

8.	Check for train failing to shunt -	[ ]
	Train short	[ ]
	light weight	[ ]
	authorised for track-block operation	[ ]
	Train speed over train length prior to incident	[ ]
	powering or coasting?	[ ]
	diesel or electric traction?	[ ]
	Rail contact surfaces clean and polished?	[ ]
	signs of recent oxide film?	[ ]
	signs of heavy contamination?	[ ]
	signs of contaminates at foot of rail?	[ ]
	Track circuit short length?	[ ]

Appendix A 6 Guidelines for Testing of Axle Counter Track Sections in Irregularity Investigations

Appendix A 6.1 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 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 an axle counter track section 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 axle counter track sections.

The procedure's purpose is to check in a logical manner, for anomalies in all parts and operating characteristics of an axle counter system or sub-component.

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 A 6.2 Possible Causes

Appendix A 6.2.1 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.

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Appendix A 6.2.2 Manipulation

Where there are local track section relays, 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 A 6.2.3 Track Section Relay Fault

Is there any mechanical defect in the track section 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 A 6.2.4 Axle Counter Wiring Fault

Is there a fault in the axle counter system or rack wiring?

Insulation test all axle counter system and rack wiring; include tests on all external equipment including wheel sensors and the applicable cables and terminations, and internal equipment including relay and internal wiring.

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 axle counter's operation.

Appendix A 6.2.5 Adjustment/Sensitivity

Are any axle counter system 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 any of the axle counter system components indicating that they are not within their calibration range, resulting in reduced reliability?

Check all operating, busbar and back up battery voltages. If any values are out of specified range, record them, and continue the tests.

After completing the other inspections and tests, return and calibrate any equipment as required and then carry out a full test of the axle counter system's operation.

Appendix A 6.2.6 False Energisation

Appendix A.6.2.6.1 Extraneous feeds

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

Appendix A 6.2.7 Fail to Correctly Detect a Rail Vehicle

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

Do the wheels of the train involved in the irregularity appear to be significantly worn?

Does the track section show correctly occupied with the use of the Dummy Wheel?

Appendix A 6.3 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 failure of the axle counter system to detect a rail vehicle. 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 A 6.4 Conclusion

If an axle counter track section 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 axle counter system for a period, in an effort to capture any transient condition.

Appendix A 7 Guidelines for Testing of ETCS in Signalling Irregularity Investigations

Appendix A 7.1 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.

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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 A 7.2 Possible Causes

Appendix A 7.2.1 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 A 7.2.2 On Board ETCS Equipment Failure

An irregularity of ETCS could occur if the on-board 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 A 7.2.3 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 A 7.3 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*.

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 A 8 Guidelines for Testing of ETCS ASDO in Signalling Irregularity Investigations

Appendix A 8.1 Failure Modes

An ASDO wrong side failure is an irregularity that permits doors opening off-platform, such as off the ends of a platform, not in a defined useable area of a platform or on the wrong side of the train. See Section 7 for further information.

An irregularity of ASDO 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 an ASDO fitted train pulling up at an ASDO fitted platform.

The most common failure modes for ASDO equipment will likely be where the doors of an ASDO fitted train do not open automatically or the on-board system is operating in a degraded mode, most likely due to a balise or balise group fault (failed or missing). This is the designed failure mode of ASDO and is not considered to be a signalling irregularity.

Incorrect manual release of doors by train crew is considered an operational error and not a signalling irregularity.

Appendix A 8.1.1 Possible Causes

Appendix A.8.1.1.1 On Board ETCS Equipment Failure

An irregularity of ASDO could occur if the on-board 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 a specific ASDO balise group.

Report to Defects and arrange for the download of logs from the on-board train (juridical recorder units TRU or JRU).

Appendix A.8.1.1.2 Balise Group Miss-Installation

With ASDO balises there is no linking, and an irregularity could occur if ASDO balises are:

- installed in a wrong location, or
- installed in the wrong order.

In these cases, only an ASDO fitted train will receive a system response and only after it pulls to a stop at an ASDO fitted platform.

Check the recent history of the area concerned, for activities such as track or signalling work which might have required either the removal and replacement, or the relocation of one or more balises. Activities could include routine maintenance, repairs, installation, trackwork etc.

The following are examples of three plausible ASDO trackside fault scenarios. Note that these faults would only be apparent at the first stopping ASDO enabled train.

1. **Balises installed at correct location but in wrong order (0,1 instead of 1,0)**
    a. **Bi-directional Platform:**

Worst-case consequence identified is where the balises at the end of the platform are in the wrong order. This will result in reading a long distance instead of a short distance, shifting the virtual platform to be in front of the train and on the wrong side. See Figure 1.

- o The on-board system will not be able to automatically detect the problem (no DMI fault text message)
- o In the case of a train overshoot, potential for wrong side failure; for example, doors to be enabled on wrong side of the train or off the platform or both.

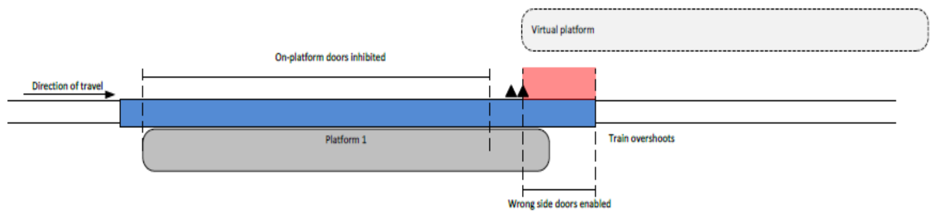

Figure 1 - Order of balises in 2nd balise group mixed up (0,1 – 1,0) for bi-directional platform

b. **Unidirectional Platform:**

If the balises in the group were installed in the reverse order, this would result in the on-board system not automatically detecting the problem (i.e. no DMI fault text message) and data will be ignored by the on-board system. The fault would cause a right-side failure and require manual door operation.

2. **Balise group is swapped with another balise group from the same platform or from another platform**

Where multiple balise groups are removed at the same time and balise groups are replaced in incorrect locations.

Potential for wrong side failure depending on whether this occurs at Unidirectional or Bidirectional platforms and the order of balises in each group. Consequences can include potential for doors to be enabled off the platform and or wrong side doors be enabled. Worst-case consequence is identified where the balise groups at the ends of the platform are in the wrong order.

- the on-board system will not be able to automatically detect the problem (no DMI fault text message).
- the on-board system will accept information from the incorrectly located balise group which is providing the wrong platform information (data will not align with the platform parameters).

3. **Reference Balise is replaced more than 350 mm from the Reference Balise marker plaque:**

For each platform, distance between rear door and end of platform barrier (fence/ASDO platform limit marker plaque) is unique for train stopping at a nominated position. Even if the balise moves more than 350 mm, the consequence will be platform specific and will depend on the magnitude of displacement.

Assessment A: Reference balise is replaced more than 350 mm (maximum tolerance) after the reference balise marker plaque (that is, the design position), in the direction of travel**:**

a. If the reference balise is placed a significant distance after the reference balise marker plaque and the reference balise is not read prior to stopping (assumes that the other balise in the group is properly decoded) a right-side failure will occur. See Section 8.6.1 for further information.

b. If the on-board reads the reference balise prior to stopping:

   - The on-board system will not be able to automatically detect the problem (no DMI fault text message).
   - The on-board may determine that the train has stopped short, and some rear doors may not open.
   - Potential for wrong side failure if the train overshoots. There is potential for door(s) to be enabled off the platform (on-board platform shifted off physical platform at the front of the train).

Assessment B: Reference balise is replaced more than 350 mm (maximum tolerance) prior to the reference balise marker plaque (that is, the design position), in the direction of travel (assumption is that both balises in the group are properly decoded):

- The on-board system will not be able to automatically detect the problem (no DMI fault text message).
- The on-board may determine that the train has overshot, and some front doors may not open.
- Potential for wrong side failure if train stops short on platform. There is a potential for some rear doors off the platform to open.

Appendix A 8.2 Rectification Responses

In the event of an ASDO wrong side failure due to a trackside equipment fault, the ASDO ‘function’ at the affected platform shall be booked out of use using the IBA form in accordance with PR S 40008 and disconnected or restricted, in accordance with PR S 40009.

Disconnect of the ASDO function is achieved by:

- covering ASDO balises by means of a lockable mechanical cover, or
- removing ASDO balises from the track.

Note:
It will not normally be necessary to place signals at stop as this does not necessarily provide protections against ASDO failure. Putting signals at stop as a result of ASDO failure scenarios could potentially cause unnecessary operational disruption.

For the majority of ASDO trackside failure situations, it may not be possible to immediately safely access the track in order to investigate and rectify the fault. Observe if there is any obvious sign of physical damage necessitating equipment replacement, such as a damaged Vortok beam or a balise, and make an initial determination of cause.

Prior to removal/disturbance of balises, perishable evidence must be captured to identify installation is to design as shown on the Site Certification Form, including:

- details of label(s) on balise and track (sleeper)
- measurements of the balise to the reference balise plaque
- distance between balises in the group (min 2.3m)
- measurement from fence/ASDO platform limit plaque to car marker
- read all balises at the affected platform with a BEPT to confirm:
  - if operational or failed
  - if it has been correctly positioned
  - if it is correctly positioned in group.

In the case where balises have been incorrectly positioned at a platform, there is the potential risk of other platforms balise groups affected at the same station. In such an event, all ASDO balise groups at the station should be likewise checked.

Replacement balise will need to be programmed in accordance with manuals and procedures.

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Appendix A 9 Irregularities and Wrong Side Failures, Types, Factors and Defects

Appendix A 9.1 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.

If ETCS operational (commissioned) balises are not read by ETCS fitted trains

Appendix A 9.2 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 block-joint.

Circuit Wiring and Contacts Incorrect/Ineffective

Incorrect:

- faulty design
- faulty installation.

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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.

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Mechanical Lock-bars, Train-bars, 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 Balise installed in the incorrect position in group
- ETCS on-board equipment defective or non-operational.

Appendix A 9.3 Defect type

Appendix A 9.3.1 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 A 9.3.2 Optical Defect

Signal lens illuminated by external light.

Lens broken.

Lens colour change.

Appendix A 9.3.3 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 A 9.3.4 Damage

Due to power surges, lightning, fire, flood, etc.

Due to construction, maintenance activity.

Due to accidents.

Vandalism.

Sabotage.

Appendix A 9.3.5 Personnel Defect

Design checking deficient.

Inspection and testing incorrectly performed.

Emergency releases incorrectly given.

Work wrongly performed, procedures not followed, substandard.

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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 A 9.3.6 Management Defect

Faulty or deficient standards.

Faulty or deficient procedures.

Faulty or deficient training, accreditation.

Faulty or deficient supervision, quality control.

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Engineering System Integrity

Engineering Procedure

Signalling and Control Systems

Signalling Safeworking

PR S 40005

Damage to Signalling Equipment including Cables

Version 2.0

Date in Force: 15 July 2021

Approved by:	Professional Head Signalling and Control Systems Engineering System Integrity	Authorised by:	Engineering Technical Publications Manager System Integrity

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Document control

Version	Date	Author/Prin. Eng.	Summary of change
1.0	16 September 2013	Y Bagaric	First issue as Sydney Trains document
1.1	21 September 2016	R Del Rosario	Updated for new titles & roles and review to mandatory ASA requirements and EI S 15-03
1.2	1 March 2019	A Sozio	Updated to include Control System
1.3	8 March 2019	C Darmenia	Inclusion of ATP/ETCS
1.4	17 December 2020	C Darmenia	Inclusion of ASDO
2.0	15 July 2021	Ian Maydew/C Darmenia	Update to include axle counter requirements

Summary of changes from previous version

Summary of change	Section
Added axle counter equipment to checklist	Appendix A

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Table of Contents

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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 systems. 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 Safeworking 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 Safeworking 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.

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Appendix A Damage to Signalling and Safeworking Equipment Checklist

INCIDENT DETAILS

Incident			
Location:			
Date:		Time:	
Report Compiled by (Name):			
Position:		Location:	

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	

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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	

ETCS L1 EQUIPMENT (ATP & ASDO)

ETCS balise junction box	
ETCS balise tail cable	
ETCS balise mounting system	
ETCS balise	
ETCS LEU	
Ethernet Network Switch	
Reference Balise marker	

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LEVEL CROSSING EQUIPMENT

Lights Stand	
Lights	
Boom Lights	
Boom Mechanism	
Booms	
Pedestrian Barriers/Lights	
ARMCO Guardrails	

TRACK CIRCUITS

Insulated Joints	
Bootleg Risers	
Matching/Tuning Units	
Track Connection Cables	
Series Bonds, Parallel Bonds	
Feed/Relay Fuses	
Impedance Bonds	
Impedance Bond Sideleads	
Electrolysis Bonds/Cables	
OHWS Spark Gap Connections	
Solar feed Units	

AXLE COUNTER EQUIPMENT

Axle counter evaluator	
Wheel sensor incl. tail cable	
Wheel sensor mounting clamp	
Wheel sensor trackside termination unit	
Axle counter external cable	

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Engineering System Integrity

Engineering Procedure

Signalling and Control Systems

Signalling Safeworking

PR S 40006

Manual Release of Interlockings

Version 2.0

Date in Force: 13 February 2023

Approved by:	Professional Head Signalling and Control Systems Engineering System Integrity	Authorised by:	Engineering Technical Publications Manager System Integrity

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Document control

Version	Date	Author/Prin. Eng.	Summary of change
1.0	16 September 2013	Y Bagaric	First issue as a Sydney Trains document
1.1	12 January 2018	Mohammed Khan	Update for new titles and roles and to meet EI S 15/03 section 14 and ASA Standards
1.2	15 July 2021	Ian Maydew, Colin Darmenia	Update to include axle counter requirements
2.0	13 February 2023	Paul Zammit, Mohammed Khan	Incorporate procedures for release of route holding, releasing switches and mechanical interlocking. Clarify and contemporise existing requirements

Summary of changes from previous version

Summary of change	Section
Title change: Manual Release of Interlockings	Title
Update content to Asset Standards Style Manual	All
Clarify requirements and make consistent where practicable, including section titles	All
Remove reference to NGE 234 and add reference to NPR 707	1
Add additional example as to 'why' releases are provided	2
Add locking principle for Indication Locking (along with Approach Locking and Route Holding)	4
New Section titles: 4.1 Locks and relays that may be released 4.2 Locking situations that may be released	4.1 4.2
Add requirement for mechanical interlocking releases (not specifically prescribed in this document).	4.1

Clarify manual releases and releasing methods	5 5.1
Add 'false feeding of relays' as a means of momentary bridging	6
Transfer the 'checking process' from old step (b) – from old Section 5.8 'Release of Points Lock relays at route control interlockings to Section 6 Momentary bridging, as such checking applies to <u>all</u> application of momentary bridging (not just Points NLR/RLR). Consequently, the 'checking process' is removed from the old Section 5.8 (b).	6 8.10
Add Train Register Book, or equivalent (as applicable) as a form of request for release as alternative to use IBA	7
IBA signature no longer mandated in NR&P, therefore may be done by recording the time, date and name of each person on the NRF 003 form.	7
Remove old section: General releasing conditions - now incorporated in specific procedures herein.	old 4
Remove momentary bridging of axle counter relay contact in Release of Normal Indication locks on signal levers – as highly unlikely AxC will be installed in mechanical interlocking areas	8.1
Add dot point one (ensure protecting signals at stop, trainstops raised) in: Release of Normal Indication and Reverse Indication locks on points levers. Also enhanced dot point three with last sentence regarding conditions not met.	8.2
Clarify paragraph five.	8.3
Add new specific procedure for release of Normal electric locks in releasing switches	8.4
Provide separate Approach Lock release procedures for Approach Stick relay at standard relay interlockings and Approach Lock Stick relay (ALSR) at route control interlockings.	8.5 8.9
Add requirement for Signal Engineer permission prior to releasing Points Lock relays at standard relay interlockings (consistent with route control interlockings and subsequent route holding releases).	8.7
Add new specific procedure for release of Route Holding relays at standard relay interlockings.	8.8
Clarified the reason for providing a release of route holding release to Points Lock relays at route control interlockings.	8.11
Add new specific procedure for release of Route Holding relays at route control interlockings.	8.12

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Table of Contents

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1 Reference documents

This procedure shall be read in conjunction with the following documents:

Signalling Safeworking Procedures

- *PR S 40002 Temporary Bridging of Signalling Circuits*
- *PR S 40008 Securing Signalling Apparatus Out of Use*
- *PR S 40051 Axle Counters*

Network Rules and Procedures

- *NPR 740 Responding to Faulty Points*
- *NPR 707 Clipping Points*
- *NSG 608 Passing Signals at Stop*
- *NRF 003 Infrastructure Booking Authority (IBA)*

2 Introduction

Release of track and indication locking is provided to manage rail vehicle movements when the interlocking is locked and unable to become free due to specific situations, resulting in train delays that would otherwise be extensive.

Most track and indication locking are 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 signallers.

3 Locking principles used in interlockings

The following locking principles relate to the release of interlockings:

Approach locking

Approach locking is provided to prevent the alteration of a route and subsequent release of locking in the face of a rail vehicle which has received a proceed aspect for the route.

The approach locking will be maintained until the approaching train has been proved to have come to a stand at the signal by a time release, if provided.

This provides an assurance of the following:

- All facing and trailing points are maintained in their correct position and locked.
- Trailing points are set for the non-conflicting position; thus, no converging routes can be set.
- Opposing signals are held at stop.

Route holding

Route holding prevents the release of locking when the train has entered the route.

The route holding will be maintained until it is safe to release the locking on points or opposing signals.

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Route holding prevents the following:

- Unlocking or movement of facing points within the route.
- Alteration of facing points in the overlap to an obstructed overlap.
- Alteration of trailing points within the route and in the overlap.
- Clearing of opposing signals.

Indication locking (NI and RI)

Indication locks prevent the release of locking until it is safe to do so. Thus, signals, points and other units which are operated or directly affected by a lever, are locked in their proper position.

Only then can a signal or points lever, or relevant indicating relay be permitted to enter the full normal or full reverse position, freeing the locking for other signals or points to be operated.

4 Rules and types of releases

Manual releases shall only be performed in accordance with these Signalling Safeworking Procedures.

Manual releases, including the application of momentary bridging and the equivalent of lifting electric locks or mechanical locks shall only be carried-out by licensed signalling personnel deemed competent to perform such activity without the requirement for supervision.

The interlocking between conflicting signals, points, and level crossings (as applicable) shall not be released.

At standard relay interlockings, relays such as Signal Reverse relays, Points Normal and Reverse relays, and Releasing Switch Normal relays shall not be released.

At route control interlockings, relays such as Route Reverse relays, and Releasing Switch Normal and Reverse Lock relays shall not be released.

Track locking (approach locking or route holding), may be released in certain circumstances.

Indication locks on mechanical levers, either signal normal indication locks or points normal or reverse indication locks, may be released in certain failure circumstances.

CAUTION:
Circuits can combine interlocking with track locking or track locking with indication locking and it is necessary to ensure that only the specific locking concerned is released.

4.1 Locks and relays that may be released

Manual releases are normally confined to the following electric locks and relays:

- At mechanical interlockings:
  - Normal Indication (NI) electric locks on signal levers
  - Normal Indication (NI) and Reverse Indication (RI) electric locks on points levers

    - Normal and Reverse (N and R) electric locks on points levers and facing points lock levers
    - Normal (N) electric locks in releasing switches.

Procedures for releasing mechanical interlocking (for example, the mechanical locking in a mechanical interlocking machine, as well as Annett locks, Fortress locks, Token keys, and the like) are not prescribed in this document due to the variability of prevailing situations.

Any such releases shall only proceed where the requirements are determined by the signal maintenance engineer (or delegate signal engineer) and subsequent permission is granted by the Signal Engineering Manager. The determination shall take into account the principles and precautions prescribed in this procedure for other release types, as relevant for the specific situation.

Whilst the responsibility to perform the release is held by licensed signalling personnel holding relevant competency, the necessary dismantling of mechanical locking required for the release shall only be done by persons competent to do such work (typically an interlocking fitter or locksmith, as applicable).

- At standard relay interlockings:
    - Approach locking in Approach Stick relays, including Approach Lock Stick relays (ALSR), as appliable.
    - Signal Normal Indication (NI) relays
    - Points Lock relays
    - Route holding in Route Stick (USR or RS) relays.
- At route control interlockings
    - Approach locking in Approach Lock Stick relays (ALSR)
    - Signal Route Normal (NLR) relays
    - Route holding in Points Lock (NLR or RLR) relays
    - Route holding in Route Stick (USR) relays.

4.2 Locking situations that may be released

The following situations are where releases can be provided:

- Failure of an electric lock and associated circuit.
- Failure of a Signal NI relay circuit or Signal Route Normal NLR relay circuit.
- Failure of an Approach Stick relay circuit or Approach Lock Stick relay circuit.
- Incorrect route set for an approaching rail vehicle, or the route needs to be changed in favour of a second rail vehicle after the first rail vehicle has passed the outer home signal.
- Track circuit or axle counter track section has failed.
- Rail vehicle remains occupying a particular section of track.

Note:

Where axle counter track sections become disturbed by events such as miscount, system failure or power failure, axle counter resets may be done in accordance with *PR S 40051 Axle Counters.*

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5 Manual releasing methods

Manual releasing shall be confined to the following methods:

- Manually lifting the electric lever lock on mechanical levers while the lever is moved.

  Pertains to Signal Normal Indication locks, Points Normal Indication and Reverse Indication locks, and Points and FPL Normal and Reverse locks, at mechanical interlockings.

- Manually lifting the electric lock in releasing switches while the releasing switch handle is operated.

  Pertains to Releasing Switch Normal lock, typically used at ground frames.

- Momentary false feeding to energise the affected relay.

  Pertains to Signal Normal Indication relays at standard relay interlockings, Points Lock relays at standard relay interlockings, and Signal Route Normal Lock relays at route control interlockings.

- Momentary bridging the relevant approach stick finger contact in circuit to energise the affected relay.

  Pertains to Approach Stick relays and Approach Lock Stick relays at standard relay interlockings and route control interlockings.

- Momentary bridging the relevant track circuit relay (or repeat relay) contact, or axle counter track section relay (or repeat relay) contact in circuit to energise the affected relay (not CBI input).

  Pertains to Points Lock relays at route control interlockings, and Route Holding relays at standard relay interlockings and route control interlockings.

6 Momentary bridging for manual releases

Momentary bridging is the bridging of specific circuit contacts or the false feeding of relays for the purpose of releasing track locking or indication locking. The jumper wire shall be always handheld (at least at one end) and never left connected.

The bridge shall be applied momentarily for just sufficient time to allow the release to be given, then immediately removed.

Prior to applying a momentary bridge for the purpose of releasing relays, check to verify the relevant relay contact intended to be bridged in circuit is in fact the correct contact providing the function required to be bridged.

6.1 Jumper wires for momentary bridging

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

Note:

Jumper wires and issuing criteria used for momentary bridging are exempt from meeting the temporary bridging requirements stated in *PR S 40002 Temporary Bridging of Signalling Circuits*.

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The jumper wire used for momentary bridging shall be either registered for further use or improvised for single use. Registered jumper wires shall be returned to the person responsible for the register and safe keeping. In this case, the reason for the issue shall be recorded in the register, as well as obtaining signatures for receipt and subsequent return.

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

7 Requesting a release

A formal request for release shall be obtained from the signaller before a manual release is provided.

Details of the release shall be entered by using form *NRF 003 Infrastructure Booking Authority* (IBA), or an entry in the Train Register Book or equivalent. The details of the release shall be acknowledged by the signaller and licensed signalling person; this is done by recording the name of each person, time, and date on the NRF 003 form.

A separate request shall be obtained for every release given, requiring a separate entry in the NRF 003 form, Train Register Book or equivalent, as applicable.

8 Procedures for providing a release

This section provides the detailed procedures to be observed for the following specific release types, as stated in Section 8.1 through to Section 8.12.

Before any release is given, the signaller shall be requested to place at stop the protecting signals and ensure they remain at stop by applying blocking facilities to such controls before the release is provided.

Additionally, an assurance shall be obtained from the signaller that all approaching rail vehicles have come to a stand and will remain so until the release process is complete.

These assurances shall be recorded on the request for release form NRF 003, Train Register Book or equivalent, as applicable.

The specific release details shall be fully explained to the signaller.

8.1 Release of Normal Indication locks on signal levers

Normal Indication (NI) locks on signal levers apply indication locking, and generally incorporate track locking for approach locking and in some cases for route holding.

Normal Indication locks on signal levers may be released when the electric lock has failed or when points need to be operated to redirect an approaching train which is occupying the track (approach) locking and preventing the signal lever from being placed to the full normal position.

The following precautions shall be observed before providing a release of Normal Indication locks on signal levers:

- Ensure the protecting signals are at stop with blocking facilities applied, and the associated trainstops (where J-type trainstops are provided) are in the raised position.
- Ensure any rail vehicle approaching the signals involved or has entered the route (occupying track circuits included in the NI lock circuit) has been brought to a stand and is clear of any points in the route ahead of the signal and will remain so until the release process is complete.

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The release shall be given by manually lifting the affected electric (NI) lock while the respective signal lever is moved to the full normal position by the signaller.

8.2 Release of Normal Indication and Reverse Indication locks on points levers

Normal Indication (NI) and Reverse Indication (RI) locks on points levers apply indication locking and do not incorporate track locking.

Normal Indication locks and Reverse Indication locks on points levers may be released when the electric lock has failed preventing the points lever being placed to the full normal or full reverse position in correspondence with the points.

The following precautions shall be observed before providing a release of Normal Indication and Reverse Indication locks on points levers:

- Ensure the protecting signals are at stop with blocking facilities applied, and the associated trainstops (where J-type trainstops are provided) are in the raised position.
- Ensure any rail vehicle approaching the route or has entered the route has been brought to a stand and will remain so until the release process is complete.
- Ensure the points are lying in correspondence with the points lever, and the points switch blades are in their respective fully closed and fully opened positions (as applicable), and that facing points are securely locked by the points lock.

  Where these conditions are not met, the release shall not be provided until the points are secured in their respective fully closed and fully opened positions (as applicable), and accordingly clipped and SL locked.
- Ensure the points will not be unlocked or moved before giving the release. If necessary, disable, disconnect, or clip and SL lock the points in accordance with the network rules and procedures.

The release shall be given by manually lifting the affected electric (NI or RI) lock while the respective points lever is moved to the full normal or full reverse position (as applicable) by the signaller.

Points that remain out of order following an initial release of the indication lock shall not be released again unless the points are booked out of use, clipped and SL locked. The failed indication lock may then be permanently released, if necessary, on condition that *NSG 608 Passing Signals at Stop* and *NPR 740 Responding to Faulty Points* are in effect. This will enable the lever to be placed in correspondence with the points position so to obtain the sequence of the interlocking.

WARNING:
Rail traffic shall not be permitted to pass over the affected facing points while the points levers is in the NI or RI position unless the points are secured in correct position by a clip and SL lock.

8.3 Release of Normal and Reverse locks on points levers or facing point lock levers

Normal and Reverse (N and R) locks on points levers or facing point lock levers incorporate track locking, generally for both approach locking and route holding.

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

Where it is necessary to release converging points to bypass a rail vehicle occupying route holding tracks (locking the points concerned) with another rail vehicle, an assurance from the signaller shall be obtained that both rail vehicle drivers are aware of the intended move. This assurance shall be documented on the NRF 003 form, Train Register Book or equivalent, as applicable.

The following precautions shall be observed before providing a release of Normal and Reverse locks on points levers or facing point lock levers:

- Ensure the protecting signals are at stop with blocking facilities applied, and the associated trainstops (where J-type trainstops are provided) are in the raised position.
- Ensure any rail vehicle approaching the route or has entered the route has been brought to a stand and will remain so until the release process is complete.
- Ensure no rail vehicle is foul of any points worked by the points lever.
- At hybrid installations containing both mechanical and relay interlocking, ensure that all relay interlocked functions are non-conflicting with the mechanical interlocking.

The release shall be given by manually lifting the affected electric (N and R) lock while the respective points lever is moved to the full normal or full reverse position (as applicable) by the signaller, or the respective facing point lock lever is moved to the ‘locked’ position by the signaller.

Subsequent releases may be provided as necessary. However, as an alternative to releasing the lock each time, the points may be booked out of use and disconnected. This shall be done in conjunction with securing the points with a clip and SL lock and a qualified worker stationed at the points acting in accordance with the network rules and procedures to manually operate the points as required. In this case, the lock can then be lifted or removed in accordance with obtaining the assurances stated in Section 7and Section 8, until the repairs have been affected.

8.4 Release of Normal electric locks in releasing switches

Normal locks in releasing switches incorporate track locking, generally for approach locking.

Normal locks in releasing switches may be released when the electric lock is inoperative due to lock failure or releasing switch circuit failure.

The following precautions shall be observed before providing a release of Normal locks in releasing switches:

- Ensure the protecting signals are at stop with blocking facilities applied (blocking facilities not applicable in auto sections), and the associated trainstops (where J-type trainstops are provided) are in the raised position.

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- Ensure any rail vehicle approaching the route (leading towards the ground frame operated points) or has entered the route has been brought to a stand and will remain so until the release process is complete.
- Ensure no rail vehicle is foul of any points worked by the points lever associated with the ground frame that is released by the releasing switch.

The release shall be given by manually lifting the Normal lock while the releasing switch handle is operated to the full reverse position by the qualified worker.

8.5 Release of Approach Stick relays at standard relay interlockings

Approach Stick relays, including Approach Lock Stick relays (ALSR) at standard relay interlockings are provided for approach locking of signals.

Approach Stick relays (including ALSR) at standard relay interlockings may be released for the following reasons:

- Prolonged failure of the approach locking circuit (the failure cannot be rectified in time to avoid major train delays).
- Rail vehicle remains occupying the tracks used for approach locking.

Note:
Where Approach Stick relays, including Approach Lock Stick relays are fitted with a time release function, the release is provided by the interlocking. In such case, a manual release is generally not required.

The following precautions shall be observed before providing a release of Approach Stick relays, including Approach Lock Stick relays:

- Ensure the protecting signals are at stop with blocking facilities applied, and the associated trainstops (where J-type trainstops are provided) are in the raised position.
- Ensure any rail vehicle approaching the signal involved has been brought to a stand and will remain so until the release process is complete.

The release shall be given by momentarily bridging the stick finger contact on the affected Approach Stick relay or Approach Lock Stick relay (as applicable).

If the relay does not energise, inform the signaller that rail traffic will need to be managed in accordance with the network rules and procedures until the situation is rectified.

8.6 Release of Signal Normal Indication relays at standard relay interlockings

Failure of Signal Normal Indication (NI) relays at standard relay interlockings may be released only if extensive train delays would otherwise occur.

Where the failure is due to track (approach) locking, such locking is released by the Approach Stick relay or Approach Lock Stick relay (as applicable).

Where the failure is due to another cause in the Signal Normal Indication relay circuit, a release of the Signal Normal Indication relay may be provided.

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The following precautions shall be observed before providing a release of Signal Normal Indication relays:

- Ensure the protecting signals are at stop with blocking facilities applied, and the associated trainstops (where J-type trainstops are provided) are in the raised position.
- Ensure any rail vehicle approaching the signals involved or has entered the route has been brought to a stand and will remain so until the release process is complete.
- Book out of use and disconnect the associated signal to prevent its operation.

The release shall be given by momentarily false feeding to energise the affected Signal Normal Indication (NI) relay.

Inform the signaller that rail traffic will need to be managed in accordance with the network rules and procedures.

8.7 Release of Points Lock relays at standard relay interlockings

Points Lock relays at standard relay interlockings apply track locking, generally for route holding, and in some cases for approach locking.

The release of Points Lock relays at standard relay interlockings may be provided except in cases of track (approach) locking. Such locking is released by the Approach Stick relay or Approach Lock Stick relay, where provided.

Permission from the maintenance signal engineer (or delegate signal engineer) shall be obtained prior to giving the Points Lock relay release. The permission shall only be granted for the following reasons:

- Prolonged failure of a track circuit that is affecting the route holding element in a Points Lock relay circuit (the failure cannot be rectified in time to avoid major train delays).
- Rail vehicle remains occupying the route holding tracks.

Where it is necessary to release converging points to bypass a rail vehicle occupying route holding tracks (locking the points concerned) with another rail vehicle, an assurance from the signaller shall be obtained that both rail vehicle drivers are aware of the intended move. This assurance shall be documented on the NRF 003 form, Train Register Book or equivalent, as applicable.

The following precautions shall be observed before providing a release of Points Lock relays at standard relay interlockings:

- Ensure the protecting signals are at stop with blocking facilities applied, and the associated trainstops (where J-type trainstops are provided) are in the raised position.
- Ensure any rail vehicle approaching the route or has entered the route has been brought to a stand and will remain so until the release process is complete.
- Ensure no rail vehicle is foul of any points worked by the points control.

The release shall be given by momentarily false feeding to energise the affected Points Lock relay while the respective points control is operated by the signaller.

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8.8 Release of Route Holding relays at standard relay interlockings

The release of Route Holding relays (USR or RS) at standard relay interlockings is permitted to avoid major train delays by placing the affected Route Holding relay to the normal position. This enables the impacted routes to operate as expected.

Permission from the maintenance signal engineer (or delegate signal engineer) shall be obtained prior to giving the route holding release. The permission shall only be granted for the following reasons:

- Prolonged failure of a track circuit that is affecting the Route Holding relay (the failure cannot be rectified in time to avoid major train delays).
- Rail vehicle remains occupying the route holding tracks.

Where it is necessary to release converging points to bypass a rail vehicle occupying route holding tracks (locking the points concerned) with another rail vehicle, an assurance from the signaller shall be obtained that both rail vehicle drivers are aware of the intended move. This assurance shall be documented on the NRF 003 form, Train Register Book or equivalent, as applicable.

The following precautions shall be observed before providing a release of Route Holding relays:

- Ensure the signals authorising the route-entry (including the signals immediately protecting any ends of points concerned) and the route-exit are at stop with blocking facilities applied, and the associated trainstops (where J-type trainstops are provided) are in the raised position.
- Ensure any rail vehicle approaching the route (including the signals immediately protecting any ends of points concerned) or has entered the route has been brought to a stand and will remain so until the release process is complete.
- Ensure that no train, having passed an immediate protecting signal is on the approach side of the point-ends concerned.
- Ensure no rail vehicle is foul of any points concerned.
- Book out of use and disconnect the associated signal (at the failed route stick relay) to prevent its operation.

The release shall be given by momentarily bridging the relevant track circuit relay (or repeat relay) contact providing the route holding function in the affected Route Holding relay circuit (USR or RS).

8.9 Release of Approach Lock Stick relays at route control interlockings

Approach Lock Stick relays (ALSR) at route control relay interlockings are provided for approach locking of signals.

An Approach Lock Stick relay at route control interlockings may be released for the following reasons:

- Prolonged failure of the approach locking circuit (the failure cannot be rectified in time to avoid major train delays).
- Rail vehicle remains occupying the tracks used for approach locking.

Note:
Where Approach Lock Stick relays are fitted with a time release function, the release is provided by the interlocking. In such case, a manual release is generally not required.

The following precautions shall be observed before providing a release of Approach Lock Stick relays:

- Ensure the protecting signals are at stop with blocking facilities applied, and the associated trainstops (where J-type trainstops are provided) are in the raised position.
- Ensure any rail vehicle approaching the signal involved has been brought to a stand and will remain so until the release process is complete.

The release shall be given by momentarily bridging the stick finger contact on the affected Approach Lock Stick relay (ALSR).

If the relay does not energise, inform the signaller that rail traffic will need to be managed in accordance with the network rules and procedures until the situation is rectified.

8.10 Release of Signal Route Normal relays at route control interlockings

Failure of Signal Route Normal (NLR) relays at route control relay interlockings may be released only if extensive train delays would otherwise occur.

Where the failure is due to track (approach) locking, such locking is released by the Approach Lock Stick relay.

Where the failure is due to another cause in the Signal Route Normal relay circuit, a release of the Signal Normal Route relay may be provided.

The following precautions shall be observed before providing a release of Signal Route Normal relays:

- Ensure the protecting signals are at stop with blocking facilities applied, and the associated trainstops (where J-type trainstops are provided) are in the raised position.
- Ensure any rail vehicle approaching the signal involved or has entered the route has been brought to a stand and will remain so until the release process is complete.
- Book out of use and disconnect the associated signal to prevent its operation.

The release shall be given by momentarily false feeding to energise the affected Signal Route Normal (NLR) relay (after driving the RLR relay down, if necessary).

Inform the signaller that rail traffic will need to be managed in accordance with the network rules and procedures.

8.11 Release of Points Lock relays at route control interlockings

The release of Points Lock (NLR or RLR) relays at route control interlockings is permitted if extensive train delays would otherwise occur. The release places the affected Points Lock relays in correspondence with the intended lie of the points, as determined by the signaller.

WARNING:
This procedure pertains to the release of track locking only. The interlocking functions incorporated in Points Lock relay circuits at route control interlockings shall not be released.

Permission from the maintenance signal engineer (or delegate signal engineer) shall be obtained prior to giving the Points Lock relay release. The permission shall only be granted for the following reasons:

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- Prolonged failure of a track circuit or axle counter track section that is affecting the route holding element in a Points Lock relay circuit (the failure cannot be rectified in time to avoid major train delays).
- Rail vehicle remains occupying the route holding tracks.

Where it is necessary to release converging points to bypass a rail vehicle occupying route holding tracks (locking the points concerned) with another rail vehicle, an assurance from the signaller shall be obtained that both rail vehicle drivers are aware of the intended move. This assurance shall be documented on the NRF 003 form, Train Register Book or equivalent, as applicable.

The following precautions shall be observed when providing a release of Points Lock relays at route control interlockings:

- Ensure all signals that interlock and lead over the points concerned are at stop with blocking facilities applied, and the associated trainstops (where J-type trainstops are provided) are in the raised position.
- Ensure any rail vehicle approaching the signals involved or has entered the routes concerned has been bought to a stand and will remain so until the release process is complete.
- Ensure no points or releases which interlock with the points concerned are in conflicting positions.
- Ensure no rail vehicle is foul of any points concerned.
- Request the signaller to position the relevant points control such that the control corresponds with the lie of points concerned, and to apply a blocking facility to such points control.
- Manually operate the points concerned to the intended (opposite) position and secure by clip and SL lock in accordance with the network rules and procedures. This will temporarily place the points out of correspondence with the interlocking and points control.
- Momentarily bridge the relevant track circuit relay (or repeat relay) contact or axle counter track section relay (or repeat relay) contact providing the route holding function in the affected Points Lock (NLR or RLR) relay circuit.
- Request the signaller to remove the blocking facility on the relevant points control and operate the control to the centre position, and to observe the 'points free' indication; then (after obtaining the points free indication) to operate the points control to the intended position (Normal or Reverse) in correspondence with the lie of points.
- Remove the bridge immediately upon the respective Points Lock relay becoming energised.
- Check that the opposite Points Lock relay is in the de-energised position.

WARNING:

No attempt shall be made to operate the Points Lock relay or points by operating the route set controls.

No contacts in the Points Lock relay circuit shall be bridged, other than those applying route holding.

Point Lock relays shall not be manually lifted or replaced with a relay in the energised position.

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8.12 Release of Route Holding relays at route control interlockings

The release of Route Holding relays (USR) at route control interlockings is permitted to avoid major train delays by placing the affected Route Holding relay to the normal position. This will enable the impacted routes to operate as expected.

Permission from the maintenance signal engineer (or delegate signal engineer) shall be obtained prior to giving the route holding release. The permission shall only be granted for the following reasons:

- Prolonged failure of a track circuit or axle counter track section that is affecting the Route Holding relay (the failure cannot be rectified in time to avoid major train delays).
- Rail vehicle remains occupying the route holding tracks.

Where it is necessary to release converging points to bypass a rail vehicle occupying route holding tracks (locking the points concerned) with another rail vehicle, an assurance from the signaller shall be obtained that both rail vehicle drivers are aware of the intended move. This assurance shall be documented on the NRF 003 form, Train Register Book or equivalent, as applicable.

The following precautions shall be observed before providing a release of Route Holding relays:

- Ensure the signals authorising the route-entry (including the signals immediately protecting any ends of points concerned) and the route-exit are at stop with blocking facilities applied, and the associated trainstops (where J-type trainstops are provided) are in the raised position.
- Ensure any rail vehicle approaching the route (including the signals immediately protecting any ends of points concerned) or has entered the route has been brought to a stand and will remain so until the release process is complete.
- Ensure that no train, having passed an immediate protecting signal is on the approach side of the point-ends concerned.
- Ensure no rail vehicle is foul of any points concerned.
- Book out of use and disconnect the associated signal (at the failed route stick relay) to prevent its operation.

The release shall be given by momentarily bridging the relevant track circuit relay (or repeat relay) contact or axle counter track section relay (or repeat relay) contact providing the route holding function in the affected Route Holding relay circuit (USR).

8.13 Releases for other situations including computer based interlocking

Other situations may arise when the interlocking has been locked and may require a release. An example of this is at computer based interlockings, where a loss of track circuit input or axle counter track section input may cause the interlocking to become locked.

In such cases, where the procedures for providing a release are not prescribed, the risks of providing such release shall be identified and determined by a signal engineer.

The principles and precautions prescribed in this procedure shall be taken into account when considering the provision of such release.

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

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Engineering System Integrity

Engineering Procedure

Signalling and Control Systems

Signalling Safeworking

PR S 40007

Seldom Used Signalling Equipment

Version 2.1

Date in Force: 20 October 2023

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Approved by:	Professional Head Signalling and Control Systems Engineering System Integrity	Authorised by:	Engineering Technical Publication Manager System Integrity

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Document control

Version	Date	Author	Summary of change
1.0	16 September 2013		First issue as Sydney Trains document
1.1	21 September 2016	R. Del Rosario	Updated for new titles & roles and EAS 15/04 requirement and move deleted PR S 40035 Section 3.2 & 3.3
2.0	13 April 2023	Paul Zammit Mohammed Khan	Procedure completely updated to incorporating all requirements associated with seldom used signalling equipment including contaminants from receding floods. Includes the residual requirements from EI S 18-06 and EA S 19-03
2.1	20 October 2023	Paul Zammit Mohammed Khan	Updated requirements emanating from engagement with relevant signal engineers

Summary of changes from previous version

Summary of change	Section
Clarify the example (in paragraph 5) for leaving the signalling operable when managing the onset of seldom used situations	4.3
Add a Note referring to auto-normalising function of points leading into sidings or refuges	5.1.5
Provide an exemption for inspection and certification intervals of points where impractical to operate during maintenance	5.2

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Table of Contents

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1 Reference documents

This procedure shall be read in conjunction with the following documents:

Signalling Safeworking Procedures

- *PR S 40008 Securing Signalling Apparatus Out of Use*
- *PR S 40009 Disconnection of Signalling Apparatus*
- *PR S 40017 Maintenance Responsibilities and Frequencies*
- *PR S 40022 Inspection and Testing of Signalling Interlockings*
- *PR S 40025 Track Circuits*
- *PR S 40026 Rerailing – Precautions to be taken*
- *PR S 40028 ETCS L1 Trackside Equipment*
- *PR S 40029 Point Lock Testing - Mechanical*
- *PR S 40030 Point Lock and Detection Testing on Power Operated Points*

Transport Standards

- *T HR SC 10014 ST Signalling Design Principle – Points*
- *TS TOC 1 Train Operating Conditions (TOC) Manual – General Instructions*

Network Rules and Procedures

- *NPR 707 Clipping Points*
- *NPR 728 Operating Emergency Crossovers*
- *NGE 220 Unreliable Track-Circuit Operation*
- *NSY 512 Manual Block Working*

2 Introduction

Signalling equipment which is not used within defined periods or is impacted by similarly causal situations is deemed 'seldom used'. This is particularly relevant in the case of track circuits. Seldom used signalling equipment can pose a risk to the safe and reliable operation of the signalling system.

Seldom used signalling equipment can apply to track circuits, points, European train control system (ETCS) balises, signals, trainstops, level crossing equipment, and potentially more. Additionally, it can apply to mechanically operated equipment, such as mechanical frames and connections, mechanical points, and semaphore signals, as well as structures used to mount signalling equipment.

Various situations and events can attribute to signalling equipment becoming seldom used. The following list provides some examples:

- **Operational changes**

  Seldom used lines, closed lines, suspended rail traffic, reduced rail traffic, altered train running such as from timetable change. Intermittent train running such as at coal loading loops. Temporary closure of local signal boxes and ground frames.

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- **Environmental and weather impacts**

  Unplanned events such as flooding, landslips, washaways, fires. Particulates from ocean spray, industrial fallout. Contaminants from haulage spills, sand or mud slurry, oil, vegetation debris.

- **Seldom operated or traversed equipment**

  Mechanisms such as signals, trainstops, points, level crossing equipment located on seldom used lines. Turnouts and crossovers associated with balloon loops, sidings, refuges and out of course working. Temporary closure of local signal boxes and ground frames. Seldom traversed or unlinked ETCS balises. Signalling equipment booked out of use for a prolonged period. Non-traversal of track circuits exceeding 72 hours.

- **Rolling stock characteristics**

  Rail vehicles of short or single consist, diesel multiple units (DMU), light engines, hi-rail / road rail vehicles. Rail vehicles with suboptimal wheel profile or with poor rail interface. Running of rail vehicles having non-predominate wheel profile (for example, ANZR 1 operating in WPR 2000 territory).

- **Engineering activities**

  Trackwork and possessions (planned and unplanned), including rerailing, equipment renewals, new or altered works. Installed equipment pending commissioning or removal. Reduction of maintenance due to line closure or other reason.

- **Track configuration changes**

  An unexpected impact to train running or signal operation caused by a change of track configuration.

The risks emanating from seldom used signalling equipment are mitigated by various controls, including the requirements stated in this procedure. Section 3 provides further information regarding such risks and mitigations.

3 Risks associated with seldom used signalling equipment

Track circuits that are seldom used can give rise to a potentially unsafe situation. The rail surface contact band required for an effective track circuit shunt may become contaminated by rust, debris, slurry or other substances potentially resulting in a loss of rail vehicle detection.

The loss of rail vehicle detection can affect the safe operation of routes and signals, the locking of points and the activation of level crossing equipment, as well as having other signalling impacts.

Seldom used or unlinked ETCS balises can fail to provide the intended protection for a situation if they become defective or missing. See Section 7 and Section 7.1 regarding seldom used and unlinked ETCS balises.

Mechanically operated equipment such as mechanical frames and connections, mechanical points, and semaphore signals that are seldom used can be impacted by the lack of operation and lubrication. Such equipment may eventually seize, potentially making them difficult to operate and maintain.

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Assets such as signal structures, level crossing F type posts (some frangible), and signalling signage posts that are not maintained (for example, due to seldom use or line closure) can lead to deterioration, impacting the asset's structural integrity. Access ladders installed on these assets may also become unusable. Both situations could potentially cause an unsafe situation.

Similarly, where active mechanisms, such as signals, trainstops, points, and level crossing equipment are inactive and not maintained, this can lead to degradation which can potentially affect their asset value and reuse capability.

Other risks too may evolve from ceased maintenance activities, such as environmental risks (for example, from leaking lubricants), fire risks (for example, from vegetation overgrowth), as well increased security risks and community hazards.

3.1 Mitigating controls

When a seldom used situation arises and no effective controls are in place, such situation can impact the safe running of trains or the use of level crossings. Consequently, signalling equipment affected by the seldom use situation, including the protecting signals are typically booked out of use and disconnected in accordance with *PR S 40008 Securing Signalling Apparatus Out of Use* and *PR S 40009 Disconnection of Signalling Equipment*, and the maintenance signal engineer is duly advised of the situation.

The procedures herein prescribe the specific requirements, including the determinations allowed for each case.

Some seldom used risks are proactively controlled by technical maintenance plans. For example, seldom used or unlinked ETCS balises have certain tasks deemed safety significant where the technical maintenance plan governs the requirements, and the maintenance is completed before the latitude period expires. See *PR S 40017 Maintenance Responsibilities and Frequencies* for further information regarding safety critical and safety significant tasks.

Where the likelihood of seldom used signalling equipment emanates from planned events, proactive controls are implemented by the signal engineer responsible for the work or the maintenance signal engineer, as agreed. Examples of such situations include possession works or other trackwork that can impact the traversal of trains over track circuits, exceeding the 72 hour requirement. The mitigation for such risk is managed in accordance with Section 4.6.

Where seldom used signalling equipment emanates from unplanned events, such as flooding affecting large areas of track which cause the line to close (even within 72 hours), the mitigation of such risk is managed in accordance with Section 4.6.2.

On lines where traffic is suspended, or when other circumstances arise that warrant a reduction (including cessation) in maintenance, such reduction can take effect only when approved by the Professional Head Signalling & Control Systems. See Section 8 for further information regarding the reduction of maintenance.

3.1.1 Controls mitigated by the Train Operating Conditions (TOC) Manual

Rail vehicles that are prone to unreliable track circuit operation are managed in accordance with *TS TOC 1 Train Operating Conditions (TOC) Manual – General Instructions*. Specific lines across the network are defined in the TOC Manual for where specific rail vehicles must operate under manual block working in accordance with *NGE 220 Unreliable track-circuit operation* and *NSY 512 Manual Block Working*.

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Diesel multiple unit (DMU) trains and metropolitan track patrol vehicles (MTPV) as specified in the TOC Manual, where fitted with functional track circuit assistors (TCA) enable an effective track circuit shunt. Therefore, such vehicles are treated as reliably operating track circuits. See the TOC Manual for further information.

For DMU trains with at least one functional TCA, the TOC Manual permits such vehicles to operate across the network using signals, negating the requirement for manual block working. DMU trains that operate without a functional TCA must operate using manual block working on those lines defined in the TOC Manual.

For single unit diesel cars (SUDC) rail vehicles, irrespective of being fitted with TCAs, the TOC Manual does not permit such vehicles to operate using signals. SUDCs must operate across the network using manual block working. This requirement does not apply to XPT power cars, as XPT power cars are considered as locomotives.

For MTPVs (as specified in the TOC Manual) with two functional TCAs, the TOC Manual permits such vehicles to operate across the network using signals, negating the requirement for manual block working. MTPVs that operate with less than two functional TCAs must operate across the network using manual block working.

4 Seldom used track circuits

Where track circuits are in use, every opportunity should be taken when in the rail corridor to inspect the condition of the rail surface for contaminants that can lead to an ineffective track circuit shunt.

Scheduled maintenance (including points maintenance) and event driven tasks associated with track circuits shall also inspect the condition of the rail surface for rust and other contaminants that can lead to an ineffective track circuit shunt.

The inspection is particularly relevant on sections of track that are prone to seldom use, such as in yards, sidings and refuges (including entry and exit points), branch lines, crossovers and so on.

4.1 Signalling protection for seldom used track circuits

Where the rail surface contact band is found to be rusty or otherwise contaminated, such that the track circuit would not detect the presence of a train, the protecting signals shall be immediately booked out of use and disconnected. Any affected signalling, such as points or level crossing equipment shall also be booked out of use and disconnected. See Section 4.2 for further information regarding affected signalling equipment. The maintenance signal engineer shall be duly advised of the situation and of the signalling protection in place.

Where the likelihood of an ineffective track circuit shunt is unclear, a train shunt check in accordance with *PR S 40025 Track Circuits* shall be performed. If the results are within acceptable values, then the signalling may remain operable. The maintenance signal engineer shall be duly notified to determine an appropriate mitigation strategy in dealing with the impending situation. If the results are not within acceptable values, then the aforementioned protection shall be applied.

The reinstatement of protecting signals over seldom used track circuits shall be conditional on such track circuits being satisfactory tested, meeting the required functional and safety tests stated in PR S 40025 for an on-going effective track circuit shunt.

Unless allowed by this procedure, any decision to retain the operability of protecting signals shall be done in accordance with Section 4.3.

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However, where the installation provides type-approved inherent protection from the risks of rusty rail (for example, axle counters), the signalling may be left fully operational.

4.2 Signalling protection for affected signalling equipment

Apart from the loss of rail vehicle detection which can impact the safe operation of signals, seldom used track circuits can also impact the safe operation of other signalling equipment and functions.

The following list provides examples of such affected equipment and functions:

- Approach locking and route holding of points (including catchpoints and derailers).
- Automatic route setting (ARS) and points auto-normalising functions
- Activation of level crossing equipment.
- Speed checking and suppression functions of trainstops.
- Track controlled releases, such as for releasing switches in auto sections.
- Track ‘out of sequence’, ‘reversing’, and ‘divide’ alarms.

For example, a loss of rail vehicle detection caused by seldom used track circuits that are used for points approach locking or route holding can cause such points to inadvertently become ‘free’ and operate whilst being traversed.

Points may also be inadvertently operated by the signaller or ARS function, or auto normalised while the train is still occupying the points.

Similarly, a level crossing may not activate within the expected approach-warning time.

Where seldom used tracks have the potential of causing an ineffective track circuit shunt, the affected signalling equipment or function (or both) shall be booked out of use and disconnected in conjunction with the protecting signals.

Any affected signalling, as well as the seldom used track circuits and protecting signals shall be tested to ensure the relevant functional and safety requirements are met prior to booking the signalling back into use.

Unless allowed by this procedure, any decision to retain the operability of affected signalling shall be done in accordance with Section 4.3.

4.3 Managing the onset of seldom used track circuits

Maintenance signal engineers shall assess seldom used situations as they arise, and also where they can potentially arise (as reasonable to do so). They shall review and action as necessary, the signalling protection requirements; or otherwise mitigate the risks to a level that is deemed ‘so far as is reasonably practicable’ (SFAIRP).

The assessment shall determine the likelihood of track circuits causing an ineffective track circuit shunt so to enable a mitigation strategy for dealing with ongoing or potential situations. The assessment shall consider the factors stated in Section 4.5, along with the requirements for seldom used points in Section 5.

Rail surface contamination matters shall be determined on-site.

Additionally, the assessment shall consider if some of the secured signalling can be made operable. This consideration shall take into account any risk associated with booking out all the affected signalling verses the risk of leaving some of the signalling operable. This can maximise the safe use of the signalling system.

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An example of leaving the signalling operable is where points are left operational to facilitate the maintenance of selective overlaps, or to ensure that all the points for the route are operated by the signalling. In the latter case, it may be preferable to leave the route setting functional (with signal controls disconnected). This manages the conflict between other routes as well as enabling points within the route to operate correctly, as designed. This can eliminate the need to manually operate the points, which can prevent a run-through.

However, where functions such as ARS or auto-normalising initiate the points operation, such functions will require disabling (as practicable) prior to making the points operable; otherwise, the affected points shall remain booked out of use and disconnected.

Additionally, signalling equipment such as shunt signals may also be left operable (with the points disconnected) as can some functions. This is on condition that the implemented controls or circumstances effectively mitigate the risk.

Before any assessment outcome to reinstate signalling affected by seldom use is implemented, the maintenance signal engineer shall consult with the regional signal engineer and the Signal Engineering Manager for endorsement. Once endorsed, the assessment shall be submitted to the Principal Engineer Signalling Integrity for approval. Any reinstatement in this case shall be subject to obtaining approval.

Where such determination is approved, a procedure or instruction shall be documented by the maintenance signal engineer so to advise the signaller of the conditions and requirements pertaining to the seldom used situation and the signalling left operable (as well as the signalling booked out of use). The conditions shall be clearly stated. This is done to highlight the requirements, such as ensuring trains are not foul of running lines and are clear of points.

Note:
Where situations cause seldom used track circuits to affect large areas, these are managed in accordance with Section 4.6.

4.3.1 Other mitigating controls

Maintenance signal engineers shall maintain a register of track circuits in their area which are seldom used or likely to become seldom used. These track circuits having an expected likelihood of incurring rail surface contamination from rust or other substances that can lead to an ineffective track circuit shunt.

Maintenance signal engineers and licensed signalling personnel shall be alert for changes in rolling stock type, train operating frequency and tonnage in their area of control or maintenance. This requirement is in addition to the rail surface inspection stated in Section 4.

Regional signal engineers shall liaise with the network operator, with an aim to ensure sufficient trains are tabled through the track circuits and associated points to maintain the rail surface in a satisfactory condition. Otherwise, the requirements of the 72 hour rule apply. See Section 4.4 for more information regarding the 72 rule.

Routine maintenance visits may need to be re-scheduled more frequently where the likelihood of contaminants prevail.

Maintenance signal engineers shall plan for eventual full reinstatement of the affected signalling. The full reinstatement shall be conditional on meeting the required functional and safety tests for the equipment concerned.

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The maintenance signal engineer, after consultation with the regional signal engineer, shall refer prevailing seldom used situations for redesign to the signal asset engineer. This is to enable provision of more capable technologies, such as axle counters, high voltage impulse track circuits, five second slow pick-up track repeat relays, and the like as deemed necessary to mitigate the risk.

4.4 The 72 hour rule

The 72 hour rule refers to a period nominated in NGE 220. The 72 hour period assumes a baseline at which the rail surface condition was relatively free of contaminants and was frequently utilised by rail traffic, such that it provided an effective track circuit shunt before the 72 hour period commenced.

The notion of running one short train over a section of track circuited line once every 72 hours generally does not allow adequate cleaning of the rail surface. Over an extended period, a slow build-up of rust and other contaminants may accumulate such that can lead to an ineffective track circuit shunt.

As an ideal minimum, train running frequency on track circuited lines within a 24 hour period should be no less than the equivalent of six 8-car sets or 5,000 tonnes, travelling at or near line speed. However, if trains are tabled only once a day and this frequency provides for an effective track circuit shunt, then such running frequency can be deemed sufficient, particularly for short crossover and turnout sections.

The cleaning action of the rail surface by rail vehicles varies according to the operation of rail traffic. For example, light weight, single or short consist rail vehicles have minimal rail cleaning capability as opposed to 8-car electric sets or freight trains. 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 to keep it free from contaminants while electric trains draw large traction currents that can break down most rail surface contaminants. This enables the track circuit to shunt more effectively.

Note:
The 72 hour rule does not apply to axle counter track sections where track circuits are not in use.

4.4.1 Varying the 72 hour period

Where the rail surface is in poor condition due to seldom use, consideration to reduce the 72 hour period (table more frequent trains) may be proposed by the regional signal engineer as an exception to the general requirement.

For example, the 72 hour period may be reduced to 48 hours where light weight, short or single consist rail vehicles, or infrequent services operate on non-electrified main line areas (Kiama to Bomaderry).

In such cases, the exception shall be documented and issued to the signaller or network operations. The Principal Engineer Signalling Integrity and Signal Engineering Manager shall be duly advised of such changes, and of the need for any further requirements to ensure track circuits in the area effectively detect trains. The maintenance signal engineer shall notify the relevant signalling maintenance personnel of such arrangements.

In certain circumstances, the regional signal engineer may determine it acceptable to extend the 72 hour period (table less frequent trains), conditional upon an assessment being done in accordance with Section 4.3 and Section 4.5.

For example, the 72 hour period may be extended to 96 hours where high voltage impulse track circuits provide an effective mitigation against rail contaminants over that period.

Approval shall be obtained from the Principal Engineer Signalling Integrity in consultation with Signal Engineering Manager, prior to any implementation.

Where approved, the exception shall be documented and issued to the signaller or network operations. The maintenance signal engineer shall notify the relevant signalling maintenance personnel of such arrangements.

4.5 Determining safe use of the signalling system – factors for consideration

The decision to allow the signalling system to operate over seldom used track circuits, relative to the potential loss of an effective track circuit shunt from contaminated rail surfaces or poor wheel-to-rail interfaces shall be assessed by the maintenance signal engineer and determined in accordance with Section 4.3.

When determining the probability of allowing the signalling system to operate during or after such prevailing circumstances, including for the resumption of services following line closure due to flooding, the following factors shall be considered as a minimum requirement:

Capability of an effective track circuit shunt

- Likelihood of an ineffective track circuit shunt.
- Type of track circuits in use.
- Type of rail surface contaminants (rust, paint, oil, grease, leaf debris, sand or mud slurry and so on).
- Cause of contaminates (new installation, seldom use, environmental, industrial, type of train running).
- Random or loose contaminants causing intermittent loss of shunt, or otherwise heavily coated.
- Rail surface contact band inadequate for the wheel profile of rail vehicles in operation over the seldom used track.

Location of contaminated rail

- Proximity to clearance points and audio frequency track circuit tuned loops.
- Length of contamination (equal to whole train or light engine).
- Contamination spanning the entire track circuit.
- Contamination spanning several track circuits.
- Seldom used track circuits operating over points:
  - mainline turnout into a yard, siding, or refuge
  - mainline crossover (including emergency crossover).
- Seldom used tracks circuits that operate in conjunction with active level crossing equipment.

Configuration and environment

- Long straight or tangent track allowing smooth rolling of wheels on rails.
- Contaminated rails in points (turnout rails only, straight rails only, or all rails).
- Points operated locally (within sighting distance), remotely, or automatically.
- Frequent train stopping locations or patterns.

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- Areas prone to high humidity, excessive rainfall, flooding, landslips and washaways, temperature extremes, snow.
- Areas prone to excessive sanding and haulage spills (grain, coal, liquids).
- Areas prone to contaminants from industrial fallout, ocean spray, environmental sediment, vegetation accumulation including leaf debris.

Rolling Stock

- Trains with electric traction.
- Diesel powered trains (no traction).
- Freight only trains.
- Mixed rail traffic.
- Length of rail vehicle:
  - shorter consist trains
  - single rail cars
  - light engines
  - maintenance rail vehicles.
- Line speed and typical speed of rail vehicle, especially regarding short or light weight rail vehicles.
- Typical axle loading and number of axles per train, gross tonnage.
- Time and frequency between rail vehicles.
- Likelihood of rolling stock operating with brake shoes (for example, heritage trains, locomotives) potentially causing tread conditioning.
- Rail contaminants emanating from rail vehicle.
- Location of driving/traction axles within the train consist.
- Wheel to rail profile interaction, variance of wheel to rail contact band (especially the risk of "hollow" wheels) of rail vehicles.
- Track circuit assistors fitted to DMU trains and approved MTPV rail vehicles.

Affected signalling

- Approach locking or route holding of points.
- Operation of points from a remote location.
- Auto-normalisation of points or ARS.
- Activation of level crossing equipment (including warning time).
- Speed checking and suppression functions of trainstop.
- Track controlled releases.
- Shunt signals replaced by track circuits (or not).
- Track ‘out of sequence’, ‘reversing’, and ‘divide’ alarms.

Maintenance/Administrative Controls

- Initiating effective condition monitoring (alarms, inspections).
- Initiating regular rail grinding.
- Utilising temporary stop-blocks to prevent trains entering sidings.

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- Accepting specific signalling left operable subject to a SFAIRP level of risk:
  - maximising the safe use of the signalling system
  - determining if manually operating signalling can increase the risk
  - determining if applying blocking facilities only in lieu of equipment disconnection effectively mitigates the risk.
- Arranging more frequent services.
- Scheduling more frequent maintenance.
- Determining if the TOC Manual provides an acceptable risk mitigation.

4.6 Seldom used track circuits affecting large areas

The onset of seldom used track circuits instigated by periods of non-use or residual contaminants from receding flood waters can affect large areas.

Trains can stop operating over large areas for many reasons, including the following:

- Trackwork
- Possessions and line closures
- Landslips and washaways
- Flooded tracks
- Fires
- Operational matters, such as derailments and incidents.

Where rail traffic has stopped operating for a period exceeding 72 hours, or when a line is temporarily closed due to flooding for any period (even within 72 hours), and the affects cover large areas of track circuited lines, suitable arrangements shall be put in place by the maintenance signal engineer in conjunction with the signal asset engineer, as applicable.

Note:
Where situations cause seldom used track circuits to affect only small areas, these are managed in accordance with Section 4.3.

Proper and timely notification, liaison and planning with the relevant parties are essential to ensure that risks associated with an ineffective track circuit shunt are mitigated. This is particularly relevant where line closures are planned; however, appropriate actions are still required to manage unplanned events as they arise.

For unplanned events, maintenance signal engineers shall ensure the track circuits that become seldom used during the period of non-use are identified, and that an effective mitigation strategy for reinstatement is done in accordance with Section 4.6.3. The actual strategy may be done by the signal engineer involved with the work.

For planned events such as possessions, maintenance signal engineers shall ensure the track circuits that are likely to become seldom used during the period of non-use are identified, and that an effective mitigation strategy for reinstatement is in place. The actual strategy may be done by the signal engineer involved with the work.

Additionally for planned events, signal asset engineers shall ensure that adequate support is provided by those managing the possession planning. Signal asset engineers shall also assist with identifying the track circuited areas (within and outside the possession) where trains including work trains, maintenance rail vehicles and so on, are not likely to be operating.

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4.6.1 Seldom used track circuits caused by trackwork, possessions and line closures affecting large areas

Trackwork, possessions and line closures can be causal to seldom used track circuit situations.

Where the non-use of track circuits is expected to exceed 72 hours, licensed signalling personnel shall liaise with signallers regarding the impending signalling protection arrangements and testing requirements. This shall be done prior to the recommencement of train running using signals over the affected area.

Notwithstanding the disconnection requirements prescribed in signalling safeworking procedures for trackwork support (including rerailing), the signals protecting the seldom used area, as well as any affected signalling shall be booked out of use until certification is complete.

The following paragraphs provide examples where track circuits can become seldom used from trackwork, possession and closed line situations.

Track circuits directly worked on

Track circuits directly worked on as part of the trackwork (for example, rerailing work involving the installation of new or rusty rails).

These tracks may not provide an effective track circuit shunt. Such risks associated with rerailing and other trackwork tasks are mitigated by the relevant signalling safeworking procedures, including *PR S 40026 Rerailing – Precautions to be taken*.

Track circuits inside the possession area or closed line

Track circuits within the possession area or closed line that are not sufficiently traversed by rail vehicles and are not part of any trackwork supported by signalling personnel.

These tracks may not provide an effective track circuit shunt. The risks associated with their non-use are mitigated in accordance with Section 4.6.3.

Track circuits outside the possession area or closed line

Track circuits outside the possession area or closed line that are not traversed by rail vehicles due to an operational variance caused by the possession or line closure.

These tracks may not provide an effective track circuit shunt. The risks associated with their non-use are mitigated in accordance with Section 4.6.3.

4.6.2 Seldom used track circuits caused by flooding affecting large areas

Seldom used track circuit situations can be caused by flooding, where residual sand or mud slurry, debris or other contaminants can be deposited over the rail surface. This can lead to an ineffective track circuit shunt. This situation can develop even within the defined 72 hour period and can impact any type of rail vehicle, including electric sets and freight trains.

Where a line utilising track circuits is temporarily closed due to flooding, licensed signalling personnel shall liaise with signallers regarding the impending signalling protection arrangements and testing requirements. This shall be done prior to the recommencement of train running using signals over the affected area. The signals protecting the affected area, as well as any affected signalling shall be booked out of use until certification is complete.

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This requirement is irrespective of the period of track circuit non-use (even within 72 hours).

The rail surfaces of track circuits within the affected area shall be inspected on-site for evidence of contamination, and the tracks tested for an effective track circuit shunt as prescribed in Section 4.6.3.

4.6.3 Testing strategy for large areas

An inspection and test plan shall be arranged and implemented by the signal engineer tasked with the certification of signalling following the non-use period of track circuits exceeding 72 hours, or line closure due to flooding. An assessment that considers the factors stated in Section 4.5 shall derive the tests noted in the inspection and test plan.

The inspection and test plan shall generally incorporate testing from the methods prescribed in Section 4.6.4. A combination of these testing methods may be required, as appropriate (noting the additional requirement for on-site inspection of flooded tracks, as stated in Section 4.6.2). Where necessary, more stringent testing may be incorporated with the prescribed testing methods to ensure an effective track circuit shunt.

The testing shall provide assurance of an effective track circuit shunt.

The inspection and test plan shall be agreed by the maintenance signal engineer in consultation with the regional signal engineer.

For areas that are particularly prone to frequent flooding, an inspection and test plan may be pre-compiled for such areas. The maintenance signal engineer shall explain the inspection and test plan to those licensed signalling personnel likely to attend such situations. Additionally, a pre-compiled copy may be made available to ICON Infrastructure.

The testing strategy may require re-evaluation if the scope of work, possession, line closure or incident recovery requirements alter throughout the period of non-use.

Trains may be manually block worked in accordance with NSY 512 through the affected sections until the lines are certified for normal operation. The signalling shall remain booked out of use until the satisfactory completion of tests.

The certification of track circuits, and subsequent train running shall not exceed 24 hours from concluding the train shunt/occupancy check (in accordance with the selected testing method).

4.6.4 Testing methods for large areas

The following paragraphs prescribe the methods of testing for an effective track circuit shunt following periods of non-use (including flood contamination) affecting large areas.

Method 1: Train shunt check

A train shunt check, done in accordance with PR S 40025, conducted over a selected sampling of seldom used track circuits. This sample can assist to provide a confident assessment of track circuit shunt capability for the affected area before certifying all the track circuits into use.

The trains used for the train shunt check are manually block worked in accordance with NGE 220 and NSY 512.

The different track circuit types shall be taken into account; aiming to select a higher sampling rate from those track circuits with a lesser shunting characteristic.

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A selection of any affected track circuits which are nominated in a contaminated rail register shall also be included in the sample test.

Track circuits used for any level crossing activation and those operating over points shall be taken into account, as well as the other relevant factors stated for consideration in Section 4.5.

Method 2: Train occupancy check using test locomotive

A test locomotive, manually block worked in accordance with NGE 220 and NSY 512 with a competent signalling person onboard can be used to operate over the affected lines.

The signalling person onboard shall communicate their exact position in reference to the track circuit to a licensed signalling person located in the signal box for the area being observed.

An observation of track sequence indications shall be made to ensure that all indications operate in correspondence with the test locomotive as it occupies and un occupies each track circuit within the test area.

The test shall be conducted in a manner that each individual track circuit is clearly differentiated from the next.

The generation of track sequencing alarms (if available) shall be taken into account.

Where observations are required over multiple diagrams or indication panels, the certification activities shall be co-ordinated by a single licensed signalling person.

Method 3: Train occupancy check using tabled or specially run trains

A series of tabled trains or specially run trains (including locomotives), manually block worked in accordance with NGE 220 and NSY 512, can be used to operate over the affected lines with a licensed signalling person located in the signal box for the area being observed.

An observation of track sequence indications shall be made to ensure that all indications operate in correspondence with each of the trains as they occupy and un occupy each track circuit within the test area.

The test shall be conducted in a manner that each individual track circuit is clearly differentiated from the next.

The generation of track sequencing alarms (if available) shall be taken into account.

Where observations are required over multiple diagrams or indication panels, the certification activities shall be co-ordinated by a single licensed signalling person.

5 Seldom used points configuration

Track circuits operating over points may become seldom used due to certain points configurations being seldom used. This can increase the likelihood of an ineffective track circuit shunt over the unused turnout portion.

The following points configurations can lead to track circuits becoming seldom used:

- Run-off points.
- Emergency crossovers.
- Power worked crossovers provided for out of course working.
- Remotely operated points at sidings or refuges.

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- Locally operated points at sidings or refuges.
- Installed points pending commissioning or removal.

Notwithstanding the general requirements stated in this section, Section 5.1.1 through to Section 5.1.6 prescribe the specific actions for where track circuits over such points configurations are likely to cause an ineffective track circuit shunt.

Where this procedure requires points to booked out of use, they shall be additionally disconnected, clipped and SL locked unless otherwise stated (for example, XL locks and spikes are required for emergency crossovers, points that are impractical to operate for maintenance purposes, and points pending commissioning or removal).

While points are booked out of use, any manual operation of the points for the purpose of train running shall be done by Qualified Workers in accordance with the network rules and procedures.

The reinstatement of points that are booked out of use shall be conditional on meeting the required functional and safety tests prescribed in *PR S 40029 Point Lock Testing - Mechanical* or *PR S 40030 Point Lock and Detection Testing on Power Operated Points*, as applicable.

Note:
Protecting signals and affected equipment (other than points) are reinstated in accordance with Section 4.1 and Section 4.2.

Where any of the points configurations stated herein are impractical to operate for maintenance purposes, a reduced level of maintenance may be performed in accordance with Section 5.2 as a minimum requirement.

5.1.1 Run-off points

The turnout portion that is rarely used which forms part of a run-off not governed by a signalled approach may be exempt from 'seldom used' requirements. The points and through signals may be left operational.

5.1.2 Emergency crossovers

Emergency crossovers, whether operated by local control panels or ground frames released from a releasing switch, duplex lock, or similar arrangement, shall be clipped and XL locked in the Normal position when the emergency crossover is not in use.

The turnout rails of emergency crossovers are inevitably seldom used.

Emergency crossovers are operated in accordance with NPR 728 Operating emergency crossovers. This method necessitates the on-site presence of a Qualified Worker, which mitigates the risk.

5.1.3 Power worked crossover provided for out of course working

Power worked crossovers provided for out of course working rely on their readiness to effectively shunt track circuits along the turnout rails. This reliance is dependent upon sufficient trains being tabled through the crossover to clean the rail surfaces.

Where such crossovers are seldom used, the likelihood increases for an ineffective track circuit shunt through the turnout portion. This may result in the points being normalised (called by the signaller, ARS or auto normalised) while a portion of the train is still occupying the points, potentially causing a derailment.

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During maintenance, a check of the crossover's rail surfaces shall be done to ensure an effective track circuit shunt can be achieved by the train. Other opportunities to check the rail surface should also be taken.

Where the rails are found to be rusty or otherwise contaminated, such that the track circuits would not detect the presence of a train, the requirements of Section 4 shall be implemented. That is, the points and protecting signals shall be booked out of use and disconnected.

This strategy necessitates the on-site presence of a Qualified Worker, which mitigates the risk.

This mitigation shall remain effective until other mitigations (as agreed) are in place, in accordance with Section 4.3.

5.1.4 Remotely operated points at sidings or refuges

Where remotely operated points that lead into sidings or refuges are seldom used, the likelihood increases for an ineffective track circuit shunt through the turnout. This can result in the points being operated while a portion of the train is still occupying the points, or a portion of the train left foul of the running line (going undetected).

During maintenance, a check of the crossover's rail surfaces shall be done to ensure an effective track circuit shunt can be achieved by the train. Other opportunities to check the rail surface should also be taken.

Where the rails are found to be rusty or otherwise contaminated, such that the track circuits would not detect the presence of a train, the requirements of Section 4 shall be implemented. That is, the points and protecting signals shall be booked out of use and disconnected.

This strategy necessitates the on-site presence of a Qualified Worker, which mitigates the risk.

This mitigation shall remain effective until other mitigations (as agreed) are in place, in accordance with Section 4.3.

5.1.5 Locally operated points at sidings or refuges

Where locally operated points that lead into sidings or refuges are seldom used, and the operator can see the clearance point and corresponding end of points, the releasing arrangements for the ground frame or local control panel, as well as any associated signals may be left operable.

However, where the operator cannot see the clearance point and corresponding end of points being operated, the likelihood increases that a portion of the train can still occupy the points, or a portion of the train can be left foul of the running line. To mitigate this situation, the releasing arrangements shall be booked out of use and disconnected.

This strategy necessitates the attendance of a licensed signalling person who shall manually release the arrangements as required to enable the points operation. Additionally, the licensed signalling person shall advise the Qualified Worker of the impending risks prior to the Qualified Worker taking control of the points.

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This mitigation shall remain effective until other mitigations (as agreed) are in place, in accordance with Section 4.3.

Note:
Where points at sidings or refuges include an auto normalising function, the points shall be treated in accordance with Section 5.1.4.

5.1.6 Installed points pending commissioning or removal

Where points are installed but are pending commissioning or removal, such that they are not fully connected to the interlocking (in accordance with their final arrangement), the signalling commissioning engineer shall ensure that the points are secured in accordance with *T HR SC 10014 ST Signalling Design Principle – Points*.

Where mandated by T HR SC 10014 ST, a points detector is provided as an interim arrangement for the points detection when in the normal running position.

Any subsequent work affecting such points shall reinstate the points in accordance with T HR SC 10014 ST.

Where such points are manually operated for the purpose of train running, the risk associated with the seldom used track circuited portion (as applicable) is mitigated by the on-site presence of a Qualified Worker working the train through the points.

An Infrastructure Booking Authority (IBA) NRF 003 form shall be compiled where installed points pending commissioning or removal are initially effected, and also for any subsequent interim operation that is required by Qualified Workers. The points shall be recertified and booked back into use (as uncommissioned points) prior to allowing trains to traverse the points in the normal running position using signals.

The assets register shall be accordingly updated to include the installed points pending commissioning. Any points pending removal shall be retained in the register until the points are removed from the track.

Periodic maintenance tasks shall be scheduled to ensure critical items such as detectors, point switch positions and point-securing devices are inspected to enable the integrity of signalled routes that operate over the points.

The relevant tasks listed in Section 5.2 shall apply as a minimum requirement. The maintenance scheduling for installed points pending commissioning or removal shall be done at intervals no greater than 30 days.

To ensure such points are registered and maintenance tasks scheduled, the commissioning engineer shall notify the signal asset engineer or maintenance signal engineer in accordance with the interface coordination requirements. The signal asset engineer and maintenance signal engineer shall agree on the responsibility for the asset register entries and the scheduling of tasks prior to the points installation.

The maintenance signal engineer shall notify the relevant signalling maintenance teams of the pending arrangements.

In addition to the aforementioned maintenance, the checking of XL locks, point clips and point spikes used to secure the installed points not fully connected to the interlocking shall be included in the maintenance signal engineer's periodic testing and inspection of interlockings. This is done in accordance with *PR S 40022 Inspection and Testing of Signalling Interlockings*.

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5.2 Where impractical to operate points during maintenance

Generally, points booked out of use, and emergency crossovers (which are clipped and XL locked) are examined to the usual tasks and intervals stated in relevant technical maintenance plans.

However, where points are impractical to operate for maintenance purposes, they shall be booked out of use, disconnected, spiked, clipped and XL locked. The points shall be maintained as a minimum requirement to the items listed herein. This is to enable integrity for the signalled routes that remain operable through the points in the normally secured position.

Consequently, the usual point lock and detection tests may be omitted on condition that the inspections listed herein are performed at intervals of no greater than 30 days. An exception to the 30 day requirement exists where points impractical to operate during maintenance can comply with the requirements for point lock and detection testing in the position of lie. In this case, the interval for such tests may be done in accordance with the technical maintenance plan on condition that the point lock and detection is tested to specifications.

Where points are impractical to operate during maintenance the following inspections shall apply, as applicable:

- Check that releasing arrangements and manual operating levers are securely locked.
- Check for damage to the point equipment, including point rods.
- Check the fastenings are secure and of the correct type (for example, nyloc nuts).
- Check that the point spikes, point clips, XL locks are in proper condition and securely fitted.
- Ensure by observation that the point lock mechanism is in its locking position and is secure (where the exemption applies, the point lock is tested to specification for the position in lie).
- Ensure by observation that the detection mechanism is in its proper position and is secure (where the exemption applies, the point detection is tested to specification for the position in lie).
- Check the closed switch is secured against the stock rail throughout its machined length (in accordance with specifications) and that the back drive is not moving or flogging during train passage.
- Check that the stretcher rods securely maintain the open switch in its correct position and ensure the minimum flange way clearance is provided.
- Check for evidence of excessive movement or wear to the points channel iron or points mechanism and ensure that the gearbox or operating bar is secured to prevent drifting of the motor-operating bar (points motor latched in the case of EP Claw Lock & EP Spherolock).
- Check for evidence of excessive movement or wear to the permanent way that would affect the points equipment.
- Inspect condition of track circuit parallel bonds including their rail connections and retaining clips.
- Ensure the access of any point mechanisms, detectors and the like are securely locked.

Any defects found shall be accordingly repaired or reported for rectification in the usual way. Protecting signals shall be immediately booked out of use and disconnected where an unsafe situation is realised.

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Certain other scheduled maintenance activities (for example, testing of clutch operation, cleaning between normally closed switch and stock rails and so on) may be omitted during the period that the points remain booked out of use, provided the reliability and integrity of the signalling is not jeopardised.

However, the insulation testing of detection circuits that affect operational signals shall still be done as scheduled in accordance with the technical maintenance plan.

Full maintenance services, at the relevant technical maintenance plan intervals shall be resumed prior to the points being booked back into use.

6 Seldom used local signal boxes or ground frames

Where a local signal box or ground frame is temporarily closed by network operators due to its infrequent operation, the associated signalling equipment shall be specially maintained upon notice that the signal box or ground frame is to be brought back into use.

Critical equipment, such as the points lock and detection, track circuits and the like shall be fully tested and certified prior to booking the equipment back into use.

Any mechanical signalling operated from such signal boxes or ground frames shall be lubricated (as required) and suitably checked for smooth and proper operation.

7 Seldom used ETCS balises

Where installed ETCS balises are not regularly traversed by ETCS fitted trains during normal operations, there becomes a risk that these seldom used balises may go unchecked by the system. Consequently, the ETCS system can fail to provide the intended protection for the situation if such balises became defective or missing.

Seldom used ETCS balises are typically located at the following situations:

- The last balise group before buffer stops.
- The balise group at the end of a line (for example, in a run-off area past where a train would normally stop).
- Trip balise group (for example, at fixed red signals or stop signs).
- The balise group at unused sidings or passing loops.

An unfavourable situation could remain latent until found through inspection. Therefore, such risks associated with seldom used balises shall be mitigated by periodic maintenance in accordance with *PR S 40028 ETCS L1 Trackside Equipment* and technical maintenance plans.

7.1 Unlinked ETCS balises

Where ETCS balises are not provided with linking information, and they become defective or missing, the system will not inherently identify the problem.

Unlinked ETCS balises are typically located at the following situations:

- Level transition locations, level 0 to levels 1 or 2.
- Yard entry and exit locations.
- Temporary speed warning locations.
- Virtual balise covers (VBC).

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An unfavourable situation could remain latent until found through inspection. Therefore, such risks associated with unlinked balises shall be mitigated by periodic maintenance in accordance with PR S 40028 and technical maintenance plans.

8 Reduction of maintenance

On lines where traffic is suspended, the Profession Head, Signalling and Control Systems may approve the reduction (including cessation) of maintenance.

Prior to any determination being made in this regard, an assessment of any prevailing unsafe situations shall be made by the maintenance signal engineer, in conjunction with the regional signal engineer and the signal asset engineer. The assessment shall mitigate any risk associated with the seldom use or maintenance reduction to a level that is SFAIRP. The risks described in Section 3 shall be taken in account as a minimum.

As part of the approval process, the assessment outcome, including any residual maintenance plan shall be endorsed by the Signals Engineering Manager and the Principal Engineer Signalling Integrity (once satisfied of the arrangements). Following endorsement, the assessment outcome shall be submitted for approval to the Professional Head, Signalling and Control Systems.

The following list provides examples of situations that could give rise to an unsafe situation emanating from seldom use and maintenance reduction:

- Level crossing F-type posts or signalling signage posts that could be hazardous to level crossing users or passers-by.
- Signal posts or other signalling structures that could collapse down embankments towards property, roadways, or waterways.
- Oil leaking from trainstops that could cause an environmental hazard.
- Fire hazards emanating from vegetation over-growth, coming into contact with electrical terminals or equipment.
- Security hazards from unchecked equipment and location housings.
- Corrosion and water ingress causing equipment to seize, seals to be damaged and so on.

Similarly, dormant (inactive) mechanisms, such as signals, trainstops, points, level crossing equipment and the like may require on-going inspection (perhaps at a reduced task and interval) to ensure the equipment's reuse capability and asset value is upheld.

Any signalling asset associated with a suspended line that can impact an adjacent operational line shall remain under its normal maintenance schedule. Where the points are impractical to operate for maintenance purposes, they shall be booked out of use and disconnected, and maintained as a minimum requirement in accordance with Section 5.2.

See PR S 40017 for further information regarding lines on which traffic is suspended.

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Engineering System Integrity

Engineering Procedure

Signalling and Control Systems

Signalling Safeworking

PR S 40008

Securing Signalling Apparatus Out of Use

Version 3.0

Date in Force: 15 July 2021

Approved by:	Professional Head Signalling and Control Systems Engineering System Integrity	Authorised by:	Engineering Technical Publications Manager System Integrity

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Document control

Version	Date	Author/Prin. Eng.	Summary of change
1.0	16 September 2013	Y Bagaric	First issue as Sydney Trains document
2.0	5 July 2017	C Darmenia	Major review and align with ASA standards
2.1	8 March 2019	A Sozio/E Pace	Updated to meet Control Systems requirements. Updated to EI S 18-03
2.2	17 December 2020	C Darmenia/A Sozio	ASDO update. Updated with the principles of using an IBA form for Control Systems
3.0	15 July 2021	Ian Maydew/ C Darmenia	Updated to include axle counter requirements

Summary of changes from previous version

Summary of change	Section
Added reference for axle counters	1, 3.2
New section added for special condition when resetting axle counter track sections during testing of axle counter track sections	6

Table of Contents

OFFICIAL

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 40028 ETCS L1 – Alstom Trackside Equipment*
- *PR S 40050 Control Systems*
- *PR S 40051 Axle Counters*
- *PR S 47110 Inspection and Testing of Signalling: Introduction*
- *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 (NCO)
- disabling of signalling apparatus by licensed signalling personnel
- booking signalling apparatus out of use.

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Signalling controls may have blocking applied by the 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 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.

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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, track circuits and axle counters) 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.

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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 ETCS functionality requires disconnection.
- 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.

Control Systems apparatus is required to be booked out of use:

1. Where the work affects the operation of the operator workstation (including controls, indications, blocks, notifications, etc.), or standalone panel indications, such that they become unavailable or disrupted or cause confusion or ambiguity to the user.
2. Where work causes a primary, secondary or spare workstation to be become unavailable for operational use.
3. Where the work causes loss or disruption to supplementary signalling applications and this results in the application of manual systems in lieu. For example ARS disabled requiring the manual setting of all routes.
4. If new functionality is be introduced then the new function is required to be booked into use. For example, where ARS functionality is introduced in a workstation. Similarly, if a function is to be removed, than that function is to be booked out of use.

An IBA is not required when the shutting down control systems equipment does not affect the signaller directly. An example of this includes maintenance workstations.

In these cases, the following approach shall be adopted; however not all actions are required for Control Systems:

- 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 as applicable.
- 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.

Examples:

- clip and SL lock points
- fit mechanical covers over unlinked balise groups.

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- 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 completed 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.

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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 NRF003 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 it is necessary to book out ETCS functions, for practicality the function is to be captured on the IBA with the various individual balises captured on a list, however, an ETCS trainstop function shall also be separately identified with its associated signal. For example:

- ATP - from kilometrage to kilometrage or signal to signal
- ASDO - at station, platform number/s
- signal number, ETCS trainstop .

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: Introduction* 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 from and in accordance with Network Rule NWT 312.

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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.

6 Special condition when resetting axle counter track sections

There can be occasions where a reset of an axle counter track section is required to enable testing of reinstated axle counter equipment while a rail vehicle is still occupying the affected track section. This special provision shall be undertaken by licensed signalling personnel in accordance with the requirements out lined in PR S 40051.

Before restoring any signalling back into use, the affected track section shall be placed in correspondence with the actual track occupancy state following the required equipment testing; that is, the axle counter track section shall be set to 'occupied' if the affected track section is occupied by a rail vehicle at the end of the work. The protecting signals shall not be brought into use until the track section correspondence is complete.

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Engineering System Integrity

Engineering Procedure

Signalling and Control Systems

Signalling Safeworking

PR S 40009

Disconnection of Signalling Apparatus

Version 2.0

Date in Force: 26 May 2022

OFFICIAL

Approved by:	Professional Head Signalling and Control Systems Engineering System Integrity	Authorised by:	Engineering Technical Publications Manager System Integrity

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Document control

Version	Date	Author/Prin. Eng.	Summary of change
1.0	16 September 2013	Y Bagaric	First issue as a Sydney Trains document
1.1	24 January 2018	C Darmenia/M Khan	Updated to EI S 15-03 & EI S 18-01, new titles and roles, updated to mandatory ASA requirements, updated wording
1.2	8 March 2019	C Darmenia/E Pace	Inclusion of ATP requirements and further update for EI S 18/01 Updated to EI S 18/03
1.3	17 December 2020	C Darmenia	ETCS update for ASDO
2.0	26 May 2022	Ian Maydew/ C Darmenia	Updated to include axle counters and WSP 2G CBI requirements

Summary of changes from previous version

Summary of change	Section
Added reference for axle counters and WSP 2G CBI	1
Deleted unnecessary paragraph as already managed under Network Rules and Procedures	3
Added reference for WSP 2G CBI	5.1
Enhance procedure for making trainstops inoperable	5.2
New section added for the disconnection of axle counter track sections	5.7

Table of Contents

OFFICIAL

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 ETCS L1 – Alstom Trackside Equipment*
- *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*
- *PR S 40051 Axle Counters*
- *PR S 40052 WSP 2G 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

ATP	Automatic Train Protection
ASDO	Automatic Selective Door Operation
EMR	Master Emergency Arrangements (Emergency Master Relay)
EOL	Emergency Operation Lock
ESML	Emergency Switch Machine Lock
ETCS	European Train Control System (type of ATP)
Facing points	Points with the switch blades facing approaching rail traffic
FPL lever	Facing Point Lock lever on a mechanical frame
IBA	Infrastructure Booking Authority (Form NRF 003)
LEU	Lineside Electronic Unit
LSpR	Low Speed Relay
NCO	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).
Qualified Worker	A worker certified as competent to carry out the relevant task.
UCR	Route Checking Relay
XR	Crossing Control relay

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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.

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 or 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 correctly apply vital blocks and 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.

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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.

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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*
- *PR S 40052 WSP 2G 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 operation. This may be achieved through the interlocking. Where the prevention of trainstop operation cannot be guaranteed for the intended purpose, for example due to being directly affected by works or interference or where the integrity of the signalling is in doubt, then in addition 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 5.8 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

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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.

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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.

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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.

5.3.2.2.2 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.

5.3.2.2.3 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.

5.3.2.2.4 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.

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- 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.

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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 be affected 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 FM001 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.

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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.

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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.

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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.

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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.
   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.
   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 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 Axle Counter Track Sections

5.7.1 Axle counter with relay interface

Axle counter track section relays shall be disconnected to prevent the energisation of the track relay/output. Care shall be taken to ensure track circuit relays/outputs are not falsely energised by other power sources.

Track section relays shall be disconnected by removing the associated track relay fuse and negative terminal pin where used to interface between the axle counter and interlocking. Alternatively, disconnection terminals may be removed for both the positive and negative paths for the track section relay. Isolation of the track relay enables the axle counter section to be set up and tested whilst maintaining its output disconnected from the interlocking.

5.7.2 Axle counter with CBI interface

Where no track section relay is provided and only an Ethernet connection is in place between the axle counter and the CBI the associated Technicians Terminal shall be accessed to apply a track section block.

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5.8 Disconnection of ETCS Equipment

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.

Refer to PR S 40028 and MN S 41604 for the correct procedures for the disconnection of a balise or an LEU.

5.8.1 Lineside Electronic Unit (LEU)

Where it is necessary to power down, 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 an ETCS fitted 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.

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.

5.8.2 ETCS Trainstops

Acceptable methods to ensure that an ETCS trainstop is maintained in the braking intervention (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.

5.8.3 ASDO

Acceptable methods to disconnect the ASDO function provide by an ASDO reference balise group are in order of preference:

- cover the balises in the balise group by means of lockable metallic mechanical covers.
- remove the balises from the track.

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Engineering System Integrity

Engineering Procedure

Signalling and Control Systems

PR S 40010

Risks and Control Associated with Testing and Certifying Equipment

Version 2.0

Date in Force: 15 July 2021

Approved by:	Professional Head Signalling and Control System Engineering System Integrity	Authorised by:	Engineering Technical Publications Manager System Integrity

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Document control

Version	Date	Author/Prin. Eng.	Summary of change
1.0	16 September 2013		First issue as a Sydney Trains document
1.1	14 February 2017	R. Del Rosario	Updated to new titles & roles and reviewed for ASA requirements
1.2	1 March 2019	A. Sozio	Updated to include Control Systems requirements
1.3	8 March 2019	C. Darmenia	Updated to include ATP requirements
2.0	15 July 2021	Ian Maydew/C Darmenia	Updated to include axle counter requirements

Summary of changes from previous version

Summary of change	Section
Updated "Reference documents" section to include PR S 40051	2
Updated "Terms and definitions" section to include axle counters	3
Axle counter tests added to Typical Inspections and Tests to Verify Physical & Functional Compliance	4.3.1

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Table of Contents

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 document

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: Introduction*
- *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 ETCS L1 - Alstom Trackside Equipment*
- *PR S 40050 Control Systems*
- *PR S 40051 Axle Counters*
- *MN T 20251 Turnout Installation and Repair*

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
Preparatory reset	The reset type defined for an axle counter section that causes an evaluator to reset the section when requested, but not restore the section to the interlocking until a train has been subsequently detected passing through the section.
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.
Unconditional reset	The initiation of a self-test of an axle counter section and, if successful, setting the count value to ‘clear section’ (not occupied)

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.

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- 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.

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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, wheel sensor 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.

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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.
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 light is 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.

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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.
Axle Counter Occupancy Test:	Test the track relay has dropped away when the associated wheel sensor is counted over via the use of the approved test tool or the passage of a rail vehicle. Alternatively, if a track relay is not used check the associated LED or LCD indications on the front of the axle counter evaluator. Wheel count information may also be viewed via a laptop interfaced with the axle counter. An approved test tool must be used when swiping over the wheel sensor/s.
Axle Counter Calibration Test:	Test wheel sensor for correct calibration values.
Axle counter track section reset	Test to confirm the correct track section occupancy is reset to a clear status only after meeting any required system conditions.
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 and 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 and 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 Principles 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.

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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 Principles 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 and 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 and 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 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.

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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, who 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.

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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 and 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 Turnout Installation and Repair* Chapter 2-1 ‘signals requirements for track work affecting points’ and Appendix A ‘checklist for turnout work’.

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Engineering System Integrity

Engineering Procedure

Signalling and Control Systems

Signalling Safeworking

PR S 40011

Renewals Work

Version 4.0

Date in Force: 15 July 2021

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Approved by:	Professional Head Signalling and Control Systems Engineering System Integrity	Authorised by:	Engineering Technical Publications Manager System Integrity

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Document control

Version	Date	Author/Prin. Eng.	Summary of change
1.0	16 September 2013		First issue as a Sydney Trains document
2.0	14 February 2017		Updated Section 1.1 Overview to incorporate Engineering Instruction EIG 11/09 Human Errors Affecting Signalling Integrity. Incorporate SPG 711.9 document and updated position titles
2.1	1 March 2019	A Sozio	Inclusion of Control Systems Like for Like works Removed samples and added table of Like for Like procedures
3.0	8 March 2019	C Darmenia	Reorganise sections and include ATP/ETCS precautions for renewals
4.0	15 July 2021	Ian Maydew/ C Darmenia	Updated to include axle counter requirements

Summary of changes from previous version

Summary of change	Section
Addition of reference to PR S 40051 Axle Counters	3
New section for axle counter equipment	11
Addition of Axle counter Like For Like Renewal work instructions – FM45 to FM52	14

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Table of Contents

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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/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 L1 - Alstom Trackside Equipment*
- *PR S 40047 Calibration of Tools and Instruments for Signalling Applications*
- *PR S 40050 Control Systems*
- *PR S 40051 Axle Counters*
- *MN S 41604 Alstom ETCS Trackside Maintenance Manual*
- *MN S 41605 Alstom ETCS Trackside Equipment Set to Work, Testing and Commissioning Manual*
- *PR S 47110 Inspection and Testing of Signalling: Introduction*

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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.

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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 Renewals

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.

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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 Axle Counter Equipment Changes

Axle counter equipment renewal pertains to the replacement or temporary removal of wheel sensors, trackside disconnection box, axle counter system cards, evaluator and associated power supplies. Renewal of these items shall be in accordance with Section 13, as well as with PR S 40051.

12 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.

12.1 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.

12.2 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.

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12.3 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.

12.4 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.

12.5 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.

12.6 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.

12.7 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.

12.8 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.

12.9 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.

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12.10 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.

12.11 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.

12.12 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.

12.13 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.

12.14 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.

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12.15 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.

12.16 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.

13 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).

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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 forLike 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.

13.1 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.

13.2 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.

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13.3 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.
- Change of axle counter system type.
- Installation of repeat relays.
- Alterations to software, data, IOS or SOE version.

13.4 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 47113 (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

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- 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

13.5 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 (Section 14).
- The work instruction for the appropriate equipment type. See Section 14 (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 work.

Note:
A competency level able to work without supervision, as defined in MN S 41412 shown against the relevant Inspection and Testing list in the Certificate of Competency will enable the person to "perform the test" for work that is treated as Like for Like Renewals.

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.

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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.

13.6 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.

13.7 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.

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14 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.

Applies to		Title	Reference
S	CS		
✓	✓	Scope of Work Authorisation – Like for Like Work Package	PR S 40011 FM01
✓		Points Electric Machine - Like for Like Renewal	PR S 40011 FM02
✓		EP Point Air Control Unit - Like for Like Renewal	PR S 40011 FM03
✓		EP Point (without micro-switches) - Like for Like Renewal	PR S 40011 FM04
✓		EP Point (with micro-switches) - Like for Like Renewal	PR S 40011 FM05
✓		Electrical Detector - Like for Like Renewal	PR S 40011 FM06
✓		Indication Box - Like for Like Renewal	PR S 40011 FM07
✓		Plunger Lock Assembly - Like for Like Renewal	PR S 40011 FM08
✓		Signal - Like for Like Renewal	PR S 40011 FM09
✓		Trainstop - Like for Like Renewal	PR S 40011 FM010
✓		Shelf Relay Like for Like Renewal	PR S 40011 FM011
✓		Releasing Switch Like for Like Renewal	PR S 40011 FM012
✓		Road Boom Gate Mechanism Like for Like Renewal	PR S 40011 FM013
✓		Pedestrian Swing Gate Mechanism Like for Like Renewal	PR S 40011 FM014
✓		Pedestrian Boom Gate Mechanism Like for Like Renewal	PR S 40011 FM015
✓		Relay Base (Plug-in) Like for Like Renewal	PR S 40011 FM016
✓		Signalling Air-Line Component Like for Like Renewal	PR S 40011 FM017
	✓	ATRICS Domain Controller Replacement - Like For Like Renewal	PR S 40011 FM019
	✓	ATRICS server replacement - Like For Like Renewal	PR S 40011 FM020
	✓	ATRICS RCS Workstation Replacement - Like For Like Renewal	PR S 40011 FM021
	✓	ATRICS Log Server Replacement - Like For Like Renewal	PR S 40011 FM022
	✓	ATRICS RCS Monitor Server Replacement - Like for Like Renewal	PR S 40011 FM023
	✓	OSS Domain Controller Replacement - Like for Like Renewal	PR S 40011 FM024
	✓	OSS APP Server Replacement - Like for Like Renewal	PR S 40011 FM025
	✓	OSS Web Server Replacement - Like for Like Renewal	PR S 40011 FM026
	✓	OSS SQL Server Replacement - Like for Like Renewal	PR S 40011 FM027

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Applies to		Title	Reference
S	CS		
	✓	OSS MET Server Replacement - Like for Like Renewal	PR S 40011 FM028
	✓	Remote Network Device Replacement - Like for Like Renewal	PR S 40011 FM029
✓	✓	Low Capacity UPS Replacement - Like for Like Renewal	PR S 40011 FM030
	✓	SCADA 2000 G32 Cable Replacement - Like for Like Renewal	PR S 40011 FM031
	✓	TDTES Domain Controller Replacement - Like for like Renewal	PR S 40011 FM032
	✓	TDTES Server Replacement - Like for like Renewal	PR S 40011 FM033
	✓	RTU Replacement - Like for Like Renewal	PR S 40011 FM034
✓	✓	Power Supply Replacement - Like for like Renewal	PR S 40011 FM035
✓	✓	Telemetry - Like for Like Replacement	PR S 40011 FM036
	✓	South Coast Train Describer Server Replacement - Like for like Renewal	PR S 40011 FM039
	✓	South Coast Train Describer Workstation Replacement - Like for like Renewal	PR S 40011 FM040
	✓	DPU Server Domain Controller Replacement - Like for Like Renewal	PR S 40011 FM41
	✓	Phoenix Code Server Replacement - Like for Like Renewal	PR S 40011 FM42
	✓	Phoenix Workstation Replacement - Like for Like Renewal	PR S 40011 FM43
✓		ETCS Balise Like For Like Renewal	PR S 40011 FM44
✓		Frauscher FAdC RSR180 Wheel Sensor Renewal Like for Like Renewal	PR S 40011 FM45
✓		Frauscher FAdC R2 Comm Board Like for Like for Like Renewal	PR S 40011 FM46
✓		Frauscher FAdC R2 Power Supply Board (PSC) Like for Like Renewal	PR S 40011 FM47
✓		Frauscher FAdC R2 Evaluator AEB101 Board Like for Like Renewal	PR S 40011 FM48
✓		Frauscher FAdC R2 IO-EXB101 Board Like for Like Renewal	PR S 40011 FM49
✓		Siemens ACM250 DEK Wheel Sensor Like for Like Renewal	PR S 40011 FM50
✓		Siemens ACM250 Track Connection Box Like for Like Renewal	PR S 40011 FM51
✓		Siemens ACM250 Evaluator Like for Like Renewal	PR S 40011 FM52
✓		TI21/ET200 Track Circuit Power Supply – Like for Like Renewal	PR S 40011 FM53

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Engineering System Integrity

Engineering Procedure

Signalling and Control Systems

Signalling Safeworking

PR S 40012

Repair/Replacement of Signalling Wires

Version 3.0

Date in Force: 15 July 2021

Approved by:	Professional Head Signalling and Control Systems Engineering System Integrity	Authorised by:	Engineering Technical Publications Manager System Integrity

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Document control

Version	Date	Author/Prin. Eng.	Summary of change
1.0	16 September 2013		First issue as a Sydney Trains document
1.1	21 September 2016		Update to mandatory ASA requirements, position titles and role description changes
1.2	12 September 2017		Update to mandatory position titles and role description changes
1.3	1 March 2019	A. Sozio	Updated to meet Control Systems requirements
2.0	8 March 2019	E Pace	Merged details from PR S 40011
3.0	15 July 2021	Ian Maydew/C Darmenia	Updated to include axle counter requirements

Summary of changes from previous version

Summary of change	Section
Reference updated to include PR S 40051	2
New axle counter section added	5

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Table of Contents

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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 communications 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 40051 Axle Counter*
- *PR S 47110 Inspection and Testing of Signalling: Introduction*

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.

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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. With external cables ensure that the cable does not go through any intermediate location.

d. 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.

e. Disconnect the affected circuits.

f. 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".

g. Insulation test the new circuit wire to earth.

h. 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].

i. Re-connect the affected circuit.

j. Advise the signaller and restore the apparatus into use.

k. 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.

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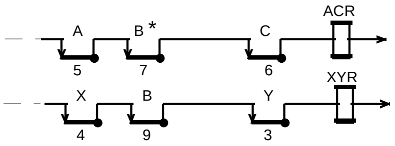
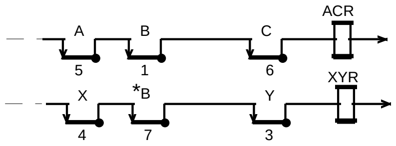
Illustration Of Necessity To Correctly Identify The Terminal Ends Of A Defective Wire And Change Over Onto Those Same Terminals

ARC circuit and contact B7 as shown in the circuit book

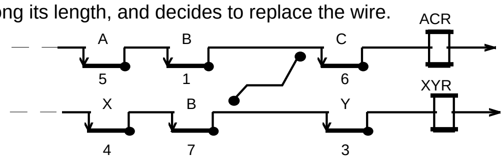


ARC circuit and contact B7 as it actually is

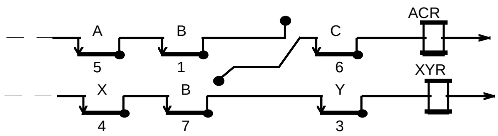


Suppose ACR circuit has failed and there is no positive voltage on the coil. Suppose in checking back through the circuit as shown in the circuit book the first positive voltage is found on B7 armature and it is checked that there is no continuity between B7 armature and C6 point. Suppose the maintainer assumes that the wire between B7 armature and C6 point is defective, open circuit somewhere along its length, and decides to replace the wire.

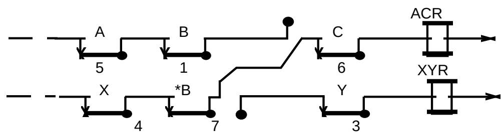
Run new wire to replace wire between B7 and C6



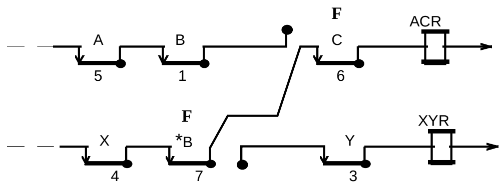
Change over at C6 point



Change over at B7 armature (suppose ACR relay picks up)

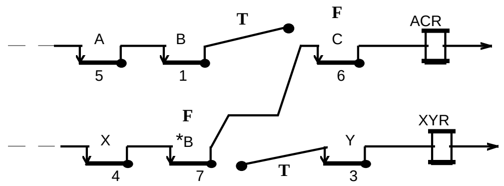


Strap and function test B7 and C6

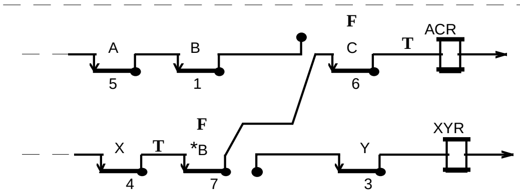


At this stage the test seem to indicate that the failure has been rectified, but in fact two separate circuits has been wrongly interconnected. **The following inspection and test are also necessary to verify the correct repair.**

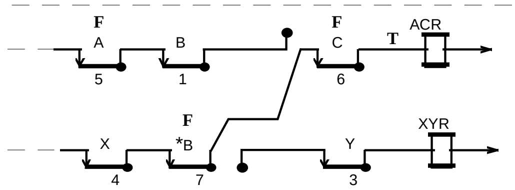
<u>EITHER</u>
Handtrace defective wire end to end



<u>OR</u>
Trace and verify wires on the other side of the contact at each point of connection



<u>OR</u>
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 terminals ends of a defective wire

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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 lead to a location be broken, or in need of replacement, then licensed signalling personnel shall follow the same procedure to that in Section 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 Axle Counter Wires – Repair, Replacement

Should an axle counter track section cable between the location and trackside disconnection box be broken, or in need of replacement then licensed signalling personnel shall follow the same procedure to that in Sections 6.

Testing of the track section shall follow the requirements as detailed in PR S 40051.

6 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.

6.1 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.

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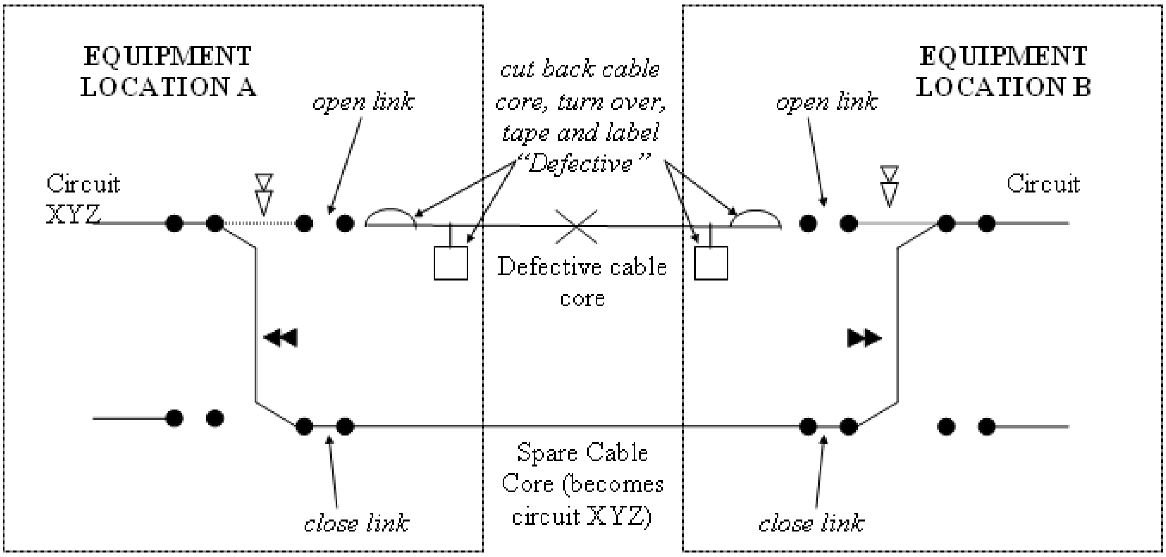

Figure 2: Transferring a circuit from a defective cable core to spare cable core

- 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.

6.2 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.

6.3 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.

6.4 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.

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7 Signalling Data Communication Links

Data communication links are utilised to connect Microlok systems, Solid State Interlocking systems, Dupline, Kingfisher, axle counters and SCADA telemetries, etc. These links consist of either copper communication type cables or optical fibre conductors.

7.1 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.

7.2 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.

7.3 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 disconnect wire coming into contact with any "live" circuit elements.

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Engineering System Integrity

Engineering Procedure

Signalling and Control Systems

Signalling Safeworking

PR S 40013

Field Paralleling of Signalling Contacts

Version 1.3

Date in Force: 17 October 2023

Approved by:	Professional Head Signalling and Control Systems Engineering System Integrity	Authorised by:	Engineering Technical Publications Manager System Integrity

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Document control

Version	Date	Author	Summary of change
1.0	16 September 2013		First issue as a Sydney Trains document
1.1	21 September 2016	R Del Rosario	Updated for new title & roles and clarity for updating circuit book & notification
1.2	9 March 2020	C De Sousa	Scheduled 3 year review
1.3	17 October 2023	A Sozio	Scheduled 3 year review

Table of Contents

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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 shall authorise this change and arrange for the circuit books to be updated.

Each additional wire shall be correctly beaded for the terminals and labelled 'PC' (or otherwise securely labelled as a 'parallel contact' wire).

Licensed signalling personnel shall 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.

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Signalling and Control Systems

Signalling Safeworking

PR S 40014

Control of Signalling Documentation Issued to the Field

Version 1.4

Date in Force: 15 July 2021

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Approved by:	Professional Head Signalling and Control Systems Engineering System Integrity	Authorised by:	Engineering Technical Publications Manager System Integrity

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Document control

Version	Date	Author/Prin. Eng.	Summary of change
1.0	16 September 2013		First issue as a Sydney Trains document
1.1	21 September 2016	R Del Rosario	Updated titles & roles and ASA requirements. Update document title
1.2	1 March 2019	A Sozio	Updated to Control Systems requirements
1.3	8 March 2019	C Darmenia	Include information for ATP/ETCS (L1 LS)
1.4	15 July 2021	Ian Maydew/C Darmenia	Updated to include axle counter requirements

Summary of changes from previous version

Summary of change	Section
Updated to include reference to axle counter configuration data	1

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Table of Contents

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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
- Axle counter configuration 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 ETCS L1 - Alstom Trackside Equipment* 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.

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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 the 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-SP-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., (e.g. 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.

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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., (e.g. 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'.

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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 this 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'.

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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.

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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 detail 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 FM01 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.

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Engineering System Integrity

Engineering Procedure

Signalling and Control Systems

Signalling Safeworking

PR S 40016

Liaison with Signallers & ICON Infrastructure and Authority to Operate Signalling Controls

Version 2.0

Date in Force: 20 October 2023

Approved by:	Professional Head Signalling and Control Systems Engineering System Integrity	Authorised by:	Engineering Technical Publications Manager System Integrity

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Document control

Version	Date	Author	Summary of change
1.0	16 September 2013		First issue as a Sydney Trains document
1.1	21 September 2016	R Del Rosario	Updated to new title and roles
1.2	9 March 2020	C De Sousa	Scheduled 3 year revies
2.0	20 October 2023	Paul Zammit/Mohammed Khan	Changed document title Contemporised and rearranged content

Summary of changes from previous version

Summary of change	Section
Changed document title to reflect content: *Liaison with Signallers & ICON Infrastructure, and Authority to Operate Signalling Controls* (formerly *Notification of Whereabouts and Liaison with Network Control Officers)*	
Liaison with signallers: retitled heading and contemporised requirements.	1
Liaison with ICON Infrastructure: retitled heading, moved section order, and contemporised requirements	2
Authority to operate signalling controls: new heading, moved section order, updated requirements in compliance with Transport standard T HR SC 02000 ST	3

Table of Contents

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1 Liaison with signallers

Licensed signalling personnel shall liaise with signallers whenever the opportunity presents so to determine the status of the signalling under their operation. Where advised of signalling problems, the symptoms shall be understood and the necessary action taken.

The signaller's permission shall be obtained before commencing any work that could interfere with train running, including the operation of level crossings.

When communicating the identification of specific signalling assets to signallers, it is imperative to convey the asset location along with the asset number. For this purpose, location prefixes should be used as shown on the signaller's control panel (where applicable) in conjunction with the asset number. This is required irrespective of a prefix label being available on the actual asset. For example, 600A points at Homebush can be communicated to the signaller as "Homebush ST600A points". This will avoid confusion where assets have the same number but are at different locations on control panels operated by the same signaller.

Where work has interfered (or had the potential to interfere) with operational signalling equipment, the signaller shall be requested to operationally test the affected signalling to ensure it is in proper operating order. This shall be done prior to leaving the work site. Such operational tests are in addition to the required engineering inspections and tests as relevant for the work.

2 Liaison with ICON Infrastructure

In addition to signaller liaison requirements, signalling personnel engaged in work that will or could impact operational signalling shall contact ICON Infrastructure at the commencement of such activities. This is to enable ICON Infrastructure to be aware of all (potentially) invasive type work. Such personnel shall remain contactable to ICON Infrastructure, as necessary.

Furthermore, licensed signalling personnel who are normally engaged to perform routine maintenance work shall contact ICON Infrastructure at the commencement and completion of duty. A workgroup leader may provide this advice on behalf of individual team members.

3 Authority to operate signalling controls

Signalling personnel shall only enter signal boxes and signalling control rooms in the course of their duties.

In most cases, the signaller shall be requested to operate signalling controls when required to test signalling equipment.

In some cases, signalling controls may be operated by signalling personnel for signalling maintenance or testing purposes. Signalling controls shall not be operated by signalling personnel for any other purpose, including train running or facilitating other activities.

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Signalling controls may be operated by signalling personnel on the following conditions:

- The operation of signalling controls is only for the purpose of signalling maintenance or testing.
- The signaller (or network controller for unattended locations, as applicable) provides consent.

  Where practicable, the consent should be a documented entry in the Train Register Book or equivalent, or otherwise the communication verbally recorded.

- The operation of controls poses no potential to endanger the movement of rail vehicles and users of level crossings.

Depending on the type of work, one of the following conditions shall apply in addition to the aforementioned conditions:

- For commissioning work, the affected signalling shall be first booked out of use.
- For maintenance work, signalling personnel shall receive an assurance from the signaller that no rail vehicles will enter the test area; otherwise, the affected signalling shall be booked out of use.

Signalling personnel shall attain an understanding of the signalling controls that are permitted to be operated by them, the extent of the test area, and the agreed time frame for the testing. Any risk of inadvertent operation shall be mitigated first.

The aforementioned requirements also apply to ground frames, local panels and closed signal boxes (facilitated by a closing lever or control).

However, where trackside releasing devices, such as releasing switches or key operated devices (including those operated by loose or captive keys) are provided for the operation of ground operated signalling, and the equipment is not disarranged, there is no need to book the signalling out of use, as the permission to operate such controls is governed by the network rules and procedures.

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Engineering System Integrity

Engineering Procedure

Signalling and Control Systems

Signalling Safeworking

PR S 40017

Maintenance Responsibilities and Frequencies

Version 2.0

Date in Force: 13 March 2024

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Prepared using: TP ESI 003 V2.0
Uncontrolled when printed

Approved by:	Professional Head Signalling and Control Systems Engineering System Integrity	Authorised by:	Engineering Technical Publications Manager System Integrity

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Document control

Version	Date	Author	Summary of change
1.0	16 September 2013	Y Bagaric	First issue as a Sydney Trains document
1.1	21 September 2016	B Howell	Updated for new titles and roles and review to mandatory ASA requirements
1.2	8 March 2019	C Darmenia	Update for ATP
2.0	13 March 2024	A Sozio	Updates including requirement from EI S 19-08 and EI S 22-05, REVCOM procedure and Axle counter requirements

Summary of changes from previous version

Summary of change	Section
Added "Reference" section (all other sections moved down in order)	1
Amended requirements for safety critical and safety significant task when the task cannot be achieved by the due date plus latitude period	3.2.4
Added new heading a paragraph for the provision for signal engineers to approval deferral of routine signal maintenance latitude	3.2.4
Updated safety critical task table to include Point history cards for Electrical, EP and mechanical	3.2.5
Updated safety critical task table to include Frauscher FAdC R2 and Siemens ACM250 axle counter system and associated form	3.2.5
Updated safety significant task table to include Thales AzLM axle counter system and associated form.	3.2.5
New section "Maintenance records". Also included paper type requirements and requirements for when starting a new card as per EI S 19-08 and EI S 22-05	3.2.6
Included new requirement for wheel sensor history cards	3.2.6
Updated section to clarify how to manage maintenance tasks where lines have been suspended	3.3
Removed "Returns, Checklists and Point History Cards" section	Appendix A

OFFICIAL

Table of Contents

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1 References

This procedure shall be read in conjunction with the following documents:

Signalling Safeworking Procedures

- *PR S 40017 Seldom Used Signalling Equipment*
- *PR S 40024 Vital Signalling Relays*
- *PR S 40025 Track Circuits.*
- *PR S 40036 Level Crossings*
- *PR S 40049 Signal Engineering Deviations*
- *PR S 40051 Axle Counters*

Engineering Procedures

- *PR A 00402 Deferrals for Preventative Maintenance*

Network Rules and Procedures

- *NRF 003 Infrastructure Booking Authority (IBA)*

2 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 Signaller panel/s, licensed signalling personnel prior to the work commencing shall contact the signaller 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 signaller 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 shall 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, however, are to be vigilant and report any defect or maintenance attention required for correction.

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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 shall 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 shall 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 shall, if required, work in adjacent areas to find and rectify the cause. In such cases, the maintenance signal engineer and relevant team manager shall be notified as soon as practical.

Licensed signalling personnel shall 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.

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Licensed signalling personnel shall 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 shall 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 shall 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 shall take the necessary action to mitigate such risk associated with the situation or otherwise arrange to book the affected signalling out of use.

3 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.

3.1 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.

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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 3.2 of this procedure, where a Signal Engineering Deviation or AMB Concession is required. Refer to *PR S 40049 Signalling Engineering Deviations*.

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, shall be recorded using Sydney Trains' maintenance reporting and recording system.

3.2 Management and reporting of safety related examinations and inspection tasks

3.2.1 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 item 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.

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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.

3.2.2 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.

3.2.3 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.

3.2.4 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 3.2.5. Additionally, a return shall 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 3.2.5 are acceptable after approval unless shown otherwise.

The Signalling Technical Maintenance Plan defines preventive maintenance tasks for signalling assets. Each task has planning latitude which reflects an allowed variation around the task due date. That is, the earliest start and latest finish date. 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.

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Safety Critical and Safety Significant tasks shall be prioritised and completed within the defined planning latitude. Safety critical and safety significant tasks not achieved by the due date plus latitude period shall immediately be booked out of order until the task is complete.

Work orders that become due within the scheduled period and are completed, shall be closed off using Sydney Trains' maintenance management system.

Reliability maintenance deferral

Maintenance signal engineers may approve deferrals for reliability based preventive signal maintenance for extension of latitude of up to 50% of the latitude period in accordance with PR A 00402 Deferrals for Preventative Maintenance. This permission does not apply to maintenance schedules of safety critical or safety significant tasks.

3.2.5 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. The forms for Safety Critical Tasks and Safety Significant Tasks are available for download from the Sydney Trains intranet and internet sites.

Safety Critical Task	Return
Checking of 50 Hz ACDR track circuits	PR S 40017 FM01
Testing of point locks and point detection	PR S 40017 FM01
Testing of derail detection	PR S 40017 FM01
Testing of selectors and bolt locks	PR S 40017 FM01
Testing of unproved electric locks	PR S 40017 FM01
Inspection of non-proved vital signalling relays – A.C. vane and D.C. shelf types	PR S 40017 FM01
Point History card (EP and Mechanical)	PR S 40017 FM03
Point History card (Electrical)	PR S 40017 FM04
Testing of Frauscher FAdC R2 axle counter system	PR S 40051 FM01
Testing of Siemens ACM250 axle counter system	PR S 40051 FM02

Safety Significant Task	Return
Testing of signalling interlockings and mechanical locking items (Signal Engineers inspection)	PR S 40022 FM01 *
Inspection of level crossing protection equipment (Signal Engineers inspection)	PR S 40036 FM02
Testing of signalling electrical conductor insulation resistance	PR S 40023 FM01 to FM06

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Safety Significant Task	Return
Testing of electro-mechanical and thermal type time limit relays	PR S 40024 FM02 *
Overhaul of non-proved vital signalling relays – A.C. vane and D.C. shelf types	PR S 40024 FM01 *
Inspection of parallel bonding	PR S 40017 FM01
Track circuit level 3 – including shunt testing, zero feed and polarity testing (2 year test)	PR S 40017 FM01
Testing of slip detectors and rainfall detectors	PR S 40017 FM01
Testing of ETCS Unlinked or Seldom Used Balises	PR S 40017 FM01
Testing of Thales AzLM	PR S 40051 FM03

* 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, *PR S 40017 FM02 Points Turnout Checklist* is to be completed as part of the risk assessment for the particular points concerned and accompany the Deviation application.

3.2.6 Maintenance records

Records of maintenance activities shall be in accordance with the following sections.

Record or history cards kept in trackside locations shall be printed on uncoated bright white paper, A4, 250-280 GSM, using indelible colour printing and preferable stored in a plastic document folder or protector.

When starting a new card, ensure that details of the first full recorded test (i.e. the earliest full record, ideally the commissioning test values) and the last full recorded test (i.e. the most recent full record) are transferred onto the new card.

Relay records

Relay records shall be prepared and submitted in accordance with *PR S 40024 Vital Signalling Relays*.

Battery records

Battery record cards shall be kept with the battery/cell in accordance with the procedure laid down herein.

Level Crossing records

Level Crossing maintenance visit sheets shall be kept in the level crossing location as defined in *PR S 40036 Level Crossings*.

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Point maintenance records

Point history cards shall 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) shall be kept near the track relay and track feed as specified in *PR S 40025 Track Circuits.*

Insulation Test Records

Insulation test records shall be kept by the maintenance signal engineer or maintenance depot and monitored against the program as scheduled in the Sydney Trains maintenance management system.

Wheel sensor history cards

Wheel sensor history card is to be kept inside the signalling location housing the associated axle counter system as specified in *PR S 40051 Axle Counters*.

Signal Engineer Inspection/Test Reports and Certificates

Reports and certificates shall 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.

3.3 Lines on which traffic is suspended

Should traffic on a line be suspended, maintenance may also be suspended. This shall be done in accordance with *PR S 40007 Seldom Used Signalling Equipment*. Any signalling asset associated with a suspended line that can impact an adjacent operational line shall remain under its normal maintenance schedule.

Network Operations shall be notified in writing regarding the reduction of maintenance (which may be totally ceased, if accordingly assessed).

Affected signalling shall be booked out of use. An Infrastructure Booking Authority using form NRF 003 Infrastructure Booking Authority (IBA) form shall be compiled as part of the notification.

The notification shall also state that no trains are to operate on such lines until full maintenance is resumed and the affected signalling is booked into use. Written acknowledgement shall be requested from Network Operations.

3.4 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 shall be duly submitted to the maintenance signal engineer.

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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.

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Engineering System Integrity

Engineering Procedure

Signalling and Control Systems

Signalling Safeworking

PR S 40019

Cleanliness and Lubrication of Mechanical Signalling Equipment

Version 1.3

Date in Force: 17 October 2023

Approved by:	Professional Head Signalling and Control Systems Engineering System Integrity	Authorised by:	Engineering Technical Publications Manager System Integrity

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Document control

Version	Date	Author	Summary of change
1.0	16 September 2013		First issue as a Sydney Trains document
1.1	21 September 2016	R Del Rosario	Updated titles, roles and removed references to Draw Locks
1.2	9 March 2020	C De Sousa	Scheduled 3 year review
1.3	17 October 2023	A Sozio	Scheduled 3 year review

Table of Contents

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1 Introduction

All mechanisms and connections shall 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 shall 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 shall be moved away, so that the connections work freely. Wet or damp conditions due to ineffective drainage, causing problems with equipment or connections, shall 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 shall 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 shall be taken not to interfere with the locking mechanism.

Each time a cover has been removed and replaced the Annett Lock shall be carefully tested.

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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 2.0

Date in Force: 8 November 2023

Approved by:	Professional Head Signalling and Control Systems Engineering System Integrity	Authorised by:	Engineering Technical Publications Manager System Integrity

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Document control

Version	Date	Author	Summary of change
1.0	16 September 2013		First issue as a Sydney Trains document
1.1	21 September 2016	R Del Rosario	Updated to new titles & roles, update to ASA requirements and merge PR S 40015 into documents
1.2	8 March 2019	A Sozio	Update to include control systems requirements
2.0	8 November 2023	A Sozio	Added Reference section and removed Position of trackside equipment section

Summary of changes from previous version

Summary of change	Section
Add "Reference" section (all other sections moved down in order)	1
Removed "Position of trackside equipment" section	1.6

OFFICIAL

Table of Contents

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1 References

This procedure shall be read in conjunction with the following documents:

Signalling Safeworking Procedures

- *PR S 40048 Signalling Locations and Equipment – Security Locks and Keys*

2 Introduction

Relay rooms, computer rooms, walk-in enclosures and lower floors of signal boxes and apparatus cupboards shall be kept clean and tidy. They shall be kept locked whenever possible. Spare or surplus material shall not be stored in these places unless it is neatly placed in racks or cupboards provided specially for that purpose. Highly inflammable material shall 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 shall be advised of any security breach, water ingress or fire or any other significant matter that requires escalation and their attention.

2.1 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, shall 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 Signalling Locations and Equipment – Security Locks and Keys*.

All signalling equipment operating mechanisms, relays, contacts, terminals etc, shall be housed in equipment units or in cupboards locked by Falcon Series locks as per PR S 40048, 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 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.

2.2 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 shall 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.

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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 shall be checked for correct operation.

Semi-sealed components shall 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 shall be changed out.

Sealed components shall 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.

2.3 Housekeeping

Access pathways, ladders and other such items shall be maintained in good order, so as to provide adequate access to signalling apparatus and housings. Excess vegetation, rubbish or surplus materials shall be removed during maintenance visits.

Vegetation shall be kept clear of signalling equipment, signal and communications line wires and shall not obstruct the sighting of signals. If obstructions become noticeable to licensed signalling personnel, the obstruction shall be removed as soon as possible and if the obstructions become unmanageable the defects to be reported to the team manager and arrangement shall be made for removal.

Lighting of relay rooms and cupboards shall 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 shall 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) shall 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.

2.4 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 shall be reported to the maintenance signal engineer. Highly combustible and inflammable 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 shall 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.

2.5 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.

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Engineering System Integrity

Engineering Procedure

Signalling and Control Systems

Signalling Safeworking

PR S 40022

Inspection and Testing of Signalling Interlockings

Version 2.0

Date in Force: 17 October 2023

Prepared using: TP ESI 003 V2.0
Uncontrolled when printed

Approved by:	Professional Head Signalling and Control Systems Engineering System Integrity	Authorised by:	Engineering Technical Publications Manager System Integrity

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Document control

Version	Date	Author	Summary of change
1.0	16 September 2013		First issue as a Sydney Trains document
1.1	21 September 2016	R Del Rosario/ C Darmenia	Updated for new titles & roles and to ASA mandatory requirements
1.2	9 March 2020	C De Sousa	Scheduled 3 year review
2.0	17 October 2023	A Sozio	Minor updates. Include new Section 1 "Reference" and removed Appendix A

Summary of changes from previous version

Summary of change	Section
Added new section for reference documents	1-
Add "Signal Key Switch" to "Mechanical Locking items" section	2.3.1
Add "Hitachi Wayside Standard Platform (WSP) 2nd Generation (2G)"	2.5
Updated "Design Integrity Testing"	3.4
Removed "Forms"	Appendix A

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Table of Contents

1 Reference

This procedure shall be read in conjunction with the following documents:

Signalling safeworking procedures

- *PR S 40017 Maintenance Responsibilities and Frequencies*

Inspection and testing procedures

- *PR S 47110 Inspection and Testing of Signalling: Introduction*

Signalling safeworking forms

- *PR S 40022 FM01 Signal Apparatus - Mechanical/Relay/Route Control Locking Test Certificate*
- *PR S 40022 FM02 Signal Apparatus - Design Integrity Test Certificate*

2 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.

2.1 Testing new works and alterations

Requirements for testing and certifying new works and alterations are detailed in Specification *PR S 47110 Inspection and Testing of Signalling: Introduction.* 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 shall 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.

2.2 Periodic maintenance interlocking tests

Periodic maintenance interlocking tests shall be carried out by a signal engineer (see Section 3) 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 shall 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 shall be appropriately treated to ensure system safety and managed by the Sydney Trains defect management system.

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The Signals Engineering Manager is to monitor performance indicators and status reports on the interlocking test programme.

2.3 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 shall be completed and certified on a PR S 40022 FM01 certificate by a signal engineer (see Section 3) every two years.

2.3.1 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); Signal Key Switch (SKS); 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.

2.3.2 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 shall be completed and certified by a signal engineer holding the appropriate authority as detailed in Section 3.

2.4 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.

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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 shall 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 shall 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
b. P.V.C. insulated and sheathed wires and cables
c. double switched external circuits to relays used for interlocking
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.), shall be tested in accordance with applicable signalling documentation as detailed for Mechanical Locking (see Section 2.3), and certified on a PR S 40022 FM01 certificate every two years.

Interlocking tests shall be completed and certified by a signal engineer holding the appropriate authority as detailed in Section 3.

2.5 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 list provides examples of computer based interlockings used on the Sydney Trains network:

- Solid State Interlocking (SSI)
- Microlok II
- Westlock
- Westrace
- Smartlock
- Hitachi Wayside Standard Platform (WSP) 2nd Generation (2G)

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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), shall be tested in accordance with applicable signalling documentation as detailed for Mechanical Locking (see Section 2.3), and certified on a PR S 40022 FM01 certificate every two years.

Interlocking tests shall be completed and certified by a signal engineer holding the appropriate authority as detailed in Section 3.

2.6 Interlocking test certificates

Interlocking test certificates shall 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 Signal Apparatus - 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 Signal Apparatus - Mechanical/Relay/Route Control Locking Test Certificate* should be used.

For all other new and altered works, form *PR S 40022 FM02 Signal Apparatus - 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.

3 Authority to test interlockings

Interlocking testing, including design integrity testing (also known as principles testing), shall only be performed by signalling personnel who hold the competency and authority for such testing.

3.1 Interlocking fitters

Licensed interlocking fitters are permitted to test mechanical interlocking frames and items, following maintenance performed by the interlocking fitter.

3.2 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.

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- 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.

3.3 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) shall 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 shall observe the layout plan to ensure the relevant signalling principles are effective during the test e.g.: (levers pulled do not clear opposing signals, etc.).

3.4 Design integrity testing

The engineer leading the design integrity testing shall be competent as prescribed on their certificate of competency, relevant for the interlocking and signalling system to be tested.

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.

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Engineering System Integrity

Engineering Procedure

Signalling and Control Systems

Signalling Safeworking

PR S 40023

Insulation Inspection and Testing

Version 2.0

Date in Force: 26 May 2022

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Version	Date	Author/ Prin. Eng.	Summary of change
1.0	16 September 2013		First issue as Sydney Trains document
1.1	1 July 2016	R. Del Rosario	Updated to new titles & roles, updated to mandatory ASA requirements and EI S 15/03
1.2	8 March 2019	C. Darmenia	Inclusion of ATP requirements
2.0	26 May 2022	C. Darmenia	Update for Axle Counters and WSP 2G interlocking

Summary of changes from previous version

Summary of change	Section
Added "Scope" section	2
Added "Purpose" section	2.1
Added "Reference document" section	3
Added " Terms and definitions" section	4
Added "Axle Counters" section	12.1
Added "Wayside Standard Platform 2nd Generation (WSP 2G)" requirements and exemptions section	13.4
Added "Forms" section with links Sample forms removed	17

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Table of Contents

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1 Introduction

Insulation inspections and tests shall 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.

2 Scope

To provide concept and process for the management of cable and wire degradation through planned testing and observation to support the integrity of the signalling system.

2.1 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.

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3 Reference documents

- *PR S 40017 Maintenance Responsibilities and Frequencies*
- *PR S 40028 ETCS L1 – Alstom Trackside Equipment*
- *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*
- *PR S 40042 Safety Issues for Signalling Personnel*
- *PR S 40052 WSP 2G Computer Based Interlocking*
- *PR S 47110 Inspection and Testing of Signalling: Introduction*
- *PR S 47114 Inspection and Testing of Signalling: Inspection and Testing Procedures*

4 Terms and definitions

The following definitions apply in this document:

ATP	Automatic Train Protection
ELD	Earth leakage detector
ETCS	European Train Control System
GST	Galvanised steel troughing
LEU	Lineside electronic unit

4.1 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 terminations.

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.

4.2 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.

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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 Section 17).

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 FM01 (see Section 17), 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.

The insulation testing program is to be scheduled by the Sydney Trains maintenance management system with documentation submitted to the maintenance signal engineer on the completion of the task. Electronic copies of attested documents are acceptable.

4.3 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.

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4.4 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, 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.

4.5 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.

4.6 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.

4.7 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 16.

4.8 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 Section 17.

Further details on insulation test record requirements are found in PR S 40017.

4.9 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.

4.10 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

5 Power Supply Busbars

All busbar voltage leakage to earth test readings and ELD test results shall be recorded on PR S 40023 FM01 form or equivalent (see Section 17) 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.

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If the fault is permanently detected the ELD faults shall be thoroughly investigated by isolating circuits.

Electrical safety in regard to earth leakage faults shall be assessed and actioned according to PR S 40042.

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 FM01 or equivalent (see (see Section 17).

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 FM01 form or equivalent (see Section 17). Under no circumstances is an ammeter to be connected between any busbar and earth.

6 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.

6.1 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.

6.2 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.

6.3 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 7.

6.4 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).

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7 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 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).

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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.

8 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.

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Insulation testing of 120 volt AC power supply mains that only feed isolating transformers for SSI Trackside Functional Modules is not required.

9 Non-Vita 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 FM01 or equivalent (see Section 17).

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.

10 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.

11 Arrestors

Arrestors or varistors to earth shall be tested using an ohmmeter or arrestor tester to ensure they are open circuit under normal conditions and will break down and 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.

12 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.

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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

12.1 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.

13 Computer Based Interlocking Systems (including exemptions to testing requirements)

CAUTION

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.

13.1 SSI, Westlock and Smartlock System

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.

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13.2 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.

13.3 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.

13.4 Wayside Standard Platform 2nd Generation (WSP 2G)

Following are the specific circuits and items that are exempted from periodic inspection and testing:

- WSP 2G central interlocking cubicle wiring and equipment
- Maintenance and Diagnostics subsystem wiring and equipment
- data link wiring and cables
- isolation transformers and secondary wiring
- FDC 3G cubicle wiring, equipment and associated input/output wiring, including external conductors (including spares, sheaths, screens or drain wires) where directly connected to inputs/outputs of field device modules.

Refer to PR S 40052 for additional Insulation testing requirements.

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14 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.

15 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.

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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.

15.1 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.

16 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 9.

17 Forms

The following reset forms are available for download in a PDF formatted documents from the Sydney Trains intranet and internet websites for printing:

- *PR S 40023 FM01* Earth Leakage And Detector Test Sheet
- *PR S 40023 FM02* Insulation Test Sheets: Signalling Circuits
- *PR S 40023 FM03* Insulation Test Sheets: Power Feeders
- *PR S 40023 FM04* Insulation Test Sheets: Main Cables
- *PR S 40023 FM05* Insulation Test Sheets: Tail Cables
- *PR S 40023 FM06* Insulation Test Sheets: Track Circuit Locals

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	Insulation Type	ELD Fitted	Double Switched in Circuit	Apparatus Function Test/Core to Core	Insulation Test			Test Frequency (years)
				Insulation Test	Screen/ Drain Wire	Spare Conductors	Conductors Working or Spare	
INTERNAL CABLES/WIRES	PVC	ELD	D/S	-	-	-	NIL	-
	PVC	ELD	NOT D/S	-	-	-	NIL	-
	PVC	NO ELD	D/S	-	-	-	ALL	4
	PVC	NO ELD	NOT D/S	-	-	-	ALL	4
	NON PVC	ELD	D/S	-	-	-	NIL	-
	NON PVC	ELD	NOT D/S	-	-	-	NIL	-
	NON PVC	NO ELD	D/S	-	-	-	ALL	2
	NON PVC	NO ELD	NOT D/S	-	-	-	ALL	2

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.

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	Insulation Type	ELD Fitted	Double Switched in Circuit	Apparatus Function Test/Core to Core	Insulation Test			Test Frequency (years)
				Insulation Test *1)	Screen/ Drain Wire	Spare Conductors *2)	Conductors Working or Spare	
EXTERNAL MAIN CABLES/WIRES	PVC	ELD	D/S	-	✓	ALL	NIL	4
	PVC	ELD	NOT D/S	CC	✓	ALL	MIN 2	4
	PVC	NO ELD	D/S	-	✓	ALL	MIN 2	4
	PVC	NO ELD	NOT D/S	CC	✓	ALL	ALL	4
	NON PVC	ELD	D/S	-	-	ALL	MIN 3	2
	NON PVC	ELD	NOT D/S	CC	-	ALL	MIN 3	2
	NON PVC	NO ELD	D/S	-	-	ALL	MIN 3	2
	NON PVC	NO ELD	NOT D/S	CC	-	ALL	ALL	2
EXTERNAL POWER CABLES	PVC	ELD/RCD	-	-	✓	-	NIL	4
	PVC	NO ELD	-	-	✓	-	ALL	4
	NON PVC	ELD/RCD	-	-	✓	-	NIL	4
	NON PVC	NO ELD	-	-	✓	-	ALL	2

Table 2: Test Frequencies

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

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	Insulation Type	ELD Fitted	Double Switched in circuit	Apparatus Function Test/Core to Core	Insulation Test			Test Frequency (years)
				Insulation Test * 1)	Screen/Drain Wire	Spare Conductors * 2)	Conductors Working or Spare	
EXTERNAL LOCAL (TAIL) CABLES/WIRES	PVC	ELD	D/S	-	✓	ALL	NIL	4
	PVC	ELD	NOT D/S	F/CC	✓	ALL	MIN 2	4
	PVC	NO ELD	D/S	-	✓	ALL	MIN 2	4
	PVC	NO ELD	NOT D/S	F/CC	✓	ALL	ALL	4
	NON PVC	ELD	D/S	-	-	ALL	MIN 3	2
	NON PVC	ELD	NOT D/S	F/CC	-	ALL	MIN 3	2
	NON PVC	NO ELD	D/S	-	-	ALL	MIN 3	2
	NON PVC	NO ELD	NOT D/S	F/CC	-	ALL	ALL	2

Table 3: Test Frequencies

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 them 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 square conductors to one another. Also test spare and working conductors to metal casing/frame of operating apparatus and 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.

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Engineering System Integrity

Engineering Procedure
Signalling and Control Systems

Signalling Safeworking

PR S 40024

Vital Signalling Relays

Version 2.1

Date in Force: 22 March 2024

Approved by:	Professional Head Signalling and Control Systems Engineering System Integrity	Authorised by:	Engineering Technical Publications Manager System Integrity

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Document control

Version	Date	Author	Summary of change
1.0	16 September 2013	Garry Ware	First issue as a Sydney Trains document, rebranded from previous RailCorp TMG J024
1.1	21 September 2016	Mohammed Khan	Updated to Engineering Instruction, mandatory ASA requirements and position titles/roles
2.0	1 December 2023	Paul Zammit	Clarify and define existing requirements. Add relay types not previously included.
2.1	22 March 2024	Paul Zammit	Amend function testing requirements for changed-relay.

Summary of changes from previous version

Summary of change	Section
Amend testing requirements for changed-relay (deleted 'strap and function test' and 'circuit function test' in lieu of 'function test'). Tests described. This change enables the work to be done in accordance with an ASI01 competency.	8.1 8.2

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Table of Contents

1 Reference documents

This procedure shall be read in conjunction with the following documents:

Signalling Safeworking Procedures

- *PR S 40004 Failures*
- *PR S 40008 Securing Signalling Apparatus Out of Use*
- *PR S 40009 Disconnection of Signalling Apparatus*
- *PR S 40010 Risks and Control Associated with Testing and Certifying Equipment*
- *PR S 40011 Renewals Work*
- *PR S 40017 Maintenance Responsibilities and Frequencies*
- *PR S 40025 Track Circuits*

Signalling Safeworking Forms

- *PR S 40011 FM11 Shelf Relay - Like for Like Renewal*
- *PR S 40024 FM01 Relay Change Form*
- *PR S 40024 FM02 2 Yearly Test of Electromechanical or Thermal Timing Relays*
- *PR S 40024 FM03 Notice of Installation of Shelf Relay Conversion Unit*

Equipment Manuals

- *Relay Equipment Manual*

2 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 shall take the necessary precautions when undertaking tasks associated with the wiring, inspecting, maintaining, replacing, dispatching and overhauling of vital signalling relays.

Vital signalling relays exist in various forms and configurations; however, all are categorised as either unproved or proved. Proved relays are proven to be in the de-energised position by another circuit, as designed. Unproved relays pose a greater risk, as a wrong side failure associated with these relays may go undetected by the system.

2.1 Relay pick-up and drop-away definitions

For the purpose of signalling safeworking procedures, the term ‘pick-up’ shall refer to the minimum current or voltage (as applicable) at which all front contacts are just closed.

Conversely, the term ‘drop-away’ shall refer to the maximum current or voltage (as applicable) at which all front contacts are open.

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3 Precautions using test instruments on vital signalling relay circuits

The following precautions shall be taken when using test instruments on vital signalling relay circuits:

- 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 when in 'ohms' and 'diode-test' modes produce a test voltage and present a risk of falsely energising the relay. These modes shall not be used without disconnecting the circuit.
- Voltmeters shall not be applied directly across contacts of operational circuits.

  At no time is the dedicated 'millivolt' setting to be used.

  Switch the voltage setting (a.c. or d.c.) to a higher range than the operational voltage or otherwise select the 'auto' range.

4 Treatment of safety related relay faults

A defective in-service vital signalling relay shall be treated as a signalling irregularity where any of the following conditions are realised or otherwise suspected:

- The relay defect prevents the relay from de-energising.
- The relay defect causes the relay contacts to falsely indicate an energised or de-energised state.
- The relay defect causes a less restrictive condition or other unsafe condition.

Such conditions shall be treated in accordance with *PR S 40004 Failures*, including the signalling protection requirements and maintenance signal engineer notification. The defective or suspected relay shall not be disturbed until instructed by the investigating signal engineer. The subsequent handling and examination requirements shall be in accordance with Section 9.

Vital signalling relays not in service (spares holding) that are found with any of the aforementioned conditions shall be duly referred to the maintenance signal engineer for action. The subsequent handling and examination shall be in accordance with Section 9.

The Principal Engineer Signalling Integrity shall be duly notified where any of the aforementioned conditions are found with vital signalling relays.

4.1 Defective or suspected relays

A relay replaced because of suspected or actual defect that has the potential to cause an unsafe operation shall be handled carefully in order to preserve evidence of the fault condition. An inspection at this stage shall be non-invasive so to preserve any fault evidence. The relay shall not be further operated or manipulated by the field team.

Notwithstanding the aforementioned notification requirements, the investigating signal engineer shall duly arrange with the Principal Engineer Signal Systems for the relay to be jointly examined and analysed in a suitable workshop environment such as at the Rail Equipment Centre.

The joint examination and analysis shall be undertaken by a suitable engineer assigned by the Principal Engineer Signal Systems and the relay manufacturer, supplier or overhaul expert (for example, Rail Equipment Centre subject matter expert).

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The pending actions, including any assigned to in-service relays or those in spares holding shall be promptly addressed and closed-out.

5 Sealing of relays

Vital signalling relays supplied by manufacturers and workshops are sealed. These relays, together with those installed in the field (that may not be sealed), shall be considered as being sealed and therefore, not opened.

Relay seals shall not be broken in the field except in exceptional circumstances, and only if directed by the relevant signal engineer.

In the event of a defect being observed in a relay, the seal shall be left intact.

6 Cyclic changing and overhauling of relays

The task for changing and overhauling unproved a.c. and d.c. shelf relays, electro-mechanical type time-limit relays, thermal type time-limit relays, and VT1 type relays shall be treated as 'safety significant' in accordance with *PR S 40017 Maintenance Responsibilities and Frequencies*.

The policy for changing and overhauling such relays is based on the relays being either unproved or proved.

Unproved shelf relays, as well as unproved electro-mechanical type time-limit, thermal type time-limit and VT1 type relays shall be changed on reaching 15 years in service, in accordance with the technical maintenance plan.

However, shelf relays, and VT1 type relays used for cut-tracks shall be changed on a 10 year basis.

Proved shelf relays, as well as proved electro-mechanical type time-limit and thermal type time-limit relays are not required to be changed on a periodic basis, rather on an as-needed basis as determined by the maintenance inspections.

Signal Branch d.c. shelf relays shall no longer be used. Where found in service, they shall be immediately replaced, preferably with DN11 type shelf relays.

Other relay types (whether unproved or proved) do not require periodic overhaul. These include Q type (BRB 930), B type, HVI type and PN150 series relays.

Note:
PN150 series relays, including variants are typically used for VCOR in some CBI installations, such as Microlok II.

Whilst not requiring periodic overhaul, Q type relays shall be sampled for detailed examination in accordance with Section 6.1. Sampling is not required for B type relays due to minimal relays remaining in service and limited spares holding. Sampling is also not required for HVI type relays and PN150 series relays.

6.1 Sampling of Q type relays

Samples of Q type relays from typical installations shall be inspected in detail after 20 years of service. This is done to assess the need for overhaul or replacement of the complete group, and to assess the period for the next sample inspection.

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The maintenance signal engineer shall define the sample base as determined by an assessment, taking into account problematic relays and relay-population. The inspection shall cover all Q type relay configuration-variants in service over a defined period as determined by the assessment.

The sampling shall be managed using the Sydney Trains maintenance management system.

The sampling inspection shall be carried out at the Rail Equipment Centre. The licensed signalling person, in conjunction with the maintenance signal engineer shall advise the Rail Equipment Centre Manager. The sample relays shall be completely dismantled during the inspection.

The Rail Equipment Centre Manager shall obtain a report from the workshops and forward copies to the Principal Engineer Signal Systems and to the maintenance signal engineer for review and determination. After the inspection report is accepted by the Principal Engineer Signal Systems, the sample relays that were dismantled for inspection may be discarded.

6.2 Q type plug-in conversion units for ACVL relays

Plug-in conversion units using Q type relays are available as a replacement for ACVL relays.

Any ACVL relay determined for replacement shall be replaced with a Q type plug-in conversion unit, where practicable.

When arranging to replace an ACVL relay with a Q type plug-in conversion unit, it will be necessary to survey the circuit book contact analysis to ensure that there are no circuits passing through the ACVL relay that has a current exceeding the 3 amp rating of the Q type relay contact (for example, trainstop motor circuits).

Prior to placing a Q type plug-in conversion unit into service, the conversion unit as a complete unit (not just the relay) shall be inspected and compared to the test certificate accompanying the relay. This is done to ensure the relay is of the same type and that the form is signed by the workshop tester and workshop supervisor.

Any straps between the local and line coil terminals shall be removed and not used.

Installation and testing shall be in accordance with *PR S 40011 Renewals Work*.

Note:
A maintenance signal engineer authorisation is required for the renewal of shelf relays with plug-in conversion units.

Once an ACVL relay has been replaced with a Q type plug-in conversion unit, form *PR S 40024 FM03 Notice of Installation of Shelf Relay Conversion Unit* shall be compiled. A copy of the completed form shall be sent to the signal asset engineer to update the asset register, and another copy sent to the Documentation Manager, Signalling and Control Systems for updating the circuit book.

For maintenance purposes, Q type plug-in conversion units shall be considered as plug in relays.

6.3 HVI type relays

HVI type relays are used in high voltage impulse track circuits. This relay type shall be kept under review until a fault or deterioration rate requires their replacement, unless otherwise outlined in the technical maintenance plan.

6.4 Relay change program and register

The maintenance signal engineer shall ensure a program and register is in place for the change-out and overhaul of vital signalling relays, as prescribed in Section 6.

The register shall include relevant details of the following relays in service:

- Shelf relays
- VT1 type relays
- B type relays
- Electro-mechanical type time-limit relays
- Thermal type time-limit relays.

The register shall also include details of the aforementioned relays that were replaced due to defect.

When a relay has been replaced, newly installed or permanently removed from service, the relay register shall be duly bought up to date to reflect the change. The details of newly installed or replaced relays, including the install date shall be included.

7 Wiring used for shelf relays

For shelf relays fitted with a detachable top, flexible stranded wire (for example, 7/0.40 mm) may be terminated on the detachable top using appropriate insulated crimp lugs. Ensure that bakelite terminal covers are fitted and that the lugs on adjacent terminals do not come in contact with one another.

When a shelf relay is directly wired (not fitted with a detachable top), flexible stranded wire shall not be terminated directly onto the relay. Rather, single strand, stiff wire (for example, 1/1.70 mm) without crimp lugs shall be used on these relays. Where required to run to a Q type relay or similar (which will not accept this wire), an interfacing terminal block shall be used.

In cases where flexible, stranded wire has already been terminated on directly wired shelf relays, the following is required:

- Ensure that crimp lugs do not touch one another or other terminals.
- Whenever it is necessary to replace the relay or to disconnect and reconnect its wiring, the following tasks shall be done:
  - label each wire with its relay terminal number
  - insulate each crimp lug as it is removed from the relay with either suitable sized plastic tubing (which will fit tightly over the crimp lug) or with similarly secure product.

8 Placing relays into service

When placing relays into service, care shall be taken to ensure the integrity of signalling is not diminished by the work, and that no alteration to the specific signalling design occurs without approval and correct process. This is particularly relevant for shelf relays.

Reference to other engineering requirements shall be sought, including *PR S 40010 Risks and Control Associated with Testing and Certifying Equipment* and PR S 40011 for precautionary measures when renewals work is undertaken. The information sought shall include applicable work instructions for the like for like renewal of equipment.

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The integrity of vital signalling relays is paramount, particularly when they are installed in circuits not proved in the de-energised position by the design. Section 8.1 and Section 8.2 specify the examination and testing requirements when placing the respective relays into service.

Once a relay is installed, it shall be observed to correctly function (energise and de-energise fully) in its operating circuit. Additionally, that a test of the end-functions passing through the changed-relay is done. Relays shall not be certified until satisfied that such end-functions are operating correctly.

Note:
The function test method is different for directly wired shelf relays as compared to plug-in type relays (including shelf relays fitted with a detachable top).
See Section 8.1 and Section 8.2 for respective function testing methods.

Defective relays

Where a relay fails an examination or test, or if there is any cause to suspect the relay is defective, then it shall be immediately and accordingly labelled, and accompanied by documented advice (electronic advice accepted) detailing the problem. Care shall be taken to preserve the fault condition during transportation.

The defective relay shall be sent to the maintenance signal engineer or commissioning engineer (as applicable) for inspection. An inspection at this stage shall be non-invasive so to preserve any fault evidence. The relay shall not be operated or manipulated by the field team. Once inspected, the relay shall be dispatched to the Rail Equipment Centre or supplier (as relevant) for further investigation.

However, before the relay is dispatched, the maintenance signal or commissioning engineer shall duly inform the Principal Engineer Signal Systems where specific concerns need to be raised, or otherwise as required by this procedure.

See Section 4, Section 4.1, Section 6.1 and Section 9 for related requirements.

Note:
Some relay defects (for example, Q type relays with high resistance contacts) may not warrant maintenance signal engineer involvement, at their discretion. Such relays may be sent directly to the Rail Equipment Centre.

8.1 Placing shelf relays, electro-mechanical type time-limit relays, thermal type time-limit relays and VT1 type relays, into service

The work of placing a.c. or d.c. shelf relays into service shall be in accordance with PR S 40011 and associated work instruction *PR S 40011 FM011 Shelf Relay – Like for Like Renewal*.

The aforementioned work instruction shall also pertain to electro-mechanical type time-limit relays and thermal type time-limit relays. Additionally, the examinations, tests and other requirements stated herein for shelf relays (particularly those directly wired) shall similarly apply to such timer relays, as applicable.

Before placing a shelf relay into service, the armature securing-screw, provided to prevent damage during transport shall be removed.

The placement task of shelf relays shall be wholly performed by one person and not transferred to another person part way through the work.

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Prior to installation, shelf relays and VT1 type plug-in relays shall be examined in accordance with the testing categories stated herein this section, as applicable.

Configuration check

Note:
The configuration check is done to the intended specific signalling design.

- Correct relay type.
- Correct voltage for the circuit.
- Correct contact configuration.

Visual examination

- Internal contacts are correctly aligned.
- Contact pigtails are correct and not touching unintended electrical components.
- No damage to the casing or relay terminals.
- No signs of foreign matter including filings, flaking plating or flaking paint inside the relay.
- For a.c. vane relays, additionally examine the following to ensure:
  - the vane is central between the pole faces
  - the vane is not spread due to striking the bottom of the relay case (detected by a mark in the paint of the case bottom)
  - no scratches or abrasions on the vane which may indicate that the vane is distorted or that air gap tolerances are incorrect
  - the counterbalance nut is secured in place by either a lock nut, locking tab or thread lock compound.

Operating bench tests

- For shelf relays directly wired, ensure the relay energises and de-energises smoothly and fully without hesitation or restriction, including the closing and opening of respective contacts.

  The test shall cycle the relay operation several times.

- Additionally for electro -mechanical type time-limit relays and thermal type time-limit relays, test to ensure the relay energisation occurs at the specified time period.

Where a relay fails any of the examinations or tests prescribed, the relay shall not be installed, and the requirements for dispatching shall be as stated in Section 8.

The arrangement of contacts and terminals may differ between relays from different manufacturers. It is therefore critical that a configuration check is done to ensure the arrangement of front and back contacts and terminal numbers are the same between the existing relay and the replacement relay. Where the contact arrangement and numbers are different, the maintenance signal engineer shall be consulted before the work commences. If the contact arrangement is different, then the maintenance signal engineer (or delegate signal engineer) shall directly certify the installation of the changed relay. If the terminal numbers only are different, then the maintenance signal engineer may provide (as opposed to directly certifying the relay) a special written instruction for the work and include an amended design (circuits and analysis) showing the changes. This documentation shall be attached to the shelf relay work instruction. In such case, the changed terminal numbers shall be certified by the licensed signalling person leading the work. At completion, the maintenance engineer shall duly forward a copy of the changed circuit diagram including analysis to Signal Design for updating the circuit book.

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In any case, it is preferential to use either a shelf relay of exactly the same configuration and terminal numbering or convert the directly wired shelf relay using a Q type plug-in conversion unit, as prescribed in Section 6.2.

Also, before placing a shelf relay into service, the nuts on the relay terminal studs shall be removed, and a check made of the bottom (back) nut to ensure it is tightened down. This ensures that each pigtail is securely maintained by a tight armature stud and that the carbon pillar is securely maintained in position. Excessive force shall not be applied on the bottom nut, as this can cause the stud to fracture.

The placement of relays shall not unsafely impact any train that is approaching or has entered the affected area.

Additionally for shelf relays directly wired, the affected signalling associated with circuits that pass through each relay contact shall be first booked out of use and disconnected in accordance with *PR S 40008 Securing Signalling Apparatus Out of Use* and PR S *40009 Disconnection of Signalling Apparatus*.

Operation, wire/null count and function test

When a relay is placed into service, the relay shall be observed several times to fully energise and de-energise smoothly without hesitation or restriction, including the closing and opening of respective contacts.

For shelf relays directly wired, the relay terminals including any terminated bridge wire shall be wire-counted to the specific circuit design before and after the replacement work. Additionally, all the relay terminals shall be null-counted to the specific circuit design before and after the replacement work. Record on a copy of the analysis sheet for both wire and null count.

Further for shelf relays directly wired, a function test of each end-function that passes through the changed-relay contacts shall be done. Ensure each end-function corresponds with the changed-relays' <u>specific contact</u> (front and back) in accordance with the signalling design (analysis). This is achieved by temporarily removing the wiring from one side of each specific contact while checking correspondence with the end-function. Record results on a copy of the analysis sheet for each end-function. Ensure all relay terminal nuts and wires are secure at the end of the test.

For shelf relays fitted with a detachable top, or VT1 type relays, a function test of each end-function that passes through the changed-relay contacts shall be done. Ensure each end-function corresponds with the changed-relay's <u>position</u> (energised and de-energised) in accordance with the signalling design (analysis). This can be achieved by operating the changed-relay while checking correspondence with the end-function.

Any detachable-top replacements shall follow the test procedure for a shelf relay directly wired.

VT1 type relays and ACVT relays shall be additionally tested in accordance with the track circuit requirements prescribed in *PR S 40025 Track Circuits*.

8.2 Placing Q type, B type, HVI type and PN150 series relays into service

Prior to installation, Q type, B type, HVI type and PN150 series plug-in relays shall be examined, as applicable in accordance with the testing categories stated herein this section.

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Configuration check

Note:
The configuration check is done to the intended specific signalling design.

- Correct relay type.
- Correct voltage for the circuit.
- Correct contact configuration.

A contact proving test shall be done for Q type relays where a new base is installed during new or altered works. This is to ensure the relay indexing is correct to its configuration, and that the relay contacts open and close in accordance with the relay's configuration label and the specific signalling design.

Visual examination

- Internal contacts are correctly aligned.
- No foreign or loose or matter inside the cover.
- No foreign matter is attached to the plug-in contact fingers (rear of relay).
- Plug-in contact fingers (rear of relay) are not bent, distorted or burnt and have not lost tension.
- Relay case is not cracked or distorted.
- Relay seals are intact.
- Relay cover and base (rear of the relay) mouldings are not chipped, cracked or warped.
- For Q type, HVI type and PN150 series relays, the indexing pins are straight and have the correct code for the relay type.

  The tampering of coding holes in bases or coding pins in relays is strictly forbidden.

- No signs of overheating within the relay.
- No signs of the plastic cover fouling the contact assembly, or the assembly being misaligned.
- Plated components not corroded and not showing signs of deterioration.
- Relay cover is transparent with no signs of internal coating (not rust coloured, metallic or greasy).

Operating bench test

- For electronic timer relays (such as QTD5 relays), test to ensure the relay energisation occurs at the specified time period.

  See Section 11 for related information.

Where a relay fails any of the examinations or tests prescribed, the relay shall not be installed, and the requirements for dispatching shall be as stated in Section 8.

The placement of relays shall not unsafely impact any train that is approaching or has entered the affected area.

Operation and function test

When a plug-in relay is placed into service, the relay shall be observed several times to fully energise and de-energise smoothly without hesitation or restriction, including the closing and opening of respective contacts.

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A function test of each end-function that passes through the changed-relay contacts shall be done. Ensure each end-function corresponds with the changed-relay's position (energised and de-energised) in accordance with the signalling design (analysis). This can be achieved by operating the changed-relay while checking correspondence with the end-function.

HVI type relays shall be additionally tested in accordance with the track circuit requirements prescribed in *PR S 40025 Track Circuits*.

8.3 Utilisation of new, refurbished and used relays

New and refurbished relays

New and refurbished relays with workshop testing dates in excess of that specified herein shall not be placed into service, and instead sent to the Rail Equipment Centre for retesting.

Q type relays	Seven years
HVI type relays	Seven years
PN150 series relays	Seven years
DC shelf relays	Five years
B type relays	Five years
VT1 type relays	Three years
A.C. shelf relays	Three years
Electro-mechanical type time-limit relays	Three years
Thermal type time-limit relays	Three years

Where new or refurbished relays are stored within the specified period, they may be placed into service on condition that the relay passes the examinations and tests prescribed in Section 8.1 or Section 8.2, as relevant.

Used Q type relays

Used Q type relays with up to 10 years of service, may be considered for reuse within the same project work if new or refurbished relays are not immediately available. This is on condition that the relay passes the examinations and tests prescribed in Section 8.2.

No other relay types shall be re-used unless refurbished.

Note:
Tests done for the reuse of relays shall be carried out using an approved tester that cycles the relay operation while measuring the contact resistance.

A contact proving test shall be done for Q type relays where re-used without being refurbished. This is to ensure the relay indexing is correct to its configuration, and that the relay contacts open and close in accordance with the relay's configuration label and the specific signalling design.

Additionally, a contact resistance test of each contact shall be done. The subsequent actions shall be as prescribed in the following:

- If the contact resistance is less than 2 ohms, then the relay may be re-used.
- If the contact resistance is greater than 2 ohms, then the contact shall be cleaned by cycle testing the contact at its full rated current.

  Retest for contact resistance.

  If the contact resistance is between 2 ohms and 7.5 ohms, then the relay may be re-used as a temporary measure.

  Replace this relay without delay. In the interim, attach a label to the relay stating, 'High Resistance Contacts – Relay to be Replaced'. The re use of this relay shall be treated as a temporary repair in accordance with PR S 40004.

Further, Q type relays shall be tested for the pick-up and drop-away voltage values as specified in the Relay Equipment Manual.

Note:
The term 'pick-up' is defined as the minimum voltage at which all front contacts are just closed.
The term 'drop-away' is defined as the maximum voltage at which all front contacts are open.

Where a relay fails any of the examinations or tests prescribed, the relay shall not be installed, and the requirements for dispatching shall be as stated in Section 8.

8.4 Cleaning contacts of Q type relays

The aforementioned contact resistance tests may also be used to full-current clean Q type relay contacts which are in service, or which have been removed from service because of suspected or proven high resistance contacts.

8.5 Relay change form

A *PR S 40024 FM01 Relay Change Form* shall be compiled for the following relays when placed into service or removed from service:

- Shelf relays
- VT1 type relays
- B type relays
- Electro-mechanical type time-limit relays
- Thermal type time-limit relays.

The completed form shall be duly forwarded to the maintenance signal engineer after the work. All relevant particulars shall be shown on the form, as well as certifying the circuits that pass through the relay as being tested and correct.

9 Handling and transporting of relays

Notwithstanding any initial requirements stated in this procedure for the dispatching of relays, the relays shall eventually be forwarded to the Rail Equipment Centre for overhaul or scrap. Each relay shall be fitted with an appropriate label and accompanied by documented advice (electronic advice accepted) detailing the reasons for its removal.

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Relays shall be handled, transported and stored with care, and not in any way that would subject them to damage or deterioration.

When relays are stored, they shall be kept on racks in an enclosed building that is clean, dry and non-corrosive. Relays should be stored in suitable packaging, where practicable.

The placing of relays (particularly plug-in types) directly on floors which are prone to dust particles and contamination should be avoided.

Any relay which is bumped or dropped shall be closely examined and tested, and if required, sent to the Rail Equipment Centre for repairs.

9.1 Handling of shelf relays

Shelf relays shall 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.

Shelf relays shall be re-fitted with an armature securing screw during transportation to prevent damage to the relay.

Shelf relays shall be transported in a box or container suitable for such purpose.

Care shall be taken not to damage the glass casing and the terminal studs.

Ensure any bridges left connected on terminals are removed prior to storage or dispatch.

9.2 Handling of Q type relays

Situations have occurred where newly installed Q type 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. Evidence proved that this fault was a result of the relay having been dropped or struck during transport or installation.

Where Q type relays have been placed on the floor during transit, installation or testing they shall be visually examined before being plugged-in again to ensure that the external (rear) contacts are aligned correctly and that no foreign matter from the floor has become attached to the contacts.

If there are any signs of damage to the relay case or internally, or if the operation or the relay is in any way suspect, the relay shall not be put into service.

9.3 Handling of B type, VT1 type, HVI type and PN150 series relays

Care shall be taken when handling and placing into service these plug-in relays, such that the external (rear) contacts can become out of adjustment due to rough handling.

B type relays are particularly prone to contact maladjustment due to the alloy casting (which holds the coil) becoming misaligned at an angle other than 90 degrees relative to the relay base. This is usually caused by the relay being dropped during transit or installation.

When B type relays are transported, they shall be packed with the contact springs vertical. A label stating ‘THIS SIDE UP’ shall be accordingly applied.

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10 Replacing magnetically latched relays

Magnetically latched relays are held in their last operated position. It is for this reason precautions shall be taken to ensure that a magnetically latched relay is in the de energised (down) position before it is plugged into service.

Magnetically latched relays are typically used as the parent relay (NLR and RLR) for route lock relays, points lock relays and release lock relays. The procedures for changing these relays are stated in the sections herein.

10.1 Replacing Route NLR and RLR relays

Prior to unplugging a route NLR or RLR relay, licensed signalling personnel shall:

- Gain an assurance from the signaller that the signal to which the route lock relay applies is at stop, the route is normalised, and that any train which is approaching the signal has been brought to a stand.
- The magnetically latched relay that is to be placed in service shall then be plugged into the magnetically latched relay position of a relay test panel and the indicator lamps observed to ensure that the relay is down.
- The relay to be removed from service is then unplugged and the new relay taken from the test base and plugged into service.
- The replaced relay is then plugged into the magnetically latched relay position of a relay test panel and the indicator lamps observed to ensure that the relay is down.

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 (or equivalent control) controlling the route. It is therefore necessary to pull the button (or cancel the equivalent control) to energise the NLR.

10.2 Replacing Points NLR and RLR relays

Prior to unplugging a points NLR or RLR relay, licensed signalling personnel shall:

- Ensure that no trains are standing foul of or passing over or approaching the points concerned.
- Gain an assurance from the signaller that all signals that protect the points concerned are at stop and that any trains which may be approaching those signals have been brought to a stand.
- The magnetically latched relay which is to be placed in service shall then be plugged into the magnetically latched relay position of a relay test panel and the indicator lamps observed to ensure that the relay is down.

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- The relay to be removed from the service is then unplugged and the new relay taken from the test base and plugged into service.
- The replaced relay is then plugged into the magnetically latched relay position of a relay test panel and the indicator lamps observed to ensure that the relay is down.

Note:

After changing a points lock relay, both points NLR and RLR relays may be down.

This will be indicated by neither points detection lights illuminated, and the transit light flashing.

Under these conditions it is necessary to move the points control to the centre position (or equivalent position) and then to return the control to its previous position which thereby energises the points lock relay for the position that the points are laying.

10.3 Replacing Releasing Switch NLR or RLR relays

Prior to unplugging a releasing switch NLR or RLR relay, licensed signalling personnel shall ensure the following:

- Ensure that no trains are standing foul of or passing over or approaching the ground frame points concerned.
- Gain an assurance that all signals that protect the ground frame points are at stop and that any trains which may be approaching those signals have been brought to a stand.
- The magnetically latched relay which is to be replaced into service shall then be plugged into the magnetically latched relay position of a relay test base and the indicator lamps observed to ensure that the relay is down.
- The relay to be removed from service is then unplugged and the new relay taken from the test base and plugged into service.
- The replaced relay is then plugged into the magnetically latched relay position of a relay test panel and the indicator lamps observed to ensure that the relay is down.

11 Time-limit relays (electronic types)

Time-limit relays shall be coarsely adjusted and tested in an approved time-limit relay test panel prior to installation.

These relays shall 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 shall be adjusted as accurately as possible to within 10 percent of the specific signalling design.

50 volt d.c. busbars powering QTD5 relays shall not be in excess of 55 volts (d.c. + a.c.). Busbars shall be adjusted between the range of 47.5 volts to 55 volts (d.c. + a.c.).

A record shall be kept of all QTD5 relay-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 volts (d.c. + a.c.) or signalling failures due to voltage supply are experienced, the maintenance signal engineer shall be advised and consulted for further instruction.

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12 QXR1 transformer rectifiers

The QXR1 transformer rectifier unit is supplied in two types. The earlier type having an input voltage adjustment of up to 115 volts a.c., and the latter type having an input voltage adjustment of up to 125 volts a.c. Whilst the pin code and labelling are identical, the earlier type only has provision for connection to D1 and D2 terminals.

Care shall be taken when installing or replacing QXR1 transformer rectifier units such that the appropriate type is used (that is, not use an earlier type where wiring is terminated on the D3 terminal or where the input supply voltage is in excess of 115 volts a.c.).

QXR1 transformer rectifier units are subject to the examination requirements detailed in Section 13.3.

13 Periodic examinations

Licensed signalling personnel are responsible for the periodic examination of relays.

During periodic inspections of relays, devices such as thermal imaging cameras may be used to detect unusual heat sources that can cause a reliability or integrity risk.

Where a relay fails any of the periodic examinations or tests prescribed, or if there is any cause to suspect that the relay is otherwise defective, then the relay shall be immediately replaced and the requirements for dispatching the relay, as stated in Section 8 shall apply.

13.1 Periodic examination of a.c. vane relays

The periodic inspection of unproved a.c. shelf and VT1 type relays shall be treated as a safety critical task in accordance with PR S 40017.

Examine a.c. vane relays in accordance with the technical maintenance plan and whenever the opportunity presents.

Particular attention (by observation through the relay case) shall be paid to the working of the vane and for any indication of the following conditions:

- Ensure correct operation of relay.
- Check for abnormal relay release operation (for example, sluggish, jerky or not falling fully to the stop position), as it may be due to defective bearings, warped bakelite tops, wax or other foreign matter in the bearings, vane obstructions and so on.
- Ensure correct condition of contacts, terminals and pigtails.
- 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 flaking paint inside the relay.
- Check the bottom of the relay case, looking for signs of filings.

  Where evidence of filings exists, a close inspection of the rollers and associated spindle shall 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.

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- Check if the vane could be spread due to striking the bottom of the relay case, potentially 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 the pole faces, done best by 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.
- Check that split pin ends are properly spread.
- Check that the counterweight lock nut is locking the counterweight and that it has not moved.
- Examine the roller stops for evidence of grooving.
- Examine the spring-type stops for evidence of grooving and ensure that the spring is effective and not fouled by its bracket when the relay is energised, and that they are tight with no signs of cracking.
- Clean contaminates from housing top and ensure no possible cause remain for tracking between the exposed relays terminals.

Special requirements for a.c. vane shelf relays fitted with black coils

Do not place a.c. vane shelf relays in service that are fitted with black coils that do not have coil-formers, as these are suspected of releasing wax from the coils when hot.

Where such relay is found in service and the relay is non-proved, it shall be immediately replaced. The maintenance signal engineer, after notifying the Principle Engineer Signal Systems shall return the relay to the Rail Equipment Centre for scrap.

Examine all proved a.c. vane shelf relays with black coils that do not have 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.

If other in-service relay types exhibit evidence of wax deposits, then such details shall be reported to the maintenance signal engineer.

Special requirements for VT1 type relays

VT1 type relays shall be examined as prescribed in Section 13.1 with special attention also applied to the following checks related to the relay’s vane movement:

- Inspect both the left and right hand vane spindle pivot pins, looking for any signs of corrosion.
- With the relay de-energised, ensure the vane is resting against the bottom roller.
- With the relay energised, ensure the vane is pushing the top roller back. Where this is not the case, the track circuit shall be checked for correct set-up and adjustment.
- With the vane operating from energised to de-energised and vice versa, the travel of the vane shall be observed to ensure a clean pick-up and drop-away, with no abnormal sound. Ensure there is no hesitation or squeaking in the travel of the vane.
- The bottom of the relay case shall be inspected for any particulate matter that would indicate the corrosion of the vane spindle.

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13.2 Periodic examination of d.c. shelf relays

The periodic inspection of unproved d.c. shelf relays shall be treated as a safety critical task in accordance with PR S 40017.

Examine d.c. vane relays in accordance with the technical maintenance plan and whenever the opportunity presents.

The following tasks shall form part of examination:

- Ensure correct operation of relay.
- Ensure 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 flaking plating or flaking paint inside the relay.
- Ensure end of split pins are properly spread.
- Inspect for any other unusual condition.
- Clean contaminates from housing top and ensure no possible cause remain for tracking between the exposed relays terminals.

If any unusual condition, defect, sluggishness or failure of the armature to drop away promptly is observed, the relay shall be replaced immediately and the maintenance signal engineer duly advised. When making this check, due allowance shall be made for a slow release relay.

13.3 Periodic examination of Q type, B type, HVI type and PN150 series relays

Q type, B type, HVI type and PN150 series relays shall be examined to the extent practical without removal.

Examine these relays in accordance with the technical maintenance plan and whenever the opportunity presents.

The inspection shall check for the following:

- Any evidence of overheating such as discoloration or distortion of plastic covers, and burn marks on circuit boards, electronic or electrical components.
- Any signs of the plastic in the covers fouling the contact assembly and are not loose due to warping or cracking.
- Any signs of contact burning or pitting of the carbon contacts.
- Any evidence of melted solder and other particulates across contacts or base of plastic cover.
- Any signs of displaced or worn carriers.
- Any signs of rust on plated components or signs of excessive deterioration of the plating.
- The retaining clip, where applicable is securing the relay in its base.

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- Any Q type relays found which are fitted with the grey-white Pertoid (fibreglass) contact operating arms and adjustment cards shall be replaced immediately.
- For Q type plug-in conversion units using vane relay housing, clean contaminates from housing top and ensure no possible cause remain for tracking between the exposed relays terminals.

13.4 Periodic examination of electro-mechanical type time-limit relays and thermal type time limit relays

The periodic inspection of electro-mechanical type time-limit relays and thermal type time-limit relays shall be treated as a safety significant task in accordance with PR S 40017.

These relays shall be tested in accordance with the technical maintenance plan and whenever the opportunity presents.

Electro-mechanical type time-limit relays and thermal type time-limit relays shall be periodically checked to ensure they operate at the specified timing. The necessary details shall be entered on form *PR S 40024 FM02 2 Yearly Test of Electromechanical or Thermal Timing Relays*. The form shall be submitted to the maintenance signal engineer.

Such relays shall be considered as defective if the timing varies by more than 10 percent of the specified time.

Type-approved electronic time-limit relays, such as QTD5 relays are exempt from having their timing function periodically tested.

14 Use of spare contacts to relays in-service

Where circuits are introduced to pre-existing spare contacts of in-service relays, there is a probability that the contact may be high resistance. Therefore, cycle testing the spare relay contact with its full rated current (see Section 8.4) before it is connected in service may reduce the contact resistance. This test shall be carried out as required.

Relay wiring shall not be altered contrary to the specific signalling design unless transferring to a spare contact for the purpose of temporary repair during failure situations. Care shall be taken to ensure that the contact configuration is not changed by the transfer. Any temporary repair made in this regard shall be in accordance with PR S 40004.

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Engineering Procedure
Signalling and Control Systems

Signalling Safeworking

PR S 40025

Track Circuits

Version 3.0

Date in Force: 10 January 2018

Procedure

UNCONTROLLED WHEN PRINTED

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Document control

Version	Date	Author/ Prin. Eng.	Summary of change
1.0	16 September 2013		First Issue as Sydney Trains Document
2.0	10 March 2014		Technical Changes
3.0	10 January 2018	J. Rasborsek / C. Darmenia	Updated for new titles & roles, ASA Standards v3.0 and inclusion of Microtrax & EBI Track 200

Summary of changes from previous version

Summary of change	Section
New sections for reference documents and Terms and Definitions	2 & 3
Clarify actions when shunt tests are outside limits	4 & 4.2
Include FS2600 detection pair test	4 & 5
New section for contact band requirements	5.4.2
Included precautions whenever polarity of power supplies are altered or changed.	5.6
Included Permanent Signal Engineering Deviations 15-0801 requirements.	7
Updated from EIS 14/03 to add Microtrax requirements.	8
Updated from EIS 15/05 to add EBI Track 200 TI21 AF Track Circuit (ET200) requirements.	9
Addition of Drop Shunt values and change of column title.	Table 1
Change in column titles, correction of ET200 value and changes and addition of Notes.	Table 2

Table of Contents

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

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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

Track Circuit Type	Fixed Shunt Resistance	Drop Shunt Resistance in dry ballast conditions
HVI Jeumont Schneider impulse track (Double rail) (1xBRTCA2-Rx)	0.25 ohms	For reference only
HVI Jeumont Schneider impulse track (Double rail) (2xRVT600-Rx)	0.25 ohms	For reference only
HVI Jeumont Schneider impulse track (Double rail) (1xRVT600-Rx)	0.5 ohms	For reference only
HVI Jeumont Schneider impulse track (Single rail) (Normal/ TV-TH1)	0.5 ohms	For reference only
HVI Jeumont Schneider impulse track (Single rail) (TV-THD2 or TV-LV)	0.25 ohms	For reference only
Single Rail AC resistor fed - Signal Branch	0.25 ohms	For reference only
Single Rail AC resistor fed – WBS	0.5 ohms	For reference only
Double Rail AC resonant impedance bonds	0.25 ohms	For reference only
Double Rail AC AAR standard	0.06 ohms	For reference only
UM71 (CSEE) audio frequency	0.15 ohms	For reference only
TI21 audio frequency	0.15 ohms	Nor power: 0.8 – 1.2 ohms Low power: 1.3 – 1.7 ohms
ET200 audio frequency	0.15 ohms	Nor power: 0.8 – 1.2 ohms Low power: 1.3 – 1.7 ohms
FS2500 WB&S audio frequency	0.15 ohms	0.8 - 1.2 ohms
FS2600 WB&S	0.5 ohms	> 0.6 ohms
USS Microtrax Coded Track	0.25 ohms	0.4 – 0.5 ohms

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

Track Circuit Type	**Test Point**	**Unit of Measure** (**FSM -** Frequency Selective Meter**)**	**Acceptable Train Shunt and Zero Feed value**	**Maximum Train Shunt Value** (with Signal Engineer's approval)
50 Hz ac	Control Terminals	V ac	<=10% of D.A. test value	30% of D.A. test value
CSEE UM71	Receiver R1& R2 (T1) or M1 &M2 (T2)	mV ac with FSM	<=30 mV	90 mV
ML TI 21	Input resistor (across 1 ohm) terminals	mV ac with FSM	(mV x GAIN) <=35	(mV x GAIN) 100
ET200	Receiver terminals TP1 & IP1	mV ac with FSM	<=20% of threshold current	50% of threshold current
WB&S FS2500	Receiver Monitor	mV ac	<=135 mV	400 mV
HVI (Jeumont Schneider)	Receiver Terminals C+/ C1 (RVT-600) 3/ C1 (BRT-CA2)	V dc with integrator	<=35 V	100 V
USS Microtrax coded track circuit	Slave end – track interface panel terminals	mV DC	Within -50mV to +50mV pulse. (zero feed test is not possible)	±80 mV pulse.
WB&S FS2600	Receiver Monitor	mV ac	<=100 mV	500 mV

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.

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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.

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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 oxidisation.

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 3- Receiver Set-up shunt value

Track Length Metres	Transmitter Tuning Unit Power Setting	Standard Receiver Set-up Shunt Value dry/damp/good ballast condition Ω	Low Ballast Resistance Receiver Set-up Shunt Value very wet/poor ballast condition Ω
50-250	Low	1.5	1.5
200-800	Normal	1.0	1.2
>800	Normal	1.0	1.4

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.

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Appendix A Sample Track Circuit History Cards

50 Hz A.C. TRACK CIRCUITS

50Hz A.C. TRACK CIRCUITS **TRACK CIRCUIT HISTORY CARD** **TRACK:** ______________

SINGLE RAIL ☐

DOUBLE RAIL ☐

Any additional information needed-(sketch of track /Location IDs, distances, equipment positioning, bonds, etc.)

LENGTH ______________________m

NUMBER OF IMPEDANCE BONDS ❖______

IMPEDANCE BOND TYPE ❖____________

TRACK FEED *

STORE 37	(100VA)	
STORE 45	(200VA)	
STORE 47	(200VA)	
W.B.S.	(220VA)	

RELAY TYPE *

VT1	
G.R.S	
KYOSAN	
McK&H / WBS	

TEST SHUNT *

WBS	S.R	0.5Ω	
SIG.BCH	S.R.	0.25Ω	
D.R. (RESONATED BOND)		0.25Ω	
D.R. (STANDARD BOND)		0.06Ω	

CHANGE OF RELAYS

DATE	SERIAL No	P.U. VOLTS	COMP.VOLTS	D.A. VOLTS

DATE	FEED END; (Location ID:)					RELAY END; (Location ID:)									CHECKS					Remarks	Tested by:
	Mains Supply Voltage	Feed Voltage (measured at Feed output)	Feed Current	Track (2) Voltage (V)		Rail Current (1) (A)		Track (2) Voltage (V)		Relay Volts (V)		Zero Feed (mV)		Drop Shunt	Polarity/ Phase Check	Fixed Shunt Test	Bonds / Rail Connections	Spark Gaps	Ballast Condition Good/Moderate/ Poor	Service Schedule (SS01, SS02, SS03, SS04, etc)	Name or initials & Signature of Testing Officer
DD/MM/YY	(V)	(V)	(A)	UP	DN	UP	DN	UP	DN	Cont	Local	Cont	Local	(Ω)	(OK)	____Ω	(Y / N)	(Y / N)	Dry/Wet		

SAMPLE

(1) CHECK RAIL CURRENTS ARE WITHIN 0.5A (2) RECORD VOLTAGE EACH RAIL TO NEUTRAL ON DOUBLE RAIL ELECTRIFIED TRACKS ❖ Where applicable * PLACE CROSS AGAINST APPROVED TYPE

AC SR&DR TC History card 2010; Page 1/2 Version: April 2003 Stock code: 1885961

50Hz A.C. DOUBLE RAIL TRACK CIRCUIT - SAFETY INSPECTION

TRACK: ________________

DATE	FEED END (Location ID:)					RELAY END (Location ID:)									CHECKS				Ballast Condition Good/Moderate/ Poor	Remarks	Tested by:
	Mains Supply Voltage	Feed Voltage (measured at Feed output)	Feed Current	Track Voltage (2) (V)		Rail Current (1) (A)		Track Voltage (2) (V)		Relay Volts (V)		Zero Feed (mV)		Drop Shunt	Polarity/ Phase Check	Fixed Shunt Test	Bonds / Rail Connections	Spark Gaps		Service Schedule (SS01, SS02, SS03, SS04, etc)	Name or initials & Signature of Testing Officer
DD/MM/YY	(V)	(V)	(A)	UP	DN	UP	DN	UP	DN	Cont	Local	Cont	Local	(Ω)	(OK)	______Ω	(Y / N)	(Y / N)	Dry/Wet		

SAMPLE

(1) CHECK RAIL CURRENTS ARE WITHIN 0.5A (2) RECORD VOLTAGE EACH RAIL TO NEUTRAL ON DOUBLE RAIL ELECTRIFIED TRACKS * Where applicable * PLACE CROSS AGAINST APPROVED TYPE

AC SR&DR TC History card 2010; Page 2/2 Version: April 2003 Stock code: 1885961

UM71 (CSEE) T1 TRACK CIRCUITS

Transport Sydney Trains

Track Circuit History Card

UM71 Type T1 Track Circuits - **TRACK:** ____________________

TRACK LENGTH ___________ m: FREQUENCY __________Hz

TX Power :HI/LO ___________ (Use High if >800mA – For high: bridge TX M2-M4 and M2-M5)

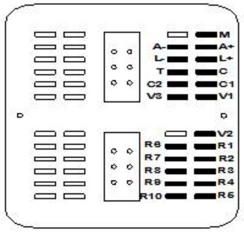
Any additional information needed (sketch of track / location IDs, equipment positioning, bonds etc)

DATE	Remarks - Service Schedule	TRANSMITTER END Location ID:					Resonated Impedance Bonds			RECEIVER END Location ID:									Fixed Shunt Test	Ballast Condition	FSM Measuring Equipment Type	Name & signature of Testing Officer
		Tx	Tx DMM /CLAMP	Tx DMM	Tx FSM	TU FSM	Loc.	Cap.	Cap. DMM	TU FSM	RX FSM	RX	Rx DMM	Volts on R1-R2 FSM			Rx	Rx				
DD/MM/YY	(SS01, SS02, SS03, etc)	Serial No.	DC Current (mA)	DC Supply (V)	Output @ Loc. Track term (V)	V1/V2 (V)	Tx Mid 1 Mid 2 Rx	(ηF)	(V)	V1/V2 (V)	Input @ Loc. Track terms (V)	Serial No.	DC Supply (V)	Unoccupied (mV)	Fixed shunt (mV)	Zero Feed (mV)	Gain Krv	Drop Shunt (Ω)	0.15Ω (tick each test pt.) (✓)	(Good/ Average /Poor & Dry/wet)	(YBM, TFA) & Number	
	Commission																					
	Last full test																					

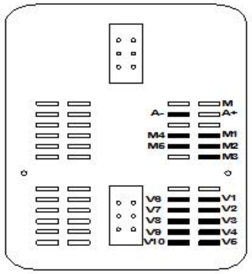
SAMPLE

Version: Oct 2016 Stock code: 1885904

Rx CONNECTIONS TYPE T1



Tx CONNECTIONS TYPE T1



FSM: Frequency Selective Meter.
YBM = Yellow Bag Meter,
TFA=Track filter Adaptor
DMM: Digital Multimeter
CLAMP: Current Clamp

FREQ Hz	K_{EM}	CONNECT		BRIDGE
		1 on Mu to	2 on Mu to	
1700	3.5	V2	V7	V3 - V4 V5 - V6
2300	4	V7	V8	
2000	3.75	V1	V7	V3 - V4 V5 - V6
2600	4.25	V1	V8	V2 - V7

K_{RV}	CONNECT		BRIDGE
	R1 to	R2 to	
1	R3	R4	
2	R5	R4	
3	R3	R5	
4	R5	R7	R3 - R6
5	R5	R7	R4 - R6
6	R4	R7	R3 - R6
7	R6	R7	
8	R3	R7	R4 - R6
9	R4	R7	R5 - R6
10	R3	R7	R5 - R6
11	R9	R7	R3 - R8 R5 - R6
12	R9	R7	R4 - R8 R5 - R6
13	R9	R7	R3 - R8 R4 - R6
14	R9	R7	R6 - R8
15	R9	R3	R4 - R7 R6 - R8
16	R9	R4	R5 - R7 R6 - R8
17	R9	R3	R5 - R7 R6 - R8
18	R9	R5	R3 - R8
19	R9	R5	R4 - R8

K_{RV}	CONNECT		BRIDGE
	R1 to	R2 to	
20	R9	R4	R3 - R8
21	R9	R8	
22	R9	R3	R4 - R8
23	R9	R4	R5 - R8
24	R9	R3	R5 - R8
25	R9	R5	R3 - R6 R7 - R8
26	R9	R5	R4 - R6 R7 - R8
27	R9	R4	R3 - R6 R7 - R8
28	R9	R6	R7 - R8
29	R9	R3	R4 - R6 R7 - R8
30	R9	R4	R5 - R6 R7 - R8
31	R9	R3	R5 - R6 R7 - R8
32	R10	R7	R5 - R6 R3 - R9
33	R10	R7	R5 - R6 R4 - R9
34	R10	R7	R4 - R6 R3 - R9
35	R10	R7	R6 - R9
36	R10	R7	R3 - R6 R4 - R9
37	R10	R7	R4 - R6 R5 - R9
38	R10	R7	R3 - R6 R5 - R9

K_{RV}	CONNECT		BRIDGE
	R1 to	R2 to	
39	R10	R5	R3 - R9
40	R10	R5	R4 - R9
41	R10	R4	R3 - R9
42	R10	R9	
43	R10	R3	R4 - R9
44	R10	R4	R5 - R9
45	R10	R3	R5 - R9
46	R10	R5	R3 - R6 R7 - R9
47	R10	R5	R4 - R6 R7 - R9
48	R10	R4	R3 - R6 R7 - R9
49	R10	R6	R7 - R9
50	R10	R3	R4 - R6 R7 - R9
51	R10	R4	R5 - R6 R7 - R9
52	R10	R3	R5 - R6 R7 - R9
53	R10	R7	R5 - R6 R3 - R8
54	R10	R7	R5 - R6 R4 - R8
55	R10	R7	R4 - R6 R3 - R8
56	R10	R7	R6 - R8
57	R10	R7	R3 - R6 R4 - R8

K_{RV}	CONNECT		BRIDGE
	R1 to	R2 to	
58	R10	R7	R4 - R6 R5 - R8
59	R10	R7	R3 - R6 R5 - R8
60	R10	R5	R3 - R8
61	R10	R5	R4 - R8
62	R10	R4	R3 - R8
63	R10	R8	
64	R10	R3	R4 - R8
65	R10	R4	R5 - R8
66	R10	R3	R5 - R8
67	R10	R5	R3 - R6 R7 - R8
68	R10	R5	R4 - R6 R7 - R8
69	R10	R4	R3 - R6 R7 - R8
70	R10	R6	R7 - R8
71	R10	R3	R4 - R6 R7 - R8
72	R10	R4	R5 - R6 R7 - R8
73	R10	R3	R5 - R6 R7 - R8

Version: Oct 2016 Stock code: 1885904

SAMPLE

UM71 (CSEE) T2 TRACK CIRCUITS

CSEE T2 Track Circuits (for ESR) **TRACK CIRCUIT HISTORY CARD** **TRACK:** ______________

TRACK LENGTH __________ m

FREQUENCY ______________ Hz

Any additional information needed (sketch of track / location IDs, equipment positioning, bonds etc)

Impedance Bonds on track?	Tx end	Rx end	Mid track
Resonated?(Y/N)			
Res.Cap. nF			
Cap Volts V			

DATE	TRANSMITTER END Location ID:				(For tracks with DPUs)	RECEIVER END Location ID:										Tests	Remarks	Tested by:
												Volts on M1-M2						
DD/MM/YY	Tx Serial No	DC Supply (V)	Tx Output (Measured @ Loc. track terminals) (V)	TU T1/T2 (V)	DPU Serial No	Rx Serial No	DC Supply (V)	TU T1/T2 / DPU MU Terminals 13 & 14 (V)	Rx Input Measured @ Loc. track terminals (V)	RX I/P Transformer fine adjustment P0 to …	RX I/P Transformer coarse adjustment S0 to …	Unoccupied (mV)	With shunt on (mV)	Zero Feed (mV)	Drop Shunt (Ω)	0.15Ω Shunt Test (OK)	Service Schedule (SS01, SS02, SS03, SS04,etc)	Name (or initials) & Signature of Testing Officer

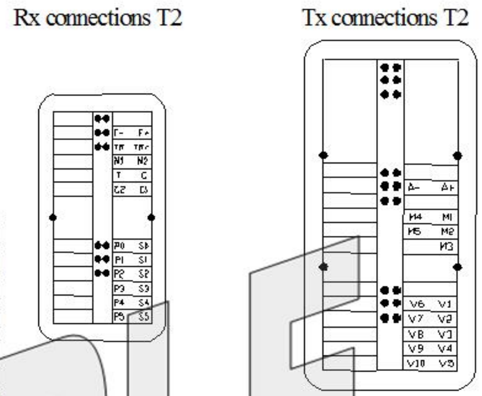
SAMPLE

CSEE T2 TC History card 2010; (Page 1/2) Version: March 2010 Stock Code: 1887439

SAMPLE

Transmitter Setup Type T2

FREQ Hz	Kem	CONNECT 1 on MU	CONNECT 2 on MU	BRIDGE
1700		V7	V8	
2300		V2	V8	V3 - V4 V5 – V7
2000		V1	V8	V3 - V7
2600		V1	V8	V3 - V4 V5 – V7

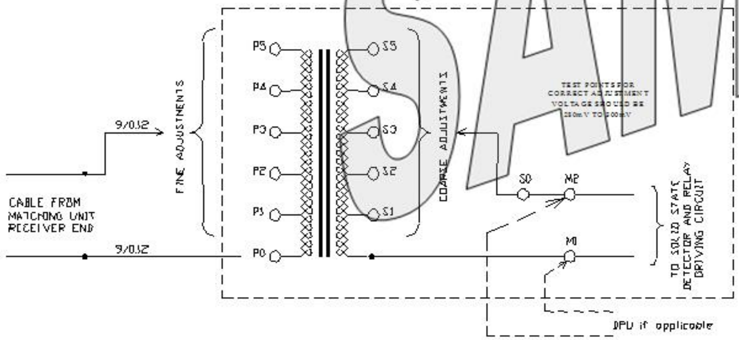


K	CONNECT		BRIDGE
0.5	11	12	
1	9	10	
1.5	9	12	10 - 11
2	8	9	
2.5	8	12	9 - 11
3	8	10	
3.5	8	12	10 - 11
4	5	9	6 - 10
4.5	5	11	6 - 12
5	5	6	
5.5	5	12	6 - 11
6	5	10	6 - 9
6.5	5	12	6 – 9 10 - 11
7	5	9	6 - 8
7.5	5	12	6 – 8 9 - 11
8	5	10	6 - 8
8.5	5	12	6 – 8 10 - 11
9	5	9	7 - 10
9.5	5	11	7 - 12

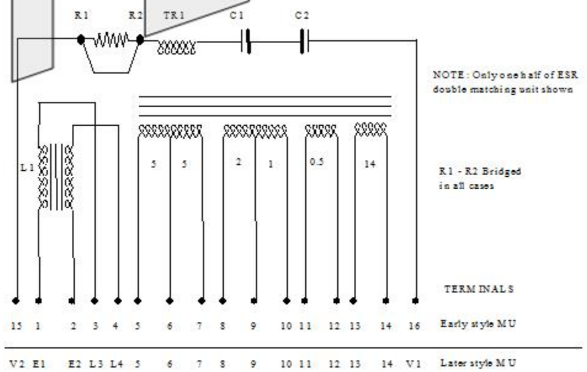
K	CONNECT		BRIDGE
10	5	7	
10.5	5	12	7 - 11
11	5	10	7 - 9
11.5	5	12	7 – 9 10 - 11
12	5	9	7 – 8
12.5	5	12	7 – 8 9 - 11
13	5	10	7 – 8
13.5	5	12	7 – 8 10 - 11
14	13	14	
14.5	11	14	12 - 13
15	9	14	10 - 13
15.5	9	14	10 – 11 12 - 13
16	8	14	9 - 13
16.5	8	14	19 – 11 12 - 13
17	8	14	10 - 13
17.5	8	14	10 – 11 12 - 13
18	5	14	6 – 10 9 - 13
18.5	5	14	6 – 12 11 - 13
19	5	14	6 - 13

K	CONNECT		BRIDGE	
19.5		5	14	6 - 11 12 - 13
20		5	14	6 - 9 10 - 13
20.5		5	14	6 - 9 10 – 11 12 - 13
21		5	14	6 – 8 9 - 13
21.5		5	14	6 - 8 9 – 11 12 - 13
22		5	14	6 – 8 10 - 13
22.5		5	14	6 - 8 10 – 13 12 - 13
23		5	14	7 – 10 9 - 13
23.5		5	14	7 – 12 11 - 13
24		5	14	7 - 13
24.5		5	14	7 - 11 12 - 13
25		5	14	7 - 9 10 - 13
25.5		5	14	7 - 9 10 – 11 12 - 13
26		5	14	7 – 8 9 - 13
26.5		5	14	7 - 8 9 – 11 12 - 13
27		5	14	7 – 8 10 - 13
27.5		5	14	7 - 8 10 – 11 12 - 13

Matching Unit Adjustment Table – Rx End Type T2



DETAILS OF INPUT TRANSFORMER BUILT INTO RECEIVER



CSEE T2 TC History card 2010; (Page 2/2) Version: March 2010 Stock Code: 1887439

WBS FS2500 TRACK CIRCUITS

WB&S FS2500 TRACK CIRCUITS **TRACK CIRCUIT HISTORY CARD** **TRACK:** ________________

TRACK LENGTH ________ m

FREQUENCY ___________ Hz

Tx OUTPUT LEVEL ________% HI / LO

Any additional information needed -(sketch of track / Location IDs, distances, equipment positioning, bonds, etc.)

Impedance Bonds on track?	Tx end	Rx end	Mid track
Resonated?(Y/N) Non-resonated			
Res.Cap. nF			
Cap Volts V			

DATE	TRANSMITTER END Location ID:					DPU (For Tracks with Intermediate Receivers Only)				RECEIVER END Location ID:										Tests		Remarks	Tested by:
DD/MM/YY	Tx	PSU		Tx	TU	DPU	Amp	Amp	Volts	Rx	PSU		TU	Rx	Monitor Volts			Rx	Drop		Ballast	Service	Name
	Serial Number	Serial Number	DC Supply (V)	Output (Measured at Loc. track terminals) (V)	Volts Across T1/T2 (V)	Serial Number	Serial Number	Gain (Hi / Lo)	Measured at Loc DPU terminals (mV)	Serial Number	Serial Number.	DC Supply (V)	Volts Across T1/T2 (V)	Input Measured at Loc. track terminals (V)	Unoc-cupied (mV)	With shunt on (mV)	Zero Feed (mV)	Sen	Shunt (Ω)	Fixed Shunt Tes 0.15Ω (OK)	Condition (Good/ Moderate /Poor/ Dry//Wet)	Schedule (SS01, SS02, SS03, SS04,etc)	(or initials) & Signature of Testing Officer

SAMPLE

FS2500 History Card.Doc: (Page 1/2) Version: April 2003 Stock Code: 1885912

RECEIVER SENSITIVITY ADJUSTMENT TABLE

SENS	CONNECT A to	CONNECT B to	BRIDGE	
1.65	-45	+5	+45 to -15	+15 to -5
1.60	-45	+15	+45 to -15	
1.55	-45	-5	+45 to -15	+15 to +5
1.50	-45	+5	+45 to -5	
1.45	-45	+45		
1.40	-45	-5	+45 to +5	
1.35	-45	+5	+45 to +15	-15 to -5
1.30	-45	-15	+45 to +15	
1.25	-45	-5	+45 to +15	-15 to +5
1.20	-15	+5	+15 to -5	
1.15	-15	+15		
1.10	-15	-5	+15 to +5	
1.05	-5	+5		
1.00	B			
0.95	+5	-5		
0.90	+15	+5	-15 to -5	
0.85	+15	-15		
0.80	+15	-5	-15 to +5	
0.75	+45	+5	-45 to -15	+15 to -5
0.70	+45	+15	-45 to -15	
0.65	+45	-5	-45 to -15	+15 to +5
0.60	+45	+5	-45 to -5	
0.55	+45	-45		
0.50	+45	-5	-45 to +5	
0.45	+45	+5	-45 to +15	-15 to -5
0.40	+45	-15	-45 to +15	
0.35	+45	-5	-45 to +15	-15 to +5

GUIDE TO Tx OUTPUT LEVEL ADJUSTMENT

Nominal Track Circuit Length	Tx Output Level	Output Number	Terminals * Used
50 - 250 m	20%	1 (LO)	1 and 2
250 - 450 m	40%	2	1 and 3
450 - 600 m	60%	3	3 and 4
600 - 750 m	80%	4	2 and 4
750 - 900 m	100%	5 (HI)	1 and 4

*The Screen Terminal is Earthed

SAMPLE

FS2500 History Card.Doc: (Page 2/2) Version: April 2003 Stock Code: 1885912

JEUMONT SCHNEIDER TRACK CIRCUITS

JEUMONT SCHNEIDER Track Circuits **TRACK CIRCUIT HISTORY CARD** **TRACK:** ____________________

DOUBLE RAIL ☐

SINGLE RAIL ☐

TRACK LENGTH __________m

Tx LOOP RESISTANCE ______Ω

TRACK TYPE (Place X for applicable type)	Rx TYPE	TOTAL Tx LOOP RESISTANCE.	TEST SHUNT
	RVT600	20Ω	0.5Ω
	BRTCA2	10Ω	0.25Ω
	2 x RVT600	20Ω	0.25Ω

Any additional information needed-(sketch of track /Location IDs, distances, equipment positioning, insulation joints, bonds, etc.)

DATE	TRANSMITTER END Location ID:							RECEIVER END Location ID:													Fixed Shunt Test	Polarity Check	Ballast condition	Remarks	Tested by:
	Power Supply		Tx Serial Number	Tx Output Volts		Track Voltage		Rx Serial Number	Track Voltage		Rx Input Volts				Volts with shunt on				Zero Feed	Drop Shunt				Service Schedule	(Name or initials) & Signature of Testing Officer
	PSU Serial number	Mains Supply (V)		C+ / C-		(V)			(V)		C+ / C2- or C2+ / C2-		3 / C1- ______		C+ / C2- or C2+ / C2-		3 / C1- ______		(High reading only)				Good/ Moderate/ Poor	(SS01, SS02, SS03 or SS04, etc.)	
DD/MM/YY				Hi	Low	Hi	Low		Hi	Low	Hi	Low	Hi	Low	Hi	Low	Hi	Low	mV	Ω	___Ω	OK?	Dry/wet		

SAMPLE

JS SR&DR TC history card 2010; Page 1/2 Version: April 2003 Stock Code: 1885946

TRACK: ____________________

DATE DD/MM/YY	TRANSMITTER END Location ID: Power Supply: PSU Serial number	Power Supply: Mains Supply (V)	Tx Serial Number	Tx Output Volts C+ / C- Hi	Tx Output Volts C+ / C- Low	Track Voltage (V) Hi	Track Voltage (V) Low	RECEIVER END Location ID: Rx Serial Number	Track Voltage (V) Hi	Track Voltage (V) Low	Rx Input Volts C+ / C2- or C2+ / C2- Hi	Rx Input Volts C+ / C2- or C2+ / C2- Low	Rx Input Volts 3 / C1- ______ Hi	Rx Input Volts 3 / C1- ______ Low	Volts with shunt on C+ / C2- or C2+ / C2- Hi	Volts with shunt on C+ / C2- or C2+ / C2- Low	Volts with shunt on 3 / C1- ______ Hi	Volts with shunt on 3 / C1- ______ Low	Zero Feed (High reading only) mV	Drop Shunt Ω	Fixed Shunt Test ___Ω	Polarity Check OK?	Ballast condition Good/ Moderate/ Poor Dry/wet	Remarks Service Schedule (SS01,SS02, SS03 or SS04, etc.)	Tested by: (Name or initials) & Signature of Testing Officer

SAMPLE

JS SR&DR TC history card 2010; Page 2/2 Version: April 2003 Stock Code: 1885946

ML/ABB/ADTRANZ TI 21 TRACK CIRCUITS (ANALOGUE RECEIVER)

ML/ABB/ADTRANZ TI 21 TRACK CIRCUITS **TRACK CIRCUIT HISTORY CARD** **TRACK: ____________**

TRACK LENGTH ________ m
FREQUENCY ___________ Hz
Tx OUTPUT LEVEL ________ HI / LO

Any additional Information needed -(sketch of track / Location IDs, distances, equipment positioning, bonds, etc.)

Impedance Bonds on track?	Tx end	Rx end	Mid track
Resonated?(Y/N)			
Res.Cap. nF			
Cap Volts V			

DATE	TRANSMITTER END Location ID:					DPU (For Tracks with Intermediate Receivers Only)				RECEIVER END Location ID										Tests		Remarks		Tested by:
DD/MM/YY	Tx Serial Number	PSU Serial Number	PSU DC (V)	Tx Output (Measured at Loc. track terminals) (V)	TU T1/T2 (V)	DPU Serial Number	Amp Serial Number	Amp Gain (Hi / Lo)	Volts Measured at Loc. DPU terminals (mV)	Rx Serial Number	PSU Serial Number.	PSU DC Volts (V)	TU T1/T2 (V)	Rx Input Measured at Loc. track terminals (V)	Monitor {mV across 1(Ω)} Unoc-cupied (mV)	Monitor With shunt on (mV)	Monitor Zero Feed (mV)	Gain Setting	Drop Shunt (Ω)	Fixed Shunt test 0.15Ω (OK)	Ballast Condition (Good/ Moderate /Poor/ Dry/wet)		Service Schedule (SS01, SS02, SS03, SS04,etc)	Name (or initials) & Signature of Testing Officer

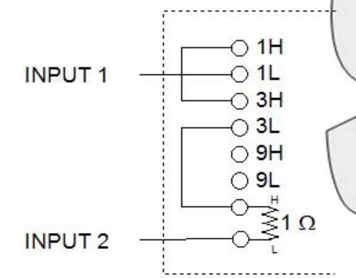
SAMPLE

TI21 TC History card 2010; (Page 1/2) Version: April 2003 Stock code: 1885938

TRACK: ____________

DATE	TRANSMITTER END					DPU (For Tracks with Intermediate Receivers Only)				RECEIVER END										Tests		Remarks	Tested by:
DD/MM/YY	Tx Serial No	PSU Serial No	PSU DC Supply (V)	Tx Output Measured @ Loc. track terminals) (V)	TU T1/T2 (V)	DPU Serial No	Amp Serial No	Amp Gain (Hi / Lo)	Rx Input Current (mA)	Rx Serial No	PSU Serial No.	PSU DC Supply (V)	TU T1/T2 (V)	Rx Input Measured @ Loc. track terminals (V)	Monitor {mV across 1(Ω)} Unoc-cupied (mV)	With shunt on (mV)	Zero Feed (mV)	Gain Setting	Drop Shunt (Ω)	0.15Ω Shunt Check (OK)	Ballast Condition (Good/ Moderate /Poor/ Dry/wet)	Service schedule (SS1, SS2, SS3, SS4,etc)	Name (or initials) & Signature of Testing Officer

SAMPLE



TYPICAL CONNECTION FOR THE GAIN = 2

GAIN	INPUT WIRING			
	1Ω H to	Input 1	Bridge	Bridge
1	1L	1H		
2	3L	1L	1H - 3H	
3	3L	3H		
4	3L	1H	1L - 3H	
5	9L	1L	1H - 3L	3H - 9H
6	9L	3L	3H - 9H	
7	9L	1H	1L - 3L	3H - 9H
8	9L	1L	1H - 9H	
9	9L	9H		
10	9L	1H	1L - 9H	
11	9L	1L	1H - 3H	3L - 9H
12	9L	3H	3L - 9H	
13	9L	1H	1L - 3H	3L - 9H

TI21 TC History card 2010; (Page 2/2) Version: April 2003 Stock code: 1885938

TI 21 ET 200 TRACK CIRCUITS (DIGITAL RECEIVER)

Transport Sydney Trains

Track Circuit History Card

TI21 Track Circuits – ET 200 **TRACK:** ____________________

TRACK LENGTH ___________ m: FREQUENCY ___________Hz

TX Power (@ TX TU):Normal (4&5) / Low (1&2) _________ Line Matching Units: Yes/No_______

Notes:

WARNING! - If LMU(Tx) & LMU(TU)are installed, around 110V would appear on feed cable & at terminals.

DATE DD/MM/YY	Remarks - Service Schedule (SS01, SS02, SS03, etc)	TRANSMITTER END Location ID: Tx Serial No.	Tx DMM DC Supply (V)	Tx FSM Output @ TX Terminals (V)	TU FSM T1/T2 (V)	Resonated Impedance Bonds Position Tx Mid 1 Mid 2 Rx	If not resonated or not adjustable write bond type Cap. (nF)	Cap. DMM (V)	RECEIVER END Location ID: TU FSM T1/T2 (V)	Rx FSM Input @ Loc. Track terminals (V)	Rx Serial No.	Rx DMM DC Supply (V)	Rx Set-up Shunt (When applic.) (Ω)	Receiver input current Display value Must be verified with FSM (mV) on terminals IP1-TP1: Threshold Current 'Ith' (mA)	Unoccupied 'Inow-AV' (mA)	Fixed shunt 'Inow-AV' (mA)	Zero Feed 'Inow-AV' (mA)	Rx Drop Shunt (Ω)	Fixed Shunt Test 0.15Ω (tick each test pt.) (✓)	Ballast level & Condition (Good/ Average /Poor & Dry/wet)	Measuring Equipment Type (DMM, FSM, TFA, Shunt Box) & Number	Name & signature of Testing Officer
	Last major track change																					
	Last full test																					

SAMPLE

Continued on back

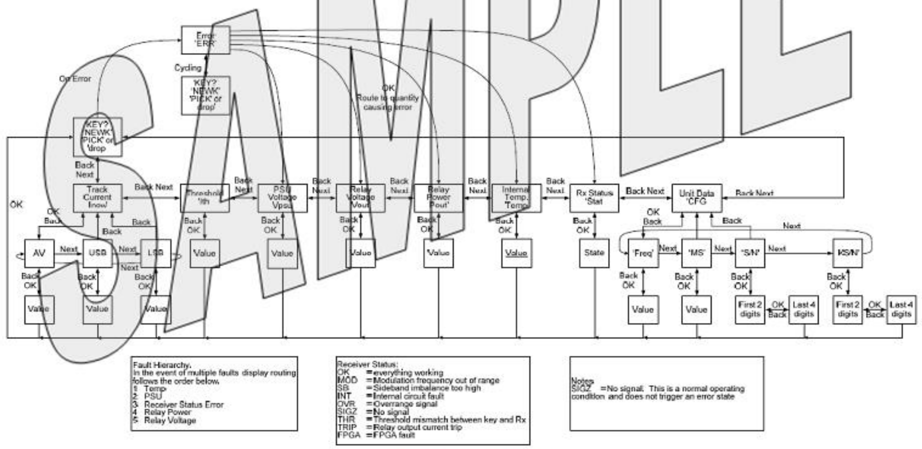
Version: September 2015

Transport Sydney Trains

Track Circuit History Card

TRACK: ____________________

DATE	Remarks - Service Schedule	TRANSMITTER END Location ID:				Resonated Impedance Bonds			RECEIVER END Location ID:					Receiver input current Display value Must be verified with FSM (mV) on terminals IP1-TP1					Fixed Shunt Test	Ballast level & Condition	Measuring Equipment Type	Name & signature of Testing Officer
DD/MM/YY	(SS01, SS02, SS03, etc)	Tx Serial No.	Tx DMM DC Supply (V)	Tx FSM Output @ Tx Terminals (V)	TU FSM T1/T2 (V)	Loc. Tx Mid 1 Mid 2 Rx	If not resonated or not adjustable write bond type Cap. (nF)	Cap. DMM (V)	TU FSM T1/T2 (V)	Rx FSM Input @ Loc. Track terminals (V)	Rx Serial No.	Rx DMM DC Supply (V)	Rx Set-up Shunt (When applic.) (Ω)	Threshold Current 'Ith' (mA)	Unoccupied 'Inow-AV' (mA)	Fixed shunt 'Inow-AV' (mA)	Zero Feed 'Inow-AV' (mA)	Rx Drop Shunt (Ω)	0.15Ω (tick each test pt.) (✓)	(Good/ Average /Poor & Dry/wet)	(DMM, FSM, TFA, Shunt box) & Number	



SAMPLE

Version: September 2015

WBS FS2600 TRACK CIRCUITS

FS2600 TRACK CIRCUITS **TRACK CIRCUIT HISTORY CARD** **TRACK:** ________________

☐ SINGLE RAIL

☐ DOUBLE RAIL (Using Track Interface Unit with Impedance bond type MJS)

TRACK LENGTH ________m

CHANNEL: ___________

Any additional information needed-(sketch of track/Location IDs, distances, equipment positioning, bonds, etc.)

TRANSMITTER	
Tx Serial Number	
Tx Output terminals	
Tx set to double rail -low	

RECEIVER	
Rx Serial Number	
Rx Sensitivity	
Links on configuration	

DATE	TRANSMITTER Location ID:			RECEIVER / RELAY END Location ID:							CHECKS					REMARKS	TESTED BY:
							Monitor Volts										
DATE DD/MM/YY	Supply Voltage (BX110) (88-121V)	Tx Output Voltage (Typical values for DR-120V) (V a.c.)	Track Voltage (3.3-20V)	Supply Voltage (BX110) (88-121V)	Track Voltage Measured at Pot head (V)	Rx Input Voltage Measured @ Loc. track terminals (V)	Unoccu-pied (3-12V)	with 0.5Ω shunt on (V)	Zero Feed Test (<100mV)	Drop Shunt >0.6Ω	Fixed Shunt Test 0.5Ω	Bonds/ Rail Connec-tions OK?	Insulated Joint Detection OK?	Lightning Protection OK?	Ballast Condition Good/Moderate/ Poor Dry/wet	Service Schedule (SS01,SS02, SS03, SS04, etc.)	Name or initials & Signature of Testing Officer

SAMPLE

FS2600 TC History Card 2010; Page 1/2 Version: April 2003 Stock code: 1885920

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FS2600 TRACK CIRCUITS **TRACK CIRCUIT HISTORY CARD** **TRACK:** ___________________

	TRANSMITTER Location ID:			RECEIVER / RELAY END Location ID:							CHECKS					REMARKS	TESTED BY:
							Monitor Volts										
DATE DD/MM/YY	Supply Voltage (BX110)	Tx Output Voltage (Typical values for DR-120V)	Track Voltage	Supply Voltage (BX110)	Track Voltage Measured at Pot head	Rx Input Voltage Measured @ Loc. track terminals	Unoccupied	with 0.5Ω shunt on	Zero Feed	Drop Shunt	Fixed Shunt Test	Bonds/ Rail Connections	Insulated Joint Detection	Lightning Protection	Ballast Condition Good/Moderate/ Poor	Service Schedule (SS01,SS02, SS03 , SS04, etc.	Name or initials & Signature of Testing Officer
	(88-121V)	(V a.c.)	(3.3-20V)	(88-121V)	(V)	(V)	(3-12V)	(V)	(<100mV)	>0.6Ω	0.5Ω	OK?	OK?	OK?	Dry/wet		

SAMPLE

FS2600 TC History Card 2010; Page 2/2 Version: April 2003 Stock code: 1885920

MICROTRAX TRACK CIRCUIT

Transport
Sydney Trains

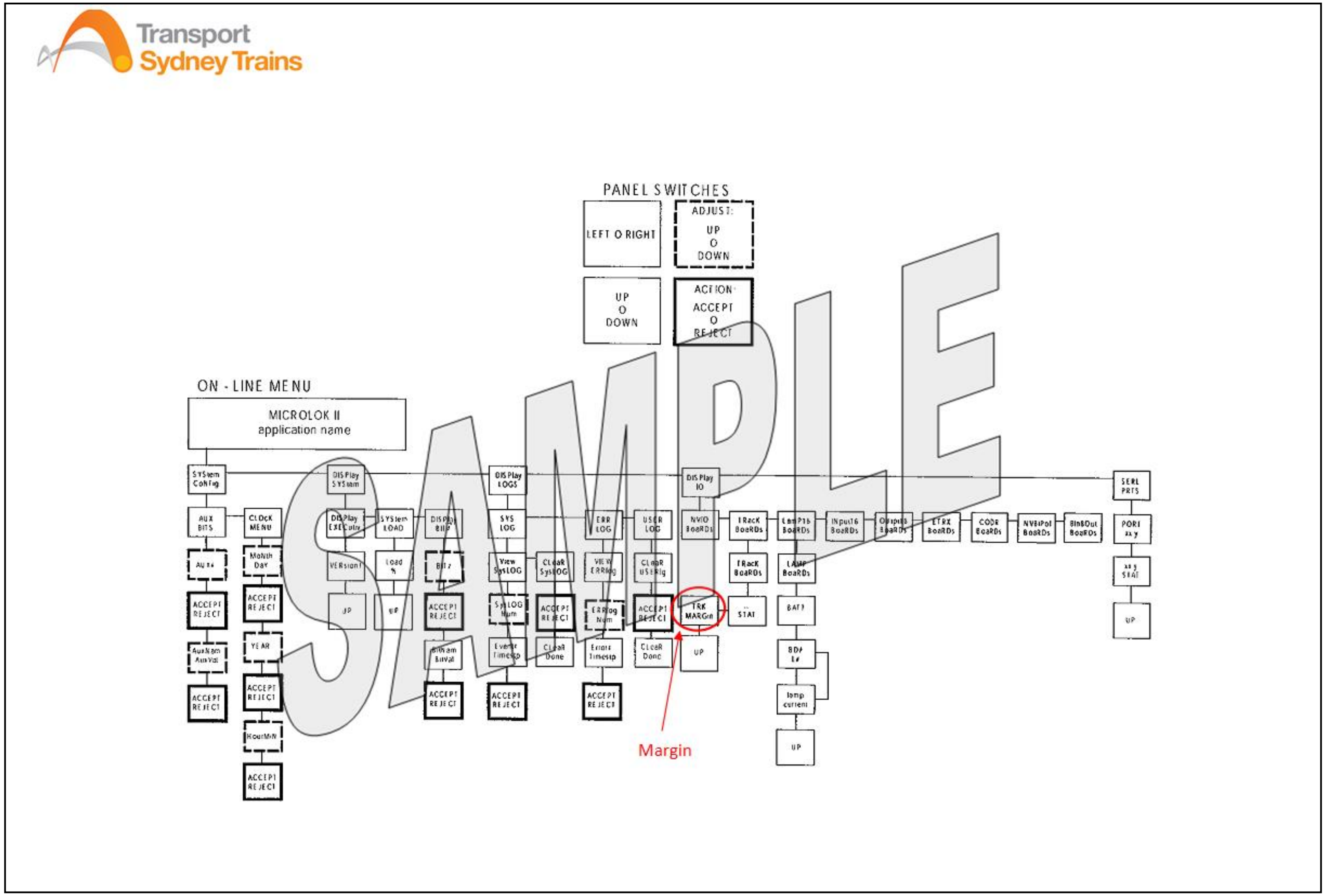
MICROTRAX TRACK CIRCUIT HISTORY CARD

TRACK.. LOCATION....................................... MASTER/SLAVE END...

ACTUAL TRACK LENGTH (m).. TRACK RESISTOR VALUE (Ω)..

Date	Comments	Track length Setting ('000 ft)	Location 120v	12V Supply Volts	Margin	Drop Shut Ω (Slave end only)	0.25Ω Shunt Test	Polarity Check (ok)	Test Equipment Used. (Type & Ser. No.)	Ballast condition	Name & Signature
	Commissioned										
	Last full test										

SAMPLE


Transport
Sydney Trains
PANEL SWITCHES
LEFT O RIGHT
ADJUST:
UP
O
DOWN
UP
O
DOWN
ACTION:
ACCEPT
O
REJECT
ON - LINE MENU
MICROLOK II
application name
SAMPLE
Margin

RESONATED IMPEDANCE BOND CAPACITOR HISTORY CARD

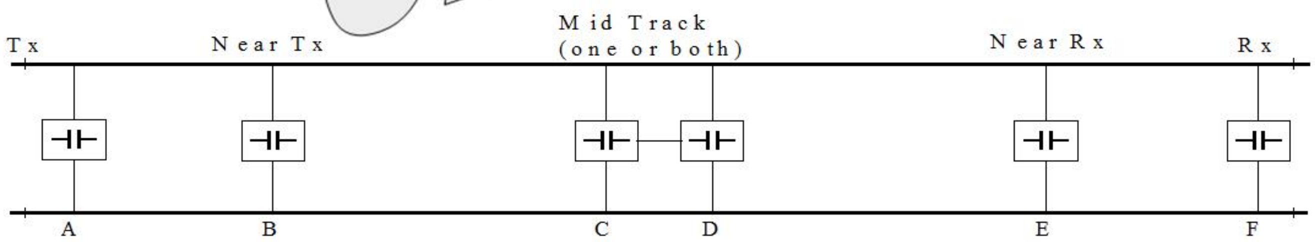
Transport Sydney Trains

RESONATED IMPEDANCE BOND CAPACITOR HISTORY CARD TOWN: TRACK:__________

(The card to be held at the Rx end of the track Location: _________)

DATE (DD/MM/YY)	IMPEDANCE BOND TYPE	POSITION ON THE TRACK						CAPACITANCE (µF/nF)	VOLTAGE ON CAPACITORS(V)	BALLAST CONDITIONS	NAME & SIGNATURE
		A	B	C	D	E	F				

SAMPLE

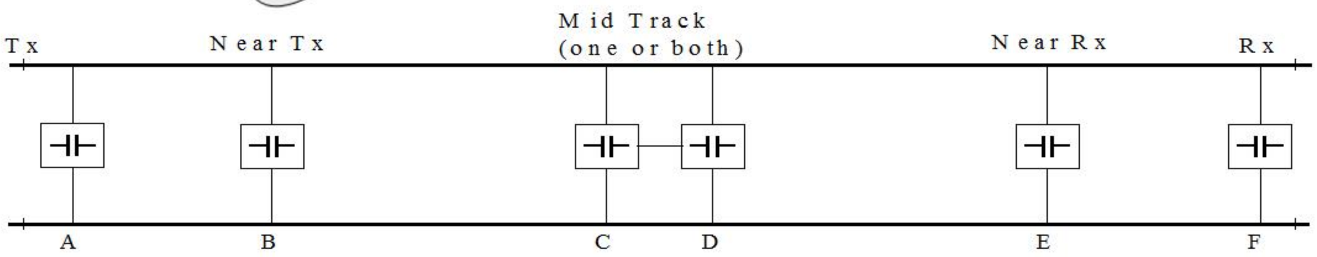


Version: February 2017 Code Stock: 1886035

LOCATION ____________________ TRACK NAME ________________

SAMPLE

DATE (DD/MM/YY)	IMPEDANCE BOND TYPE	POSITION ON THE TRACK						CAPACITANCE (µF/nF)	VOLTAGE ON CAPACITORS(V)	BALLAST CONDITIONS	NAME & SIGNATURE
		A	B	C	D	E	F				



Version: February 2017 Code Stock: 1886035

Sydney Trains

Engineering System Integrity

Engineering Procedure

Signalling and Control Systems

Signalling Safeworking

PR S 40026

Re-railing – Precautions to be Taken

Version 2.2

Date in Force: 15 July 2021

Approved by:	Professional Head Signalling and Control Systems Engineering System Integrity	Authorised by:	Engineering Technical Publications Manager System Integrity

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Document control

Version	Date	Author/ Prin. Eng.	Summary of change
1.0	16 September 2013	Y Bagaric	First issue as Sydney Trains document
1.1	13 February 2017	R Del Rosario/C Darmenia	Updated to new titles and roles, updated to mandatory ASA requirements and EI S 15-03
2.0	8 March 2019	C Darmenia	Inclusion of ATP equipment precautions and relocate traction bonding requirements
2.1	17 December 2020	C Darmenia	Update for ASDO, shunt testing & EI S 20-08
2.2	15 July 2021	Ian Maydew/C Darmenia	Updated to include axle counter requirements

Summary of changes from previous version

Summary of change	Section
Update to introduction to include axle counters	1
Section updated to include PR S 40051	3
Update to various sections within Authorisation and Attendance	4
Update Precautions section to include axle counters	5
Traction return section updated to include axle counter consideration	5.1.2

OFFICIAL

Table of Contents

OFFICIAL

1 Introduction

When rerailing or during other trackwork activities that involve breaking the rail occurs in axle counter, 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
- correct location, installation and certification of axle counter wheel sensors
- 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 Temporary Bridging of Signalling Circuits*
- *PR S 40008 Securing Signalling Apparatus Out of 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 ETCS L1 – Alstom Trackside Equipment*
- *PR S 40051 Axle Counters*
- *PR S 47118 Inspection of Testing of Signalling: Signal Support Work*
- *MN S 41604 Alstom ETCS Trackside Maintenance Manual*
- *GL S 43003 Use of Kago Clamps for Temporary Rail Connection of Track Circuit and Traction Cables*

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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 engineering work affects the signalling interlocking
- at points, in any intermediate location outside an interlocking
- in plain track circuited 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
- where axle counter wheel sensors are affected 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 a balise).

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
- removing axle counter wheel sensors and their rail clamps
- disconnecting associated signalling equipment.

At the end of the work, licensed signalling personnel shall reinstate and perform the required testing to the affected ETCS equipment, track circuits and axle counters. They shall also ensure that the rail surfaces are sufficiently clean to provide an effective track shunt on track circuited lines. 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 adept in the use of the Temporary Rail Bonds. Refer to Section 6 of this procedure for more detail.

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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, axle counter 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.
- Axle counter wheel sensors affected by the rerail are position marked and removed from the track (refer to applicable Sydney Trains equipment manual for methods to mark the position of the wheel sensors prior to their removal).
- 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 or overlap track section wheel sensors, 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.

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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 circuit or axle counter track section 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 axle counter track sections are directly interfaced with a CBI then the associated section/s shall be blocked on the Technicians Terminal.

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.

The application of any bonding shall not provide opportunity for false activation of track circuits.

PR S 40027 shall be referenced for information in relation to the precautions and safeguards which apply to traction return.

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5.2 Newly Installed Rails in Track Circuited Lines

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 Requirements

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.

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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)

Also applies to point switch and stock rails of any length, but not beyond the expected length of the switch and stock rail arrangement:

- 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, axle counters and ETCS equipment affected by rerailing in accordance with PR S 40025, PR S 40028 and PR S 40051 respectfully.

Testing and certification of the track circuits shall be done only after the traction return arrangements have been reinstated.

For track circuited areas, 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.

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- 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.

In axle counter train detection areas where axle counter wheel sensors have been removed due to trackworks, it is important that they are reinstated in exactly the same location as they were removed from. Refer to the applicable axle counter Sydney Trains equipment manual for the process to follow for the correct marking and positioning of wheel sensors.

When re-installing the wheel sensor ensure they are:

- located in exactly the same position as was removed from
- installed on the correct rail
- orientated correctly on the rail
- correctly calibrated to the associated evaluator
- tested to ensure correct occupancy detection using the approved testing tool.

Note:
On completion of the works the track section will require resetting in accordance with *PR S 40051 Axle Counters*.

If trainstops have been affected by the rerailing, they shall be gauged and any temporary bridging removed.

Where ETCS balises are removed due to trackworks, it is critical that they are reinstated in exactly the same position and order. Key to this requirement are 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, refer to Figure 1.

Additionally, for the ASDO Reference Balise a supplementary circular ID plate on the balise and an ASDO reference balise marker plaque (aluminium) fitted on the platform vertical face to identify the exact design position of the ASDO reference balise (N_PIG=0), refer to Figure 2.

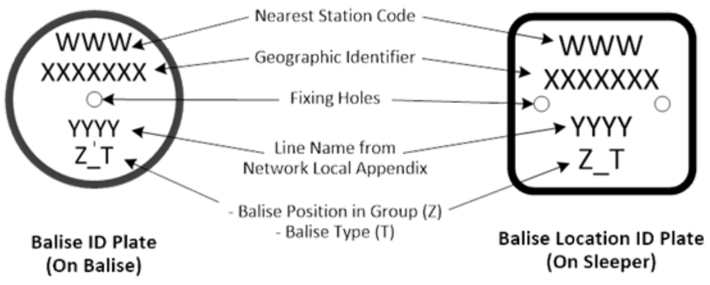

Figure 1: Balise ID Plate and Balise Location ID Plate

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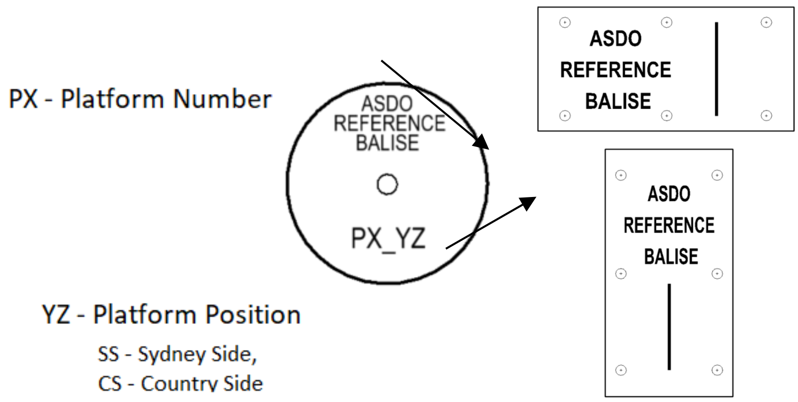

Figure 2: ASDO ID Plate and ASDO Reference Balise marker Plaque

   - Where the work does not require the replacement of sleepers and the ETCS balise location ID plate remains in place, the balise can be reinstated by placing it alongside the balise location ID plate. The ASDO reference balise shall always be replaced within +/-350 mm longitudinally of the ASDO reference balise marker plaque (located on the platform vertical face).
   - 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 required to be tested shall be tested in accordance with the ETCS Balise Function Test described in PR S 40028.
- All affected signalling, with the exception of ASDO, 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. Handsignallers 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.

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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 adept at performing 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, refer to *GL S 43003 Use of Kago Clamps for Temporary Rail Connection of Track Circuit and Traction Cables*. 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.

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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 and Control Systems for determination.

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Engineering System Integrity

Engineering Procedure

Signalling and Control Systems

Signalling Safeworking

PR S 40027

Traction Return (1500V DC)

Version 4.0

Date in Force: 15 July 2021

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Approved by:	Professional Head Signalling and Control Systems Engineering System Integrity	Authorised by:	Engineering Technical Publications Manager System Integrity

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Version	Date	Author/Prin. Eng.	Summary of change
1.0	16 September 2013		First issue as Sydney Trains document
2.0	10 January 2018	C Darmenia	Updated to mandatory ASA and EIS requirements and titles and roles
3.0	8 March 2019	C Darmenia	Inclusion of precautions for track works and other clarifications
4.0	15 July 2021	Ian Maydew/C Darmenia	Updated with the inclusion of axle counter requirements

Summary of changes from previous version

Summary of change	Section
Updated to include reference to PR S 40051	1
New section to cover temporary track bonding does not affect neighbouring track circuits	2.5

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Table of Contents

OFFICIAL

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 40051 Axle Counter*
- *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.

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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.

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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.

2.5 Energisation of Track Circuits by neighbouring Axle Counter Track Sections

It shall be ensured that any temporary traction bonding between axle counter track sections, and neighbouring track circuited sections does not provide a path for false energisation of the track circuit or the possibility for the track circuit to not effectively shunt.

If an axle counter track is temporarily bonded to a track circuited track for the purpose of traction current, then there may be the need to isolate the track circuit in accordance with Section 3.2 due to possible circulating currents.

3 Precautions when renewing Traction Bonds or Works affecting Track 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.

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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.

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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

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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 1500V 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.

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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 Sections 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

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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 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.

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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 1500V 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.

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Engineering System Integrity

Engineering Procedure

Signalling and Control Systems

Signalling Safeworking

PR S 40028

ETCS L1 – Alstom Trackside Equipment

Version 3.0

Date in Force: 30 November 2022

OFFICIAL

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Document control

Version	Date	Author/Prin. Eng.	Summary of change
1.0	8 March 2019	C. Darmenia	New document
2.0	2 December 2020	C. Darmenia	Updated for ASDO, EI S 19-05 & EI S 20-08
3.0	30 November 2022	Daniel Calladine	Updated to EI S 21-01

Summary of changes from previous version

Summary of change	Section
Updated "Management of Data Files" section	13.1
Removed "Maintenance" section	13.1.1
Removed " Interim As-built" section	13.1.2

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Table of Contents

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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 currently four different levels of ETCS these being:

- ETCS Level 0 the ETCS application level provided to cover where an ETCS-fitted vehicle is 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 2 involves continuous supervision of train movement with continuous communication 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. The train location and integrity is managed by the ERTMS system, i.e. there is no need for lineside signals or rail vehicle detection systems on the trackside other than balises and train integrity is supervised by the train itself. Commonly referred to as moving block.

Limited Supervision (LS) is an ETCS mode giving partial protection against over speed and over run. The driver has to observe and obey to line side signals and operating rules. Limited Supervision enables the train to be operated in areas equipped with lineside signals where ETCS only has information regarding the status of selected signals and other high risk supervised locations.

Full Supervision (FS) is a mode in levels 1, 2 and 3 where all train and track data, which is required for complete supervision of the train, is available on board. In this mode, the system provides protection for overspeed and overrun.

TfNSW has implemented ETCS L1 Limited Supervision (LS).

ETCS Level 0 trackside equipment consists of balises to announce level transitions and other specific commands. While in Level 0 the on board system supervises maximum network ceiling speed, maximum train speed with no implementation of in cab signalling.

ETCS Level 1 trackside equipment, depending on the function, 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 (refer to Section 2). ASDO and speed sign supervision will only require a fixed balise group; however any function which can change state depending on the state of the signalling system (e.g. ETCS trainstops, High Risk Turnouts) 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.

In most cases a balise group will consists of one or two balises, however, there are occasions where the data will not fit in two and three balises are provided.

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

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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 action or braking reaction from the train, as well as the appropriate information to be displayed on the Driver's display.

2 Scope

This procedure covers the signalling safeworking requirements for trackside equipment associated with ETCS Level 0 and Level 1LS.

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.
- Automatic Selective Door Operation (ASDO).

The ETCS system is identified as a signalling system, system integration shall be conducted in accordance with the relevant signalling inspection and testing standards and procedures.

2.1 Purpose

The purpose of this document is to specify the Signalling Safeworking requirements for the maintenance, faulting and failure rectification of ETCS track mounted and trackside equipment.

2.2 Application

This procedure applies to ETCS L0 and L1 LS trackside equipment where Sydney Trains is the Rail Infrastructure Manager (RIM).

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3 Reference documents

Document Name	Document ID
Network Rules & Network Procedures	-
Alstom ETCS Trackside Maintenance Manual	MN S 41604
Alstom ETCS Set To Work, Testing and Commissioning	MN S 41605
Balise Placement and Metal Mass Assessment Guide	EGG1656
Geographic Data for ETCS L1	GL S 45202
BEPT G3 User Manual	MN S 41607
Alstom ETCS BEPT User Profiles and Passwords	MN S 41616
Inspection & Testing of Signalling: Introduction	PR S 47110
Installation of Trackside Equipment	SPG 0706
Failures	PR S 40004
Damage to Signalling Equipment including Cables	PR S 40005
Apparatus Seldom Used	PR S 40007
Securing Signalling Apparatus Out of Use	PR S 40008
Disconnection of Signalling Apparatus	PR S 40009
Risks and Controls Associated with Testing and Certify Equipment	PR S 40010
Renewals Work	PR S 40011
Maintenance Responsibilities and Frequencies	PR S 40017
Insulation Inspection and Testing	PR S 40023
Rerailing - Precautions to be Taken	PR S 40026
Solid State Interlocking (SSI) and Smartlock 400T	PR S 40032
Safety Issues for Signalling Personnel	PR S 40042
ETCS Data Storage and Access	PR S 45005
ETCS L1 LS Data Design Process	PR S 45006
Inspection and Testing of Signalling: Signal Support Work	PR S 47118

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4 Terms and definitions

The following terms and definitions apply in this document:

ASDO	Automatic Selective Door Operation. An ETCS function that enables only doors which give passengers safe access to platform and inhibits those which do not
ASDO Platform Limit marker Plaque	A metal plaque that is fixed to the horizontal face of each platform to indicate the design position for the design target location where the target location is on a platform
ASDO Reference Balise	The balise in the ASDO balise group to aid with accurate location information (a calibration function). The balise has an additional circular ID plate engraved with "ASDO Reference Balise". The Balise is assigned N_PIG=0 position in group
ASDO Reference Balise marker Plaque	A metal plaque that is fixed to the vertical face of each platform to indicate the design position of the ASDO reference balise
ATP	Automatic Train Protection. An ETCS function that provides a safety system that warns of or enforces speed limits and stopping before supervised locations.
Balise	A transponder on the track that is read by on-board ETCS equipment
Balise Group (BG)	One or more closely spaced balises at the same location on track. The telegrams transmitted by all the balises of a group form a track-to-train message
Balise ID Plate	A circular identification name plate fitted to each balise **Note: ASDO reference balises include an additional (supplementary) circular identification plate**
Balise Junction Box	Trackside ETCS Junction Box
Balise Location ID Plate	A rectangular (metal) identification name plate fitted to the track adjacent to each balise
Balise Tail Cable	A cable between the balise and the trackside ETCS Junction Box
Barrier	In the context of ASDO: the end of platform infrastructure defining limit of usable platform length. It may take the form of a fence, a wall, a post/pole, top of ramp or some other point of interest
BEPT	Alstom Balise and Encoder Programming Tool
BMM	Big Metal Mass

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CAN Warning	Condition Affecting the Network
CB	Circuit Book
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 and ASDO)
ETCS Level 0 (L0)	The ETCS application level normally used on essentially unfitted or uncommissioned lines
ETCS Level 1 (L1)	The ETCS application level that uses balises to send information 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 radio to transmit movement authorities and other information to trains and uses pre-existing signalling system methods to determine train position
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 on-board an ETCS fitted train
LED	Light Emitting Diode

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LEU	Lineside Electronic Unit. The term LEU is a generic descriptor. Alstom's LEU product is the Cobalt 'Micro-Coder'
Configuration Key	An Alstom programmable device which connects to an LEU and contains the LEU configuration data
Limited Supervision (LS)	An ETCS mode giving partial protection against over speed and over run. The driver has to observe and obey to line side signals and operating rules when in limited supervision mode
Micro-Coder	An LEU 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)
RS900	Siemens Ethernet switch model RS900-24-D-C2C2C2
SCF	Site Certification Form. A site specific form located in the signalling circuit book containing the location details of the ETCS critical assets
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 pre-set (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
Vortok	A mounting system for a balise using a glass fibre resin insulated beam fixed between rails (brand name Vortok)

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 on-board equipment are not considered to be signalling failures, if signalling personnel become aware of ETCS on-board issues, such issues shall be reported to ICON Infrastructure as soon as possible. ICON Infrastructure shall advise the relevant on-board maintainer of the information required.

If there is a discrepancy between information displayed on the on-board 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

ETCS trackside equipment failure will result in an ETCS fitted train receiving a warning message 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.

ASDO trackside equipment failures will result in a train fitted with ASDO receiving a warning message on the Driver Machine Interface (DMI) due to an ASDO balise failure. In the case of an ASDO balise group failure, there will be no brake intervention.

These are considered to be right side failures and may occur if an ETCS balise or LEU is missing, defective or damaged to the extent that it is not capable of sending out a valid and complete telegram to a train.

5.1.1 ETCS L1

In the case of ETCS L1 LS, the linking information (if provided) 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.

In the case of ETCS L1 LS balises, the balise linking information provides a level of protection for the failure and trains would be expected to continue to obey the track conditions or the more restrictive braking requirements imposed by the ETCS failure.

5.1.2 ASDO

In the case of ASDO balises, in the event of a partial-read or misread of a message (e.g. only one balise in the BG), the on-board system will generate a special DMI text message and the driver may need to operate (release or open) the doors manually (at the affected platform) by means of ASDO Bypass until the trackside failure can be repaired. ASDO balise groups are unlinked, and if the entire BG is missing or completely failed, there will be no DMI message to alert the Driver. However, in this event, the failure will be detected by a first stopping ASDO enabled train requiring use of the missing or failed Balise Group.

Depending on which balise(s) have failed at any particular platform, this may cause:

- No operational impact.

  or

- 'ASDO Bypass' selected by the Driver (possible minor operational impact).

  or

- Degraded Mode operation (possible minor operational impact).

For right side failures of ASDO trackside equipment, there are no specific requirements for the management of the failure until it is fixed, other than the use of ASDO Bypass by the Driver.

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 is an irregularity which may bring the system to an unsafe condition.

The condition where operational (commissioned) balises are not read by trains due to the implementation of a VBC function shall be deemed as a wrong side signalling irregularity.

A wrong side failure of ETCS equipment, both ETCS L1 LS and ASDO, shall be treated in accordance with PR S 40004.

5.2.1 ETCS L1

A wrong side failure of ETCS L1 LS trackside equipment is 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 ETCS L1 LS 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.

5.2.2 ASDO

In the event of an ASDO unprotected wrong side failure of trackside ETCS equipment, a train shall be prevented from using the ASDO function at the affected platform by covering the balise group using the approved metallic (mechanical) cover as a first preference or the removal of the balise group.

Prior to removal or disturbance of balises, perishable evidence must be captured to identify position including details of label(s) on balise and track as well as measurements to the reference balise plaque and distance between balises in the group.

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.

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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 reinstatement/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.

Appendix A 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 programming activities. Personnel conducting the data validation process shall be independent of the data programming and data verification activities.

6.2 Balise Like for Like Renewal

For precautions associated with the Like for Like renewal of balises, see Section 10.2.

Only one balise should be disconnected or re-instated at a time to prevent incorrect reconnection.

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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, 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.
- That an ASDO reference balise is aligned within tolerance of the ASDO reference balise marker plaque (located on the platform vertical face) and its supplementary circular ID plate is checked against the physical location (i.e. the position along the platform and placed at the correct platform number) prior to and when re-installed.
- 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 signalling documentation, shall require measuring and marking, prior to installation of the replacement balise.

Use of a Vortok Universal spreader beam in accordance with drawing M05-545 is permitted for temporary repairs and where on sleeper Vortok beams or direct fixing, are not suitable.

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 programmed, 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 10.1.

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 or 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 Track Support Activities

In order to maintain integrity of the ETCS system the removal and reinstatement of balises shall be conducted in accordance with relevant signalling safeworking procedures and documented to manage the removal, reinstatement and certification of balises affected by the possession related works.

Work instructions containing a list of affected balises or a *PR S 40028 FM01 Balise Replacement Testing (ETCS M1)* form for each affect balise is required for removal, reinstatement and certification. Activities shall be progressively documented as they occur.

In addition, the Site Certification Form (SCF) and *PR S 40028 FM01 Balise Replacement Testing (ETCS M1)* form is also required where the balise or balise group required:

- Identification re-established.

  or
- Correct balise location needed to be identified by measurement.

  or
- Was replaced.

  or
- Has been programmed.

The requirements for identifying a balise to be removed and reinstated for planned track works and identifying the exact location of the balise vary according to the situation:

- For the removal and reinstatement of a balise that is currently identifiable on the track or that does 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.

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- That an ASDO reference balise is aligned within tolerance of the ASDO reference balise marker plaque (located on the platform vertical face) and its supplementary circular ID plate is checked against the physical location (i.e., the position along the platform and placed at the correct platform number) prior to and when re-installed.
- 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 signalling documentation, shall require measuring and marking prior to installation of the replacement balise.
- For 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 (SCF), shall require measuring and marking prior to installation of the replacement balise. For an ASDO reference balise, the ASDO reference balise marker plaque may be used as a point of reference.

Use of a Vortok Universal spreader beam in accordance with drawing M05-545 is permitted for temporary repairs and where on sleeper Vortok beams or direct fixing, are not suitable.

7.1.1 Support by authorised non-signalling discipline personnel

Authorised non-signalling discipline personnel may be utilised for the removal and reinstatement of fixed ETCS L1 balises (ATP and ADSO), within a possession on the Sydney Trains maintained network with the exception of excluded balise/balise groups listed in Section 7.1.2.1.

Where non-signalling discipline personnel are utilised then specific work instructions *PR S 47118 FM032 ETCS Balise Remove Reinstate – Other Disciplines* and *PR S 47118 FM033 ETCS Balise Certification Post Other Disciplines* shall be used for the task management and assurance activities.

Where there is any ambiguity in the identification and correct location of balises or there has been a need to measure the balise location from reference assets to identify the correct location, the balise reinstatement and certification activities must be performed by licensed signalling personnel.

7.1.2 Testing following Track Work

All fixed and controlled balises, once reinstalled or reinstated, require a Balise Telegram Test (as part of Functional Testing).

An exception to the Balise Telegram Test requirement applies to reinstated fixed balises for signal support of possession related works other than for fixed balises or balise groups:

- Identified as excluded in Section 7.1.2.1.

  or

- Where the identification of the balise or balise location needed to be established.

  or

- If a balise has been replaced/programmed.

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7.1.2.1 Excluded balise/balise groups

- Transition announcement balise group between Level 0 areas to and from Level 1 areas:
  - Identified with the nomenclature "LT(A)" on a balise plan.
- VBC balises:
  - Identified on site with red tags with the nomenclature "VBC" on a balise plan.
- Trip balises: stop light, stop sign balise groups:
  - Identified as being always associated with a fixed red signal or stop sign with the nomenclature "TS" on a balise plan.
- The last balise group before buffer stops:
  - Identified as being the last balise before a buffer stop with the nomenclature "BS(TR)" on a balise plan.
- Yard entry exit balises:
  - Identified as being the first 2 balise groups as the train departs a yard with the nomenclature "YDN" or "YDX" on a balise plan.

8 Periodic Maintenance

Periodic inspections of all ETCS equipment shall be done in accordance with TMPs.

Periodic functional testing of ASDO balises is not required. ASDO balise failures are self-revealing and will require intervention by train crew for the manual release of doors.

Seldom used balises and certain unlinked balises (such as yard entry/exit and VBC), require a periodic functional test by reading the telegrams using the BEPT to verify that the balise is working.

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.

8.1 Seldom Used Balises

Where installed ETCS balises are not regularly traversed by ETCS 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.

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8.2 Unlinked Balises

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.
- ASDO balise groups.

8.3 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. Refer to MN S 41604.

8.4 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.

9 Authority Levels

9.1 General

Three independent personnel are required for the installation of ETCS data into a balise or an LEU configuration key. The first to program the data (using the BEPT), the second to verify the data (also using the BEPT), and the third to validate the installed data (using the checksum detailed on the existing ETCS L1 Data Release Note for that installation).

The independence shall relate to the following activities:

- Programming of data using the BEPT.
- Verification of data using the BEPT.
- Validation of data against the Installed Data Forms for the specific installation.

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9.2 ETCS Data Programming

As part of the replacement and data programming of a balise or LEU configuration key, licensed signalling personnel, subject to limitations in Sections 9.3 and 9.4, 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.

9.3 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 (excluding VBC balises) with a BEPT.
2. Import verification missions into a BEPT as detailed on the ETCS Installed Data Form.

Signal engineers are additionally permitted to:

- Verify the loaded data for VBC balises with a BEPT.
- Verify the loaded data for LEU configuration keys with a BEPT.

9.4 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 L1 Data Release Note.
2. Validate the loaded data for LEU configuration keys against the ETCS L1 Data Release Note.

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.

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10 Precautions

10.1 LEUs

There are two types of LEU input interfaces: 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 contract sensing will not affect the signal lamps or the aspects.

10.1.1 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.

10.1.2 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.

10.2 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 already established. Examples of single balise groups include the last balise just before a buffer stop, or a 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.

To ensure the correct reading of a balise group, a minimum distance of 2.3 m is required between balises. At guardrail installations the minimum distance of 3.6 m is required.

The longitudinal positioning of a balise along the track 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.

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Table 1

ETCS Balise Function	Maximum Longitudinal offset from original design location permitted without Engineering Approval
ASDO reference balise	+/- 350 mm (from Reference Balise marker Plaque)
All other balises	+/- one sleeper increment (nominal 600 mm)

The reinstatement of ETCS balises shall be done in accordance with Section 6 and Section 7.

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.

The ASDO Reference balise supplementary ID plate shall be also checked to ensure the correct balise is installed.

In scenarios where an ASDO reference 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 function shall be booked out of use in accordance with PR S 40008, removed or muted using the approved metallic (mechanical) cover and re-installed at the next available opportunity.

CAUTION:
ASDO balises are unlinked. If these are re-installed incorrectly, ETCS on-board will not be presented with a DMI text message and may enable incorrect doors to operate.

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.

11 Equipment Specific Information

11.1 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.

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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.

11.2 Virtual Balise Cover

The purpose of the Virtual Balise Cover (VBC) function is to inhibit the on-board system from acting on telegrams received from trackside; thus VBC instructs an ETCS fitted train to ignore or commence to read any balises within a defined area.

VBCs are commissioned operational assets. 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.

Balise data contains a VBC Marker attribute. An ETCS fitted train will only apply the VBC function to balises with a VBC Marker that is contained in the VBC balise group data. This allows for a project or multiple projects to be co-ordinated in the same area with only those balises having a VBC marker in the VBC group to be ignored and not affect normal operations.

Whilst ASDO balise data contains a specific ASDO VBC Marker, they utilise a defined ETCS data packet to instruct the ETCS fitted train not to react to an ASDO balise for ATP functions.

VBC balise groups consists of two identical pairs of balise. Each BG consists of two balises for redundancy. This is to ensure that in the event of a failure in a balise group, that the on-board systems still receive the command to either cease or commence the receiving of message from the track side infrastructure. They 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.

In the case when a VBC has failed due to damage or technical problem, the on-board system will issue a DMI Text Message and Service Brake Intervention (SBI) ordering the train to a stand before it can proceed.

To protect against the occurrence of unwarranted service brake interventions or a condition where operational (commissioned) balises not being read by trains it is essential that:

- The order of balises in a VBC group is correct .
- VBC groups are reinstated into their correct position prior to any ETCS fitted train passing through a location requiring a VBC group.

A VBC 'OFF/OFF' balise may be used for the final commissioning stage of an ETCS project where the on board system is required to not retain a VBC set (ON) order for the area being commissioned. For further information on VBC functionality refer to PR S 45006.

11.3 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.

11.4 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.

11.5 Automatic Selective Door Operation (ASDO)

ASDO balise groups provide the train with specific information about the approaching platform such as platform length, platform position relative to direction of authorised movement (left or right side), direction of travel and distance to end of platform, so that only doors aligned with the platform and within platform constraints (defined by the end of platform barriers) are released.

Where the on-board system determines some doors as being uncertain to be on the platform, they are inhibited from opening automatically.

Each ASDO balise group consists of two fixed balises. One balise is identified as the ‘reference balise’ and is always assigned position 0 (N_PIG=0). The remaining balise is identified as ‘the other balise’ and assigned to position 1 (N_PIG=1).

11.5.1 ASDO Reference Balise and Reference Balise marker Plaque

The ASDO reference balise is used to maximise the number of doors which can be opened at a platform and is placed closest to the stopping location.

An ASDO reference balise marker plaque is placed at the platform vertical face to enable accurate re-installation during the asset life cycle. ASDO reference balises shall be maintained in a position accurate to the designed position as shown in Table 1, inclusive of rounding errors, for the life of ASDO.

Refer to the Alstom ETCS Trackside Maintenance Manual MN S 41604 for further details of the ASDO reference balise marker plaque.

11.5.2 ASDO Platform Limit marker Plaque

ASDO platform limit marker plaques are fitted at each ASDO fitted platform. The purpose of the plaque is an on-site indicator of the design position for the design target location, when the target location is on a platform (e.g., end of usable platform limit). The term "fence" is often used for the purpose of describing the infrastructure defining the usable limit of platform (barriers). Not all usable platform limits are defined by actual fences, and at some locations the barrier may be a line on the platform, a wall, or the end of the horizontal coping. Positional information is contained in the Site Certification Form (SCF) located in the circuit book.

The platform limit marker plaque is a metal plate engraved with an arrow and located on the horizontal face of the platform at the applicable end of the platform. The target location/reference asset position (limit) are defined by the arrow tip on the plaque. When a plaque is located at a barrier, such as a fence, the tip of the arrow normally indicates the measurement reference at the inside face of the barrier at platform surface level.

For emergency repairs where the ASDO reference balise marker plaque is missing, the closest ASDO platform limit marker plaque may be used for re-establishing the approximate position of the reference balise until the exact position of the replacement ASDO reference balise marker plaque can be ascertained by survey.

Sydney Trains Customer Operations Branch, Facilities Maintenance is responsible for maintenance of the platform limit marker plaques and car markers.

Refer to the MN S 41604 for further details of the ASDO platform limit marker plaque.

11.6 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 or ALGIZ10)
- 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.

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12 Balise and Encoder Programming and Test Tool (BEPT)

12.1 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*.

Prior to any programming activities and after erasing BEPT mission data, the BEPT shall be rebooted to ensure any CRC left on the BEPT's volatile memory has been erased.

The BEPT shall not be left on top of a balise within the four foot during passage of a train.

The BEPT shall be considered as a sealed unit and shall not be opened by the user for any reason.

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.
- Base software version.
- 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 forward Principal Engineer Signal Systems.

Balise or LEU configuration key data, or missions shall not be kept stored in the BEPT, as referenced in Section 13 of this procedure.

BEPT calibration is not required.

12.2 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.

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12.3 BEPT Application Software

The BEPT Core utilises a proprietary base software that includes the operating system. A backup of the software is provided in the BEPT 'USB Booting Key'.

BEPT USB Booting Keys shall have the latest compatible TfNSW/Sydney Trains approved base software.

BEPT serial numbers prior to 557 were supplied with a USB Booting Key with software version 3.7.2_DUO2. This version is not compatible with BEPTs with a serial number of 557 or higher.

BEPT serial numbers 557 and later are supplied with a USB Booting Key with software version 3.7.3_DUO2. Being backwards compatible it is also suitable for BEPTs with serial numbers prior to 557.

Note:
Due to hardware limitations with BEPTs having serial numbers prior to 215, the BEPT will display version 3.7.3_Duo1 software whilst BEPTs with serial number 215 and greater will display 3.7.3_Duo2. There is no difference between the Duo1 and Duo2 to the operator apart from the display.

13 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 ETCS L1 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.

13.1 Management of Data Files

The ETCS L1 data is managed by ESI, Signalling and Control Systems.

ETCS L1 data files include LEU configuration key and balise data files, missions, ETCS Data Release Notes, ETCS Installed Data Forms, ETCS Tables and Balise Plans.

Processes for the management of ETCS L1 data control and configuration within the Sydney Trains network are detailed within *PR S 45005 ETCS Data Storage and Access*. Data selection decision flowcharts are provided to guide maintainers and ICON Infrastructure for various scenarios.

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14 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.

14.1 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.

14.1.1 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 it 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.

14.1.2 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.

14.2 Effect of Variations in LED Lamp Current Draw

14.2.1 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.

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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.

14.3 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.

15 Equipment Removed from Service

Failed balises, LEU power supplies, LEUs and RS900 modems should be returned to the manufacturer or their authorised agent as required, for warranty assessment and failure analysis.

LEU's are able to recovered from the inhibited "fused" state and logs extracted by the manufacturer or their agent.

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 where applicable) 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.
- 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.

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15.1 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.

15.2 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.

15.3 LEU Configuration Key

Where an LEU configuration key is recovered for potential re-use, additional care must be taken as it can only be overwritten, 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.

15.4 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.

16 Forms for ETC 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.

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Appendix A Sample Forms

PR S 40028 FM01 Balise Replacement Testing (ETCS M1)

Transport Sydney Trains NSW

PR S 40028 FM01
Balise Replacement Testing (ETCS M1)

SAMPLE

PART A

Completed By:		**Date:**	/ /	**BEPT Serial No:**		
Location ID		**Line Name**		**Signal Name**	If applicable	
Installation Tests				**Balise PIG:**	0/1	
Serial Number / Version (Revision)				V XXXXX	X	
Balise ID Plate (on Balise)						
Balise Location ID Plate (on Sleeper)						
Horizontal distance from balise side to rail (in each corner) are equal +/- 10mm (direct fixed balises only).					**OK**	☐
Vertical distances from top of the balise to highest part of the rail are equal +/-10 mm (direct fixed balises only).					**OK**	☐
Not closer than 2.3m (3.6m at guard rails) to another balise					**OK**	☐
No other cable within 1000 mm (400 mm for Alstom) of Balise.					**OK**	☐
Where Balise Location ID Plate is missing, measure & record distances from As Built SCF reference asset.				Asset 1 Distance		
Tick "OK" for balise location within permitted tolerance (+/-600mm for ATP and +/-350mm for ASDO Reference Balise)					**OK**	☐
Tick "OK" for ASDO BG supplementary ID plate - platform number & end of platform correct					**OK**	☐
If direct fixed to sleeper check side BRM is 93 mm – 193 mm from top of rail.				Details	**OK**	☐
Mounting Type (circle mounting type):		Universal Beam / eClip / FastClip / Direct / Guardrail installation				

Note: Only 1 balise should be removed and replaced at any one time unless necessary in support of track works

PART B

	Balise Programming		
	Programming performed? (If no go to testing in Part C)	Y/N	
Prog.	Configuration file name including Version (#_#_#)		#_#_#
Prog.	Programming mission executed successfully (from BEPT)	**OK**	☐
Verifier	Verification mission executed successfully (from BEPT)	**OK**	☐
Verifier	Write CRC (from BEPT)	XXXX XXXX	
Verifier	Request Validator to confirm CRC and file Version match and record the response	Yes / No	
Verifier	If match confirmed, write CRC and file Version (#_#_#) from Validator	XXXX XXXX	#_#_#

☐ **Tick "OK" for each test or check completed successfully**

PART C

	Balise Telegram Testing		
Verifier	Country Code (NID_C)	Default	Connected
Verifier	Balise Group ID (NID_BG)	Default	Connected
Verifier	Position in Group (N_PIG)		
Verifier	Message counter (M_MCOUNT)	Default	Connected
Verifier	File Name Matches Balise ID Plate information	**OK**	☐

Note: For a controlled balise, readings from the BEPT should be taken with the cable disconnected and again with the cable connected.

PART D

***Programmer**	Name	Signature	/ /
Verifier	Name	Signature	/ /
***Validator**	Name	Signature	/ /

Note: *Only required if programming has occurred

- Maintenance activities - copy of form to be sent to the maintenance signal engineer.

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Version 1.1

PR S 40028 FM02 LEU Replacement Testing (ETCS M2)

Transport Sydney Trains NSW

PR S 40028 FM02
LEU Replacement Testing (ETCS M2)

Part A - Installation

Completed By:		**Date: / /**	**BEPT Serial No:**
Location ID:	**Signal Name:**		**LEU ID:**
LEU Serial No. X______	**LEU Hardware Version:**		**LEU Software Version:**
LEU Configuration Key tether cord length 190mm (+/- 10mm)			**OK** ☐
LEU Configuration Key secured (screws not loose)			**OK** ☐
LEU Hardware and Software is approved version			**OK** ☐
LEU Vital Plug Coupler(s) secured (screws not loose)			**OK** ☐

☐ Tick "OK" for each test or check completed successfully

PART B - TESTING

NID_C	NID_BG	N_PIG	M_MCOUNT

Enter values read from BEPT shown on "Current Telegram Reading" screen

Proceed Aspect	State (ON/OFF)	Mode	Fault (Yes/No)	Current (mA)	Signal Name
Lamp 1					
Lamp 2					
Lamp 3					
Lamp 4					
Lamp 5					
Lamp 6					

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.

Where two balises are connected to one LEU, or more than two LEU's exist at the location, LEU output to the balise output cable correlated	**OK** ☐
LEU Clock Set	**OK** ☐

☐ Tick "OK" for each test or check completed successfully

PART C- Certification

Certified by	Name	Signature	/ /
Maintenance Signalling Engineer	Name	Signature	/ /

This form is to forwarded to the maintenance signal engineer for review and filing

SAMPLE

PR S 40028 FM03 Configuration Key Replacement Testing (ECM 3)

PR S 40028 FM03
Configuration Key Replacement Testing (ETCS M3)

Completed By:	**Date:** / /	**BEPT Serial No:**
Location ID:	**Signal Name:**	

			LEU A		LEU B (Look-Ahead)	
PART A - Programming	**Prog.**	**LEU ID**				
		Configuration file name including Version (#_#_#)		#_#_#		#_#_#
		Programming mission executed successfully (from BEPT)	**OK** ☐		**OK** ☐	
	Verifier	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**

PART B - Testing	**ETCS Input Correspondence Testing**													**From BEPT**			
	Aspect	**LEU A**						**LEU B (Look-Ahead)**						NID_C	NID BG	N_PIG	M_M Count
		1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**				

Enter values from BEPT 'Calibration Table Reading' screen: 0 Low; I High; ⁎ Flashing; X Don't Care; or FAULT

Note - All aspects designed for the configuration key need to be tested and compared with the values shown in the as-built circuit book control table.

Part C - Certification	**Programmer**	Name	Signature	/ /
	Verifier	Name	Signature	/ /
	Validator	Name	Signature	/ /
	Maintenance Signalling Engineer	Name	Signature	/ /

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Page 1 of 1
Version 1.1

SAMPLE

PR S 40028 FM04 ATP Power Supply Maintenance Testing (ETCS M4)

Sydney Trains

Engineering System Integrity
PR S 40028 FM04
ATP Power Supply Maintenance Testing (ETCS M4)

Completed By:		Date:	/ /	Multimeter Serial No:	

Location ID		LEU ID		MIPS200 Serial No.		MIPS200 Hardware Ver.	

MIPS200 Power Supply Testing					
	Signal /LEU	Voltage Measured	Acceptable Range	Volts to Earth Active/Positive	Volts to Earth Com./Negative
Input 120Vac (No Load)		V a.c	96/132 V a.c	V a.c	V a.c
Busbar 120Vac (Lights etc.)		V a.c	96/132 V a.c	V a.c	V a.c
PSU 1 Output (No Load)		V d.c	24 V d.c (+/- 5%)	V d.c	V d.c
PSU 1 Output (Loaded)		V d.c	24 V d.c (+/- 5%)	V d.c	V d.c
PSU 2 Output (No Load)		V d.c	24 V d.c (+/- 5%)	V d.c	V d.c
PSU 2 Output (Loaded)		V d.c	24 V d.c (+/- 5%)	V d.c	V d.c
PSU 3 Output (No Load)		V d.c	24 V d.c (+/- 5%)	V d.c	V d.c
PSU 3 Output (Loaded)		V d.c	24 V d.c (+/- 5%)	V d.c	V d.c

NOTE: In the 24 V circuit, the negative is connected with the earth (design of the equipment)

Contact Sensing (Toroidal Transformer) Power Supply Testing			
Toroidal Transformer ID:	Volts (Vac)	Acceptable Range	Current (mA)
Input 120 V a.c (No Load primary)		96-132 V a.c	
Busbar 120 V a.c (on load)		96-132 V a.c	
Transformer Secondary 1 (12 V a.c)		10.6-15.7 V a.c (8.5:1 ±5%)	
Transformer Secondary 2 (12 V a.c)		10.6-15.7 V a.c (8.5:1 ±5%)	
Transformer Current Balance		Currents within 10% (of each other)	OK / Not OK

Remarks:

Tester	Name	Signature	/ /
Maintenance Signalling Engineer	Name	Signature	/ /

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Date in Force: 26 September 2022
Page 1 of 1
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SAMPLE

Engineering Procedure
Signalling and Control Systems

Signalling Safeworking

PR S 40029

Point Lock Testing – Mechanical

Version 1.1

Date in Force: 21 September 2016

Procedure

Transport Sydney Trains

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NSW GOVERNMENT

Approved by :	George Gadzuric Professional Head Signalling and Control Systems Signalling and Control Systems	Authorised by:	Michael Kemmis Asset Standards Manager Systems Assurance

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Document control

Version	Date	Author/Prin. Eng	Summary of change
1.0	16 September 2013	Y Bagaric	First issue as a Sydney Trains document
1.1	21 September 2016	Colin Darmenia	Updated to ASA Standards

Summary of changes from previous version

Summary of change	Chapter
Terminology change from F.P.L. to Point Locks (consistent with power operated points)	All
Prerequisites added, Wide Cut Lock Slides added, Derail reference added	1.1, 1.3, 3.0
Type D point lock adjustment added	2.2

Table of Contents

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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 70*4 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 70*4*.*

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).

- For the trailing only switch – the point lock is to be adjusted so the lock enters with a switch opening of 4.8 mm and must 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 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.*

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Engineering Procedure
Signalling and Control Systems

PR S 40030

Point Lock and Detection Testing on Power Operated Points

Version 1.2

Date in Force: 14 February 2017

Procedure

Transport
Sydney Trains

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NSW
GOVERNMENT

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Document control

Version	Date	Author/Prin. Eng	Summary of change
1.0	16 September 2013	K Bush	First issue as a Sydney Trains document
1.1	21 September 2016	B Howell / C Darmenia	Updated to ASA standards and Engineering Instructions
1.2	14 February 2017	C Darmenia	Update Sections 3.2 & 3.5

Summary of changes from previous version

Summary of change	Chapter
Clarify when ohms setting is used in detection testing	3.2
Include open position switch detection limit on single bladed catchpoints and independent points in the open position (relocated from Section 3.5)	3.2
Change to section title and requirements for increasing detection settings on trailing-only points and catchpoints	3.5

Table of Contents

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 S*ignal 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 S*ignal 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 (ie 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.

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Engineering Procedure
Signalling and Control Systems

Signalling Safeworking

PR S 40031

Maintenance of Signal Sighting and Signals

Version 2.0

Date in Force: 1 June 2021

Procedure

UNCONTROLLED WHEN PRINTED

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Document control

Version	Date	Author/ Prin. Eng.	Summary of change
1.0	16 September 2013	Garry Ware	First issue as a Sydney Trains document, rebranded from previous RailCorp TMG J031
1.1	11 November 2014	Mohammed Khan	Added requirements for Treating Issues Associated with Excessive LED Signal Brightness as per EIS 02/10
1.2	21 September 2016	Rhoel Del Rosario	Updated to mandatory ASA requirements and titles & roles updated.
2.0	1 June 2021	C De Sousa / C Darmenia	Scheduled 3 year review

Summary of changes from previous version

Summary of change	Chapter
Deleted Appendix A	-
Update form references to include *PR S 47117 Inspection and Testing of Signalling: Standard Forms*	3
Updated form reference from TMG E1590 to MN S 41590	9
Deleted reference to Appendix A	10
Updated names and titles of approving authorities on page 2	-

Table of Contents

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 shall 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 shall 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 shall 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 shall 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 shall 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 leaving a signal that has been accessed, licensed signalling personnel shall check that the doors are securely closed and locked.

The back of a colour light signal shall 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 shall 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 shall 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 shall 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 shall 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 shall preferably be done in collaboration with a lead train crewing representative, providing an opportunity to obtain their perspective whilst enabling effective liaison.

Running signals shall be checked every 26 weeks on passenger main lines and 52 weeks on non-passenger lines.

The lights displayed by mechanical signals shall 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 this has not provided sufficient control, maintenance signal engineers are to liaise with Signalling Technical Section for guidance.

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 shall use the Signal Sighting Checklist to assist in the completion of the Signal Sighting Form. *(Signal Sighting Checklist and Forms are included in SPG 0711.7 / PR S 47117 Inspection and Testing of Signalling: Standard Forms).*

4 Signs

Signs referred to in this section pertain to signage as shown on a Signalling Plan or Working Sketch.

Signs shall be inspected periodically in accordance with the signalling technical maintenance plan to ensure the wording remains in accordance with the signalling design.

Signs shall be regularly cleaned and inspected for: damage, legibility and clear sighting.

Signs shall 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 shall be checked for colour fade and retro-reflective signs shall 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 shall be regularly cleaned. Since many lenses are made of plastic, water with soap or mild detergent only shall 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 shall be appropriately packaged or wrapped against damage.

Lenses shall 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 Signalling Technical Section approved graffiti removal product may be used.

Where lenses are regularly subjected to graffiti attack, a Signalling Technical Section approved graffiti protective coating may be applied.

5.1 Incandescent Lenses

Outer lenses of colour light signals shall 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 shall 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 shall 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 shall be replaced by the same type and care shall 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 shall be reported in accordance with the failure reporting procedures and the defect promptly rectified.

Care shall 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) shall be a good fit in the holder and properly seated with the main filament at the focal point of the lens. Multi-filament lamps shall be inserted in the holder so that the main filament is normally illuminated. It shall also be checked that on breaking the main filament circuit, that the auxiliary filament is illuminated.

When replaced, new lamps shall be observed to light up before being left in service.

New lamps shall 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 shall 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.

Lamp Rating	**Maximum**	**Minimum**
	Voltage	Voltage
10 Volt 5 Watt	9. 7 v	9.4 v
10 Volt 11 Watt	9. 7 v	9.4 v
10 Volt 13/3.5Watt	9. 7 v	9.4 v
10 Volt 18 Watt	9.5 v	9.0 v
10 Volt 18/3.5 Watt	9.5 v	9.0 v
10 Volt 25 Watt (Level crossings)	9.7 v	9.4 v
12 Volt 2/2 Watt	10.7 v	9.0 v
12 Volt 24/24 Watt	11.7 v / 11.5 v*	11.3 v / 11.1 v*
12 Volt 24/24 Watt (Subsidiary and Marker lights)	10.7 v / 11.3 v^{+}	10.2 v / 11.1 v^{+}
12 Volt 36 Watt	11.2 v	10.7 v
12 Volt 36 Watt (Subsidiary lights only)	10.1 v	9.5 v
120 Volt 15 Watt	Bus Bar Volt	
130 Volt 60 Watt	Bus Bar Volt	

Table 1: Lamp Rating

* 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 shall be reported in accordance with the failure reporting procedures and the defect promptly rectified.

LED modules shall 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 shall be managed for change-out.

LED modules for level crossing shall display no less than 75% of the applicable individual LEDs contained within the module or otherwise they must be promptly replaced.

Care shall 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 shall be checked.

When a LED module is replaced or wiring has been altered and circuit proving is employed in that circuit, the current shall be checked and the proving circuit shall be checked for functionality by breaking the circuit to the lit LED module. Aldridge type LED modules used with QSR3 circuit proving relays shall be checked by testing according to the published guidelines for Aldridge LED modules.

Replacement LED modules shall 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 Technical Section for further advice on the matter.

8 Mechanical Signals

The cleaning of lower quadrant mechanical signals shall be attended to by licensed signalling personnel. It is essential that a thoroughly efficient light be maintained in all signals. Licensed signalling personnel shall 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 shall be reported for further action.

The signal operating structure, including its signal wire length and supports, shall 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 shall be checked to ensure they remain clear of the structure gauge.

The back-spectacle shall be adjusted to enable the back-light to be seen only when the signal arm is horizontal.

Signal arms, particularly the enamelled type, shall be kept clean and bright. Any grime should be removed as necessary by the application of cleaning compound and water.

Licensed signalling personnel shall 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, shall 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 shall 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 shall be made to *MN S 41590 Signal Structures – Examination and Maintenance*.

Maintenance frequencies shall be in accordance with the relevant Technical Maintenance Plan (TMP).

10 Inspections Forms

Inspection forms are only required to be compiled as an exception where an inspection has initiated a rectification action of the signal structure.

The following forms are available for download from the Sydney Trains intranet and internet websites.

- PR S 40031 FM01 Ground Mount Structures Structural Assessment Records
- PR S 40031 FM02 Gantry Cage Mounted Signal Equipment Structural Assessment Record

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

Procedure

Transport
Sydney Trains

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NSW GOVERNMENT

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Document control

Version	Date	Author/Prin. Eng	Summary of change
1.0	16 September 2013	Y Bargaric	First issue as a Sydney Trains document
2.0	1 July 2015	Colin Darmenia	Inclusion of Smartlock requirements
2.1	September 2016	R. Del Rosario	Updated to new titles & roles and ASA mandatory requirement
2.2	8 March 2019	C. Darmenia	Inclusion of ATP / ETCS

Summary of changes from previous version

Summary of change	Chapter
Include ATP abbreviations used in this document	2
Include disconnection requirements on signals with associated ETCS equipment.	6.3.1
Precautions for disconnection of ETCS Equipment associated with TFM lamp circuits	6.3.3

Table of Contents

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.

2 Glossary

2oo2	Two-out-of-Two channel configuration, i.e. 2 channels available from 2 fitted channels.
2oo3	The 2oo3 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 3oo3
ATP	Automatic Train Protection
CISR	Central Interlocking Status Record
CIXL	Central Interlocking (central computer used within Smartlock 400T system and based on the standard 2oo3 platform)
DLI	Data Link Interrogator
DLM	Data Link Module
DLTG	Data Link Telegram Generator
EAU	Ethernet Adaptation Unit
ESD	Electrostatic Discharge
ETCS	European Train Control System
FE	Front End (part of the TFMGW connected to the CIXL)
GW	Gateway (part of the TFMGW connected to the TDL)
HMI	Human Machine Interface
HSCU	High Speed Communications Unit
IDNET	Internal Data Network
IMNET	Internal Maintenance Network
IXL	Interlocking
KVM	Keyboard Video Mouse
LDT	Long Distance Terminal
LEU	Lineside Electronic Unit
LRU	Line Replaceable Unit
MM	Memory Module
MPM	MultiProcessor Module
MPU	Main Processing Unit
NVRAM	Non-Volatile Random Access Memory
NTP	Network Time Protocol
PM	Points Module
PPM	Panel Processor Module
PSU	Power Supply Unit
REDMAN	Redundancy Management
SM	Signal Module
SML400T	Smartlock 400T System
SSI	Solid State Interlocking
SSER	Support Server
SSYS	Support System
TDL	Track Side Datalink
TFM	Trackside Functional Module
TFMGW	TFM GateWay
TICC	Trackside Interface Communication Cubicle
TT	Technicians Terminal
USB	Universal Serial Bus
VIXL	Virtual Interlocking
XAU	eXtended Adaptation Unit

3 Types of Module/Cubicles

SSI utilises the following modules:

MultiProcessor Module	MkII & MkIII
Memory Module	MkII & MkIII
Panel Processor Module	MkII
Long Distance Terminal	MkII
Data Link Module	MkII, MkIII & MkIIIA
Signal Module	MkII & MkIIIA
Points Module	MkII & MkIIIA

Smartlock 400T System comprises of the following

Cubicle	Subsystem	Subcomponents/details
CIXL Cubicle	I/O Sub system	XAU, EAU, I/O PSU
	Computing Subsystem	MPU, HSCU, REDMAN, Channel PSU, USB keys A/B/C with IXL Application data
	Maintenance panel	ID plugs for computing channels
	Fan Units	Above and below the computing channels
	Switches and Fuses Panel	
	I/O Panel	Plugs and connectors
	Main inlet panel	Segregated power input from UPS
	Main Power Supply unit	
TICC Cubicle	TFM Gateway	Front End, FE rack PSU
		Gateway, Gateway configuration Key, Gateway PSU
	LDTs	MKII
	Gateway Switches and Fuses	
	D - Sockets	To connect FEs and GWs
	I/O Sockets	Plugs and connectors
	Power inlet panel	Segregated power input from UPS
	Power Distribution Rail	MCBs for LDTs
Support System Cubicle	Support Servers	Industrial PC servers
	KVM Switch	Keyboard, Video, Monitor
	Client Gateways	Local client gateway PCs, Remote client
	Time server	GPS clock
	LAN Switches	IDNET, IMNET
	Power Strips	Power outlets for SSYS Equipment

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.

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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 CIXL has duplicated main PSUs. If necessary, the CIXL 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 CIXL to shut down and hence should be avoided.

During operation of CIXL, 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 CIXL 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 CIXL 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 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 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 FEs, 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 approximately10 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.
3. Power off the Computing Channels A, B and C through front panel switches.
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 TFMs, 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.

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.

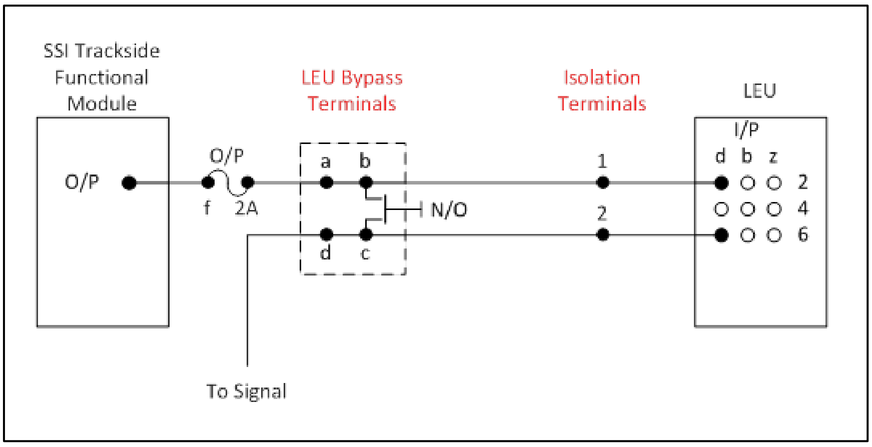

Figure 1 Current Sensing Arrangement

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'.

- PM. 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.

Note: DLMs, signal and points modules are moving towards higher types, MkII to MkIII etc., due to improved reliability.

The numbers of spare SSI equipment held is a logistics issue and will be determined by the local Signal Maintenance Engineer.

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

Report No.: ____________________ **Control Centre:** ____________________

District: ____________________

What Interlocking is equipment connected to:

____

____

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

Time of Failure: ____________________ Date of Failure: ____________________

Tech. Terminal Fault Printout: ____________________

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 or what type of point machine: ____________________

  Which indications were alight on arrival at site:

  ☐ Power ☐ System ☐ Rx Data ☐ Points X ☐ Points Y

SAMPLE

- **Data Link Module**

  At which location: ____________ Which Data Link (A or B): ____________

  Manufacturer: ____________

- **Long Distance Terminal**

  At which location: ____________ Which Data Link (A or B): ____________

  Manufacturer: ____________

  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: / /

SAMPLE

Transport Sydney Trains

PR S 40032 FM02
Technician Terminal Controls Log

Control Centre: ________________________________

Interlocking Name: ________________________________

TIME & DATE	CONTROL APPLIED	BY WHOM	REASON FOR CONTROL	CONTROL REMOVED	BY WHOM	TIME & DATE

SAMPLE

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Page 1 of 1
Version 1.0

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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		
Subsystem/Equipment	**Failure?**	**Form attached**
CIXL	☐	☐
TICC	☐	☐
Support System / Network	☐	☐
Repair time		
Arrival time:	Date & time of fault clearance	
Active repair time:		

SAMPLE

PR S 40032 FM04

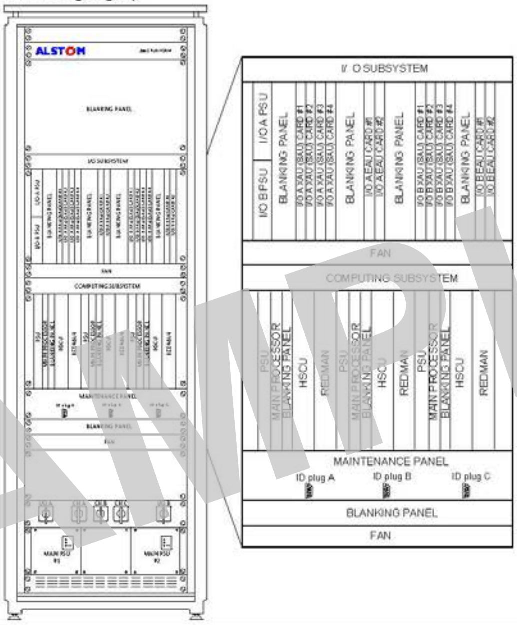
Smartlock 400T CIXL Failure Report

Date & Time:	CIXL Name:

Failed Items			
Part Number	**Serial Number**	**Mod**	**Symptom (if relevant)**

Failed Items Location

Identify Failed LRU location: (circle of highlight)



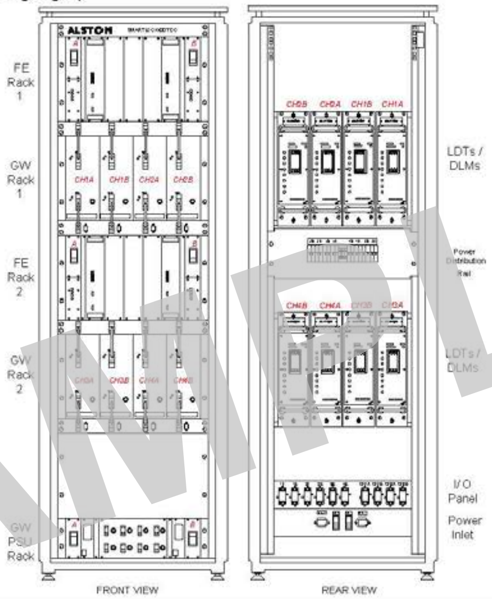
SAMPLE

Replacement fitted			
Part Number	**Serial Number**	**Mod**	**Symptom (if relevant)**

PR S 40032 FM05

Smartlock 400T TICC Failure Report

Date & Time:			TICC Name:
Failed Items			
Part Number	**Serial Number**	**Mod**	**Symptom (if relevant)**
Failed Items Location			
Identify Failed LRU location: (circle of highlight)			



SAMPLE

Replacement fitted			
Part Number	**Serial Number**	**Mod**	**Symptom (if relevant)**

PR S 40032 FM06

Smartlock 400T Support System Failure Report

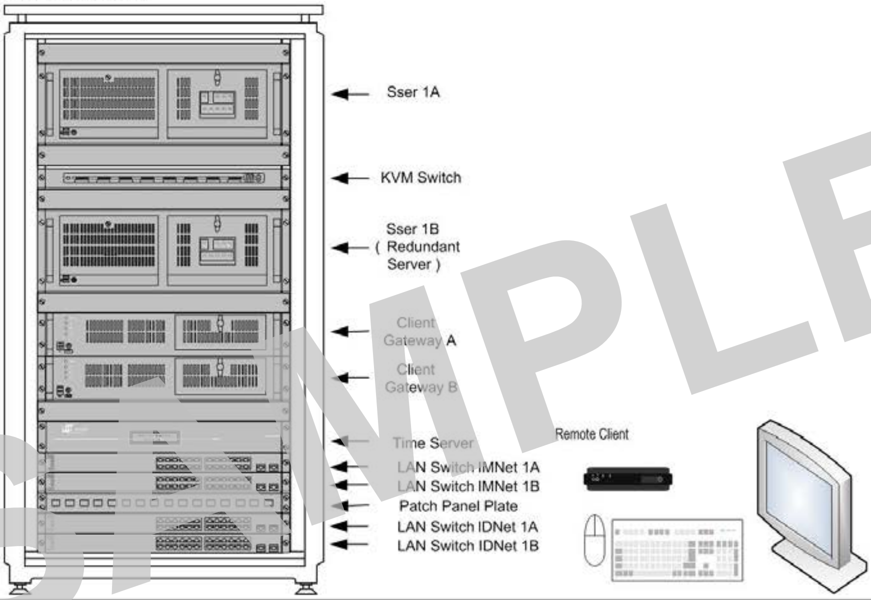
Date & Time:	Cubicle Name:

Failed Items

Part Number	Serial Number	Mod	Symptom (if relevant)

Failed Items Location

Identify Failed LRU location:



SAMPLE

Replacement fitted

Part Number	Serial Number	Mod	Symptom (if relevant)

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Version 1.0

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

Procedure

Transport
Sydney Trains

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NSW GOVERNMENT

Approved by:	George Gadzuric Professional Head Signalling and Control Systems Signalling and Control Systems	Authorised by:	Michael Kemmis Asset Standards Manager Systems Assurance

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Document control

Version	Date	Author/Prin.Eng	Summary of change
1.0	16 September 2013		First issue as a Sydney Trains document
1.1	21 September 2016	R. Del Rosario	Updated to mandatory ASA requirements and title & roles. Remove reference to Electric Train Staff.

Summary of changes from previous version

Summary of change	Chapter
Updated section 1 to ASA section 34. Key listing updated and added keys to be used for maintenance purpose only	1
Remove reference to Electric Train Staff	1, 2 & 2.1

Table of Contents

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 Alteration*s *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

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PR S 40034 FM01
Operational Safeworking Keys or Staffs Sent for Repairs or Alterations or Cancellation

Key/s No/s: ______________ Section: ______________
Type: ______________ Inscription: ______________

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**

____

SAMPLE

Sydney Trains

Engineering System Integrity
Engineering Procedure
Signalling and Control Systems

Signalling Safeworking

PR S 40035

Use of XL Keys, Master Keys and Staffs

Version 2.0

Date in Force: 13 March 2024

Prepared using: TP ESI 003 V2.0
Uncontrolled when printed

Approved by:	Professional Head Signalling and Control Systems Engineering System Integrity	Authorised by:	Engineering Technical Publications Manager System Integrity

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Document control

Version	Date	Author	Summary of change
1.0	16 September 2013		First issue as a Sydney Trains document
1.1	21 September 2016	R Del Rosario	Updated to mandatory ASA requirements and title & roles. Remove Section 3 and relocate to PR S 40007.
2.0	13 March 2024	A Sozio	Scheduled review. Added References section.

Summary of changes from previous version

Summary of change	Section
Added "References" section	1

OFFICIAL

Table of Contents

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1 Reference

- *PR S 40006 Manual Release of Interlockings*
- *PR S 40007 Seldom Used Signalling Equipment*
- *PR S 40008 Securing Signalling Apparatus Out of Use*
- *PR S 40009 Disconnection of Signalling Apparatus*

2 Master Keys and Master Staffs

2.1 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.

2.2 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 Manual Release of Interlockings*, *PR S 40008 Securing Signalling Apparatus Out of Use* and *PR S 40009 Disconnection of Signalling Apparatus*.

3 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.

3.1 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 Seldom Used Signalling Equipment* and PR S 40009.

3.2 Approval

XL keys used for signalling installation, maintenance, or renewal purposes shall only be issued to maintenance signal engineers by the Professional Head Signalling & Control Systems.

The maintenance signal engineer issued with a XL key is responsible for its safe custody, and except in the case provided for transfer, shall not allow the XL key out of their possession.

The Professional Head Signalling & Control Systems shall maintain a record of XL keys issued to maintenance signal engineers and hold in safe keeping XL keys returned by signalling personnel.

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3.3 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 Signalling 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 shall be obtained each time an XL key is transferred.

The maintenance signal engineer shall maintain a record, specifying the nature of the work and the period that the XL Key will be required. The maintenance signal engineer shall 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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Engineering System Integrity

Engineering Procedure

Signalling and Control Systems

Signalling Safeworking

PR S 40036

Level Crossings

Version 2.0

Date in Force: 29 August 2022

Approved by:	Professional Head Signalling and Control Systems Engineering System Integrity	Authorised by:	Engineering Technical Publications Manager System Integrity

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Document control

Version	Date	Author/Prin. Eng.	Summary of change
1.0	16 September 2013		First issue as a Sydney Trains document
1.1	21 September 2016	R Del Rosario	Update to mandatory ASA requirements and title and roles. See summary of changes below.
2.0	29 August 2022	Paul Zammit/Mohammed Khan	Add document reference section. Add detail for keeping level crossing forms. Clarify content and update to Asset Standards Style manual

Summary of changes from previous version

Summary of change	Section
Remove forms from procedure appendix; forms are now referenced in the procedure and downloaded as separate files from the website	All
Add document reference section (all subsequent sections thus incremented)	1
Add details for keeping level crossing location maintenance visit forms in Level Crossing location	3 3.1
Update content to clarify requirements (to read better)	All
Update content to Asset Standards Style Manual	All

Table of Contents

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1 Reference Documents

This procedure shall be read in conjunction with the following documents:

Signalling Safeworking Procedures

- *PR S 40004 Failures*
- *PR S 40008 Securing Signalling Apparatus Out of Use*
- *PR S 40009 Disconnection of Signalling Apparatus*
- *PR S 40010 Risks and Control Associated with Testing and Certifying Equipment*
- *PR S 40017 Maintenance Responsibilities and Frequencies*
- *PR S 40031 Maintenance of Signal Sighting and Signals*

Signalling Safeworking Forms

- *PR S 40036 FM01 Level Crossing Location Maintenance Visit Sheet*
- *PR S 40036 FM02 Signal Engineers Level Crossing Inspection*

Network Rules and Procedures

- *NGE 218 Type F Level Crossing Management*
- *NPR 716 On-site Testing of Type F Level Crossings*

2 Introduction

Level crossing protection systems and mechanisms shall be installed and maintained in accordance with signal design principles, level crossing equipment manuals, and Signalling Safeworking procedures.

The treatment of failures and signalling irregularities of level crossings shall be carried out in accordance with *PR S 40004 Failures*.

The securing and disconnection of level crossing protection equipment shall be carried out in accordance with *PR S 40008 Securing Signalling Apparatus Out of Use* and *PR S 40009 Disconnection of Signalling Apparatus.*

3 Maintenance and Inspection

The moving parts of boom gates and half boom barriers, including pedestrian boom gates, swing gates, and emergency gates shall 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 shall be balanced when installed and the balance shall not be altered unless an alteration has been made to the booms or fittings, or otherwise as determined from maintenance inspection or incident investigation.

In the case of AC electric type gate mechanisms, particular attention shall be given to the magnetic brake, and the armature shall be adjusted as necessary to compensate for brake shoe wear. The friction drive or clutch shall also be checked and adjusted as necessary.

Where automatic half boom barriers are provided, licensed signalling personnel shall observe for correct operation of the mechanism and check the operating time. Where the descending or ascending times are considered excessive, the situation should be reported to the maintenance signal engineer for investigation.

It is essential that good visibility of the warning lights and signs is available to all users of the level crossing. Licensed signalling personnel shall check the focus and intensity of

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such lights as part of their maintenance visit. This will necessitate viewing the lights and signs from approximately 100 m (or the maximum sighting distance if less than 100 m) on all road approaches to the level crossing.

Where the sighting of warning lights is affected by direct sunlight shining on the lens, then these shall be investigated thoroughly and the maintenance signal engineer notified to provide an appropriate solution. Any configuration change in this regard shall be approved by the Professional Head Signalling & Control Systems.

The operation and focus of Type "F" flashing lights shall be checked regularly, the lenses and reflectors shall be kept clean and replaced when scratched or tarnished, and lamps replaced as necessary. The voltage on each lamp shall be checked under operating conditions (with the main power supply isolated) to meet the recommended value at intervals not exceeding six months. See *PR S 40031 Maintenance of Signal Sighting and Signals* for more information.

Where warning lights are of the LED type, maintenance of these lights shall be in accordance with PR S 40031.

Where road signs at level crossings (that are positioned outside the railway boundary) become obscured, missing, or damaged, signalling personnel shall notify the relevant signal asset engineer in order for them to engage with stakeholders from the road authority to discuss the situation. Any such notification shall be noted on Form *PR S 40036 FM01 Level Crossing Location Maintenance Visit Sheet* and followed-up as necessary.

Form PR S 40036 FM01 shall be kept at each level crossing location. Tests and observations carried out each maintenance visit and events related to level crossing protection equipment shall be recorded using this form. This record shall be kept at the level crossing location.

3.1 Additional inspections

Licensed signalling personnel shall 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, booms and gates (as applicable).

Further to maintenance by licensed signalling personnel, maintenance signal engineers shall 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.

Form *PR S 40036 FM02 Signal Engineer Level Crossing Inspection* shall be compiled to record the inspection results undertaken by the attending signal engineer. This record shall be kept at the level crossing location.

This inspection shall be scheduled at no less than the following intervals for level crossings fitted with:

- lights and bells (no booms or gates), not remotely monitored and tested – 3 monthly
- lights and bells (no booms or gates), remotely monitored and tested – 6 monthly
- lights, bells, booms and/or gates, not remotely monitored and tested – 6 monthly
- lights, bells, booms and/or gates, remotely monitored and tested – 12 monthly.

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3.2 Upper quadrant signal mechanisms used to operate pedestrian boom barriers

Upper quadrant signal mechanisms on pedestrian boom barriers shall be used in the normal direction of rotation only, that is 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, then the unidirectional ratchet wheel will need to be reversed. 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.

3.3 Pedestrian swing gates

Maintenance of pedestrians swing gates shall be done in accordance with the tasks and frequencies prescribed in the applicable technical maintenance plan.

This includes checking of emergency exit gate facility operation and maintenance tasks.

At approximately five yearly intervals (depending on rail traffic density), the motor/gearbox assembly shall be removed and returned to the manufacturer for service.

3.4 Cantilevered flashing light signal posts

Where level crossing cantilevered flashing light signal posts are installed, a suitable maintenance contractor shall be engaged to rectify such lights as they become defective. The contractor shall 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 follows:

- The lights shall be inspected from the ground only.
- Cleaning of these lights shall be based on need, dependent of the ground inspection outcome.
- Structural maintenance is the responsibility of Sydney Trains Civil & Structures Engineering discipline.

The work shall be carried out under the supervision of licensed signalling personnel who shall 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 will 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 should also be conducted.

4 Investigating reports of power supply failure

Licensed signalling personnel shall immediately investigate any report of defect associated with the level crossing power supply. This is indicated by either an extinguished power supply indicator (PSI) lights, or an alarm generated by the remote monitoring device (where fitted).

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4.1 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 *NGE 218 Type F Level Crossing Management*.

This test shall 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 the operation of the test switch. See Section 4.1.2 if a test switch is not fitted. PSI lights shall 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 shall report to ICON Infrastructure the results of the above tests, defects identified and confirm that the PSI lights were observed to be on. ICON Infrastructure will record the test results.

A level crossing operation test shall also be performed by licensed signalling personnel during scheduled maintenance visits or whenever investigating reports of defective level crossing equipment, including power supply.

4.1.1 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. However, licensed signalling personnel shall perform the required tests during maintenance visits in accordance with the technical maintenance plan or when investigating reports of defects associated with the level crossing protection equipment.

Where the remote monitor and test device is not operating correctly, a daily test shall be performed as described in Section 4.1 until the remote monitor is again functional.

4.1.2 Level Crossings not fitted with test switches

At some level crossings where a remote monitor and test device are fitted, a test switch may not be installed. In these cases, licensed signalling personnel should first isolate the mains supply to the battery charger before activating the level crossing for the operation test. The manual operation switch will be used to activate the level crossing for two minutes.

PSI lights located inside the equipment location shall be observed to indicate normal supply during this test.

4.1.3 Reinstatement following maintenance

Fault or warning conditions, detected by a level crossing monitor shall be cleared before leaving the level crossing site.

Whenever level crossing lights are replaced or readjusted, the level crossing shall be operated for sufficient time to confirm that the level crossing monitor's lamp detection system (where fitted) is working correctly. See Section 5 for further information.

Before leaving the level crossing, licensed signalling personnel shall ensure that the level crossing protection equipment 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, including switch boxes and equipment housings, shall be left secured.

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Fault and warning indications displayed by the level crossing monitor or remotely reported by the level crossing monitor shall be investigated and rectified with appropriate urgency.

5 Remote Level Crossing monitors

The level crossing monitor system has a facility to prevent false alarms from reporting to its control centre when maintenance is carried out. The fault reset button shall be pressed and held until the LOGIC led starts to flash (about 5 seconds). This is done to temporarily disable the reporting of alarms and warnings. At the completion of maintenance activities, all fault and warning conditions raised by any of the maintenance actions shall be cleared and then the fault reset button shall be pressed to resume normal operation.

The maintenance disable feature times-out (nominally at 45 minutes); subsequently, 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 so they shall be cleared by maintenance staff in accordance with the level crossing monitor equipment manual.

Fault and warning conditions will not be cleared until the level crossing monitor has detected that the actual fault or warning condition has been rectified. Therefore, all lamps shall be operated 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. Where a lamp fault or warning occurs, the lamp learn procedure shall be carried out in accordance with the level crossing monitor equipment manual.

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Engineering System Integrity

Engineering Procedure

Signalling and Control Systems

PR S 40038

Microlok II Computer Based Interlocking

Version 2.0

Date in Force: 24 February 2022

Approved by:	Professional Head Signalling and Control Systems Engineering System Integrity	Authorised by:	Engineering Technical Publications Manager System Integrity

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Document control

Version	Date	Author/Prin. Eng.	Summary of change
1.0	16 September 2013		First issue as Sydney Trains document
1.1	21 September 2016	B Howell	Updated to EI S 15/03 requirements and title and roles.
2.0	24 February 2022	Mohammed Khan and Ata Mehmet	Scheduled 3 year review. Incorporated EI S 20-09 V2.0. Updated to AMB mandatory requirement V4.

Summary of changes from previous version

Summary of change	Section
Updated "References" section	2
Updated manufacturer name to Hitachi Rail STS	1, 2, 15, 15.2
Incorporate EI S 20-09 V2.0 Microlok II Duplicated System with Seamless Changeover	2 6.2.1 8.1
Enhance precaution on use of portable media devices such as USBs	5
Circuit design to be updated for Elsafe module replacement	7
Updated sections to AMB mandatory requirements V4 for restoring blocks and actioning of failed Diagnostic workstations	17.2, 20

OFFICIAL

Table of Contents

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1 Scope

The following instructions apply to Microlok II cardfile and Object Controller equipment manufactured by Hitachi Rail STS (formerly Ansaldo STS or Union Switch & Signal).

2 Reference Documents

The following documents are referenced and will need to be read in conjunction with this procedure:

- *PR S 40004 Failures*
- *PR S 40008 Securing Signalling Apparatus Out of Use*
- *PR S 40009 Disconnection of Signalling Apparatus*
- *PR S 40014 Control of Signalling Documentation Issued to the Field*
- *PR S 40023 Insulation Inspection and Testing*
- *PR S 40025 Track circuits*
- *PR S 40050 Control Systems*

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 6800C – Microlok II Integrated Vital Interlocking, Coded Track Circuit, and Non-vital Code Line Controller – System Startup, Troubleshooting, and Maintenance*
- *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.

For Microlok II Duplicated System with Seamless Changeover (MDSC) refer to the following manufacturer manuals:

- *SM 1D1.0027 – Microlok II Synchronization Printed Circuit Board (PCB)*
- *SM 1D1.0026 – Microlok II Communication Printed Circuit Board (PCB).*

Where there is conflict between this document and the Hitachi Rail STS documents, this document will take precedence. Discrepancies should be reported to the Professional Head Signalling & Control Systems.

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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 shall be returned to the manufacturer or their agent, for repair.

4 Handling and Storage

Boards and modules shall be handled, transported and stored with care and not subjected to damage or deterioration.

The boards and modules shall be stored on racks in enclosed housings in a clean, dry and non-corrosive environment below 60°C.

Anti-static protection handing procedures shall be applied when handling boards and modules.

5 Tools and Test Equipment

Tools and test equipment used on Microlok based interlocking systems shall 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 shall have an input impedance of 1 MΩ or greater for the voltage measurement.
- 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.
- External shunts are not to be fitted to test equipment when testing on input and output circuits.
- Multimeter current mode shall not be used when testing. Current measurements shall 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 shall not be used without the disconnection of the circuit.
- Test equipment inputs shall be floating; not referenced to a common potential.
- Multi-channel test equipment shall have all channels isolated from each other.
- Test equipment lead probes shall be chosen and applied such to minimise the likelihood of probes causing a short-circuit across an input.

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Third party devices such as USB sticks shall be checked to 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. Refer to PR S 40050 for guidance on use of portable media such as USB devices.

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 shall 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 **shall 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.

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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 shall 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 shall 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.

6.2.1 Microlok II Duplicated Systems with Seamless Changeover (MDSC)

The MDSC provides a hot standby arrangement with synchronisation of I/O using hardware and firmware in lieu of providing synchronisation via complex application logic. The original Microlok II hardware is used with a CPU card executive with a firmware version CC3.2 or later and the Synchronisation and Communication cards.

MDSC application logic requires version CC3.0 compiler and diagnostic tool or later. The "active" of each synchronised pair of Microlok units is designated as the Online unit with the other being the Offline unit.

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 shall 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 shall 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 shall be repaired.

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- 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 shall 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 shall be powered down using the B12 fuse or switch (if provided). N12 connections to the equipment shall 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 module is the approved and direct maintenance replacement for the type 216640 Elsafe module.

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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.

Changes to the module type are to be advised to the signal engineer to enable the updating of the circuit design as applicable.

8 Maintenance

Also refer to Section 8.1 for additional safeworking instructions specific to Microlok II Duplicated Systems with Seamless Changeover.

Scheduled maintenance is carried out as per the Technical Maintenance Plan schedule.

The system event log and system error log 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 in accordance with Section 6.4.

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:

Refer to Section 8.1.5to check the VCOR relay of an MDSC system.

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 shall 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.

8.1 Maintenance of Microlok II MDSC Systems

This section provides additional safeworking instructions specific to Microlok II Duplicated Systems with Seamless Changeover (MDSC).

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8.1.1 Competency and Training

Signalling personnel are considered competent to work on MDSC systems if they have successfully completed the MDSC training course in addition to an earlier (pre-MDSC) Microlok II training course.

8.1.2 Power-Up Delay Switch

The Power-Up Delay switch located on the front face of the Synchronisation card can set to SLOW or FAST. One Microlok unit is set to FAST and the other is set to SLOW, the former will become Online and the latter will become Offline if both units are simultaneously power cycled.

8.1.3 Quarantine Switch

The Quarantine switch located on the front face of the Synchronisation card can be set to YES or NO. Where one Microlok unit is set to YES it will trigger Online changeover to the partner Microlok II if it is not already Online and the quarantined unit is prevented from becoming Online again.

This switch can be used for maintenance purposes and shall not be left in the quarantine position unattended. If there is a fault in the Online system it will be unable to changeover to the Offline system and cause complete failure of the interlocking. The maintainer shall ensure the Quarantine switch is set to NO prior to leaving site.

Use of the Quarantine toggle switch is restricted to the following tasks:

- Fault finding and card replacement.
- VCOR functional test with Microlok master units.
- Uploading the executive or application logic for the installation.

Note:
For uploading new application logic to MDSC systems, refer to Section 8.1.7

8.1.4 Reset Push Button

A Reset push button is located on the front face of both the Synchronisation card and Communication card. This button will restart the card and trigger a changeover to the partner Microlok II if it is not already online. Assuming the system is not under any fault, the reset will not have an effect on the running railway. However, if the system is unable to changeover the interlocking will be unavailable for the time it takes for the card to restart (80 seconds for the Synchronisation card and 50 seconds for the Communication card).

Use of the Reset push button is restricted to resolving a suspected fault with the card.

8.1.5 VCOR Functional Check

To perform a VCOR functional check on a Microlok II MDSC system:

a. Confirm both Online and Offline system are not under any fault.
b. Set the Online system's quarantine toggle switch to YES.
c. Monitor the operation of the VCOR (and any repeat relays) and confirm the partner Microlok II becomes the Online unit.
d. Set the quarantine toggle switch to NO.
e. Observe the VCOR (and any repeat relays) energise.

f. Repeat steps b) to e) on the partner Microlok II unit.

g. Replace any VCOR (or repeat relay) if it does not drop away and pick up cleanly and then retest.

8.1.6 Failure of a Synchronisation Card or Communication Card

Corrective maintenance of Microlok II MDSC system components shall be limited to the correction of basic wiring, push button reset of cards or replacement of cards. As with all other Microlok cards, field repairs of Synchronisation or Communication cards shall not be attempted. These cards do not require programming of firmware for replacement.

Depending on the cause of failure and warranty period, faulty equipment is to be returned to Hitachi Rail STS as per current practice or properly disposed.

8.1.7 Uploading New Application Logic

Uploading of application data can be achieved with minimal impact on the running railway using the following procedure.

Note: This description assumes "Unit-A" is Online and partner "Unit-B" is Offline.

1. Confirm both Unit-A and Unit-B are not under any fault.
2. Place the Offline unit (Unit-B) into quarantine.
3. Power down quarantined unit (Unit-B).
4. Follow the manufacturer's documentation to prepare the CPU card programming jumpers for loading of application software. Power up Unit-B.
5. Using the Microlok tool, go to system configuration icon and enter password.
6. Update the variable ID (data version, cardfile number, interlocking number, Executive SW number (CC3.2)), IP addresses for Synchronisation and Communication cards (IP address can be found in the circuit book or DRF).
7. Place the Online unit (Unit-A) into quarantine. (The interlocking will be down at this point).
8. Release Unit-B out of quarantine.

WARNING
There will be a short period of time where the entire interlocking will be down until Unit B comes online.

9. Confirm Unit-B becomes Online and its VCOR relay has energised. This is to ensure the data upload is successful.
10. Power down quarantined unit (Unit-A).
11. Follow the manufacturer's documentation to prepare the CPU card programming jumpers for loading of application software. Power up Unit-B.
12. Using the Microlok tool, go to system configuration icon and enter password.
13. Update the variable ID (data version, cardfile number, interlocking number, Executive SW number (CC3.2)), IP addresses for Synchronisation and Communication cards (IP address can be found in the circuit book or DRF).
14. Release Unit-A out of quarantine.
15. Confirm Unit-A remains Offline and its VCOR relay has energised. This is to ensure data upload is successful.

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Note:
Unit modes will now be Unit-B Online and Unit-A Offline.

16. Place the Offline unit (Unit-A) to quarantine.
17. Power down Unit-A, and return the CPU card jumpers back to the non-programming position in accordance with the manufacturer's documentation.
18. Power up Unit-A.
19. Release the quarantine for Unit-A.
20. Repeat steps 16 to 19 for Unit-B.

Once all steps have been completed the unit modes should have returned to the original configuration of Unit-A Online and Unit-B Offline.

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 shall 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 investigated and actioned. The maintenance signals engineer is to be informed of outcomes.

11 System Failure and Initialisation

11.1 Initialisation

All N12 connections to a Microlok II cardfile or Object Controller shall 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.

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11.2 CPS Shutdown

A CPS (Conditional Power Supply) shutdown which shall 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. Refer to Section 6.4.

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 re-signalling 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.

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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 shall 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 shall 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 shall 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 shall 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 shall be notified of the CPU module replacement.

13.2 Signal Engineers

In the event of a CPU module failure, the replacement CPU module shall 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.

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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 shall 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 shall 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 shall 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 shall 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 shall 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 shall 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 Hitachi Rail 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 shall 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, refer to Section 6.4.
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 shall 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 shall 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 shall 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 WEBTOOL 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.

Note:

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 Hitachi Rail STS 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 bard. 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.

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- 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 shall 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 book out and disconnect signalling apparatus, the necessary Network Rules, and Network Procedures, for securing out of use PR S 40008 as well as the disconnection philosophy as stipulated in PR S 40009 shall 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-re-clear 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. In the event of a failure or replacement of a CBI workstation or CPU module it is essential that records are checked to ensure that any previously applied blocks that could have been lost (removed) as a result of the failure or replacement are reinstated.

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-re-clear 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.

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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 shall always be completely removed for a disconnection.

If the disconnections are to be left unattended, an isolation blue plug is to be applied over the links and the disconnections clearly labelled to prevent inadvertent reconnection. An Elsafe Blue Maintenance flag 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 mis-matching on the Microtrax module. The Microlok shall 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 shall 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.

Information derived from diagnostic workstations can be used as evidence when investigating serious incidents and signalling irregularities. Therefore, a failure of such equipment shall be promptly actioned and rectified.

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Engineering Procedure
Signalling and Control Systems

Signalling Safeworking

PR S 40039

Westrace Computer Based Interlocking

Version 2.0

Date in Force: 29 January 2019

Procedure

UNCONTROLLED WHEN PRINTED

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Document control

Version	Date	Author/ Prin. Eng.	Summary of change
1.0	16 September 2013		First issue as a Sydney Trains document
1.1	21 September 2016	R. Del Rosario	Updated to mandatory ASA requirements and title & roles.
2.0	29 January 2019	E Pace	Added Part B – Westrace II

Summary of changes from previous version

Summary of change	Chapter
Added part B covering requirements for Westrace II.	Part B

Table of Contents

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 60º 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 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.

6.2 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

VPIM	Vital Parallel Input Card
VROM	Vital Relay Output Module
VLOM	Vital Lamp Output Module
HVLC	Hot standby Vital Logic Card
HVLM	Hot standby Vital Logic Module
DM	Diagnostic Module
ICS	Integrated Configuration System
S2	System 2 Telemetry system capable of panel processing (Westinghouse)
EPROM	Erasable Programmable Read Only Memory

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 60º 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.

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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

Engineering Procedure
Signalling and Control Systems

Signalling Safeworking

PR S 40040

Use of Radio Transmitters Near Electronic Signalling Systems

Version 1.1

Date in Force: 21 September 2016

Procedure

UNCONTROLLED WHEN PRINTED

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Document control

Version	Date	Author/Prin.Eng	Summary of change
1.0	16 September 2013		First issue as a Sydney Trains document
1.1	21 September 2016	R. Del Rosario	Move 3.6 – Test Equipment into Section 3 - Precaution

Summary of changes from previous version

Summary of change	Chapter
Move 3.6 – Test Equipment into Section 3 - Precaution	3

Table of Contents

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;

Mode	Minimum Distance
Not in a call	3 m
Answering a call	3 m
Making a call	3 m
Once call is established	1 m

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.

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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

Procedure

Transport
Sydney Trains

UNCONTROLLED WHEN PRINTED

NSW GOVERNMENT

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Document control

Version	Date	Author/ Prin. Eng.	Summary of change
1.0	19 August 2013	Y, Bagaric	First issue as a Sydney Trains document
1.1	21 September 2016	R. Del Rosario	Updated title & roles and reference to Australian standard
2.0	12 June 2018		Updated Section 8.1
2.1	8 March 2019	C. Darmenia	Include precautions for ATP

Summary of changes from previous version

Summary of change	Section
New section for ETCS equipment and advice of electromagnetic radiation emitted by the aerial under ETCS fitted trains	23

Table of Contents

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:

Hazard	**Control Measure**
Electric shock due to contact with live terminals	Work in accordance with the SMS and guidance provided by Sections 3, 4, 5, 7, 8, 9, 10, 11 and 21 of this procedure.
Electric shock due to stored electrical charge	Work in accordance with the SMS and guidance provided by Sections 5.3, 9.4 and 9.5 of this procedure.
Arc, blast and flash injuries	Work in accordance with the SMS and guidance provided by Sections 3, 4, 5, 8 and 9 of this procedure.
Physical injury from equipment operation	Work in accordance with the SMS and guidance provided by Sections 4.4 and 13 of this procedure.
Toxic substances and gases from secondary batteries	Work in accordance with the SMS and guidance provided by Section 5.2 of this procedure.

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

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/yymmdd/n" where "ggggg" identifies the work area issuing the permit, "xx" is the initials of the person issuing the permit, "yymmdd" 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:

Hazard	**Cause**	**Control measure**
Foreign objects in eyes.	Compressed air travels at high speeds with great force, which can blow dust, grit, etc into eyes.	Safety Glasses. Ensure exhaust air and leaking air is directed away from people and objects it may reflect off.
Compressed air itself	High-pressure compressed air directed at the skin may break the skin and enter the blood stream.	Ensure exhaust air and leaking air is directed away from people and objects it may reflect off.
Noise	Compressors and exhaust air can be produce loud noise.	Hearing protection as required.
Burst or leaking hoses or connections	Damaged, or worn hoses and connections can fail resulting major air leaks blowing dust, grit, etc.	Inspections of hoses and connections. Use of correctly rated hoses and fittings.
Explosion of pressure vessels	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.	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.
Compressed air released from pressure relief valves	Pressure relief valves may vent exhaust air at any time.	Work is not to be done near pressure relief valves without protection against exhaust air.
Air filter bowl breakage	Physical damage causing broken glass, and compressed air leak.	Vigilance and care when working near Air filter bowls.

Hazard	Cause	Control measure
Equipment movement	Equipment operated by compressed air moves with both speed and force.	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.

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.

Electric shock hazard from:	Control Measure
Galvanised Steel Troughing between equipment locations.	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.
Cable ladders between equipment locations	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
Metallic pipes for Air Lines or cables between equipment locations.	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.
Metallic cable sheaths, or protective layers.	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.
Metallic cable sheaths or protective layers for Telecommunications cables.	Sheath is connected through and not earthed at Signalling Locations.
Metal fences.	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.
Multiple earth faults on the Signalling AC power	Maintain the signalling AC power as earth free.
Touch Potential on metal work in power rooms	Earth bonding of metal work to power earth.
Fallen Power lines	Visual inspection prior to entering location.
Overhead Wiring (OHW) structures	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.

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.

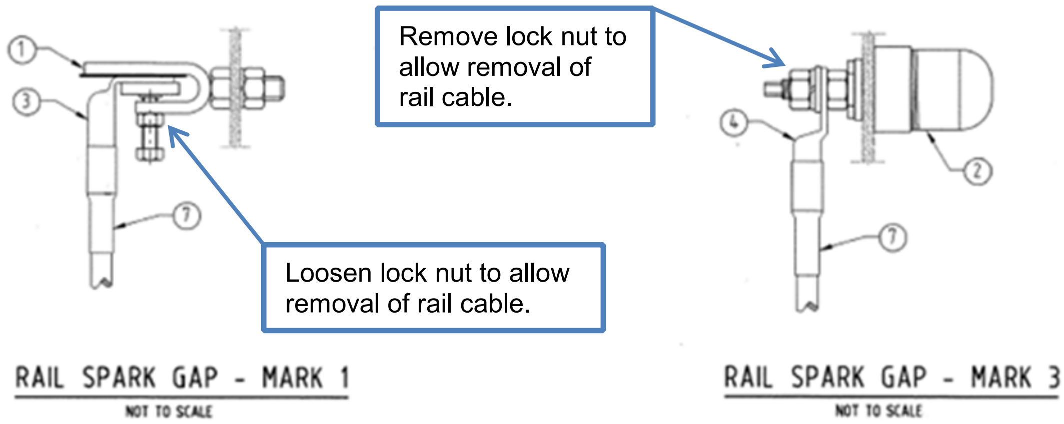

Diagram 1 – Methods of removing rail cable

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.

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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;

a) Use the ‘bypass’ function to make direct voltage readings without integration,

b) 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.

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- 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.

Sydney Trains

Engineering System Integrity

Engineering Procedure

Signalling and Control Systems

Signalling Safeworking

PR S 40044

General Signalling Maintenance Management, Administration and Supervision Responsibilities

Version 2.0

Date in Force: 28 March 2023

OFFICIAL

Prepared using: TP ESI 003 V2.0
Uncontrolled when printed

Approved by:	Professional Head Signalling and Control Systems Engineering System Integrity	Authorised by:	Engineering Technical Publication Manager System Integrity

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Document control

Version	Date	Author/Prin. Eng.	Summary of change
1.0	16 September 2013		First issue as Sydney Trains document
1.1	21 September 2016	R Del Rosario	Updated to title and roles and added roles to Section 1
1.2	8 March 2019	A Sozio	General update to document and inclusion o new roles for Control Systems
2.0	28 March 2023	A Sozio	Minor update to document

Summary of changes from previous version

Summary of change	Section
Added new section for reference documents	1
Updated title for Control Systems Supervisor	2

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Table of Contents

1 Reference documents

This procedure shall be read in conjunction with the following documents:

- *MN S 41412 Process for Signalling and Control Systems Personnel – Authorisations and Licensing*
- *MN S 41418 Signalling Safeworking Incident Investigation*
- *PR S 41419 Authority to Work on Sydney Trains Signalling Infrastructure – Permit to Work*

2 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
- Supervisor Control Systems
- Commissioning Engineers
- Asset Engineers
- Team Manager Signals
- Team Leader Signals
- Work Group Leader Signals.

2.1 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.

2.2 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.

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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, Technical Maintenance Plan (TMPs), Standard Operating Instructions (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 feed back 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.

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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 Signalling and Control Systems Personnel – Authorisations and Licensing*.

o. Signalling safeworking breaches or incidents by signalling personnel accessed according to *MN S 41418 Signalling Safeworking Incident Investigation*.

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.

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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.

v. The clean-up of material released and unserviceable and its appropriate disposal.

w. Keeping a specific record of all temporary repairs made and ensuring that permanent repairs are carried out without undue delay.

x. 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.

y. 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.

z. When there has been a change of wiring or circuits on any vital signalling controls ensuring that the new work is properly tested by licensed signalling personnel before it is commissioned into service.

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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Engineering System Integrity

Engineering Procedure

Signalling and Control Systems

Signalling Safeworking

PR S 40045

Surveillance Inspections

Version 1.2

Date in Force: 15 July 2021

OFFICIAL

Approved by:	Professional Head Signalling and Control Systems Engineering System Integrity	Authorised by:	Engineering Technical Publications Manager System Integrity

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Document control

Version	Date	Author/Prin. Eng.	Summary of change
1.0	16 September 2013		First issue as Sydney Trains document
1.1	21 September 2016	R Del Rosario	Updated to mandatory ASA & EI S 15/03 requirements and titles & roles
1.2	15 July 2021	I Maydew/C Darmenia	Updated to include axle counter requirements

Summary of changes from previous version

Summary of change	Section
General update to include equipment history cards	3

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Table of Contents

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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 feedback 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, equipment history 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.

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Engineering Procedure
Signalling and Control Systems

Signalling Safeworking

PR S 40046

Guidelines for the Safe Use of Temporary Recording, Monitoring and Logging Equipment on Signalling Systems

Version 1.1

Date in Force: 21 September 2016

Procedure

Transport
Sydney Trains

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Approved by:	George Gadzuric Professional Head Signalling and Control Systems Signalling and Control Systems	Authorised by:	Michael Kemmis Asset Standards Manager Systems Assurance

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Document control

Version	Date	Author/ Prin. Eng.	Summary of change
1.0	16 September 2013		First issue as a Sydney Trains document
1.1	21 September 2016	R. Del Rosario	Updated to title & roles and use of banana plugs for temporary unattended connections

Summary of changes from previous version

Summary of change	Chapter
Banana plugs or other types of probes intended for temporary unattended connections must be risk assess and approved by maintenance signal engineer	3.2

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Table of Contents

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_{peak} input channel to device power supply isolation
- 1000 V_{peak} input channel to earth isolation
- 1000 V_{peak} input channel to output isolation
- 1000 V_{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.

Signalling Circuit	Maximum Allowable Leakage Current
12 Volt DC	8 milliamperes DC
50 Volt DC	5 milliamperes DC
120 Volt AC	4 milliamperes AC

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 2.0

Date in Force: 27 January 2022

Procedure

OFFICIAL
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Approved by:	Mark Albrecht Professional Head Signalling and Control Systems Engineering System Integrity	Authorised by:	Aaron Manvell A/Engineering Technical Publications Manager System Integrity

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Document control

Version	Date	Author/Prin. Eng.	Summary of change
1.0	16 September 2013		First issue as a Sydney Trains document
1.1	21 September 2016	R. Del Rosario	Updated to TMG J047 v1.5 May 2013
1.2	14 February 2017	R. Del Rosario	Update to Section 7 – Calibration Requirements Table
1.3	7 January 2019	E Pace	Incorporate requirements of EI S 17/12 Multimeters approved for use with signalling infrastructure
1.4	27 January 2022	Ian Maydew/Colin Darmenia/Ron Heward	Update to Section 8 - Calibration Requirements Table Incorporate requirements of EI S 20-04 Incorporate requirements of EA S 18-03 Updated AMS numbering Updated to AXC counter requirement

Summary of changes from previous version

Summary of change	Section
Incorporate requirements of EA S 18-03	4
Updated AMS numbering	4
Items added and modified to Calibration Requirements Table	8
Incorporate requirements of EI S 20-04	8
Calibration Requirements for Monitoring & Measuring Equipment Used for Signalling Work updated to include axle counter test tools	8

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Table of Contents

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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

AS/NZS ISO 10012:2004	*Measurement management systems – Requirements for measurements processes and measuring equipment.*
Sydney Trains SMS-16-OP-3076	*Inspection, testing and Monitoring procedure v2.0*
Sydney Trains AMS-05-SOP-001	*Control of Monitoring & Measuring Equipment Operational Procedure*
Sydney Trains AMS-05-FRA-002	*Monitoring, Measuring, Analysis & Evaluation System Requirement*

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.

Multimeters not approved for use	**Multimeters approved for use**
Fluke 27 II	Fluke 27
Fluke 28 II	Fluke 70
Fluke 83 V	Fluke 76
Fluke 87 V	Fluke 83
Fluke 175	Fluke 83 III
Fluke 177	Fluke 85
Fluke 179	Fluke 85 III
Fluke 287	Fluke 87
Fluke 289	Fluke 87 III
Fluke 1587 Insulation Multimeter (can only be used as an insulation resistance tester)	Fluke 87 IV
	Fluke 89
	Fluke 89 IV
	Fluke 187
	Fluke 189
	Fluke 287/NUC
	Gossen Metrawatt M241A (Restricted to use on Thales axle counter system and with the Test Case)

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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 for the Control of Monitoring and Measuring Equipment (MME) are provided in *AMS-05-SOP-001 "Control of Monitoring & Measuring Equipment Operational Procedure"*.

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.

Fluke products that are shipped with a "Statement of Calibration Practices" are legally accepted by Fluke that calibration has been performed using traceable measurement standards. In these instances the asset owner is to complete the "For customer use only" form with the serial number of the instrument, date instrument received and date next calibration due (to be taken from the date of instrument received). The asset owner is to retain the "Statement" with their records as the initial calibration certificate for the device.

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.

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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

No.	Item and type	Application	Calibration Standard/Specification	Applicable Functional Test Range	Minimum accuracy for Sydney Trains Application	Calibration Frequency	Remarks
1	Multimeter (see Section 3)	General checking and fault finding	Manuf. Spec	All	N/A	N/A	
		Certification tests – signal lamps and power supplies	Manuf. Spec	AC volts 0-12 AC volts 0-120 DC volts 0-20	± 0.1 @ 50Hz ± 1 @ 50Hz ± 0.1 volts	3 Y	**Note 1**
		Certification tests – track circuits	Manuf. Spec	AC mA 0-300 AC mV 0-300 AC V 0-3 AC V 0-200 DC V 0-10 DC V 0-500	± 5mA@2KHz ± 5 @ 2KHz ± 0.1 @ 50Hz ± 1 @ 50Hz ± 0.1 ± 5	3 Y	**Note 1**
2	Tong/Clamp Ammeters AC and DC (Kyoritsu, and other approved models)	General checking and fault finding	Manuf. Spec	All	N/A	N/A	
		Certification Testing	Manuf. Spec	AC A 0-10 AC A 0-100	± 0.1 @ 50Hz ± 1 @ 50Hz	2 Y	
				DC A 0-10	± 0.1 @ 50Hz		
				DC A 0-100	± 1 @ 50Hz		
				AC V	As per multimeters		
				DC V			
3	Insulation Resistance Tester – 'Megger'	Measure insulation resistance	Manuf. Spec	Meg Ohms Output volts Output current into short cct	-0 @ 1MΩ 500/-0 @ 1MΩ <3mA	2 Y	

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No.	Item and type	Application	Calibration Standard/Specification	Applicable Functional Test Range	Minimum accuracy for Sydney Trains Application	Calibration Frequency	Remarks
4	Track circuit Pulse Integrator	General checking and fault finding	Sydney Trains	N/A	N/A	N/A	
5	TFA – Track Circuit Frequency Adaptor	General checking and fault finding	Sydney Trains	N/A	N/A	N/A	
		Periodic Maintenance checks	Sydney Trains	AC V 0-2 AC V 0-20	± 0.1 @ 1.7kHz ± 1 @ 2kHz	2 Y	
				AC V 0-20	± 1 @ 2.3kHz		
				AC V 0-20	± 1 @ 2.6kHz		
				AC V 0-20	± 1 @ BB		
6	FSM – Frequency Selective Meter	General checking and fault finding	Sydney Trains	N/A	N/A	N/A	
		Periodic maintenance checks/ Certification tests		AC V 0-2, 20, 200 AC V 0-2, 20, 200	± 0.1 @ 1.7kHz ± 1 @ 2kHz	2 Y	Tests for all ranges
				AC V 0-2, 20, 200	± 1 @ 2.3kHz		
				AC V 0-2, 20, 200	± 1 @ 2.6kHz		
				AC V 0-2, 20, 200	± 1 @ BB		
7	Track Shunt Tester – DN2000	Certification testing	Sydney Trains	N/A	-0 / +5%	4 Y	**Note 2**
8	Combination Insulation & Continuity Test Set	Measure insulation resistance	Manuf. Spec	Meg Ohms Output volts Output current into short cct	-0 @ 60MΩ 500 / -0 @ 1MΩ <3mA	4 Y	
		Continuity		Maximum Ohms	100 / +0	4 Y	
9	Continuity (Bell Test) Set	Continuity	Manuf. Spec	Maximum Ohms	100 / +0	N/A	
10	'Clancy' Rail Current Meter	General checking and fault finding	Sydney Trains	All	N/A	N/A	
11	'Ras Coil' Rail Current Transformer	General checking and fault finding	Sydney Trains	N/A	N/A	N/A	
12	Audio 'Clancy'	General checking and fault finding	Sydney Trains	All	N/A	N/A	
13	RelayPro/ Relay Doc/ Relay Doc Portable	General checking and fault finding	Manuf. Spec	N/A	N/A	N/A	
		Periodic and certification testing	Manuf. Spec	All	Manufacturer's Specification	1 Y	
14	Chart Recorder - Analogue	System monitoring	Manuf. Spec	All	Manufacturer's Specification	N/A	Manuf. Recom.
15	Chart Recorder - Digital	Event monitoring	Manuf. Spec	N/A	N/A	N/A	Manuf. Recom.

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No.	Item and type	Application	Calibration Standard/Specification	Applicable Functional Test Range	Minimum accuracy for Sydney Trains Application	Calibration Frequency	Remarks
16	Oscilloscope	General testing and fault finding	Manuf. Spec	All	N/A	N/A	
17	Oscilloscope /Meter Combination	General testing and fault finding	Manuf. Spec	All	N/A	N/A	Manuf. Recom.
		Measure critical levels	Manuf. Spec	all	Manufacturer's Specification	N/A	
18	Lightning Arrestor Tester	Test arrestors & varistors	Sydney Trains	Limiting volts Low scale High scale	± 20 V ±50 V	4Y	**Note 3**
19	Points Gauge	Check points adjustment	Sydney Trains	thickness	+ 0mm	N/A 1 Y	Inspect for damage
20	Trainstop Gauge	Check trainstop arm adjustment	Sydney Trains	dimensions	± 10mm (M04-022 – Trainstop Gauge for Setting Stoparm)	1 Y	Inspect for damage
21	Annett Key Gauge	Check Annett lock warding	Sydney Trains	N/A	N/A	N/A	
22	Torque wrench		Manuf. Spec	Torque - Nm	Manufacturer's Specification	N/A	Manuf. Recom.
23	Cable Locator		Manuf. Spec		Manufacturer's Specification	N/A	Manuf. Recom.
24	Measuring Wheel	Non-critical distance measurements	Manuf. Spec	metres	± 2%	1 Y	Inspect for wheel wear
25	Crimping Tool		Manuf. Spec	Tension test on sample crimps	Sigs Std Spec SPG 0707	1 W	**Note 4**
26	Axle counter testing plate	Occupancy test	Sydney Trains	N/A	N/A	N/A	Inspect for damage prior to use

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 arrestor tester using standard devices as reference.

Note 4: 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

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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.

The effectiveness of crimpers and die used for 300 mm2 cable lugs are to be checked by routinely measuring across the crimped flats on a lug with a Vernier calliper. The measurement shall be within the die size +/- 0.2 mm.

Manuf. Spec: Manufacture’s specifications (Always refer to Manufacturer’s specifications unless specified in PR S 40047 Safeworking Procedure)

Manuf. Rec: Manufacturer’s recommendations

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Engineering System Integrity

Engineering Procedure

Signalling and Control Systems

Signalling Safeworking

PR S 40048

Signalling Locations and Equipment – Security Locks and Keys

Version 2.0

Date in Force: 14 November 2023

OFFICIAL

Approved by:	Professional Head Signalling and Control Systems Engineering System Integrity	Authorised by:	Engineering Technical Publications Manager System Integrity

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Document control

Version	Date	Author	Summary of change
1.0	5 November 2014	S Rendell	First issue as a Sydney Trains document rebranded from previous RailCorp TMG J048
1.1	21 September 2016	R Del Rosario	Updated to mandatory ASA & EIS requirements and title & roles. See summary of changes below
1.2	8 March 2019	A Sozio	Inclusion of Control Systems requirement
2.0	14 November 2023	A Sozio	Remove ET200 key and minor formatting updates

Summary of changes from previous version

Summary of change	Section
Added "Reference" section	1
Removed "ET200 Track Circuit Set-Up and Configuration Key"	5
Removed reference to ET200 key	7.1 Table 4
Removed reference to ET200 key	7.2
Included sentence advising only Sydney Trains issued keys should be used on the Sydney Trains network	7.4
Updated Signalling competency procedures references	7.4 & 7.7.1
Updated title of section	8
Changed title from Major Signal Boxes to Control Centres in line with T HR SC 02000 ST Mandatory Requirements for Signalling Safeworking Procedures	11.3

Table of Contents

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1 References

This procedure shall be read in conjunction with the following documents:

Sydney Trains Competency Documents

- *MN S 41412 Process for Signalling and Control Systems Personnel – Authorisations and Licensing*
- *MN S 41418 Signalling Safeworking Incident Investigation*
- *PR S 41419 Authority to Work on Sydney Trains Signalling Infrastructure – Permit to Work*
- *RG S 41415 Signalling Personnel – Licensing and Authorisation Status*

2 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).

3 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.

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4 Old series signalling security keys

Typically, these keys are not in general use and shall therefore only be issued on a needs basis to signalling personnel as defined in Table 1.

Table 1 – Old Series Signalling and Safeworking Keys

Key	Signal Engineer	Signal Electrician	Signals Mechanical	Signals Ancillary	Signals Authorised Person
Best 7	Yes	No	No	No	No
Best 8	N/A	Yes	Yes	Yes	Yes
Yale 6	Yes	Yes	No	No	Yes
Yale 9	Yes	Yes	Yes	Yes	Yes
Yale R	Yes	Yes	No	No	No
SWI old	Yes	Yes	No	No	No
SWI new	Yes	Yes	No	No	No
Staff old	Yes	Yes	No	No	No
Staff new	Yes	Yes	No	No	No
STEL	Yes	Yes	Yes	Yes	Yes
PIM	Yes	Yes	Interlocking Fitter only	No	No
Corbin old	Yes	Yes	No	No	No
Corbin new	Yes	Yes	No	No	No

5 SL keys

SL keys are still in general use and may be issued to signalling personnel as defined in Table 2.

Table 2 – SL Keys

Key	Signal Engineer	Signal Electrician	Signals Mechanical	Signals Ancillary	Signals Authorised Person
SL	Yes	Yes	Yes	No	No

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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 3 – Falcon Series Keys

Falcon Series Number	Authorised Key Holder
1	Professional Head Signalling and Control Systems
2	Signal Engineer
4	Signal Electrician Signal Engineer Control Systems Engineers Control Systems Technician Licensed Signals Mechanical Licensed Signals Ancillary Signals Authorised Person
6	No longer in use
7	Not issued by Signals Discipline
8	Sydney Trains Apprentice Electrical Mechanic (from second year)
10	No longer in use
12	No longer in use
14	Operational Technology personnel Authorised Major Works personnel
15	Operational Technology personnel Authorised Major Works personnel
16	Operational Technology personnel Authorised Major Works personnel
17	Operational Technology personnel listed in RG S 41415 as an Authorised Person
20	Operational Technology personnel, Authorised Major Works personnel
22	Personnel as approved by Electrical Engineering Manager

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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 shall be approved by the Professional Head Signalling & Control Systems.

6.2 Core configuration authority

The configuration of Falcon interchangeable cores shall be performed by the Sydney Trains Locksmith. Where this is not achievable, then the configuration shall 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 shall hold all key blanks and arrange for the cutting and numbering of all keys, ensuring that the allocation of numbers is unique.

Each key shall 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 shall be approved by the Professional Head Signalling & Control Systems.

Table 4 – Approved Key Controllers

Series Number	Business Group	Key Controller
1, 2, 4 and SL	Engineering System Integrity – Signals & Control Systems	Senior Signalling Mechanical Engineer
2, 4, 8, 18 and SL	Network Maintenance Division	Maintenance signal engineers Operational Technology Manager Control & Co-ordination Manager
4, 8 and SL	Major Works Division	Test & Commissioning Manager or his/her delegate

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Series Number	Business Group	Key Controller
	External Signalling Resources (engaged on contract to Sydney Trains)	Relevant Key Controller issuing the Permit to Work certificate or Senior Signalling Mechanical Engineer
7	Network Operations	Not controlled by Signalling
14, 15, 16 17, 20 and 21	Operational Technology	Not controlled by Signalling
22	Engineering & System Integrity - Electrical	Delegated Electrical Officer

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.

The Key Controller shall maintain a Key Pool to meet the expected demand.

The Central Key Controller shall supply keys for the Key Pool upon request from Key Controllers.

The Sydney Trains Locksmith shall 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 shall secure all blanks and cut keys in a safe or secure cabinet.

7.4 Issuance control

Signalling personnel listed in *RG S 41415 Signalling Personnel – Licensing and Authorisation Status* 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 shall be recorded with details of the individual concerned (position, location, contact details, employer, project, key number, etc.) and date of issue.

Only keys formally issued by Sydney Trains shall be used on the Sydney Trains network.

Issued keys may be retained by the Key Holder subject to the provisions prescribed in Section 7.5.

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7.5 Return of issued keys

Key Holders shall 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 shall also return their signalling keys to the Key Controller. A new issue of keys shall be provided in accordance within the provisions stated in Section 7.4.

The Key Controller shall 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 shall be dealt with under *MN S 41418 Signalling Safeworking Incident Investigations*. 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 Technical Assured Organisation (TAO)

The Professional Head Signalling & Control Systems may authorise another TAO to hold an allocation of signalling security keys for signalling works. The TAO shall 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.

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11.3 Control centres

Signalling 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.

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Appendix A Falcon key hierarchy

	LOCK	No.	KEY	OPENS LOCKS																									
1		1	MASTER	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
2	DISTRICT SECURITY	2	SUB-MASTER D.E.		2		4		6	7	8	9	10	11	12					17						22			
3	PROJECT SECURITY 1	3	NOT REQUIRED			3	4	5	6	7	8			11	12	13				17						22			
4	RELAY ROOM	4	SUB-MAST MAIN ELECT				4		6	7	8	9	10	11	12					17						22			
4X	RELAY ROOM	4	NOT REQUIRED				4																						
5	PROJECT SECURITY 2	5	NOT REQUIRED				4	5	6	7	8			11	12	13				17						22			
6	U/S SIGNAL BOXES	6	NOT REQUIRED						6	7	8	9	10	11	12														
7	OPERATIONS (SIG BOXES)	7	OPERATIONS							7																			
8	SIGNALLING EQUIPMENT	8	PADLOCK (STEL replacement)								8																		
9	DISTRICT STORES	9	NOT REQUIRED									9																	
10	ELECTRICIANS/SECTMANS DEPOT	10	NOT REQUIRED										10	11	12														
11	AMENITES (RESTRICTED)	11	NOT REQUIRED											11															
12	AMENITES (GENERAL)	12	NOT REQUIRED												12														
13	PROJECT STORES	13	NOT REQUIRED													13													
14	COMMS-CITYRAL	14	COMMS-CITYRAIL														14	15	16		18				21				
15	COMMS-CITYRAL	15	COMMS-CITYRAIL															15			18			20A	21				
16	COMMS-SPARE	16	COMMS-SPARE																16										
17	COMMS-JOINT ACCESS	17	COMMS-JOINT ACCESS																	17									
18	COMMS-CITYRAL	18	COMMS-CITYRAIL NOT FOR ISSUE																		18			20A	21				
19	SPARE	19	SPARE																										
20	SPARE ON LOAN	20	SPARE ON LOAN TRAIN RADIO																				20	20A					
20A	COMMS-TRAIN RADIO	20A	TRAIN RADIO																					20A					
21	COMMS-CITYRAL	21	COMMS-CITYRAIL FOR USE BY TELSTRA																						21				
22	ELECTRICAL (R SERIES)	22	ELECTRICAL (R)													(OPTION 22,23,24)										22			
23	ELECTRICAL	23	ELECTRICAL																								23		
24	ELECTRICAL	24	ELECTRICAL																									24	
25	ELECTRICAL SPARE	25	ELECTRICAL SPARE																										25
26		26	EMERGENCY KEY				4		6																				

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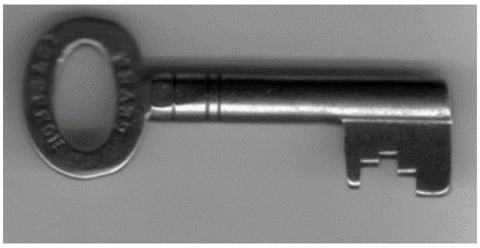
Appendix B Key types

In general use

	**Falcon Series** Numbered
	**SL** Not Numbered

Not in general use

	**Best Series** Numbered
	**Yale 6** Numbered
	**Yale 9** Numbered
	**Yale R** Numbered

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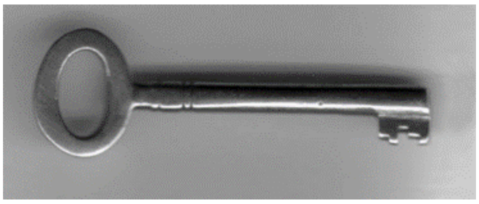
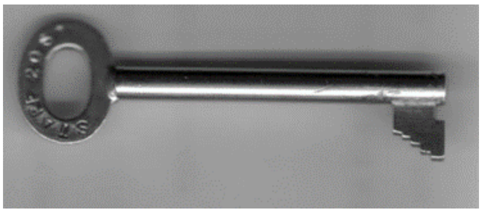
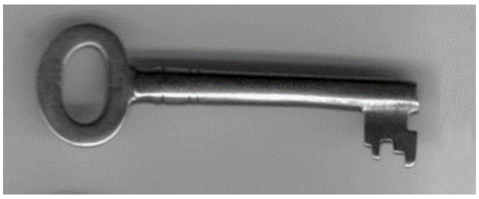
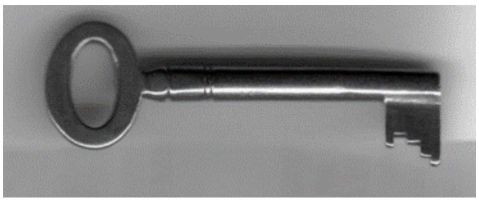
Not in general use (cont'd)

	**STEL** Not Numbered (all numbered 1020)
	**Corbin New** Not Numbered
	**Corbin Old** Not Numbered
	**SWI New – ABLOY** Numbered
	**SWI Old** Numbered
	**Staff New** Numbered
	**Staff Old** Numbered
	**PIM** Numbered

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Sydney Trains

Engineering System Integrity

Engineering Procedure

Signalling and Control Systems

Signalling Safeworking

PR S 40049

Signal Engineering Deviations

Version 2.0

Date in Force: 28 March 2023

Approved by:	Professional Head Signalling and Control Systems Engineering System Integrity	Authorised by:	Engineering Technical Publication Manager System Integrity

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Document control

Version	Date	Author/Prin. Eng.	Summary of change
1.0	5 March 2015	Colin Darmenia	First issue as a Sydney Trains document including additional process requirements, removal of ASA responsible items and rebranded from previous Sydney Trains TMG J049.
1.1	24 October 2016	Rhoel Del Rosario	Updated for new titles, roles and deviation management
2.0	28 March 2023	Alfonso Sozio	Scheduled 3 year review

Summary of changes from previous version

Summary of change	Section
New section added for reference documents	1
Update ASA to TfNSW AMB	2.1
Update Signalling Engineering procedure references	3 and 5

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Table of Contents

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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 40010 Risks and Controls Associated with Testing and Certifying Equipment*
- *PR S 40049 FM01 Signal Engineering Deviations Request for Approval Form*
- *PR S 45000 to PR S 45004 Design Procedures*
- *PR S 47110 to PR S 47117 Inspection and Testing of Signalling*
- *PR A 00402 Deferrals of Preventative Maintenance*
- *MN S 41412 Process for Signalling and Control Systems Personnel – Authorisations and Licensing*
- *PR S 41419 Authority to Work on Sydney Trains Signalling Infrastructure – Permit to Work*
- *RG S 41415 Signalling Personnel – Licensing and Authorisation Status*
- *SPG 0703 Signalling Documentation and Drawings*
- *SPG 0705 Construction of Cable routes and Signalling Civil Works*
- *SPG 0711 Inspection and Testing of Signalling*

2 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.

2.1 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.

A TfNSW Asset Management Branch (AMB) Concession is required for variation from documents under its control. The process to request a concession and the application form is available on the AMB 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.

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2.2 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.

3 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 and procedures, particularly SPG 0711, PR S 47110 to PR S 47117, PR S 45000 to PR S 45004 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 with 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.

4 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.

5 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 (MN S 41412, RG S 41415, PR S 41419 & PR S 40001, PR S40010).

6 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.

7 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.

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8 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.

9 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.

10 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.

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11 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.

12 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.

13 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.

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14 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.

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Engineering System Integrity

Engineering Procedure
Signalling and Control Systems

Signalling Safeworking

PR S 40050

Control Systems

Version 2.0

Date in Force: 17 April 2024

Approved by:	Professional Head Signalling and Control Systems Engineering System Integrity	Authorised by:	Engineering Technical Publications Manager System Integrity

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Document control

Version	Date	Author	Summary of change
1.0	8 March 2019	A Sozio	First issue as a Sydney Trains document
2.0	17 April 2024	A Sozio	Content update regarding USB usage, information security, Phoenix DPU and audio muting

Summary of changes from previous version

Summary of change	Section
Updated “Reference” section	2
Added "Information security" section	3.2
Removed “Insulation Testing” section	4.3
Added “Booking Control Systems out of use” section 6	6
Removed “Replacement of Tunnel Management System” section	7.7
Updated “Control systems work instructions” section with further requirements when replacing a server and workstation	8
Added “Phoenix DPU Servers” section	8.2.1
Combined Section 7.5 “Replacement of a Control Systems Network devices (Hard Wired Non-Vital System)”and Section 8.3 “Network Switches (Network Peripherals)” and renamed new section “Replacement of a control systems network device	8.5
Added requirement to ensure the audio is not muted on operator workstation	9.4.1

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Table of Contents

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1 Introduction

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 *IA A 09001 Signalling, Operational Technology 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* shall be strictly observed.

2 References

This procedure shall be read in conjunction with the following documents.

Signalling safeworking procedures

- *PR S 40001 Introduction to Signalling Safeworking Procedure*
- *PR S 40003 Derailments, Collisions and Major Incidents*
- *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 Associated with 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 Liaison with Signallers & ICON Infrastructure and Authority to Operate Signalling Controls*
- *PR S 40017 Maintenance Responsibilities and Frequencies*
- *PR S 40020 Security, Fire Protection, Weather Proofing and Cleanliness of Signalling Equipment, Housing and Locations*
- *PR S 40023 Insulation Inspection and Testing*
- *PR S 40040 Use of Radio Transmitters Near Electronic Signalling Equipment*
- *PR S 40042 Safety Issues for Signalling Personnel*
- *PR S 40044 General Signalling Maintenance Management, Administration and Supervision Responsibilities*
- *PR S 40046 Guidelines for the Safe Use of Temporary Recording, Monitoring and Logging Equipment on Signalling Systems*
- *PR S 40047 Calibration of Tools and Instruments for Signalling Applications*
- *PR S 40048 Signalling locations and equipment - Security Locks and Keys*

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- *PR S 40049 Signal Engineering Deviations*

Signalling Safeworking Forms

- Control Systems Like for Like work instructions.

Inspection and testing procedures

- *PR S 47114 Inspection and Testing of Signalling: Inspection and Testing Procedures*
- *PR S 47117 Inspection and Testing of Signalling: Standards Forms*

CSMS

- *ST A 0816 Secure Disposal Standard*

Signals and control systems cyber procedures

- *PR S 41516 Signalling and Control Systems Sensitive Information Labelling Procedure*
- *PR S 41517 Management and use of Portable USB Storage Devices in the Operational Signals and Control Systems Environment*

Control systems procedures

- *PR N 49000 Control Systems Change Management Process*

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 Portable USB devices

The two most significant risks of using portable USB storage devices are information security and malware infection. Adequate controls are essential to manage these risks.

The use of portable USB storage devices has the potential to transfer malware into the operational environment and significantly disrupt rail operations. This is not limited to malware in malicious files but can include malicious firmware from any type of unauthorised USB device.

Signals and Control Systems personnel may require use of USB data storage for preventative or corrective maintenance, testing and commissioning, and incident investigations in the operational Signals and Control Systems environment and are required to understand the risks and requirements associated with using a portable USB device. Refer to *PR S 41517 Management and use of Portable USB Storage Devices in the Operational Signals and Control Systems* environment for further information.

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3.2 Information security

All Signalling and Control Systems technical information created by Signals and Control Systems and found within artefacts such as technical documentation, configuration files and log files are considered in scope of this document shall be considered as **OFFICIAL: Sensitive – NSW Government**.

The objective of labelling sensitive information in S&CS is to maintain confidentiality of S&CS information and systems which ensures information is only accessible to authorised persons for approved purposes. Refer to *PR S 41516 Signalling and Control Systems Sensitive Information Labelling Procedure* for further information.

3.3 Security of control systems software

Only authorised Control Systems Design personnel are permitted to make application data changes, configuration changes and software changes in accordance with the relevant procedures.

Control Systems personnel to ensure the following:

- Only the current version of software and data shall be used as per the release documentation and Control Systems circuit book.
- No Control Systems maintenance and configuration software shall be copied onto third party machines or supplied to unauthorised personnel.
- No unauthorised changes to be made to the system, including software, data, and firmware.
- No databases to be directly updated on the operational system.
- No change to be made without the change process being followed. Please refer *PR N 49000 Control Systems Change Management Process*.

3.4 Control systems workstations and servers

Only authorised and type approved workstations or server hardware shall be used on the Control System.

At no time shall any workstation or server associated with the control system be connected to any external network and shall not be used for anything other than its intended purpose. This also includes the installation of unauthorised software, firmware, drivers, or applications on any of the Control Systems workstations.

3.5 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.

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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, network switches, workstations, servers, and peripherals
- recording of power supply voltages and settings
- data and software logging
- dip switch setting
- 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 shall 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 shall not be used; it shall be treated as defective.

All modules, cardfiles or pluggable equipment shall 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. Additionally, following the replacement of the equipment, verify functionality of the system by confirming its status through the appropriate monitoring facilities and server checks.

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4.3 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 shall 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 *ST A 0816 Secure Disposal Standard* for secure destruction.

4.4 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

Hardware components such as hard drives, expansion cards and SCADA 2000 IO cards shall be handled, transported and stored with care and not subjected to damage or deterioration.

The hardware components shall be stored on racks in enclosed housings in a clean, dry and non-corrosive environment below 60° C.

Anti-static protection handing procedures shall be applied when handling boards and modules.

6 Booking Control Systems equipment out of use

The booking out of Control Systems equipment is a formal agreement between the signaller and licensed signalling personnel that the equipment is offline or unavailable for operational purposes. Please refer to *PR S 40008 Securing Signalling Apparatus Out of Use* for further information.

7 Tools and test equipment

Tools and test equipment used on Control Systems shall 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 *PR S 47114 Inspection and Testing of Signalling: Inspection and Testing Procedures.*

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8 Control systems work instructions

As a general requirement:

a. Any equipment shall 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 shall 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.

8.1 Replacement of a control systems domain controller

A domain controller shall be replaced as a single unit.

The replacement is to be performed by an authorised Control Systems Engineer with the appropriate administrative privileges.

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 FM19 ATRICS Domain Controller Replacement - Like for Like Renewal*.

8.2 Replacement of a control systems server

A Server shall be replaced as a single unit.

The replacement is to be performed by a Control Systems Engineer or Control Systems Technician.

Prior to shutting down a Rail Control Server, ensure:

1. That the signaller is advised is made aware of the task and is advised what alarms and indications are to be expected.
2. Once the peer side and telemetry are master, confirm that the system is operating correctly.

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. Unless it is for emergency or fault rectification purposes, all shutdowns of the Rail Control Serve shall be done after hours between 2000 and 0400 for routine maintenance purposes.

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Detailed step by step procedures for the replacement of the relevant control system servers are provided within *PR S 40011 FM20 ATRICS RCS Replacement - Like for Like Renewal*.

8.2.1 Phoenix DPU servers

After restarting a Phoenix DPU server, the system allows up to 30 minutes to achieve synchronisation. After 30 minutes, the history log shall be checked to confirm that there is no synchronisation error.

If a synchronisation error occurs, the following will appear in the online DPU history log as:

'OOSCHECK - Offline checksum ... doesn't match with online checksum ...'.

If the message appears in the history log, you shall restart the offline DPU and wait a further 30 minutes to ensure no further synchronisation errors are reported.

8.3 Replacement of a control systems operator or maintenance workstation

The replacement is to be performed by a Control Systems Engineer or Control Systems Technician.

Whenever an operator workstation is required to be worked on, ensure that the alternative workstation is first in operation. Before requesting the signaller to take control of the peer or spare workstation, confirm that the peer or spare workstation is functioning, maps are correcting configured and no alarms are present.

Request the signaller to relinquish control of the workstation, and immediately take control of the peer or spare workstation. Confirm that the signaller has full signalling and train control and if required that ARS is re-enabled where appropriate. This will enable the workstation to be isolated from operation.

Detailed procedures for the replacement of the relevant operator or maintenance workstations are provided within *PR S 40011 FM21 ATRICS Workstation Replacement - Like for Like Renewal*.

8.4 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.

When performing maintenance or tasks on the telemetry always ensure that the telemetry system that is being maintained is standby.

Before initiating any work, communicate with the signaller. Inform them about the upcoming task and ensure they are aware of what alarms and indications to expect during the process.

If mastership needs to be swapped, verify the health of the peer system. Please note that all field equipment can be swapped, or each individual telemetry system can be separately swapped. The field maintainer shall confirm that the telemetry system is in standby with the Control Centre maintainer before commencing any work.

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Note:
The modems for a Dupline telemetry system are 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 FM36 Telemetry - Like for Like Renewal*.

8.5 Replacement of a control systems network device

Replacement of remote network devices shall be performed by licenced personnel with the assistance of the ESI Signalling & Control Systems IDC team

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 remote router is provided within *PR S 40011 FM29 Remote Network Device Replacement - Like for Like Renewal*.

The replacement of the Core Network Switch and other control centre network devices including encryptors and NTP devices shall be performed by a Control Systems Engineer in conjunction with ESI Signalling & Control Systems IDC team.

Note:
Replacing a Core Network Switch and affects multiple control panels.

8.6 Replacement of a control systems cable (G32, ethernet, fibre, copper)

Control Systems cables shall 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 FM31 SCADA 2000 G32 Cable Replacement - Like for Like Renewal*. 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 Repair/Replacement of Signalling Wires* for further information in replacing a G32 cable.

8.7 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 FM24 OSS Domain Controller Replacement - Like for Like Renewal*, *PR S 40011 FM25 OSS APP Replacement - Like for Like Renewal*, *PR S 40011 FM26 OSS WEB Replacement - Like for Like Renewal*, *PR S 40011 FM27 OSS SQL Replacement - Like for Like Renewal* and *PR S 40011 FM28 OSS MET Replacement - Like for Like Renewal*.

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9 Equipment specific issues

9.1 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.

9.2 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 shall be vigilant during the process of disconnection and reconnection of any plug coupler or connector. Labelling of disconnected cables, couplers and connectors shall be undertaken to control the risk of incorrect insertion.

Cable connector pins shall be checked for damage (bent pins) prior to insertion. Plug couplers shall be carefully installed ensuring alignment with the coupler and orientation prior to insertion.

Prior to returning to operation a check shall be performed ensuring the correct bits are active.

9.3 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 shall 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, then a licensed signal electrician is required to assist with the disconnection of the power supply before replacing the power supply.

All cables shall be labelled prior to disconnection and re-connected ensuring correct polarity.

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9.4 Workstations

9.4.1 Alarms

An alarm is raised when the Signal Control System has detected an event of importance, such as a signalling infrastructure failure and safety alerts such as a SPAD (Signal Passed at Danger). An audible alarm is provided to alert the operator that an event has occurred, and when the event has been rectified.

If the audio output is muted, either on the operating system, or audio arrangement, such as the speaker or KVMA, there is a risk that the operator may miss an alarm, which depending on the alarm, could lead to disruption to the network.

Under no circumstances shall sound on the Signal Control System operator workstation be muted, either on the Operator workstation operating system or audio arrangement.

9.5 Peripherals

9.5.1 Monitors

When installing new monitors, a check to ensure the correct screen setting shall be undertaken. A check to ensure correct:

a. Screen resolution
b. Colour mapping
c. Alignment.

9.5.2 Keyboard, mouse

Prior to any equipment installations the network controller shall be informed of any disruption to their working area and the expected time to complete restoration.

Cable connector pins shall be checked for damage (bent pins) prior to insertion. Plug couplers shall be carefully installed ensuring alignment with the coupler and orientation prior to insertion.

9.6 Eastern standard and eastern daylight time

All Control Systems equipment (enabled systems) clocks are to be set to Eastern Standard Time (EST) and shall sync to the Sydney Trains system servers.

9.7 Powering down of equipment

Control Systems equipment shall be powered down as detailed by their specific product manual/maintenance manuals.

10 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 *PR N 49000 Control Systems Change Management Process.*

Control Systems software and data is only to be kept in storage locations managed by and detailed in the change management process, and relevant build documentation.

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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.

11 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 Failures.*

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PR S 40051

Axle Counters

Version 1.0

Date in Force: 4 May 2022

OFFICIAL

Approved by:	Professional Head Signalling and Control Systems Engineering System Integrity	Authorised by:	Engineering Technical Publications Manager System Integrity

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Document control

Version	Date	Author/Prin. Eng.	Summary of change
1.0	4 May 2022	Ian Maydew/Colin Darmenia	First issue as Sydney Trains document

Table of Contents

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1 Introduction

This safeworking procedure relates to the Frauscher FAdC R2, Siemens ACM250 and Thales AzLM axle counter equipment used on the TfNSW network.

Axle counter equipment shall be managed in accordance with this and other 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 Maintenance Responsibilities and Frequencies*.)

Signalling Maintainers are responsible for maintaining axle counters for safe and reliable operation.

2 Scope

Only licensed signalling personnel who have been trained and are competent for the axle counter type may perform engineering activities as prescribed within this procedure on operational axle counter systems.

Licensed signalling personnel are to perform, as a minimum, the periodic inspection, test and maintenance tasks as described in this procedure and at frequencies specified below:

- For Safety Critical Tasks - as stipulated in this procedure.
- Where not stipulated in this procedure - frequencies as stipulated in the approved Technical Maintenance Plan.

Additionally, licensed signalling personnel are to be vigilant for potential axle counter problems whenever the opportunity permits.

Axle counter inspection, test and maintenance requirements include the following specific tasks:

- Maintaining axle counter test records (history cards)
- Diagnostics
- Reset
- Adjustments
- Testing and Certification
- Booking out of use
- Changing boards
- Incident investigation
- Periodic inspection, test and maintenance tasks
- Precautions to be taken during track and civil works.

Licensed signalling personnel shall make themselves aware of the relevant equipment manuals and specifications to maintain the Thales AzLM, Frauscher FAdC R2 and Siemens ACM250 systems.

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3 Reference document

The following documents have been referenced within this signalling safeworking procedure:

- *MN S 41589 Frauscher FAdC R2 Equipment Manual*
- *MN S 41588 Siemens ACM250 Equipment Manual*
- *MN S 41591 Thales AzLM Equipment Manual*
- *MN S 41629 Kiama - Bomaderry Signalling Maintenance Instruction*
- *NGE 204 Network Communication*
- *NWT 312 Infrastructure Booking Authority*
- *NRF 003 Infrastructure Booking Authority*
- *NPR 704 Using Infrastructure Booking Authorities*
- *PR S 40004 Failures*
- *PR S 40008 Securing Signalling Apparatus Out of Use*
- *PR S 40009 Disconnection of Signalling Apparatus*
- *PR S 40011 Renewals Work*
- *PR S 40014 Control of Signalling Documentation Issued to the Field*
- *PR S 40017 Maintenance Responsibilities and Frequencies*
- *PR S 40047 Calibration of Tools and Instruments for Signalling Applications*
- *PR S 40051 FM01 FAdC R2 Axle Counter Wheel Sensor (RSR180) History Card*
- *PR S 40051 FM02 ACM250 Axle Counter Wheel Sensor (DEK) History Card*
- *PR S 40051 FM03 Thales Sk30K Wheel Sensor History Card*
- *PR S 40051 FM07 - Axle Counter Track Section Unconditional Reset Assurances - Normal Train Operations*
- *PR S 40051 FM08 - Axle Counter Track Section Unconditional Reset Assurances - LPA or TOA with Track Section(s) CLEAR*
- *PR S 40051 FM09 - Axle Counter Track Section Unconditional Reset Assurances - LPA and TOA with Track Section(s) OCCUPIED*

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4 Definitions/Terms

ACE	Axle Counter Evaluator (Thales AzLM)
AXC	Axle Counter
Detection Point	The Thales Zp30K representing the combined EAK and detection contacts (wheel sensors Sk30K)
DWZ	Defined Work Zone
EAK	Trackside Electronic Unit (Thales AzLM)
GAK	Trackside disconnection box (Frauscher FAdC R2)
Line Clear	Section of track is free of any rail traffic, including work trains, plant equipment and road rail (hi-rail) vehicles
PDCU	Power Data Coupling Unit (Thales AzLM)
PMC	Possession Management Centre
PO	Protection Officer
PPO	Possession Protection Officer
Preparatory reset	A reset type that causes an evaluator to reset the track section but not restore the track section to the interlocking until a train has subsequently correctly counted into and out of the track section proving it clear.
Signaller	Person overseeing operations of specific sections of the railway.
Sweep Complete	A function within ATRICS that is enabled by the signaller once the driver of a sweep train has confirmed they have passed through the block complete.
Sweep Train	A train running under signaller's instructions used to prove the track section clear and thereby restore an axle counter track section as part of the 'Preparatory Reset' process.
TCB	Trackside Connection Box (Relates to Siemens equipment)
Technician terminal (Tech terminal)	An integrated localised system that is able to access an interfaced CBI for diagnostic, replay, blocking and to initiate axle counter reset requests.
Unconditional Reset	A reset type that immediately will reset and restore a track section to clear if no technical faults are present.
URE	Unconditional Reset Enable
WPoZ	Wheel pulse without count
WTC	Work Train Coordinator

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5 Equipment requiring maintenance

The objective of testing and examining axle counters is to find and remove any potential failure condition and ensure, as far as possible, that the axle counter will function safely and satisfactorily until the next scheduled examination.

This includes testing and examination of all associated axle counter equipment as applicable, including:

- Axle counter system
- Wheel sensor
- Trackside Connection Box/Electronic Box/Disconnection Point
- Interface to interlocking
- Power supplies
- Surge protection
- Axle counter communication system
- Wiring
- Track leads and connections.

Licensed signalling personnel are to refer to the relevant equipment manuals and specifications for the respective axle counter equipment.

6 Test records (wheel sensor history cards)

Each wheel sensor shall have its own test record (history card). The wheel sensor history card is to be kept inside the signalling location housing the associated axle counter system and tests are to be recorded thereon.

The wheel sensor history card provides a past record of the performance of the axle counter. It serves to highlight variations that need to be accounted for. Recorded observations and comparison of values provides a way of detecting trends in performance, allowing problems to be detected before they cause a failure. Gradual consistent variations indicate the deterioration of a component. The causes of these problems are to be identified and resolved.

When a wheel sensor history card is completely filled up and a new card started, copy the top row of the old card across to the top row of the new card and then copy the last row of the old card onto the second row of the new card. This provides a long term base-line against which to compare changes.

Wheel sensor history cards shall be completed during routine maintenance inspections, unconditional resets and after setup or adjustment (refer to Section 8.3).

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7 Axle counter reset

WARNING:
Where signalling personnel perform an unconditional axle counter track section reset, they shall be licensed signalling personnel holding suitable competency for the task.

Axle counters are a discrete form of track vacancy detection. They determine whether a section of track is clear by counting wheels in and out of the section.

An axle counter track section indicates two possible states, that being 'clear' (unoccupied) and 'occupied'. The axle counter system will show occupied when the axle counter system has detected a rail vehicle entering the track section. An occupied state can also be indicated when a miscount or disturbance of the axle counter system has occurred.

Axle counter miscounts may occur from events such as the following:

- Hi-rail vehicle enters or exits the axle counter track section at a mid-location not counted by wheel sensors.
- Rail vehicle wheel profile is outside the parameters set by the wheel sensor.
- A wheel sensor has been swiped (counted) by a source other than a rail vehicle wheel (such as maintenance activity or vandalism).
- The count-in number at the entry end is different to the count-out number at the exit end.

Axle counter disturbances may occur from events such as the following:

- After powering up the axle counter system.
- After a power interruption to the axle counter system.
- After or during maintenance or construction activities.
- After failures in the axle counter system equipment.
- After the axle counter equipment has been re-connected.

An axle counter miscount or disturbance will require the affected track section to be reset in order to enable operational use. Such resets can be facilitated by different means, depending on the specific reset facilities provided.

Note:
Refer to Section 7.3 for the different axle counter reset methods.

The following are the two types of axle counter resets permitted on the Sydney Trains network:

- Preparatory Reset - a valid and successful preparatory reset will reset the track section count value to zero but does not restore the track section to clear until a train (known as a sweep train) has successfully counted into and then out of the track section proving the track section clear.
- Unconditional Reset - a valid and successful unconditional reset of the axle counter track section will reset the count value to zero and the track section will be restored to clear.

WARNING
Reset procedures outlined in this document shall be strictly followed to ensure the safe running of rail vehicles.

7.1 Preparatory reset

A preparatory reset is only permitted by the Signaller.

Licensed signalling personnel shall not perform a preparatory reset.

A Preparatory reset may not be available, accepted or clear the track section if:

i. There is a maintainer's track block on that track.

ii. The track is already unoccupied.

iii. The Sweep function has not been applied.

iv. There is a communications fault preventing the signaller from applying the preparatory reset.

   a. System diagnostics will need to be carried out and the communications fault rectified before the axle counter section can be enabled for resetting, or

v. There is a fault with the axle counter equipment.

   a. System diagnostics will need to be carried out on the axle counter system. The faulty equipment must be repaired or replaced before the axle counter section can be reset, or

   b. The Preparatory reset process was not followed correctly.

vi. The sweep train was incorrectly counted in or out of the section.

vii. A train is still in section.

viii. The Signaller has not acknowledged the passage of the sweep train using the Sweep complete command.

7.2 Unconditional reset

Where signalling personnel perform an unconditional axle counter track section reset, they shall be licensed signalling personnel holding suitable competency for the task.

Unconditional resets shall be done in conjunction with the applicable Network Local Appendix (NLA).

Assurances obtained and provided during the reset process shall be recorded in the applicable form as detailed in Section 20. Completed forms shall be retained as electronic copies in accordance with regulatory requirements and no less than 2 years.

Prior to initiating an unconditional reset of an axle counter track section, specific conditions shall be first met. The conditions vary for resets undertaken during normal train operations and those undertaken during track possessions.

Section 7.2.1 refers to the required conditions when undertaking resets during normal train operations and Section 7.2.2 refers to the conditions required when undertaking resets during track possessions.

In either situation, all the stated conditions shall be met before initiating an unconditional reset. Where all the conditions cannot be met, an unconditional reset shall not be initiated and instead shall be referred to the signaller to perform a preparatory reset.

All assurances provided by the Signaller in regard to an unconditional reset shall be over a recorded communication link and in permanent form by the licensed signalling person undertaking the reset.

Communications with the Signaller shall comply with the requirements in NGE 204 Network Communication.

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To enable an unconditional reset, an Unconditional Reset Enable (URE) function is applied to the affected track section. The URE is applied by the Signaller. The licensed signalling person shall check with the Signaller that a URE is not currently in place for the affected track section before requesting to apply the URE.

Note:
Only one URE is applied per track section.

If the Signaller informs that a URE for the track section is already in place, then the licensed signalling person shall coordinate with the person who first requested the URE.

Unconditional resets shall be recorded on the applicable wheel sensor history card at the time of track section certification.

Note:
In the event a preparatory reset was applied by the signaller prior to an unconditional reset being requested. The signaller will need to apply a 'Conclude Sweep' to close out the preparatory reset after the unconditional reset has been completed. If this is not performed the track section will remain indicated as occupied.

7.2.1 Unconditional reset during normal train operations

7.2.1.1 Commencing an unconditional reset

When commencing an unconditional reset of track sections during normal operations (not under track possession), the following process shall be observed to ensure that the correct conditions are present prior to initiating the reset:

1. The licensed signalling person confirms with the Signaller which track section(s) requires a reset and asks if a URE is currently in place for the affected track section(s).
2. The Signaller provides an assurance that all protecting signals associated with the affected track section are at stop with blocking facilities applied and will remain so for the duration of the reset.
3. The Signaller provides an assurance that the last rail vehicle to have entered the defined block is confirmed to be clear and complete, particularly the affected track section requiring reset.

   Where the signaller cannot provide the assurance that the affected track section is clear, the licensed signalling person shall undertake this assurance and ensure that a direct visual inspection of the affected track section is performed to establish that it is unoccupied before initiating the reset. The name of the person performing the inspection shall be recorded on PR S 40051 FM07 by the licensed signalling person.
4. The Signaller provides an assurance that any rail vehicle approaching an associated protected signal has been brought to a stand and will remain so for the duration of the reset.

Note:
Signaller assurances in points 2, 3 and 4 shall be recorded on PR S 40051 FM07 by the licensed signalling person.

5. If the Signaller confirms that no other URE is currently in place to the affected track section(s), then the Signaller applies the URE to the affected track section(s) as requested. Refer to Section 7.2 if a URE is already in place.

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6. The licensed signalling person shall check that the URE is applied to the correct track sections. This can be achieved by observing the maintenance interface (for example, technician's terminal or trackside reset facility). The licensed signalling person shall advise the Signaller of any URE that is applied to an incorrect track section.
7. The licensed signalling person can then initiate the unconditional reset.
8. The licensed signalling person shall ensure only the correct track section(s) was reset. This can be achieved by observing the maintenance interface.

7.2.1.2 Restoring an affected track section following unconditional reset

Upon initiating an unconditional reset of affected track sections, the following process shall be observed to ensure its correct reinstatement prior to permitting resumption of normal train running:

1. The licensed signalling person shall advise the Signaller that the reset was successfully completed and to remove the requested URE for the affected track section(s) and associated blocks.

Note:
This Signaller assurance shall be recorded on PR S 40051 FM07 by the licensed signalling person.

2. Once removed, the licensed signalling person shall confirm that the correct URE was removed by observing the maintenance interface.

7.2.2 Unconditional reset during track possessions

7.2.2.1 Commencing and unconditional reset

When commencing an unconditional reset of track sections during track possessions (not normal train operations), the following process shall be observed to ensure that the correct conditions are present prior to initiating the reset:

1. The licensed signalling person advises the Signaller and the Possession Protection Officer or Protection Officer which track section(s) requires a reset and asks the Signaller if a URE is currently in place for the affected track section(s).
2. The Possession Protection Officer or Protection Officer provides an assurance that any rail vehicle approaching the affected track sections and protecting signals has been brought to a stand and will remain so for the duration of the reset.
3. The Possession Protection Officer or Protection Officer provides an assurance that the last rail vehicle to have entered the defined block, particularly the affected track section(s) requiring reset is confirmed to be clear and complete.
4. The Signaller provides an assurance that all protecting signals associated with the affected track section are at stop with blocking facilities applied and will remain so for the duration of the reset.

Note:
Signaller and PPO/PO assurances in points 2, 3 and 4 shall be recorded on PR S 40051 FM08 by the licensed signalling person.

5. If the Signaller confirms that no other URE is currently in place to the affected track section(s), then the Signaller applies the URE to the affected track section(s) as requested. Refer to Section 7.2 if a URE is already in place.

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6. The licensed signalling person shall check that the URE is applied to the correct track sections. This can be achieved by observing the maintenance interface (for example, technician's terminal or trackside reset facility). The licensed signalling person shall advise the Signaller of any URE that is applied to an incorrect track section.
7. The licensed signalling person shall ensure that a direct visual inspection of the affected track section(s) is performed to establish the track occupancy state. This inspection and the name of the person performing it for each track section shall be recorded on PR S 40051 FM08 by the licensed signalling person.

Note:
A special provision for initiating an unconditional reset of occupied track sections during a track possession for testing purposes is stated in Section 7.2.2.3.

8. The licensed signalling person can then initiate the unconditional reset.
9. The licensed signalling person shall ensure only the correct track section(s) was reset. This can be achieved by observing the maintenance interface.

7.2.2.2 Restoring an affected track section following unconditional reset

Upon initiating an unconditional reset of affected track sections, the following process shall be observed to ensure its correct reinstatement prior to restoring the track section:

1. The licensed signalling person shall advise the Signaller and Possession Protection Officer/Protection Officer that the reset was successfully completed and the track section is left clear and advise the Signaller to remove the requested URE and associated blocks.

Note:
These Signaller and PPO/PO assurances shall be recorded on PR S 40051 FM08 by the licensed signalling person.

2. Once removed, the licensed signalling person shall confirm the correct URE was removed by observing the maintenance interface.

7.2.2.3 Special provision to facilitate testing with a track section occupied by a rail vehicle

WARNING:
This special provision applies during track possessions only.
Under no circumstances shall an unconditional reset be done while a rail vehicle occupies the affected track section during normal train running.

There can be occasions where a reset is required to enable testing of reinstated axle counter equipment while a rail vehicle is still occupying the affected track section. This work could arise during a track possession as a result of axle counter equipment being maintained, renewed or removed (for example, to facilitate re-railing). This reset provides an opportunity for resources to carry out efficient and effective equipment testing well before the fulfilment period of a track possession.

In such cases, the axle counter track section shall first be disconnected and booked out of use (as is required for its disarrangement) in conjunction with all associated protecting signals in accordance with PR S 40008 and PR S 40009. Points within the affected (defined) block section shall also be prevented from operating by disabling the points and requesting the signaller to apply blocking facilities.

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Prior to commencing such unconditional reset, the attending licensed signalling person shall notify another licensed signalling person of the intention to initiate an unconditional reset while the affected track section is occupied with a rail vehicle, using this special provision. The second licensed signalling person shall hold suitable competency for the task and be of the same authority level as the first licensed signalling person, or higher. The second licensed signalling person shall endorse the intention to undertake the reset and then later seek confirmation that the track section is left in correspondence with the actual track occupancy before the signalling can be booked back into use. Both licensed signalling personnel shall be accountable for the safe restoration of the track section.

Before restoring any signalling back into use, the affected track section shall be placed in correspondence with the actual track occupancy state following the required equipment testing; that is, the axle counter track section shall be set to 'occupied' if the affected track section is occupied by a rail vehicle at the end of the work. The protecting signals shall not be brought into use until the track section correspondence is complete.

The following process shall be observed to ensure that the correct conditions are present prior to initiating the reset with a rail vehicle occupying the affected track section:

1. The licensed signalling person advises a second licensed signalling person, holding suitable competency and authority level for the work. The second licensed signalling person shall consent to the intention to undertake the reset.
2. The licensed signalling person advises the Signaller and the Possession Protection Officer or Protection Officer which track section(s) requires a reset and asks the Signaller if a URE is currently in place for the affected track section(s).
3. The Possession Protection Officer or Protection Officer provides an assurance that the rail vehicle occupying the affected track section, as well as any rail vehicle approaching the affected track sections and protecting signals has been brought to a stand and will remain so for the duration of the reset.
4. The licensed signalling person shall ensure that all the affected signalling (including any points) used to protect the track section disarrangement has been accordingly booked out and disconnected, including blocking facilities applied.
5. The Signaller has confirmed that all points within the route affected by the track section(s) reset are in the desired position with blocking facilities applied and will remain so for the duration of the reset.

Note:

Second licenced signalling person, Signaller and PPO/PO assurances in points 1, 3, 4 and 5 shall be recorded on PR S 40051 FM09 by the licensed signalling person.

6. The Signaller confirms that no other URE is currently in place to the affected track section(s), then the Signaller applies the URE to the affected track section(s) as requested. Refer to Section 7.2 if a URE is already in place.
7. The licensed signalling person shall check that the URE is applied to the correct track sections. This can be achieved by observing the maintenance interface (for example, technician's terminal or trackside reset facility). The licensed signalling person shall advise the Signaller of any URE that is applied to an incorrect track section.
8. The licensed signalling person can then initiate the unconditional reset(s) to facilitate the required equipment testing.

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9. The licensed signalling person shall ensure only the correct track section(s) was reset. This can be achieved by observing the maintenance interface.
10. Upon completion of the axle counter equipment testing work and before restoring any signalling back into use, the affected track section shall be placed in correspondence with the actual track occupancy state; that is, the axle counter track section shall be set to 'occupied' if the affected track section is occupied by a rail vehicle at the end of the testing.

WARNING:
The protecting signals and points shall not be brought into use until the track section correspondence is complete.

11. The licensed signalling person shall advise the second licensed signalling person that the affected track section was placed in correspondence with the actual track occupancy state. The second licensed signalling person shall acknowledge this confirmation and if satisfied, permit the signalling to be booked back into use (pending any other works).
12. The licensed signalling person shall advise the Signaller that the reset was successfully completed and to remove the requested URE and associated blocks. Both the Signaller and licensed signalling person shall close-out the IBA used for the reset.
13. Once removed, the licensed signalling person shall confirm the correct URE was removed by observing the maintenance interface.
14. The licensed signalling person shall advise the Protection Officer or Possession Protection Officer that the affected track section was left in correspondence with the actual occupancy state.
15. When the affected signalling is being booked back into use it is important to advise the Signaller that the affected track section was left in correspondence with the actual occupancy state. The licensed signalling person shall confirm with the Signaller of the correct track occupancy status before booking the signalling into use.

Note:
Second Licenced Signalling person, Signaller and PPO/PO assurances in points 11, 12, 14 and 15 shall be recorded on PR S 40051 FM09 by the licensed signalling person.

7.3 Axle counter reset methods

An unconditional reset will immediately restore a track section provided the axle counter system is setup and operating correctly.

Collaboration between the Signaller and the licensed signalling person is required to perform an unconditional reset.

An unconditional reset of an axle counter system is **only** possible:

i. Using a maintenance PC at each axle counter location or technician's terminal – refer to Section 7.3.2.

Note:
Unconditional resets via the maintenance PC or technician's terminal are only enabled when the Signaller has applied URE to the associated track section via the ATRICS.

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ii. Directly from a trackside reset facility – refer Section 7.3.1.

Note:
Unconditional resets at a trackside reset facility may not require URE to be applied by the Signaller depending on the installation.

If unconditional reset is unavailable or the reset request is rejected:

iii. There is a maintainer's track block on that track section.

iv. The track section is already unoccupied.

v. The signaller has not applied URE to the associated track section/s on ATRICS, or

vi. There is a communications fault stopping the reset enable (URE) function from being applied.

   a. System diagnostics will need to be done and the communications fault rectified before the axle counter section can be enabled for resetting, or

vii. There is a fault with the axle counter equipment.

   a. System diagnostics will need to be carried out at the axle counter system. The faulty equipment must be repaired or replaced before the axle counter section can be reset, or

viii. The unconditional reset process was not correctly followed.

7.3.1 Trackside reset facility

A trackside reset facility may take multiple forms including controls on the evaluator or a trackside reset box.

If the track section requiring reset is indicated on ATRICS then Unconditional resets using a trackside reset facility shall be under the direction of the signaller.

Figure 1 provides an example of a trackside reset box.

An operator reset facility is available for the Thales axle counter system at Bomaderry – refer to MN S 41629.

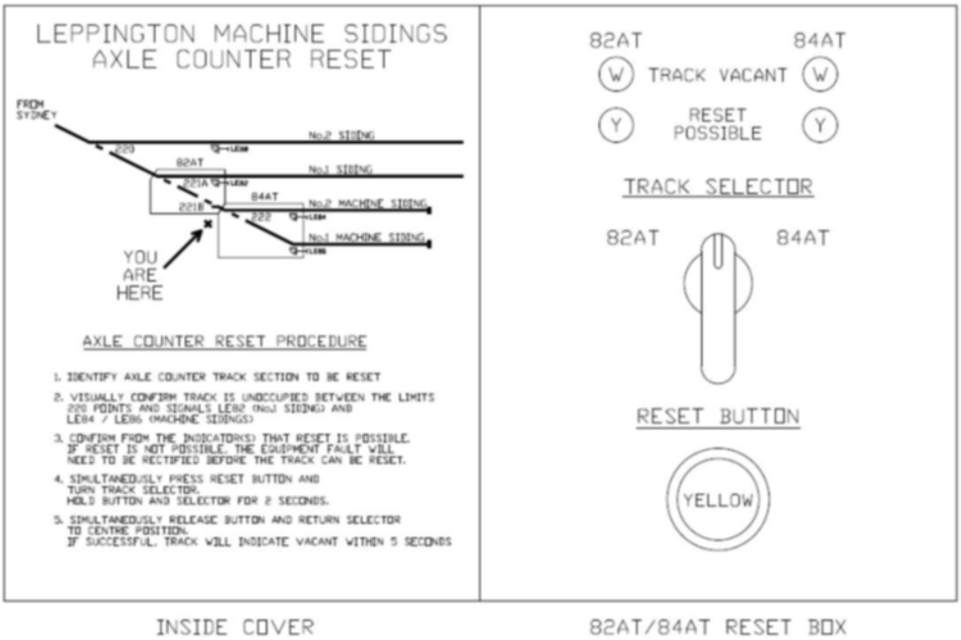

Figure 1: Axle counter reset box example

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The trackside reset box shall have an indicator light provided for each axle counter section. A white 'Track Vacant' light which identifies the track section to be unoccupied and a yellow 'Reset Possible' light which indicates if the track section can be reset. The reset possible indication also includes URE has been given by the signaller (where applicable).

Note:
If the yellow 'Reset Possible' light is not lit and the 'Track Vacant' light is not lit with no train in section then there may be a fault.

7.3.1.1 Trackside reset box – reset steps

The reset procedure may take up to 10 minutes to complete.

The axle counter section may need to be temporarily booked out of use if rail traffic is affected in accordance with PR S 40004 and PR S 40008. Follow NPR 704 procedures and use NRF 003 Infrastructure Booking Authority (IBA) forms if required.

i. Notify the Network Control Officer on arrival.
ii. Confirm which track section(s) require resetting.
iii. Refer to Section 7.2 regarding which (during normal operations or during track possession) unconditional reset commencement setup conditions to follow.
iv. At the reset facility, check that the 'Reset possible' indicator light(s) are lit yellow. If Reset is not possible, i.e., no lit yellow indicator, then URE was not applied, or an equipment fault is present and will need to be rectified before the track can be reset.
v. Via visual inspection confirm that the section(s) is not occupied by a rail vehicle or other obstruction and ensure approaching rail vehicles have come to a stop.
vi. Simultaneously press the reset button and turn the 'Track Selector' switch to the required track to be reset. Hold the 'Reset Button' and 'Track Selector' for 2 seconds.
vii. Simultaneously release the 'Reset Button' and return the 'Track Selector' to the centre position. If successful, the track will indicate vacant within 5 seconds.
viii. Repeat the process for the other track if required.
ix. Confirm that the 'Track Vacant' indicator light(s) of the axle counter section(s) is lit white to indicate that the sections are unoccupied. It will take approximately 10 seconds from operating the 'Track Selector' switch and 'Reset Button' to the 'Track Vacant' indicator lights changing from not lit to lit (white). If reset has been successful, go to step xii.
x. If the 'Track Vacant' indicator lights are still not lit after 15 seconds, attempt the reset process again, that is steps ii to vii.
xi. If three attempts of an Unconditional reset are performed and the axle counter section(s) continue to indicate occupied (not lit) without a train in the section, then treat it as an axle counter equipment failure – refer to Section 8 Fault Diagnostics. Equipment repair followed by an unconditional reset shall be attempted.
xii. Refer to Section 7.2 regarding which (during normal operations or track possession) restoration of affected track sections following unconditional reset to follow.
xiii. If the axle counter section was temporarily booked out of use, then book the axle counter section back into use. Follow NPR 704 procedures and use NRF 003 Infrastructure Booking Authority (IBA) forms.
xiv. Record on the wheel sensor history card that an unconditional reset has occurred.

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7.3.2 Frauscher FAdC R2 reset steps via maintenance PC or technician's terminal

Steps to unconditionally reset via the local maintenance PC at a trackside enclosure:

i. Notify the signaller on arrival.

ii. Confirm which track section(s) require resetting.

iii. At the axle counter check absence of any error messages or system anomalies. If there is a system error the equipment fault will need to be rectified before the track can be reset.

iv. Refer to Section 7.2 regarding which (during normal operations or during track possession) unconditional reset commencement setup conditions to follow.

v. On the technician's terminal or utilising the 'Remote Desktop Protocol' (RDP) software on the maintenance PC unconditionally reset the track section(s).

vi. Confirm the track section on the maintenance PC indicates the correct track occupancy state.

Note:
If an IO-EXB is installed confirm an 'O' is displayed on the LCD associated with the track section being reset.

vii. Refer to Section 7.2 regarding which (during normal operations or track possession) restoration of affected track sections following unconditional reset to follow.

If the track section is not reset wait 10 seconds and then repeat from step v again. Attempting an unconditional reset before the 10 second time interval will result in the system ignoring the reset command.

7.3.3 Siemens ACM250 reset steps

This section is provided for future introduction of Siemens ACM250 axle counters reset procedure.

7.3.4 Thales AzLM reset steps

The reset procedure may take up to 30 minutes to complete:

i. Notify the Network Control Officer on arrival. Determine whether the Network Control Officer has already attempted an Operational Reset. An Operational Reset will not be possible if there is a fault with the axle counter hardware or the Operator Reset facility itself.

ii. At the Axle Counter Evaluator, inspect the power supply, computer, serial I/O and parallel I/O modules diagnostic indications. Repair any faults.

iii. If time permits, use the Graphical Diagnostic Interface (GDI) Tool on a laptop to download and save the history and status logs. Start dates and times for the log download are to begin at least 24 hours before the disturbance time.

iv. If possible, confirm the cause of the section disturbance either from the diagnostic LED indications from step (ii) above or from the diagnostic logs. Possible causes include (and are not limited to):

    a. Detection point miscount

    b. Loss of power to the ACE and/or detection point

    c. Faulty ACE module(s)

    d. Faulty detection point (electronic unit, rail contact or ISDN cables)

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e. Wheel drifting or oscillation event. Wheel drift/oscillation occurs when a wheel passes one rail sensor but not both; a wheel count is not registered when this occurs. It is indicated as WPoZ (wheel pulse without count) in the diagnostic logs. Two consecutive occurrences of WPoZ will result in the axle counter section becoming disturbed, requiring a reset.

f. Maintenance or construction activities

g. Vandalism

v. Ensure that signals protecting the track section(s) are at stop (BY5 and 8).

vi. Ensure that the axle counter section is not occupied by a rail vehicle by either:

a. Visual checking, only permitted if the whole section is in line of sight

b. Walking the section

vii. Ensure the Reset Available LED (LED 8) on the parallel card is illuminated.

viii. Notify the Network Control Officer that a technician's reset is about to be performed.

ix. On the ACE parallel I/O module (ensure the correct one is selected), simultaneously turn the key and press the reset button for 1 to 2 seconds; the module will lock out if the button is held for too long (over 6 seconds). If a parallel I/O module lockout occurs, remove the parallel I/O module from the ACE, wait approximately 10 seconds, reinsert the module and reset correctly.

x. If the reset has been successful, LED's 1 and 2 on the parallel I/O module will briefly illuminate indicating that an unconditional reset has been requested, followed by LEDs 5, 6 and 7 illuminating indicating that the section is clear and no longer in a disturbed state.

xi. Inform the Network Control Officer that the reset has been completed.

xii. **Note** down on the wheel sensor history card that a technician's reset was performed.

WARNING:
The parallel card reset key is to remain attached to the associated parallel card at all times.

8 Fault diagnostics

LED diagnostic indications are provided on the:

- Siemens ACM250 evaluator module and its Trackside Connection Box.
- Frauscher FAdC R2 boards. If an IO-EXB is installed, then an LCD is also provided that will indicate wheel counts and error messages.
- Thales ACE module and its trackside EAK.

The LEDs and LCD indications can be used to assist with the diagnoses of any system fault. The LED indications provide general fault status.

For greater system diagnostics a laptop or maintenance PC (if installed) can be connected to the:

- ACM250 evaluator via Ethernet cable
- FAdC R2 boards via the ASD cable
- Thales ACE via ethernet cable

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8.1 Frauscher FAdC R2

Diagnostic indications are provided on all FAdC R2 equipment:

i. The IO-EXB LCD display provides fault status in the form of Error codes identified as the letter 'E' with a corresponding number.

ii. The LED indications on each of the system boards provide general fault status.

Licensed signalling personnel shall refer to the Sydney Trains equipment manual *MN S 41589 Frauscher FAdC R2 Equipment Manual* for error code meanings and log retrieval procedures.

For greater system diagnosis the Frauscher ASD Ethernet cable must be connected the associated Frauscher AEB or COM board.

CAUTION:
When connecting a laptop to the AEB or COM boards via the ASD cable, ensure that the board port is isolated from earth.
To achieve this, use a laptop that is battery powered or not connected to an earthed power supply.

8.1.1 Frauscher diagnostic system (FDS)

Logs can be downloaded from the Frauscher Diagnostics System (FDS) where installed using a blank USB key inserted into one of the USB ports on the FDS. Insertion of the USB shall download the last 90 days of events. The USB must not be removed whilst downloading.

The FDS can also be accessed via the maintenance network on the technician's terminal or technician's PC by typing the FDS IP address into a web browser.

8.2 Siemens ACM250

Licensed signalling personnel shall refer to the Sydney Trains equipment manual *MN S 41588 Siemens ACM250 Equipment Manual* for error code meanings and log retrieval procedures.

CAUTION:
When connecting a laptop to the ACM250 via the Ethernet cable, ensure that the board port is isolated from earth. To achieve this, use a laptop that is battery powered or not connected to an earthed power supply.

8.3 Thales AzLM

Licensed signalling personnel shall refer to the Sydney Trains equipment manual *MN S 41591 Thales AzLM Equipment Manual* for error code meanings and log retrieval procedures.

CAUTION:
When connecting a laptop to the ACE diagnostic serial port, ensure the ACE serial port is so isolated from earth.
To achieve this, use a laptop that is battery powered or not connected to an earthed power supply.

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9 Setup and adjustment

Correct positioning of axle counter wheel sensor will ensure rail vehicle wheels are accurately detected.

As part of installation works the wheel sensor cable must be reduced in length to the minimum required cable run from the disconnection point to the wheel sensor via the designated cable route. Minimising the cable length will reduce the likelihood of a wheel sensor being incorrectly installed in a location during future maintenance or track related activities.

Checks and adjustments (as required) are to be done after:

- Setting up of a new wheel sensor
- Changing position of a wheel sensor (requires approved design)
- Rails have become heavily worn
- After civil works such as rail grinding, tamping and re-railing
- Defect warnings are recorded in the diagnostic logs.

Note:
Wheel sensor removal and reinstallation must follow location identification requirements as detailed in their respective Sydney Trains equipment manuals (*MN S 41589 Frauscher FAdC R2 Equipment Manual* or *MN S 41588 Siemens ACM250 Equipment Manual* or *MN S 41591 Thales AzLM Equipment Manual*).

Approved testing meters in accordance with *PR S 40047 Calibration of Tools and Instruments for Signalling Applications* must be used for recording of test values.

9.1 Frauscher FAdC R2

9.1.1 RSR180 wheel sensor position – checks and adjustment

The RSR180 wheel sensor must be positioned and fitted to the rail in accordance with Sydney Trains equipment manual *MN S 41589 Frauscher FAdC R2 Equipment Manual*.

9.1.2 RSR180 wheel sensor setup

The wheel sensor and corresponding AEB has an operational range of between 280mV to 500mV. To improve reliability of the track section the calibration reading should be approximately 390mV, which is the midpoint of the range.

The following checks are to be performed on the RSR180 wheel sensor when correctly installed on track – refer Section 9.1.1 for positioning requirements:

i. Measure and record the received Sys1 and Sys2 voltage without the dummy wheel on the wheel sensor.

ii. Adjust the wheel sensor positioning (refer to *MN S 41589 Frauscher FAdC R2 Equipment Manual*) if required to obtain the required current values.

iii. Ensure the difference between the Sys1 and Sys2 current values are no greater than 20mV.

iv. If values are still not within tolerance re-calibrate (refer Section 9.1.2.1 RSR180 wheel sensor calibration) the wheel sensor and re-test.

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Once the Sys1 and Sys2 values are within tolerance and recorded on the wheel sensor history card, perform occupancy detection testing on the axle counter sections - refer to Section 10.

CAUTION:
Magnetic objects such as multimeter magnetic holders are to be kept at least 1m away from the FAdC R2 system including wheel sensors.

9.1.2.1 RSR180 wheel sensor calibration

To ensure reliable operation the AEB will require calibrating to the associated RSR180 wheel sensor. Calibration shall be required after:

- Setting up a new RSR180 wheel sensor.
- Changing position of the RSR180 wheel sensor.
- After civil works such as rail grinding, tamping and re-railing.
- Defect warnings are recorded in the diagnostic logs.

The following process shall be followed for re-calibration of the AEB:

i. Push both toggle switches to the left within 0.5 seconds.
ii. Keep both toggle switches in this position for at least 0.5 seconds.
iii. Release both toggle switches within 0.5 seconds.
iv. Keep both toggle switches in the neutral position for a maximum of 2 seconds.
v. Push both toggle switches to the right within 0.5 seconds.
vi. Keep both toggle switches in this position for at least 0.5 seconds.
vii. Release both toggle switches within 0.5 seconds.

Calibration should be completed within 5 seconds of successfully following the above calibration process.

Note:
If calibration deviates from the above process or takes longer than 30 seconds then calibration will not take place and the function is inhibited for 6 seconds.

9.2 Siemens ACM250

9.2.1 DEK wheel sensor position – checks and adjustments

The DEK wheel sensor must be positioned and fitted to the rail in accordance with Sydney Trains equipment manual *MN S 41588 Siemens ACM250 Equipment Manual*.

9.2.2 DEK wheel sensor setup

The Trackside Connection Box has an operational voltage range of between 30 to 72VDC.

Calibrated wheel sensor readings taken at the Trackside Connection Box should be no greater than 10mVAC between receiver voltages.

The following checks are to be performed at the Trackside Connection Box once the DEK wheel sensor is correctly installed on track – refer Section 9.2.1 for positioning requirements:

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i. Measure and record the transmitter frequency on terminals 8 and 9 are between 41.5 – 44.5 kHz.

ii. Measure and record receiver voltage 1 on terminals 3 and 4 are between 60 – 150mV AC.

iii. Measure and record receiver voltage 2 on terminals 1 and 2 are between 60 – 150mV AC.

iv. Confirm the difference between receiver voltages is less than 10mV AC.

v. If values are still not within tolerance re-calibrate (refer Section 9.2.2.1 DEK Wheel Sensor Calibration) the wheel sensor and re-test.

Once the Transmitter frequency on terminals 8 and 9 and Voltage 1 and 2 values are within tolerance and recorded on the wheel sensor history card, perform occupancy detection testing on the axle counter section - refer to Section 10.

CAUTION:
Magnetic objects such as multimeter magnetic holders are to be kept at least 1m away from the ACM250 system including wheel sensors.

9.2.2.1 DEK wheel sensor calibration

To ensure reliable operation the ACM250 evaluator and Trackside Connection Box will require calibrating to the associated DEK wheel sensor. Calibration shall be required after:

- Setting up a new DEK wheel sensor.
- Changing position of the DEK wheel sensor.
- After civil works such as rail grinding, tamping and re-railing.
- Defect warnings are recorded in the diagnostic logs.

The calibration order and process of the ACM250 evaluator and Trackside Connection Box is as follows:

i. Trackside Connection Box calibration:

   a. Push both KAL buttons simultaneously until both L4 LEDs show a steady green light.

   b. Release the KAL buttons and check indications.

   c. Confirm if both L4 LEDs are off.

   d. Confirm if both L3 LEDs are flashing green.

Note:
If calibration deviates from the above process then calibration will not take place, wait 10 seconds before restarting the process.

ii. ACM250 evaluator calibration:

   a. Press the “CL” button on the ACM for approx. 3 seconds. The “CAL” LED should show a steady yellow light.

   b. To calibrate the ACM for wheel detector DS1, press “DIR1” for approx. 3 seconds, alternatively.

   c. To calibrate the ACM for wheel detector DS2, press “DIR2” for approx. 3 seconds.

As soon as the “DIR1” or “DIR2” LED shows a steady yellow light, release the “DIR1” or “DIR2” button.

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After calibration has been completed, the result is indicated for 5 seconds:

a. "DIR1/DIR2" LED briefly shows a steady green light: calibration successful.

b. "DIR1/DIR2" LED shows a steady red light: calibration not successful.

Note:
If calibration of the ACM250 evaluator deviates from the above process or takes longer than 15 seconds then calibration will not take place. Calibration of the ACM250 evaluator must be restarted.

9.3 Thales AzLM

9.3.1 Sk30K wheel sensor position – checks and adjustment

The Sk30K wheel sensor must be positioned and fitted to the rail in accordance with Sydney Trains equipment manual *MN S 41591 Thales AzLM Equipment Manual*.

Checks and adjustments are to be performed using the Thales test case and dummy wheel. The dummy wheel bracket is to be set to 25mm. This is required for accurate detection of hi-rail vehicles. Checks and adjustments are to be recorded in the history card.

The following checks are performed on the Thales electronic junction box (EAK) and recorded on the history card:

i. The internal 24Vdc EAK channel power supplies are to be within the range 22Vdc to 35Vdc.

ii. The MESSAB voltages are to be within ±20mV of the last measurement shown on the wheel sensor history card. The voltage magnitude will also need to be within the range 80mVdc to 1000mVdc. EAK MESSAB adjustments are required if it is out of range, refer to adjustment section below.

iii. The PEGUE voltages are to be within ±20mV of the last measurement shown on the wheel sensor history card. It will also need to be ±2% of the MESSAB voltage measured in step ii above. EAK PEGUE adjustments are required if it is out of range, refer to adjustment section below.

iv. The external 110Vdc power measured across X101 connector, pins 1 and 2, are to be within the range 40Vdc to 130Vdc.

Detection Point MESSAB and PEGUE adjustments:

Perform the following steps to adjust MESSAB1 and PEGUE1, then repeat these steps for MESSAB2 and PEGUE2:

i. Measure and record the MESSAB voltage magnitude without the dummy wheel on the rail contact.

ii. Place the dummy wheel on the rail contact (rail contact SK1 if adjusting MESSAB1, or rail contact SK2 if adjusting MESSAB2), measure and record the MESSAB voltage magnitude - ignore the negative '-' sign on the multimeter reading. The dummy wheel bracket is to be set at 25mm.

iii. Add the MESSAB magnitude values recorded in steps (i) and (ii) above. Record this added value.

iv. Halve the value calculated in step (iii) above. Record this halved value.

v. Subtract 30mV from the value recorded in step (iv) above. Record this value: this is the new positive MESSAB value to be adjusted to.

vi. Remove the dummy wheel from the rail contact if it is still sitting on it.

vii. Use the potentiometer (MESSAB1 for SK1 rail contact or MESSAB2 for SK2 rail contact) and adjust to the new positive MESSAB value recorded in step (v). Ensure that this measurement is performed without the dummy wheel sitting on the rail contact. Record this adjusted positive MESSAB value on the history card.

viii. Add 30mV to the value recorded in step (iv) above. Put a negative sign (-) in front of this value and record as a negative number.

ix. Place the dummy wheel on the rail contact and measure the MESSAB value. Check that the measured MESSAB value is within ±10mV of the value calculated in the previous step (viii). Record this negative MESSAB value with the dummy wheel on the history card.

x. Remove the dummy wheel from the rail contact if it is still sitting on it.

xi. Use the potentiometer (PEGUE1 for SK1 rail contact, or PEGUE2 for SK2 rail contact) and adjust the PEGUE value to the new positive MESSAB value recorded in the history card in step (vii). The PEGUE value can be ±2% of the MESSAB value. Record this adjusted PEGUE value on the history card.

xii. Repeat the previous steps (i) to (xi) to adjust MESSAB2 and PEGUE2 (if not yet done).

CAUTION:

Magnetic objects such as multimeter magnetic holders are to be kept at least 1m away from ACE, trackside electronic unit and wheel sensors.

CAUTION:

Only the following digital multimeters are permitted for use during adjustments of the axle counter system: Gossen Metrawatt model M241A (supplied in the test case), Fluke 287/NUC.

10 Track section occupancy detection testing

Occupancy detection testing shall include correspondence of the axle counter track section and the respective track relay where installed. Occupancy detection testing assures the correct connection and functionality of the wheel detection equipment sensors and that a correct counting direction can be guaranteed.

Occupancy detection testing is required:

1. During commissioning (initial set up) of the axle counter section(s).
2. Fault rectification e.g. change of equipment or repair of damaged cable.

Note:

An assignment check of the Frauscher FAdC R2 RSR180 wheel sensor is also required during commissioning or rectification works – refer Section 10.1

3. In accordance with the TMP to confirm correct operation.

Occupancy detection testing may be carried out by the traversal of a wheel or by using an approved testing tool. Occupancy detection testing may be observed via:

- the ATRICS panel.
- Local Track Section Relay (where provided).
- Trackside equipment indications.
- Technician Terminal.

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- Maintenance PC interfaced to the trackside equipment.
- Laptop interfaced to the trackside equipment.

In all cases the wheel sensor operating ranges must be documented on a new line of the associated wheel sensor history card – refer to Section 9.1.2 for the Frauscher FAdC R2, Section 9.2.2 for the Siemens ACM250 or Section 9.3.1 for Thales AzLM.

Where a wheel traversal is not available then physical occupancy testing using approved test equipment and observing the associated indications on the trackside equipment will be required:

- PB200 testing plate shall be used for testing the Frauscher RSR180 wheel sensor – refer to Section 10.2, or
- Wheel traversal simulator shall be used for testing the Siemens DEK wheel sensor.
- Thales dummy wheel bracket set to 25mm shall be used for the Thales Sk30K wheel sensor.

CAUTION:
Occupancy detection testing will affect the occupancy state of a neighbouring axle counter track section.

10.1 Frauscher FAdC R2 RSR180 assignment check

The assignment check confirms 'Sys1' and 'Sys2' of the relevant wheel sensor are in alignment with the associated AEB.

The assignment check process should take approx. 5 minutes to complete:

i. Confirm the track section is clear of rail vehicles and that approaching rail vehicles are brought to a stand and will remain so clear of the section.

ii. Confirm the corresponding AEB board 'Sys1' or 'Sys2' LED operates correctly:

   a. Place the PB200 testing plate on the wheel sensor 'Sys#' of the track section under test (# denotes the Sys number e.g. 1 or 2). The IO-EXB (if installed) will display error message 'E17' for the track section under test. '- - 0' will be displayed on the IO-EXB of the adjacent track section.

   b. Confirm the corresponding 'Sys#' illuminates on the AEB.

   c. Place the PB200 testing plate on the opposite wheel sensor 'Sys#' (# denotes the Sys number e.g. 1 or 2). The 'E17' error message will remain on the IO-EXB for the track section under test. 'E17' will now also be displayed for the adjacent track section.

   d. Confirm the corresponding 'Sys#' illuminates on the AEB.

Note:
The PB200 testing plate must be placed on the wheel sensor and not swiped. Swiping shall result in a wheel count

10.2 Frauscher FAdC R2 track section occupancy check

The occupancy detection process should take approx. 5 minutes to complete. The process has been developed to minimise the number of track sections required to be reset on conclusion of the track section occupancy check.

1. Confirm the track section is clear of rail vehicles and that approaching rail vehicles are brought to a stand and will remain so clear of the section.
2. Confirm that the respective track relay (if installed) is energised or the track section is indicating occupied on the Tech Terminal or ATRICS.
3. Using the PB200 testing plate, slowly sweep **once into** the track section under test.
    a. At the IO-EXB (if installed) or via the ASD cable interface to the applicable AEB the track section is evaluated on, confirm an 'E17' error message is displayed for the adjacent track section that was swiped **out of**.
    b. Still at the IO-EXB (if installed) or via the ASD cable interface to the applicable AEB the track section is evaluated on, check the wheel count indicates a count of 1 on the track section counted **into**.
4. At the wheel sensor slowly sweep once out of the track section under test.
    a. At the IO-EXB (if installed) or via the ASD cable interface to the applicable AEB the track section is evaluated on, confirm an 'E17' error message still remains for the adjacent track section counted **out of**.
    b. Still at the IO-EXB (if installed) or via the ASD cable interface to the applicable AEB the track section is evaluated on, check the wheel count indicates a count of '0' on the track section under test and the track relay (if installed) is energised or the track section is indicating clear on the Tech Terminal or ATRICS.
5. A reset of the adjacent track section that was counted out of will be required.
6. Ensure the track relay (if installed) is energised or the track section indicates clear on the Tech Terminal or ATRICS.

Note:
A reset shall be required if the PB200 test tool is not correctly counted, or the process is incorrectly followed during this test.

10.3 Siemens ACM250 track section occupancy check

The occupancy detection process should take approx. 5 minutes to complete. The process has been developed to minimise the number of track sections required to be reset on conclusion of the track section occupancy check.

1. Confirm the track section is clear of rail vehicles and that approaching rail vehicles are brought to a stand and will remain so clear of the section.
2. Confirm that the respective track relay (if installed) is energised, or the track section is indicating clear on the ATRICS or technician's terminal.
3. Using the ACM250 wheel traversal simulator testing tool, slowly sweep **once into** the track section under test.
    a. At the ACM250 evaluator confirm the TVDS LED is illuminated for the adjacent track section that was swiped **out of**.
    b. At the ACM250 evaluator confirm the TVDS LED is illuminated for the track section that was swiped **into**.

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4. At the wheel sensor slowly sweep **once out** of the track section under test.
   a. At the ACM250 evaluator confirm the TVDS LED remains illuminated for the adjacent track section that was swiped back **into**.
   b. At the ACM250 evaluator confirm the TVDS LED is not illuminated for the track section that was swiped **out of**. Confirm the track relay (if installed) is energised or the track section is indicating clear on the Tech Terminal or ATRICS.
5. A reset of the adjacent track section that was counted out of will be required.
6. Ensure the track relay (if installed) is energised or the track section indicates clear on the Tech Terminal or ATRICS.

Note:
A reset shall be required if the ACM250 wheel traversal simulator test tool is not correctly counted, or the process is incorrectly followed used during this test.

10.4 Thales AzLM track section occupancy check

Two teams will be required, one team at the BY5 ACE and the other team to be at the detection point:

1. Perform a technician's reset of both 5BT and 5CT track sections at the BY5 ACE parallel I/O modules, refer to Section 7.3.4.
2. Starting at BY5B DP and using the dummy wheel, slowly sweep three times into 5BT section (from Bomaderry to Berry direction). At the ACE, check the indication LED's on the Parallel I/O card belonging to the 5BT section. Ensure LEDs 5 and 6 are both off to indicate that 5BT section is occupied. Record this on the history card.
3. Still at BY5B DP, slowly sweep the dummy wheel three times out of 5BT section (from Berry to Bomaderry direction). At the ACE Parallel I/O card for 5BT section, confirm that LEDs 5 and 6 are both lit green to indicate that the section is vacant. Record this on the history card.
4. Repeat step (1), technician's reset of both 5BT and 5CT sections.
5. Move to BY5C DP and using the dummy wheel, slowly sweep three times into 5CT section (Bomaderry to Berry direction). At the ACE Parallel I/O card for 5CT section, check that LEDs 5 and 6 are both off to indicate that the 5CT section is occupied. Record this on the history card. **Note** that the adjacent 5BT section will be in the disturbed state, ignore this.
6. Still at BY5C DP, slowly sweep the dummy wheel three times out of 5CT section (from Berry to Bomaderry direction). At the ACE Parallel I/O card for 5CT section, check that LEDs 5 and 6 are both lit green to indicate that the 5CT section has become vacant.
7. Repeat step (1), technician's reset of both 5BT and 5CT sections.
8. Move to BY5D DP and using the dummy wheel, slowly sweep three times into 5CT section (from Berry to Bomaderry direction). At the ACE Parallel I/O card for 5CT section, check that LEDs 5 and 6 are both off to indicate that the 5CT section is occupied. Record this on the history card.
9. Still at BY5D DP, slowly sweep the dummy wheel three times out of 5CT section (from Bomaderry to Berry direction). At the ACE Parallel I/O card for 5CT section, check that LEDs 5 and 6 are both lit green to indicate that the 5CT section has become vacant.
10. Repeat step (1), technician's reset of both 5BT and 5CT sections. Confirm that both 5BT and 5CT sections are shown as vacant – LEDs 5 and 6 on the two ACE Parallel I/O cards are lit green.

11 Test and certification

For the testing of the reset capability compliance with *PR S 40010 Risks and Controls Associated with Testing and Certifying Equipment* is mandatory.

12 Booking out of use

Booking out of use shall be as per *PR S 40008 Securing Signalling Apparatus Out of Use*.

Tests, examinations and certification may be performed without booking-out or disconnecting the equipment if the work satisfies *PR S 40008 Securing Signalling Apparatus Out of Use*.

13 Disconnection

Disconnection requirements shall be as per *PR S 40009 Disconnection of Signalling Apparatus.*

The Thales AzLM system is used at Bomaderry for track sequencing. Disconnection shall be achieved via removal of the B110 fuse and N110 pin for the respective PDCU.

14 Like for like renewals

Only one item of equipment should be disconnected or re-instated at a time to prevent incorrect reconnection.

Board and component changes shall be undertaken in accordance with *PR S 40011 Renewals Work* and associated like for like work packages.

14.1 Board and component changes

14.1.1 Frauscher FAdC R2

The FAdC R2 boards are hot swappable i.e. boards may be replaced with the board still powered. The following is to be adhered to when changing any board:

- The use of an antistatic wrist strap is mandatory.
- Only approved boards are to be used. Replacement boards must have an identical part number to the one they are replacing.
- Ensure dip switch positions are correct and that the board is inserted into the correct slot.
- COM boards must only be replaced one at a time.

Note:
If both COM boards require change out when wait 30 seconds between changes to ensure syncing has been completed. Failure to comply will require a reset of all track sections associated with the axle counter system.

- The compact flash card must also be replaced in the event of a COM board replacement.
- Only approved software versions correct/checked site specific data are to be installed.

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- Replacement PSC boards must only be replaced one at a time to ensure power is not lost to the board. Power loss will result in a reset of all track sections associated with the axle counter system.

14.1.2 Siemens ACM250

The following is to be adhered to when changing an ACM250 evaluator module:

- The use of an antistatic wrist strap is mandatory.
- Only approved evaluators are to be used. Replacement evaluators must have an identical part number to the one they are replacing.
- The ID Plug must also be replaced in the event of an evaluator replacement.
- Only approved software versions correct/checked site specific data are to be installed.

14.1.3 Thales AzLM

The following is to be adhered to when changing an AzLM evaluator module:

- The use of an antistatic wrist strap is mandatory.
- Only approved modules are to be used. Replacement modules must have an identical part number to the one they are replacing.
- Ensure jumper settings are correct and that the module is inserted into the correct slot.
- The CPU module must not be removed or inserted while the ACE is powered.
- In the event that the CPU module is replaced, the compact flash card must also be replaced.
- Only approved software versions correct/checked site specific data are to be installed.
- The PSU module must not be replaced while there is power to the ACE subrack.
- The serial modules and parallel modules are hot swappable, i.e. they can be replaced when the ACE subrack is powered.
- The PDCU may be replaced only while the 110Vdc power is disconnected.

14.2 Programmable storage devices

FAdC R2 Compact flash cards, ACM250 ID Plugs and AzLM ACE CPU compact flash cards are pre-programmed with site specific data. The FAdC R2 CF Card must be installed in the applicable COM board. The ACM250 ID Plug must be installed in the applicable ACM250 evaluator module. The AzLM CF Card must be installed in the applicable ACE module.

Only one axle counter ID Plug or CF card shall be removed and replaced at any one time during works within a location or cabinet.

Any new or replacement ID Plug or CF card shall have the correct data installed, verified and validated prior to placing into service. Where programmed prior to going on site the ID Plug or CF card shall be appropriately and securely labelled to ensure it will be matched to the correct location. The current installed data version is to be recorded in the circuit book.

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Powering down the axle counter Comms board/s (FAdC R2) or evaluator (ACM250) or ACE module will be required prior to installing/replacing the ID Plug or CF card. Powering up the axle counter will initialise the data.

A reset of the affected track sections will be required after power up of the system as all tracks will be indicated 'occupied' – refer to Section 7 Axle counter reset.

14.2.1 FAdC R2 compact flash card

The application version and checksums on the compact flash cards are to be checked before they are inserted into the COM board. Check the last four digits of the checksum on the label against the signalling circuit book. The data checksum is also to be checked once the COM board is installed by using the ASD cable and laptop or maintenance PC.

14.2.2 ACM250 ID plugs

The application version and checksums on the ID Plug are to be checked before they are inserted into the ACM250 evaluator. Check the last four digits of the checksum on the label against the signalling circuit book. The data checksum is also to be checked once the evaluator is powered by using the Ethernet cable and laptop or maintenance PC (web browser) if installed.

14.2.3 AzLM compact flash card

The application version and checksums on the compact flash cards are to be checked before they are inserted into the CPU module. Check the last four digits of the checksum on the label against the signalling circuit book. The data checksum is also to be checked once the ACE is powered up by using the Graphical Diagnostic Tool.

15 Non-volatile site specific data storage and management

Pre-programmed spare FAdC R2/AzLM compact flash cards (CF Card) and ACM250 ID Plugs are to be securely kept in clean and dry locations as per *PR S 40014 Control of Signalling Documentation Issued to the Field*.

16 Incident investigation

Investigations involving irregularities or alleged irregularities, such as failure to detect a train, shall be performed as per *PR S 40004 Failures*.

For any reported signalling irregularity, the investigation must include:

- the observation of the successful passage of a sweep train and preparatory reset process prior to certification, or
- the successful unconditional reset of the affected track section(s) prior to certification.

17 Periodic inspection, test and maintenance tasks

Periodic inspection, test and maintenance tasks shall be performed as per the approved Technical Maintenance Plans.

17.1 Frauscher FAdC R2

The following tasks have been designated as Safety Critical tasks:

- Check of the axle counter track section occupation.
- Wheel sensor system calibration.
- Correct operation of IO-EXB LED status indication.

Where an RSR180 wheel sensor has not been traversed within a 12 month period then a track section occupancy check using the dummy wheel (PB200) test tool, or the observation of a rail vehicle traversing the RSR180 wheel sensor at no greater than a 12 month interval is required. Where there has been traversal of an RSR180 wheel sensor by a rail vehicle within a 12 month period then the track section occupancy check is required at no greater than a 24 month interval.

The occupancy detection section of the RSR180 wheel sensor history card shall be used to record this test. Each track section occupancy detection test is to be reflected separately on the history card if the wheel sensor is shared by track sections.

RSR180 wheel sensor system calibration and the correct operation of IO-EXB LED status indications are to be performed at no greater than a 24 month interval.

If an RSR180 wheel sensor is not traversed for longer than the maximum permitted cycle of traversing, then the following checks must be carried out prior to the first train run:

- Occupancy detection capability of the wheel sensor.
- Correct clear and/or occupied indication of the axle counter.

Non periodic inspection, test and maintenance are required whenever there are events that may cause change(s) which could affect adjustment, etc. and thus impair the safe and reliable operation of the axle counter. Any condition found with the potential to reduce the reliability of the axle counter is to be actioned immediately if practicable, or otherwise brought to the notice of the maintenance Signal Engineer and dealt with As Soon As Possible.

Periodic insulation testing on cables used for the axle counter system is not required. The signals are monitored by the AEB boards. Insulation faults will be self-revealing.

17.2 Siemens ACM250

The following tasks have been designated as Safety Critical tasks:

- Check of the axle counter track section occupation
- Wheel sensor system calibration

Where a DEK wheel sensor has not been traversed within a 12 month period then the track section occupancy check using the wheel traversal simulator, or the observation of a rail vehicle traversing the wheel sensor at no greater than a 12 month interval is required.

The occupancy detection section of the DEK wheel sensor history card shall be used to record this test. Each track section occupancy detection test is to be reflected separately on the history card if the wheel sensor is shared by track sections.

DEK wheel sensor system calibration and the correct operation of LED status indications on the ACM250 evaluator and Trackside Connection Box are to be performed at no greater than a 12 month interval.

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If a DEK wheel sensor is not traversed for longer than the maximum permitted cycle of traversing, then the following checks must be carried out prior to the first train run:

- Occupancy detection capability of the wheel sensor.
- Correct clear and/or occupied indication of the axle counter.

Non periodic inspection, test and maintenance are required whenever there are events that may cause change(s) which could affect adjustment, etc. and thus impair the safe and reliable operation of the axle counter. Any condition found with the potential to reduce the reliability of the axle counter is to be actioned immediately if practicable, or otherwise brought to the notice of the maintenance Signal Engineer and dealt with As Soon As Possible.

Periodic insulation testing on cables used for the axle counter system is not required. The signals are monitored by the ACM250 evaluator. Insulation faults will be self-revealing.

17.3 Thales AzLm

Routine maintenance testing of the UPS at A-Pts power location will cause the detection points to lose power. This will result in 5BT and 5CT sections becoming disturbed. The axle counter sections will need to be reset after UPS testing.

If 5AT also drops on the changeover, it is possible that the track sequencing for the Berry – Bomaderry section may be affected.

17.3.1 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:

- Indoor equipment:
  - Examine power supplies powering the ACE. Ensure voltages are within tolerance.
  - Download and check the ACE logs by using a diagnostic PC. Check for drift warnings (DRW) as a large number of these would suggest that an adjustment of the detection point is required.
- Trackside equipment:
  - Examine connections to the rails and the condition of Rail Contacts.
  - Examine condition of transmitter and receiver cables and fasteners to sleepers.
  - Examine layout of transmitter and receiver cables. No loops, coils or separation is permitted.
  - Examine EAK for any physical damage and ensure good earthing connections. Opening the EAK for visual inspections is not required.

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17.3.2 Level two 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 12 months.

- Trackside Equipment:
  - Measure all voltages indicated on the detection point history card. Record all results on a new row of the history card. Investigate variations from past values.

If the readings show a variation from the last recorded value which is large enough that it cannot be accounted for by normal variations, then further investigation and tests shall be carried out. Severe degradation in performance of the Axle Counter outside normal behaviour or known symptoms of failure must be reported to the maintenance signal engineer.

18 Quick reference guides

18.1 Frauscher FAdC R2 quick reference guide

Task	FAdC R2 process	Section
Power supply (PSC) replacement	No configuration is required, the board can be changed like for like.	N/A
AEB replacement	Confirm dip switch are identically positioned to the AEB being replaced.	N/A
	Calibrate the AEB	9.1.2.1
	Perform wheel sensor assignment check	10.1
IO-EXB replacement	No configuration is required, the board can be changed like for like.	N/A
COM-xxx replacement	Confirm dip switch are identically positioned to the COM-xxx being replaced	N/A
	Transfer the CF card from faulty board into the new Com-xxx board. Confirm that the correct configuration data is on the CF card.	14.1.3
Surge arrestor replacement	Calibrate the AEB	9.1.2.1
GAK (Trackside disconnection box) replacement	Calibrate the AEB	9.1.2.1
	Perform wheel sensor assignment check	10.1
RSR180 wheel sensor replacement or position adjustment	Position in accordance with *MN S 41589 Frauscher FAdC R2 Equipment Manual*	N/A
	Calibrate the AEB	9.1.2.1
	Perform wheel sensor assignment check	10.1
	Perform track section occupancy check	10.2

Table 1: Frauscher quick reference guide

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18.2 Siemens ACM250 quick reference guide

Task	ACM250 process	Section
ACM250 replacement	Transfer the ID Plug from faulty ACM250 into the new ACM250. Confirm that the correct configuration data is on the ID Plug.	14.1.3
	Calibrate the DEK wheel sensor to the Trackside Connection Box and then to the ACM250	9.2.2.1
	Perform track section occupancy check	10.3
Trackside Connection Box replacement	Calibrate the DEK wheel sensor to the Trackside Connection Box and then to the ACM250	9.2.2.1
	Perform track section occupancy check	10.3
DEK wheel sensor replacement or position adjustment	Position in accordance with *MN S 41588 Siemens ACM250 Equipment Manual*	N/A
	Calibrate the DEK wheel sensor to the Trackside Connection box and then to the ACM250	9.2.2.1
	Perform track section occupancy check	10.3
Surge arrestor replacement	Calibrate the DEK wheel sensor to the Trackside Connection box and then to the ACM250	9.2.2.1

Table 2: ACM250 quick reference guide

19 Wheel sensor history cards

The following wheel sensor history cards (test records) are available for download in a PDF formatted documents from the Sydney Trains intranet and internet websites for printing. The wheel sensor history cards shall be printed on uncoated bright white paper, A4 size, 250-280 GSM, using indelible colour printing.

- *PR S 40051 FM01 FAdC R2 Axle Counter Wheel Sensor (RSR170) History Card*
- *PR S 40051 FM02 ACM250 Axle Counter Wheel Sensor (DEK) History Card*
- *PR S 40051 FM03 Thales Sk30K Wheel Sensor History Card.*

20 Reset forms

The following reset forms are available for download in a PDF formatted documents from the Sydney Trains intranet and internet websites for printing:

- *PR S 40051 FM07 Axle Counter Track Section Unconditional Reset Assurances - Normal Train Operations*
- *PR S 40051 FM08 Axle Counter Track Section Unconditional Reset Assurances - LPA or TOA with Track Section(s) CLEAR*
- *PR S 40051 FM09 Axle Counter Track Section Unconditional Reset Assurances - LPA and TOA with Track Section(s) OCCUPIED.*

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Engineering System Integrity

Engineering Procedure
Signalling and Control Systems

Signalling Safeworking

PR S 40052

WSP 2G Computer Based Interlocking

Version 1.0

Date in Force: 26 May 2022

OFFICIAL

Approved by:	Professional Head Signalling and Control Systems Engineering System Integrity	Authorised by:	Engineering Technical Publications Manager System Integrity

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Document control

Version	Date	Author/Prin. Eng.	Summary of change
1.0	26 May 2022	C Darmenia/A Consiglio	First issue as a Sydney Trains document

Table of Contents

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1 Introduction

This procedure relates to the Hitachi Wayside Standard Platform 2nd Generation (WSP 2G) computer based interlocking (CBI) equipment, including Field Device Controller 3rd Generation (FDC 3G) equipment that interface to the trackside signalling equipment.

The information contained herein shall be fully known to licensed signalling personnel working in WSP 2G CBI interlocking areas.

Where there is conflict between this document and the manufacturers manuals listed in Section 4, the maintenance procedures detailed in this document are to take precedence. Discrepancies should be reported to the Professional Head Signalling & Control Systems.

The WSP 2G CBI is a safety critical system. Any maintenance of the WSP 2G or FDC 3G equipment that does not align with the requirements of the WSP 2G and FDC 3G Operation and Maintenance manual could compromise safety. Do not modify a WSP 2G or FDC 3G installation except under direction of a competent WSP 2G designer.

The WSP 2G incorporates the following features:

- WSP 2G can be arranged in various configurations for different installation environments.
- WSP 2G can be used as a central interlocking only, capable of being a direct hardware replacement of the Microlok II cardfile.
- WSP 2G can interface to existing Microlok II object controller equipment using communications based on the Master Slave Ethernet (MSE) safety protocol and the existing Microlok II safety protocol, utilising FDC 3G as a protocol converter.
- WSP 2G utilising FDC 3G equipment can interface to standard relay circuits, signals and Hitachi eurobalises. WSP 2G can interface directly with Frauscher axle counter (FAdC) equipment for train detection.
- WSP 2G can be used as an ETCS (Level 2) radio block centre, capable of communications with other supplier radio block centres.
- WSP 2G can operate from a local installation or can operate from a remote installation, utilising closed or open transmission systems.

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2 Glossary

2oo2	Two-out-of-Two channel configuration
ART	Alarms Recording and Telecommunications
ATP	Automatic Train Protection
CBI	Computer Based Interlocking
CPLD	Complex Programable Logic Device
D&M	Diagnostic and Maintenance
ESD	Electrostatic Discharge
ETCS	European Train Control System
FAdC	Frauscher axle counter
FDC 3G	Field Device Controller 3rd Generation
HMI	Human Machine Interface
HRSTS	Hitachi Rail (manufacturer of the WSP 2G CBI)
IXL	Interlocking
KVM	Keyboard Video Mouse
LRU	Line Replaceable Unit
MCB	Miniature Circuit Breaker
MSE	Master Slave Ethernet
NTP	Network Time Protocol
PSU	Power Supply Unit
RCE	Registration Chronological Event. Log application on ART server that generates reports.
TCS	Train Control System
WSP 2G	Wayside Standard Platform 2nd Generation

3 Scope

This document outlines the signalling safeworking actions and considerations during maintenance activities including in the event of various faults with the WSP 2G CBI System.

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4 References

The following documents are referenced in this document.

- *PR S 40004 Failures*
- *PR S 40009 Disconnection of Signalling Apparatus*
- *PR S 40012 Repair/Replacement of Signalling Wires*
- *PR S 40014 Control of Signalling Documentation Issued to the Field*
- *PR S 40046 Guidelines for the Safe Use of Temporary Recording, Monitoring and Logging Equipment on Signalling Systems*
- *PR S 40047 Calibration of Tools and Instruments for Signalling Applications*
- *PR S 40051 Axle Counters*
- *PR S 47111 Inspection and Testing of Signalling: Roles, Responsibilities and Authorities*
- *T HR SC 01000 SP Common Signals and Control Systems Equipment Requirements*

The WSP 2G system is detailed in the following manuals:

Source	Code	Title
HRSTS	S00X.0102054.S07.00EN	WSP 2G System Architecture & Wayside Interface Design
HRSTS	B21A.0100019.R04.00EN	WSP 2G Reliability Prediction
HRSTS	B21B.0100129.S11.00EN	WSP 2G Technical Specification
HRSTS	P00X.0100032.G00.00EN	FDC 3G Installation, Use, Diagnostics & Maintenance Manual
HRSTS	S00X.0102054.G04.01EN	WSP 2G CBI Operations and Maintenance Manual
HRSTS	S00X.0102054.G05.00EN	Mount Victoria WSP 2G User Manual

5 Handling and Storage

All racks, backplanes and modules shall be handled, transported and stored with care, and not in any manner, condition or circumstance that would subject them to damage or deterioration.

Best practice anti-static protection handling actions shall be applied when handling backplanes and modules. This includes the use of antistatic bags and antistatic wrist straps.

Spare racks, backplanes and modules shall be appropriately stored in a secured place on shelves, in a clean, dry and non-corrosive environment between -40°C and +85°C.

Spare equipment (housings, racks, backplanes, modules, I/O connectors) shall be the correct model and version for the system and checked prior to placing into service.

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6 Cyber Security Requirements

All work on WSP 2G equipment shall comply with Transport for New South Wales (TfNSW) procedure T HR SC 01000 SP cyber security requirements. Where the procedure is not specific, the following applies:

- Only approved devices with current version virus protection shall be used to connect to the WSP 2G or the physical network that the WSP 2G resides.
- Devices connected to the WSP 2G or network where the WSP 2G resides shall not be connected to other unintended networks (e.g., corporate WANs, 4G Networks, wireless hotspots).
- Third party devices such as USB storage devices shall be proven to be free of viruses and malicious software before being inserted into the interlocking or signalling computers such as maintenance workstations.
- Media storage devices shall only be used for their dedicated task and are not to be used with any other system for any other task.
- Unused USB ports shall have physical port blockers installed.
- Unused network ports shall be disabled.
- Only software that is validated, approved and in accordance with type approval requirements shall be installed.

7 Equipment cubicles

The WSP 2G cabinet upper section houses the Safety Nucleus (NS) which contains the vital software in charge of safety communications and processing, whereas the lower section houses the non-vital ART subsystem responsible for RCE recording, system diagnostic and maintenance functions.

The FDC 3G cabinet houses field device controllers that are the vital devices used to receive commands from WSP 2G, transmit them to field devices, acquire indications and controls from field devices and provide them to the WSP 2G.

WARNING:
WSP 2G and FDC 3G equipment contain sensitive components. Strong magnetic fields can cause equipment faults.
Magnets (e.g. the magnetic attachment clips for multimeters) shall not be placed in close proximity to the WSP 2G cabinet or FDC 3G cabinet/rack.

7.1 Alarm and Error indications

The indicator LEDs on the WSP 2G and FDC 3G modules provides diagnostic information. The passive state of an indicator LED is not sufficient as the sole information for a module failure or safety critical test, for instance, a module may be in failure state due to an adjacent interlinked module failure. Detailed information on the failure state of the WSP 2G and FDC 3G equipment can be observed via the Diagnostic and Maintenance terminal.

7.2 Actions when WSP 2G modules are operating in reserve

In the event that the Safety Nucleus or ART servers are operating in Reserve mode, the LEDs of the Normal modules shall be observed to ensure no fault status indications are present. If a fault is indicated investigate to rectify.

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7.3 Actions when FDC 3G modules are operating in reserve

The FDC 3G has one of the two processing units is active, while the second one is ready to take over in the event that the first unit should incur an error or a failure. The FDC 3G is biased to the Normal side. Observing that the FDC 3G is operating on the Reserve side, is an indicator that there is an issue on the Normal side that requires investigation.

7.4 CPU replacement permissions

Maintenance personnel shall have received the appropriate level of training and be accredited to carry out the CPU replacement & installation procedures. Procedures shall be performed as described in the WSP 2G User and Operations & Maintenance manuals.

8 Diagnostic and Relay System

The maintenance subsystem is composed of a Diagnostic HMI (also known as WiSion 2G) and a Replay HMI.

The Diagnostic HMI implements signalling specific maintenance functions, including:

- Real-time status of WSP 2G CBI equipment, relating trackside equipment, associated telecommunications links and the signalling installation.
- Management of the display, acknowledgement and archiving of alarms and warnings for the WSP 2G CBI equipment, related equipment and associated telecommunications links.
- Display, application and removal of maintainer's vital blocks, from local Diagnostic HMI via a SIL4 Transaction Authentication Number (TAN) procedure.
- All monitoring and interrogation functions required by the maintainer to comply with the maintenance related processes and safety related constraints for the WSP 2G CBI equipment.
- Web interface to Frauscher Diagnostic System (implemented in FAdC subsystem).

The replay HMI implements offline playback of signalling information recorded by the WSP 2G CBI event recorder. This is downloaded and packaged on a daily basis for use.

Where a replay or log is required for the current day, it is preferred to first consider using another source such as an ATRICS replay, as creating a replay or log will stop the associated ART server from logging events. If the replay or log is required to be obtained, where it possible shall be from the ART 2 server so that a full copy of the log will be available for archiving by the system from the ART 1 server.

WARNING:
Downloading of the current day replay will require the ART logging to be stopped. Where this is essential, it is preferable that it is performed on the ART 2

The Diagnostic HMI and Replay HMI also act as hosts for read only remote desktop access from a remote maintenance terminal.

Maintainers shall check the status of alarms on the Diagnostic and Maintenance system in accordance with the TMP and whenever the opportunity arises. On actioning alarms they shall be acknowledged in order to identify newly raised alarms. Any alarms raised are to be attended to and prioritised accordingly, and captured in the Sydney Trains defect management system.

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9 Failures

Incidents, including signalling irregularities, shall be attended and managed in accordance with PR S 40004.

Refer to the WSP 2G User and Operations & Maintenance manuals for details on accessing the Diagnostic and Maintenance terminal for viewing faults, module indications, alarms and reports.

10 Disconnections and Vital Blocking

WARNING:
Where signalling personnel apply or remove a Vital Block, they shall be Licensed Signalling Personnel holding suitable competency for the task.

Vital blocks provide the means of disconnecting signalling equipment to prevent its operation for the purpose of securing equipment out of use.

Where signalling equipment requires direct disconnection (isolation), the disconnection shall be in accordance with PR S 40009.

Vital blocks are applied to prevent requests being accepted by the interlocking from the control system.

Vital blocks are applied and removed via the HMI Diagnostic and Maintenance terminal through a SIL4 Transaction Authentication Number (TAN) procedure. Refer to the WSP 2G User manual.

In the event of a shutdown of the two Safety Nucleus pairs and consequent loss of status of the interlocking, upon start up, licenced signalling personnel shall confirm that all last known vital blocks are applied before initialising the interlocking.

To ensure that all vital blocks are reapplied, licenced signalling personnel shall run a RCE History report using the HMI Diagnostic and Maintenance terminal (refer to the WSP 2G User Manual).

Where the interlocking is shutdown unintentionally, the active vital blocks shall be established by obtaining and analysing the RCE History report for vital blocks on ART 1.

For precautions to be taken during planned works refer to Section 12.

Ensure that when a vital block is applied or removed confirm the appropriate indication is received on the HMI.

It is essential that any failures of the Diagnostic and Maintenance terminal be promptly attended to, to ensure its availability to apply, remove and review vital blocks.

10.1 Applying Vital Blocks

A vital block can be applied to a route (main and shunt), track section, signal (main and shunt) and points.

Applying a vital block is achieved by executing the block command through the Diagnostic and Maintenance terminal. Refer to the WSP 2G User Manual for details in executing a vital block command.

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Before applying a vital block, ensure that:

- Points are in the correct position (normal or reverse).
- Signal Aspect is at STOP.
- Affected routes are normalised, and auto-reclear is not set.

10.2 Removing Vital Blocks

Removing a vital block is achieved by executing the unblock command through the Diagnostic and Maintenance terminal.

Refer to the WSP 2G User Manual for details in executing the unblock command.

Prior to removing a Vital Block, the licenced signalling personnel shall check and ensure that all applicable point ends are clear of rail traffic and there are no rail vehicles approaching any point ends.

10.3 Disconnection of Signals

Signals controlled from a WSP 2G interlocking are disconnected by means of a vital block applied from the HMI. This control will inhibit all routes associated with the signal. When applying the vital block, the signal shall be first ensured to be at stop.

Where multiple routes are available on a signal, vital blocks for only the required routes shall be applied using the HMI.

Trainstops associated with the required routes can be made inoperable through the interlocking. Refer to PR S 40009 for when a higher level of disconnection is needed and the additional requirements.

10.4 Disconnection of Points

Points controlled from a WSP 2G interlocking can be prevented from operating by means of a vital block applied from the HMI. The vital block applied to points inhibits the operation of all ends of the selected points.

Where points are disconnected for the purpose of either disabling their operation or booking out of use, the vital block can be applied to meet the requirements for disconnection unless required by the Network Rules, Network Procedures or other factors.

Where the point motor is defective or isolated to prevent its operation, the points shall be clipped, locked, and disconnected in accordance with the PR S 40009.

Where points are disarranged, or in any other scenario the points shall be managed in accordance with PR S 40009.

11 Axle counter reset

The WSP 2G HMI provides the ability to perform an Axle Counter reset. This is an unconditional reset that will immediately reset the count to zero and restore the track section to an unoccupied state. Performing the reset shall strictly be in accordance with PR S 40051 and the WSP 2G User Manual.

The reset is only available when the signaller has enabled the unconditional reset (URE) function.

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When performing the unconditional reset from the HMI, the system will also require entering the TAN code to confirm the action. Refer to the WSP 2G User Manual for further details.

WARNING:
Where signalling personnel perform an unconditional axle counter track section reset, they shall be Licensed Signalling Personnel holding suitable competency for the task.

12 Maintenance Procedures

12.1 Powering Down of Equipment

Prior to powering down WSP 2G interlocking, confirm and record what vital blocks are currently applied by running a RCE History block report and observing the Diagnostic & Maintenance terminal HMI.

When powering down the entire WSP 2G interlocking, the shutdown procedure defined in the WSP 2G User Manual shall be followed.

The power supply distribution rack provides circuit protection and isolation to individual modules via the MIAT, MIFI and MIST MCB's located at the top of the rack.

In the event of replacing equipment on the WSP 2G rack, equipment that is connected via power cables (fan units/routers/firewalls/KVM) shall be isolated via the respective MIAT and MIFI MCB's located at the top of the rack as they are not hot-swappable.

Modules on the FDC 3G requiring replacement that are connected via the rack backplane are considered "hot-swappable" and do not require isolating before replacing. Isolating modules will result in loss of power to CPU's or vital equipment and may result in a FDC 3G system shutdown depending on reserve module availability.

If an entire cubicle is to be isolated for maintenance or replacement purposes, ensure all power supplies are isolated including any emergency power supplies.

If both ART servers need to be powered down or restarted, a loss of communication to ATRICS will occur. The licenced signal personnel shall first contact the network area controller as ATRICS will report a loss of communications (blue outline).

12.2 Powering up of equipment

When powering up the WSP 2G interlocking, the start-up procedure defined in the WSP 2G User Manual shall be followed.

When powering up equipment, it is important that the occurrence of a double master condition is avoided. A double master condition will result in there being no active side. To avoid this, the licenced signalling personnel shall ensure, before starting the WSP 2G Safety Nucleus, that all the links (interfaces, cables, switches, etc.) between the vital CPU of the normal pairing and back-up pairing are correctly in place, not damaged and that at least one ART is working.

If a Slave Safety Nucleus pairing alarm is displayed after the restoration of the system, the licenced signalling personnel shall investigate as it may indicate a double Master Safety Nucleus condition. The licenced signalling personnel shall confirm that all links (interfaces, cables, switches, etc.) between the vital CPU of the normal pairing and back-up pairing are correctly in place, not damaged and that at least one ART is working, otherwise the

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responsible person shall switch off the previously identified Slave Safety Nucleus and restart following the correct start up procedure.

When the Master Safety Nucleus completes its start-up sequence, it takes approximately 30 seconds before communications pass through the first CPIC Processor Ethernet Interface board. After this time the HMI will be updated.

Note:
When the HMI is updated, the HMI loses the appearance of the actual field element status indications, where the display is a magenta colour.

If the WSP 2G CPU or CPIC processor Modules have been replaced and the LED indication of the Slave Mode Nucleus starts blinking (which happens before reaching the full availability of redundancy). The time needed to allow the system to fully restore will take approximately 30 seconds for up to 20 FDC 3G subracks and an additional 1 second for every FDC 3G subrack above 20.

Note:
1 cabinet can house up to 4 FDC 3G subracks

Communications through the CPIC second and third Ethernet interface channels (toward ART and CC), are not affected by this delay of initialisation.

Once the interlocking has powered up the system will be in a pre-initialisation state. While in the pre-initialisation state, the system will not accept commands sent from the Control System except for the URE command.

WARNING:
A complete shutdown of the interlocking will clear all vital blocks. These blocks shall be re-applied prior to initialisation of the interlocking.

If the system has restarted due to a total loss of power, then the licenced signalling personnel shall confirm any last known vital blocks and reapply. Refer to Section 12 for details on vital blocks.

The licenced signalling personnel is required to initialise the system by executing the initialisation command on the HMI as described in the user manual.

Successful initialisation is indicated by the green steady start up indicator at the top left-hand side of the HMI.

12.3 Repairs

Field repairs shall not be carried out on any WSP 2G or FDC 3G equipment. All WSP 2G and FDC 3G equipment (housings, racks, backplanes, modules and I/O connectors) are vital components and should not be modified. Faulty equipment shall be returned to Logistics for sending to Hitachi Rail STS or agent for repair.

12.4 Rack/Backplane Replacement

In the event a rack or backplane requires replacement, the entire cabinet shall be electrically isolated. This will require disconnection of multiple wires and shall be in accordance with PR S 40012.

12.5 Replacement of Lineside Replacement Unit (LRU) modules

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12.5.1 General Module Replacement

In the event a WSP 2G or FDC 3G module is identified as faulty and requires replacement, the following requirements apply:

- If removing an operational module that acts in redundancy, ensure its redundant modules are operational.
- Unless noted as "Hot Swappable" ensure module is isolated at the MCBs before removal.
- The replacement module shall be checked to ensure it is the same as the module being replaced model, type, configuration and firmware (as applicable). Some units are required to be supplied with firmware preloaded by Hitachi Rail STS. These shall be supplied with the latest software certificates.
- Modules shall be checked for physical condition prior to installation or use. Modules that are not in good physical condition or have loose parts shall not be used and shall be treated as defective.
- Personnel shall preferably use an earth strap or alternatively touch earthed metalwork with both hands before replacing any modules.
- The original module should be restored prior to further testing if a replacement module did not correct the fault.
- After replacement of a module, the module operation is to be checked by observing indications on the module and reviewing the Diagnostic and Maintenance terminal for any residual alarms. A sample of inputs or outputs shall be tested for correct operation.
- Defective modules shall be tagged with the date, defect, and location, and returned for repair.

12.5.2 CPU Module Replacement

Prior to replacing a defective CPU module, a check shall be made of the replacement module to ensure it is of the same type and contains the latest software, as approved. It shall be necessary to cross-verify the replacement module with the Installed Data form in the circuit book prior to installing the module.

After replacing a CPU module inspect the module LEDs and ensure there are no associated alarms raised on the Diagnostic and Maintenance terminal. Also ensure there is no watchdog errors, and the system has both sides operational.

12.5.3 Replacement of I/O Connectors

When replacing I/O connectors ensure the following precautions:

- Care is taken when removing or replacing plug and socket so not to cause damage to the plug or socket.
- Remove connectors via the plug. Do not pull on the cable.
- Avoid touching the backplanes.
- Do not use tools or practices that may cause damage.

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12.6 Loading Data

WARNING:
Signalling personnel carrying out the procedure to upload data, shall be Licensed Signalling Personnel holding suitable competency for the task.

Actions required to load data onto the WSP 2G includes an upload process and verification process using USB memory sticks. Preparation of USB sticks, data upload and verification shall follow the procedure defined in the WSP 2G User manual.

USB flash memory sticks used to upload and verify data shall be 8GB in capacity and of identical type with a clearly visible read/write blinking LED. Refer to Section 6 for Cyber security requirements.

Actions required to load data onto the FDC 3G include an upload process using a maintainers laptop and a verification process using the WiSion2G (Diagnostic and Maintenance terminal). Data upload and verification shall follow the procedure defined in the WSP 2G User Manual.

WARNING:
When loading data on the FDC 3G, switching off the subrack will cause signals to black out.

Prior to a change of data, a check shall be performed to identify the current installed version.

As part of the verification process, the data version and checksum shall be cross verified against the Installed Data form and confirmed to be correct by another licensed signalling person.

If a new release of data is to be loaded, a copy of the existing data shall be on hand to restore the system to its previous state in the event of an error with the new release data.

12.6.1 Authorities for loading data

Signal Electricians and Signal Engineers are permitted to load like for like data as shown on the respective Installed Data form. The persons carrying out the activity are to be captured in the Sydney Trains failure management system or defect management system as applicable.

Any change to data shall be considered as a commissioning activity, done in accordance with PR S 47111.

12.7 Data Management

The management, distribution and version control of WSP 2G data issued and installed in the field shall be in accordance with PR S 40014.

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12.8 Pre-Programmed Spares

Pre-programmed modules shall be taken into account to support operational critical interlockings.

The maintenance signal engineer shall determine the holding requirement for pre-programmed spares considering such factors as system redundancy, operational criticality and any previous incidents at that interlocking.

Pre-programmed spares shall be appropriately labelled to ensure version control. Pre-programmed module spares shall be labelled with their version number, checksum, application image CRC, software version, Software CRC and date of programming.

12.9 Insulation Testing

Wiring that is connected directly to the WSP 2G or FDC 3G shall not be insulation tested.

When insulation testing other wiring shall first be disconnected from the WSP 2G and FDC 3G by the removal of plugs, fuses, links or by the de-energisation or removal of relays.

Refer to PR S 40023 for insulation testing requirements and exemptions.

12.10 System Time

WSP 2G, ART, DGM and maintenance terminal date and time is managed by a Network Time Protocol (NTP) server. Separate correction for Eastern Standard Daylight Time is not required. Refer to the WSP 2G user manual for details.

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