Ref:	**NR/L3/SIG/10064**
Issue:	13
Date:	07 June 2025
Compliance date:	06 September 2025

Level 3

Work Instruction

General Instructions to Staff Working on S&T Equipment

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Ref:	**NR/L3/SIG/10064**
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User information

This Network Rail document contains colour-coding according to the following Red–Amber–Green classification.

Red requirements – *no variations permitted.*

- Red requirements are to be complied with and achieved at all times.
- Red requirements are presented in a red box.
- Red requirements are monitored for compliance.
- Non-compliances will be investigated, and corrective actions enforced.

Amber requirements – *variations permitted subject to approved risk analysis and mitigation*

- Amber requirements are to be complied with unless an approved variation is in place.
- Amber requirements are presented with an amber sidebar.
- Amber requirements are monitored for compliance.
- Variations can only be approved through the national variations process.
- Non-approved variations will be investigated, and corrective actions enforced.

Green guidance – *to be used unless alternative solutions are followed*

- Guidance should be followed unless an alternative solution produces a better result.
- Guidance is presented with a dotted green sidebar.
- Guidance is not monitored for compliance.
- Alternative solutions should be documented to demonstrate effective control.

Ref:	NR/L3/SIG/10064
Issue:	13
Date:	07 June 2025
Compliance date:	06 September 2025

Compliance

This Network Rail standard/control document is mandatory and shall be complied with by Network Rail Infrastructure Limited and its contractors if applicable from 6th September 2025.

Where it is considered not reasonably practicable[1] to comply with the requirements in this standard/control document, permission to comply with a specified alternative should be sought in accordance with the Network Rail standards and controls process, or with the Railway Group Standards Code if applicable.

If this standard/control document contains requirements that are designed to demonstrate compliance with legislation they shall be complied with irrespective of a project's Project Acceleration in a Controlled Environment (PACE) phase or equivalent governance framework. In all other circumstances, projects that have formally completed PACE strategic development & project selection phase may continue to comply with any relevant Network Rail standards/control documents that were current when PACE phase 1 was completed.

NOTE 1: *Legislation includes National Technical Specification Notices (NTSNs)*

NOTE 2: *The relationship of this standard/control document with legislation and/or external standards is described in the purpose of this standard.*

NOTE 3: *For more information on PACE see NR/L2/P3M/201.*

Disclaimer

Supply

Copies of standards/control documents are available electronically, and for free to third parties working with Network Rail, from Network Rail's Official Standards Portal, found via the Network Rail website. Hard copies of this document may be available on request.

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[1] *This can include gross proportionate project costs with the agreement of the Network Rail Assurance Panel (NRAP).*

Ref:	NR/L3/SIG/10064
Issue:	13
Date:	07 June 2025
Compliance date:	06 September 2025

Issue record

Issue	Date	Comments
1	Jan 1998	Emergency issue by Railtrack
2	Apr 2006	Updated to Network Rail issue
3	Jun 2009	Updated section U004 in reference to Hardlock nuts fitted to point stretcher bars
4	Dec 2010	Updated to include new G!/B004 requiring preservation of evidence after accidents and incidents
5	Dec 2016	New module B005, E022 updated to incorporate LOI323 and module A011 withdrawn. Re-categorised as Level 3 document
6	March 2018	Module B005 update to reflect actual product installed
7	Sept 2018	Modules A003 & A013 – Minor amendments to remove out of date references to ORR documents. Module A012 withdrawn as out of date.
8	June 2019	Modules X01 to X04 withdrawn as superseded by NR/L3/SIGELP/50003 and E041 reissued to reflect modern technology
9	Dec 2020	New Modules added – B006 Damaged Signalling Equipment and R001 Remote Maintenance – EBI Track 200 Calibration Guide.
10	Sep 2021	Review and re-issue of all modules as part of a full document review.
11	June 2022	Minor corrections to B001, B002, U033, T001 Flow Chart symbols corrected and U034 full re-write.
12	December 2024	New Module Added – B009 Disconnections – Protection for T3-D by Technician's Controls B002 and B008 excludes box updated to reflect New B009 Module
13	June 2025	New Module Added – R004 - Remote Maintenance – EBI Track 400 Calibration Guide

Legislation

No legislation has been identified that is applicable to the content of this standard/control document.

Contents

Ref:	NR/L3/SIG/10064
Issue:	13
Date:	07 June 2025
Compliance date:	06 September 2025

1 Purpose

This Handbook covers personal safety issues and the essential features of S&T equipment. The Handbook also includes information not covered by the Rule Book which is necessary for any S&T staff involved in lineside or technical work.

2 Scope

This Handbook applies to signal engineering staff.

Ref:	NR/L3/SIG/10064
Issue:	13
Date:	07 June 2025
Compliance date:	06 September 2025

3 Contents

Ref:	**NR/L3/SIG/10064**
Issue:	13
Date:	07 June 2025
Compliance date:	06 September 2025

Part E				
E001	Electrical Interference	3	04/09/2021	04/12/2021
E002	Electromagnetic Compatibility with Rolling Stock	3	04/09/2021	04/12/2021
E003	Use of Mobile Telephones, Radio Transmitters and Un-Suppressed Portable Devices	3	04/09/2021	04/12/2021
E004	Safe Handling of Electrostatic Sensitive Devices	3	04/09/2021	04/12/2021
E005	Segregation of Wiring	3	04/09/2021	04/12/2021
E022	Rectification of Earth Faults	4	04/09/2021	04/12/2021
E041	Signalling Circuits in Telecommunication Systems	4	04/09/2021	04/12/2021
E052	Insulation of Unterminated Wires	3	04/09/2021	04/12/2021
E054	Securing Points Out of Use	3	04/09/2021	04/12/2021
E055	Rusty Rails	1	04/09/2021	04/12/2021
Part G				
G001	Cable Replacement - Top Nutting Process	1	04/09/2021	04/12/2021
G002	Status of Existing Cable - Check Sheet	1	04/09/2021	04/12/2021
G003	Cables Terminated on RHS - Check Sheet	1	04/09/2021	04/12/2021
G004	Cable Terminated on Left Hand Side - Check Sheet	1	04/09/2021	04/12/2021
G005	Top-Nutted Cable on RHS Check Sheet	1	04/09/2021	04/12/2021
G006	Top-Nutted Cable on LHS - Check Sheet	1	04/09/2021	04/12/2021
G007	Cable on Right Hand Side Changeover - Check Sheet	1	04/09/2021	04/12/2021
G008	Cable on Left Hand Side Changeover - Check Sheet	1	04/09/2021	04/12/2021
Part M				
M002	Seasonal Precautions	3	04/09/2021	04/12/2021
M003	Alignment of Unipart Dorman Signal Heads	1	04/09/2021	04/12/2021
Part P				
P001	Painting of Signalling Equipment	3	04/09/2021	04/12/2021
P011	Labelling Internal Equipment	3	04/09/2021	04/12/2021
P015	Safety Signs for S&T Installations	3	04/09/2021	04/12/2021

Ref:	**NR/L3/SIG/10064**
Issue:	13
Date:	07 June 2025
Compliance date:	06 September 2025

Part R				
R001	Remote Maintenance – EBI Track 200 Calibration Guide	2	04/09/2021	04/12/2021
R002	Remote Signalling Busbar Monitoring (II)	1	04/09/2021	04/12/2021
R003	Track Circuit Calibration for Remote Condition Monitoring (RADAR)	1	04/09/2021	04/12/2021
R004	Remote Maintenance – EBI Track 400 Calibration Guide	1	07/06/2025	06/09/2025
Part T				
T001	Testing - General	4	04/06/2022	03/09/2022
T002	Emergency Testing	1	04/09/2021	04/12/2021
Part U				
U001	Tools, Measuring Instruments and Calibration	3	04/09/2021	04/12/2021
U002	Inspection and Safety of Tools, Plant and Protective Equipment	3	04/09/2021	04/12/2021
U003	Fixings: Nuts, Bolts, Screws, Washers, etc	3	04/09/2021	04/12/2021
U004	Hardlock Nuts	4	04/09/2021	04/12/2021
U005	Torque Wrenches	3	04/09/2021	04/12/2021
U007	Checking Gauges	3	04/09/2021	04/12/2021
U012	Extractor Tools	3	04/09/2021	04/12/2021
U017	Insulation Displacement Connectors	3	04/09/2021	04/12/2021
U019	Use of the Volt Stick	1	04/09/2021	04/12/2021
U020	Meters for Signalling Use	3	04/09/2021	04/12/2021
U021	Insulation Test Equipment	3	04/09/2021	04/12/2021
U033	Use of Monitoring and Test Equipment	4	04/06/2022	03/09/2022
U034	Management and Control of Temporary Straps	4	04/06/2022	03/09/2022
U041	Miscellaneous Test Equipment	3	04/09/2021	04/12/2021
U042	Earth Fault Test Adapters	3	04/09/2021	04/12/2021
U043	AWS Strength and Polarity Meter	3	04/09/2021	04/12/2021
Part W				
W002	Portable Plant, Tools and Materials at the Lineside	3	04/09/2021	04/12/2021
W004	Common Worksite Hazards for S&T Staff	3	04/09/2021	04/12/2021
W011	Asbestos	3	04/09/2021	04/12/2021
W012	Polychlorinated Biphenyls (PCBs)	3	04/09/2021	04/12/2021

Ref:	**NR/L3/SIG/10064**
Issue:	13
Date:	07 June 2025
Compliance date:	06 September 2025

Part X				
X011	Electrical Safety - Cathode Ray Tubes	3	04/09/2021	04/12/2021
X021	Safety in Battery Rooms	3	04/09/2021	04/12/2021

END

1. Definitions

1.1 A glossary of general signalling terms is given in GK/GN0802. Those terms are not repeated here except where they have been given a more technical definition for use within this document.

1.2 Any reference to source indicates that the definition has been taken from an external document.

Term	Definition
Adequate sighting	Checking that the driver's view of a signal is not obstructed, e.g. by trees, bushes, buildings or other structures, and be seen and interrupted by the driver as required by the Signal Sighting Assessment Form (see NR/L2/SIG/10157).
Affected lever/locking	Lever, mechanical locking or lever lock that could be affected by the work being carried out. The work might affect the integrity of the locking, for example: a) Through the removal of a locking mechanism b) A potential release of the locking mechanism allowing a lever to become free when it should be locked c) An alteration to the settings and associated locking, or any inadvertent alteration to the mechanical locking.
Alterations	Changes to existing installations (including the provision of new signalling) which forms part, or all of a self-contained scheme. A single alteration, is by definition, one which is designed to be commissioned on a single occasion.
Apparatus	The equipment needed for a particular activity or purpose.
Apparatus case	An apparatus housing which is intended for unprotected outdoor use, is smaller than a building or REB and is usually capable of being transported as a made-up unit. Can also be known as an apparatus cupboard.
Apparatus cupboard	See Apparatus case.
Apparatus housing	This is provided to house relays and/or other equipment at lineside locations or interlockings, and can consist of an apparatus case, disconnection box, equipment room, REB, signal box, control centre, or other equipment building.
Application criteria	Document(s) specifying the constraints applied to the installation and maintenance of a system or an item of equipment in order that it can be guaranteed to deliver the performance attributes stated in the system or equipment specification.

Term	Definition
Approval	Authorisation of a product type for use (see NR/L2/RSE/100) or, in the case of infrastructure works, for scheme plan acceptance or for construction (see NR/L2/CIV/003 and NR/L2/SIG/11201). See also Product Acceptance.
Aspect test	See Signal Aspect Test.
Assessment	Carry out an investigation to arrive at a judgement based on evidence of: a) Suitability of a product/system b) Competence of a person c) Acceptability of a risk.
Automatic function	A signalling function that, under ordinary operation, is operated automatically by the passage of trains. The function is associated with a particular signal box from which its operation is supervised, unless some form of local monitoring is provided. The state of the function when there are no trains present is designated normal.
Back (B) contact	A contact of a relay which is made when the relay is released and broken when it is operated.
Back feed	An inadvertent feed which has arisen at an intermediate point within a circuit due to the uncontrolled combination of positions of several pieces of control equipment.
Balise	A track mounted spot transmission unit that uses magnetic transponder technology. Its function is to transmit/receive messages to/from the train passing overhead.
Balise Certificate of Conformity	Provides conformation that the Balise has been correctly programmed to allow replacement under SMTH (see NR/SMTH/Part01/Module/15).
Balise Positioning Form (BPF)	Provides all the necessary information to the Installer to allow the accurate trackside positioning and installation of the Balise.
Block tests (various)	A test to check correct operation of specified block equipment (see NR/SMTH/Part03).
Bonding plan	A detailed plan of the track layout showing individual rails and position of IRJs, together with track circuit feed and relay connections with polarities, cross bonds, structure bonds, impedance bonds etc. (as applicable). This term can also include track plans and negative Bonding Plans in D.C. electrified areas.
Brush	A maintenance task to remove all loose dirt from apparatus and foundations.
Cable function test	A test to verify that each circuit in a cable functions correctly after work on that cable (see NR/SMTH/Part03/TestB04).
CEN60	Rail Section of 60kg/m rail.

Term	Definition
Change-over contact	See dependent contact.
Check	A task to verify correct operation within its defined tolerances, and/or fulfilment of purpose, by visual, audible and/or physical inspection for alignment, obstruction, breakage, decay, obvious damage.
Circuit diagrams	A collection of individual drawings showing the equipment layout and circuit arrangement associated with a location, an interlocking or signal box.
Circuit function test	A test of each individual circuit to verify the presence of the necessary controls. This test applies to signalling works testing.
Class I equipment	Electrical equipment that requires the connection of the exposed-conductive-parts to a protective conductor connected to earth, to provide personal safety. See BS 2754.
Class II equipment	Electrical equipment with double or reinforced insulation, either to prevent contact with exposed-conductive-parts, or to prevent contact between such parts and live parts. The insulation is not therefore to be pierced by screws. Such equipment is never connected to earth. See BS 2754.
Clean	A maintenance task to remove moisture, dirt, corrosion or roughness e.g. from contact faces.
Closure list	Final Index of design details issued to the tester in charge.
Common cause failure (CCF)	A failure which is the result of an event(s) which, because of dependencies, causes a coincidence of failure states of components in two or more separate channels of a redundancy system, leading to the defined system failing to perform its intended function.
Competence	The ability to undertake responsibilities and to perform activities to a recognised standard on a regular basis. A combination of practical thinking skills, experience and knowledge, and can include a willingness to undertake work activities in accordance with agreed standards, rules and procedures (See NR/L2/CTM/012).
Concentrator	A facility to connect several telephone circuits to one terminal and thus avoid the need for a telephone instrument for each circuit.
Configuration control	A procedure to check that the functional and physical characteristics of a design or product are satisfactorily identified and that changes to these characteristics are controlled and traceable throughout the life cycle of the design or product, by recording its version or modification state. Also known as version control.

Term	Definition
Configuration (system)	The structuring and interconnection of the hardware and software of a system.
Construction	The carrying out of any building, civil engineering or other engineering work, particularly that which falls within the scope of the Construction (Design and Management) Regulations. Also known as Installation.
Continuity test	A test to verify the continuity and correspondence of each individual wire/cable core shown on the wiring diagrams.
Control point	A signal box (including control centre), gate box or ground frame (including ground switch panel or shunting frame).
Control table test	A test to check that each signalling function conforms to all the requirements specified in the approved Control Tables. This test applies to signalling works testing.
Controlled function	A signalling function that, under ordinary operation, is controlled from the signal box (or other control point) to which the function is allocated and can be interlocked with other signalling functions.
Correlation	The comparison of the configuration and version status of a system with the design records, to verify that the two are in agreement.
Correspondence	Checking that the following all agree: a) The controlling device, e.g. relay or SSI telegram, AND b) The operated function, AND c) The associated signal box indication(s), e.g. repeat relay or SSI telegram.
Custodian (of records)	The organisation appointed by the Infrastructure Manager to manage the master records. Also known as records custodian.
Cut section (track circuit)	A method of reducing the continuous length of a track circuit by the use of individual track circuits, each one controlling a common final track repeat relay, or equivalent. These are indicated as one track circuit on the Signaller’s display. This is also known as a multi-section track circuit.
Data (signalling)	Site specific geographical and control information in an electronic form, which can be of a safety-critical nature or otherwise.
Data link	A serial data transmission system.
De-energised (relay)	See Released.
Degraded conditions	The state of the part of the railway system when it continues to operate in a restricted manner due to the failure of one or more components.

Term	Definition
Dependent contact	A contact set which consists of a front contact, a back contact and one arm shared between them, with not more than one contact path made at any one time. Also referred to as change-over contact.
Design	A wide term including specification and the production of drawings, design details and bills of quantity (including specification of systems or equipment).
Design authority	Network Rail or such other organisation as is contracted by Network Rail to undertake specified design work on a system or on the infrastructure.
Design details (signalling)	Any plans, control tables, engineering details and data, which are required to define signalling systems and equipment for production or record purposes.
Design records	Design details defining the current state of the signalling infrastructure/system.
Destructive test	A test which can alter the electrical, mechanical or physical state of the equipment.
Difference list	A computer/data processor generated print out (produced by a validated software program) which details the data differences between two versions of a software program or data.
Disarrangement of interlocking	The interlocking can no longer be relied on to operate safely because of the removal or disturbance of component parts.
Disconnection box	An apparatus housing for unprotected outdoor use, which is intended to contain mainly terminations and is commonly smaller than an apparatus case.
Double-cut (circuit)	The inclusion of controls in both feed and return legs to mitigate the risk associated with a false feed or earth fault.
Drop away (DA) voltage (relay)	The maximum voltage applied to an operated relay coil at which the last front contact breaks.
Drop shunt	The maximum value of non-inductive resistance which, when placed across the rails, causes the track relay to fully open its front contacts.
Drop-away time (track circuit)	The time between the application of a shunt to the rails and the front contacts of track relay (TR) fully opening. The converse is pick-up time.
Dust	A task involving a light dusting of equipment with brush (with no exposed metallic surfaces) or duster e.g. relay tops.
Earth fault	Unintentional contact between a circuit conductor and a conductive part at earth potential, by which an earth fault current might flow.
Earth fault detector	A device, wired to the busbars, that detects an earth fault on the power supply and give an alarm. Also known as earth leakage detector.
Earth fault loop impedance	The impedance of the earth fault current loop starting and ending at the point of earth fault. (Source: BS 7671 extract).

Term	Definition
Earth leakage detector	See earth fault detector.
Earth test	A test to verify that leakage current to earth is below specified limits.
Emergency situation	A current unforeseen or unplanned event which has life threatening or extreme loss implications and requires immediate attention (e.g. a fire).
End of Movement Authority (EoA)	Location to which the train is authorised to proceed and where the target speed is zero under ERTMS.
Energised	See operated.
Engineering details (signalling)	Design details from which a signalling system is constructed.
Engineers Line Reference (ELR)	A unique alphanumeric code used by Network Rail to define each route segment of the network.
Equipotential bonding	Electrical connection maintaining various exposed-conductive-parts and extraneous-conductive-parts at substantially the same potential. It need not include a direct connection to earth. (Source: BS 7671 augmented).
European Rail Traffic Management System (ERTMS)	ERTMS comprises the European Train Control System (ETCS), the Global System for Mobile Communications – Railway (GSM-R), Traffic Management Systems (TMS) and operating rules.
Examine	A task involving a close physical inspection of apparatus and connections for wear, security, corrosion, deterioration decay and damage.
Exposed-conductive-part	A conductive part of equipment that can be touched and which is not a live part, but which might become live under fault conditions. (Source: BS 7671).
External (circuit or power supply)	Any circuit/power supply that fails to wholly meet the internal criteria.
Extraneous-conductive-part	A conductive part liable to introduce a potential, generally earth potential, and not forming part of the electrical installation, e.g. structural metalwork. (Source: BS 7671 augmented).
Extraneous lighting	An external light source affecting a signal aspect, e.g. from an open signal head door or nearby streetlamps.
Fail-safe	A concept which is incorporated into the design of a product such that in the event of failure, it enters or remains in a safe state. (Source: BS EN 50129).
Functionally Equivalent Design (FED)	Allow staff without formal design qualifications to undertake minor design changes providing they demonstrate experience in producing clear, unambiguous, legible designs and an understanding of the equipment types being worked on (See NR/L2/SIG/11201/Mod A2-9).

Term	Definition
Final functional test	A test carried out immediately prior to "signing-in" for operational use to verify all equipment is fully connected and operates correctly.
FREDDY	Flange Reading Electronic Detector Designed at York. FREDDY treadles are not approved for use on Network Rail Managed Infrastructure.
Free-wired interlocking	A relay interlocking that comprises individually wired relays, rather than pre-wired geographical sets of relays.
Frequency division multiplex (FDM)	A data transmission system that uses unique frequencies to separate channels over a single pair of conductors.
Front (F) contact	A contact which is made when the relay is operated and broken when it is released.
Functional earthing	The connection to earth necessary for the proper functioning of electrical equipment, i.e. an earth return. This can be used for telecommunications purposes but is no longer permitted for new signalling circuits. Conductors for functional earthing are identified by the colour cream. (Source: BS 7671 augmented).
Gauge or Test	A task to examine apparatus for correct functioning and adjustment within the specification, by operating or by using a calibrated gauge, tool or instrument.
Global Positioning System (GPS)	A non-railway system used to determine geographical location.
Guaranteed power supply	See secure power supply.
Independent checking	Independent checking means that one person undertakes the work and another person checks or tests it. In some cases, the work can allow two staff to work on two tasks and then change over to check or test each other's work (as long as both are suitably competent).
Infrastructure Manager	As defined in the Railways and Other Guided Systems Regulations (ROGS) 2006, means an organisation who: a) In relation to infrastructure other than a station, is responsible for developing and maintaining that infrastructure b) In relation to a station, the organisation who is responsible for managing and operating that station, except that it does not include any organisation solely on the basis that they carry out the construction of that infrastructure or station or its maintenance, repair or alteration c) Manages and uses that infrastructure or station, or permits it to be used, for the operation of a vehicle.
Inspection	A visual check to verify that the specified equipment has been installed securely, undamaged and in accordance with the design details.

Term	Definition
Installation (infrastructure)	That part of the signalling system associated with the infrastructure at a particular place.
Installation (function)	See construction.
Insulated block joint (IBJ)	See insulated rail joint (IRJ).
Insulated rail joint (IRJ)	A method of joining rail ends together whilst maintaining electrical insulation between them. An alternative non-preferred term is insulated block joint (IBJ).
Insulation test	A test to verify that a cable, wire, spare core or other equipment meets the required insulation criteria.
Interlocking (building)	The building housing the interlocking system, where separate from the signal box (or other control point).
Interlocking (equipment)	The equipment that performs the role required of the interlocking system.
Interlocking (system)	The safety-critical locking provided between signalling functions in accordance with control tables.
Interlocking area	The area of railway controlled by a particular interlocking, extended up to a boundary with each other adjacent interlocking controlled by the same or another signal box.
Internal (circuit)	A circuit that does not leave the apparatus housing in which it originates, and which is fed from a busbar which feeds only internal circuits. This includes the feed to an isolated transformer supplying an external circuit. Circuits that extend between adjacent apparatus housings can be considered internal, if they are run in a protective non-conducting duct and are judged to be away from any environment that might be susceptible to earth faults.
Internal (power supply)	A power supply feeding only internal circuits. Also known as local power supply.
Joint hopping	Where fast moving short vehicles pass from one track circuit to the next, the difference between the pick-up and drop-away times can cause the vehicle to momentarily be undetected. Also known as light engine syndrome or track jumping.
Jumper	An interconnecting cable (commonly single core) between two termination points within an apparatus housing.
Jumper cable (track circuit/traction)	An interconnecting cable (commonly single core) between two pieces of rail that are not adjacent, for track circuit or traction purposes. This includes midpoint connections to impedance bonds.

Term	**Definition**
Lamp proving relay	A neutral D.C. relay designed to operate from the current supplied to signal lamps and to release when lamp or lamps burn out. Some relays incorporate a bridge rectifier to operate from A.C. lamp currents.
Left hand relay	The left-hand half of a twin relay as viewed from the front. In a 930 series twin relay this controls the contacts in banks C and D.
Less-vital	Safety-related but not safety-critical.
Light engine syndrome	See joint hopping.
Like for like replacement	The removal and restoration of an item of equipment, including a cable, in a previously working and commissioned system where the work does not change the design. This can involve restoring the original item of equipment or replacing it with an operationally equivalent new item.
Line circuit	An external relay circuit that is not a trackside circuit, i.e. a circuit that runs between apparatus housings, but does not go via trackside equipment.
Local panel	A panel provided at the interlocking and capable of being used to take over control from the main panel at the signal box. It can also be used as a maintainer's monitoring panel, when the operating function is not in use.
Local power supply	See internal power supply.
Location	A group of all signalling lineside apparatus housings (including buildings) at a particular site and the equipment contained within (this excludes apparatus housings that perform a main interlocking function, although some interlocking local to ground frames or level crossings can be included). Alternatively known as lineside location.
Lubricate	A task to oil and grease parts to reduce friction or provide protection. Surplus lubricant to be wiped off.
Main cable	A twin or multicore lineside cable carrying signalling functions or power supplies between apparatus housings.
Main earthing terminal (MET)	The terminal or bar provided for the connection of protective conductors, including equipotential bonding conductors, and conductors for functional earthing if any, to the means of earthing.
Maintainer's monitoring panel	An indication panel situated at the interlocking that repeats the indications sent to the Signaller and allows the maintainer to observe the state of the interlocking. It also indicates various fault conditions. This can be combined with a test panel.

Term	**Definition**
Maintainer's terminal	It is used to obtain essential fault diagnostic information and also acts as an interface with the system to enable restrictive controls on the equipment to be set. Also known as Technician's terminal.
Maintenance	The combination of all technical and administrative actions, including supervision actions, intended to retain a product in, or restore it to, a state in which it can perform a required function, i.e. prevent or rectify a failure. (Source: BS EN 50126 augmented). See also maintenance task.
Maintenance records	a) Design records kept on site for maintenance purposes. Also known as site records. b) Records of maintenance that has been undertaken.
Maintenance task	The individual task which is carried out in order to achieve the required level of safety and reliability whilst optimising the useful working life of an item of infrastructure. (Source: NR/L3/SIG/10661). An interval between services that meets the requirement for signalling infrastructure maintenance is specified in NR/L3/SIG/10661.
Maintenance tester	A person certificated as competent in the application of Maintenance Testing.
Master record	The approved signalling design record from which duplicates are obtained for issue.
Mechanical locking function test	A test to verify that each mechanical lever is locked in its correct position and conforms to the mechanical locking table.
Mentor	A person appointed as guide and councillor to a Trainee in a specific competence. The Mentor retains responsibility for the Trainee's actions in the Mentored Competence, enabling the Trainee to gain the necessary experience under operational conditions. The Mentor verifies the safety and integrity of the signalling system.
Meshed circuit	Complex circuitry feeding more than one relay, where the same could be achieved by independent circuits, thereby requiring duplication of contacts. Not all paths in a meshed circuit are applicable to all relays.
Method statement	A comprehensive plan of how the work is to be safely carried out to confirm that all hazards are considered, and risks minimised.
Missing equipment	Equipment which was previously working, and which is physically missing or separated from its normal position.
Mod state	See modification status.

Term	Definition
Modification status	The detail that defines the particular version of the design or specification, relative to the functional and physical characteristics of an item of equipment or system. This is recorded under configuration control procedures. Colloquially known as mod state.
Modifications	Changes to the design details which are required to be carried out after they have been officially issued, usually as a result of installation, testing and commissioning activities.
Monitored, local (level crossing)	Checked by the observation of driver's indicator. Which provides the driver with the status of the equipment? See also supervised (level crossing).
Monitored, remote (level crossing)	Checked by the observation of Signaller's indications. Which provide the Signaller with the status of the equipment? See also supervised (level crossing).
Multi-section (track circuit)	See cut-section.
Non-conceptual work	Non - conceptual work is no-longer acceptable and is now covered by NR/L2/SIG/11202/Mod A2-9 which now outlaws this type of work. See Functionally Equivalent Design (FED).
Non-destructive test	A test which can involve: a) Visually examining signalling equipment b) Taking measurements or readings without disturbing or disconnecting the equipment or its wiring, or without affecting the electrical characteristics of the system.
Non-safety-contact	A relay contact that is not a safety contact. This includes metal to metal contacts for medium duty use, where both elements are made of silver, silver cadmium oxide, or 60/40 silver palladium.
Non-safety-related	A signalling function or sub-system where operational safety and the integrity of the interlocking are not directly affected. Also known as non-vital.
Non-vital	An obsolete term. See non-safety related.
Normal (function)	Position of a lever when it is fully back in the lever frame (away from the operator). The non-operated or quiescent state of a two-state system. In the case of points, the normal position is defined on the signalling plan and is generally that which provides the maximum protection, or otherwise the most regularly used position. The converse is reverse.
Note (failure investigation records)	Make a physical record of the visible state, the position, or displayed indications of the equipment or item and its associated controls or operating system(s).

Term	Definition
NR60	Network Rail designed point layouts using CEN60 rail section.
Observe	Look at the equipment in use to confirm it is working correctly and is not faulty. i.e. LED indication and moving parts.
Operate time (relay)	The time interval between the energisation of the relay coil and the first front contact making. In the case of a specification BR949 relay, it is the time between the energisation of the relay coil and the first back contact breaking. The converse is release time.
Operate voltage (relay)	The minimum voltage applied to a released relay coil at which the last front contact makes. Also known as pick-up (pu) voltage.
Operated (relay)	The state of a relay when the armature is energised, picked up (PU), or latched, all front contacts are made, and all back contacts are broken. Also known as energised, and colloquially as ‘picked’ or ‘up’. The converse is Released.
Operationally equivalent	The replacement item of equipment is functionally identical to the item it replaces.
Out of use	Non-operational equipment that is still connected to the infrastructure. See also spare.
Output	This includes all relevant indications, displays, communications links, power drives, etc.
Pick-up (PU) shunt	The minimum value of resistance between the two running rails at which the track relay just closes its front contacts.
Pick-up (PU) voltage (relay)	See operate voltage.
Pick-up time (track circuit)	The time between the removal of a shunt to the rails and the first front contact of the track relay (TR) making. The converse is drop-away time.
Pin-code	See registration pin-code.
Plugboard	The permanent mounting block and termination for external wiring, for use with plug-in equipment.
Plug-in	The attribute of an item of electrical equipment which can be replaced without disconnecting any wiring.
Point detection & correspondence test	A test to verify the required correspondence between points, their controls and indications is achieved and to check detection contacts are effective.
Polarised circuit	A circuit where the resulting operation is dependent on the polarity or phase angle of the feed.
Pre-wired equipment building	See relocatable equipment building.

Term	Definition
Primary function relay	The relay by which the logic required to control a signalling function is brought together. It is the first relay in a chain that directly controls all safety-critical signalling functions. it is the only function relay which has back contacts valid for use in safety-critical functions.
Principles test	A test to confirm that the signalling system provided conforms to Railway Group Standards and Statutory Requirements and is fit for purpose including satisfying the scheme requirements and the operational needs of the layout. This test applies to signalling works testing.
Product acceptance	Authorisation of a product type for use. See NR/L2/RSE/100.
Protect	A task to apply approved protecting agents.
Public emergency telephone system (PETS)	A special high integrity telephone system for use at level crossings, which includes provision for proving that handset connections are intact and also for the transmission of level crossing status indications. The speech path has priority over other facilities.
Pulse code modulation (PCM)	A serial data transmission system by which many channels of information are passed over a data link, by use of a multiplexer.
Random hardware failure	Failures occurring at random times, which result from a variety of degraded mechanism in the hardware. Note 1) There are many degradation mechanisms occurring at different rates in different components and since manufacturing tolerances cause components to fail due to these mechanisms after different times in operation, failures of a total equipment comprising many components occur at predictable rates but at unpredictable (i.e. random) times. Note 2) A major distinguishing feature between random hardware failures and systematic failures is that system failure rates (or other appropriate measure), arising from random hardware failures, can be predicted with reasonable accuracy but systematic failures, by their very nature cannot be accurately predicted. That is, system failure rates arising from random hardware failures can be quantified with reasonable accuracy but those arising from systematic failures cannot be accurately quantified. (Source: BS EN 61508).

Term	Definition
Record (noun)	Information bearing media, irrespective of date or physical format, created or received in the course of carrying out the duties and functions of an undertaking, and subsequently retained by the undertaking or its successors as evidence, as a reference source, or to meet legal or regulatory obligations.
Record	Enter the obtained measurement readings or observations on a record card or in a site logbook.
Records custodian	See custodian (of records).
Rectify	To make good any defects encountered.
Registration pin-code	A series of locating pins assembled in a unique pattern to prevent equipment being incorrectly used. The unique pattern also acts as a means of identification for a specific style and variant of a relay. The term registration pin-code is commonly abbreviated to pin-code.
Release time (relay)	The time interval between the removal of the supply (at rated voltage) to the relay coil and the last front contact breaking. The converse is Operate time.
Released (relay)	The state of a relay when the armature is de-energised, dropped away (DA), or unlatched, all back contacts are made, and all front contacts are broken. Also known as de-energised and colloquially as ‘dropped’ or ‘down’. The converse is Operated.
Relocatable equipment building (REB)	Apparatus housing to specification BR 1615 or equivalent. Also known as walk-in location or pre-wired equipment building.
Reset	Placing a system into a state which corresponds with the actual state of the railway prior to restoration into service, fault finding or testing. For an axle counter, this is the action of setting the number of axles registered in a track section to zero.
Residual voltage	The voltage remaining across the rails or relay of a track circuit after the feed has been disconnected. It can be caused by mutual interference between adjacent single rail track circuits, the battery effect of the track formation, cathodic protection measures, or D.C. traction return or other stray currents.
Restoration	Accepting reset systems back into service by the Signaller after maintenance, failure or (for axle counters) miscount.

Term	**Definition**
Reverse (function)	Position of a lever (or switch) when it is fully out of the lever frame (or operated). The operated state of a two-state system. In the case of points, the reverse position is merely the opposite of the normal position. The converse is normal.
Right hand relay	The right-hand half of a twin relay as viewed from the front. In a 930 series twin relay this controls the contacts in banks A and B.
Right side failure (RSF)	A failure which does not result in the protection provided by the signalling system being reduced. The converse is wrong side failure.
RT60	Point layouts using CEN60 rail section to Railtrack specification
Safe state	Any one of the following: a) the state of the last valid request at the interlocking; or b) correspondence with the state of the trackside equipment; or c) the most restrictive state.
Safety contact	A relay contact that is specified for safety purposes in the 930 series specifications. These are non-weld metal to carbon contacts, generally silver to silver impregnated graphite (SIG) for ordinary use.
Safety-critical	Carries direct responsibility for safety. (Source: BS EN 50129). Also known as vital.
Safety-critical failure	See Wrong side failure.
Safety-critical (function or subsystem)	A function or subsystem where operational safety or the integrity of the interlocking is directly affected. Also known as vital.
Safety-related	Carries responsibility for safety, direct or indirect. (source: BS EN 50129).
Safety-related, but not safety-critical (function or subsystem)	A function or subsystem which might be protected by the interlocking, but where human intervention is part of the process and misleading information could create an unsafe situation or allow one to remain unnoticed. Also known as less-vital.
Scrape	A task to scrape all dirt and surplus grease off apparatus and foundations, e.g. bed timbers.
Secure power supply	A power supply system that can be relied upon to keep certain safety-critical signalling functions operating for a predetermined minimum time, in the event of a total failure of the main incoming supply. Also known as guaranteed power supply.

Term	**Definition**
Signal aspect test	A test to verify that only the correct aspects and indications as specified in the approved control tables and signal aspect sequence charts are displayed to the driver. See NR/SMTH/Part03/Test/B07
Signalling function	Final discrete component of a signalling system listed on control tables with a unique identity (such as signals, points, train detection devices, releases and level crossing barriers) and the circuitry or logic by which it is controlled and/or proved. Signalling functions are allocated (as defined by the control tables) to a specific interlocking controlled by a particular signal box (or other control point) and are given a unique identity within a particular Signaller's area.
Signal Sighting Assessment Record	A record that depicts the profile, location and other details of each signal as agreed by the signal sighting committee. See NR/L2/SIG/10158
Signal Reversion (Conventional Lineside Signalling)	Any occasion where a signal displaying a proceed, preliminary caution, or caution aspect reverts to a more restrictive aspect because of: a) It being returned to a more restrictive aspect by a person working in accordance with the GE/RT8000 or b) In an emergency; or c) It being returned to a more restrictive aspect by any person in error; and d) Failure of signalling or level crossing equipment.
Signal Reversion (ERTMS Signalling)	Any occasion where a cab display movement authority to proceed is changed to a more restrictive aspect or the authority is revoked, and a driver observes an immediate required reduction in speed as the braking curve of the MA has changed.
Signalling system	Equipment, circuitry and software associated with: a) Lineside signals b) Point operation c) Level crossings d) Train detection e) Trainborne equipment conveying information about the state of the line f) Operational telecommunications (excluding electrification control systems and electrification telephones) g) Fixed trackside safety systems.
Single cut (circuit)	The inclusion of controls in either the feed or return leg, but not both, to be used only where there is no significant risk of false feeds or earth faults (See double cut).
Site records	See maintenance records.

Term	Definition
Slow acting relay	A relay in which both operation and release are intentionally delayed.
Slow to operate relay	A relay in which the operation is intentionally delayed and the operate time is significantly longer than the release time.
Slow to release relay	A relay in which the release is intentionally delayed and the release time is significantly longer than the operate time.
Software controlled system (SCS)	Any item of electronic equipment which is controlled by software to enable it to perform the required activities. Examples include, general purpose microprocessor systems (e.g. proprietary Personal Computers), dedicated systems using microprocessors or Digital Signal Processors. Note that a SCS might be composed of separate items, which are referred to in this document as “the parts of the SCS”. Note: Application Specific Integrated Circuits (ASICs) have similar characteristics to software. For example, they are not readily visible to the Tester, they might be created by software-controlled machines, and they might themselves require configuration by data. Therefore, the term SCS shall be taken to include ASICs, and consideration shall be given to applying these requirements to machines which contain no software but do contain ASICs.
SPAD	The term used to describe an event where a train or any part of a train, passes without movement authority a signal displaying a stop indication or stop aspect or an ERTMS EoA.
Spare	Equipment not connected to any part of the infrastructure. See also out of use.
Specialist investigation	Examination or monitoring by a competent, independent signalling and telecommunications specialist capable of undertaking comprehensive technical investigation of equipment and systems, where necessary using complex instrumentation.
Stagger (electrical)	The phase or polarity difference between one track circuit and the next, or between the rails on either side of an IRJ within one track circuit.
Stagger (physical)	Occurs where two IRJs in a pair of rails are not exactly opposite each other, thus creating a dead section between track circuits or within a track circuit.

Term	Definition
State (of a function)	Position or action of the equipment. Examples of complementary states are: operated / released, normal / reverse, on / off, raised / lowered, locked / free, enabled / inhibited, energised / de-energised. In data driven systems this is stored as variable data.
State (of the infrastructure)	Configuration of an installation defined by the current design records.
State (of the railway)	The functional position of trackside equipment which should correspond to the state of the controlling device and the signal box indication.
Strap and function test	A Circuit Function Test where the presence and operation of each individual contact is verified by the application of a test strap. This test applies to signalling works testing.
Supervised (level crossing)	Checked by visual observation, either directly or by use of CCTV. See also monitored (level crossing).
Supervisor	A person with engineering supervisory responsibility for Technician's.
Supervisory (circuit)	Control or indication circuit, particularly in respect of electric traction power supplies.
Systematic failures	Failures due to errors (including mistakes or acts of omission) in any safety life-cycle activity which cause it to fail under some particular combination of inputs or under some particular environmental condition. Systematic failures could arise in any safety life-cycle phase. Examples of systematic failure include: a) Systematic failures due to errors in the safety requirements specification b) Systematic failures due to errors in the design, manufacture, installation, operation of the hardware c) Systematic failures due to errors in the design, implementation etc. of the software. (Source: BS EN 61508)
Tail cable	A cable between trackside or on-track signalling equipment and other such equipment or a lineside apparatus housing. For track circuits, see also track cable.
Technician (signalling)	A person with technical competency to work on signalling equipment, under the direction of a supervisor.
Technician's terminal	See maintainer's terminal.

Term	Definition
Temporary diversion of circuits	The short-term re-allocation of cable cores or relay contacts, where those allocated in the design are no longer available. This might be due to contacts becoming high resistance or a cable suffering insulation breakdown. Alternatively, the emergency repositioning of an item of equipment which has been operating correctly.
Temporary work	Alterations which remain in use for a limited period of time.
Terminated	A wire that is finally connected in its allotted position.
Test	Verify correct, by measurement using test equipment, gauge or tool or by operation.
Test panel	A control panel provided at the interlocking for testing or maintenance purposes. It can be provided temporarily for a commissioning or the function can be performed by the local panel.
Tester	A person who administers a test. In signalling terms this can be a Works Tester, a Maintenance Tester, or a G110 Tester.
Through circuit	A circuit or function which starts at one physical site and ends at another. The circuit or function may be transmitted via a physical cable, or electronic transmission means. A relay through circuit is also known as a line circuit.
Through test	A test to check that each individual circuit between the supply source and the final control function operates and is installed throughout as shown in the approved design details. This test applies to signalling works testing.
Time division multiplex (TDM)	A non-safety-critical serial data transmission system that addresses each channel in turn and converts it into a unique digital code. It is used to transmit operating controls and indications between a signal box and interlockings.
Top-nutting	Top-nutting is the connection of temporary or stagework cables or wires to the top of one side of a terminal strip with the links between the terminal columns removed, so as to interlink with existing circuitry beneath.
Track cable	A track circuit tail cable which connects directly to the rails.
Track jumping	Occurs when a fast-moving vehicle passes over a very short track circuit (or a short arm of a longer track circuit) and fails to de-energise the track relay.
Trackside circuit	An external circuit run to, or via, an item of trackside or on-track signalling equipment in a tail cable.
Train register	This also includes any other book or form prescribed for the purposes of recording times and exceptional occurrences.

Term	Definition
Uninterruptible power supply (UPS)	A power supply with a secondary source which is capable of providing an uninterrupted changeover in the event of a failure of the incoming supply. It consists of low maintenance cells, a charger, voltage regulator, and monitoring, changeover and bypass devices.
Verification	Confirmation by examination and provision of objective evidence that the specified requirements have been fulfilled. (Source: BS EN 61508).
Version control	See configuration control.
Vital	See safety critical.
Walk-in location	See relocatable equipment building.
Wash	A task to remove contaminated oil’s, greases and dirt by applying an approved cleaning agent, or by using a detergent and water, and then drying.
Wipe	A task to rub apparatus with a cloth so as to remove dirt, grease etc.
Wire count	A visual examination to confirm that the specified number of conductors is securely connected to each terminating point as shown on the wiring diagram and/or contact analysis, and that the conductors are correctly labelled.
Wrong side failure (WSF)	A failure which reduces the protection normally provided by the signalling and telecoms infrastructure. (Source: NR/L2/SIG/10047). Also known as safety-critical failure. The converse is right side failure.
WSF protected	A WSF where another part of the Signalling Infrastructure system provides an acceptable level of protection.
WSF unprotected	A WSF where no other part of the Signalling Infrastructure system provides an acceptable level of protection.

END

1. Briefing

1.1 All staff shall be briefed on the standards and work instructions that are applicable to their duties.

1.2 Managers shall keep a record of all staff that are briefed and rearrange catch-up sessions for those unable to attend.

1.3 Staff shall confirm that those standards that require a change in working practice are clearly understood, e.g. by means of a question and answer session, or discussion with feedback.

Arrangements to brief those staff returning from long term leave/sickness shall be put in place.

Staff should receive a verbal brief prior to the compliance date, but, when this is not reasonably practicable, other methods can be used such as written briefs and web based software.

Special briefings might be necessary before particular projects or activities are undertaken.

The applicable standards should be made available so that that staff can access them regularly and keep up to date.

END

Removable Media Devices

This module is for staff who require removable media devices (USB data storage devices, external hard drives, DVDs, CDs, memory cards etc.) to carry out their role in an operational environment. It informs on the safe and secure use of removable media devices in an operational environment where alternatives to removable media are not suitable. This promotes best practice that will allow good data hygiene and process to support safe and secure working where anti-virus/malware is not available.

The following summarises dos and don'ts when using removable media in an operational environment. Understand your responsibilities when using our systems, data, and the applicable policy and standards.

Do…	
✓	Scrub USB devices before loading new data.
✓	New removable devices should only be procured through the IT service catalogue.
✓	Review the contents of removable media devices to identify out of date or unwanted files and securely destroy unwanted files when they are no longer needed.
✓	Make sure data and information is securely deleted from removable media devices as soon as possible
✓	Store removable media in a secure location when not in use. Secure locations can include locked cabinets and safes. Removable media devices should never be taken off site without line manager approval.
✓	Make sure removable media devices are specific to each system. In practice this may mean multiple removable media devices.
✓	Any lost or stolen devices should be reported to asksecurity@networkrail.co.uk and line manager informed.
✓	Return allocated removable media to your line manager if you are leaving employment, changing roles or no longer have a requirement to use the device.
Do not…	
×	Do not store Network Rail data or information on a device used to store personal data/information.
×	Do not use your own removable media devices or devices not assigned to the signalling and operational equipment. Using an incompatible device may cause the system to fail affecting the operation running of the railway. This includes mice, keyboards and other peripheries such as device charging.
×	Do not transfer any Network Rail confidential or Network Rail secret data from any removable media devices to any external devices.
×	Do not share details of encryption passwords or pin codes for removable media. unless authorised by the information owner for information sharing purposes.

END

1. Definition of Safety-Critical Work

1.1 Safety Critical Work is defined in Railways and Other Guided Transport Systems (Safety) Regulations (ROGS) and Railway Safety Publication 4 (RSP 4). This includes:

a) Installing signalling components.

b) Testing of signalling equipment.

c) Maintenance of signalling equipment.

d) Inspection of signalling equipment.

1.2 The Requirement to hold an IRSE licence for Safety Critical Work is contain in NR/L2/SIG/10160 – Specification for Application of the IRSE Licensing Scheme

END

1. Disconnection of Signalling Equipment

1.1 Whenever it is necessary to disconnect signalling equipment the provision of section B002 shall be strictly observed.

2. Testing of Signalling Apparatus

2.1 After repairs or alterations to signalling apparatus the equipment shall be tested.

See section T001.

3. Altering or Repairing Signalling Equipment

3.1 For a checklist before starting work, see section D001.

3.2 Alterations to signalling arrangements shall only be made in accordance with the engineering details supplied for the work.

3.3 Signalling Technicians shall not manipulate signalling equipment to cause it to work by any means other than the designed arrangement unless they are authorised by the SM(S).

3.4 Alterations to existing installations shall not reduce the overall safety integrity of the original installation.

3.5 Signalling Technicians shall always make a point of seeing that a correct entry has been made by the Signaller in the Train Register, and that it is properly signed.

3.6 Where it is not practicable to enter the signal box, Signalling Technicians shall communicate with the Signaller and have the train register entry read back to them.

3.7 It is important that the Signaller is clearly informed of the nature of the work to be undertaken.

4. Temporary or Emergency Alterations

4.1 No temporary or emergency alterations to the signalling arrangements, mechanical or electrical, shall be made by Signalling Technicians unless they are authorised by the SM(S).

4.2 A WAIF to the SM(S) shall be submitted as described in NR/SMS/PartA/A08 (Items for Renewal).

5. Seals

5.1 Seals on instruments, relays and other apparatus shall not be broken by Technicians unless so instructed by the SM(S).

5.2 Some timing relays might require unsealing before adjustment and do not require permission. These shall then be resealed.

6. Lever Collars or Reminder Appliances

6.1 When any signalling equipment has been damaged or disconnected, or is otherwise out of use or under repair, Signalling Technicians shall verify that lever collars or other reminder appliances are placed on the levers or panel switches concerned, to remind the Signaller.

6.2 Before such levers or switches are moved, the Signaller shall be aware that those working on the equipment concerned be warned that it is about to be operated.

7. Temporary Approach Control Links (TACLs)

7.1 A Signalling Technician can be instructed to disconnect a signal TACL to restrict the speed of trains in connection with emergency or engineering situations.

7.2 TACLs are also used at junction signals to facilitate the placing of temporary speed restrictions on routes beyond the junction, in accordance with RIS-0734-CCS

8. Distant Signal Restriction

8.1 During failure of a distant signal repeater, block indicator, or single line block, the Rule Book series TS requires the Signaller to keep the relevant distant signal at caution.

8.2 Signalling Technicians shall confirm/verify that the protecting distant signal is restricted to caution when disconnecting level crossing equipment.

END

1. Principles

1.1 No work shall be done which interferes with the normal operation of signalling equipment without the agreement of the Signaller.

1.2 Rule Book Module HB19 defines the necessary arrangements for work which:

a) Will not affect the normal passage of trains and

b) Does not need the Signaller's co-operation and

c) Will not affect the normal operation of the signalling equipment.

1.3 Rule Book Module HB19 permits certain work that can interfere with the normal working of signalling equipment to be carried out without completing form RT3187, Signal Engineering Work.

1.4 An entry shall be made in the Train Register for this type of work.

1.5 Work which does not interfere with the normal operation of signalling equipment such as oiling and cleaning can be done at any time.

1.6 Work that might interfere with the normal working of signalling equipment does not need to be carried out under Line Blockage or Possession if all the following apply:

a) The work is of a type specified under Permissible Work in Section 3.

AND

b) The work is carried out in accordance with the Signalling Maintenance Specifications or other defined procedures.

AND

c) The work can be carried out between trains without affecting the normal passage of trains.

AND

d) The work is either self-protecting, or protection shall be provided by temporarily removing fuses or slipping links, but wires shall not be removed from terminals or plugboards for this purpose. For disconnection of signalling equipment see section B002.

1.7 Signalling Technicians working on the interior of a point machine, who require the machine to be isolated for their own protection, arrangements can be found in NR/SMS/PartA/A04 (Method Statement Summary).

1.8 The agreement of the Signaller is required before isolating the machine, but no form RT3187 has to be completed.

2. Personnel Protection

2.1 Rule Book Handbook 19 is all about protecting trains, it does not give staff any protection at all.

2.2 If staff need personal protection, they shall make separate arrangements with the Signaller under Rule Book Handbook 8.

3. Permissible Work

3.1 The following are considered as permissible work:

a) Track circuit testing and adjustment.

b) Point testing and adjustment.

c) Signal lamp/module and route indicator lamp/module changing, testing and adjustment.

d) Cable testing, providing that no disconnection of wires, other than by sliding links, is involved.

e) Re-terminating or jointing a single core cable (e.g. track circuit connection).

Multicore cables, tail cables with more than one core, and wires in interlockings or internal wires in apparatus cases are excluded.

f) Re-terminating or jointing cables to telephones or similar lineside equipment.

g) Disconnection of power supplies for cell replacement or other remedial action.

h) Temporary disconnection of AWS for testing.

i) Temporary disconnection of TPWS for testing.

j) Reading Balise messages.

k) Changing a plug-in pin-coded component such as a relay, a reed transmitter or receiver, or an SSI trackside functional module.

l) Routine testing at level crossings, emergency replacement switches, signal replacement switches or timers.

m) Short duration tests on non-safety-critical equipment such as remote control and train describers.

n) Routine maintenance of signal and detonator placer motors.

END

Includes:	During failures, when working on S&T equipment and when a release of controls is required.
Excludes:	Additional protection for line blockages that is pre planned (See B008). Protection for T3-D by Technician's Controls (see B009)

1. Application of this Module

1.1 The content of this module applies to the following situations.

a) The failure of signalling equipment.

b) Work on signalling equipment.

c) When a release of controls is required.

This module should be read in conjunction with Rule Book HB19.

2. Disconnecting and Working on Equipment

2.1 No work shall be done which interferes with the normal working of signalling equipment without the agreement of the Signaller.

2.2 Section B001 defines the arrangements necessary for working on equipment which is in service.

2.3 Disconnection of signalling equipment shall follow the requirements of Rule Book module HB19. In selecting the means of disconnection, the following shall be taken into account:

a) Do not rely upon disconnection of the equipment which is being worked on or which might be disturbed or affected during the work.

b) Do not apply a disconnection which might be ineffective under some circumstances (e.g. disconnection of track circuit to hold a signal at danger might not be effective if the signal has permissive working facilities).

c) Do not apply a disconnection which subsequently has to be reinstated for the purposes of testing the work prior to hand back to the Signaller.

d) If the work is partially completed and some of the equipment is handed back for operational service, the disconnections shall remain effective for that equipment which is not available for use.

2.4 Disconnections shall be planned and documented by a Tester and shall be checked by an independent Tester.

2.5 The effectiveness of disconnections shall be verified before they are relied upon and the presence of Signaller's reminder devices shall be confirmed.

2.6 Disconnections shall be clearly labelled to prevent inadvertent reconnection.

2.7 If you need to operate a lever, button, switch or other signalling equipment for test purposes, you shall:

a) Request the Signaller to operate it, or

b) Request the Signaller for permission before you operate it.

2.8 Any disconnection of a circuit that affects the signalling equipment, including level crossing telephones and other telecoms circuits, shall be advised to the Signaller who shall put in place the necessary method of working.

2.9 Signalling equipment shall not be manipulated to cause it to work by any means other than the designed arrangement unless special instructions are issued to the contrary.

2.10 Before working on the interlocking, specifically relating to electrically operated points and signals, the points and signals associated with the work shall be disconnected, as described in Section 3, this is to prevent them from inadvertently being operated.

2.11 When the changing of any part of electrically operated points, which would interfere with the correct functioning of the equipment, the Technician shall treat the points as being out of order in accordance with module HB19 of the Rule Book and isolate them as described in section 6 of B003.

3. Procedure for Making Disconnections

3.1 Table 1 details the signal disconnection requirement for each type of equipment that is to be worked on.

3.2 Where the work is within the overlap of the protecting signal, the need to disconnect the signal approaching the protecting signal shall be considered.

3.3 This decision shall be based on the proximity of staff to the signal and the consequences of a signal passed at danger (SPAD).

3.4 Where large numbers of disconnections are required, the use of alternative methods of work, such as possession of the line shall be considered.

Equipment being worked on		**Disconnection required**
Signal on track circuit block lines:		
-	Signal not inoperative or not exhibiting most restrictive aspect	Yes
-	Signal inoperative and exhibiting most restrictive aspect	No
Signal on lines other than track circuit block lines:		
-	Signal applicable to movements in the normal direction	(#1 only)
-	Signal applicable to movements in the wrong direction	No
Point		
-	Worked by machine/clamp lock	Yes
-	Switch diamond/swing nose crossing	Yes
-	Other mechanical points	Yes (#2)
Track Circuit		
-	TPR not disconnected	Yes
-	TPR disconnected	No (#1)
AWS		
-	Magnet	No (#1)
ATP		
-	On track equipment	No
-	ATPLIT or UT (GWML only)	Yes
Level Crossing		
-	Manned Controlled Barriers/Gates, CCTV controlled barriers, AHBCs with stopping/non-stopping controls	Yes
-	other types of crossing (other AHBCs, ABCL, AOCL, etc.)	No
Cables		#3
Other, signalling		
-	no effect on integrity of interlocking	No (#1)
-	causes 'disarrangement of interlocking'	yes
#1	The distant signal 'on lines other than track circuit block lines' shall be disconnected.	
#2	Only signals for movements in the facing direction over the points being worked on.	
#3	Work on cables might affect other equipment which is remote from the site of work. To confirm that full protection of trains is provided, the function operated over each cable core shall be checked. Disconnections might be required if any core carries a function as listed in this table.	

Table 1 – Signal Disconnections

4. Direct and Indirect Disconnections

4.1 Where signals are to be disconnected and the point of disconnection has been identified on predefined disconnection lists, the relevant entry shall be confirmed.

4.2 Where these are not available, the relevant control tables, signalling plans and circuit diagrams shall be checked to confirm that all relevant signals/routes are disconnected.

4.3 The preferred method of disconnecting a signal is to use a Direct Disconnection, these are described in Section 5.

A Direct Disconnection is where the point of disconnection is in the circuit which controls the signal aspect.

4.4 The disconnection shall maintain the signal at danger.

4.5 Alternatively, a signal can be disconnected using an Indirect Disconnection, these are described in Section 6.

An Indirect Disconnection is where the point of disconnection is not in the circuit which controls the signal aspect, e.g. disconnecting a link in the line feeding a TPR, the TPR in turn will 'disconnect' the HR.

4.6 The Tester shall verify that the disconnection is effective in holding the relevant signal(s) at their most restrictive aspects.

5. Disconnection of Signals (Direct)

<u>Relay Interlocking</u>

5.1 The following, in order of preference, are the methods of disconnecting signals on conventional relay interlockings:

a) As stated on the predefined disconnection list, where available.

b) Withdraw the Route Disconnection Link (or GY link) for each route affected.

c) Where individually fused, remove the aspect relay (HR, UGR, GR, etc.) circuit fuse.

d) Disconnection of a link controlling the aspect relay (HR, UGR, GR, etc.) where the link is at the same location as the relay.

e) Removal of the coil spade/connection of the relay controlling the aspect (HR, UGR, GR, etc.), which shall be insulated using an approved method.

The following options can be used where no work which subsequently affects the integrity of the disconnection is to be carried out:

f) Disconnection of a link in the cable remotely controlling the aspect relay (HR, UGR, GR, etc.).

g) Disconnection at a terminal of the cable core remotely controlling the aspect relay (HR, UGR, GR, etc.) which shall be insulated using an approved method.

Electronic Interlockings

5.2 Signals/routes shall be disconnected so that the ARS cannot route into an area where disconnections have been made to protect equipment being worked on.

5.3 Confirm that alternative routes are not available.

5.4 The following are the methods of disconnecting signals:

a) For Solid State Interlockings, signal disconnection is via the Technician's terminal, using the aspect disconnection procedure.

b) For other systems, by using the prescribed method, or as stated on the predefined disconnection list, where available.

Mechanical Signalling

5.5 The following, in order of preference, are the methods of disconnecting mechanical signals:

a) A catch handle locking device fitted to the signal lever.

b) The catch handle shall be disconnected from the catch rod and a reminder collar placed on the signal lever.

c) Disconnect the signal wire at the lever tail.

NOTE: *For colour light and motor semaphore signals controlled from a mechanical signal box, disconnect as shown in section above on Relay Interlocking.*

6. Disconnection of Signals (Indirect)

Track Circuits

6.1 There are a number of pitfalls, particularly where track circuits can release as well as lock, or might not lock at all. Problem areas include:

a) Automatic signals (see Rule Book modules S5 for automatic signals being passed at danger if the SPT fails).

b) Shunt signals and shunt moves from main signals.

c) Permissive lines.

d) Level crossings.

6.2 The Tester shall confirm that the proposed disconnection effectively holds the signal(s) at their most restrictive aspect.

Where the following conditions are met, it is permissible to disconnect the TPR:

a) The TR controls no relays or equipment other than the first TPR.

b) No more than one TPR is controlled from the TR.

Method of Disconnecting Track Circuit TPRs

6.3 When it is permissible to disconnect a TPR in accordance with the previous paragraph, one of the following methods shall be used:

a) Where individually fused, remove the TPR circuit fuse.

b) Withdraw a link in the feed to the coil of the TPR.

c) Remove, and suitably insulate (module E052) the coil spade/connection of the TPR.

d) Disconnect, and suitably isolate at a binding post in the feed to the coil of the TPR.

Using Axle Counters

6.4 The use of axle counters for disconnection purposes shall be avoided wherever possible.

Method of Disconnecting Point KRs

6.5 Disconnection of point KRs is of limited use.

6.6 It cannot be used where detection tests are required as part of the work.

6.7 Consider carefully the alternative methods before using the disconnection of point KRs.

NOTE: *Point detection circuitry can use 1 or 2 relays (WKR or NKR/RKR) and might be wired as a 2, 3 or 4 wire circuit.*

6.8 When it is required to disconnect a point KR, one of the following methods shall be used:

a) Where individually fused, remove the KR circuit fuse.

b) Withdraw a link or links in the feed to the coil of the point KR(s).

c) Remove the coil spade(s)/connection(s) of the point KR(s) and insulate using an approved method.

d) Disconnect at a binding post or binding posts in the feed to the coil(s) of the point KR(s) and insulate using an approved method.

Alternative Methods

6.9 Other methods of disconnection can be used to suit local circumstances (ground frame release, block lines, etc.).

6.10 It is the responsibility of the Tester to confirm the correct protection is in place.

7. Missing/Illegible Diagrams

7.1 Where on site records are missing or illegible, an attempt shall be made to obtain information from another set of diagrams (e.g. relay room copy).

7.2 If this is not possible and the Tester knows which equipment is to be disconnected, but not which links or fuse provides the disconnection, the Tester can, under these circumstances only, disconnect and insulate the relay coil/spade connection of the controlling relay.

8. Selection of Procedure

8.1 When making signal disconnections confirm that disconnections are effective and that the risks of inadvertent reconnection are low.

8.2 The correct method of work shall be selected by comparing the work to be done against criteria listed for Local and Remote disconnections.

8.3 When using automatic signals to protect the work, it needs to be noted that the Rule Book module S5 allow automatic signals to be passed at danger if the SPT has failed.

8.4 To confirm that the SPT is operational, it shall be tested prior to relying on the automatic signal for protection.

8.5 If the SPT does not work, arrangements shall be made to provide alternative protection, such as a different disconnection point or protection procedure.

Local Disconnection Procedure, criteria for use:

a) The disconnection(s) are for maintenance or faulting.

b) Disconnections required for short duration, typically less than 1 hour.

c) Small number of disconnections (up to 6).

d) No change of Tester during work.

e) All disconnections in single location or equipment room.

f) Work within visual range of the disconnection point or the access to it (e.g. location, equipment room door).

Remote Disconnection Procedure, criteria for use:

g) Any work that does not meet the criteria of the Local Disconnection Procedure.

9. Local Disconnection Procedure

9.1 Before work starts:

a) Identify signal(s) to be disconnected.

b) Identify where effective disconnection(s) can be made to place required signal(s) at their most restrictive aspect(s).

c) Make disconnection(s). Where the disconnection(s) are not made using links, the Tester shall confirm that any bare conductors, e.g. relay spades, ring crimps, etc., are suitably insulated, in accordance with section E052.

d) A SMTH log sheet shall be completed for each disconnection.

e) Record the numbers of the signal(s) kept at danger by disconnection(s) on the RT3187 form (Signal Engineering Work).

9.2 After work is completed:

a) Reconnect links, relay spades, etc. that were disconnected and test the signal(s).

b) Complete SMTH log sheet as required.

c) Verify that equipment that was disconnected is now operational.

Where the Tester considers there is a risk of inadvertent reconnection, perhaps due to shift changes, disconnections shall be labelled.

10. Remote Disconnection Procedure

10.1 Before work starts:

a) Identify signal(s) to be disconnected.

b) Identify where effective disconnection(s) can be made to place required signal(s) at their most restrictive aspect(s).

c) Make disconnection(s). Where the disconnection(s) are not made using links, the Tester shall confirm that any bare conductors, e.g. relay spades, ring crimps, etc. are suitably insulated, in accordance with section E052.

d) A SMTH log sheet shall be completed for each disconnection.

e) Each disconnection point shall be labelled with a warning label. The label shall state "Danger work in progress - do not reconnect" and state the name of the person doing the work and contact details.

Maintenance Testing

f) All disconnections shall be made in accordance with the following procedures:

- Section 11 for slipping links.
- NR/SMTH/Part04/CA01 (Remove and Refit a Cable Core or Wire) - for the removal and refitting of a cable/wire, including spade connections.

g) All disconnections shall be recorded.

h) The record of disconnections shall contain the following information:

- Equipment being worked upon and Controlling Signal Box.
- Equipment Room/Location where disconnections are carried out.
- Signals/Routes disconnected.
- Method of disconnection.
- Date and time disconnections are made.
- Name and signature of person making disconnections.

i) The disconnection record shall be placed in the equipment room/location where the disconnections have been made. Where possible the record shall be placed in the signalling equipment room logbook.

Works Testing

j) All disconnections shall be made in accordance with the procedures described in NR/L2/SIG/30014 – Signal Works Testing Handbook.

During the work

k) The person carrying out the disconnections shall communicate the whereabouts of the disconnection record sheet when relieved.

l) This is to enable staff who did not carry out the disconnections to be fully conversant with the current status of disconnections before making any reconnections.

m) For maintenance testing, the handover arrangements are given in NR/SMTH/Part02 of the Signalling Maintenance Testing Handbook (SMTH).

After work is completed:

n) Reconnect links, relay spades, etc. that were disconnected and test the signal(s).

o) Remove warning labels.

p) Complete SMTH logbook sheets as required.

q) Confirm that equipment that was disconnected is now operational.

r) When the reconnections are made, the date, time and the name/signature of the person making the reconnections shall be recorded.

This shall be done on the same record as the original disconnections.

11. Links

11.1 Where a terminal block and/or its links (and any red dome nuts) have to be removed during work, their original position shall be recorded.

11.2 Where a link has to be slipped during the work this shall be recorded.

11.3 Any previously slipped links in the vicinity of the work shall be recorded to avoid inadvertent replacement.

11.4 The recording shall include, as a minimum, the vertical strip designation and the link number.

11.5 Where a link or connector has to be removed or slipped during the work and shall not be replaced, such as during a temporary diversion of circuits, this shall be recorded.

11.6 Reminder arrangements shall be made on site, such as the fitting of red dome nuts to terminals.

11.7 If the person doing the work is unable to guarantee that the equipment cannot be reconnected without their knowledge the isolating link shall be labelled.

The label shall state “Danger, work in progress – do not reconnect” and include the name of the person doing the work or testing.

11.8 On completion of work a check shall be made to confirm that the configuration of links and any red dome nuts is correct.

11.9 Where cable cores are spare and unused by any circuit or function, any links fitted to the terminal blocks at either end of the unused core shall be removed.

11.10 Where testing is handed on to a different team the details of outstanding slipped links shall be forwarded to the person taking over.

END

1. Releases and Restoration

1.1 Special arrangements exist for resetting or restoring axle counters and other equipment where the restoration process could result in a false clear indication being given.

This section covers both:

a) One-shot release of facilities during degraded working (Sections 3 to 8), as permitted by the Rule Book and NR/L2/SIG/30009/GERT8071.

and

b) Initialisation, and resetting and restoration following failure, incorrect operating sequence, maintenance disconnection, or changeover between alternative systems (Sections 8 to 14).

2. Erroneous Releasing of Locking

2.1 In some cases, the inadvertent releasing of locking can occur when equipment is removed/replaced.

Examples include:

a) Release of single line locking when changing a track repeat relay.

b) Moving a set of points when changing a latched relay.

2.2 Testers assess the potential for such situations when undertaking work and confirm that the protection arrangements and the way in which the work is performed avoid any risk to safety.

3. Principles of Giving a Release

3.1 The Signaller can under the provisions of Rule Book module HB19 request that a release be given:

a) For a failed track circuit which is locking points, solely to enable the points to be moved, but a signal is not to be cleared over the affected track circuit.

b) For a failed track circuit or other failed signalling equipment which is locking a route, solely to allow the release of the affected route so that signals can be worked for movements clear of the failure.

c) For a track circuit occupied for an extended time by engineering work, derailment or other exceptional circumstances, solely to allow the working of signals for movements clear of the obstruction.

d) For a track circuit occupied for an extended time by failure, engineering work, failed train or other exceptional circumstances, solely to allow a level crossing to be opened to road traffic.

e) For a track circuit, to allow single line working by pilotman.

f) To obtain a token to release a ground frame, during single line working by pilotman.

3.2 Advise the Signaller if giving a release is likely to cause delay/take longer than the faulting process, or a release cannot be safely arranged. The following general requirements shall apply:

a) A release given under this authority shall only apply for one train, unless b) applies. Whenever possible the release shall be removed before any associated train movement takes place.

Otherwise the person giving the release shall remain on site until the train passes, confirming the release has been normalised by the passage of the train or has been withdrawn immediately afterwards.

b) Exceptionally, where arrangements are required to remain in place for more than a single release, this shall be specially authorised in writing by the SM(S) and be subject to formal design and test (NR/L2/SIG/11201 and NR/L2/SIG/30014). Or a NR/L3/SITH/G130 Test Plan is applicable.

c) No signal shall be allowed to clear over a failed track circuit.

d) Electric lever locks which carry interlocking (lock cover might be painted red) on mechanical frames shall not be released.

e) Before any release is given, confirmation shall be obtained from the Signaller that there are no train movements on any line within the area controlled by the frame or interlocking and that the movement for which the release is required can be made safely and there are no conflicting routes.

f) The Signaller shall be advised just prior to any release being given and when train movements can be resumed.

3.3 The precise, physical method of releasing shall be documented (see Section 4). Any covers moved or temporary arrangements made to give the release shall be correctly restored immediately afterwards.

3.4 If the release request is unsafe or there is any doubt about the release requirements the SM(S) shall be advised.

3.5 Special arrangements exist for resetting or restoring axle counters and other equipment where the restoration process could result in a false clear indication being given see NR/SMS/PartC/AX00 (Axle Counters – General).

4. Authorisation and Records

4.1 A separate form RT3186 shall be completed or dictated on each occasion that the Signaller requests a release. A clear understanding of what is to be released shall be reached and details of the work shall be entered on the form, as follows:

a) When the Technician is present at the signal box, the Signaller completes a form RT3186 and the Technician shall take a copy before giving the release.

b) If the Technician is not at the signal box, the Signaller dictates the RT3186 form to the Technician who shall read it back to the Signaller before giving the release.

Form RT3186 is not required where axle counter restoration form BR29789/2 (or equivalent) applies, see NR/SMS/PartC/AX00 (Axle Counters – General).

5. Methods of Giving a Release

5.1 Track circuit releases given below might not be appropriate for axle counter sections. Where necessary, local instructions shall be issued relating to the release of points or route locking that are held by a failed axle counter section. Axle counter resetting and restoration is covered in see NR/SMS/PartC/AX00 (Axle Counters – General)

5.2 Mechanical Frame (track circuit or route locking release)

This method shall only be used to:

- Allow a signal lever to be returned to normal.
- Allow a point or FPL lever to be moved to normal or reverse.

It shall never be used to allow a signal lever to be reversed.

a) Make sure that the movements for which the release is being given can be made safely and that the lever lock concerned does not carry interlocking.

b) Get a confirmation from the Signaller that the trains on any line controlled by the lever frame have been stopped.

c) Inform the Signaller that you are about to give the release.

d) Lift the armature of the electric lock on the correct lever and inform the Signaller which lever number you have released.

e) Ask the Signaller to operate the lever to the required position.

f) Release the armature, replace and secure the lock cover.

g) Inform the Signaller that train movements can be restarted.

NOTE: *Precautions should be taken when working beneath mechanical frames.*

5.3 Miniature Lever Power Frame (track circuit or route locking release)

This method shall only be used to:

- Allow a signal lever to be returned to normal.
- Allow a point or FPL lever to be moved to normal or reverse.

It shall **never** be used to allow a signal lever to be reversed.

a) Confirm the movements for which the release is required can be made safely and there are no conflicting routes.

b) Get confirmation from the Signaller that the movement of trains on any line controlled by the power frame has been stopped.

c) Inform the Signaller that you are about to give the release quoting the lever number.

d) Lift the armature of the selection lock on the correct lever.

e) Request the Signaller to operate the lever to the required position.

f) Release the armature, replace and lock the lever frame covers.

g) Inform the Signaller that the train movements can be restarted.

5.4 Relay or SSI Interlocking (track circuit release)

Method used to give release:

a) Confirm the movements for which the release is required can be made safely and there are no conflicting routes.

b) Go to the location case or equipment room containing the TR for the track circuit concerned.

c) Using the circuit diagrams, find the contacts of the TR which control the TPR or TFM circuit to the interlocking at which the release is required.

d) Using test straps (one or two) to strap out at the same time the TR contact(s) controlling the TPR or TFM, note the number of test straps used.

e) Monitor the outgoing TPR or TFM circuit with a meter or monitor the outgoing telegram with an interrogator.

f) Request confirmation from the Signaller that the movement of trains on any line within the interlocking area has been stopped and that any route set over the track circuit concerned has been cancelled.

g) Inform the Signaller that you are about to give the release.

h) Put the straps in position on the TR to false feed the TPR or TFM circuit.

i) If necessary, ask the Signaller to operate the points to the correct position(s).

j) Confirm that the points have moved to the required positions and / or the route indications have been cancelled.

k) Remove the test strap(s) at both ends straight away and put them away, checking that the number remove corresponds to the number of straps used.

l) Check voltage has gone from the TPR lines or the telegram shows track occupied. Obtain confirmation from the Signaller that the track circuit shows occupied.

m) Remove the meter from outgoing lines.

n) Inform the Signaller that train movements can restart.

NOTE: *The use of temporary straps shall be controlled in accordance with Section U034.*

<u>Relay Interlocking (route locking release)</u>

Method used to give release:

a) Confirm the movements for which the release is required can be made safely and there are no conflicting routes.

b) Check which route or part of the route needs releasing and relate this to the position of the relevant relays in the interlocking.

c) Identify, by checking the circuit diagrams, which latched or polar-stick relays need to be operated to the opposite position to give the required release. (See Table 1).

NOTE: *This can vary according to the system in use.*

d) Get confirmation from the Signaller that the movement of trains has been stopped on any line within the area controlled by the relay room and that any route set over the track circuit concerned has been cancelled.

e) When in position in the relay room, advise the Signaller that you are about to give the release.

f) Remove the chosen latched or polar stick relay, place in the bench test set and operate to the required position. Replace the relay in its original position.

Or

In the case of Westpac Mk1, apply the N50 briefly to the geographical plug coupler terminal d9.

g) Confirm that the release has been effective.

h) Inform the Signaller that train movements can be restarted.

Interlocking	Release Method
Free wired	Unlatch RLR (if a latched relay). Latch up NLR.
WR (E10k) free wired & AEI-GRS geographical	No latched route relays.
ScR geographical	Unlatch UR.
Westpac Mk1	Apply N50 to terminal d9 of the geographical plug coupler of the correct point or track unit.
Westpac Mk2 to 4	Latch up LUR in correct point or track unit. If necessary, unlatch UER, OER or UFR in the correct signal.
GEC/SGE geographical	Latch up NLR in the entrance set or Latch up USR in the point set or Latch up XLR in the exit set or Latch up LCR in the countermove set.

Table 1 – Release Methods

For other types of route relay interlocking, see Local Instructions.

Electronic Interlocking

5.5 No Technician's route release is available, unless covered by system specific instructions. Where necessary, local instructions shall be issued relating to the release of points or route locking that are held by a failed track section.

6. Sealed Releases

6.1 Where a sealed release is provided for the use of Signallers, in the event of equipment failure, the equivalent invasive releases in Section 4 are not permitted.

6.2 After a sealed release has been used, Technicians shall reseal the release as soon as possible after the fault is rectified.

6.3 The broken seal shall be replaced used and the resealing reported to the SM(S).

7. Manual Operation, Isolation and Restoration of Points

7.1 For mechanically operated points, see Section 4.1 (Technician) or Section 6 (Signaller's release).

7.2 For power operated points, the operating procedure given in Rule Book HB4 is initiated by the Signaller in the event of points failure.

7.3 Points mechanisms shall be electrically isolated before commencing work. The detection fuse (or links) shall also be removed to prevent signals being cleared, see NR/SMS/PartA/A02 (Preventative and Corrective Maintenance).

7.4 Local detection is restored as soon as the fuse is reinstated, but the control system is not reset until the points are operated under power.

7.5 Isolation, point handle operation and restoration shall be performed as follows:

Clamp Lock:

a) Turn the switch from 'POWER' to 'MANUAL' this isolates the unit from the power supply.

b) Use the pump handle to manually operate the points. The direction of movement is determined by moving the selector into either the 'Normal' or 'Reverse' position.

c) Check that the switch is correctly fitted to the stock rail, not just at the toe, even if it has completed its travel and locked.

d) When manually operating switches fitted with supplementary drives, check that the full movement of the switch is completed. Check the switch is correct.

__NOTE:__ The selector shall be returned to the 'Neutral' position and the switch turned to the 'Power' position when the equipment is to be restored to power operation.

Hydro-Pneumatic Train Operated:

e) Locate the pump handle for manual operation, in a cabinet adjacent to the equipment.

f) To manually operate the points, turn the relief valve ON (lever vertical - valve open) and operate the hand pump.

The points will move to the reverse position against the force exerted by the main actuator and accumulator.

g) The points will be restored to their normal lie by the action of the accumulator when the relief valve is turned OFF (lever horizontal - valve dosed).

Style M2

h) The motor is not automatically isolated when the manual crank handle is used, so the motor fuse shall be removed.

The crank handle for this machine is located on the side.

Style M3 & M3A

i) Withdrawal of the pin holding the crank aperture cap cover strap isolates the motor.

The crank handle is inserted through the top of the machine.

Style 63

j) To electrically isolate the machine, remove the motor fuse.

k) Insertion of the crank handle alone is no longer an acceptable method of electrically isolating the Style 63-point machine.

l) Any malfunction of the cut-out contacts shall be repaired or reported to the SM(S).

HW Type

m) Unlock the crank handle cover flap and open, insert the point handle part way in and lift up.

n) The crank handle reset button shall be seen to "pop out". If it does not pop out cleanly, then the cut-out assembly might be defective.

o) Continue to insert the handle into the end of the machine until it contacts the end of the crank handle drive shaft and then, whilst continuing to push it in, rotate until the pin in the handle engages with the slot in the shaft.

p) Undersize or worn crank handles can jeopardise the integrity of the cut-out switch and shall not be used.

q) Check for sticking latch mechanisms, worn cut-out assemblies or loose assembly mountings as these have caused wrong side failures.

NOTE: *The operating shaft of a crank handle should be 27/32 inch diameter. A simple check is to compare the diameter of the operating shaft with a 1p coin. A correct sized handle is slightly larger than the coin. If it is not larger, or it is suspected of being defective in any way, it should be reported/returned to the SM(S).*

<u>HPSS</u>

r) Move the power isolation paddle to the 'power off' position, it is released from the 'on' and 'off' positions by pulling out a sprung sleeve.

s) This uncovers the access point for the crank handle, which can be inserted either from the side (Low Lid Machines), or the end (High lid machines).

t) After removing the handle, power is restored by pulling out the sprung sleeve again whilst the paddle returns to the 'power on' position.

NOTE: *Full details are given in the HPSS Operation & Maintenance Manual.*

NOTE: *If 110V a.c. power is lost, the HPSS loses both normal and reverse detection. After power is restored, it is necessary to operate the machine, either manually or under power, to reset the detection output.*

Further details are given in the HPSS Handbook.

8. Level Crossing Release and Restoration

8.1 If a Technician is asked to give a release this shall be 'one-shot' for one crossing opening only. The release shall be removed as soon as the crossing has been opened, otherwise the person giving the release shall remain on site until the release can be removed.

8.2 When level crossings are subject to resetting and restoration following failure, incorrect operating sequence, maintenance disconnection, or changeover between alternative systems, the following requirements apply:

a) A failure/maintenance disconnection procedure.

b) Isolation/protection arrangement.

c) Manual or automatic resetting to correspond with the state of the railway.

d) Restoration to service procedure.

e) Records to be kept of each disconnection/restoration.

8.3 Some automatic crossings might be provided with automatic failure protection to cater for extended (or transient) track occupancy or failure, incorrect operating sequence, or power supply failure.

After a specified time, the crossing will open to road traffic and any directional controls will be cancelled. Automatic restoration is provided in the event of the failed track section clearing or emergency plunger operation, but otherwise Technician's attendance can be required to reset the crossing.

Power supply failure is also self-restoring. Further details are given in Part X of NR/L2/XNG/30020.

9. Solid State Interlocking (SSI) Release and Restoration

9.1 No Technician's route release is available.

9.2 A Technician's Terminal is used to start the interlocking, and apply and remove restrictive controls, as described in NR/L2/SIG/17004.

9.3 Verify that Trackside Functional Module (TFM) outputs operate correctly after a reset following the loss of output interface.

9.4 SSI Central Interlocking initialisation, failure and power changeover is protected by the protocols given in SSI 8003-10. Data links to the TFMs are similarly protected.

NOTE: *When replacing a processor module, the procedures given in NR/SMTH/Part04/SS01 (Replace an SSI MPM or PPM) is to be followed to avoid the processor blowing its security fuse.*

9.5 An Emergency Signals on Control is provided to remove the power from a Central Interlocking, in accordance with SSI 8500F.

NOTE: *A 'Mode 2' or 'Mode 3' start will result when changing to a stand-by power supply or when a Signaller's Emergency Signals On control is operated.*

9.6 All the information stored in RAM is lost if the power supply to the RAM chip fails.

9.7 RAM stands for Random Access Memory and this is a read/write memory chip which is used to store information during the operation of the program. One of its most important functions is to store the current state of the railway. Each bit in the RAM has two states known as 'one' and 'zero'.

This means that when power is first applied to a Central Interlocking, a part of the software known as the Initialisation Program sets up all of the RAM to a predefined safe state.

9.8 If power is lost, a capacitor connected to the RAM allows the RAM contents to be retained for at least six hours, but as data from the Trackside Functional Modules has been lost in the interim period it is still necessary for areas of the RAM to be set back to a safe state. The extent to which this is required is determined by the three Interlocking Processors comparing the state of their RAM memory immediately after start-up, and invoking one of three start modes:

<u>Start-up Modes</u>

<u>Mode 1:</u>

a) If the RAM capacitor has been discharged, or there is more than one disagreement in the state of the Technician's control bits in signal, points, route and track circuit memory.

This would be the case when power is first applied to a Central Interlocking after a long power failure.

b) In a 'Mode 1' start all the contents of RAM are set to zero with the exception of the Technician's controls on routes, track circuits, points and signals, and the points key position bits (which are all set to one), and the elapsed timers and signal approach locking timers (which are stopped).

This means that all routes and latches are unset, points are not controlled or detected, and the key switch position is undefined, track circuits are in the undefined state, sub-routes and sub-overlaps are locked, and signals are not lamp-proven.

c) When the program starts to operate after initialisation is complete, the normal processing of output telegram data for signals will set the 'free of approach locking' and 'signal stick' bits for the signals. When telegrams start to be received from Trackside Functional Modules, the track circuit 'occupied' and 'clear' bits, the points detection bits and signal 'lamp proving', and 'not red retained' bits will be set to the appropriate states.

d) As the track circuits clear, the sub-routes and sub-overlaps will be freed sequentially (because all routes are unset) by the flag operations data.

This leaves the Interlocking with all points detected in the direction in which they are lying (but both point control bits unset), all routes unset, and sub-routes and sub-overlaps free (except where held locked by occupied track circuits).

e) After a 'Mode 1' start, panel requests from the Panel Processors and other Central Interlockings are ignored and all telegram outputs are set to their most restrictive state.

f) After a time delay the Technician's Terminal can be used to 'enable' the Interlocking (using the 'start' control), and normal operation commences.

Mode 2:

a) If Mode 1 is not invoked and either there is a disagreement in the state of the route memory bits or points memory control bits, or there are more than six disagreements between the flag memory bits.

This covers the case where a short-term power failure occurs while the route was being set or cancelled or a set of points being called.

b) In a 'Mode 2' start the contents of RAM are initialised as for 'Mode 1', except that the original states of the Technician's control bits are preserved. If the one permitted disagreement between the Interlocking Processors exists, then this Technician's control bit is set to zero (control applied) in all three Interlocking Processors.

c) After a 'Mode 2' start the Interlocking is initially disabled as in 'Mode 1' but will recommence normal operation after the four-minute time delay without the need to be re-enabled from the Technician's Terminal.

Mode 3:

a) If neither Mode 1 or Mode 2 is invoked. This covers the case of a short-term power loss with nearly all the RAM information being preserved.

b) In a 'Mode 3' start the contents of RAM are initialised as for 'Mode 1', but all the Technician's control, points control, route and flag bits are preserved, except where there is a disagreement between Processors, in which case the bits concerned are set to zero.

This means that one additional Technician's control can be applied, and up to six sub-routes, sub-overlaps or latches might be locked. After a 'Mode 3' start the Interlocking commences normal operation immediately.

c) As all the routes are preserved, the signals for routes which were set will have their 'free of approach locking' and 'signal stick' bits held at zero, and for each route.

d) The Signaller will have to pull the entrance button and then 're-stroke' the route to set the 'signal stick' bit (via the clearing and setting of the 'bpull' bit respectively) to allow the signal to clear.

e) As all signals will have their 'auto' bits held at zero the Signaller will have to push the replacement buttons for automatic and semi-automatic signals to allow these signals to clear.

10. Radio Electronic Token Block (RETB) Failures

10.1 An emergency keyswitch is provided for use when radio data communication fails.

When the emergency keyswitch is used in conjunction with a security number and functional command entered by the Signaller, the interlocking will execute the command without the transmission or reception of radio data, provided it is safe to do so. Further details are given in NR/L2/SIG/30009/GKRT0054.

The emergency keyswitch is only operable by a key allocated for that purpose. Each use of the keyswitch increments a counter.

10.2 Those with RETB installations shall identify the circumstances when the emergency keyswitch can be used and shall have, secure procedures in place for the use and storage of the key.

10.3 When replacing a processor module, the procedures given in NR/SMTH/Part04/SS01 (Replace an SSI MPM or PPM) shall be followed to avoid the processor blowing its security fuse.

11. Reset and Restoration of Block Systems

11.1 The correct SMTH defined test from Part03 of the SMTH shall be carried out to restore the system.

11.2 Tokenless block, interlocked absolute block and OTW without staff are subject to the following requirements for each existing system:

a) A failure/maintenance disconnection procedure.

b) Isolation/protection arrangement.

c) Manual or automatic resetting to correspond with the state of the railway.

d) Restoration to service procedure.

e) Records to be kept of each disconnection/restoration.

These requirements also apply to keyless lockout systems.

12. Electric Token Systems

12.1 When dealing with electric token instruments of any type, the Technician shall verify that the Signaller is fully aware of the extent of the work so that the Block Regulations in the TS modules of the Rule Book are followed.

In certain circumstances, disconnections under Rule Book HB19 might be required.

12.2 No section signals are to be released by the technician when it is necessary for tokens to be withdrawn or inserted into instruments. Any section signal release shall be destroyed by removing two tokens and then replacing one of them. Entries shall be made in both the Train Register and the signalling staff Token Register stating the number of tokens dealt with.

12.3 When a token is damaged, the Technician shall be in possession of the damaged token before putting the instruments into phase.

12.4 When a token has been lost, the Technician shall only put the instruments into phase with authority of the designated Operations Manager or representative who shall be present when the instruments are put into phase.

12.5 When it is necessary to transfer tokens from one instrument to another, except where magazines are used, an even number shall be transferred.

12.6 To destroy any section signal release an odd number of tokens shall be removed, one more than required for transfer, and then one replaced into the instrument.

12.7 The token system shall be functionally tested before and after token transfer to verify correct operation. No token shall be removable if a token is out, or only one if all tokens are in the instruments.

12.8 During single line working by pilotman, the pilotman can request a token to release an in-section ground frame. Under these circumstances, the Technician shall arrange for a token to be withdrawn from the instrument.

13. Working on Axle Counter Equipment, Reset and Restoration

See NR/SMS/PartC/AX00 (Axle Counters – General).

14. Equipment Seals

14.1 Seals on instruments, relays and other apparatus shall not be broken unless authorised by the SM(S).

14.2 Some timing relays can require unsealing before adjustment, these shall then be resealed and do not require authorisation of the SM(S).

14.3 Seals on SSI modules are colour coded, to indicate which organisation has sealed the module, see Table 2.

Authority	**Seal**
Network Rail staff (and appointed agents)	red plastic seals for Siemens modules and sealing pliers that indicate 'NR' for Alstom modules
Siemens (manufacturing operations)	black plastic seals
Siemens (project delivery)	grey plastic seals
Siemens (overseas) not for use on NR	blue plastic seals
Alstom	lead type with correct identification.

Table 2 – Seal Identification

15. Use, Diversion and Reinstatement of Multicore Cables

For the use of single post terminations with red dome nut protection, and other issues, see NR/SMTH/Part01/Module/13 (Procedure for Monitoring a Damaged Cable) and Test Plans in NR/SMTH.

16. Temporary Signalling Alterations and Reinstatement

For alterations and reinstatement, see section D013 and SITH Test Plans.

END

1. General

1.1 This section covers your responsibilities to assist in the preservation of evidence following an accident or incident.

1.2 The Rule Book requires evidence to be preserved for major accidents or incidents. However, the scope is to be extended to other Signalling and Telecommunications safety related incidents.

1.3 It applies to all Signalling and Telecommunications Engineering staff, employed directly by or contracted to Network Rail and working either directly (for instance, Maintenance or Faulting) or indirectly (for instance, producing work which can affect Network Rail assets, such as Signalling Design, Installation or Testing work) on Network Rail infrastructure.

1.4 This section also reinforces the Signalling Maintenance Testing Handbook NR/L3/SIG/11231 and the Telecommunications Maintenance Testing Handbook NR/L2/TEL/31001.

2. Safety

2.1 The first duty of any staff working on Signalling and Telecommunications equipment is always the safety of themselves, third parties, the trains and the infrastructure.

2.2 Where an accident or incident can be prevented, by removing dangerously defective equipment from use, or protecting it, this shall be done in accordance with Rules, Standards and Procedures. Such protection is outside the scope of this General Instruction.

3. Major Accidents and Incidents

3.1 Rule Book Module G1 applies. In summary, this looks to safety first (securing the train, protecting the line, having the electric traction turned off, calling the emergency services and protecting passengers, staff and any other people that might be involved).

3.2 A second important priority is to leave the evidence undisturbed until a responsible person arrives to take control of the investigation.

4. Other Accidents and Incidents

4.1 Where a situation is discovered with the potential to cause a train accident or to injure the public or staff (other than those covered within Rule Book Module G1) arising from a defect or error within the Signalling or Operational Telecoms system, then the same principles shall apply.

Examples of accidents or incidents to be included are:

a) Design deficiencies discovered after the signalling has been commissioned.

b) Testing errors or omissions discovered after the signalling has been commissioned or brought into use.

c) Vandalism leading to a wrong side failure.

4.2 The first duty is protection of the line, staff, and other personnel.

4.3 Protection of the line could involve blocking the line with the Signaller if the incident is serious enough or signing the signalling out of use.

4.4 All Signalling and Operational Telecommunications related incidents or accidents will involve investigation under Signal Maintenance Testing Handbook or Telecoms Maintenance Testing Handbook procedures.

4.5 Until a person qualified under one of these two handbooks arrives to take charge of the investigation, Signalling and Telecommunications staff are to leave any evidence pertaining to the incident undisturbed.

4.6 Once the line has been protected, examples of evidence that shall be left undisturbed include:

a) State of the diagrams at the time of the incident.

b) Defective equipment.

c) Testing straps and jumpers left in circuits.

d) Extraneous wires.

e) Seized pulleys, wheels and cranks.

f) Obstructing vegetation.

g) Third party property.

h) Incorrectly installed equipment.

i) External items - detritus etc.

j) GSM-R logging information and alarms.

k) Concentrator card alarms.

l) Data Logging/Intelligent Infrastructure equipment.

The above list is not exhaustive.

4.7 Once the Failure Investigator arrives, they will take charge of the situation.

4.8 The person who will investigate is trained in assessing the situation and arranging for the appropriate level of investigation.

4.9 It is essential that this is done for an accurate diagnosis of the immediate and root causes of the accident or incident - looking to prevent repetition in the future.

4.10 Signalling and Telecoms staff can be asked to assist or cooperate in the investigation, and it is essential that regardless of affiliation, a professional approach is taken at all times.

END

1. General

1.1 This module covers the remote resetting of SSI TFMs.

2. Background

2.1 If an SSI TFM failure is recoverable, such as input or output interface failures, an attempt can be made to reset the module remotely whilst Signalling Technicians are en route.

2.2 If the module resets correctly, this will temporarily enable the train service to be restored and the failure to be investigated.

2.3 The use of the reset system is not an alternative to the Signalling Technician’s attendance.

3. Principles of Giving a Reset

3.1 The request for a reset will be made by the Signaller to resolve a known fault.

The following requirements shall apply:

a) A reset given under this authority shall only be undertaken twice for a given SSI TFM in a 24-hour period and is enforced in the reset software.

b) Before a reset is given, assurance shall be obtained from the Signaller that there are no train movements on any line(s) within the area controlled by the SSI TFM.

NOTE: *The SSI Reset software displays the functions being controlled.*

c) The Signaller shall be advised just prior to any reset being given and when train movements can be resumed.

d) The precise method of reset is documented in section 6.

e) If the reset request is considered unsafe or there is any doubt about the reset requirements, the SM(S) shall be informed.

4. Competence

4.1 A reset shall only be undertaken by a competent person authorised by the S&TME.

5. Authorisation and Records

5.1 The S&TME is accountable for:

a) All authorised Users under their control and record of these.

b) Briefing of users prior to the process being used.

c) The removal of any user who no longer requires access.

This should be within 2 weeks.

5.2 Records are kept electronically within the SSI Reset log file for each login and include:

a) User Name.

b) Time and Date.

c) Equipment Reset.

d) Reason for reset.

e) Successful Reset [Yes/No].

6. Method of Resetting SSI TFM

6.1 Check that the correct TFM is selected and the equipment controlled by it does not affect train movements. Assurance shall be obtained from the Signaller.

6.2 Login and Browser Information.

The reset process is initiated from a web-based application.

Login screen (Figure 1) is presented. Enter user name, password and click OK.

Figure 1 – Login Screen

6.3 Reset Operations: Screen 1

Once logged in, a list of reset operations you are authorised to undertake (Figure 2) are presented. Select ‘Reset SSI’.

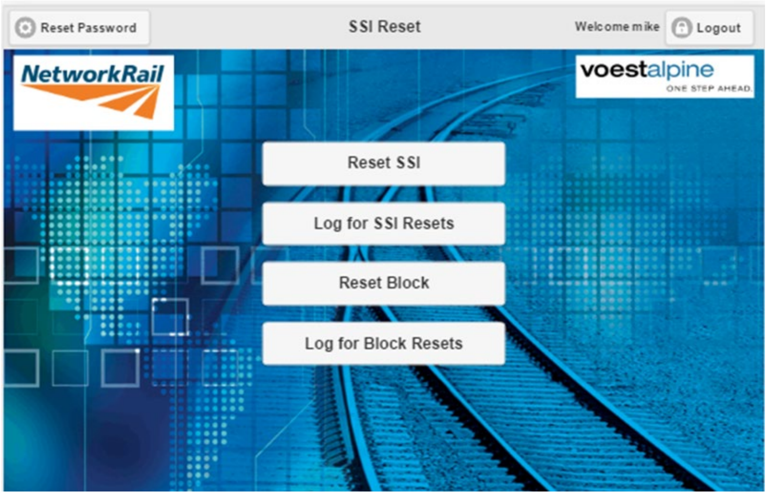


Figure 2 - Reset Selection Screen 1

6.4 Reset Operations: Screen 2

The second Reset Operations screen (Figure 3) shows the locations of the modules and selecting a location will take you to a sub menu listing all of the TFM’s at that site. The process is shown in Figures 3 to 6.

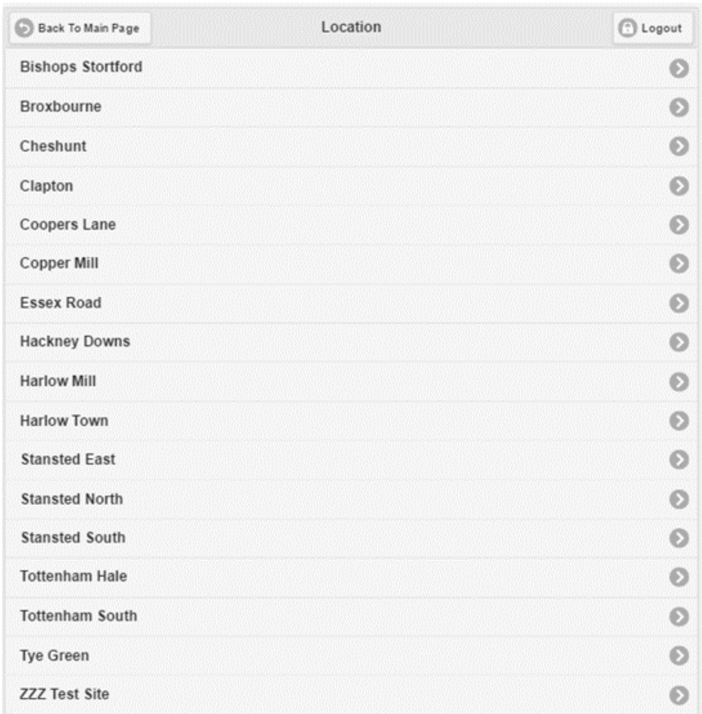


Figure 3 - Reset Selection Screen 2

Figure 4 – Reset Sub-Selection Screen 2 after selecting Broxbourne in Figure 3

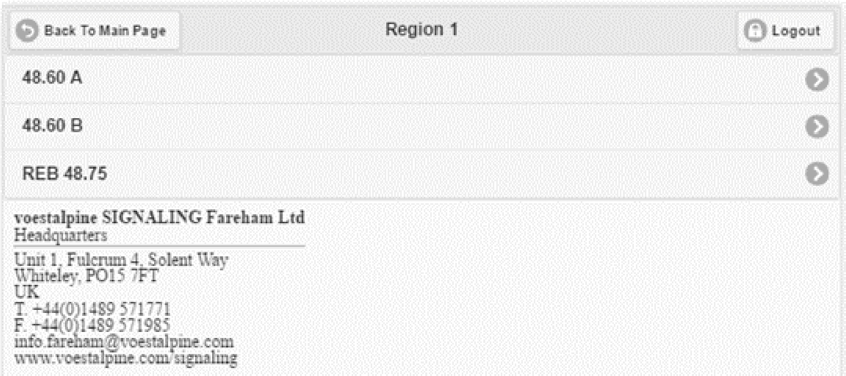
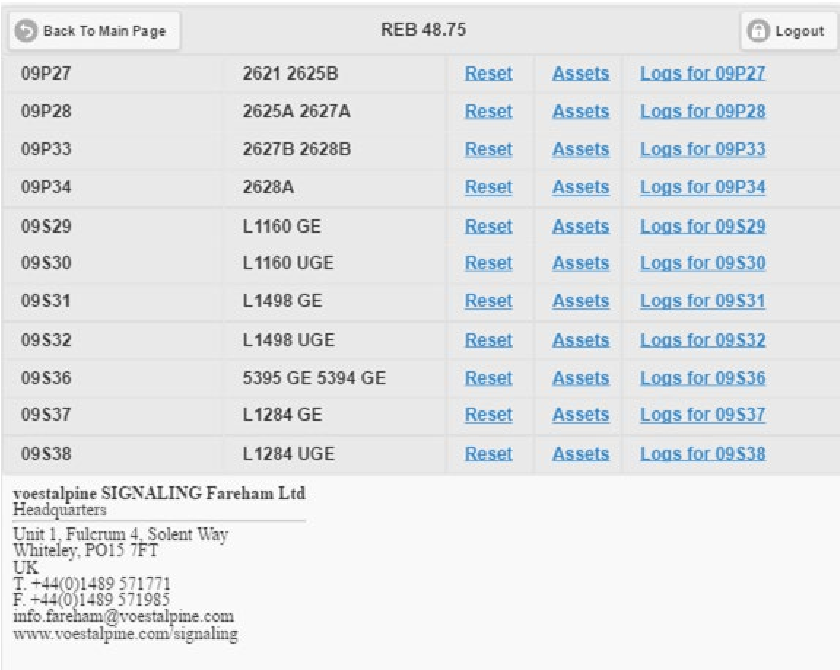


Figure 5 - Reset Sub-Selection Screen 3 after selecting Region 1 in Figure 4



09P27	2621 2625B	Reset	Assets	Logs for 09P27
09P28	2625A 2627A	Reset	Assets	Logs for 09P28
09P33	2627B 2628B	Reset	Assets	Logs for 09P33
09P34	2628A	Reset	Assets	Logs for 09P34
09S29	L1160 GE	Reset	Assets	Logs for 09S29
09S30	L1160 UGE	Reset	Assets	Logs for 09S30
09S31	L1498 GE	Reset	Assets	Logs for 09S31
09S32	L1498 UGE	Reset	Assets	Logs for 09S32
09S36	5395 GE 5394 GE	Reset	Assets	Logs for 09S36
09S37	L1284 GE	Reset	Assets	Logs for 09S37
09S38	L1284 UGE	Reset	Assets	Logs for 09S38

Figure 6 - Reset Sub-Selection Screen 4 after selecting REB 48.75 in Figure 5

You can then select;

a) Reset (see 6.3.1) or

b) Assets (see 6.7.1) or

c) Logs (see 6.7.2)

6.5 Reset

The reset screen is a confirmation that you wish to reset the selected module (Figure 7).

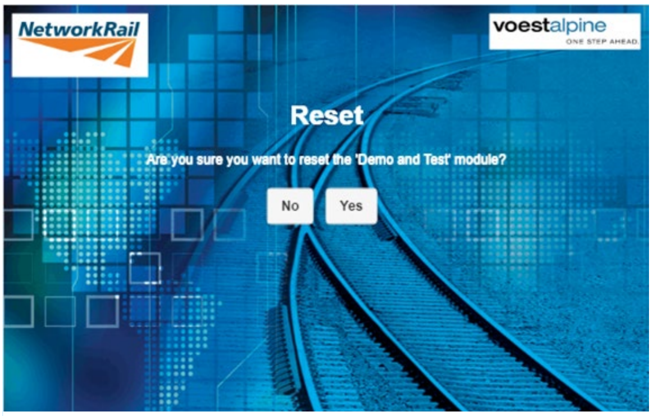


Figure 7 - Confirmation Dialogue Box

6.6 Signaller Check

Selecting 'Yes' to the confirmation brings up a screen to confirm that the Signaller has been informed (Figure 8).

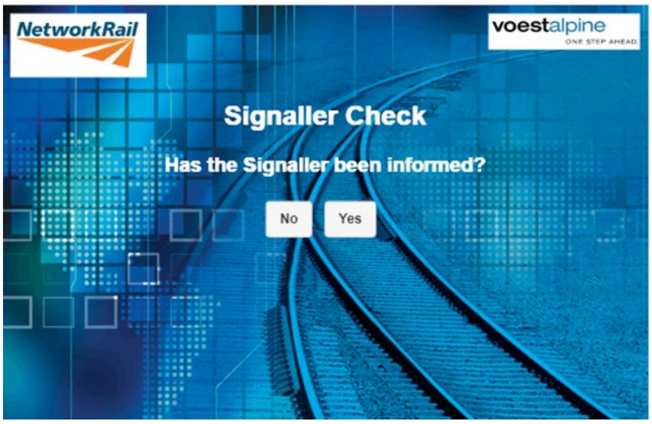


Figure 8 – Signaller Check Screen

6.7 Reset Reason

Clicking 'Yes' in the confirmation dialog box brings up the reset reason screen (Figure 9).

Enter the six-digit fault number, select a reason for reset and re-enter the password to the TFM reset process. Then click 'OK'.

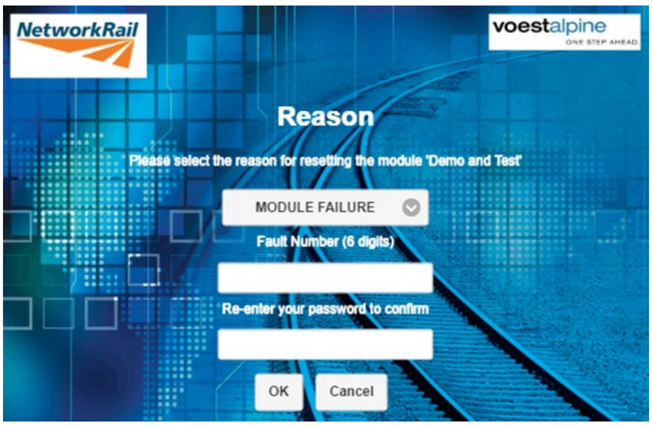


Figure 9 - Reset Reason Screen

6.8 Resetting Screen

The progress of the reset process is reported on the web page and shows successful connection and reset initiation. The SSI TFM has been reset when 'Completed' appears (Figure 10).

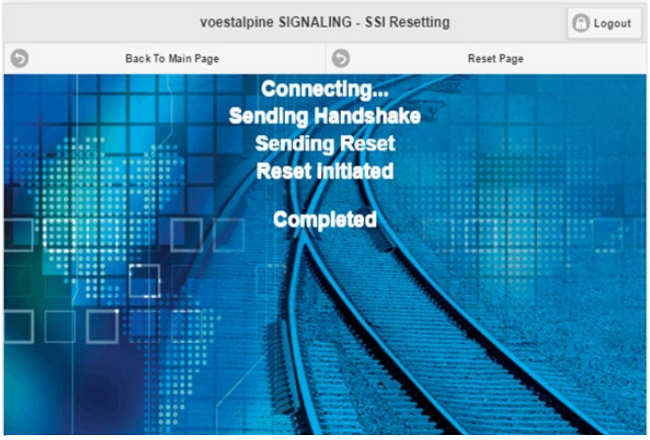


Figure 10 - SSI Reset Complete

6.9 SSI Reset successfully?

The next screen to appear requests if the reset was successful, enter 'Yes' or 'No'.

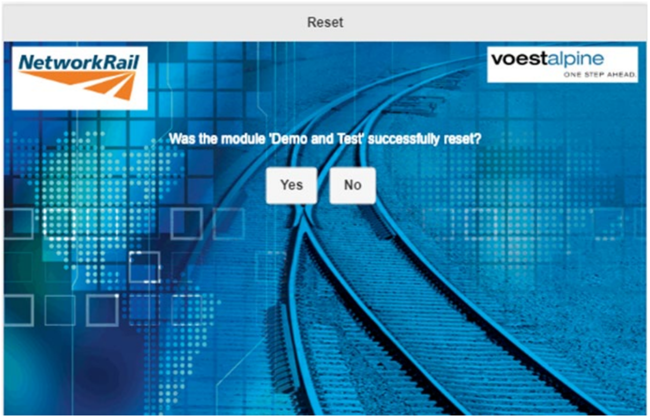


Figure 11 - SSI Reset Successful

6.10 Assets

By clicking on the asset box in the Module, Description or Logs columns a pop-up box with additional information about the unit (Figure 12) will appear.

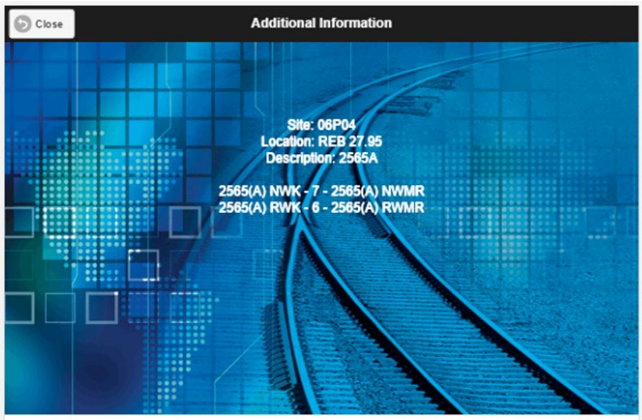


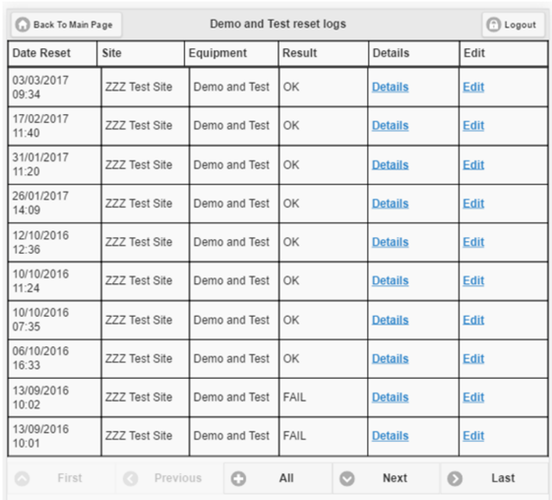
Figure 12 - Additional Information

6.11 Logs

The Logs section gives you access to further information about each asset. See Figure 13.

By selecting detail, you can see further details of the TFM, shown in Figure 14.

The edit column allows you to update information about the TFM, such as a new Serial Number. This page is shown in Figure 15.



Date Reset	Site	Equipment	Result	Details	Edit
03/03/2017 09:34	ZZZ Test Site	Demo and Test	OK	Details	Edit
17/02/2017 11:40	ZZZ Test Site	Demo and Test	OK	Details	Edit
31/01/2017 11:20	ZZZ Test Site	Demo and Test	OK	Details	Edit
26/01/2017 14:09	ZZZ Test Site	Demo and Test	OK	Details	Edit
12/10/2016 12:36	ZZZ Test Site	Demo and Test	OK	Details	Edit
10/10/2016 11:24	ZZZ Test Site	Demo and Test	OK	Details	Edit
10/10/2016 07:35	ZZZ Test Site	Demo and Test	OK	Details	Edit
06/10/2016 16:33	ZZZ Test Site	Demo and Test	OK	Details	Edit
13/09/2016 10:02	ZZZ Test Site	Demo and Test	FAIL	Details	Edit
13/09/2016 10:01	ZZZ Test Site	Demo and Test	FAIL	Details	Edit

Figure 13 - Logs

Figure 14 – TFM Reset Details

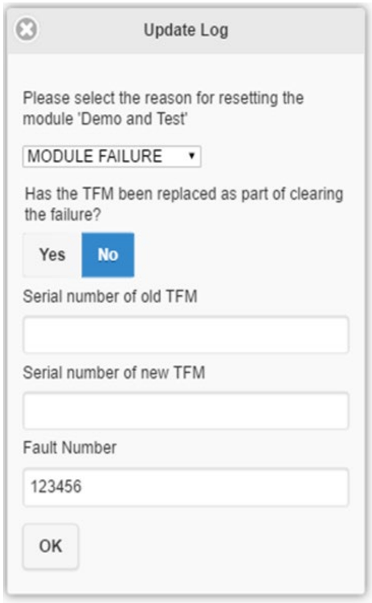


Figure 15 - Edit details of the TFM

6.12 Close Browser

Once the reset is completed, it is recommended that the browser is closed to end the session to prevent any unauthorised access.

7. Investigation of Fault

Signalling Technicians shall attend site to investigate the failure before the fault can be closed in FMS.

END

1. Principles

1.1 When the Signalling Technician becomes aware of signalling equipment that has suffered damage, the first consideration is to make the operational railway "safe."

1.2 The Signalling Technician might become aware of the damage by being informed (by Signaller or control), or could find the damage during normal work activities. The damage might have caused a signalling failure, in which case the failure should be rectified in accordance with established practices and techniques by authorised staff. Alternatively, the damage might not initially be classified as a failure, or has no apparent effect on train running or performance.

1.3 Once aware of the damage, the Signalling Technician shall assess its effect on trains and their safety, and the safety of the infrastructure and persons working upon it. If the Signalling Technician has any concerns for the safety of the railway, the Signaller shall be informed to stop traffic. If the situation is considered serious, the Signalling Technician shall stop the trains in accordance with the Rule Book immediately, and then inform the Signaller. If the damage is cosmetic, and unlikely to have any effect on trains, the Signaller shall be informed but advised that trains can continue to run.

1.4 Actual permanent repair of damaged equipment is covered in instructions elsewhere, and beyond the scope of this standard. Where the equipment is not immediately repaired, it shall be made safe (which might include temporary repair) before being restored to service.

2. Making Damaged Equipment Safe

2.1 In all cases, damaged equipment shall be made safe. This could include:

a) Securing the damaged equipment, to prevent passing trains suffering damage.

b) Disconnecting protecting signals.

c) Having the Signaller prevent rail traffic approaching the damaged equipment.

The list is not exhaustive.

2.2 The methods used can depend upon the damage caused. The Rule Book and this document contain instructions for use in some situations. By their very nature, all the different modes of damage are large in number and vary in complexity.

For example, a location case could have its doors ripped off through vandalism. The location case could continue to operate, although the security and weather protection of the location needs to be restored by the Signalling Technician.

Alternatively, a signal might be knocked over by road-rail plant. The Signaller needs to be told immediately so that necessary warnings can be given to approaching trains.

3. Temporary Repair

3.1 Should a permanent repair not be immediately possible, it is essential that any temporary repair (or making damage safe) is fit for purpose and itself presents no risk to rail traffic.

As an example, loose mechanical signalling equipment needs to be secured. A broken mechanical FPL casting is subject to severe dynamic forces when trains pass over it. The points require to be clipped and scotched in accordance with the Rule Book, but the FPL requires to be held down also (as it might foul a passing train). A “Zippy” tie is totally inadequate for a temporary repair holding the broken FPL casting in place. Instead, a metallic strap (or straps), or similar device(s) shall be used to secure the FPL equipment in place to parts that are fixed down. In this example, it might be possible to take the damaged equipment away, another method of rendering it safe.

3.2 Temporary repairs shall be logged in the defect management system and permanently repaired in accordance with any time limits given in NR/L2/SIG/19807 Prioritisation of Signal Engineering Equipment Defects. Where the damage repair timescale is not covered by standards, effort shall be made to complete a permanent repair, and not leave the temporary repair in place for an extended period.

3.3 Where a temporary repair has been completed, it is essential that the Signaller is informed of the nature of the repair and any restrictions or disconnections necessary. The Signaller’s occurrence book and Form 3187 shall be used.

4. Permanent Repair

4.1 When a permanent repair is completed, any restrictions and disconnections shall be restored and any Form 3187 withdrawn. All necessary entries shall be made in the Signaller’s occurrence book.

END

Includes:	S&T staff facilitating additional protection for pre-planned line blockages by signalling disconnections or Technician's controls
Excludes:	During failures, when working on S&T equipment and when a release of controls is required (See B002). Protection for T3-D by Technician's Controls (see B009)

1. Application of this Module

1.1 This module applies to all S&T Staff in Maintenance and in Works Delivery and applies to pre-planned Line Blockages only.

1.2 This module covers the Planning and Application of Disconnections or Technician Controls when they are for the purpose of providing Additional Protection for a Line Blockage only.

1.3 This module does not cover Disconnections or Controls that are applied for any other reason (see B001 and B002).

This module is to be read in conjunction with Rule Book HB8 and HB21.

2. Clarification of terms

2.1 The primary means of protection for a line blockage is always implemented by the Signaller.

2.2 Additional Protection is a secondary action taken to shield the site of work from inadvertent action by the Signaller.

2.3 Additional Protection does not need to hold the primary protecting signal for the line blockage at danger, but it does need to hold the signals immediately protecting the work at danger within the line blockage.

2.4 Additional Protection can be provided by disconnecting or controlling signalling equipment.

2.5 Signalling equipment disconnections or controls for Additional Protection can be achieved by methods such as:

a) Isolating a signalling circuit at a designed disconnection point.

b) Applying a Technician's Control (e.g. Route Bar).

c) Disabling a Panel Button.

d) Disabling a Mechanical Lever.

e) Taking control of a Ground Frame*.

f) Taking control of points (i.e. by switching to manual and setting halfway to break the detection).*

**For the purposes of providing additional protection, taking local control of signalling equipment is treated as a physical disconnection.*

This list is not exhaustive. Whichever method is selected shall be independently checked as appropriate and effective as per this instruction.

2.6 The Signaller does not have to 'see' the disconnection or control for it to still be effective.

2.7 There is no requirement to complete an RT3187 when a signalling disconnection or control is made for the sole purpose of providing Additional Protection.

3. Planning

3.1 An S&T Technician shall propose the disconnection(s) or Technician's control(s) to be applied to provide additional protection for a particular line blockage.

3.2 The proposed method shall detail the following:

a) The signal(s) prevented from clearing by the disconnection(s) or control(s).

b) The function(s) being isolated or controlled.

c) The Location Case / REB ID or Technician's Terminal where the disconnection or control is to be applied.

d) The fuse(s) to be pulled, link(s) to be slipped or the control(s) to be applied.

3.3 An independent S&T Technician shall check the proposed method as appropriate and effective by referring to wiring diagrams and control tables.

Line Blockage Reference			
Location			
Line Blockage Detail			
Prepared by		Date	
Checked by		Date	

Signal(s) held at Danger	Function disconnected or controlled	Disconnection or Control location e.g. Relay room, Loc case, Dis box, TF, etc	Disconnection or Control detail e.g. Rack, Row, Link No., Control, etc.	Disconnected by		Reconnected by	
				Name	Signature	Name	Signature

Table 1 - Pro-forma for planning and recording disconnections

3.4 The Supervisor/Manager responsible for the staff that are to be applying and removing the disconnections or controls shall undertake a workload assessment considering the complexity and the repetitiveness of the work.

For example, where the line blockage is to be taken and given up 'between trains' or at Control Centres where multiple line blockages might be facilitated by the same Technician.

4. Physical Disconnections

4.1 Physical disconnections are only to be made at a designed isolation point by pulling a fuse, slipping a link or by turning a switch or key.

4.2 Wires shall not be removed from a terminal or a plugboard.

4.3 Physical disconnections and restorations shall only be carried out by a competent S&T Technician in liaison with the Signaller, in accordance with the Rule Book (Handbook 8).

4.4 Competent to carry out pre-planned physical disconnections at a designed isolation point is defined as holding Sig 25 (Take and relinquish responsibility for Signalling equipment).

4.5 The S&T Technician making the disconnection is responsible for checking that the disconnection is appropriate and effective in conjunction with the Signaller.

4.6 All disconnections shall be recorded.

4.7 If a physical disconnection is going to be left unattended then a label shall be applied to the disconnection to prevent inadvertent reconnection.

Example disconnection label

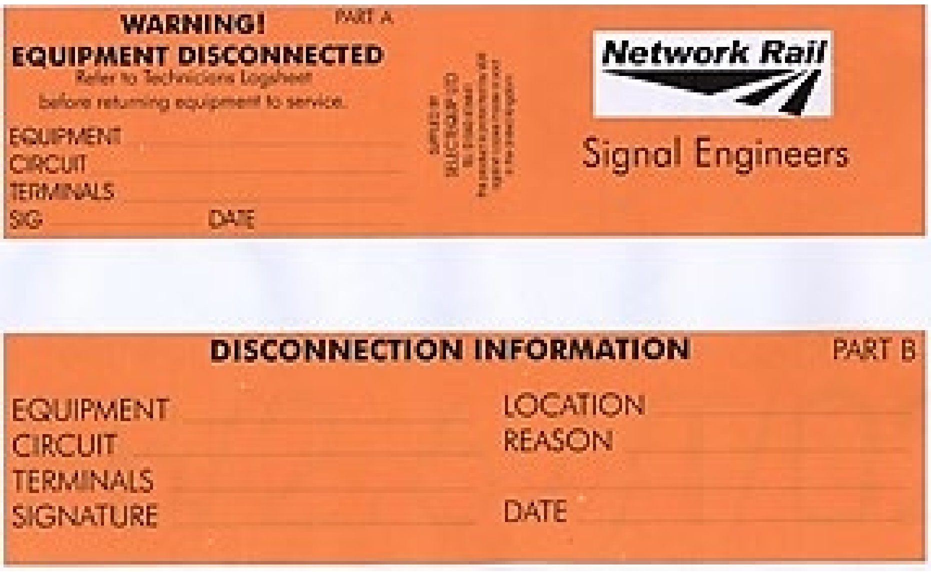


Figure 1 - URLT/004363

4.1 Technician's Controls

4.8 Technician's Controls applied for the purpose of providing additional protection for a line blockage shall only be made at the designated Technician's Terminal (or modern equivalent).

4.9 The application and removal of controls shall only be carried out by a competent S&T Technician.

4.10 Competent to apply or remove controls for the purposes of providing additional protection for a line blockage is defined as being suitably trained and familiar with system type and competent in Sig 25 (Take and relinquish responsibility for Signalling equipment).

4.11 The S&T Technician applying the control is responsible for checking that the control is appropriate and effective in conjunction with the Signaller.

4.12 All Interlocking Controls shall be documented in accordance with local procedure.

4.13 Technician's Terminals (or modern equivalents) that have a Remote Facility (such as TFR+) shall have a process in place for managing this arrangement.

5. RACI

Disconnections or Controls for Additional Protection RACI Chart	S&T Supervisor / Manager	S&T Technician	Signaller
Planning the disconnections / controls, allocating resource	**A/R**	**C**	**I**
Applying / Removing disconnections / controls, confirming effectiveness	**I**	**A/R**	**C**

END

Includes:	S&T staff facilitating additional protection for pre-planned T3-D Possessions by Technician's controls
Excludes:	During failures, when working on S&T equipment and when a release of controls is required. (See B002). Preplanned line blockages (see B008)

1. Application of this Module

1.1 This module shall apply to all S&T Staff in Maintenance and in Works Delivery and shall apply to pre-planned T3-D possessions only.

1.2 This module covers the Planning and Application of Technician Controls when they are for the purpose of providing Additional Protection for T3-D possessions only.

1.3 This module does not cover Disconnections or Controls that are applied for any other reason (see B001, B002 and B008).

NOTE: *This module is to be read in conjunction with Rule Book HB8 and HB21.*

2. Clarification of terms

2.1 The primary means of protection for a T3-D possession shall always implemented by the Signaller.

2.2 Additional Protection is a secondary action taken to shield the possession from inadvertent action by the Signaller during the T3-D possession.

2.3 Additional protection shall hold the primary protecting signal(s) for T3-D possession at danger.

2.4 Additional Protection shall be provided by disconnection with a technician's control being applied to the signalling system.

2.5 Disconnections with a control being applied to the signalling system for Additional Protection shall only be achieved by use of the Technicans Terminal (or modern equivalent).

2.6 The methods used to achieve the disconnection by applying a control to the signalling system shall be independently checked as appropriate and effective as per this instruction.

2.7 The Signaller does not have to 'see' the disconnection by application of a control to the signalling system for it to still be effective.

2.8 There is no requirement to complete an RT3187 when a signalling disconnection with a control being applied to the signalling system is made for the sole purpose of providing Additional Protection.

3. Planning

3.1 A Control Centre Technician shall propose the disconnection(s) to be provided by application of a control to the signalling system to provide additional protection for a particular T3-D possession.

3.2 The proposed method shall detail the following:

a) The signal(s) prevented from clearing by the technician's control being applied to the signalling system.

b) The function(s) being controlled.

c) The Technician's Terminal where the technician's control is to be applied.

d) The control(s) to be applied.

3.3 An independent Control Centre Technician shall check the proposed method as appropriate and effective by referring to diagrams and control tables.

3.4 The Supervisor/Manager responsible for the staff that are to be applying and removing the disconnections with a control being applied to the signalling system shall undertake a workload assessment considering the complexity and the repetitiveness of the work.

For example, where the possession limits require changing during the length of the possession or at Control Centres where multiple possessions and/or line blockages might be facilitated by the same Technician.

4. Physical Disconnections

4.1 Physical disconnections are not permitted under T3-D possession arrangements.

5. Technician's Controls

5.1 Technician's Controls applied for the purpose of providing additional protection for a T3-D possession shall only be made at the designated Technician's Terminal (or modern equivalent).

5.2 The application and removal of controls shall only be carried out by a competent Control Centre Technician.

5.3 Competent to apply or remove controls for the purposes of providing additional protection for a T3-D possession is defined as being suitably trained and familiar with system type and competent in Sig 25 (Take and relinquish responsibility for Signalling equipment).

5.4 The Control Centre Technician applying the control is responsible for checking that the control is appropriate and effective in conjunction with local procedures.

5.5 All Interlocking Controls shall be documented in accordance with local procedure.

5.6 Technician's Terminals (or modern equivalents) that have a Remote Facility (such as TFR+) shall have a process in place for managing this arrangement.

6. RACI

Technician's controls for additional protection in relation to T3-D Possession RACI Chart			**Local Procedure**		
Activity / Role	S&T Supervisor/Manager	Control Centre Technician	Signaller	Independent Control Centre Technician	Independent Control Centre Technician Review of print out
Planning the Technician's controls, allocating resource	A/R	R/C	I		
Applying / Removing technician's controls, confirming effectiveness	I	A/R	C	A/R	A/R

Table 1 – RACI

7. Example of Completed T3-D disconnection plan

NR/L3/SIG/10064/B009
(Disconnections – additional protection for T3-D possessions by signalling disconnections or technician's controls)

POSSESSION REFERENCE			
DISCONNECTION REFERENCE			
LOCATION			
POSSESSION LIMITS		PICOP NAME	
		PICOP CONTACT NUMBER	
		EMPLOYER	

PREPARED BY	**NAME:**		SIGNATURE		DATE
CHECKED BY	**NAME:**		SIGNATURE		DATE

Terminal Controls check

Terminal & Location	Interlocking	Disconnector Before T3D	Verifier Before T3D		Disconnector After T3D	Verifier After T3D

ASSET TO BE CONTROLLED	FUNCTION CONTROLLED	CONTROL LOCATION	CONTROL DETAIL		Special Remarks
			Interlocking	ID	
		TYNESIDE ROC			

DISCONNECTED BY		RECONNECTED BY	
NAME		NAME	
SIGNATURE		SIGNATURE	
DISCONNECTION VERIFIED BY		**RECONNECTION VERIFIED BY**	
NAME		NAME	
SIGNATURE		SIGNATURE	

END

1. Standard Structure Gauge

1.1 Signalling equipment shall be located so that it does not encroach on the standard structure gauge limits shown in Figures 2 and 4, except as permitted below.

1.2 The Signalling Technician shall consult the SM(S) regarding any new equipment which would be foul to gauge and report any existing equipment such as stay wires, balance levers and ground signals which is foul to gauge.

1.3 All guys or line wires permanently above the track shall be fixed at height not less than 6100mm above rail level.

1.4 Temporary wires or ropes over the track shall not be lower than 5500mm above rail level or, if less, no train shall be allowed to pass until the wire or rope has been removed.

1.5 Supports for carrying temporary wires or ropes shall be fixed securely and, if necessary, guyed.

2. Signal Structures on Lines of 100mph or Less

2.1 Where the maximum permitted speed is 100mph or less, the standard structure gauge (Table 1) requires the following:

a) No part of any signal structure such as post, SPT, ladder, hoops, platform, handrails, or screening etc below 4640mm above rail level, shall encroach within 1624mm of the running edge.

Where a) is not achievable:

b) An absolute minimum distance of 1364mm can be used in case of difficulty, such as where sighting is obstructed by OLE masts, the National Gauging team shall be consulted.

c) Any further reduction (e.g. to take advantage of the curvature of the vehicle gauge) is subject to individual site assessment by the National Gauging Team.

2.2 A straight post shall not be installed between two lines unless there is a minimum distance of 2728mm, plus the width of the widest part of the structure, between running edges.

See Section 6 for horizontal and vertical increases due to canted and curved track.

2.3 Signals shall be installed so that they do not infringe the standard structure gauge unless the Signal Sighting Assessment Form indicates that specific authority has been given by the National Gauging Team.

2.4 When sighting signals, signal structure drawings should be used to enable the width of the structure or the position of the signal post centre line to be calculated.

2.5 When positioning ground signals, use the detailed lower sector structure gauge in section 7.

3. Signal Structures on Lines over 100mph

3.1 Where the maximum permitted speed exceeds 100mph, but does not exceed 125mph, the standard structure gauge shall be the same as in Table 1, but with a distance of 2480mm substituted for the 1624mm in point a).

4. Walkways

4.1 The requirements for walkways given in NR/L2/OHS/069 are illustrated in Figure 3.

4.2 The minimum distance from the running edge is 1300mm, but a distance of 2000mm shall be provided where practicable. This shall be increased to 2406mm adjacent to an un-boarded conductor rail, or 2100mm where the maximum permitted speed exceeds 100mph.

NOTE: *The 2100mm still applies where speed exceeds 125mph even though staff access is prohibited, since traffic can be temporarily restricted to allow access.*

See Section 6 for horizontal increases on the above figures due to canted and curved track.

4.3 The width of the walkway is to be 700mm.

5. Cable Routes

5.1 The requirements for cable routes are illustrated in Figure 3.

5.2 Where possible, a distance of 2600mm from the running edge shall be provided to minimise interference in signalling and telecoms cables.

The normal minimum distance of a cable route is 2000mm from the running edge, passing on the trackside of apparatus cases, signals, overhead line masts and other obstructions.

A reduced clearance of 1250mm from the running edge is permitted in case of difficulty. If this is not achievable, the SM(S) shall be consulted.

No increases on the above figures are required due to canted and curved track.

As an option of last resort, a cable route can be positioned beneath the walkway, provided the lids are flush with the surface.

A troughing route shall not be installed between two lines unless there is a minimum distance of 4100mm between running edges.

6. Cant and Curvature

6.1 Additional allowance for cant and curvature shall be added to the structure gauge dimensions, as given in Figure 1.

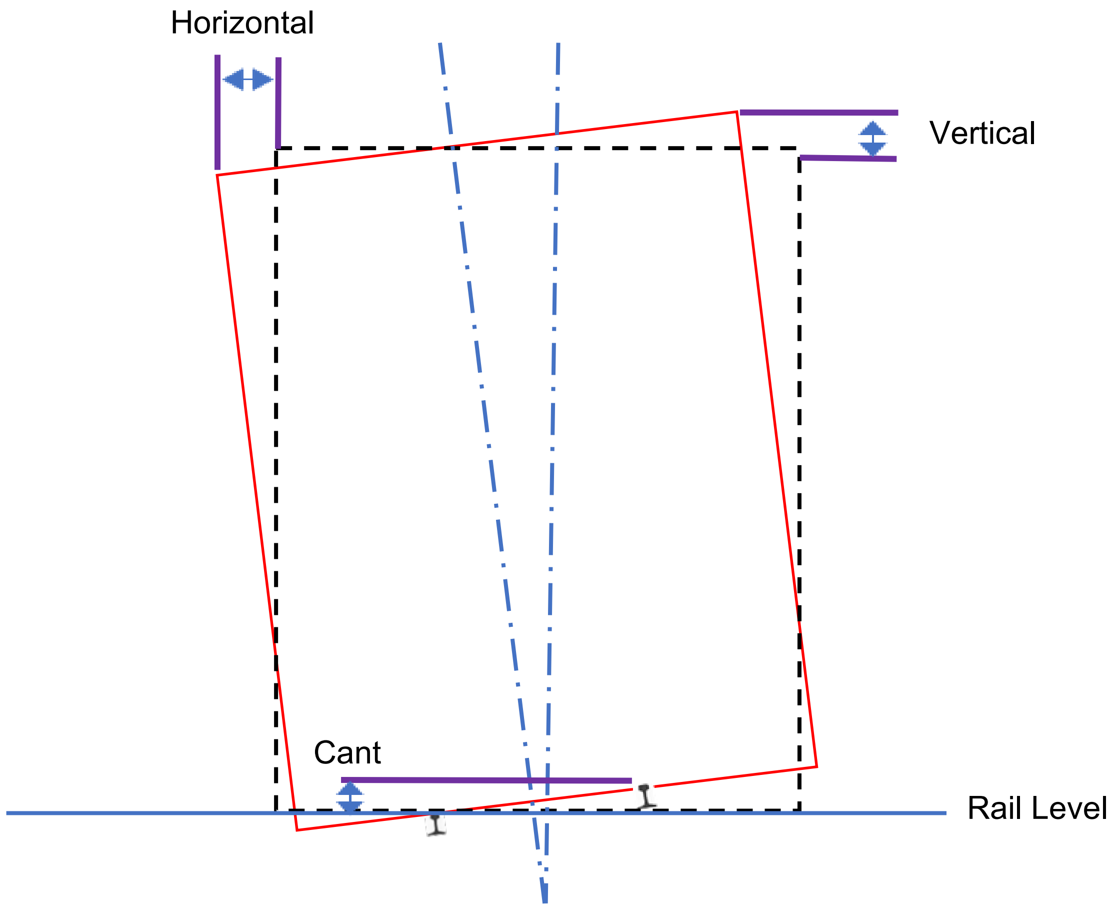


Figure 1 – Additional Clearance Required for Cant and Curves

6.2 The horizontal allowances (Tables 1 and 2) are to be added to the required horizontal clearance measured from the correct running edge.

The vertical allowance (Table 1) is to be added to the required vertical clearance measured from the lower rail.

All distances in this module shall be measured vertically or horizontally, irrespective of the plane of the rails.

Cant	Add Horizontal #	Add Vertical
0	0	0
10	33	22
20	65	43
30	97	64
40	129	86
50	161	107
60	193	128
70	225	150
80	257	171
90	289	192
100	320	214
110	352	235
120	383	256
130	415	277
140	446	299
150	477	320
160	509	342
170	540	363
180	571	385
190	602	406
200	632	427

Table 1 - Allowance for Cant in mm

Radius of curve (m)	Centre-throw increase on inside of curve		End-throw increase on outside of curve
	16m bogie centres	17m bogie centres	
100	330	371	346
125	264	297	279
200	165	185	176
250	132	148	141
300	110	124	118
400	83	93	89
500	66	74	71
600	55	62	59
750	44	50	48
1,000	33	37	36
1,500	22	25	24
2,000	17	19	18
5,000	7	8	8
more than 5,000	0	0	0

Table 2 - Horizontal Allowance for Overthrow of Rolling Stock on Curves in mm

NOTE: *1 The horizontal figures from Table 1 and 2 are to be added together.*

NOTE: *2 Tables 1 & 2 are based on the 4640mm vertical clearance and1624mm horizontal clearance from the running edge.*

NOTE: *3 The lower rail is taken as rail level for vertical clearances.*

Added only to dimensions on inside of curve (dimensions on outside of curve unaffected).

7. Detailed Lower Sector Structure Gauge

7.1 The lower sector structure gauge (Figure 4) shall be used for signalling equipment located within the four foot or within 1m of the running edge.

7.2 The top of the signalling equipment shall not encroach above rail level unless authorised by the National Gauging Team.

NOTE: *It is accepted that trainstops in the raised position are foul to gauge.*

7.3 Additional allowance for cant and curvature shall be added to the dimensions when positioning ground signals, as given in Table 2.

This depends on whether the route has acceptance for Eurostar rolling stock or 2.6m wide containers.

The horizontal allowances "X1" & "X2" (Tables 3 and 4) are both to be added to the required 730mm horizontal clearance measured from the correct running edge.

The vertical allowance "Y" (Table 4) is to be subtracted from the permitted 915mm vertical distance on the inside of the curve, measured from the lower rail.

NOTE: *Eurostar rolling stock requires an additional clearance of 30mm, even on straight track.*

Radius of curve (m)	Standard Gauge	Class 373 Eurostar	2.6m Wide Containers	
			inside curve	outside curve
< 160	subject to special assessment			
160	96	126	145	96
200	63	93	104	63
250	37	67	71	37
300	20	50	49	20
360	5	35	31	5
≥ 500	0	30	0	0

Table 3 - Horizontal Overthrow Allowance "X1" mm

NOTES:

1. The horizontal figures from Table 3 and 4 are to be added together.
2. Tables 3 & 4 are based on the 915mm vertical distance and 730mm horizontal clearance from the running edge.
3. The lower rail is taken as rail level for vertical clearances.
4. Table 3 includes a 5mm allowance for side wear on curves.
5. Table 4 applies only to dimensions on inside of curve (dimensions on outside of curve unaffected).
6. The figures in Table 3 are based on the formulae given in GI/RT7073 for the lower sector infrastructure gauge.

Cant	Add Horizontal "X2"	Subtract Vertical "Y"
0	0	0
10	6	5
20	13	10
30	19	15
40	25	20
50	32	25
60	38	31
70	44	36
80	50	41
90	56	46
100	62	51
110	68	56
120	74	61
130	80	66
140	86	81
150	92	86
160	98	92
170	103	97
180	109	102
190	115	107
200	121	112

Table 4 - Allowance for Cant in mm on inside of curve

8. Enhanced Structure Gauge

8.1 The enhanced structure gauge in Figure 5 published by ORR, is only for use where specially authorised.

9. Non-Standard Structure Gauges

9.1 If there is any doubt as to the structure gauge for a particular route, the details shall be ascertained from the National Gauging Team, via the SM(S), before commencing work. The appendices in GE/GN8573 describe several possible vehicle gauges.

10. Clearance and Fouling Points within S&C

10.1 See NR/L2/SIG/11752 for detailed requirements for both standard and Eurostar rolling stock.

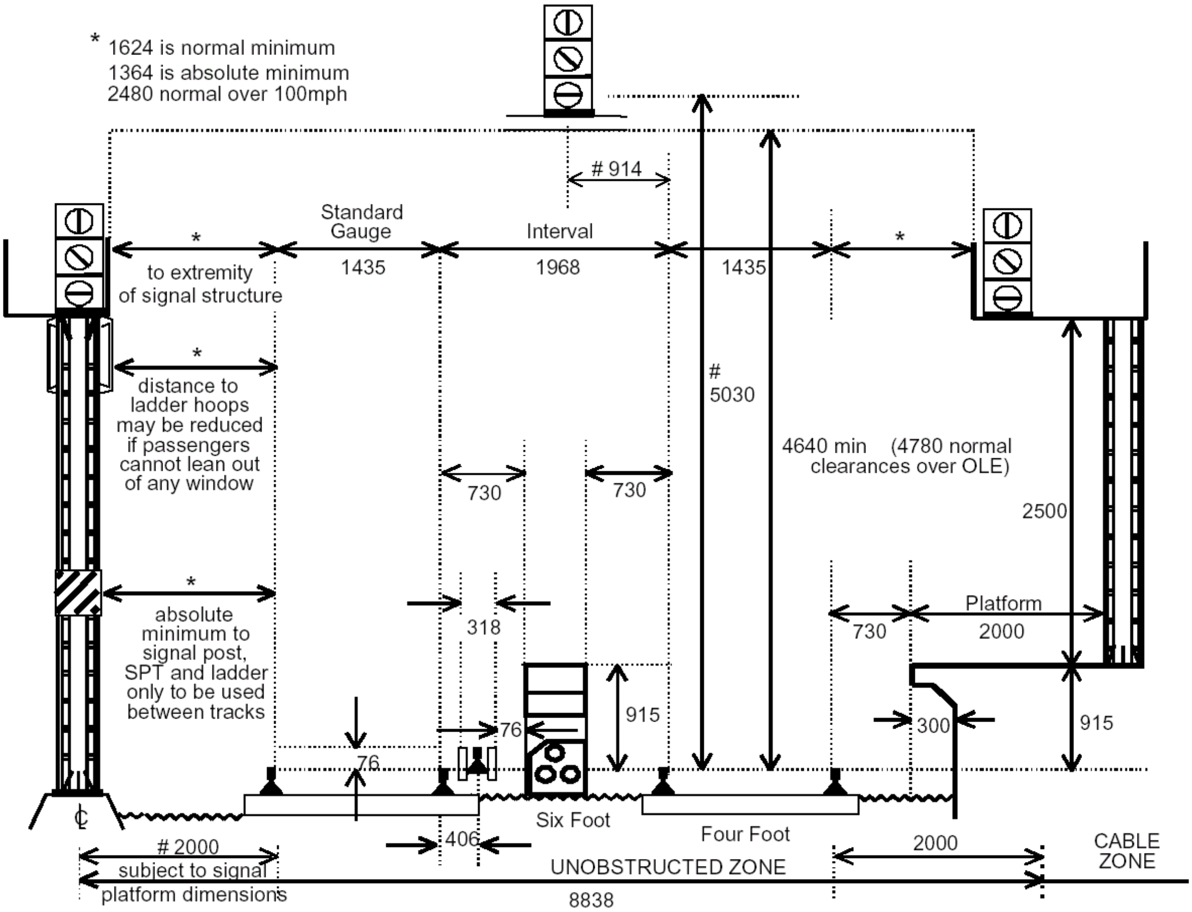


Figure 2 - Clearances for Lineside Equipment on Straight and Level Track where Permissible Speed does not exceed 125mph

NOTES:

1. See section 7 for Eurostar rolling stock on straight track. For additional clearances required for cant and curvature, see Figure 1.
2. # = optimum position. Actual distance to be determined by Signal Sighting Committees.
3. Any proposal for further reduction in clearance is subject to site assessment by the National Gauging Team.

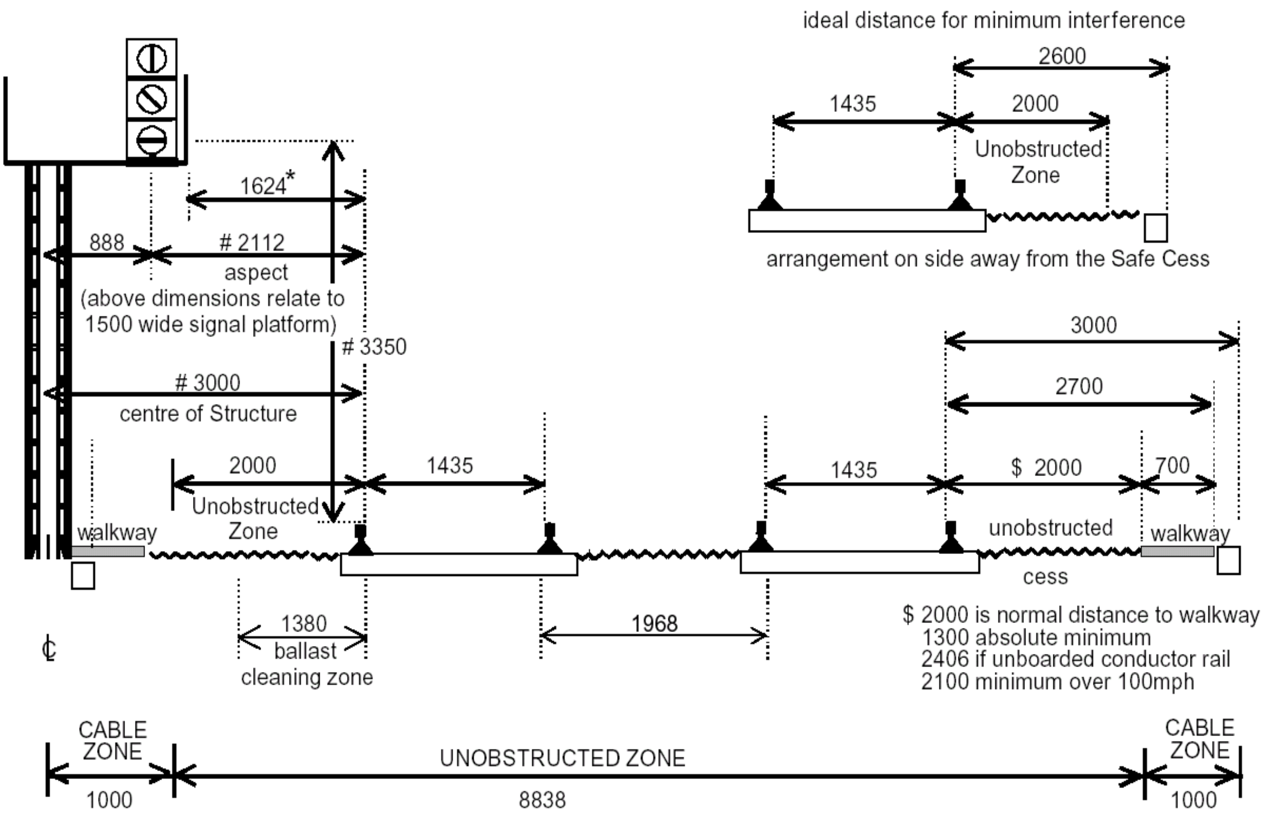


Figure 3 - Clearances for Lineside Equipment on Straight and Level Track - Walkways and Cable Routes

NOTES:

1. * = see Figure 2. For additional clearances required for cant and curvature, see Figure 1.

2. # = optimum position. Actual distance to be determined by Signal Sighting Committees.

3. Any proposal for further reduction in clearance is subject to site assessment by the National Gauging Team.

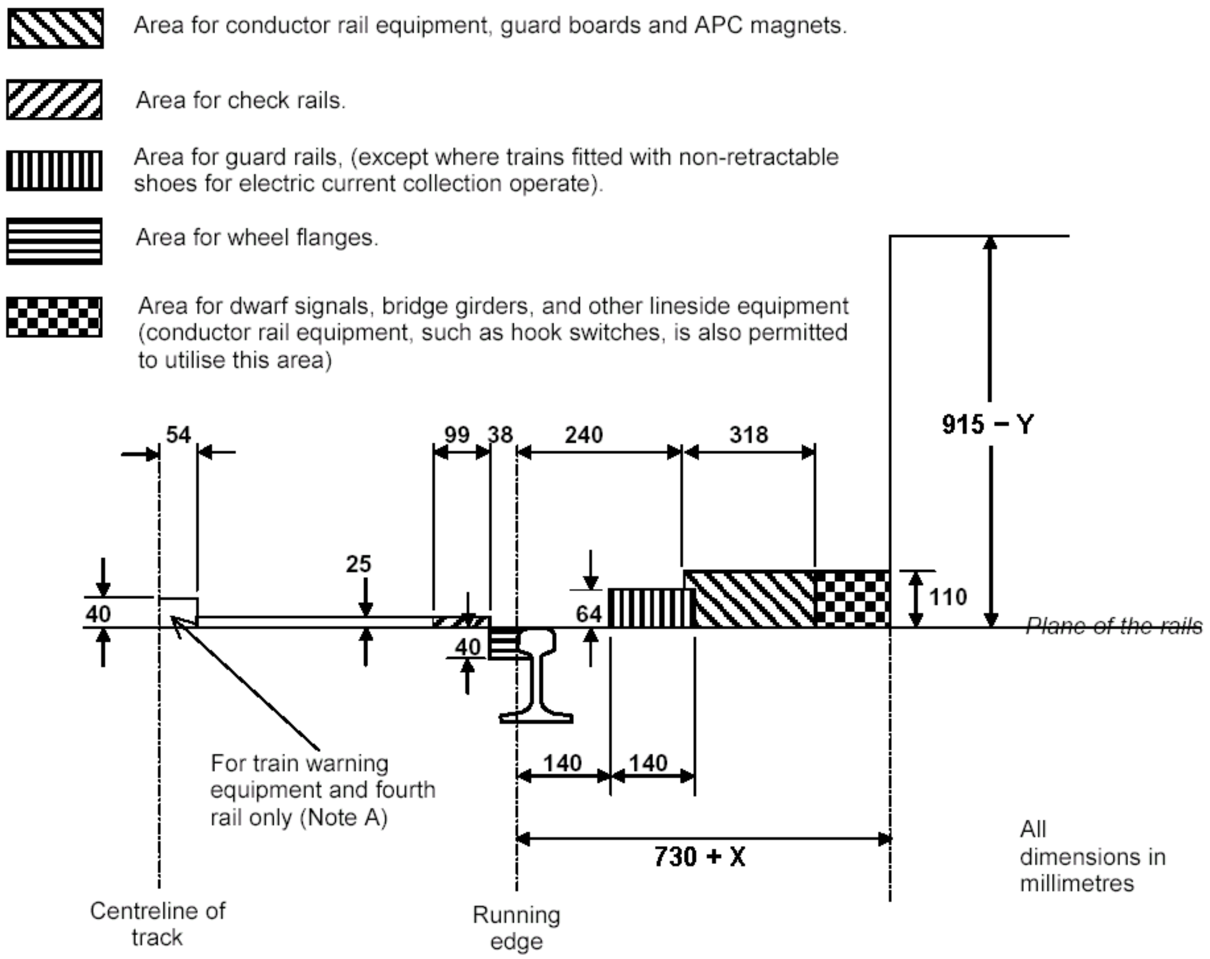


Figure 4 - Detailed Lower Sector Structure Gauge (see Table 1 for "X" and "Y" Dimensions)

NOTE: *For lines electrified on the fourth rail system, the fourth rail equipment extends to 40mm above plane of the rails.*

On other lines equipment close to the centre line of the track shall not extend more than 25mm above plane of the rails.

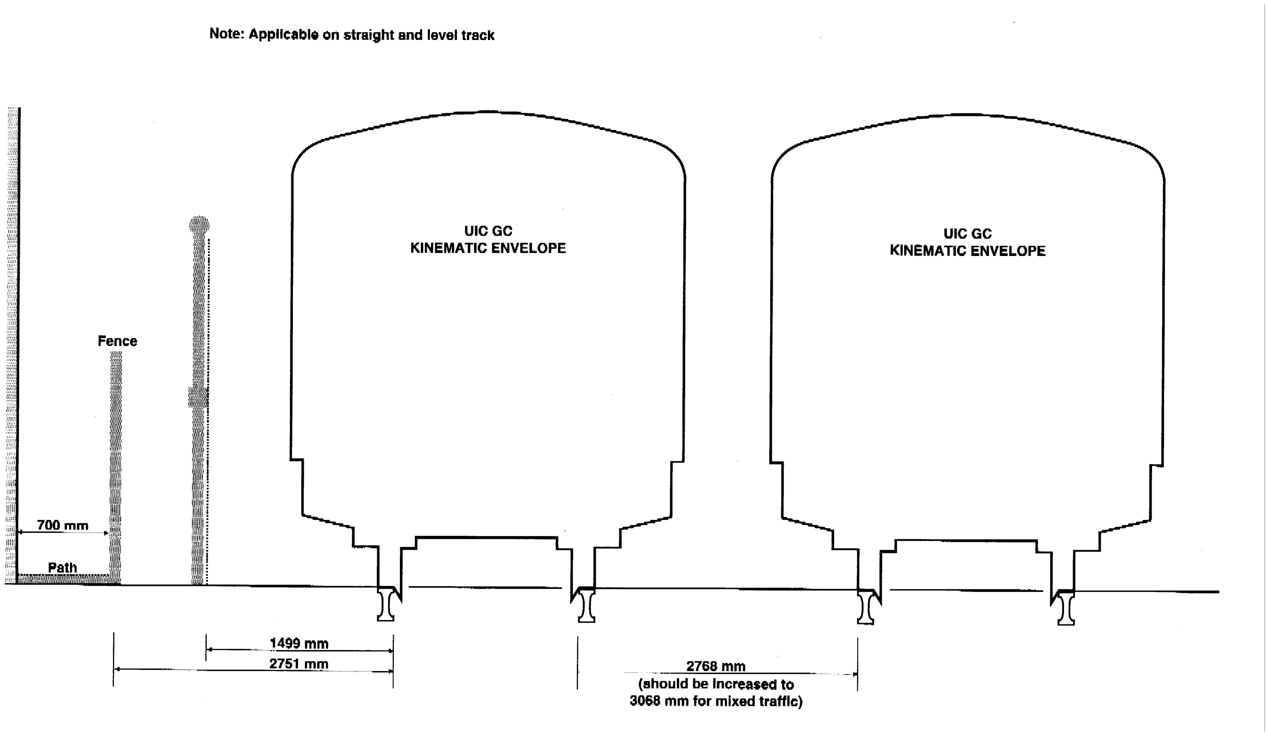


Figure 5 - Enhanced Structure Gauge for Permissible Speed up to 300 km/h (for kinematic envelope up to 3290mm wide and 4700mm high)

END

1. Before Starting Work Check List

1.1 The following checklist gives items to consider before starting work:

a) Do you have access to any handbooks or manuals necessary for the work?

b) Do you have any specialist tools you required to carry out the task?

c) Is the Signaller aware of the work and is it entered in the Train Register (A017)?

d) Do you have a safe system of work and are you familiar with the method statement for the work?

e) Has Rule Book protection for trains and staff been arranged where necessary?

f) Do you have the correct version of the site records or alteration drawings for the work (D025)?

g) Is there anything to suggest that the installation does not conform to the records (NR/L2/SIG/11201/ModA2-20)?

h) Is there a risk assessment to permit redundant equipment/wiring to remain in situ?

i) Are you aware of any Health & Safety warnings on the drawings, or signs to be affixed?

j) Are you aware of any hazards in the vicinity of the work (Hazard Directory)?

k) Will power supplies and/or conductor rail be isolated, or will the equipment be live (NR/L3/SIGELP/50003)?

l) If excavating, driving earth rods, or stake mounting, do you have records of buried services?

m) Have you assessed for manual handling any heavy or bulky items of equipment that need to be moved?

n) Does work involve asbestos or other substances harmful to health, such as lead or PCBs (W004, W011 and W012)?

o) Is working at height involved?

p) Are your tools or plant approved for the work and, where applicable, is the calibration and/or inspection within date (U001, U002 and NR/SMS/PartA/A05 (Plant, Tools & Calibration)?

q) Is electronic equipment involved and are there any electromagnetic compatibility issues (E001)?

r) Are the materials and any new/replacement equipment approved for use NR/SMS/PartA/A06 (Materials)?

s) Is there wire degradation or other damage that should be reported?

t) Are the maintenance record cards available for recording measurements?

u) Do you have an arrangement for disposing of any waste from the worksite NR/SMS/PartA/A14 (How to Care for the Environment)?

v) Is there adequate space on racks, in trunking and on fuse/terminal racks for any additional equipment?

w) Is the power supply and/or air conditioning adequate for any additional load?

x) Is any other signalling work being undertaken at the same installation that might affect the work (NR/L2/SIG/11201/Mod A2-12)?

y) Is there anything else that should be assessed (NR/L2/SIG/11201/Mod A2-19)?

z) Is there anything that is likely to put the public at risk related to your work i.e. at level crossings, on platform etc.

END

1. Bonding of Broken Rail Joints

1.1 The track engineer is responsible for the integrity of the rails at all times. Track circuits are not provided to identify rail breaks or disconnections.

1.2 In the event of a rail break, the track engineer can make a temporary repair to allow the passage of trains.

1.3 Where rail breaks involve S&C components (including crossings), Section 2 can apply.

1.4 Where rail breaks are associated with plain line, a temporary joint can be bonded around to allow the track circuit to work normally.

1.5 Before restoration to service, a full track circuit test shall be carried out.

***NOTE:** If the expected time to repair the joint is less than the time required to complete the bonding, it is not necessary to bond around the temporary joint.*

2. Trackwork Associated with Switches and Crossings

2.1 This section sets out the procedure to be adopted if temporary alterations to track circuit bonding or point detection circuits have to be made as a result of the track engineer being unable to replace a broken switch, stock rail, or crossing nose.

2.2 It also sets out the procedure to be adopted for restoring the permanent track circuit bonding or point detection circuits after the broken switch, stock rail or crossing nose has been reinstated.

It applies in the following situations:

a) Where a crossing is temporarily taken out of use or is replaced by a rail for one of the two routes.

b) Where a switch is removed but the stock rail remains.

c) Where a stock rail and switch are replaced by a single rail fixing the point lie in one of the two possible positions (where a stock rail is replaced by plain rail, the switch rail shall also be removed).

This instruction does not cover any situations where the points would have to be moved for flank or operating purposes.

3. Temporary Alterations (Associated with Switch and Crossings)

3.1 All affected routes, together with the points and the track circuit containing the broken crossing stock rail or switch, shall be signed out of use in accordance with the Rule Book Handbook 19.

Crossings (Situation A):

a) When a broken crossing cannot immediately be replaced, the relevant points shall be clipped, scotched and padlocked so that no movements can take place towards broken or missing rails.

b) If the track circuit is capable of operating and the bonding does not require a design alteration, a full track circuit test shall be carried out.

c) If the track circuit cables are affected carry out the relevant CAXX SMTH Test Plan.

d) If the track circuit is not capable of operating, as a result of missing bonding, as a result of the replacement rail being installed, a design for temporary bonding shall be added to the existing bonding plan to simulate the missing rail(s).

e) Where the missing bonding, as a result of the replacement rail being installed is identified as yellow bonding, the SM(S) shall be informed.

f) The Signalling Technician shall identify all signalled routes which require disconnection passing over the missing or broken rails.

g) An independent person competent in signalling failure investigation or an independent qualified signalling design checker, shall check the list of proposed signalled route disconnections and the proposed temporary bonding arrangements.

h) The design for temporary bonding and the list of signalled routes to be disconnected shall be signed and dated by the persons who have produced and checked these details.

i) The Signalling Technician shall then arrange for all identified and checked signalled routes passing over the missing or broken rails to be disconnected and for temporary bonding to be installed in accordance with the checked bonding plan.

j) The effectiveness of disconnections shall be verified and checked before they are relied upon and the presence of Signaller's reminder devices shall be confirmed.

k) An independent tester shall test all work carried out before the track circuit is restored as available for use.

Test Plan NR/L3/11235/G130/AR1002 - Temporary Alterations to Track Circuit Bonding should be used.

Stock and Switch Rails (Situations B and C):

l) Track circuits shall be dealt with as described in Crossings - Situation A steps b) to e).

m) The production of temporary design details for the alteration of point detection circuits to allow signalled movements over intact parts of the affected layout, shall be carried out by a Signalling Designer or Functional Equivalent (FE) Designer.

n) The temporary design shall include as much of the original detection circuitry and contacts as the circumstances allow, having regard to the requirements of "Securing of Switch Rails"

o) All temporary design shall be checked by an independent person competent in signalling failure investigation or an independent qualified signalling design checker.

p) All temporary design drawings shall show the signatures of the persons producing and checking the design.

q) All temporary wiring shall be installed with an easily identifiable coloured wire, (not red), in accordance with the checked temporary design details and to installation standards.

r) Labelling shall be applied to all temporary wiring.

s) A Test Plan for the temporary alterations shall be produced and checked by an independent tester.

t) The Test Plan should be selected from, or based on the following Test Plans:

- Test Plan NR/L3/11235/G130/AR1001 - Temporary Alterations to Point Detection.
  or
- Test Plan NR/L3/11235/G130/AR1002 - Temporary Alterations to Track Circuit Bonding.

u) To maintain independence, no person involved with the production or checking of design details or with the installation work, shall take part in any testing activity, except in an assisting capacity.

Securing of Switch Rails

v) This section is for situations B) and C) where a switch on either side has been removed but the stock rail remains or has been replaced by a rail, the remaining switch on the opposite site is required to be secured in the closed position, this shall be as specified in E054.

w) The stretcher bars shall be removed, if instructed to do so by the SM(T), together with any detector or lock rods or clamp lock components which have been disconnected from the missing switch.

x) If the remaining switch on the opposite side would normally require to be secured in the open position, the requirement for all stretcher bars to be fitted to secure the open switch cannot be met. In these circumstances the switch blade shall be removed. In this case all stretcher bars and detector or lock rods or clamp lock components which have been disconnected from the switches shall be removed.

y) If a point end which has been dealt with in this way is part of double ended or multiple ended points, all the ends involved shall be clipped, scotched and padlocked in the position required by the Signaller.

4. Reinstatement

Crossings (Situation A)

4.1 When a crossing is to be reinstated and temporary bonding was not required in “Temporary Alterations - Crossings (Situation A)”, the replacement crossing shall be bonded in accordance with the bonding plan.

4.2 If the track circuit is capable of operating and the bonding does not require a design alteration, a Full track circuit test shall be carried out.

4.3 All affected routes together with the points which were signed out of use and the track circuit can then be restored as available for use.

4.4 If the bonding of the replacement crossing has involved the removal and reinstatement of track circuit cables or jumpers this shall be tested in accordance with relevant CAXX SMTH Test Plan.

4.5 When a crossing is to be reinstated and temporary bonding has been applied in accordance with “Temporary Alterations - Crossings (Situation A)”, a new copy of the permanent bonding plan shall be obtained, and the replacement crossing shall be bonded in accordance with this bonding plan.

4.6 Otherwise, the original, marked up, copy can be used, in which case a replacement clean record copy shall be provided as soon as practicable.

4.7 The Signalling Technician shall then arrange for all signalled routes which have been disconnected in accordance with “Temporary Alterations - Crossings (Situation A)”, to be reconnected.

4.8 An independent tester shall test all work carried out before the points, routes and the track circuit are restored as available for use.

<u>Stock and Switch Rails (situations B and C)</u>

4.9 When a switch or stock rail is to be reinstated, track circuits shall be dealt with as described in “Reinstatement - Crossings (Situation A)”,

4.10 All stretcher bars, detector or lock rods or clamp lock components shall be re-installed.

4.11 A new copy of the original wiring diagrams shall be obtained, and the permanent wiring of the point detection circuits reinstated, and all temporary wiring removed.

4.12 Otherwise, the original, marked up, copy can be used, in which case a replacement clean record copy shall be provided as soon as practicable.

4.13 The Signalling Technician shall then arrange for all signalled routes which have been disconnected in accordance with “Reinstatement - Crossings (Situation A)”, to be reconnected.

4.14 An independent tester shall test all work carried out under this section, before the points, the signalled routes and the track circuit are restored as available for use.

END

1. Types of Drawing

1.1 The diagrams provided for maintenance, installation or testing purposes fall into the following categories:

a) Plans and Schematics.

b) Circuit Diagrams and associated information.

c) Signal Sighting Assessment Forms.

d) Control Tables.

e) Other Engineering Details and Schedules.

A list referencing more information about each type of drawing is given in Table 1.

1.2 Site records, in black and white, are endorsed MAINTENANCE COPY and carry at least the "produced" initials to signify that they are a true copy of a certified master record.

1.3 Similarly, prints issued for correlation purposes are endorsed CORRELATION COPY.

1.4 Diagrams supplied for installation work are endorsed INSTALLATION COPY and carry both "produced" and "checked" initials and an issue date.

1.5 The only exception to this rule is for diagrams which have been colour printed from a Computer Aided Design system, in which case the "produced" initials signify that the original has been checked and the colouring is correct.

1.6 Any design details that are unchecked and issued for preliminary information, or material ordering, etc., are endorsed PRELIMINARY COPY or DRAFT COPY and carry an issue date.

1.7 Similarly, prints issued for testing purposes, generally on pink paper, are endorsed TEST COPY.

2. Types of Drawings from the Signalling Design Handbook

Documentation
Scheme Plan
Signalling Plan
Signal Box Notes and General Notes
Numbering Grids
Signal Spacing Parameters
Aspect Sequence Charts
Table of Signal Routes
Stage Scheme Plans
Signal Sighting Forms
Level Crossing Ground Plan
Control Tables
Track Section Schedule
Location Area Plans
Bonding Plans
Soleplate or S&C Plans
Cable Route Plan
Cable Schematic Plans
Cable Core Plans
Power Distribution Plans
Mechanical Locking Charts and Lever Details
Mechanical Operation Details
Mechanical Engineering Details for Points and Signals
Signal Box and Interlocking Circuit Diagrams
Index Sheet
Explanation or Reference Sheet
Equipment Room Layout
Equipment Rack Layouts
Electronic System Schematic and Allocation
Inter-Rack/Cubicle Cable Schematic Analysis
Power Cubicle/Rack Layouts
Power Supply and Earthing Arrangements
Fuse Analysis
Lever Lock and Circuit Controller Analysis
Contact Analysis
Cable Termination Rack Layout
Cable Termination Analysis
Temporary Approach Control and Route Dis Link Analysis
Remote Control and Train Describer Interface Circuits
Interlocking, Control and Associated Circuits
Alarm and Indication Circuits
Signalling Control and Display System Circuits
Fusing and Looping Arrangements
Maintainer's Monitoring Panel Circuits

Documentation
Level Crossing Schematics
System Schematics (external)
Lineside Location Circuit Diagrams
Location Circuit Diagrams: Frontsheet
Location Circuit Diagrams: Case or Equipment Room Layout
Location Circuit Diagrams: Power Supplies & Busbar Analysis
Location Circuit Diagrams: Train Detection Circuits
Location Circuit Diagrams: Signal Circuits
Location Circuit Diagrams: Point Circuits
Location Circuit Diagrams: Miscellaneous Circuits
Location Circuit Diagrams: Analysis
Electronic System Details
Train Describer System Details
Signalling Control and Display System Details
Lockout Device Diagram
Isolation Overlays
Signaller's Route Lists
Operating Notice Diagrams
Safety Diagrams

Table 1 - Types of Drawings from the Signalling Design Handbook (Part A)

3. Plans

3.1 Plans are usually drawn to scale. They show an overall view of a particular site or area of work.

3.2 All plans carry a title block.

3.3 The information that this contains is similar to that shown in Table 1 except that for a Scheme Plan the version reference is a single letter, the original being "A", the next "B" etc.

3.4 The symbols used on plans are given in NR/L2/SIG/11201/ModA5-1, Symbols for Plans and Sketches Used in Signalling Applications.

3.5 Any symbols shown dotted (but uncoloured) on a signalling plan means that the equipment has been physically removed, but the circuitry for it remains in the interlocking. Wiring symbols shown broken mean something different (see D023).

3.6 Standards have changed over the years, so some symbols used on old plans might be different to those presently in use.

4. Plans Typically Include

Scheme Plan

4.1 Shows the general signalling arrangements for the completed scheme. It also shows the equipment to be removed.

Signalling Plan

4.2 Shows the current signalling features and identities.

Location Area Plan

4.3 Shows the position of lineside location cases and rooms. Gives their identities and areas of influence.

Cable Route Plan

4.4 Shows the position and details of the cable route. It is sometimes combined with the Location Area Plan.

Bonding Plan

4.5 Shows track circuit details such as insulated rail joints, connections, jumpers, traction bonds, cross bonds, structure bonds.

4.6 Some bonding plans for electric traction areas are prepared jointly by the organisations responsible for designing the signalling system and the electrification infrastructure.

4.7 They include details of track circuit bonding, but also electrification requirements that are to be installed by others. Track circuit bonding is shown with thin lines and traction bonding with thick lines.

4.8 However, for single rail track circuits, the insulated rail is depicted with a thick line and the common (or traction) rail with a thin line.

4.9 Alternatively, the track circuit bonding and insulated rail may be coloured, using different colours to distinguish between adjacent track circuits.

A typical Bonding Plan is shown in Figure 1.

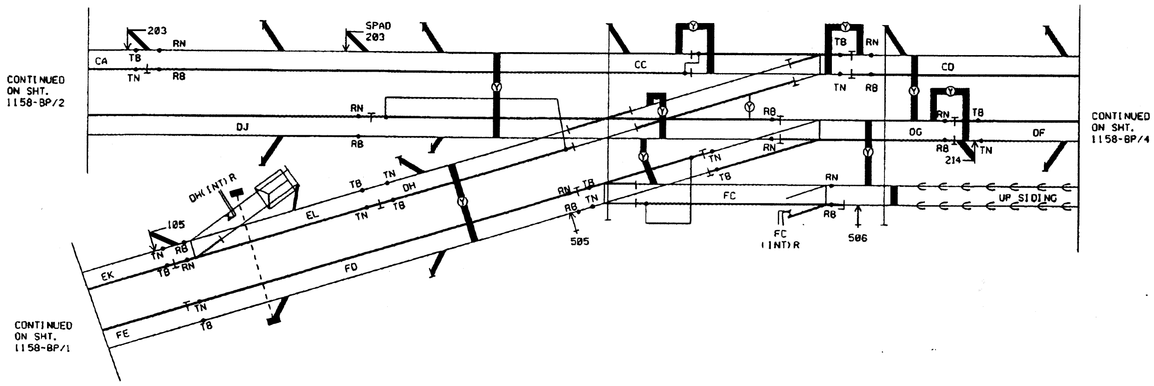


Figure 1 - Typical Bonding Plan

Cable Schematic

4.10 Shows the signalling cables required between cases and rooms.

Power Cable Schematic

4.11 Shows the power supply distribution.

Level Crossing Ground Plan

4.12 This is a scaled and dimensioned drawing showing the position of all equipment, utilities and associated features in the vicinity of the level crossing, and the detail necessary for engineering, operating, maintenance and statutory requirements.

5. Circuit Diagrams

5.1 Circuit diagrams are detailed drawings showing the wiring connections between items of equipment.

5.2 The layout of the equipment is also shown, together with various analysis sheets.

5.3 The diagrams are usually supplied in book form.

5.4 They are divided into sections, each of which applies to an installation, such as one apparatus case or equipment room.

5.5 Diagrams for each installation include the following:

a) Index.

b) Approvals & Issue Record (this shows the job description and version reference for all the alterations that have taken place in that area).

c) Equipment layout for each room, rack and frame.

d) Wiring between all the pieces of equipment.

e) Tabulations showing the usage of various contacts, terminals, fuses and links. This is known as the “Analysis”.

5.6 Wiring symbols are described in D023.

6. Analysis

6.1 These summarise which relay contacts, terminals, and links are in use. Some of the analysis sheets also show:

a) the sheet number of the wiring diagrams where each contact appears.

b) how many wires are connected to each termination?

Figures 2 and 3 give typical examples, together with notes on their interpretation.

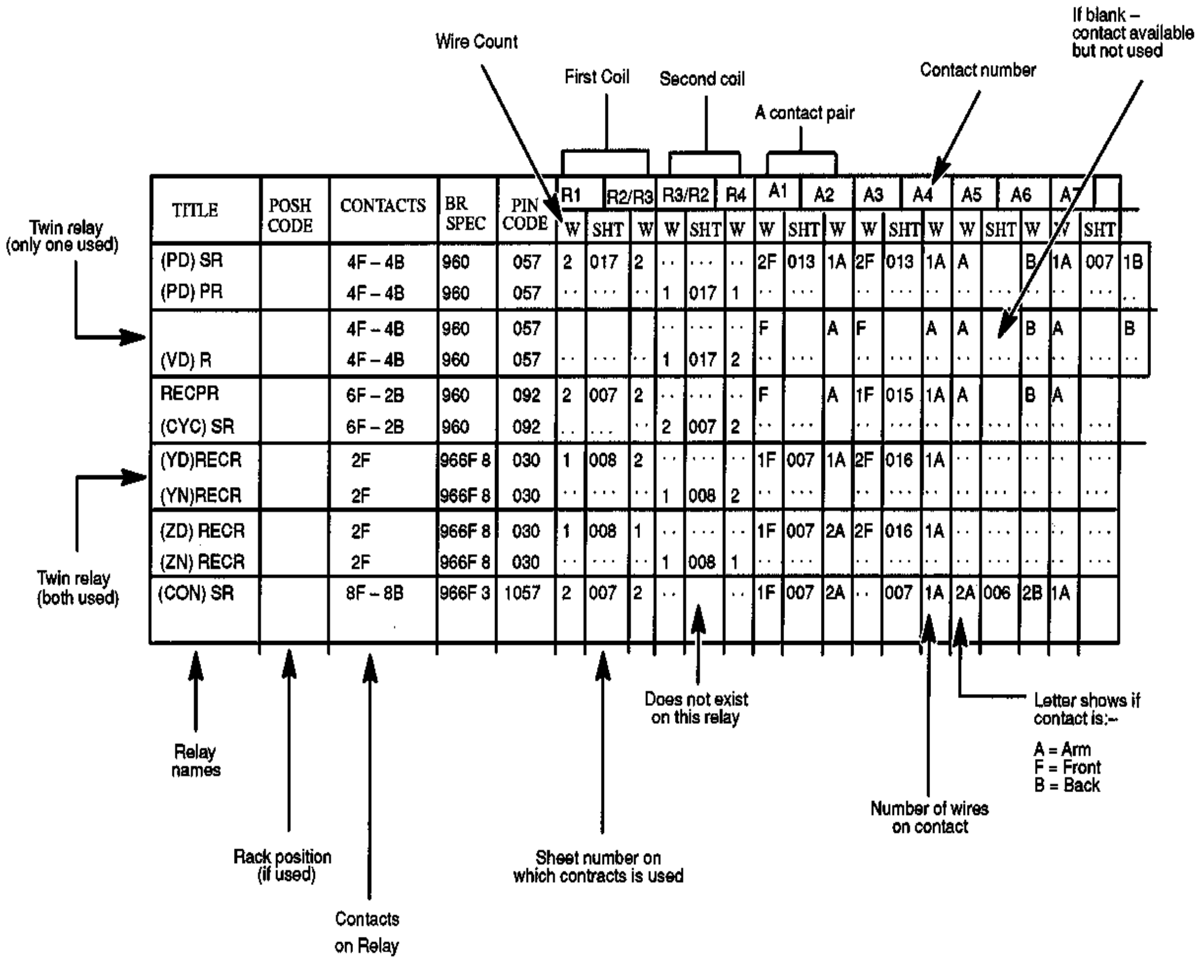


Figure 2 - Typical Relay Contact Analysis

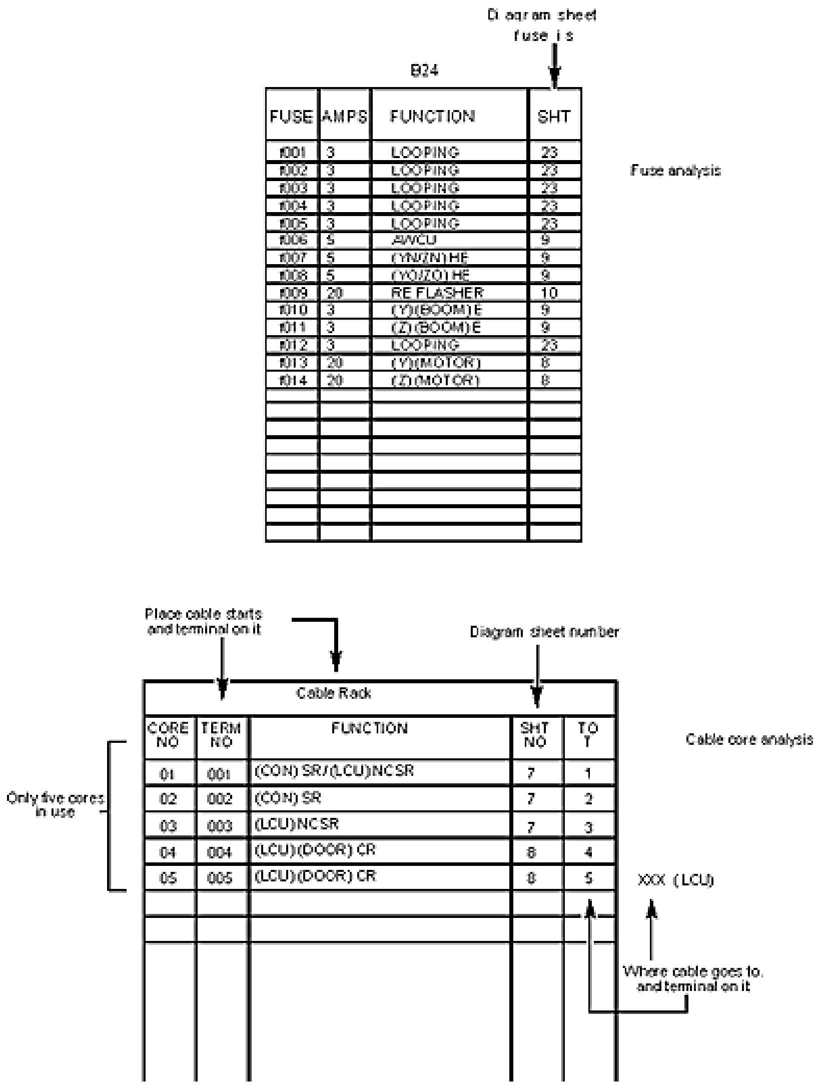


Figure 3 - Typical Fuse and Cable Analysis

7. Signal Sighting Assessment Form

7.1 Are designed to be self-explanatory. Be aware of the differences between metric and imperial measurements when reading these documents. Also, the calculations that have been made using different references over the years.

8. Control Tables

8.1 Control Tables can be very complicated documents requiring more explanation than can be given here.

Training in how to understand them is provided where needed.

9. Other Engineering Details

9.1 These are provided as necessary to the work.

A common example is:

a) Control Panel Facia Diagrams or Signal Box Layout Diagrams are detailed drawings of the actual apparatus.

9.2 They show the final or alteration arrangements.

9.3 If coloured to show new or recovered work, the colouring follows the method used for circuit diagrams.

END

1. General

1.1 Diagrams are mainly printed in black on a white background, but colours are used to indicate particular things:

a) Equipment or wiring shown in RED means that it is NEW.

b) Equipment or wiring shown in GREEN means that it is to be RECOVERED.

1.2 Where the colour code would apply to the whole diagram sheet there is an alternative method.

1.3 A normal black on white diagram is supplied with:

a) an endorsement in red, “ALL NEW WORK” if it is new.

b) a green cross through the whole sheet if it is to be recovered.

1.4 In some drawings both new and recovered work are shown on the same sheet. In this case the wires to be removed are marked with small crosses as well as being coloured green.

1.5 There are occasions when two copies of each drawing are issued.

These are:

a) First Copy showing the wiring and equipment to be removed – in green.

b) Second Copy showing the new wiring and equipment – in red.

1.6 The way in which relays and their contacts are coloured red or green can also show if they are to be re-used or renamed.

END

1. Wiring Symbols

1.1 Signalling circuits use symbols to represent the various pieces of equipment which are shown in NR/L2/SIG/11201.

1.2 An outline of the basic principles is given in this module. Any non-standard abbreviations, symbols, or notes will be fully defined on every sheet used.

1.3 Before carrying out any work check that you understand the diagram.

1.4 The wiring is drawn in a standard way and the following apply to modern circuits:

a) Wires are shown as full lines connecting one termination to another.

b) Functional apparatus is represented by rectangular blocks, usually with broken lines.

c) Broken lines are also used to show grouping or containment, for example, the boundary of an item of equipment or terminal block.

d) Broken lines are also used to show wiring or equipment in outline as a reminder or their existence, with full details given elsewhere.

However, if a broken line is coloured green, it means the item is to be removed.

e) Contacts (of relays, plungers etc.) are always shown as “made” (i.e. drawn on the line) even if that is not their normal position.

For polarised relays, reference should be made to NR/L2/SIG/11201, since these symbols are more complex.

f) If possible, the whole of a circuit is shown on one sheet. This means that the termination points or contacts for one item of equipment (e.g. a relay) might be spread over numerous sheets.

2. Apparatus Names (Identities)

2.1 Apparatus is described on the circuit diagrams by a number and letter code.

2.2 An example might be “101 GR”:

a) The last letter describes the type of apparatus.

b) In this case “R” indicates that the apparatus is a relay.

c) The preceding letter describes the apparatus.

d) “G” indicates that the relay applies to a signal.

e) The “101” indicates that the signal is numbered 101.

2.3 The letter code therefore tells both what the item of apparatus is and what it does.

See the tabulation in Table 2.

2.4 If a description is needed which is not in the list, then some fairly obvious abbreviation is used.

2.5 If the abbreviation needs to be kept separate for clarity, then it is put in brackets. For example:

a) 143G(OFF)R 143 Signal “off” relay.

b) West(PO)R West “power off” relay.

2.6 The “description” letters indicate how the termination is used.

For example:

Letter	Description
B	Positive feed of a DC supply.
N	Negative feed of a DC supply.
BN	Intermediate connection on a DC supply.
BX	Feed end of an AC supply.
NX	Return end of an AC supply.
BNX	Intermediate connection on an AC supply.
E	Earth connection.

Table 1 - “Description” letters and meanings

2.7 Numbers added after the “Description” letter indicate the voltage.

2.8 Numbers after the “Apparatus” letter indicate the number within a group of items.

For example:

- B12 f - Indicates the positive 12 volts fuse.
- BX110 t6 - Indicates the sixth terminal on the feed side of the 110 volts AC supply.
- N24 f6 - Indicates the sixth fuse on the 24 volts negative supply.

2.9 If there is a need to give further descriptions, additional letters can be added after the voltage numbers.

For example:

a) B50 (X) f5 indicates the fifth fuse on the B50 external supply.

b) N50 (L) t4 indicates the fourth terminal on the N50 local supply.

c) BX110A f3 indicates the third fuse on the feed side of the 110 volts “A” supply.

2.10 If there are several external or local supplies, a number is added after the “X” or “L” to identify them, e.g. B50 (X2) f5 refers to fuse 5 on the second external B50 supply.

2.11 The current rating of the fuse is shown close to the fuse symbol (e.g. “20A” indicates a twenty-amp rating).

Descriptive Term (preceding letters)		**Apparatus (last letter)**	
A	Approach; Automatic; Relay Contact - Arm	A	Axle Counter
B	Block; Bolt; Relay Contact - Back	B	Block Instrument
C	Checking or Proving; Coding	C	Contact
D	Clear (green); Decoding; Relay Contact - De-energised	D	not used
E	Light; Lamp; Heat (externally applied); Emergency; Earth	E	Light; Lamp; Earth
F	Fog; Flashing; Feed; Relay Contact - Front	F	Detonator Placers

Descriptive Term (preceding letters)		**Apparatus (last letter)**	
f	Frequency	f	Fuse
G	Signal	G	Signal Apparatus
g	not used	g	Lightning Arrestor
H	Caution (yellow)	H	Capacitor
HH	Preliminary Caution (double yellow)	HH	not used
I	AWS	I	Inductor
J	Time (delayed action)	J	Rectifier; Diode
K	Indicating or Detecting	K	Indicator Electro-mechanical
L	Locking; Left	L	Lock
M	Marker; Magnetic	M	Motor
N	Normal	N	Release; Hand Operated Switch; Push Button or Key
O	Retarding	O	Resistor; Heater
P	Repeating	P	Lever Latch or Trigger Contact
Q	Treadle or Bar	Q	Local Coil of a Double Element Relay; Treadle; Bar
R	Reverse; Right; Danger (red)	R	Relay or Contactor
Rx	Receiving	Rx	Receiver
S	Stick	S	not used
T	Track Circuit	T	Transformer
t	not used	t	Terminal

Descriptive Term (preceding letters)		**Apparatus (last letter)**	
Tx	Transmitting	Tx	Transmitter
U	Route	U	Unit
V	Trainstop (including TPWS)	V	Trainstop (including TPWS) Apparatus
W	Points	W	Point Operating Apparatus
X	Audible Annunciator; Level Crossing; Wrong Direction	X	Audible Annunciator (bell, buzzer, horn, etc.)
Y	Slotting or Disengaging	Y	Slotting or Disengaging Apparatus
Z	Special (to be explained on diagram)	Z	Special Unit (to be explained on diagram)

Table 2 - Meaning of Equipment Code

3. Terminal Names

3.1 Terminals which act as power supply terminations have been dealt with in the previous section.

3.2 For other terminals and links a general system is used, as follows.

3.3 A group of terminals or links is indicated by a capital letter.

3.4 A particular item within a group is indicated by a number.

3.5 For example, written below the symbol for a link might be “H19”:

- H19 indicates the nineteenth in group “H”.

3.6 In recent drawings, a leading zero is used if there is only one number, for example:

- E05 indicates the fifth in group “E”.

3.7 If more complicated descriptions are required, letters and numbers are alternated.

For example, written beside the “dot” symbol for a tunnel type screw terminal might be “A25R18”:

a) A - Indicates rack “A”.

b) 25 - Indicates the twenty-fifth row of terminals on that rack.

c) R - Indicates the terminals are on the rear of the rack. (“F” would indicate the front).

d) 18 - Indicates the eighteenth terminal in the row.

In case of doubt, the supervisor should be asked for advice.

3.8 For the naming of telecom type tag blocks and connectors see Telecoms Equipment standards.

4. Termination Numbers

4.1 Many pieces of apparatus have a number of terminals.

4.2 Examples include relays and transformers. In these cases, the circuit diagrams also show which terminal is which.

4.3 This is done with more numbers and/or letters.

4.4 These are written beside the termination symbol in the wiring diagram.

4.5 The numbers and letters correspond with whatever is shown on the actual apparatus. See Figure 1 for examples.

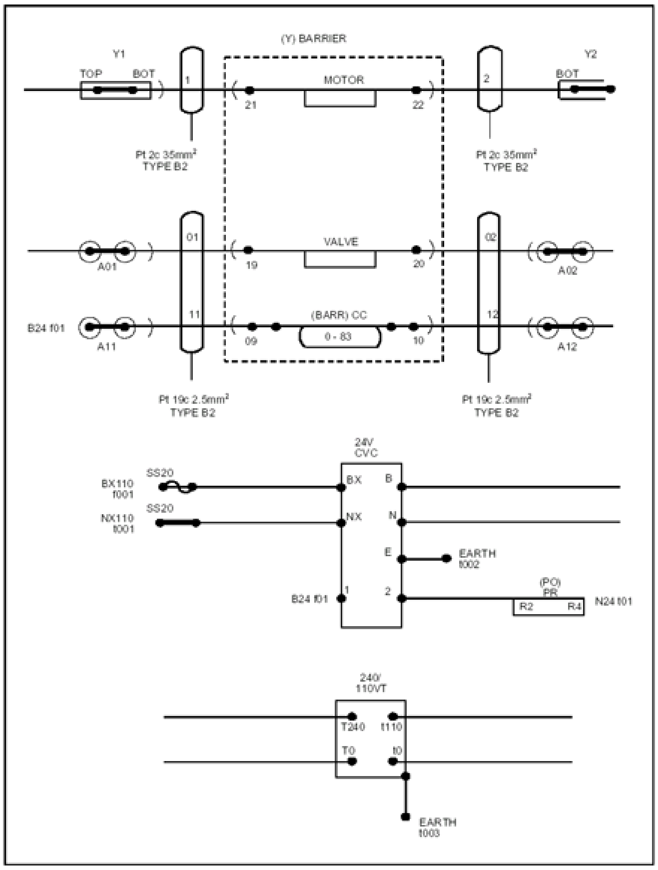


Figure 1 - Termination Numbering Examples

NOTE: *Circuits shown only as examples of number.*

5. Lever and Switch Contacts

5.1 These are shown on wiring diagrams by a circular symbol.

5.2 The letter (or letters) inside the circle indicate the portion of the movement that the contact is made. Figures 2 and 3 show how the lettering system works.

5.3 Note that a different lettering system is used depending on whether the normal position of the lever/switch is at the end (N-C-R) or the middle (F-M-T) of the movement.

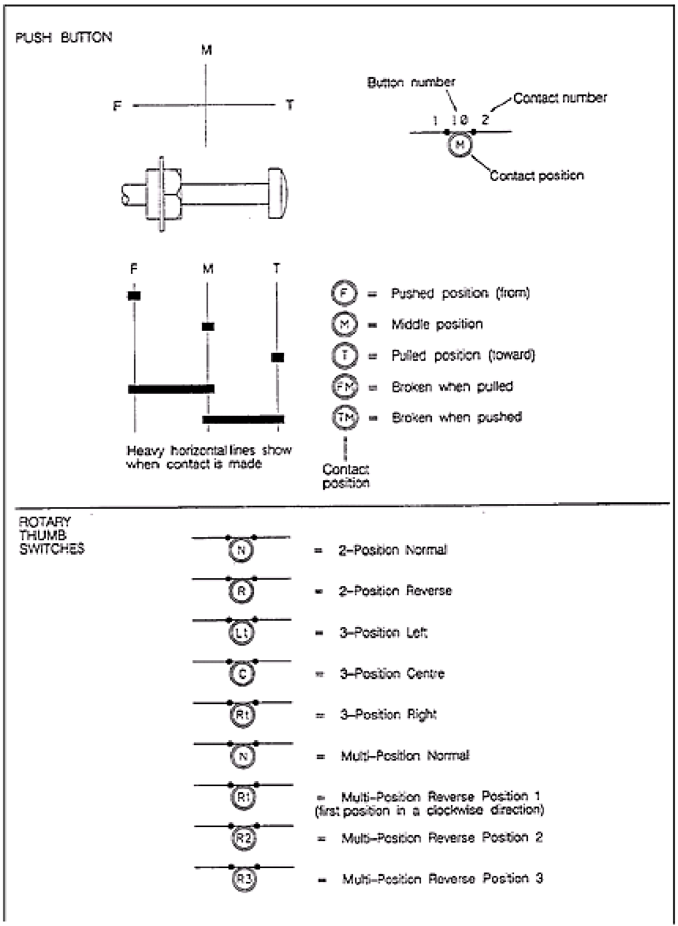


Figure 2 - Push Button and Switch Contacts

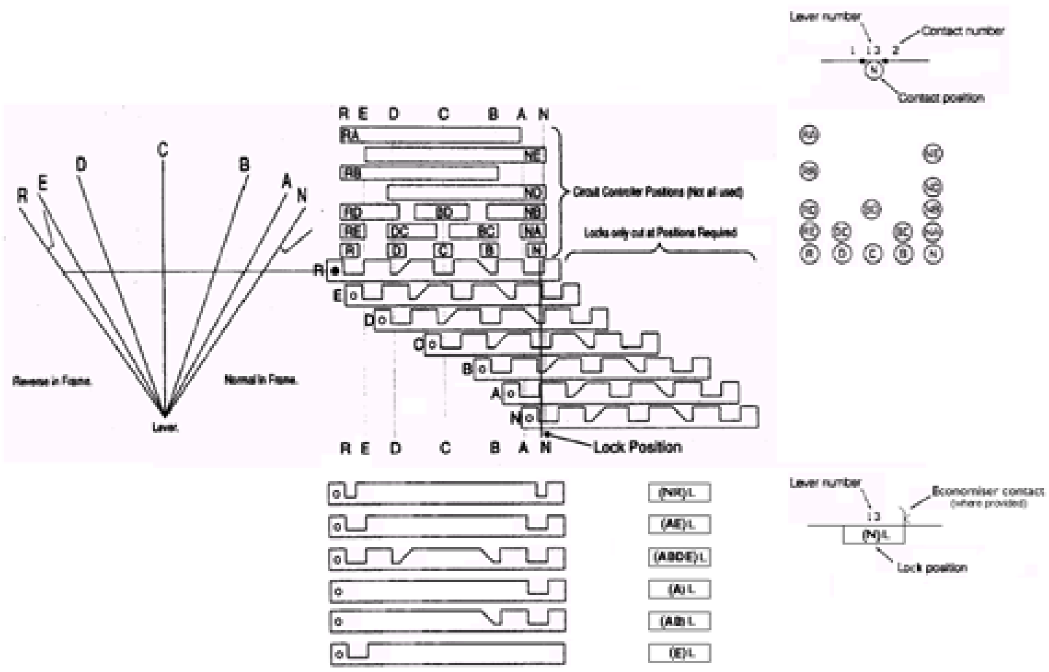


Figure 3 - Circuit Controller Contacts and Lever Lock Positions

5.4 Lever locks and controllers have more positions available, which are generally used for the purposes described in Tables 3 and 4.

Lock	Selection	Electrical Interlocking (where provided)
NR	Tight lock: for track locking mechanically operated points that are not fitted with an FPL.	
AE	(often known as NR) For locking points normal or reverse.	Interlocking that locks a lever in either position ($^{B}/_{W}$).
ABDE	(known as NBDR) Points equipped with indication locking, the (B) and (D) locks preventing the lever from completing the stroke until detection is made.	
A	(often known as N) For locking signals normal with no backlock (mechanically operated signals should be adjusted to be on and the wire relaxed, with the lever in this position). FPLs that stand normally in.	Interlocking that locks another lever normal, i.e. where one lever locks another, is released by another, is locked by another between stroke (converse of $^{B}/_{W}$), counter conditional, or sequential locking.
AB	(often known as NB) Signals requiring a backlock (mechanically operated signals should be adjusted to be on and the wire relaxed, with the lever in the B position). Ground frame and level crossing releases.	
E	(often known as R) For locking FPLs reverse that stand normally out.	Interlocking that locks a lever reverse, i.e. where one lever releases another (converse of released by), or counter conditional locking.

Table 3 - Typical Lock Positions

Contact	Selection	Electrical Interlocking (where provided)
N	Contact proves lever normal beyond the (A) lock position, used in block circuits, or sequential locking (the fine contact proves a forced drop lock effective).	Contact proves lever normal beyond the (A) lock position (the fine contact proves the forced drop lock effective).
NA	Contact proves lever normal beyond the (B) lock position, as used in selection circuits, e.g. to prove signal normal in signal stick and route stick circuits, to call points normal, for correspondence proving, or a free light for an (A) lock.	
NX	Proves lever normal beyond the (B) lock position, to call points normal (miniature lever frames only).	
NB	Contact proves lever normal beyond the (C) lock position, to call points normal in connection with indication locking.	

Contact	Selection	Electrical Interlocking (where provided)
ND, or NE	FPL of mechanical points with electrical detection, where FPL stands normally out.	
A	Contact made as lever being reversed approaches the (A) lock position, to economise the (A) lock.	Contact made as lever approaches the (A) lock position, to economise the (A) lock.
BC, or BD	Contact made as lever being normalised approaches the (B) lock position, to initiate backlock timers and economise the (B) lock, or free light for a (B) lock.	
DC	Contact made as lever being reversed approaches the (D) lock position, to economise the (D) lock.	
E	Contact made as lever being normalised approaches the (E) lock position, to economise the (E) lock.	Contact made as lever approaches the (E) lock position, to economise the (E) lock.
AE	Contact made as lever approaches the (A) or (E) lock positions, to economise the (AE) lock.	Made as lever approaches the (A) or (E) lock positions, to economise the (AE) lock.
RA, or RB	FPL of mechanical points with electrical detection, where FPL stands normally in.	
RB	Contact proves lever has not passed the (B) lock position, used in simplified backlock stick circuits (not for new work).	
RD	Contact proves lever reverse beyond the (C) lock position, to call points reverse in connection with indication locking.	
RY	Proves lever reverse beyond the (D) lock position, to call points reverse (miniature lever frames only).	
RE	Contact proves lever reverse beyond the (D) lock position, as used in selection circuits, e.g. to call points reverse, or for correspondence proving.	
R	Contact proves lever reverse beyond the (E) lock position, used for signal operation, or release to ground frame or level crossing	Contact proves lever reverse beyond the (E) lock position (the fine contact proves the forced drop lock effective).

Table 4 - Typical Circuit Controller Contact Positions

In miniature lever frames, additional contact positions X (between A & B) and Y (between D & E) are provided, such that NX contacts are used in lieu of NA and RY instead of RE.

END

1. Wire/Cable Types

1.1 Present design standards require the installation drawings to show the sizes of all wires and cables, but older drawings might not.

1.2 Some drawings only included the details of nonstandard wire or cable size and type.

1.3 The standard wire/cable for a particular application is detailed in the Signalling Installation Handbook.

1.4 A summary of the most commonly used standards for safety signalling circuits is given in sections 2 to 6.

1.5 Wire and cable type for non-safety signalling circuits varies considerably according to the application. If the type to be used is not specified on the drawings, the SM(S) should be asked for advice.

2. Internal Wiring

The following are typical applications:

2.1 Single wires internal to an equipment room, location case, or signal box (but not associated with signal lever, locking frame, or block shelf areas) - not in touch with metal surfaces and run within all plastic trunking or conduit, separate from any cables, and which cannot be damaged by sharp edges or corners:

a) 0.75mm2 wires to NR/PS/SIG/00005 Type A1, black, rubber insulated, for circuits fused at 3A.

b) 1.15mm2 wires to NR/PS/SIG/00005 Type A1, black, rubber insulated, for circuits fused at 5A to 15A.

c) 24/0.20mm wires to DEF STAN 61-12 Part 6, Type 3, white, PVC insulated, for circuits in SSI installations fused at 2A or 3A.

d) 32/0.20mm wires to DEF STAN 61-12 Part 6, Type 3, pink, PVC insulated, for circuits in SSI installations fused at 5A to 15A.

2.2 Single wires internal to an equipment room, location case, or signal box, not conforming to the environment described in clause 2.1:

a) 0.75mm2 wires to NR/PS/SIG/00005 Type A2, black, for circuits fused at 3A.

b) 1.15mm2 wires to NR/PS/SIG/00005 Type A2, black, for circuits fused at 5A to 15A.

2.3 Multicore cables internal to an equipment room, location case, or signal box:

a) Cables to NR/PS/SIG/00005 Type A3, black, with 0.75mm2 cores.

3. External Wiring

3.1 External single wires (for signal repeaters, ground frames, etc.) but not on track:

a) 2.5mm2 wires to NR/PS/SIG/00005 Type B1, black.

3.2 External multicore cables within cable route protection and not on track:

a) Cables to NR/PS/SIG/00005 Type B2, black, with 0.75mm2 cores (1.5 or 2.5mm2 cores are non-preferred alternatives).

3.3 External cables for on track use:

a) Flexible cables to NR/PS/SIG/00005 Type C1 (single core) or Type C2 (multicore), black, with 2.5mm2 (f) cores.

4. Power and Earthing Cable

4.1 Signalling power or earth bonding cable can be:

a) Cable to NR/PS/SIG/00005 Type B1 (single core) or Type B2 (2 core) for copper conductors with rubber insulation. The conductor size is specified on the drawings.

b) Cable to BS 6004:2000 Table 4 for single core copper conductors with PVC insulation, e.g. for earth bonding. The conductor size is specified on the drawings.

c) Cable to BS 6346:1997 Table 8 for two core aluminium conductors. The conductor size is specified on the drawings.

5. Fuses

5.1 Where fuse ratings are not shown on a diagram, the fuse analysis sheet shall be checked. If no value is shown, a 3A cartridge fuse to BS 714 is to be assumed.

For electronic systems, a different default value can be specified.

6. Exceptions

6.1 Exceptions will have the conductor size, wire/cable type, or fuse rating either:

a) Written alongside the wire to which it applies (sometimes in the form of a symbol referring to a footnote), or

b) Given as a general note on a particular wiring sheet or reference sheet, or

c) Given as a cable size and type, where the wires are part of a cable (see below).

6.2 Wires shown on signalling installation diagrams are assumed to be single wires (not part of a twin or multicore cable) unless otherwise indicated.

6.3 Exceptions will have the cable size and type indicated by one of the following:

a) A special note adjacent or arrowed to the wires to which it applies

b) A balloon round the affected wires, with the cable description added.

c) A description or note on the link, terminal, or cable analysis sheet.

END

1. Version Control of Diagrams

1.1 Each diagram of alterations carries a title block as shown in Figure 1. The block includes the name and a number for identification and also gives a version reference in the Version box beneath the Sheet Number.

1.2 The original diagram for the first job is called Version “AA1” and each subsequent change to this version increases the last digit - to give “AA2”, “AA3” etc. When the next alteration to the diagram takes place (i.e. the next job) the alteration letters, e.g. “AB”, would change giving a version reference “AB1”, with subsequent changes to that as “AB2”, etc.

1.3 The version reference in Figure 1 indicates that the sheet applies to alteration “AB” and change “2”.

1.4 The Update Block, shown on the left of the title block, might give a clue as to what has happened previously. The alteration letters of jobs that have been completed previously are shown but note that jobs do not always happen in alphabetical order. The version of the current job does not appear here until the drawing is re-issued after the records have been updated.

1.5 If different versions of the same drawing are causing confusion, the SM(S) should be asked for advice.

1.6 Once updated, the new maintenance records will show the same version reference in the Update Block as in the Version box.

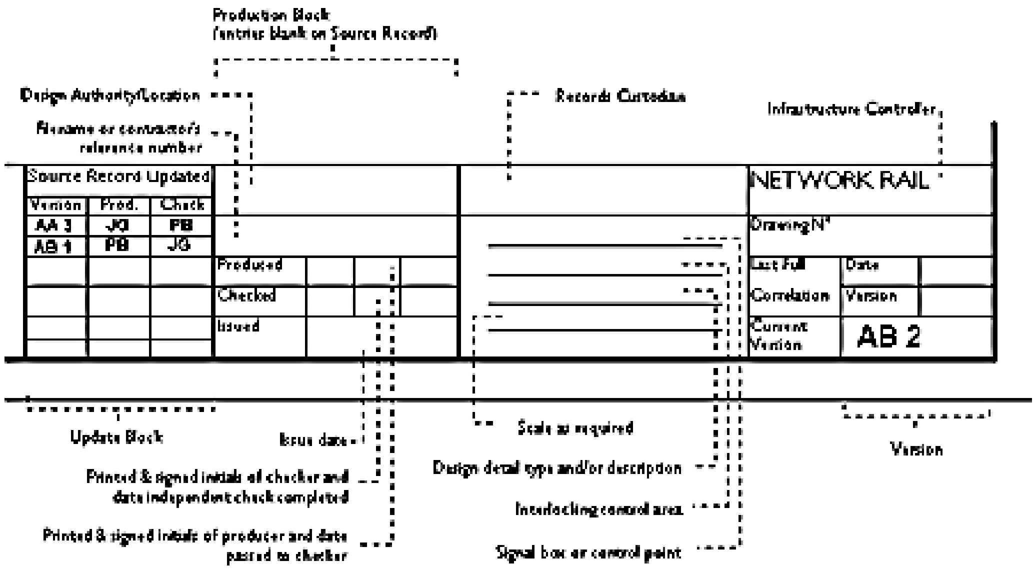


Figure 1 - Circuit Diagram Title Block

END

1. Temporary Records

1.1 Maintenance records on site shall be maintained up to date with the current state of the infrastructure at all times.

1.2 When it is necessary to endorse a maintenance copy with a modification, (or correlation correction, or maintenance alteration), these become a temporary maintenance copy. These shall be replaced with a final copy within 12 months.

2. Final Records

2.1 Final maintenance records, including the source record, signed master record, and approvals and issue record, shall be provided to the records custodian within 6 weeks of stage work or final commissioning, unless otherwise agreed in the design specification.

2.2 Maintenance copies of final records for apparatus cases, the under portions of signal boxes, and where otherwise specified, shall be supplied on a durable material that is capable of being written on with a permanent ink pen.

3. Version Control of Site Records

3.1 Version control is specified in NR/L2/SIG/11201.

3.2 If there is reason to doubt that the site records are the latest version, the SM(S) should be asked to confirm the status with the National Records Group.

END

1. Types of Interference

1.1 Electrical interference can arise in various ways including:

a) Traction current contamination.

b) Induction from parallel A.C. or high frequency circuits.

c) Direct contact with earth or rails through insulation damage.

d) High frequency contamination of electronic systems.

e) Electrical surges, such as lightning strikes, flashovers from the traction supply and switching transients, affecting solid state components.

f) Magnetic interference between low current devices.

1.2 Background information on electromagnetic compatibility is given in NR/L2/SIG/11201/ModB5 and further information NR/L2/RSE/30041.

1.3 The majority of S&T electronic equipment is immune to all but exceptional levels of radio frequency (rf) signals.

1.4 This includes equipment such as telecommunication systems, remote control systems, panel processors, electronic track circuits, SSI, IECC and CCTV equipment.

1.5 At worst, exceptional levels of radio interference can cause a safe shutdown of the systems concerned.

1.6 This can occur where long component leads or cables exist within equipment housings and a radio signal is generated alongside.

2. General Precautions

2.1 Electronic equipment shall have leads as short as practicable, which can be screened or consist of twisted pairs, and not be located close to known interference sources, such as HVI track circuit equipment.

2.2 Where surge protectors or filters are provided, the ‘clean’ side wiring shall be segregated from the ‘dirty’ side and from unfiltered power supplies.

2.3 Equipment likely to produce electromagnetic disturbance in apparatus housings, such as base station transmitters, shall have the associated cabling screened and earthed, and any aerial shall be mounted externally.

2.4 Restrictions on the use of mobile telephones, vacuum cleaners, power tools or any other form of transmitting communication equipment are given in Section E003.

2.5 Fast transient earths and EMC shielding are considered in NR/L2/SIG/11201/Mod B6.

2.6 Where special restrictions apply to positioning or wiring of equipment, this shall be clearly shown in the design records (see NR/L2/SIG/11201), so that the restrictions are readily apparent to staff.

2.7 Otherwise, manufacturer's product instructions should be consulted for installation, operation and maintenance purposes. SM(S) should check that these are available where necessary.

2.8 The proximity constraints given in this section can be regarded as being satisfied if each relevant item of equipment is CE marked and provided with an EMC declaration of conformity that addresses the particular proximity problem. Such declaration should be referenced in the design records.

2.9 There might be additional restrictions on the use of equipment operating at certain frequencies on lines with route acceptance for traction units likely to emit electromagnetic interference, including trains with three phase or induction motor drives. See E002.

2.10 A comprehensive set of rules is provided here, additional features can be found in the engineering details supplied for the work.

2.11 Technicians should note the wiring restrictions to protect against parallelism or crosstalk.

3. Audio Frequencies – General

Axle Counters

3.1 Relay coils in axle counter circuits can require suppressing to prevent electromagnetic interference to axle counter evaluators by connecting a reverse biased diode across the coil.

3.2 Where axle counters and audio frequency track circuits are installed in the same vicinity, it is preferable for the track circuit receiver, rather than the transmitter, to be adjacent to the axle counter section.

3.3 Axle counter heads (rail contacts) shall not be installed as follows:

a) Within 100mm of a TASS (or TCS) Balise, guard rails, point drive equipment, lubricator, ramp or other metalwork.

b) Within 1m of an AWS (or APC) inductor, or TPWS loop.

c) Within 2m of another rail contact.

d) Within 5m of a track circuit tuned zone.

e) Within 15m of an end termination unit.

3.4 In addition, 30kHz axle counter heads shall not be installed:

a) In the vicinity of any equipment operating in the frequency range 27.4 kHz to 31.3 kHz.

3.5 SEL 5kHz axle counter heads shall not be installed:

a) Within 100m of an EBI Track 200 track frequency E or G transmitter (1549 Hz or 1848 Hz), or a Z type transmitter of 1580 Hz or 1850 Hz.

b) Within 200m of an EBI Track 200 track frequency A transmitter (1699 Hz), or an Aster U type/SF15 transmitter of 1700 Hz.

Track Circuits

3.6 Restrictions to prevent the mutual interference of track circuits can be found in NR/L2/SIG/11752 and the associated specifications for individual track circuits.

3.7 To avoid intermodulation effects, the following audio frequency equipment shall be separated from each other by a minimum of 150mm, i.e. one row clear:

a) Reed track circuit, point detection, or FDM equipment.

b) Aster track circuit equipment.

c) EBI Track 200 and 400 track circuit equipment.

d) FS2600 track circuit equipment.

e) HVI track circuit equipment.

3.8 Their wiring shall not run parallel in the same ducting.

3.9 A final power supply unit shall not be common to more than one system and shall only feed one transmitter or receiver of a given frequency.

3.10 HVI wiring is also prohibited from running in the same ducting as SSI wiring (section 7).

3.11 FS2600 wiring shall not run in the same ducting as, nor parallel to (within 1m of) any other wiring.

TPWS

3.12 TPWS loops shall not be installed:

a) Above SSI cables, or close to EBI Track 200 and 400 track or power cables.

b) Within 1m of a high current traction cable, an AWS (or APC) inductor, a reed track circuit loop an impedance bond, an axle counter rail contact, electronic treadle, guard rail, point drive equipment, lubricator, ramp or other metalwork.

c) Within 2m of ATP loop ends or transpositions, a 4th rail gap, a LUL CSDE antenna, or another TPWS loop.

d) Within 5m of a track circuit tuned zone.

e) Within 10m of HABD equipment, an uneven load detector, or a wheel impact load detector.

f) Within 15m of an EBI Track 200 and 400 track centre feed.

g) Within 75m of GATSO camera inductive road loops.

h) Within 100m of 10kHz rail circuits, Hima-Sella TrackLink selective door controls, or an automatic vehicle identification beacon.

3.13 TPWS control modules shall not be installed within the same apparatus case as, or in an equipment building within 2m of, FDM equipment, nor within 20m of an electrical substation, feeder station, track paralleling hut or sectioning cabin.

CCTV equipment

3.14 CCTV equipment and audio frequency equipment shall not be housed:

a) In the same apparatus case.

b) In an equipment building within 2m of each other.

Convertors

3.15 D.C./D.C. converters shall not be housed adjacent to, nor fed from a battery supplying, any audio frequency signalling equipment.

Audio Nuisance

3.16 When locating equipment, such as EBI Track 200 and 400 track transmitter tuning units, which emit an audible frequency, assess that it does not cause a nuisance to local residents. If necessary, sound proofing shall be specified on the design details.

4. Reed Systems

4.1 The following restrictions apply to reed track circuits, point detection and FDM. For restrictions between reed and other equipment, see Section 3.

a) All connections to reed filters, and other reed system wiring longer than 400mm, shall be run in approved twisted pair cable and segregated from other wiring. Within housings, 0.75mm2 twisted pair Type A to NR/PS/SIG/00005 is preferable for all reed equipment wiring.

b) The positioning of equipment shall be designed, so as to keep the wiring as short as reasonably practicable, particularly the transmission line and power supply line.

The wiring shall not be laced or placed in trunking but kept separate from the wire runs for other reed systems (also from EBI Track 200 and 400 track circuits and other audio frequency equipment).

c) Twisted pair twin cable shall be used wherever practicable for the transmitter switching circuit, particularly if it is external to the equipment housing or exceeds 2m in length (this is not applicable to point detection since it is strapped out).

d) Non-safety A.C. relays shall not be used to provide input contacts for reed transmitters as they could give rise to A.C. harmonics on the line. A D.C. repeat relay is required.

e) Reed power supply units shall not feed more than one transmitter or one receiver of the same frequency, nor equipment belonging to different systems.

They shall only feed equipment within the equipment housing concerned.

f) To avoid mains-based interference, reed power supply units shall not be mounted within 150mm of reed receivers or transmitters, i.e. one row clear.

g) Reed receiver filters shall not be mounted within 300mm of a track filter of a different frequency, nor a constant voltage transformer.

h) Reed receiver filters shall not be mounted within 50mm of any power amplifier or reed follower relay.

i) All reed equipment shall be installed with their terminals on the wiring side of the racking. Equipment layout shall be designed so as to keep the transmission line and power supply line as short as possible, subject to other requirements.

j) Reed follower relays (or power amplifiers) shall not be mounted within 50mm of reed receivers but can be mounted adjacent in the row above or below.

k) Track circuit receiver filters (or constant voltage transformers) shall not be mounted within 300mm of reed receivers, i.e. two rows clear.

l) Reed filters shall not be mounted in the same apparatus case as, or in an equipment building within 2m of, other reed equipment of the same frequency or a harmonically related frequency.

Consequently, transmitters and receivers of the same frequency shall not be located in the same case (this does not apply to track circuit equipment, so long as it follows the layout given in the reed track circuit specification).

Reed Track Circuits

4.2 Restrictions to prevent the mutual interference of reed track circuits can be found in NR/L2/SIG/11752 and the associated specification for reed track circuits.

Frequency Division Multiplex (FDM)

4.3 These systems were designed to operate satisfactorily in the presence of interference containing any odd harmonic of a fundamental in the range 48.5 to 50.5Hz, up to 100V per harmonic.

4.4 Vital systems shall also make allowances for traction supply faults, e.g. including even harmonics and induced voltages up to 1,000V A.C.

Due to a relaxation in mains frequency tolerance, the range is now 47 to 50.5 Hz. This can be accommodated by further restricting the permissible frequencies.

4.5 The following restrictions apply in addition to those given in section 4.1:

a) FDM systems can be carried in conventional signalling cable to NR/L2/SIG/00005, provided:

- The direction of lay alternates for successive core layers.
- Each system uses a pair of adjacent conductors in the same layer.
- Additional systems in the same cable are separated as far as practicable and do not use a conductor adjacent to another system.

b) Through crimps shall be used between internal wiring and cables rather than disconnection links; also, where cables join.

Vital Reed

4.6 The following restrictions apply in addition to those given in section 4.3:

a) Type RR vital reed channels 410, 411, 414, 415, 416 are not affected by the relaxation in mains frequency tolerance.

New work shall consequently be restricted to these five frequencies.

b) New vital FDM systems shall be carried in an approved twisted pair signalling cable.

c) Otherwise, within conventional signalling cable, each vital channel shall only be used once. Alternate pairs shall be transposed midway between line isolation points (see point h).

d) Non-vital systems shall not be run in the same conventional signalling cable, unless it can be ascertained that no channels with similar frequencies, and no channels exceeding an operating value of 700mV, are used.

e) Regular earth testing is to be carried out to detect first earth faults (see adapter in U042). This should be stated on drawings for O&M purposes.

f) Twisted pair twin cable shall be used between the power supply unit and the first transmitter or receiver.

This shall not exceed 3m in length.

g) Twisted pair twin cable shall be used between each reed receiver and its follower relay.

This shall not exceed 20m in length. Any correspondence contacts in this loop shall not be broken, other than transiently, when the receiver is energised.

h) Earthed twisted screened cable shall be used between a master transmitter and its associated transmitter repeater units. The outputs of successive TRUs shall be connected in antiphase.

i) Where line length exceeds 2km, a line amplifier is to be provided at both ends. Intermediately, alternately isolating transformers and line amplifiers are to be provided every 2km (where necessary two-line amplifiers can be provided consecutively).

j) In A.C. and dual electrified areas, a filter unit is to be provided at each line amplifier and an immunisation unit is to be provided at each vital reed receiver filter.

k) The only lightning protection devices that can be fitted to vital systems are those that are specifically approved, such as the amplifier choke.

No such device shall be permitted to have an earth connection, due to the risk from multiple earth faults.

l) High and low frequency type R reed transmitters shall not be housed in the same apparatus case, or in an equipment building within 2m of each other, so as to avoid over amplifying lower frequency signals and subsequent false operation of adjacent channels.

<u>Reed Point Detection</u>

4.7 This system uses vital reed (FDM) transmitters and receivers, so follows the FDM rules in section 4.4, but in addition it is preferable for each channel to use a separate pair in the cable, rather than multiplexing.

5. Time Division Multiplex (TDM)

5.1 TDM systems are susceptible to electromagnetic interference and are not generally suitable for safety-critical applications, unless specifically designed to have the required integrity, in conjunction with an appropriate medium for transmission. See RT/E/PS/00801.

5.2 In A.C. and dual electrified areas, TDM transmission circuits shall use balanced pairs in telecoms cables.

5.3 Earth free terminations shall be used, preferably with a maximum unbalance ratio in excess of 200.

5.4 The TDM system shall be approved for this particular environment and designed to operate satisfactorily in the presence of 10mV induced interference.

5.5 See NR/WI/TEL/00113 for TDM systems in telecoms cables and section E041 for the use of third-party telecommunications systems.

6. Closed Circuit Television (CCTV) Transmission Systems

6.1 For proximity restrictions between CCTV and other equipment, see Section 3.

6.2 In A.C. and dual electrified areas, lengths of co-axial transmission lines for CCTV level crossings vulnerable to dangerous levels of induced voltages shall be screened.

6.3 A 10 M ohm resistor shall be provided between each conductor and earth at each termination to prevent the build-up of static charge.

7. Solid State Interlocking (SSI)

7.1 The requirements of this paragraph do not apply if each relevant item of equipment is provided with an EMC declaration of conformity that addresses the particular proximity problem.

7.2 HVI track circuit transmitters, feed transformers, or cable connecting them, shall not be housed in the same apparatus case as, or in an equipment building within 2m of, as Mark I or Mark II TFMs (signal and points modules), DLMs (data link modules), or LDTs (long distance terminals).

SSI interlockings and HVI track circuit equipment shall not be installed in close proximity to each other.

Mark III TFMs are not susceptible to HVI interference, and therefore shall not be replaced by Mk I or Mk II TFMs when in proximity to HVI equipment.

7.3 Wiring between DLMs (or LDTs) and their associated repeater DLMs and TFMs shall be in twisted pair cables and limited to a length of 5m.

Where SSI DLMs and TFMs are housed in the same equipment room, the TFMs connected to each pair of DLMs shall be mounted in a related group, so as to avoid confusion.

7.4 Wiring from tail cables shall be segregated from the data and power wiring (see section E005). It is also preferable for track circuit tail cables to be routed separately from other tail cables directly connected to a TFM.

Segregation between individual data link cables is not, however, necessary.

7.5 To avoid electrically induced noise, SSI cabling shall be kept as short as practicable.

All SSI circuits shall be subject to the requirements of SSI 8500, particularly those relating to length restrictions and double cutting.

External inputs shall be double cut.

Due to the highly coded nature of SSI, any corruption cannot affect safety, but only dependability.

SSI systems are extremely tolerant to interference and a length of external loop input to TFMs of 2,000m (4,000m loop) is permitted, but it is preferable to limit this length to 200m (400m loop) for inputs from on-track equipment.

This length should be further reduced on D.C. electrified lines, to avoid premature ageing of the TFM transzorbs, and the cabling should be routed away from conductor rail ramps.

7.6 TFM outputs that require double cutting shall be buffered with an interface relay, isolating transformer, or transformer rectifier, as they are not double cut by the module (Lever locks require an interface relay).

7.7 Interface relays for connection across TFM signal module outputs shall be 110V A.C. BR 966 F7 style.

Where voltage-free contacts are required from a standard TFM output feeding equipment, such as signal lighting, a lamp proving relay (BR 941 style) can be used in series between the TFM and the load, in the supply leg (not in the return leg).

7.8 To minimise the impact of lightning strikes and interference induced on data links, a Data Link Isolation Transformer (DLIT) shall be provided at least every 2km in A.C. and dual electrified areas and at the mid-point of every data link elsewhere.

This requirement applies only to new work, since DLITs are liable to attenuate the line and affect the data link design.

Where they connect to DLMs and DLITs, trackside data link cables shall be immunised with surge protection units (to GS/ES1937 for new work).

So far as is practicable, the clean wiring shall be segregated from the unclean wiring. See SSI 8503 for details.

7.9 Power supplies shall be protected by an approved transient protection device. This can be at the primary stage of the main supply transformer (650V or 400V as applicable) or at the secondary stage of each 110V and 140V transformer, or at high lightning risk sites both options can be applied.

External inputs and outputs of TFMs can also be protected from transients by a device that has specific approval for the application in question.

Such a device shall be used in accordance with any conditions or restrictions applicable.

More than one protection device per TFM shall not be earthed, due to the wrong side failure potential of multiple earth faults.

7.10 To prevent damage to TFMs from back EMF, relay contacts that can de-energise the output load shall not be introduced into the circuit between the TFM and its load.

Contacts used for down proving or cross proving are acceptable.

7.11 For restrictions on the use of mobile telephones and other transmitting equipment, see E003.

Test equipment shall only be connected in accordance with section U033.

8. Panel Multiplexers (PMUXs)

8.1 Panel multiplexers are vulnerable to electromagnetic interference and the following safeguards are required:

a) For new panels and where practicable for existing panels, subject to point c), the panel multiplexer shall be located within the panel framework; or otherwise in a cubicle as close as reasonably practicable to the panel.

b) The panel multiplexer to panel cabling shall be screened cable, the screen of which shall be earthed at one end only.

The inputs and outputs shall be in separate cables. See E005.

c) The proximity of adjacent equipment and cables shall be considered to minimise possible electrical interference, especially when routing the panel multiplexer to panel cabling.

END

1. General

1.1 A route can be associated with infrastructure systems susceptible to electromagnetic interference (EMI), such that:

a) Existing vehicles with route acceptance require higher susceptibility levels from the infrastructure.

b) New or proposed vehicles require higher susceptibility levels from the infrastructure.

c) Certain infrastructure systems or configurations have a susceptibility lower than any standard susceptibility levels which have been defined for that type of equipment.

1.2 The details of any such enhanced or deficient route susceptibility should be supplied by the Network Rail Acceptance Panel for incorporation into the appropriate standards.

1.3 On lines with route acceptance for new traction units likely to emit electromagnetic interference, including trains with three phase or induction motor drives, there can be supplementary restrictions on the use of equipment operating at certain frequencies.

1.4 If there is any doubt as to the susceptibility level applicable to a particular route, the details shall be ascertained from the SM(S) before commencing work.

1.5 The following list gives examples of infrastructure systems and equipment which could have their safety performance reduced as a consequence of EMI:

a) Train detection systems (including track circuits and axle counters).

b) Interlocking systems (including TDM and FDM remote control systems).

c) Signals and point operating equipment and their controlling circuits.

d) Train warning and protection systems.

e) Telecommunications systems (including voice and data transmission, and supervisory control and data acquisition (SCADA) systems).

f) Radio systems (including voice and data transmission, fixed and mobile systems).

g) Lineside beacons.

h) Level Crossing equipment.

END

1. Susceptible Electronic Equipment

1.1 The following items shall not be used within 3 metres of apparatus cases (with doors open) or equipment racks, if there is susceptible electronic equipment present which is not protected as required by Rule Book Handbook 19:

a) Power tools.

b) Vacuum cleaners.

c) Mobile telephones, tablets and laptops.

d) Any other form of transmitting wireless communication equipment.

1.2 Susceptible electronic equipment includes:

a) Vital/non-vital reed receivers.

b) Audio frequency track circuits.

c) Axle counter equipment.

d) ATP and TPWS equipment.

e) TDM and other multiplexers.

f) SSI and other computer based interlocking equipment.

g) Lineside Beacons.

h) Level Crossing equipment.

These lists are indicative and not exhaustive.

NOTE: *When CE marked, such products should be regarded as only being susceptible up to one metre, or otherwise as stated in the declaration of conformity.*

NOTE 2: *Type RR reed receivers with radio frequency suppression have a type number suffix 'B' or 'C'.*

1.3 It is recognised that members of the public and railway staff, other than S&T staff, can use radios, portable telephones and power tools near S&T equipment.

This is unlikely to cause a problem providing that apparatus case and equipment room doors are kept shut.

2. Explosive Atmospheres

2.1 Electrical devices shall be switched off if there is a known risk associated with an explosive atmosphere, such as when refuelling equipment or vehicles with petrol.

3. Distractions

3.1 Mobile phones offer many benefits, but they can distract those carrying out safety-critical tasks such as duties driving, operating plant, acting as lookout, or whilst on or near the line.

3.2 If it is not possible to turn the phone off or to silent, it is essential that people involved in these activities do not respond to their phone, until they are in a place of safety. If they are responsible for the safety of others these too shall be in a place of safety.

3.3 When calling a mobile phone, always ask if it is safe for the other person to talk and offer to call back if it is not.

3.4 It is illegal to use a hand-held mobile phone when driving, even when you are stopped at traffic lights or in a queue of traffic. This includes making or answering calls, reviewing pictures, text messaging or accessing the Internet.

4. Warning Signs

4.1 Wherever susceptible electronic equipment is located, a "switch off mobile phones" warning sign (see P015) shall be affixed to the outside doors of equipment rooms and apparatus cases.

END

1. General

1.1 The following precautions apply to personnel who are required to handle, store, transport, install or repair any equipment containing Electrostatic Sensitive Devices (ESDs).

2. Background

2.1 Static electrical discharge can cause damage to micro devices at all stages of handling. An electrostatic charge can easily build up on people, and the subsequent rapid discharge to earth via the device, can cause severe damage. The severity of this damage depends on the size of charge dissipated. In many cases the damage is not total, and the device can continue to work at a reduced performance level, but its in-service life might be affected.

2.2 Unless precautions are taken, ESDs can be damaged by static discharge at any time. A Printed Circuit Board (PCB) offers only limited protection to the components.

2.3 Devices within sealed modules are also vulnerable, as contact with an unprotected connector can provide a discharge path.

2.4 Complete systems are not usually at risk from the dangers of inadvertent electrostatic discharge, as steps are taken at the design stage to shield the ESDs with enclosures and covers which protect the ESDs from damage. It is when connectors are exposed that ESDs are most likely to be damaged by electrostatic discharge.

2.5 References in this document to modules and sub-assemblies assume that they have ESDs fitted.

3. Training

3.1 No staff shall handle ESDs until trained in the techniques for the safe handling of ESDs.

This is normally carried out during equipment specific training.

4. Precautions

4.1 Precautions to prevent static damage shall be taken whenever handling equipment containing ESDs, such as printed circuit boards (PCBs). Avoid unnecessary touching of the edge connectors.

4.2 Equipment incorporating ESDs shall not be subject to sudden discharges from stored energy devices such as electromagnetic coils and capacitors.

4.3 Equipment incorporating ESDs shall be protected against the risk of static discharge caused by staff who can become electrostatically charged in the normal course of their duties, for instance:

a) Moving a chair across the floor.

b) Friction caused by walking across the floor

c) Brushing clothing against another surface or against other clothing, especially where clothing contains man-made fibres.

d) Removing paper from plastic envelopes or separating plastic envelopes that have stuck together.

e) Handling freshly produced photocopies.

f) Applying identification labels which might become charged when separating two surfaces.

5. Handling Area

5.1 ESDs should only be handled in an electrostatic Safe Handling Area (SHA). This is an area which prevents the inadvertent discharge of static electricity through vulnerable devices.

6. Packaging

6.1 ESDs shall be transported in static shielded containers and packaging to prevent the build-up of static charges, protect against electrostatic fields and to prevent mechanical damage during storage and transportation (see Section 11).

7. Marking

7.1 The actions of labelling and removal of a label at component, PCB or module level might cause static damage. This process should only be undertaken in a controlled de-ionised environment which is produced by the use of an air-ionisation blower or a similar device.

7.2 Suitable markings, identifying the presence of ESDs should be attached to racks, cabinets, data sheets, storage bins, cupboards and protective wrapping materials.

7.3 All sites designated as SHAs should be dearly identified with posters and labels.

7.4 All electrostatically sensitive apparatus shall be labelled using distinctive markings in accordance with BS EN 61340-5-1 (2016).

8. Transportation and Storage

8.1 Confirm that equipment containing ESDs is suitably packaged and correctly labelled during transportation and storage.

8.2 Labelling should be undertaken in a controlled, de-ionised environment.

8.3 Individual ESDs, PCBs and sub-assemblies should be shielded against electrostatic discharge by screening provided by the packaging, which should also prevent mechanical damage during transportation and storage.

8.4 Suitable protective packaging for ESDs includes:

a) Transparent electrostatic shielding bag:

- The identification details should be entered on the label used for sealing the bag.
- The label should, at a glance, differentiate between serviceable and non-serviceable items.
- This label should seal the bag, and the contents of an unsealed bag are considered to be unserviceable.

b) Transportation containers:

- These are made from conductive material, with cushioning and separation to prevent damage to the devices held within them.
- A container should be fitted with a 10mm stud for connection via a resistive 1 M ohm Common Point Ground (CPG) lead to an earth point before the case is opened.
- Only devices known to be serviceable should be held in the container.
- Devices can be contained in a shielding bag or placed directly into the container. Where a shielding bag is used, then the label shshould be intact, and the bag sealed.
- A device should only be removed from the transit packaging in a SHA (see Section 11).

9. Transportation

9.1 All new components and parts should be delivered and stored in anti-static packaging until required.

9.2 All transportation containers (including field servicing kits) should be bonded to the SHA before being opened.

9.3 Modules should be checked to confirm that the conductive connector covers are fitted prior to dispatch.

NOTE: *These covers are only to be fitted in a SHA.*

10. Storage

10.1 There should be a specific, clearly marked area set out for the storage of ESDs, PCBs, sub-assemblies and modules. Access to this area should be restricted to suitably trained personnel instructed in the precautions required for the handling of ESDs.

10.2 Storage racks for ESDs, PCBs and modules can be made of metal, and this should be bonded to a common earth point.

10.3 All containers or bins used on such racks shall be of metal or conductive plastics construction.

10.4 ESDs should be kept separate, and never stored with other components to prevent the risk of protective procedures being overlooked in subsequent handling.

10.5 Unless they are stored in spare racks/slots identified for the purpose of storage, all ESDs packed individually in the manufacturer's protective packing or packed in bulk in metal or anti-static plastic tubes, shall be stored in the original packing.

10.6 Where individual ESDs are removed from the manufacturer's protective packing and stored, then the following shall apply:

a) PCBs shall be stored in sealed shielding bags, which may themselves be contained in protective packaging. PCBs shall only be removed from the bags in a SHA.

b) Integrated Circuit chips (ICs) and other small static sensitive devices shall be stored in anti-static containers.

c) EPROMs (Erasable Programmable Read Only Memories) shall be stored in either a conductive IC storage box, or in a conductive storage tube.

d) Modules shall be supplied and stored with conductive covers fitted over the connectors.

11. Special Precautions for EPROMs

11.1 EPROMs shall only be removed from the protective wrapping in a SHA. EPROMs shall not be transported in storage bins.

11.2 No EPROM shall be removed from the SHA before it is packaged in an ant-static container.

11.3 EPROMs shall only be programmed in a SHA.

11.4 EPROMs shall only be inserted into, or removed from, a PCB or module in a SHA; after removal from a PCB or module, the EPROM shall be placed in a temporary conductive storage bin or IC storage box or case.

12. Safe Handling Areas

<u>General</u>

12.1 A SHA is a working area, where individual ESDs (as well as boards, sub-assemblies and sealed modules) can be handled safely without damage being caused by the discharge of static electricity.

12.2 A SHA should be created at each working site. The SHA can be permanent or portable.

12.3 If within touching distance of other equipment, shall be bonded so that the equipment is included within the protection afforded by the SHA.

12.4 All equipment racks and metalwork shall be properly bonded.

12.5 Any mains power supply within the SHA shall be supplied via a Residual Current Circuit Breaker (RCCB) complying with BS EN 61008. The maximum sensitivity of the RCCB shall not exceed 30 mA.

<u>Permanent Safe Handling Area</u>

12.6 Figure 1 shows an example of a permanent SHA layout. Each permanent SHA site shall consist of a combination of items, as listed below, to provide for the safe handling of ESDs:

a) Clear markings, identifying the site as a SHA.

b) A work bench with a dissipative mat placed on the work surface, and a conductive floor mat which shall be equipotentially connected using a 1 M ohm CPG lead to an equipment earth or ground point, and the mains supply earth (via the 10mm stud on a 13 Amp dummy plug).

c) A chair with conductive covers and 10mm studs. Conductive bins for the storage of ESDs.

12.7 Any staff carrying out work on equipment shall be grounded via a 2 M ohm resistive lead and wrist strap.

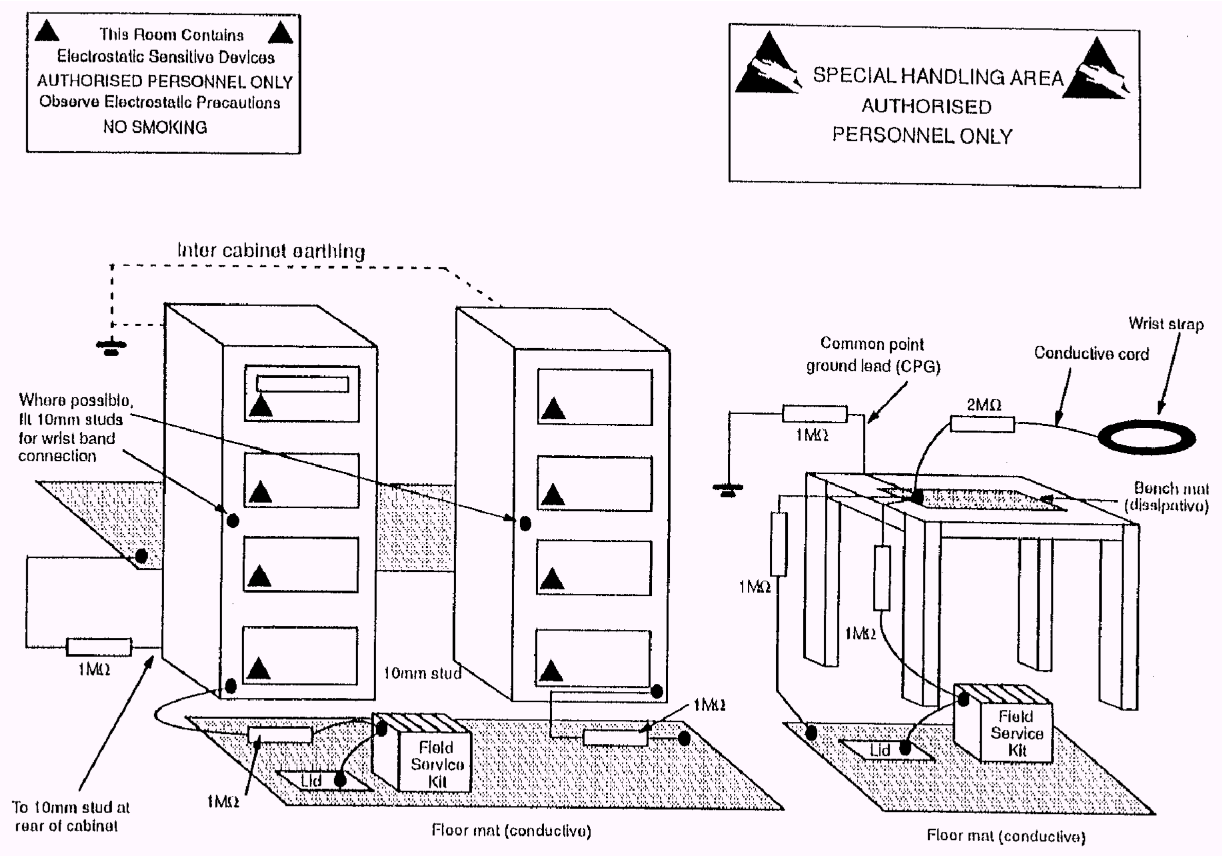


Figure 1 - Example of a Permanent Safe Handling Area

Portable Safe Handling Area

12.8 Figure 2 shows an example of a portable SHA layout. A portable SHA site uses a dissipative mat, including integral 10mm stud, which can be rolled up for transportation, and included pockets to hold leads, wrist strap, clips and connectors.

The mat is the working area and any staff carrying out work on equipment shall be grounded via a 2 M ohm resistive lead and wrist strap, and also connected via clips/connectors to:

a) 1 M ohm resistive CPG lead(s) to bond the dissipative mat to a CPG.

b) An equipment earth bonding point.

c) The mains supply earth (via the 10mm stud on a 13 Amp dummy plug).

Additional Requirements

12.9 If ICs need to have labels changed, then an air-ionisation air blower or similar item should be provided.

13. Apparatus

13.1 In general, all apparatus and racks incorporating ESDs shall be fitted with 10mm studs for connection of a wrist strap and leads, conductive floor mat, or portable SHA CPG lead. As a minimum, there shall be one 10mm stud on each working face of each rack or module.

13.2 The studs shall be labelled with an earth bonding point label to indicate the connection point.

13.3 See Figures 1 and 2 for examples of typical interconnections necessary to provide protection to ESDs at a SHA.

14. Static Control

14.1 To confirm the effectiveness of any static control precautions, the special items shall be checked regularly.

14.2 The frequency of checks of each individual item depends on the nature of that item, its frequency of use, and the risk of damage or deterioration.

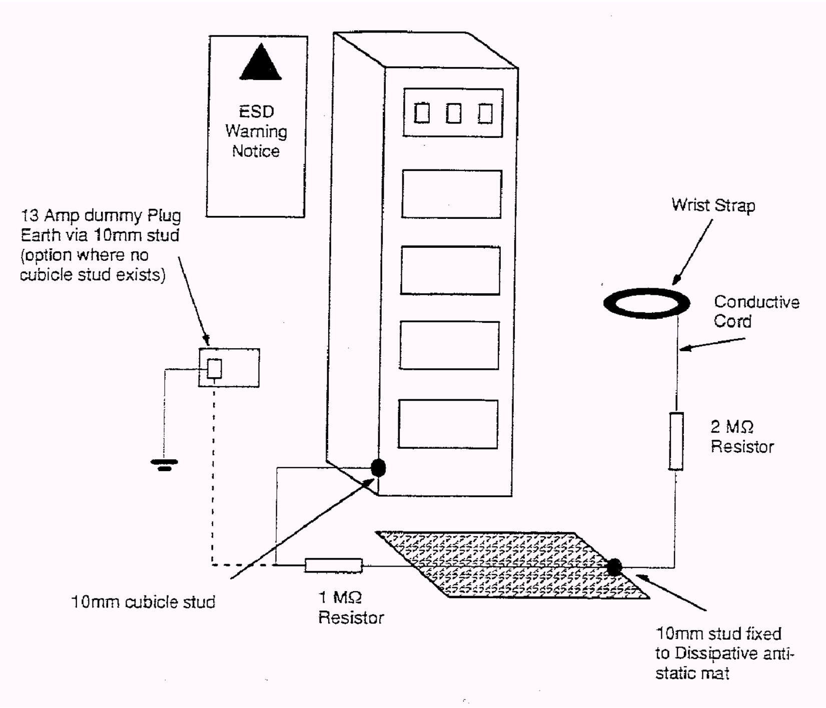


Figure 2 - Example of a Temporary Safe Handling Area

14.3 Equipment to test the integrity and correct functioning of the SHA items, and the correct operation of air-ionisation blowers should be readily available. This test equipment should be forwarded to an approved service/calibration centre at appropriate intervals.

14.4 Records shall be kept showing PASS/FAIL status and any remedial actions taken.

END

1. Introduction

1.1 This module covers the reasoning why wires and cables need to be installed in separate runs.

2. Cross-Contamination

2.1 To avoid contamination leading to insulation degradation, separate cable routes should be provided to maintain physical separation between copolymer or PVC insulated conductors and those with PCP or rubber insulation.

2.2 Modern rubber wire, e.g. Type A1 to NR/PS/SIG/00005, does not use PCP and is not affected by PVC contamination, although mixing is not generally desirable. Segregation should be maintained unless it can be ascertained that all wire is PCP free.

3. Internal and External Wiring

3.1 Internal type cables (Type A) shall not be permitted in:

a) The same wiring route as external (Type B).

b) Or on-track type cables (Type C).

c) Or in unprotected metal trunking.

NOTE: *If it is desired to use the rules for internal circuits (i.e. single cutting and internal power supply) for circuits extending between adjacent equipment housings, a fully enclosed protective non-conducting duct should be used.*

4. Protection from Traction Faults

4.1 It is important in electrified areas that cables connected to the rails, e.g. track cables, are kept separate from internal wiring and fitted with enclosed terminations to protect equipment and personnel from traction faults.

4.2 In DC. electrified areas, many equipment buildings use in-line fusing for all external circuits to protect internal equipment.

5. Input and Output Integrity

5.1 Where there is a particular risk of wrong side circuit faults arising from cable damage, inputs and outputs should be allocated to separate cables.

Examples include point detection tail cables and cables to panel multiplexers.

6. Transient Protection

6.1 Inputs and outputs from system protection surge arrestors and line isolating transformers should be segregated to keep "clean" and "dirty" signals apart.

7. Fast Transient Earth Bonding

7.1 An FTE conductor requires the shortest practicable route to earth. It might conduct surges, such as lightning, so should not be run in trunking with other wiring.

8. Electromagnetic Interference (EMI)

8.1 Section E001 gives many examples of audio frequency and other susceptible systems, the wiring of which is kept separate to prevent crosstalk. Such cabling should also be kept as short as possible, often in twisted pairs and not ducted.

8.2 Wiring from tail cables should be segregated from the data and power wiring for electronic systems. It is also preferable for track circuit tail cables to be routed separately from other tail cables directly connected to electronic units, such as a TFM.

8.3 With some electronic systems, separation is achieved by diverse routing.

9. Thermal Effects

9.1 Cable overheating can be exacerbated by the bunching of wires in a duct. BS 7671 gives tables showing the relative effects of running cables by different methods.

9.2 It can be beneficial to reduce the heating effect of current flowing, particularly in normally energised circuits and power supply cables, by not tightly filling ducts.

10. Voltage Separation

10.1 The insulation of any cable should be sufficient as to enable the cable to withstand the applied voltage and any foreseeable transient over-voltages. The insulation should also be sufficient to withstand the applied voltage within any other cable with which it comes into direct contact, in particular where mixed with power cables.

10.2 There are three common options (see BS 7671):

a) Each cable in a cable route or ducting is insulated for the highest voltage present in the route.

b) A separate compartment is provided for each voltage system present, e.g. over or under 175V.

c) Each susceptible cable has an earthed metallic covering.

10.3 For telecommunication circuits, data transfer circuits and similar, electrical interference, both electromagnetic and electrostatic shall be assessed.

10.4 Telecommunication circuits shall be segregated in accordance with BS 6701.

10.5 NR/SP/ELP/27224 requires cable routes for high voltage cables to be separated by a minimum of 1m and, wherever practicable, routed on the opposite side of the track from cable routes for signalling and telecoms cables.

NOTE: *Except for cables connected to equipment attached to a running rail, such as point machines, cables energised at a nominal voltage of more than 110V should not be routed on the surface across the track.*

11. Fire Protection

11.1 Fire alarm and emergency lighting circuits shall be segregated from all other cables and from each other in accordance with BS 5839 and BS 5266.

END

1. Background

1.1 For power supplies of more than 175V work is to be carried out to NR/L2/ELP/27320 and E&P systems for recording and rectification of defects are be followed.

2. First Earth Fault on Signalling Power Supplies

2.1 Some power supplies have indications of earth faults to both Signaller and Technician. The Technicians can use the Earth Leakage Detector equipment to help with fault finding up to 110VA.C. and 120VD.C. This is important, because earth faults need to be quickly located and rectified.

2.2 Traditionally, earth faults on signalling power supplies have not prevented the operation of the railway signalling system. When an earth failure is found, Signallers see no operational advantage in the repair. They have, at times, been reluctant to allow staff access to the equipment because they have considered the running of traffic more important than a failure having no operational effects.

2.3 Signallers and Operational Control Staff have now been requested to give every assistance to Technicians, with access to clear the first earth fault on the new systems before a second earth fault disconnects the power supply. Power disconnection can disrupt train movements more than allowing access for the Technician to locate the first earth fault.

3. Clearing the First Earth Fault

3.1 Technicians shall attempt to find and clear the fault immediately, if practicable. If rail traffic makes this impractical, a fault team shall return to investigate the fault within 48 hours of access being denied.

Recognising that these faults can be difficult to find, further attempts might need to be made, in liaison with Operations Control and Signallers.

3.2 The fault should normally be rectified within 10 working days.

If this is not possible, the power supply is liable to be signed over to live working procedures (see Section 4) until the failure is located. The S&TME may grant an extension of up to a total of 4 weeks.

If the failure is not rectified at the end of this time, 4 weeks after discovery, the power supply shall be treated as defective and live working techniques applied to all activities on equipment fed from the affected power supply.

4. Live Working Procedures

4.1 When a power supply has an earth fault present for longer than 4 weeks (see Section 3), any work on the power supply or on equipment fed from it (other than rectification of the earth fault) shall be subject to the live working techniques given in NR/L3/SIGELP/50003.

END

1. General

1.1 In some installations, signalling functions are transmitted via telecommunication systems.

1.2 Telecoms systems are provided by Telecoms, who have responsibility for maintenance and faulting of all circuits/services contained within the systems.

1.3 The Telecoms Engineer should obtain authorisation before commencing work on a telecoms system that could, or is known to contain, signalling circuits.

1.4 The SM(S) is responsible for checking that any signalling circuitry that is required to be isolated from the telecommunications system is disconnected before work starts.

1.5 Certain specified tests can be permitted without the disconnection of signalling circuits.

1.6 This instruction defines the procedures that shall apply to work on telecommunications systems that carry signalling circuits and enables compliance with NR/L2/TEL/30067. Unless information is available to the contrary, all signalling circuits shall be regarded as being safety related.

2. Telecoms Cables Carrying Signalling Functions

2.1 Telecoms cables reserved solely for signalling circuits shall be identified and treated as signalling cables. They are the responsibility of the signalling maintainer. All work on such cables shall comply with Signalling Testing Procedures.

2.2 Telecoms cables carrying both telecoms and signalling circuits are the responsibility of the Telecoms Engineer. All work on such cables is subject to agreement between the Telecoms Engineer and the Signalling Engineer, in accordance with NR/L2/TEL/30067. This includes bearer circuits transmitting coded signalling functions compliant to BS EN 50159.

3. Definitions

Signalling Circuit

3.1 A circuit carrying information used for the operation of the railway signalling system associated with the safe movement of trains. These circuits can be provided using bearer circuits in operational telecoms cables.

Operational Telecommunications

3.2 All fixed and, radio-based telecommunication systems, that are associated with the safe movement of trains, including signal post telephones, block telephones, level crossing telephones, RETB, GSM-R, cab secure radio and operational IP/Ethernet data networks.

Network Termination Point (NTP)

3.3 The termination point at which a signalling circuit enters or exits the telecommunications cable or system, for example (Figure 1):

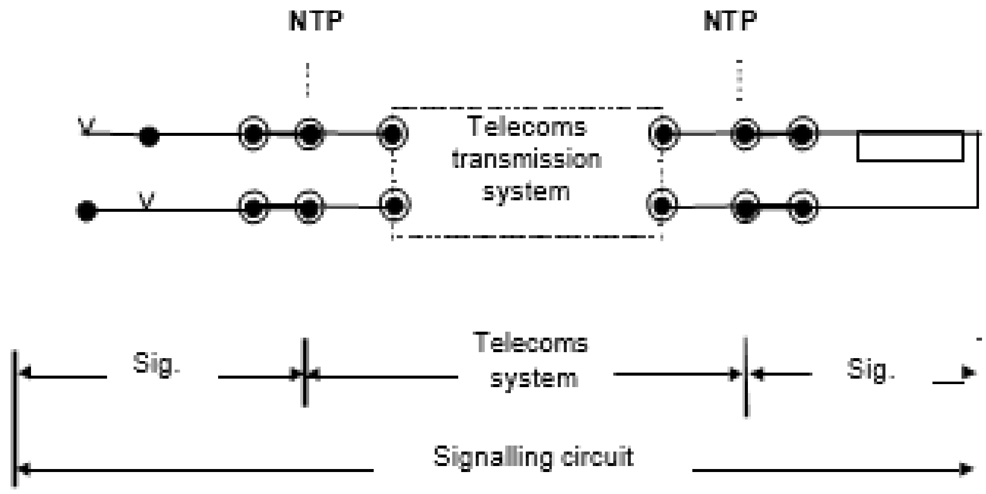


Figure 1 - Example

3.4 An NTP is only valid (from a signalling perspective) if an authorised disconnection point is provided, e.g. 2BA links/WAGO terminations, Ethernet or fibre optic patch panels.

NOTE: *There might be more favourable places to make disconnections (Section 4), e.g. at the modem for a TDM system.*

3.5 Through crimps and Krone blocks are not permitted as NTPs, since there is no disconnection point.

4. Telecoms Cables and Systems Carrying Both Telecoms and Signalling Circuits

4.1 Before work is started on a telecoms cable or system, the Telecoms Engineer shall confirm the absence of signalling circuits in that cable by consulting up to date records.

NOTE: *Some signalling circuits do not carry D.C. voltage or A.C. signal until they need to be operated.*

4.2 If there is any doubt, or where signalling circuits are confirmed to be present, the Telecoms Engineer shall consult with the SM(S).

4.3 Before authorising work to start, the SM(S) shall identify the circuits involved and arrange disconnection (or diversion) of any signalling circuits from the telecommunications system. Disconnection is not required in the following circumstances:

a) Where work is restricted to measuring voltage.

b) Where work is restricted to disconnection of telecommunication circuits (i.e. circuits that are not classed as signalling circuits) by slipping links and where jumper wires are not to be provided or removed between any NTPs.

c) Where work involves the change of use of telecoms pairs or channels already in service, providing it does not involve re-jumpering the cable and does not involve signalling circuits.

d) Log into network switches and routers for traffic monitoring statistics (incoming/outgoing data).

4.4 All work on such systems shall be compliant with NR/L2/TEL/30067 and this Module.

4.5 Diverted circuits shall be subject to the temporary design procedure NR/L2/SIG/11201/ModA2-9 and Maintenance Testing (see Section 5).

4.6 Disconnection of equipment in connection with Rule Book Handbook 19 is the responsibility of the signalling function.

5. Diversion of Circuits in Telecommunication Systems

5.1 If it is necessary to temporarily divert a circuit the following shall apply:

a) Existing wiring which is to be diverted shall be clearly labelled.

b) New wires shall be of single core wire, installed in trunking and labelled in accordance with NR/WI/TEL/00113. They shall also be clearly visible.

c) Alternative cable cores shall be labelled at each termination point in the diversion.

d) Where multiple cable core diversions are required, each shall be completed and successfully tested before commencing the next core diversion.

e) A cable core diversion shall only be applied to the terminations at each end of the faulty core.

f) All affected maintenance records shall be endorsed in red, signed and dated.

g) The local Telecom Engineer shall maintain a record of cable diversions and associated dates.

h) A full insulation and continuity test shall be carried out within 48 hours of the diversion (72 hours where no existing cable diversions are present on the same cable). Where possession of the cable is not possible, the full test can be deferred subject to a 10% minimum test of cores being carried out (see TMTH Test Plan CAB006).

i) The local telecom bearer steward manager shall check that all temporary diversions are rectified as soon as practicable. All temporary wires and labels shall be recovered, and drawings updated as necessary.

j) All diversions over one-month duration shall be subject to risk analysis by the S&TME to determine the ongoing testing regime.

k) Diversion of circuits on Telecom diverse network within transmission systems or network switches is the responsibility of Telecoms Engineer. The Telecoms Engineer shall advise the SM(S) and endorsed affected maintenance records.

6. Managing Work on Telecommunications Cables or Systems that Contain Signalling Circuits

<u>Before Telecoms work can start:</u>

6.1 The Telecoms Engineer shall advise the SM(S) of the following:

a) List of cables and systems to be affected.

b) List of network switches and systems to be affected.

c) Scope of work.

d) Date/time work is to take place.

e) Time required to complete the work.

f) Point of contact.

6.2 A SM(S) shall review the proposed work and liaison with the Telecoms Engineer might be necessary at this stage.

6.3 The SM(S) shall arrange a maintenance disconnection or diversion of affected signalling circuits at the NTPs, as necessary, to a programme of work agreed with the Telecoms Engineer. A full list of all disconnected and diverted circuits shall be returned to the SM(S) with the maintenance testing documentation.

6.4 The Telecom Engineer shall arrange a telecom maintenance disconnection or diversion of affected signalling circuits at the network switch ports, Ethernet or fibre optic patch panel or telecom transmission systems as necessary, to the programme of work as agreed with the SM(S).

A full list of all disconnected and diverted circuits shall be returned to the telecom supervisor c/c to SM(S) with the maintenance testing documentation.

NOTE: *Refer to disconnection exemptions in Section 4.*

6.5 Following disconnection of all necessary signalling circuits, the signalling Technician (or SM(S)) shall complete and jointly sign the Authority to Work Certificate (Figure 2), with the Telecoms Engineer.

The copy shall be returned to the SM(S), together with Maintenance Testing documentation, etc. Where no disconnection of circuitry is required, this can be done by confirmed correspondence.

6.6 Telecoms work can only commence after handover of the Authority to Work Certificate to Telecoms Engineer.

Where the Signalling Technician and Telecoms Engineer's representative are present, the certificates, items 6.5) and 6.7), can be signed in person. Otherwise, the form shall be dictated and read back before being verbally endorsed. Paper copies shall subsequently be forwarded by e-mail.

After Telecoms work has been completed:

6.7 The Telecoms Engineer shall complete a duplicate Cable/System Restoration Certificate (Figure 3), to be jointly signed with the Signalling Technician (or SM(S)); top copy to be retained by Telecoms Engineer, the other copy to be returned to the SM(S).

6.8 The certificate shall include detail of the testing done on each circuit prior to handover, including the following test results, where practicable, for recording on the fault management system (see TMTH Test Plans CAB001 to CAB006, as required):

a) Continuity test.

b) Loop resistance test.

c) Insulation test (core to core and core to earth).

NOTE: *This applies to only the affected pairs. See NR/SMS/PartZ/Z05 (Cable - Reference Values).*

Y1564 Ethernet service tests within specification (International Telecommunication Union (ITU) standard.

6.9 When the correct tests have been completed, the Signalling Technician can restore the disconnected and diverted circuits. Before being returned to service, each signalling circuit shall be Cable Function Tested NR/SMTH/Part03/Test/B04 (Defined Test: Cable Function Test). Reference shall be made to the disconnection list to assist in this process.

NOTE: *Where it is safe and practicable to accept a partial restoration of cables/systems, precise details of which cables/cores/systems/sub-systems are being offered back shall be documented on the certificate and tested as for signalling use.*

A separate plan shall be implemented to return the remaining circuits to service to include all necessary handover and testing as above.

7. Records

7.1 The following forms for use with this procedure are provided below:

a) Authority to Work Certificate (Figure 2).

b) Cable/Systems Restoration Certificate (Figure 3)

7.2 The following records shall be retained:

a) Maintenance Test Plans and SMTH Log Sheets.

b) Completed Authority to Work Certificate.

c) Completed Cable/System Restoration Certificate.

Signalling Circuits in Telecommunication Systems
Authority to Work Certificate

The following signalling circuits have been affected or disconnected **

(continued overleaf**)

I hereby give permission for work to commence on the following cables/systems:

Granted by:

Signed: …………………………………… Date: ………………
(For S&TME)

Time: ……………...

Accepted by:

Signed: …………………………………... Date: ………………
(For Telecoms Engineer)

** Delete as necessary

Figure 2 – Authority to Work Certificate

Signalling Circuits in Telecommunication Systems
Cable/System Restoration Certificate

I hereby confirm that I have completed work on the following circuits and that they have been tested as follows:

(continued overleaf**)

Correlated **	
Wire Counted **	
Continuity Tested **	
Insulation Tested **	
Y1564 Ethernet service Test**	
Other **	

The following circuits are not yet restored to service:

Completed by:

Signed: …………………………………… Date: ………………
(For S&TME)

Time: ……………...

Accepted by:

Signed: …………………………………... Date: ………………
(For Telecoms Engineer)

** Delete as necessary

Figure 3 – Cable/System Restoration Certificate

END

1. Insulation of Unterminated Wires

1.1 Alterations to signalling equipment shall only be made in accordance with the engineering details supplied for the work.

1.2 Before any signalling equipment is brought into use, any wires that are not terminated shall be insulated or terminated.

1.3 The termination methods described in this module shall be used whenever wires are run or disconnected on any signalling equipment that contains working circuits.

NOTE: *In this section, 'spade' includes any connector such as relay spade, ring tongue terminal, eye etc.*

2. Running New Wires

2.1 Wires which cannot be terminated shall be run, labelled, checked and then made safe by insulating the ends and securing them in a safe position. In the case of a single wire which cannot be terminated, it should have its connector fitted before insulation.

2.2 Wires which are to be attached to an existing wire, or which are to be interchanged with an existing pair of two wires, are not to have any connector fitted. They are to be labelled, checked, insulated and made safe until the commissioning. The wire end shall not be stripped before insulation.

2.3 Under no circumstances shall any wiring be attached to working circuits (including power supply busbars and looping) until the new circuits are commissioned under an agreed testing and commissioning plan.

2.4 The type of insulation required for new wiring is given in the flow chart in Figure 1.

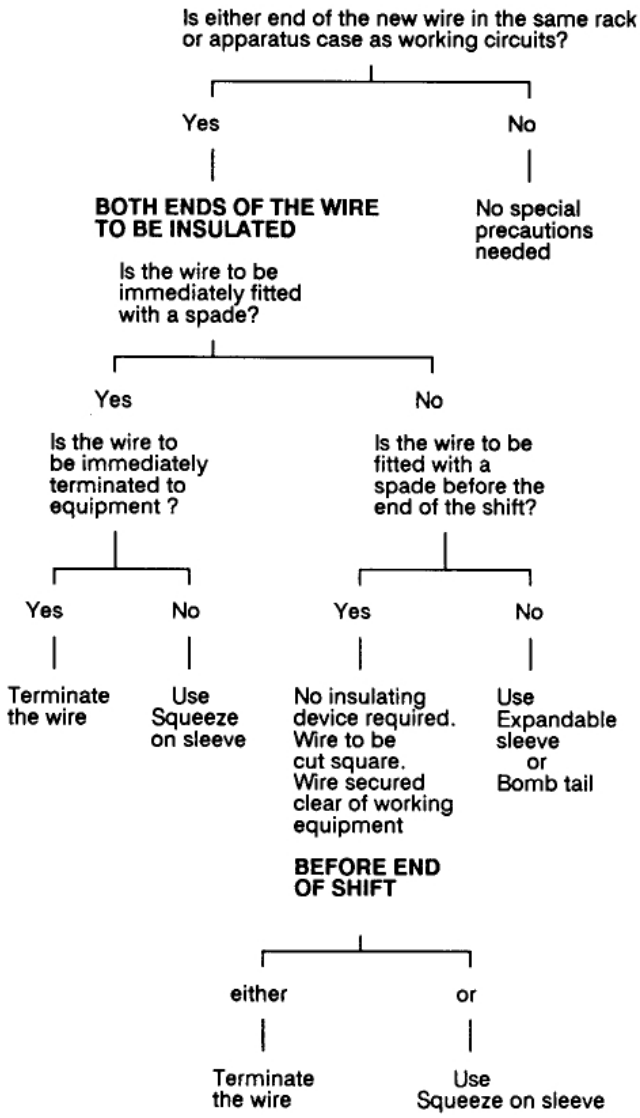


Figure 1 – New Wiring

3. Unterminated and Disconnected Wires

3.1 These shall be fully disconnected from working circuits at both ends. If a redundant wire cannot be completely removed, it shall be immediately disconnected, insulated at each end and secured so that it cannot make contact with working circuitry.

<u>Permanent</u>

3.2 BOMB TAILS (see Section 4) can be used as a permanent insulation with the wire cut away from any apparatus.

Temporary

3.3 The following temporary insulation methods can be used for a maximum of 12 weeks:

a) Bomb Tails, wire not cut away (see Section 4).

b) Squeeze on Sleeves (see Section 5).

c) Expandable Sleeves (see Section 6).

3.4 The type of insulation required for redundant wiring is given in the flow chart in Figure 2.

4. Bomb Tails

4.1 These are available in two sizes and the correct size shall be selected. An AMP tool, with handles coloured to match the bomb tail colour, are used to crimp the tail onto the wire. This method can be used as permanent insulation.

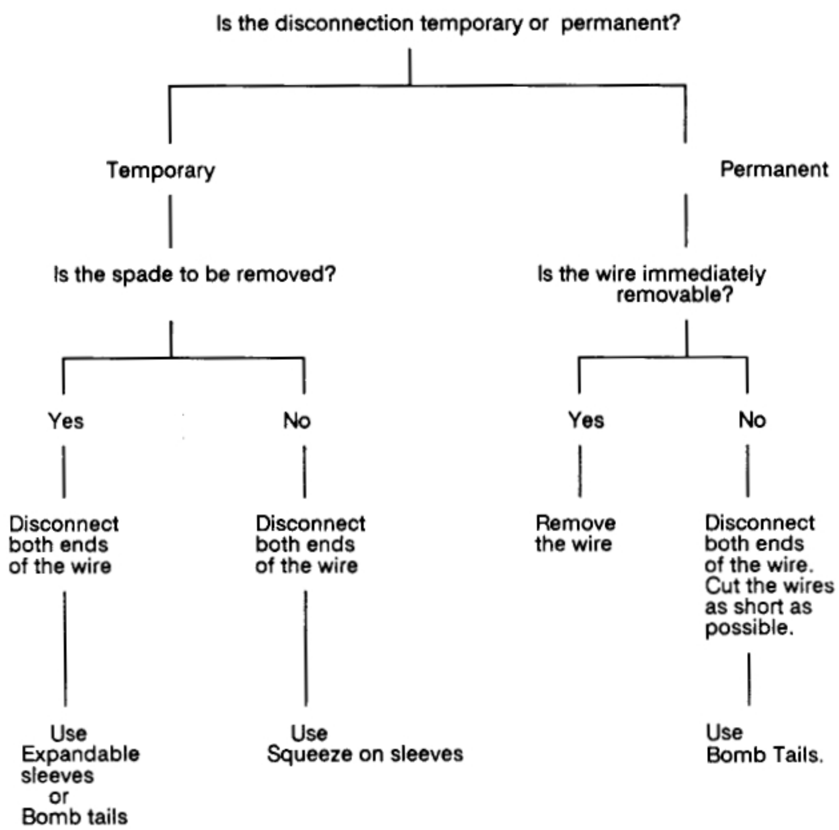


Figure 2 – Disconnection of Redundant Wires

4.2 Installation Method

a) Type of Installation

- Permanent insulation: Cut the wire end away from any apparatus and strip the wire by no more than 10mm.
- Temporary insulation: Strip the wire by no more than 10mm.

b) Choose a bomb tail and its matching tool.

c) Insert the bomb tail in the tool.

d) Insert the wire in the bomb tail.

e) Grip and squeeze the tool.

f) Check that the bomb tail and its insulation are captive on the wire.

4.3 For further details on the use the use of maintenance of crimping tools refer to the Signalling Installation Handbook.

5. Squeeze on Sleeves

5.1 Squeeze on sleeves are for wires fitted with BR 831 relay spades or 0BA/2BA ring connections but should not remain in use longer than 12 weeks.

5.2 Installation Method

a) Crimp the wire to a spade.

b) Squeeze the tube between fingers.

c) Insert spade until it is in the middle of the tube and release the sleeve.

d) Check that the spade is captive by trying to pull the spade out of the tube by its wire (grip the tube at the open end away from the spade).

6. Expandable Sleeves

6.1 Expandable Sleeves are for use on wires, cables, relay spades and flat connectors by choosing the correct size sleeve, but these should not remain in use longer than 12 weeks. A tool is needed to expand the sleeve before fitting.

6.2 Installation Method

a) Choose a sleeve and tool to suit the wire's outer diameter.

b) Cut the wire square and leave as a blunt end.

c) Fit the sleeve onto the prongs of the tool.

d) Squeeze the handles of the tool.

e) Push the wire 3/4 of the way into the tube.

f) Release the handles of the tool and using your other hand squeeze the end of the sleeve onto the wire. Ease the tool out of the sleeve.

g) Check that the end of the wire is 3/4 of the way into the tube.

h) Confirm that the sleeve is captive by pulling the open end of the sleeve and the wire.

7. Additional Checks

7.1 Observe that insulated wire connections are undamaged and secure on the wire. If there is the slightest doubt about the quality of the insulation, cut the insulator off and insulate the wire again. All bare metal shall be well covered, with the insulator

7.2 After insulating the wires/connectors, make them secure by fixing them away from the working circuits. Check they cannot become caught in moving parts. Use cable ties (groove side out) or insulation tape to secure the wires out of the way.

7.3 Insulation tape shall not be used as the principal insulation but can be used in addition to one of the above methods if necessary, for reinforcement or security.

7.4 Do not re-use insulation tape; discard any that has been used once and subsequently removed.

END

1. Securing Points Out of Use when Not Connected to a Controlling Signal Box or Ground Frame

1.1 Switches and switch diamonds which are in a running line (but which are not connected to a signal box or ground frame because they are new and not yet connected, or redundant ones waiting to be removed) shall be secured in a safe position by scotch, clip and padlock, or by fitting a switch securing block to both the closed and open switch blades.

1.2 Switches and switch diamonds shall be secured out of use, as described in clause 1.1, when their associated crossings have been removed (plain lined).

1.3 The SM(T) is responsible for making the points safe in one of these ways, but the SM(S) shall confirm that the SM(T) has been advised of this requirement.

1.4 Technicians shall not disconnect redundant points unless they have been made safe in that manner.

1.5 If the points do not have a facing point lock, the fixings provided by the track supervisor should make them secure. There might, be special cases where the Signal Technician is requested to fit the points with a temporary facing point lock mechanism until they are either brought into use or removed.

1.6 If the out of use point has supplementary drives, these shall remain connected.

1.7 The SM(S) shall be advised of any out of use points that have been installed or disconnected and which are fitted with signalling equipment.

This is so that they can arrange for the equipment to be regularly checked and serviced.

If the out of use points are equipped with a facing point lock, the Signal Technician shall make the lock effective, as described in Section 2, 3, 4 and 5.

NOTE: *Always replace any covers and padlocks to prevent anyone tampering with the equipment.*

2. Mechanical Points

2.1 Secure out of use by bolting the lock plunger to a bracket screwed to the wooden sleeper or the plunger can be screwed directly to the sleeper.

3. Clamp Locks

3.1 Secure the mechanism with a pin (see Figure 1) inserted up through the hole at the closed tongue end of the drive lock slide. The head of the pin needs to be filed so that it fits flush with the end of the clamp lock body. Fit and secure an RKB221 padlock through the hole in the top end of the pin.

Early versions of the clamp lock did not have provision for securing the drive lock slide with a pin and padlock. In such cases, the mechanism is to be secured by replacing the closed switch side actuator with a special locking rod.

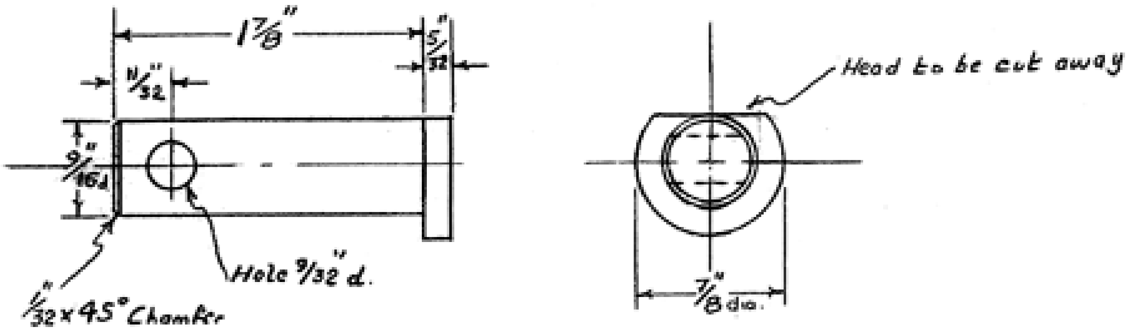


Figure 1 - Clamp Locks: Mild Steel Pin for Securing Out of Use

4. Point Machine

4.1 Secure out of use by rotating the machine by hand crank until the lock dog is fully home. Disconnect and insulate the control wires (if fitted) and remove the control circuit fuses.

5. HPSS

5.1 To secure out of use complete the following:

a) Power operate the points to either the normal or reverse position as required, confirming that the switches have fully completed their travel.

b) Disconnect all fuses and remove power supply.

c) Clip and scotch the points.

d) Check that point covers are secure and locked.

e) If the HPSS is secured out of use temporarily prior to the testing and commissioning process, it is recommended that the set-up procedure detailed in NR/L2/SIG/11400 is repeated prior to handover to testing.

END

1. Background

1.1 Installation of new rail, or where trains have not operated over a line for a period of time, can lead to track circuits not operating correctly due to rust build up on the rail head.

1.2 A layer of rust forms on the railhead which prevents electrical contact being made with the train wheels, until the rust has worn away. This can cause a wrong side failure where track circuits are in operation.

2. Bringing new or out of use rail into use, in a track circuited area

Signalling Tester

2.1 Before newly installed or out of use rail that has a coating of rust on the rail head is brought into use for train running, the Signalling Tester shall notify the Signaller of the extent of the rail being brought into use by either:

a) Providing identification of the track circuit(s) affected.

b) By identifying the signals/points that would be used to route trains over the affected area.

2.2 A clear understanding of the extent of the area affected and the possibility of rusty rails preventing the track circuits showing occupied, shall be reached between the Signalling Tester and the Signaller.

Signaller

2.3 Once notified that a section of rail has been brought into use for train running, the Signaller will apply Rule Book Handbook TS11.

END

1. Inclusions and Exclusions

1.1 This process allows the top-nutting an existing cable terminated on links (one core at a time) to enable a replacement cable to be terminated ready for changeover.

1.2 Cables with any cores terminated on binding posts, Clamp type terminations, Tail cables are excluded from this process.

2. Authority, Planning and Timescale Considerations

2.1 This work shall be classed as Pre-Planned work and shall follow the process described in NR/SMTH/Part01/Module08 - Pre-Planned Work and Non-Corrective Maintenance Testing.

2.2 Authority to renew a cable using this process shall be given by the SM(S).

2.3 Where cable sizes, specification or cable type change, a set of temporary, updated site records shall be issued pending the final issue of updated site records.

2.4 The renewal process in this module is broken into two parts to allow the work to be programmed over two visits.

a) Part 1 - Top-nutting the existing cable.

b) Part 2 - Installation and changeover the new cable.

NOTE: *The maximum time limit between (a) and (b) is 30 days.*

3. Check Sheets

3.1 The following check sheets shall be used to record each stage of the cable renewal process and templates:

a) Status of Existing Cable Check sheet.

b) Cables Terminated on RHS.

c) Cables Terminated on LHS.

d) Top Nutted Cable on RHS.

e) Top Nutted Cable on LHS.

f) Cables Changeover on RHS.

g) Cables Changeover on LHS.

PART 1

4. Top-nutting the existing cable - Preparation

4.1 Carry out and record the following, using the "Existing Cable Status Check Sheet" at both ends of the cable.

a) A WIRE COUNT.

Where an undocumented wire exists on the internal side of the termination, STOP and consult your SM(S). All such anomalies shall be resolved before proceeding.

b) Check that no terminals are used as binding posts (or fitted with red dome nuts, unless associated with temporary strapping).

c) Note any cable cores that are through crimped.

d) Note any terminals with no link fitted.

4.2 Check the identity of the existing cable by tracing or electrically proving.

4.3 Check no intermediate terminations, links or contacts exist between the cable ends to be disconnected.

4.4 Check equipment terminals associated with the existing cable are correctly labelled.

4.5 Check that each cable core is isolated from the supply.

5. Top-Nut the Existing Cable

5.1 Depending on the side of the link which the cable being renewed is connect too, chose one of the following check sheets for each end:

a) Cables Terminated on RHS or

b) Cables Terminated on LHS.

5.2 Establish communication between each end of the cable and ensure that each end understands that work is to be completed on one core at a time.

5.3 Figure 1 shows a single link at one end of the cable, before work begins:

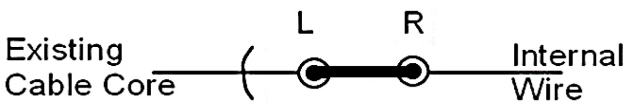


Figure 1 – A Single Link Starting Point

5.4 Remove the link (where appropriate) Figure 2:

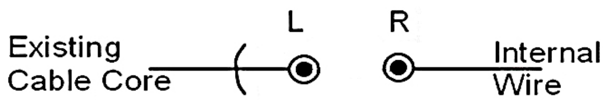


Figure 2 – Link Removed

5.5 Disconnect the Existing cable Figure 3:

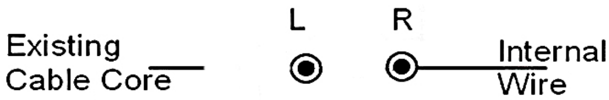


Figure 3 – Existing Cable removed

5.6 Transfer the cable core from the external to the internal side of the termination point. Figure 4:

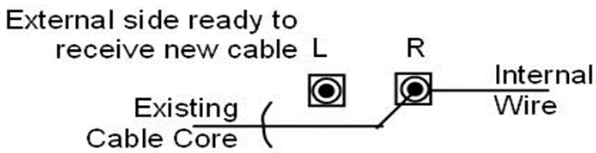


Figure 4 – Existing Cable Transferred

5.7 Fit red dome nuts to terminals.

5.8 Endorse the appropriate column of check sheet and confirm the work is completed at the other end of the cable before proceeding to the next link.

5.9 Where temporary strapping exists (link previously removed), remove and insulate the faulty core.

5.10 A core that has been used for a diversion shall be moved to the internal side together with the temporary strap.

6. After Top-Nutting Completed

6.1 Check top-nutted cable is correctly installed.

6.2 Check top-nutted cable is not susceptible to mechanical damage.

6.3 WIRE COUNT the top-nutted cable and record the results on Check Sheet.

6.4 Confirm red dome nuts are secure and correctly fitted.

6.5 Test all affected circuits for correct operation.

7. Records

7.1 If the cable renewal has involved a change in cable size or type, or removal of jumpers, the site maintenance records shall be endorsed accordingly. Final updated records shall be arranged in accordance with D031 (Site Records).

7.2 The cable database shall be updated to reflect the renewal.

7.3 Both completed “Existing Cable Status” and “Cables Terminated” check sheets shall be returned to the SM(S), unless Part 2 of this process is to be carried out immediately.

PART 2

8. Installation and Changeover the New Cable - Preparation

8.1 Steps 8.2 to 8.4 are not to be carried out if Part 2 of the process follows immediately after Part 1.

8.2 Check identity of the existing cable by physically tracing or electrically proving.

8.3 Check no intermediate terminations, links or contacts exist between the cable ends to be disconnected.

8.4 WIRE COUNT the top-nutted cable at both ends and record the results using the correct “Top Nutted Cable” check sheet.

This shall be correlated with the final “WIRE COUNT” on the previously recorded “Cable Terminated” Check Sheet.

Any issues shall be investigated before proceeding.

8.5 Check the replacement cable is the correct type and is not damaged.

8.6 Check the terminals associated with the existing cable are correctly labelled.

8.7 Install the replacement cable at both ends into the location/Equipment room.

8.8 Check replacement cable is correctly installed and correctly labelled.

8.9 Record the results on the correct “Top Nutted Cable” Check Sheet.

9. Prepare the Replacement Cable

9.1 The “Cable Changeover Check Sheet shall be completed for each core during this test.

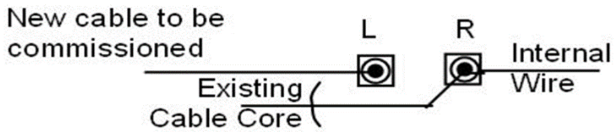


Figure 5 – New Cable Terminated

9.2 Establish communication between each end of the cable.

9.3 Check the replacement cable is correctly installed and correctly labelled.

9.4 CONTINUITY TEST all cores in the replacement cable.

9.5 INSULATION TEST all cores in the replacement cable.

9.6 Check replacement cable has safe insulation.

9.7 Check replacement cable is not susceptible to mechanical damage.

10. Changeover the Replacement Cable

10.1 The changeover shall be completed simultaneously at both ends of the cable, one core at a time.

10.2 The “Cable Changeover Check Sheet shall be completed for each core during this test.

10.3 Remove and insulate existing cable cores/straps and replace the required links using the information previously recorded on the Status of Existing Cable Check Sheet.

11. Commission the Replacement Cable

11.1 WIRE COUNT the replacement cable to the wiring diagram.

11.2 Check any links and red dome nuts are correctly replaced and secure.

11.3 CABLE FUNCTION TEST the affected circuits.

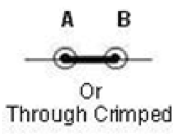
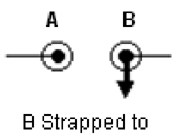
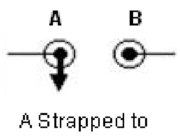
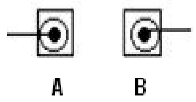
11.4 Check that updated (temporary) record copy diagrams are left on site.

11.5 Completed check sheets shall be returned to your SM(S).

END

Signal Box:		**Cable Identification:**	
Location/Equipment Room From:		**Location/Equipment Room To:**	
Name:		**Date:**	
Signature:		**Company:**	
Comments:			

Status of Existing Cable

Cable Core No.	Wire Count			Red Dome Nuts	No Link Fitted
	Either	Or	Or		
					
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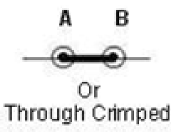
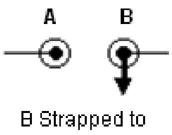
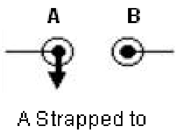
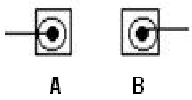
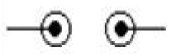
Status of Existing Cable					
Cable Core No.	Wire Count			Red Dome Nuts	No Link Fitted
	Either	Or	Or		
					
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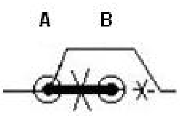
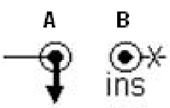
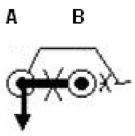
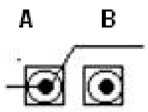
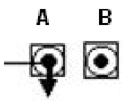
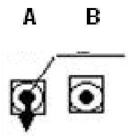
Signal Box:		**Cable Identification:**	
Location/Equipment Room From:		**Location/Equipment Room To:**	
Name:		**Date:**	
Signature:		**Company:**	
Comments:			

Top Nut a Cable From Right Hand Side to Left Hand Side (B-A)						
Cable Core No.	Top Nutting Process			Final Wire Count		
	Normal Situation	Faulty Core	Diverted Core	Either	Or	Or
						
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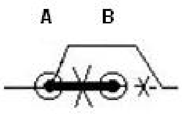
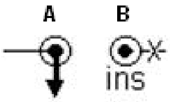
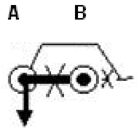
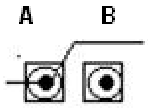
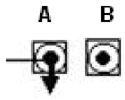
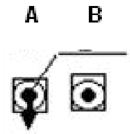
NR/L3/SIG/10064 General Instructions to Staff Working on S&T Equipment		
NR/GI/G003		
Cables Terminated on Right Hand Side - Check Sheet		
Issue No: 01	Issue Date: 04/09/2021	Compliance Date: 04/12/2021

Top Nut a Cable From Right Hand Side to Left Hand Side (B-A)						
Cable Core No.	Top Nutting Process			Final Wire Count		
	Normal Situation	Faulty Core	Diverted Core	Either	Or	Or
						
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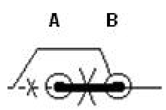
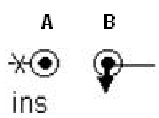
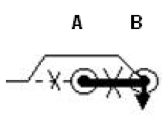
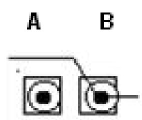
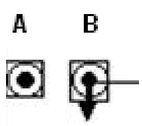
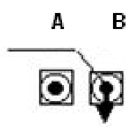
END

NR/L3/SIG/10064 General Instructions to Staff Working on S&T Equipment		
NR/GI/G004		
Cable Terminated on Left Hand Side - Check Sheet		
Issue No: 01	Issue Date: 04/09/2021	Compliance Date: 04/12/2021

Signal Box:		**Cable Identification:**	
Location/Equipment Room From:		**Location/Equipment Room To:**	
Name:		**Date:**	
Signature:		**Company:**	
Comments:			

Top Nut a Cable From Left Hand Side to Right Hand Side (A-B)						
Cable Core No.	Top Nutting Process			Final Wire Count		
	Normal Situation	Faulty Core	Diverted Core	Either	Or	Or
						
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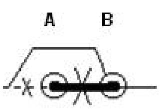
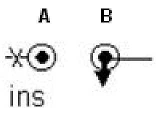
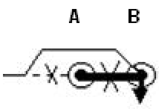
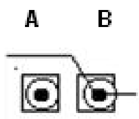
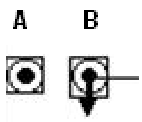
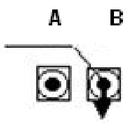
Top Nut a Cable From Left Hand Side to Right Hand Side (A-B)

Cable Core No.	Top Nutting Process			Final Wire Count		
	Normal Situation	Faulty Core	Diverted Core	Either	Or	Or
						
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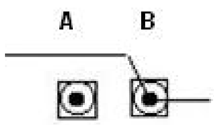
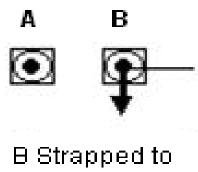
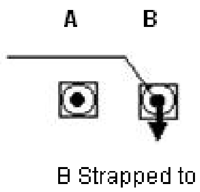
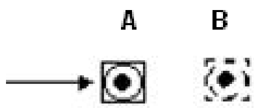
END

Signal Box:		**Cable Identification:**	
Location/Equipment Room From:		**Location/Equipment Room To:**	
Name:		**Date:**	
Signature:		**Company:**	
Comments:			

Original / Existing Cable Top-Nutted on Right Hand side (B)				
Cable Core No.	Check and Wire Count			Cable Run and Insulation Tested
	Either	Or	Or	
				
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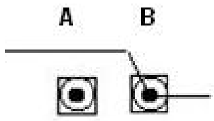
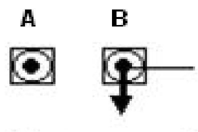
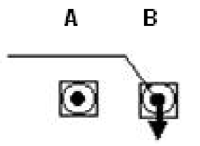
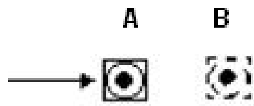
Original / Existing Cable Top-Nutted on Right Hand side (B)

Cable Core No.	Check and Wire Count			Cable Run and Insulation Tested
	Either	Or	Or	
		 B Strapped to	 B Strapped to	
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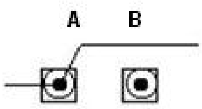
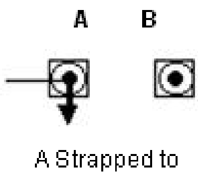
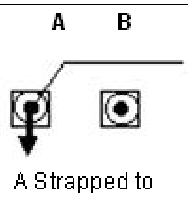
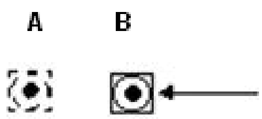
END

NR/L3/SIG/10064 General Instructions to Staff Working on S&T Equipment		
NR/GI/G006		
Top-Nutted Cable on Left Hand Side - Check Sheet		
Issue No: 01	Issue Date: 04/09/2021	Compliance Date: 04/12/2021

Signal Box:		**Cable Identification:**	
Location/Equipment Room From:		**Location/Equipment Room To:**	
Name:		**Date:**	
Signature:		**Company:**	
Comments:			

Original / Existing Cable Top-Nutted on Left Hand Side (A)				
Cable Core No.	Check and Wire Count			Cable Run and Insulation Tested
	Either	Or	Or	
				
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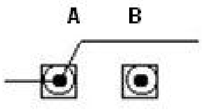
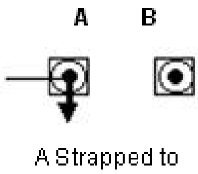
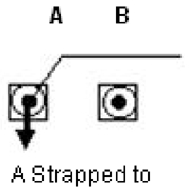
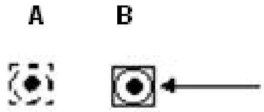
Original / Existing Cable Top-Nutted on Left Hand Side (A)				
Cable Core No.	Check and Wire Count			Cable Run and Insulation Tested
	Either	Or	Or	
				
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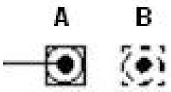
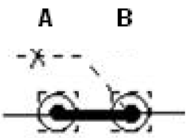
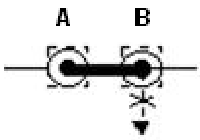
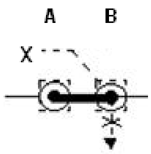
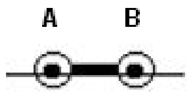
END

NR/L3/SIG/10064 General Instructions to Staff Working on S&T Equipment		
NR/GI/G007		
Cable on Right Hand Side Changeover - Check Sheet		
Issue No: 01	Issue Date: 04/09/2021	Compliance Date: 04/12/2021

Signal Box:		**Cable Identification:**	
Location/Equipment Room From:		**Location/Equipment Room To:**	
Name:		**Date:**	
Signature:		**Company:**	
Comments:			

Original / Existing Cable Top Nutted on Right Hand Side (B)					
Cable Core No.	Cable Terminated & Insulation Tested	Cable Core Changeover			Cable Complete
		Either	Or	Or	
					
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	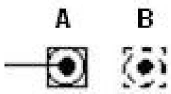	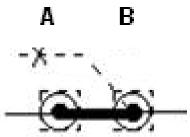	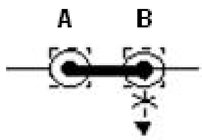	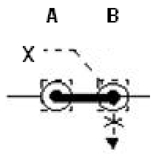	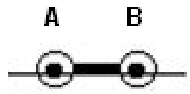
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END

NR/L3/SIG/10064 General Instructions to Staff Working on S&T Equipment		
NR/GI/G008		
Cable on Left Hand Side Changeover - Check Sheet		
Issue No: 01	Issue Date: 04/09/2021	Compliance Date: 04/12/2021

Signal Box:		**Cable Identification:**	
Location/Equipment Room From:		**Location/Equipment Room To:**	
Name:		**Date:**	
Signature:		**Company:**	
Comments:			

Original / Existing Cable Top Nutted on Left Hand Side (A)					
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	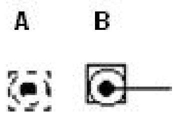	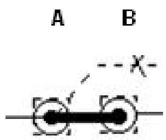	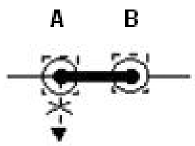	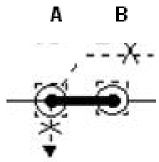	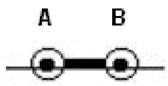
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	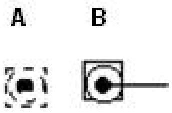	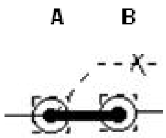	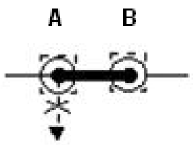	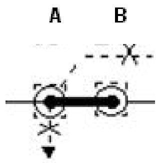	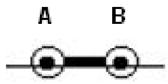
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1. Preparation for Winter

1.1 Mechanical Adjustments

Signal wires which can be regulated under the signal box should be examined to confirm that they are in correct adjustment for winter use, Signal wires and cross rods should be kept clear of ballast which can freeze.

1.2 Anti-frost Lubricants

To reduce the effects of freezing temperatures on the correct operation of point equipment, an anti-frost lubricant, similar to grease, such as “Kilfrost”, should be applied to all external parts of mechanical fittings, detector slides, FPL slides, pulley wheels, points, and cranks, etc.

The lubricant can be applied by brush or grease gun as required. To assist penetration of some mechanisms, oil may be mixed with the grease to reduce its viscosity. The anti-frost lubricant should be applied in autumn. Repeat applications might be necessary during the winter months according to the operational environment, severity of the prevailing conditions and dilution.

The anti-frost lubricant can also be used to lubricate other equipment / components associated with mechanical signals, such as cranks and signal arm spindles. It is not recommended for use on the internal components of point machines or level crossing barrier equipment which require a lighter grade of lubricant.

Petroleum jelly should be used on contact surfaces on outside equipment, such as detectors, point machines, etc. It should not be allowed to come into contact with wire insulation.

Anti-frost agents used by the track engineer might affect the correct functioning of track circuits and other signalling equipment.

1.3 Terminals

All equipment terminals and terminal blocks in lineside apparatus cases and ground equipment (but not in heated equipment rooms) should be cleaned and then protected against corrosion, by application of an approved protecting agent (see with a soft non-conductive brush. Protection should not be applied to lever locks and controllers, nor to any contact faces.

NOTE: *If using volatile cleaning solvents, protective gloves and eye protection should be worn and the work carried out in a well-ventilated area. No smoking is permitted, and staff should be familiar with the content of Safety Data Sheet/s.*

1.4 Heaters

All heaters in ground equipment and apparatus cases should be operative from early October to the end of the winter period, usually the end of April.

1.5 Gaskets

Gaskets of point machines, electrical detectors and other ground equipment should be checked that they effectively sealed. All worn and damaged gaskets should be replaced immediately to prevent water penetration that might cause a problem, particularly if it freezes.

1.6 Drainage

Where drain holes are provided at the bottom of point machines, electrical detectors, impedance bonds and other ground equipment, they should be frequently inspected and kept clear during the winter months.

1.7 Signalling Cable

Suitable quantities of cable should be in stock for use in cases of emergency.

1.8 Electro-Pneumatic Installations

Air main pipe runs, and reservoirs should be drained regularly. If an undue amount of water is drained from the system, the SM(S) should be advised.

1.9 Signal Post Telephones

Check the telephone seal is effective and the door remains closed if not the telephone should be replaced.

1.10 Stand-By Supplies

Where stand-by supplies are provided a check should be carried out at regular intervals to confirm that they are in good working order should they be required.

1.11 Motor Transport

Vehicles should be prepared for winter conditions in accordance with the Drivers Handbook.

2. Preparation for Summer

2.1 Mechanical Adjustments

Signal wires, points, rodding should be regulated/adjusted during the spring, before summer temperatures set in during hot weather.

2.2 Heaters

During the summer (typically April to September) apparatus case heating should be switched off (heat is the main cause of cable degradation).

2.3 Foliage

Lineside foliage should be kept under control to allow visibility of the lineside signs and signals. Where visibility of signs and/or signals is obstructed by lineside foliage, the SM(S) should be informed so that corrective action can be arranged.

Roadside foliage at level crossings should be monitored to allow visibility of the crossing.

3. Preparation for Autumn

3.1 Seasonal TCAIDs should be prepared and batteries renewed, as described in NR/SMS/PartC/TC91 (Track Circuit Assister Interference Detector (TCAID) before the start of leaf fall season.

4. Hour Changes

4.1 Level crossing timer clocks should be reset during the spring and autumn to correspond with the British Standard Time or Greenwich Mean Time adjustment made at the beginning and end of the summer months. Preferably the adjustment should be carried out on the night of the time change so that the crossing continues to comply with the Level Crossing Order. Where this is not practicable, due to the number of crossings to be attended, every effort should be made to complete the time change within one week (either side) of the national time adjustment.

END

1. Dorman Signal Head Types

1.1 There are 3 signal head types manufactured by Dorman that are covered by this module:

a) Classic.

b) CLS LITE.

c) iLS (integrated Lightweight Signal).

2. Signal and Structure Compatibility

2.1 The information in this module defines the 'best-practice' alignment process for the different combinations of Dorman signal heads fitted to generic structure types.

2.2 Staff are reminded that when aligning a signal, they should be competent to undertake the task and be familiar with the equipment.

2.3 Staff should always refer to the relevant operation and maintenance (O&M) manual, which are regularly reviewed and updated by Signal manufacturers to assure they are complete and definitive.

2.4 The beam of any signal should always be aligned to a position defined on the approved Signal Sighting Assessment Form (SSAF).

This is achieved by viewing a target through the sighting device and adjusting as necessary.

2.5 In the unique case of the Dorman iLS or CLS LITE fitted to an Assisted Lift Trunnion (ALT), the sighting scope is fixed to the post 1200mm above the baseplate and the view through it should be aimed at the ground at the specified distance, shown on the SSAF. This has been designed to achieve the same beam alignment and is set during the manufacturing process.

3. Dorman Classic

3.1 The Classic signal head can be identified from within the housing by the sighting scope moulded into the RYG module, see Figure 1.

3.2 The signal should be aligned by viewing through this device to a target positioned at the distance and height specified in the approved SSAF. Adjustment is performed at the signal head.

Figure 1 – Dorman Classic

3.3 The sighting tool lens cap can be cleaned by releasing and tilting the module back slightly to access the front of it.

3.4 If the view is cloudy or there are signs of condensation within the sighting tool the cap can be temporarily removed and cleaned internally.

3.5 If the view has permanently deteriorated the whole module should be replaced.

4. Dorman CLS LITE (not fitted to ALT)

4.1 The CLS LITE signal head can be identified from within the housing by the smaller and lighter modules, prominent cooling fins and plug couplers.

4.2 A sighting device is not supplied in the head and is temporarily fitted to the upper right inside corner if the door is hinged on the left, and vice-versa.

NOTE: *that the plastic module spacer needs to be removed in order for the scope to fit properly and is to be refitted, see Figure 2.*

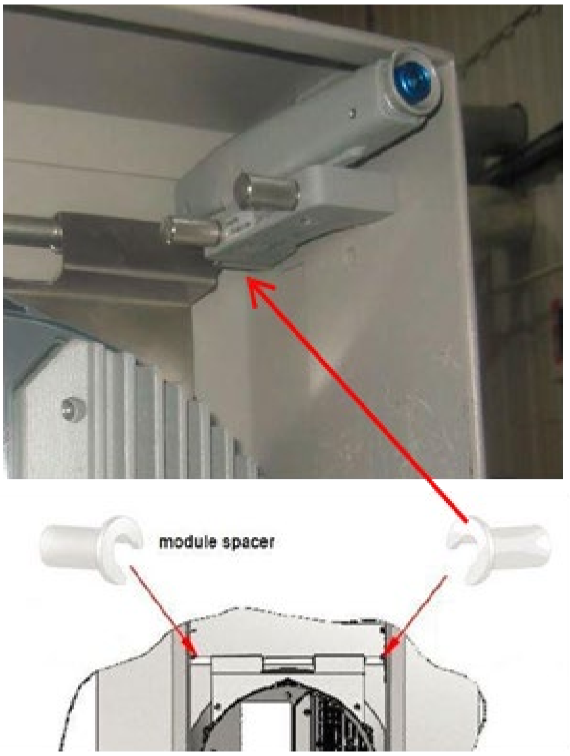


Figure 2 – CLS LITE

4.3 The signal is aligned by viewing through this device to a target positioned at the distance and height specified in the approved SSAF. Any adjustments are performed at the signal head.

<u>Viewing a Target</u>

4.4 The image in Figure 3 shows the view to expect through the alignment device when a Dorman Classic or CLS LITE is aligned correctly.

NOTE: *The target disc (set at the height and distance specified on the SSAF) is within the upper third of the inner circle.*

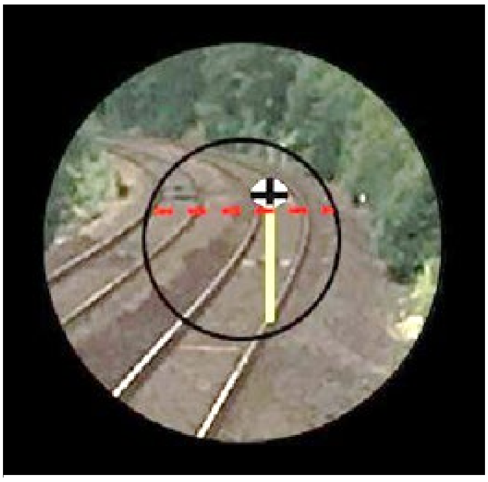


Figure 3 – Beam alignment

4.5 This results in the respective signals being aligned to different points within the conical beam.

4.6 Aligning the beam outside of this sector might increase the risk of a phantom aspect being created by reflected light from another source, e.g. sunlight.

This compromise has been established by scientific analysis following a number of incidents where signals have shown the effects of phantom aspects.

Signals most at risk

4.7 Signals facing East (at sunrise) or West (at sunset) are most vulnerable to phantom aspects, especially those on falling gradients. The axis of the beam (indicated by the centre of the marked circle) should be on or below the horizon.

If the axis of the beam is above the horizon the signal should be dipped so that the target appears on the top edge of the marked circle.

5. Dorman iLS and CLS LITE fitted to ALT

5.1 The iLS signal head can be identified by the head and associated indicators integrated in a single housing.

5.2 The ALT is a post mounted directly to a trunnion which is hinged at the base. The approved sighting tool should be temporarily fitted for the purposes of alignment to the mounting holes on the side of post, 1200mm above the baseplate. See the green arrow in Figure 4.

5.3 The signal should be aligned by viewing through this device to a position on the ground at the distance specified in the approved SSAF, not to a target.

5.4 The correct beam alignment is achieved by this method because the height of the signal and beam angle is taken into account during the manufacturing process.

5.5 Any vertical and horizontal adjustment is performed at the 4 signal base studs ringed in Figure 5.

Figure 4 – Sighting. Mounting Point

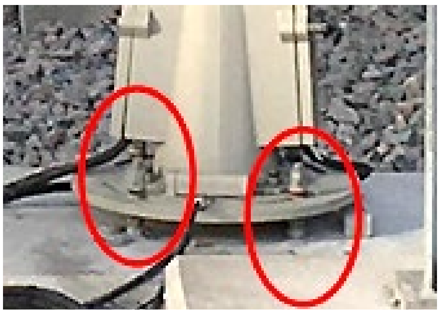


Figure 5 – Adjustment Studs

Viewing to the ground (iLS and CLS LITE fitted to ALT only)

5.6 Figure 4 shows the view to expect through the alignment device when a Dorman iLS or CLS LITE fitted to ALT is aligned correctly.

5.7 The centre of the inner circle should be aimed at a point on the track at the distance specified on the SSAF.

5.8 Aligning the beam outside of this sector might increase the risk of a phantom aspect being created by reflected light from another source, e.g. sunlight.

Figure 6 – Beam Alignment

NOTE: *Speed boards and lineside vegetation, especially on curves, should be kept clear of the line of sight of the alignment device.*

6. Remote Viewing Device

6.1 Two Product-Accepted brackets are available from Unipart Dorman that attach to the fixed (Classic) and removable (CLSlite) alignment devices. They have been designed so that an action camera (to be obtained separately) can be attached using a tripod mounting adapter.

6.2 The action camera image can then be viewed remotely on a mobile phone using the App, as detailed in the manufacturer's operating instructions.

7. Dorman Classic Bracket

7.1 The bracket for the Classic scope can be attached without any modification to the modules. See Figure 7.

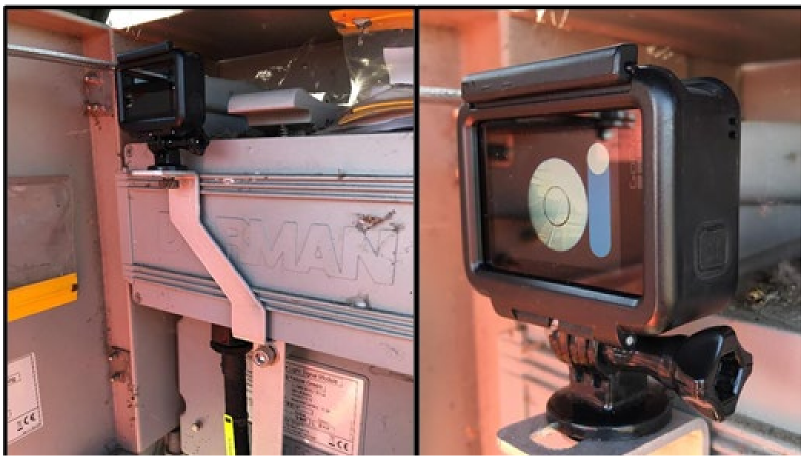


Figure 7 – Dorman Classic Bracket

8. Dorman CLS lite Bracket

8.1 This bracket requires a modification to the CLS lite removable alignment device. It should be returned to Unipart Dorman for calibration and for mounting holes to be drilled to accept the bracket, or a new bracket purchased, which has the holes pre-drilled.

Figure 8 - Dorman CLS lite Bracket

9. Alignment of Other Indicators

9.1 Indicators such as Position Light Junction Indicators, Stencil Indicators, Banner Repeating Signals and Preliminary Route Indicators should also be aligned in accordance with the requirements noted on the SSAF.

9.2 Stencil Indicators, Banner Repeaters and Preliminary Route Indicators have a tube on the top of the indicator through which the target should be visible when correct alignment is achieved.

9.3 An alignment device might not be provided on indicators, such as a Position Light Junction Indicator, where the beams of the lamps are broader.

9.4 Dorman LED Position Light Junction Indicators have also shown effects of phantom aspects.

If reference to the alignment point for the indicator is NOT made on the SSAF, then it should be broadly aligned to the same point as the main aspect. Use engineering judgement to confirm it is angled horizontally and vertically similar to that of the main signal head.

10. Reference Table

10.1 Table 1 is a quick reference guide to help identify the correct alignment method for head and mounting combination.

Head Type	Description	Collis spring-assisted fold down post	Non-accessible structure e.g., crown post, mid- platform bracket etc	Accessible conventional structure e.g., gantry or post with ladder	Dorman Assisted Lift Trunnion with integrated spring-assisted fold down post
Dorman Classic	Multi-aspect LED signal head, adjustable mounting plate, fixed sighting tool in head	Align to target using fitted sighting tool via either a suitable access platform or remote viewing device	Align to target using fitted sighting tool via either a suitable access platform or remote viewing device	Align to target using the sighting tool fitted to the module	N/A
Dorman CLS lite not fitted to ALT	Multi-aspect LED signal head, adjustable mounting plate, removeable sighting tool in the head	Align to target using a modified removeable sighting tool via either a suitable access platform or remote viewing device	Align to target using a modified removeable sighting tool via either a suitable access platform or remote viewing device	Align to target using removeable sighting tool	N/A
Dorman iLS or CLS LITE fitted to ALT	Multi-aspect LED signal head mounted on an integrated post and hinged trunnion, removeable sighting tool fitted on the post, 1200mm above the baseplate	N/A	N/A	N/A	Align to the ground using removeable sighting tool fitted to post

Table 1 – Alignment Reference Table

END

1. Painting Frequencies

1.1 Signal structures and trackside apparatus cases due to their exposed locations are the items that require re-painting most often. A guide to the frequency of re-painting is as follows:

a) Items in coastal areas, every two years.

b) Items in industrial areas, every five years.

c) Items in other areas, every ten years.

2. Paint Application

2.1 NR/L3/CIV/039 and NR/GN/CIV/002 give detailed instructions on surface preparation and application, the basic rules are as follows:

a) Surfaces to which the paint are be applied should be sound and free of rust, old paint which is flaking or other contaminates (e.g. oil or grease). Surfaces can be rubbed down with wire wool or glass paper, contaminates can be removed by a de-greasing cleaner.

b) Bare metal (or wood) should first be primed, and then an undercoat applied before the topcoat is applied.

NOTE: *Before any painting work is undertaken, hazard instructions supplied with the paint and other applicable materials should be first read and understood. In case of doubt, the SM(S) should be consulted before proceeding. The correct PPE should be worn when painting (e.g. gloves, face mask).*

2.2 Paint that has been applied before 1970 might contain high amount of lead and other materials that could be hazardous to heath. If there is doubt about any old paint, SM(S) should be consulted before removing it.

3. Colours

3.1 Equipment should be painted to Network Rail's requirements. Where colours are not specified, equipment should be painted to a scheme consistent with the existing equipment. Preferred topcoat colours are listed in Section 4.

3.2 Some former BR regions might have had different colours for certain types of older equipment; in this case, both options are shown. If there is any doubt as to the correct colour, the SM(S) should be consulted.

4. Maintenance Painting – Top Coat Colours

Mechanical Signal Boxes	
Levers	NR/SMS/PartC/LV00 applies
Quadrants	Black finishing paint
Gate Wheels	Black finishing paint
	Brown finishing paint
Single Line Tokens Configuration Code A	Red finishing paint
Single Line Tokens Configuration Code B	Blue finishing paint
Single Line Tokens Configuration Code C	Green finishing paint
Single Line Tokens Configuration Code D	Yellow finishing paint
Locking frame ironwork	Silver or grey
Locks and controller cover's	

Signal Structures	
Post	Silver or Grey and Black OR
	Silver or Grey and White (semaphore signals)
Brackets and Gantries	Black (see section below)
Handrails etc	Silver or GreyOR
	Black
Fixtures and Fittings	Black
Number Plate Backgrounds	

Signals	
CLS Heads: Front	Matt Black (see section below)
CLS Heads: Rear	Silver or Grey (see section below)
Semaphore Arms (wood)	RIS-0758-CCS
Semaphore Arms (enamel)	Do Not Paint

Trackside and Track-Mounted Equipment	
Ramps or Cover Plates	Silver or Grey
Point Machine Covers	

Trackside Apparatus Cases and Disconnection Boxes	
Steel or Wood	Silver or Grey OR
	Silver

Level Crossing Mechanical Gates	
Gate Columns	Black
Gates, Fittings and Fencing	White finishing paint
Enamel Target Boards	Do not paint

Level Crossing Lifting Barriers	
Barrier Cages and Units	Grey finishing paint
Barrier Booms, Edge Facing Road (all types)	Alternate Red and White Vertical Bands 61cm (24”) in length, Red tip
Barrier Booms, Edge Facing Track (all types)	White
Barrier Skirting (all types, both sides)	Red and White to Follow Bands on Boom OR
	White

Level Crossing Road Lights	
Road Lights, Hoods and Backboards (front & Rear)	Matt Black
Road Light Posts and Caps	Grey finishing paint

NOTE: *Reflective and Retro-Reflective boarders are NOT to be painted.*

5. Painting of Colour Light Signals

5.1 A colour light signal head, including allied route and junction indicators and subsidiary position light signals, shall have the front surfaces (as seen by approaching drivers on the line to which the signal applies) painted matt black.

5.2 The remainder of the signal head and structure shall be silver or grey, as shown in Figure 1.

5.3 Other parts of the signal:

a) Silver or grey - signal posts, vertical supports of brackets and gantries, ladders, rear of number plates.

b) Blue - the surround or back board of a SPAD indicator.

c) Matt black - remainder of brackets and gantries, railings, safety hoops, signal bases, signal hoods.

5.4 Position light ground signals and any other form of signal (such as driver’s crossing indicators and points indicators, etc.) shall be treated in a similar fashion.

5.5 Newly galvanised surfaces are a satisfactory silver/grey colour and should not be painted unless necessary for other reasons, and only then after the surface has been suitably weathered or specially treated to allow adhesion of the paint coatings.

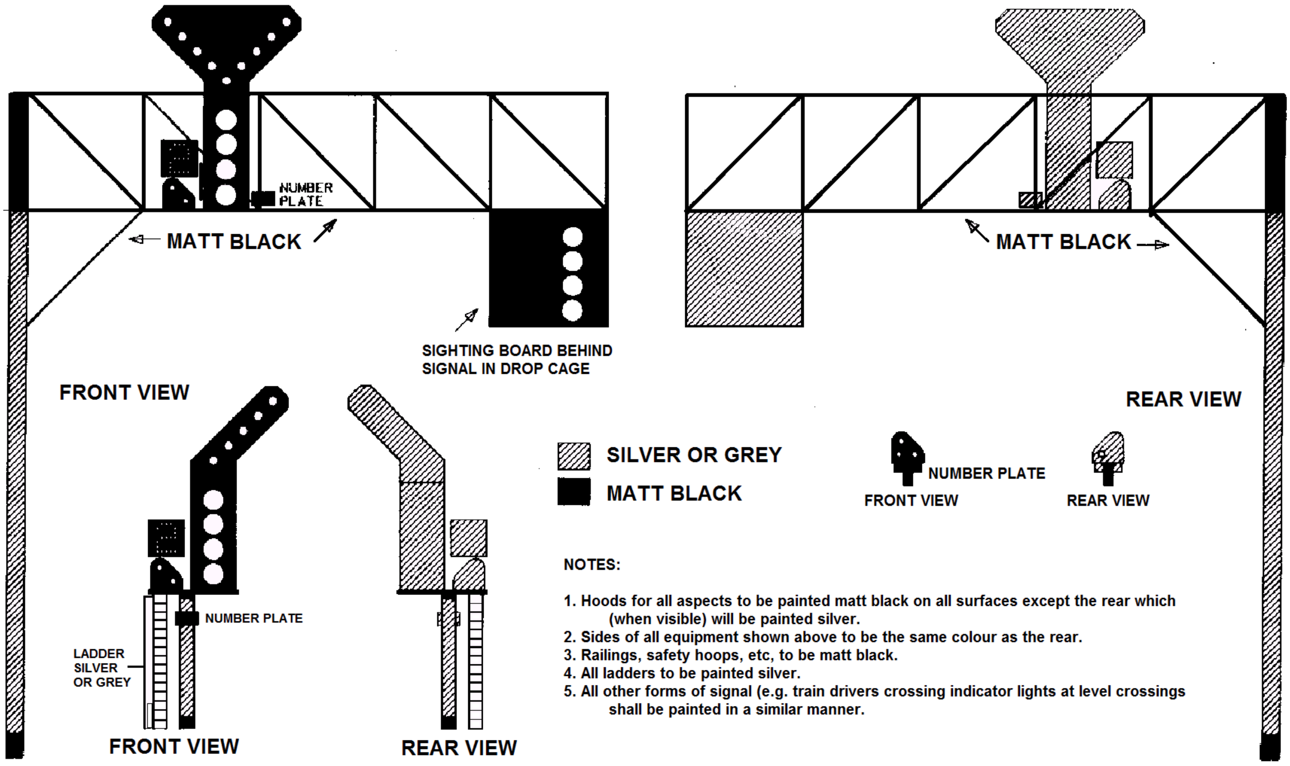


Figure 1 – Typical surface colours of signal heads and structures

END

1. General

1.1 This module covers equipment within buildings and location cases.

2. Label Colour

2.1 Equipment at less than 175V - white with black lettering.

2.2 Equipment at 175V or more - white with red lettering.

2.3 All internal equipment and terminations carrying 175V or higher should be labelled with a “Caution, risk of electric shock” 25mm safety sign, as described in Module P015.

2.4 A legend should be added, stating the maximum voltage present if exceeding 250V.

3. Label Material

3.1 Mechanically punched (“Dymo” type) labels are not be used.

4. Lettering Size

4.1 This should be chosen to suit the label size and position, to make the label easily legible. The overriding requirement is legibility.

5. Label Position

5.1 Where possible, a label should be fixed to the racking closely adjacent to the equipment to which it refers. Labels can be fixed directly to equipment only if it rarely changes.

5.2 If possible, position the labels to be obvious to a person of average height.

5.3 Labels should be placed on the front and back of equipment where this assists installation, testing or maintenance.

5.4 In new installations, fix the front and back labels for plug-in relays below the relay to which they refer. The preferred method is to mount the labels on 25mm x 25mm plastic angle strip fixed to the betaduct with plastic headed bolts and dome headed nuts. In existing installations, follow the previous labelling arrangement to avoid a confusing mixture of standards.

5.5 Labels for double relays (two relays in one case), should be made up or fixed so that the two relay names are one below the other. The upper name should be the left-hand relay as viewed when reading the label.

5.6 If equipment carrying a label does have to be changed, make sure that the label is also changed or a new one fitted. Remove all redundant or superseded labels.

6. Fixing the Labels

6.1 Provided the surface is clean and free from grease, the pressure sensitive adhesive on the labels prepared by the approved electronic system will satisfactorily adhere to most smooth surfaces including stainless steel. If the surface is insufficiently smooth or large, a rigid white self-adhesive backing label is available, and this can be secured to the equipment or racking first, and the descriptive label then attached to the white one.

6.2 In exceptional cases, non-standard labels may be required to suit special equipment or match an existing arrangement. Choose a method of fixing to suit the type of label and the surface to which it is to be fixed. Examples are:

a) A high-quality permanent adhesive (e.g. Araldite).

b) A good quality double sided adhesive tape.

c) Bolts, nuts or “pop” rivets - where suitable fixing brackets and holes are provided.

6.3 If adhesives are used, make sure the surfaces are clean and grease free before applying the label. Where adhesion is difficult, for example on some stainless steel or aluminium, special rails or supports for the labels might be needed.

6.4 Pressure sensitive adhesives are not suitable for surfaces that become warm. Check with the manufacturer’s instructions before using in these situations.

6.5 Adhesives are only effective if used on firm surfaces. Do not stick labels to flaking paint.

6.6 Certain types of equipment might have their own in-built labelling system where special types or positions of label are necessary, follow the in-built system.

END

1. Introduction

1.1 Safety signs are there for information and protection. They are never to be altered or removed without the authority of the SM(S).

2. Regulations

2.1 The Health and Safety (Safety Signs and Signals) Regulations 1996 require employers to provide specific safety signs whenever there is a risk that has not been avoided or controlled by other means, e.g. engineering controls and safe systems of work. Where a safety sign would not help to reduce that risk, or where the risk is not significant, there is no need to provide a sign.

Safety signs are not a substitute for those other methods of controlling risks, such as engineering controls and safe systems of work.

2.2 The Regulations apply to all workplaces and to all activities where people are employed. The Regulations also require, where necessary, the use of road traffic signs in workplaces to regulate road traffic.

3. Fitting of Signs

3.1 Signs conforming with the Regulations are to be provided as shown on the engineering diagrams supplied for the work.

3.2 All signs should be of the self-adhesive type (sizes 25mm, 100mm or 150mm), with the exception of the larger workshop signs (300mm or 600mm) which can be of plastic laminate construction.

3.3 When applying self-adhesive signs, the surface is to be dry, smooth, and free from oil, grease, corrosion or dry powdery deposits. The surface should be abraded to a smooth finish and cleaned using a cleaning pad, or abrasive powder, and a detergent solution. The surface should then be wiped dry with a clean cloth. The sign should be applied at a temperature above 10^{o}C by removing the backing paper, positioning carefully and then, from the centre working outwards, pressing down.

3.4 External safety signs for apparatus cases are to be fitted on the normal approach side door.

3.5 The maintenance of safety signs is to be undertaken during normal maintenance routines.

END

Includes:	EBI Track 200
Excludes:	All other types of equipment that requires calibration

1. General

1.1 This module defines the required calibration thresholds/counts for assets that are to be migrated to the RCM2 method of maintenance. The thresholds defined within this module are also to be used to specify the baseline condition for any asset.

1.2 It applies only to assets that have been migrated across to the EBI Track 200 RCM2 method of remote maintenance.

2. Calibration

EBI Track 200 – Intelligent Infrastructure

2.1 The shunting characteristics are set in respect to the 'Threshold Current' (ITHR) set during the commissioning of the Digital Rx or if changed during maintenance visits.

3. Track Circuit Current Levels

Track Occ Level (ITHR)

3.1 This value is automatically pulled from the datalogger, which corresponds to the ITHR values set on the Digital Rx. The ITHR value is the point at which the Digital Rx becomes occupied and clear, so effectively the drop away and pick up current of the track circuit.

3.2 A track current that drops below ITHR becomes occupied, whilst a track circuit current above ITHR remains clear.

NOTE: *A track current at ITHR maybe at either an occupied or clear state.*

High Occ Level

3.3 In normal operation, the track current at the Digital Rx is 0mA when the track is occupied. This band is to give pre-warning of potential WSF conditions, typically during leaf fall or on known railhead contaminated areas (i.e. low usage lines / sidings etc).

3.4 This level shall be set to 50% of ITHR to prevent spurious Alarms during the transition between clear and occupied states.

Track Clear Level

3.5 The track clear level shall be set to 1mA higher than the value of ITHR, (for example if ITHR is 40mA then the track clear level shall be set to 41mA).

Excess Current Level

3.6 This level shall be set to Alarm if the current in the track circuit goes too high and there is a danger that the presence of a train on the track circuit might not divert enough current away from the digital rx to allow it to drop.

3.7 The Excess Current Level shall never be set to greater than 350% of ITHR for normal power and 275% for low power.

3.8 Where Practical, the Excess Current Level should be set as per Tables 1 and 2.

Range at set-up to permit this Alarm Setting (ITHR / INOW)	Alarm Setting for Excess Current (× ITHR)	
> 63.5%	Out of expected Range	
59.5% to 63.5%	1.95	16.0% to 23.8%
55.5% to 59.4%	2.10	16.6% to 24.7%
50.1% to 55.4%	2.25	12.7% to 24.7%
45.5% to 50.0%	2.50	13.8% to 25.0%
41.7% to 45.4%	2.75	14.7% to 24.9%
38.5% to 41.6%	3.00	15.5% to 24.8%
35.8% to 38.4%	3.25	16.4% to 24.8%
33.0% to 35.7%	3.50	15.5% to 25.0%
< 33.0%	Out of expected Range	

Table 1 - (Normal Power) *Permissible setting for Excess Current Levels based upon set-up conditions (1.0Ω shunt).*

Range at set-up to permit this Alarm Setting (ITHR / INOW)	Alarm Setting for Excess Current (× ITHR)	
> 71.2%	Out of expected Range	
67.4% to 71.2%	1.70	14.6% to 21.0%
61.3% to 67.3%	1.85	13.4% to 24.5%
56.9% to 61.2%	2.00	13.8% to 22.4%
52.2% to 56.8%	2.20	14.8% to 25.0%
48.1% to 52.1%	2.40	15.4% to 25.0%
44.1% to 48.0%	2.60	14.7% to 24.8%
41.8% to 44.0%	2.75	14.6% to 21.0%
< 41.8%	Out of expected Range	

Table 2 - (Low Power) *Permissible setting for Excess Current Levels based upon set-up conditions (1.5Ω shunt).*

Out of Range	Investigate TC, remedy any faults and repeat set-up. If TC set-up remains out of range consult Alstom with details for further analysis.
Marginal	Check TC, drop-shunt and repeat set-up if necessary, before changing alarm setting. Then continue to monitor TC as per normal process.
Typical	Permissible, change alarm setting, then continue to monitor TC as per normal process.

Table 3 – Key to Tables 1 and 2

Low Clear Level

3.9 The Low Clear Level shall be set to no lower than 130% of ITHR.

3.10 Setting this level too high results in false Alarms if the track circuit current falls during wet weather. Setting the level too low (too close to the Track Occ Level) increases the risk that Alarms are not generated until the track circuit is very close to failing right side.

4. Setting the Times

4.1 There are a number of time "Deadbands" to be set. These allow the monitoring system to differentiate between events that are normal (i.e. the passage of a train) and those that, due to the time they last, are not.

Low Clear Level (Deadband)

4.2 This is the time after which an event is generated if the track clear current is low.

4.3 Setting this too short risks false Alarms, due to the current value passing through this band as it is going from clear to occupied or vice versa.

4.4 This time shall be set to 20 seconds; This is acceptable for most track circuits

High Occupied Level (Deadband)

4.5 This is the time after which an event is generated if the current (when the track circuit is occupied) rises above the High Occ Level.

4.6 Setting this too short risks false Alarms, due to the current value passing through this band as it is going from occupied to clear or vice versa. Setting the time too long risks missing a Poor Shunt event.

4.7 This time shall be set to 5 seconds. This is acceptable for most track circuits.

4.8 This time might be increased (with SM(S) authority) to >5 seconds where the track circuit has a centre-fed arrangement and the passage of a train over these sections can be slow (for example, due to being on the approach to a junction or station).

NOTE: *This value has additionally been derived with a High Occ Level value set at 50% of ITHR. If any other value is used for this threshold, this Deadband time needs to be changed.*

Excess Current (Deadband)

4.9 The purpose of this Deadband is to prevent an Alarm being generated during the transition from clear to occupied (or vice versa) where the track current level might briefly spike as the train enters/leaves the tuned zone.

4.10 This time shall be set to 5 seconds; This is acceptable for most track circuits.

Clear-Occupied-Clear Flick Range (Lower Limit)

4.11 This time shall be set to 0.3 seconds to prevent an Alarm count during the initial occupation of the track circuit where the current might briefly occupy then clear.

Clear-Occupied-Clear Flick Range (Upper Limit)

4.12 If a track circuit is occupied for less than the time set in this value, a track flick event is generated. The value shall be set to less than the time for which the shortest, fastest train occupies the track circuit. Any occupation shorter than this is should be treated as a genuine fault.

Occupied-Clear-Occupied Flick Range (Lower Limit)

4.13 This time shall be set to 0.3 seconds to prevent an Alarm count during the initial occupation of the track circuit where the current might briefly occupy then clear.

Occupied-Clear-Occupied Flick Range (Upper Limit)

4.14 If a track circuit is clear for less than the time set in this value, a track Flick event is generated. The value should be set to less than the minimum time between trains. Any clearance shorter than this should be treated as a genuine fault.

4.15 This time shall be set to 20 seconds; This is acceptable for most track circuits.

4.16 This time might need to be reduced for track circuits near busy junctions where the time between trains is <20 seconds.

5. Setting the Counters

5.1 Each time an event (such as a track Flick or a Poor Shunt) is detected, it increments a counter. When the counter reaches a set value, an Alert is generated, and when further increments take it over a second threshold, an Alarm is generated.

5.2 The counters reset at approximately 05:00 each morning to clear the previous day's events. For perfectly behaving track circuits, the Alert and Alarm thresholds can be low, but they might need to be increased (with SM(S) authority), where the track circuit displays a background level of events every day. Any issues that require the Alert/Alarm thresholds to be increased should be recorded locally for reference when calibrating.

5.3 The default value for the Alert (Hi) threshold is 1, meaning that the first event of the day (after 05:00) generates an Alert. The default for the Alarm (HiHi) threshold in most cases is 5 (Unstable Clear Current is set at 25), so that a single event does not initiate a response, but a repetitive event is highlighted for investigation.

6. Other Alarms Associated with EBI Track 200

Side Band Ratio

6.1 The EBI Track 200 consists of two frequencies - Upper and Lower Side Bands; The Tx generates these two frequencies. Within the Tuning Units are filters for both the Pole and Zero frequencies. If either filter is off frequency, then the current seen at the abutting receiver might vary between the two Side Bands.

6.2 The ratio between the two Side Bands is a comparison in the quality of the tuned components within the EBI Track 200 track circuit.

6.3 The thresholds for the Side Bands shall be set as follows:

a) Alert Levels-

- 0.63:1 (Lo)
- 1.60:1 (Hi)

b) Alarm Levels-

- 0.55:1 (LoLo)
- 1.80:1 (HiHi)

The above levels are acceptable for most track circuits.

6.4 If the Side Band ratio exceeds 2:1 the track circuit is likely to fail, therefore, Alarm thresholds shall never exceed 2:1 (0.5:1).

Power Supply Voltage

6.5 The Digital Rx is powered by a 24v power supply; This power supply has limits of 22.5v – 30.5v, as defined within the SMS.

6.6 Powering the Rx outside of these limits can have a detrimental effect and as such Alert/Alarm thresholds have been set accordingly to give forewarning of such events.

6.7 The thresholds for the Power Supply Voltages shall be set as follows:

a) Alert Levels-

- 22.5v (Lo)
- 30.5v (Hi)

b) Alarm Levels-

- 20v (LoLo)
- 32v (HiHi)

New ITHR Ratio

6.8 This is a reference Alarm to end users to see where a Digital Rx has been re-setup with an ITHR value greater than 20% (1.2:1 or 0.8:1) of the original value.

NOTE: *If the ITHR value is found to have changed, all other thresholds should be amended.*

Communications Status

6.9 This is a two-state Alarm that shows Green (healthy) or Red (warning). A Red indication gives warning that the communications on the RS485 bus between the Rx and datalogger has become disturbed (i.e. D-Type disconnected / damaged twisted pair cable / loose termination etc) and requires investigation).

6.10 The nominal state for this Alarm is Green.

Receiver Status

6.11 This is a two-state Alarm that shows Green (healthy) or Red (warning). A Red indication gives warning of a valid error state within the Rx. A review of the error codes can be seen on the II application (by pressing the ‘Error Codes’ button) and a description of each can be found within the SMS (Appendix 08).

6.12 The nominal state for this Alarm is Green.

Relay Output Voltage and Current

6.13 To give forewarning of potential faulty coils within Track Relays, an Alarm is generated where the relay drive voltage is greater than 40v but less then 20mA current is drawn. A fixed Deadband time of 2.5s is applied to suppress Alarms being generated during Clear-Occupied and Occupied-Clear transitions.

6.14 The Relay Voltage shall be set to 40v for mod state 1 and 2 receivers.

6.15 The Relay Voltage shall be set to 48v for receiver mod state 3 and above.

Unit Internal Temperature

6.16 The internal temperature of the Digital Rx is logged as part of the RS485 datastream and displayed within the application.

6.17 This level shall be set to a maximum of 90 degrees Celsius to generate an Alarm if a temperature greater than this value is recorded.

APPENDIX A - Intelligent Infrastructure EBI Track 200 Track Circuit Calibration and Setup Guide

The table below gives a summary of the initial calibration levels for an EBI Track 200 track circuit. Ideally 14 days of data is required to allow for accurate setting / verification of threshold levels and limits.

Before any asset is migrated to the RCM^2 method of maintenance, the following pre-checks shall be undertaken:

1. Check in the 'Logger Offsets' tab to confirm that the TC asset is mapped correctly.
2. In the 'Details' tab check that data is being received for train shunts; a valid current value and track circuit occupation count is displayed.
3. Allow at least 24 hours, then review the asset for any Alerts/Alarms. Any Alerts/Alarms present should be investigated to ascertain the cause.

Specifications	EBI Track 200	Notes
Track Occ Level (ITHR)	This value is obtained from ITHR on the Digital Rx (ITHR)	'Occupied Level' is defaulted to the ITHR value within the Digital Rx.
Track Clear Level	This value is set to 1mA >ITHR	
High Occ Level	This value is obtained from a derivative of ITHR (**0.5 * ITHR**)	Set to 50% of the drop away value (ITHR). There should be no need to adjust this figure. **If the value used is different from that shown above, then the High Current – Occupied Deadband times need to be amended.**
Low Clear Level	This value is obtained from a derivative of ITHR and set no lower than (**1.3 * ITHR**)	This value shall be set no lower than 130% of the drop away value (ITHR)
Excess Current Level	This value is obtained from a derivative of ITHR no greater than (**3.5 * ITHR**) for normal power and(**2.75 * ITHR**) for low power	Where practicable, the excess current level should be set as per the tables A & B as per clause 3.8
Occupied – Clear – Occupied (Lower Limit)	Nominally 0.3 Seconds	This value should not be set higher than 0.3s. If it can be reduced, then it should be.
Occupied – Clear – Occupied (Upper Limit)	Nominally 20 Seconds	Requires reducing if time between trains is less than 20s
Clear – Occupied – Clear (Lower Limit)	Nominally 0.3 Seconds	This value should not be set higher than 0.3s. If it can be reduced, then it should be.
Clear – Occupied – Clear (Upper Limit)	Nominally 5 Seconds - Usually, requires to be reduced for short track circuits	Should be set to less than the time for which the shortest, fastest train occupies the track circuit.
Low Clear Level (Deadband)	Nominally 20 Seconds	Might require adjustment to suit specific TC characteristics.

Specifications	EBI Track 200	Notes
High Occupied Level (Deadband)	Nominally 5 Seconds	Might require adjustment to suit specific TC characteristics.
Excess Current (Deadband)	Nominally 5 Seconds	Might require adjustment to suit specific TC characteristics.
Relay Voltage	Set to 40v Mod State 2 and 48v Mod State 3 and above	
Temp Hi Alarm Threshold	Defaulted to 90ºC	Might require adjustment to suit specific Location / REB characteristics.
Side Band Ratio	Defaulted to 0.63:1 / 1.6:1 (Alert) & 0.55:1 / 1.8:1 (Alarm)	Might require adjustment to suit specific TC characteristics. Shall never exceed 2:1 (0.5:1).
Power Supply Voltage	Defaulted to 22.5v / 30.5v (Alert) & 20v / 32v (Alarm)	

END

1. General

1.1 The Intelligent Infrastructure Signalling Busbar Monitor (II-BMD) monitors earth leakage resistance and supply voltage for ‘earth free’ AC and DC signalling power supplies/busbars over a voltage range of 12 to 160 volts.

Integrating measurement instrumentation and remote monitoring technology, the II-BMD has the capability to monitor multiple power supplies. The acquired measurement data is viewable both on site and remotely. See Figure 1.

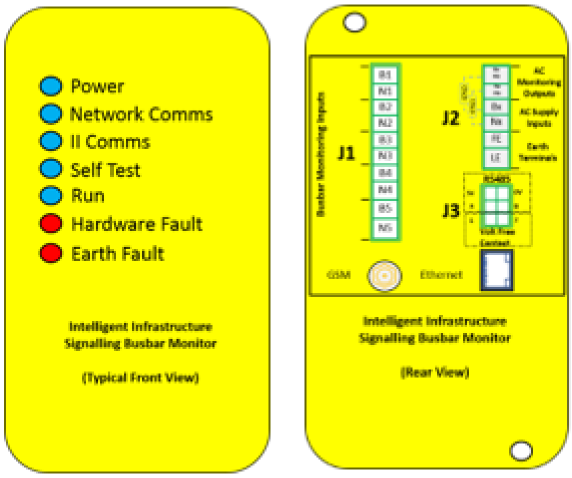


Figure 1 – Generic Front and Rear

1.2 The device is distinctively coloured yellow, is the approximate size of, and mounts in the space of, a BR 930 spec relay and has the capability to monitor up to 5 busbars via individual inputs. Each input is typically tested for 1.5 seconds sequentially one at a time in a repeated cycle. See Section 2 for a description of device operation.

1.3 Acquired measurements may be viewed on site using the device diagnostics interface or remotely via the II-RADAR system. Additionally, the device has status indication LEDS on its front panel (see Section 3).

1.4 Where a signalling supply is monitored by an II-BMD, the device should be used as the primary method of acquiring voltage and earth leakage test values and replaces the requirement to perform voltage and earth tests manually using a digital multi-meter. See Section 4 for local diagnostics.

1.5 II-BMD replaces all other types of earth leakage monitoring; a power supply and associated busbars shall only be monitored by one device.

1.6 The II-BMD is produced by 3 manufacturers; all devices are physically equivalent, but do have differing input voltage arrangements:

a) Voestalpine Earth Watch (Input 1 – AC Only, Inputs 2 to 5 - DC Only).

b) MPEC SA380-IT (Inputs 1 to 5 AC or DC).

c) Findlay Irvine BMD 396 (Inputs 1 to 5 AC or DC).

1.7 Where it is necessary to make earth test measurements with a digital multi-meter, the device is to be temporarily disconnected for the duration of the test. In which case the disconnection/reconnection procedure shall be followed (see Section 5).

1.8 The device measures the value of resistance of the supply/busbar with respect to earth (k ohms) and voltage with respect of both poles of the busbar supply.

<u>DC measurements consist of:</u>

a) Vs - Busbar voltage B to N.

b) R1- Resistance to Earth of busbar 'B' leg.

c) R2- Resistance to Earth of busbar 'N' leg.

<u>AC measurements consist of:</u>

d) Vs – Busbar voltage Bx to Nx.

e) R – Resistance to Earth.

f) DC Offset – Flag raises when DC offset is detected on AC busbar (Equivalent to AC test V1-V2>1V).

1.9 To avoid unnecessary data being transmitted to the II-RADAR system, the device has two measurement modes:

a) Acquire on Threshold Breach (AOTB) – Where the value of resistance crosses any of the thresholds in Table 1 in the downward direction, the first incidence of the value is immediately transmitted to the central system.

Once the resistance value has settled within a band (between thresholds), the device switches to averaging mode (see bullet b)). Averaging mode continues unless a lower threshold is crossed or the reset condition for rising values of resistance is met.

b) Averaging Mode - Where value of resistance remains above the 'Notify' threshold or remains within a band below any threshold in Table 1 – the device operates in 'averaging' mode. Moving average values are transmitted to the central system at 60-minute intervals unless an AOTB occurs. In the event of an AOTB the average value is transmitted immediately paired with the newly acquired AOTB value.

Threshold	**AC (kΩ)**	**DC (kΩ)**	**Reset Condition**
Notify	100	300	Value rises above 2 x the 'Notify' threshold (200kΩ AC, 600 kΩ DC)
Reportable	50	150	Value rises above 'Notify' threshold
Min- Acceptable	20	100	Value rises above 'Notify' threshold
Safety Minimum	11	50	Value rises above 'Reportable' threshold

Table 1 - Acquire on Threshold Breach (AOTB) Values

1.10 The II-BMD can be utilised for remote maintenance of busbars.

1.11 All II-BMDs are required to be supplied fitted with factory seals; units with broken or missing seals shall not be used. Faulty units, including SIM card faults, shall be withdrawn from service with seals intact. Where required, repairs or failure investigations shall be carried out by an approved service agent only.

2. BMD Description

2.1 II-BMD monitoring wiring connections to busbars is distinctively coloured grey - type A1, 0.75mm2 wire. Earth point connection wiring is coloured green and yellow - 1.5mm2 wire.

Connections to the device are made via multi-way connector plugs and sockets (see Figure 2):

a) 10-way plug J1 – Monitoring inputs 1 to 5.

b) 6-way plug J2 - AC supply Input, Earth Terminals and AC Monitoring Outputs.

c) 6-way plug J3 – Volt free contact and RS485 port.

The device is provided with two remote monitoring options:

d) GSM mobile comms (Antenna connects via SMA socket).

e) Ethernet connection (Rear RJ45 socket).

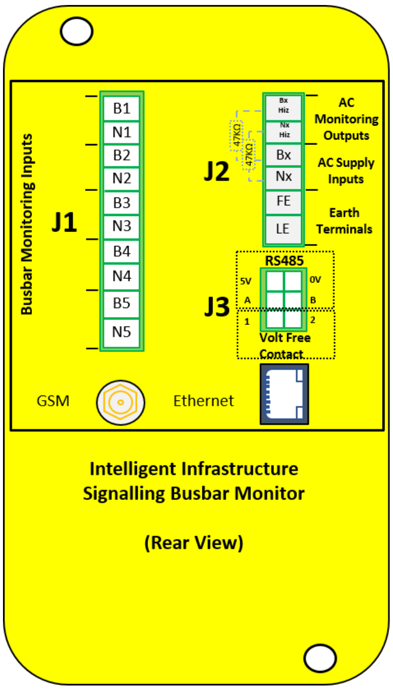


Figure 2 – BDM Front View

The default setting is GSM, but the device can be configured for Ethernet communications e.g. FTN.

2.2 Monitoring connections are made via in-line 47kΩ resistor modules#1 installed in each leg, close to the busbar end, of the monitoring circuit.

The resistors provide current limiting protection avoiding an adverse effect on signalling circuits should the monitoring equipment fail catastrophically; this arrangement adheres to Instrumentation Engineering principles (see U033).

Only resistor modules specifically approved for this purpose shall be used. Figure 3 shows a typical wiring arrangement.

#1 The device is provided with an AC monitoring output “BxHiz” and “NxHiz” (terminals 1 and 2 of plug J2) fed from the AC input via internal 47kΩ resistors. External resistors are not required, and the AC monitoring output can be wired directly to monitoring input channel 1.

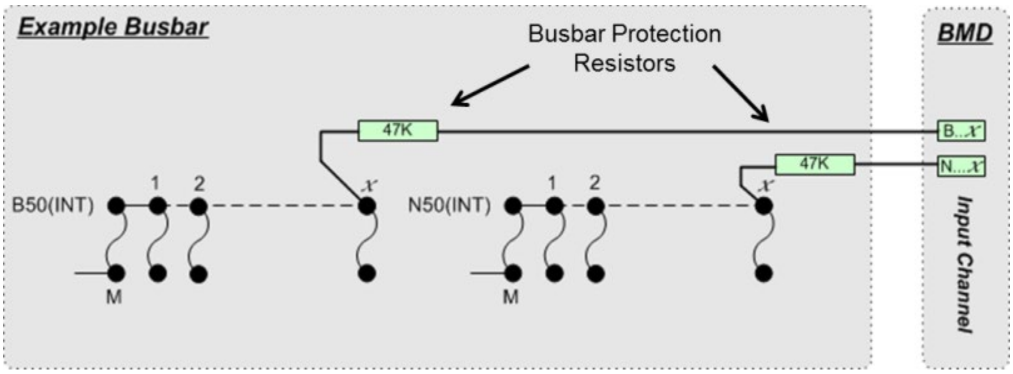


Figure 3 - Monitoring connections

2.3 To allow for conditions affecting signalling supplies such as electrical interference or capacitance, the device typically acquires insulation resistance measurements using 3 modes of operation:

a) Fast Scan Cycle – The device samples each monitoring input channel for up to 1.5 seconds; if a settled measurement can be obtained in that time span, the measurement is recorded. If a settled measurement cannot be obtained for a channel a timeout occurs.

b) Medium Scan Cycle – Where a 1.5 second timeout occurs; the device extends the sampling time of the next scan cycle for the affected channel to 4 seconds. Only one 4 second scan is permitted per cycle; where more than one channel times out, medium scans are queued and carried out in sequential order, in subsequent scans.

c) Slow Scan Cycle – In the event the device cannot obtain a measurement for that channel in Fast/Medium Scan mode, then it switches to Slow Scan mode. In this mode, the device allocates up to 30s of dedicated Scan time to that channel every 15 minutes to attempt to obtain a Measurement. This allows the best opportunity to obtain a measurement for supplies affected by higher levels of capacitance or electrical interference.

d) Timeout – If the device cannot obtain a measurement at all, even after using Slow Scan mode, then timeout is reported to the II-RADAR system for that Busbar.

2.4 Self-Testing and Status – During start-up and periodically during normal operation the device carries out a self-test to prove integrity of operation.

This includes checking the measurement circuits are operating correctly and within tolerance. In the event an error is detected, dependent upon the severity, the device might cease the earth testing routine and in all cases the status error message is logged and transmitted to the remote monitoring system.

Additionally, the 'Hardware Fault' indication illuminates on the device front panel. Typical errors are shown in Table 2:

Status Fault Type	Impact	Comments
Self-Test Fail	Run routine paused	Component Fault –requires device replacement.
Earth loop out of tolerance (LE to FE resistance)	Run routine paused	Occurs if Earth loop value is >999Ωs, disconnected or fluctuates. The HW light auto clears immediately upon return to tolerance, however the flag to the system remains until after x1 complete period (60 mins) of being back within tolerance.
Busbar channel voltage out of tolerance (>+/- 40%)	Affected channel measurement paused	Auto clears after voltage returns to within tolerance. The flag to the system remains until after x1 complete period (60 mins) of being back within tolerance.
Device supply voltage low	Run routine paused	Auto clears after voltage returns to within tolerance for >60 mins.

Table 2 – Status Errors

3. II-BMD Device Indications

<u>Start up</u>

3.1 At start up the device initialises for a period up to 30 seconds. The power indication remains illuminated whilst the device detects the presence of 110 VAC at the Bx and Nx input terminals.

3.2 After the initialisation period the ‘Self-Test’ indication illuminates to confirm the device integrity test routine is running. Taking 15 to 30 seconds to complete, the test is scheduled to run at start up and at hourly intervals thereafter.

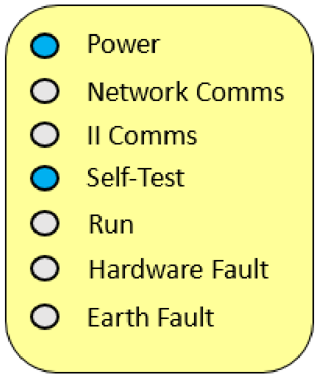


Figure 4 – Start Up Indications

<u>Normal Operation</u>

3.3 During normal operation the ‘Network Comms’ indication illuminates to confirm the device has established communications with the mobile or FTN network.

3.4 Illumination of the ‘II Comms’ indication confirms, when last attempted, the device has communicated successfully with the II server.

3.5 The ‘Run’ Indication illuminates when the device measurement cycle is operating normally and flashes off and on to indicate the end and start of the measurement cycle.

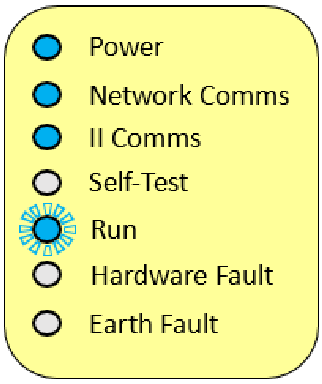


Figure 5 – Normal Operation Indications

3.6 If ‘Network Comms’ is not established within 5 minutes, check the SIM card settings with the network provider (The SIM number is displayed on the front of the device).

3.7 If ‘Network Comms’ is established and after 5 minutes has elapsed ‘II Comms’ is not established, ask for the remote system to be checked to confirm the correct device serial number is set up for the site.

3.8 Attempt one restart of the device. If communications cannot be established or the ‘Run’ indication fails to illuminate check the diagnostic application for error messages and request further advice from the II team.

3.9 Do not attempt to open the device to investigate suspected faults; where an internal fault is suspected, including the SIM card, the device requires to be withdrawn from service.

Earth Fault

3.10 The ‘Earth Fault’ indication illuminates in the event the measured value of resistance to earth on one or more busbar legs is lower than the reportable threshold. The thresholds are set to 150KΩ for DC busbars and 50KΩ for AC busbars.

3.11 In addition to the indication the device earth fault relay operates and the ‘volt free’ contact opens. (Socket J3 terminals 1 and 2). The alarm indication and relay does not latch; once all the resistance values have risen >10% above the threshold the indication is extinguished, and the alarm relay contact closes.

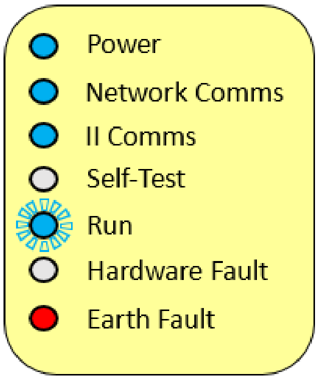


Figure 6 – Earth Fault Indications

Hardware Fault

3.12 The ‘Hardware Fault’ indication illuminates in the following circumstances:

a) The device fails the internal integrity self-test.

b) The voltage measurements of one or more channels are >40% higher or lower than the nominal busbar voltage or >175v maximum limit.

c) The earth loop resistance measurement between (J2 terminals FE and LE) is >999Ω or the device detects the reading is fluctuating or FE / LE is disconnected.

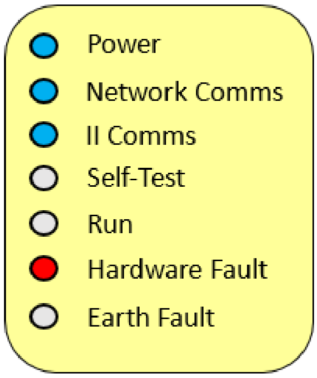


Figure 7 – Hardware Fault Indications

3.13 In the case of hardware failure, the indication latches, and dependent upon the cause of failure the device might cease to run the normal measurement routine. Diagnostic information helping to identify the cause of failure can be obtained from the Manufacturers’ local diagnostic application and from the II asset screens.

3.14 If the device detects the earth loop has returned to normal limits (0 to 999Ω) or has once again become stable; the hardware fault self-clears after a period of 60 minutes of stability has elapsed.

3.15 Alternatively, the hardware fault might be cleared by restarting the device, do not attempt this until the cause of failure has been investigated, and it has been confirmed that the fault condition has been rectified.

3.16 Where the fault is confirmed as an internal component failure or component out of tolerance the device shall be withdrawn from service.

4. II-BMD Local Diagnostics

Voestalpine Earth Watch

4.1 The information below is sourced from the Manufacturer's User Manual and gives the basic information for users to connect to the device to obtain readings and diagnostic information. In addition, the user also requires either, a laptop and Ethernet cable, or Android or IOS device, e.g., smart phone or tablet together with a USB to Wi-Fi adaptor.

For further details regarding the diagnostics functionality please refer to the manual, which can be accessed from the manufacturer's website by scanning the QR Code on the front of the device.

4.2 To connect using Ethernet Front Port carry out the following:

a) Setup the Ethernet port on the device connecting to the EarthWatch to obtain an IP address automatically or use the IP address 192.168.8.100.

b) In the address bar of a browser type http://192.168.8.1/ This connects to the device web pages.

4.3 To connect using USB to WiFi Adaptor

a) Connect the USB to-Wi-Fi adaptor to the USB port on the front of the logger. Note, the USB port is for USB-to-Wi-Fi adaptors only and shall not be used for other purposes.

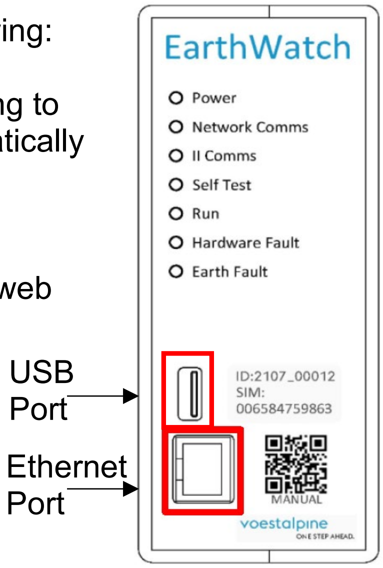


Figure 8 – Earth Watch Front View

b) The unit now initialises the USB-To-Wi-Fi adaptor and then creates a Wi-Fi network called 'earthwatch'. Connect the device being used to the 'earthwatch' network using the password "1107vasig"

c) In the address bar of a browser type http://192.168.8.1/ This connects to the device web pages.

<u>MPEC SA380-IT</u>

4.4 The information below is sourced from the Manufacturer's User Manual and gives the basic information for users to connect to the device to obtain readings and diagnostic information. The user also requires either, IOS device, e.g., iPhone or iPad together with a Lightning to Ethernet adaptor cable or, a laptop and Ethernet cable.

4.5 For further details regarding the diagnostics functionality please refer to the manual. Note, the manual can be accessed from the manufacturer's website by scanning the QR Code on the front of the device.

4.6 To connect to an Apple Device directly using a Lightning to Ethernet Cable:

a) Download the SA380-IT application from the Apple App Store.

b) Connect the Lightning to Ethernet adaptor.

c) Open the Application, it shall connect to default IP address – http://192.168.100.115/ and the reading and diagnostics webpages are automatically loaded. If the device IP address has been changed, the alternative IP address needs to be manually entered.

4.7 To connect to a Computer directly using an Ethernet Cable

a) Setup the Ethernet port on the device connecting to the SA380-IT to use the IP address 192.168.100.1 (assuming the SA380-IT is on the default setting 192.168.100.xxx subnet).

NOTE: *The settings port might require elevated user rights.*

b) In the address bar of a browser type the default IP address http://192.168.100.115/.

Alternatively type the address displayed on the front of the device if it has been changed from the default. This connects to the device web pages.

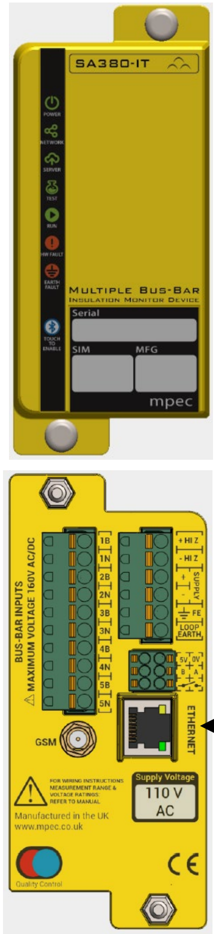


Figure 9 - SA380-IT Front View

<u>Findlay Irvine BMD396</u>

4.8 The information below is sourced from the Manufacturer's User Manual and gives the basic information for users to connect to the device to obtain readings and diagnostic information. The user also requires an IOS device e.g. I-phone or I-Pad tablet together with the FI Bluetooth dongle.

4.9 To connect to an Apple Device directly using the FI Bluetooth Dongle

a) Download the Findlay Irvine 'BusbarMonitor' application from the Apple App Store. Enter authentication password '1960'.

b) Check Bluetooth is switched on in the device settings then plug the dongle into the 9-way connector on the front of the device (see Figure 10). Note, this port is not to be used for any other purpose.

c) After a short delay the application home screen 'Logger' button turns green to confirm the presence of the dongle. Tap 'Connect' next to the Green button to proceed.

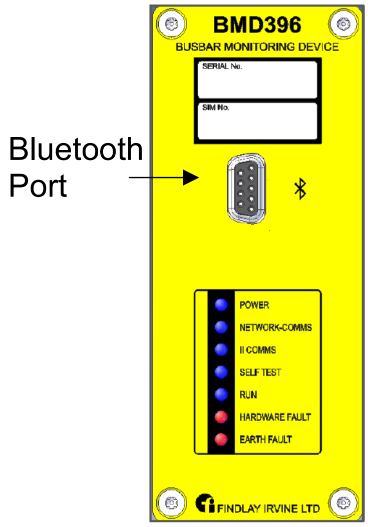


Figure 10 - BMD396 Front View

5. II-BMD Disconnection / Reconnection Status Procedure

5.1 Carrying out the manual earth test with the II-BMD connected might result in the false alarms being raised in the remote monitoring system as the device shall measure either the 150KΩ shunt fitted to the digital multi-meter terminals during the DC test, or the AC earth test adaptor 33KΩ resistor during the AC test.

5.2 Additionally, multi-meter readings, taken as part of the manual earth test, might appear unstable or pulsing with the device operating the normal earth test cycle.

The device is to be used as the primary method of acquiring earth test readings. However, where this is not possible, and a manual test is required to be carried out, carry out the following steps:

Check the Device Status Before Disconnection.

a) Check the POWER and the RUN LEDs on the BMD unit are illuminated.

b) Check the Hardware Fault LED is not illuminated. If a hardware fault is identified, report as a fault.

c) Check if the Earth Fault LED is illuminated (LED illuminated indicates a reportable level earth is present on one or more of the monitored busbars).

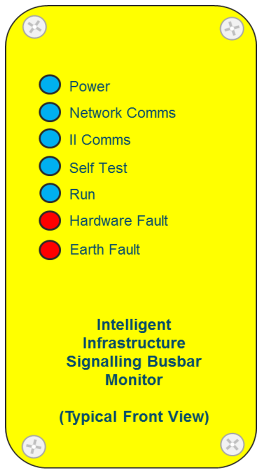


Figure 11 – II BMD Front View

Device Disconnection

d) At the rear of the device check Plug Couplers J1 and J2 are fully inserted and all wires are secure.

e) In the correct order gently remove - J2 (6-way connector), then J1 (10-way connector) from the base.

f) Carry out manual earth tests as required.

Device Reconnection

g) In the correct order gently reinsert J1 (10-way connector), then J2 (6-way connector).

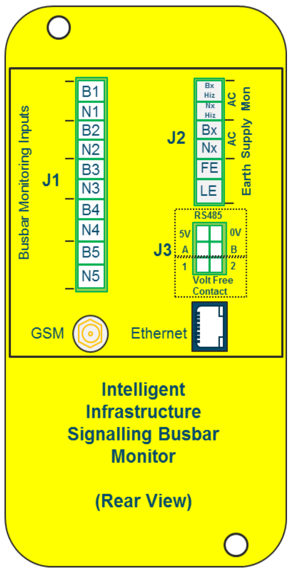


Figure 12 - II BMD Rear View

h) Check Plug Couplers J1, J2 and J3 are fully inserted and all wires are secure.

i) Wait for the device to restart and check the POWER and RUN LEDs on the front of the BMD are illuminated.

j) Check the Hardware Fault LED is not illuminated. If a hardware fault is identified, report as a fault).

END

Includes:	AC, DC (all types), HVI and FS2600 Track Circuits
Excludes:	EBI200

1. General

1.1 The settings detailed in this module are used to setup an asset for monitoring on the RADAR system. Any changes to these settings that reduce the effectiveness of the system (i.e. any change that reduces the number of Alerts or Alarms received) shall only be made with the authority of the SM(S).

1.2 Any changes that increase the sensitivity of the system (i.e. increase the number of Alerts and Alarms) can be undertaken without the authority, however, consideration should be given to the required impact of increased Alerts and Alarms on the system and monitoring staff.

2. Principles

2.1 In normal operation, the current in a track circuit relay is expected to be in one of two states:

a) ‘Clear’ and energised with enough current flowing through the relay circuit for reliable operation.

or

b) ‘occupied’ and de-energised with relay current at or close to 0mA.

As illustrated in Figure 1.

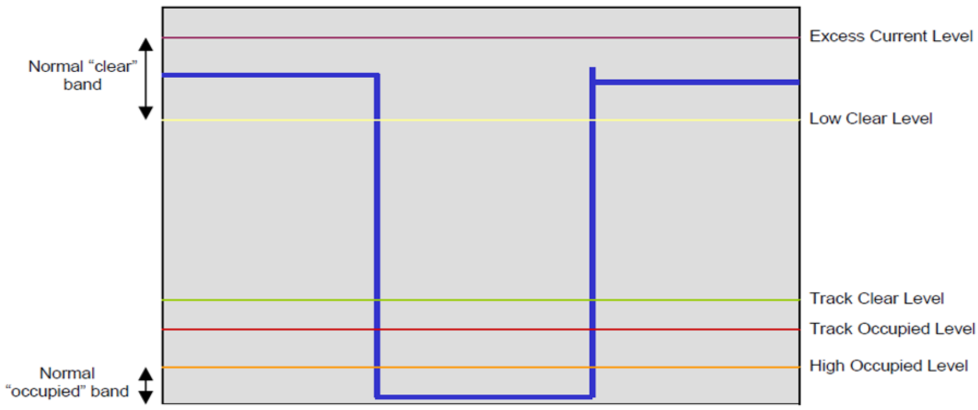


Figure 1 – Relay States

2.2 The RADAR system uses levels and bands to determine the operating sequence of the track circuit as it changes state and to generate events should the track circuit current behave in an unexpected way.

Normal Clear Band

2.3 The 'clear' current should sit somewhere between the 'excess current level', where there is a risk that the train shunt is not low enough to reduce the current in the track circuit relay below the drop away value, and a 'low clear level', where the current is getting close to dropping the relay without the presence of a train.

Normal Occupied Band

2.4 When 'occupied', the current should be somewhere between 0mA and the 'high occupied level' - the defined maximum acceptable level of current whilst the track circuit is occupied.

2.5 The track circuit current goes outside these bands during a transition between clear and occupied but this transition is expected to happen quickly (and therefore, the time outside the "normal" bands is minimal). It is also expected to happen in sequence, so the current falls from the normal 'clear' current to the normal 'occupied' current and vice versa, rather than occupying the bands in any other order.

3. Track Circuit Events

Low Clear Current

3.1 A low clear current event is generated if the current falls below the 'low clear current level' threshold but remains above the 'track occupied level' for a time greater than the deadband. Typical failure modes causing a reduction of current in the circuit would be deteriorating rail insulation (pads and nylons), high resistance tail cables or connections or the failure of a block joint.

Unstable Clear Current

3.2 This event is generated if the track circuit current falls below the 'low clear current level' for a short duration but then recovers into the normal operating band again. This could be caused by an intermittent connection (loose track circuit pin, damaged tail cable, loose back nut).

Excess Current

3.3 If the value of current measured in the track circuit rises above the 'excess current level' threshold an alarm is generated. Causes of this include work on the track circuit reducing the loss of current along the track circuit (renewal of pads and nylons), failure of an un-staggered block joint leading to current from an adjacent track affecting the relay.

High Occupied Current

3.4 A high occupied current event is generated if the current value rises from below the high occupied level' to above the high occupied level' for a time greater than the deadband but does not rise above the 'track clear level'.

Typical causes might be severe wheel or rail contamination or the failure of an unstaggered block joint, allowing current from an adjacent track circuit to flow through the relay.

Poor Shunt

3.5 This event is generated if the track circuit current rises above the 'high occupied level' for a short duration but then falls back into the normal occupied band but does not rise above the 'track clear level'. The 'poor shunt' could be alternatively defined as an 'unstable occupied' event. This might be caused by wheel or rail contamination briefly preventing the train from properly shunting the track circuit.

A Poor Shunt Alarm in itself is not classified as a Wrong Side Failure (WSF); however, it might be an early indication of a potential WSF and should be investigated utilising any additional information or data (i.e. Centrix)

Track flick: Clear – Occupied – Clear

3.6 If the track circuit current value falls briefly from above the 'track clear level' to below the 'track occupied level' and then rises above the track clear level' – a 'clear-occupied-clear' event shall be generated.

Track flick: Occupied – Clear – Occupied

3.7 If the track circuit current value rises briefly from below the 'track occupied level' to above the 'track clear level' then falls below the 'track occupied level' – an 'occupied-clear-occupied' event shall be generated.

4. Calibration

Track circuit current levels

4.1 The first task in calibrating track circuit monitoring is to set the levels at which the track circuit normally operates:

Track Occupied Level

4.2 This parameter is set according to the drop away current of the track relay. For DC track relays this value might be determined from the relay specification. The table below lists the common types of plug in DC relays. Alternatively, the value might be determined from details given on the relay label. The condition and length of the track have no bearing on this level.

4.3 For all other types of track relays, and, where the specified value for the type of DC track relay is not known, carry out a drop shunt test and set the ‘track occupied level’ to the current value shown on the RADAR trace between the end of the drop shunt test and the start of the pick-up test.

Specification	**Pin Code**	**Coil Resistance**	**Average Drop-Away Current**	**Minimum Pick-up Current**
BR939A	105	20Ω	58mA	81mA
BR938A	101	4Ω	76mA	103mA
BR966F2	110	9Ω	88mA	120mA
BR966F9	104	60Ω	38mA	47mA
NT2A	-	9Ω	50mA	67mA

Table 1 – Values for Common Relay types

Track Clear Level

4.4 Like the ‘track occupied level’, this level is set specific to the relay type and is set to the minimum specified value of pick-up current. Table 1 lists the values for common types of plug in DC relay.

4.5 For all other types of track relays, and, where the specified value for the type of DC track relay is not known, carry out a pick-up test of the TC and set the track circuit clear current to the current value shown on the RADAR trace at the time the relay energised.

High Occupied Level

4.6 In normal operation, the current through the track relay is approximately 0mA when the track circuit is occupied. Set the High occupied current level a little way above the normal value seen when the track circuit is occupied to detect when a poor wheel shunt allows some current to flow in the relay. This level should be set no higher than 30% of the occupied level.

Low Clear Current (Low Clear Level)

4.7 Set this level at 20% lower than the lowest level of current measured when the track circuit is clear.

Setting this level too high results in false alarms if the track circuit current falls during wet weather. Setting the level too low (too close to the track occupied current) means that alarms are not generated until the track circuit is very close to failing right side – leaving you little time to react and fix it.

The low clear current level should be set no lower than 50% above the nominal pick-up value.

Excess Current Level (Excess Level)

4.8 This level should be set to alarm if the current in the track circuit relay goes too high and there is a danger that the presence of a train on the track circuit does not divert enough current away from the relay to allow it to drop.

Set the level at 20% above the highest level of current measured when the track is clear.

Setting the Times (Deadbands)

4.9 There are a number of time "deadbands" to be set. These allow the monitoring system to differentiate between events that are normal and those that, due to the time they last, are not.

Low Current – Clear Deadband

4.10 This is the time after which an event is generated if the track clear current is low. This value should be set at 2s.

Setting it too short risks false alarms due to the current value passing through this band as it is going from clear to occupied or vice versa.

The time should be set longer only to allow for situations where known characteristics extend the time of the current value passing through this band.

High Current – Occupied Deadband

4.11 This is the time after which an event is generated if the current when the track circuit is occupied rises above the High occupied current level.

Setting the time too short risks false alarms due to the current value passing through this band as it is going from occupied to clear or vice versa.

Setting the time too long risks missing a poor train shunt event.

This is normally set at 2s but can be reduced to a value at least 0.5 seconds lower than the minimum TC occupied time.

Track Circuit Flick Time: Clear – Occupied – Clear; Lower Limit

4.12 This value shall be set at 0s.

Track Circuit Flick Time: Clear – Occupied – Clear; Upper Limit

4.13 This value should be left at 5s, but if a track circuit is occupied for less than the time set in this value, a track flick event is generated. In such cases the value should be set to less than the time for which the shortest, fastest train occupies the track circuit. Any occupation shorter than this is counted as a genuine fault.

NOTE: *See Appendix A 'TC Minimum Occupation Time Matrix', for further guidance with setting this level.*

Track Circuit Flick Time: Occupied – Clear - Occupied; Lower Limit

4.14 This value shall be set at 0s.

Track Circuit Flick Time: Occupied – Clear - Occupied; Lower Limit

4.15 This value should be left at 20s, but if a track circuit is clear for less than the time set in this value, a track flick event is generated. In such cases the value should be set to less than the minimum time between trains. Any clearance shorter than this is counted as a fault. In complex junction areas, this time might be quite short.

5. Setting the Counters

5.1 Experience in monitoring track circuits has shown that they sometimes show behaviour that would be detected by the condition monitoring software and generate an event, but upon investigation it is determined that it is a characteristic that cannot be easily resolved and does not present a risk to either the performance or the safe operation of the track circuit concerned. To prevent these generating unwanted alerts and alarms, there is a system of counters provided.

5.2 Each time an event (such as a track flick or a poor shunt) is detected, it increments a counter. When the counter reaches a particular value, an alert is generated and when further increments take it over a second threshold, an alarm is generated.

5.3 The counter is reset at a nominal time of day (typically 05:00) to clear out the previous day's events by the first TC occupation following the reset time.

The default values for Alerts (Hi) and Alarms (Hi Hi) is defined in Table 2.

Event	Alert (Hi)	Alarm (Hi Hi)
Occupied – Clear – Occupied	1	5
Clear – Occupied – Clear Flick	1	5
Low Clear Current	1	5
High Occupied Current	1	5
Poor Shunt	1	5
Unstable Clear Current	1	25

Table 2 – Default Values

APPENDIX A - TC Minimum Occupied Time Matrix

Effective Length (metres) = TC Length + Train Length	Line Speed MPH: 125	120	115	110	105	100	95	90	85	80	75	70	65	60	55	50	45	40	35	30	25	20	15	10
300	5.3	5.5	5.8	6.1	6.3	6.7	7.0	7.4	7.8	8.3	8.9	9.5	10.3	11.1	12.2	13.4	14.9	16.7	19.1	22.3	26.8	33.5	44.7	67.1
290	5.1	5.4	5.6	5.8	6.1	6.4	6.8	7.2	7.6	8.1	8.6	9.2	9.9	10.8	11.7	12.9	14.4	16.2	18.5	21.6	25.9	32.4	43.2	64.8
280	5.0	5.2	5.4	5.6	5.9	6.2	6.5	6.9	7.3	7.8	8.3	8.9	9.6	10.4	11.3	12.5	13.9	15.6	17.8	20.8	25.0	31.3	41.7	62.6
270	4.8	5.0	5.2	5.4	5.7	6.0	6.3	6.7	7.1	7.5	8.0	8.6	9.2	10.0	10.9	12.0	13.4	15.1	17.2	20.1	24.1	30.2	40.2	60.4
260	4.6	4.8	5.0	5.2	5.5	5.8	6.1	6.4	6.8	7.2	7.7	8.3	8.9	9.6	10.5	11.6	12.9	14.5	16.6	19.3	23.2	29.0	38.7	58.1
250	4.4	4.6	4.8	5.0	5.3	5.5	5.8	6.2	6.5	6.9	7.4	7.9	8.6	9.3	10.1	11.1	12.4	13.9	15.9	18.6	22.3	27.9	37.2	55.9
240	4.2	4.4	4.6	4.8	5.1	5.3	5.6	5.9	6.3	6.7	7.1	7.6	8.2	8.9	9.7	10.7	11.9	13.4	15.3	17.8	21.4	26.8	35.7	53.6
230	4.1	4.2	4.4	4.6	4.9	5.1	5.4	5.7	6.0	6.4	6.8	7.3	7.9	8.5	9.3	10.2	11.4	12.8	14.7	17.1	20.5	25.7	34.3	51.4
220	3.9	4.1	4.2	4.4	4.6	4.9	5.1	5.4	5.7	6.1	6.5	7.0	7.5	8.2	8.9	9.8	10.9	12.3	14.0	16.4	19.6	24.6	32.8	49.2
210	3.7	3.9	4.0	4.2	4.4	4.6	4.9	5.2	5.5	5.8	6.2	6.7	7.2	7.8	8.5	9.3	10.4	11.7	13.4	15.6	18.7	23.4	31.3	46.9
200	3.5	3.7	3.8	4.0	4.2	4.4	4.7	4.9	5.2	5.5	5.9	6.3	6.8	7.4	8.1	8.9	9.9	11.1	12.7	14.9	17.8	22.3	29.8	44.7
190	3.4	3.5	3.6	3.8	4.0	4.2	4.4	4.7	5.0	5.3	5.6	6.0	6.5	7.0	7.7	8.5	9.4	10.6	12.1	14.1	17.0	21.2	28.3	42.5
180	3.2	3.3	3.5	3.6	3.8	4.0	4.2	4.4	4.7	5.0	5.3	5.7	6.1	6.7	7.3	8.0	8.9	10.0	11.5	13.4	16.1	20.1	26.8	40.2
170	3.0	3.1	3.3	3.4	3.6	3.8	4.0	4.2	4.4	4.7	5.0	5.4	5.8	6.3	6.9	7.6	8.4	9.5	10.8	12.6	15.2	19.0	25.3	38.0
160	2.8	2.9	3.1	3.2	3.4	3.5	3.7	3.9	4.2	4.4	4.7	5.1	5.5	5.9	6.5	7.1	7.9	8.9	10.2	11.9	14.3	17.8	23.8	35.7
150	2.6	2.7	2.9	3.0	3.1	3.3	3.5	3.7	3.9	4.1	4.4	4.7	5.1	5.5	6.1	6.7	7.4	8.3	9.5	11.1	13.4	16.7	22.3	33.5
140	2.5	2.6	2.7	2.8	2.9	3.1	3.2	3.4	3.6	3.9	4.1	4.4	4.8	5.2	5.6	6.2	6.9	7.8	8.9	10.4	12.5	15.6	20.8	31.3
130	2.3	2.4	2.5	2.6	2.7	2.9	3.0	3.2	3.4	3.6	3.8	4.1	4.4	4.8	5.2	5.8	6.4	7.2	8.3	9.6	11.6	14.5	19.3	29.0
120	2.1	2.2	2.3	2.4	2.5	2.6	2.8	2.9	3.1	3.3	3.5	3.8	4.1	4.4	4.8	5.3	5.9	6.7	7.6	8.9	10.7	13.4	17.8	26.8
110	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.7	2.8	3.0	3.2	3.5	3.7	4.1	4.4	4.9	5.4	6.1	7.0	8.2	9.8	12.3	16.4	24.6
100	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.6	2.7	2.9	3.1	3.4	3.7	4.0	4.4	4.9	5.5	6.3	7.4	8.9	11.1	14.9	22.3
90	1.6	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.5	2.6	2.8	3.0	3.3	3.6	4.0	4.4	5.0	5.7	6.7	8.0	10.0	13.4	20.1
80	1.4	1.4	1.5	1.6	1.7	1.7	1.8	1.9	2.1	2.2	2.3	2.5	2.7	2.9	3.2	3.5	3.9	4.4	5.1	5.9	7.1	8.9	11.9	17.8
70	1.2	1.3	1.3	1.4	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.2	2.4	2.6	2.8	3.1	3.4	3.9	4.4	5.2	6.2	7.8	10.4	15.6
60	1.0	1.1	1.1	1.2	1.2	1.3	1.4	1.4	1.5	1.6	1.7	1.9	2.0	2.2	2.4	2.6	2.9	3.3	3.8	4.4	5.3	6.7	8.9	13.4
50	0.8	0.9	0.9	1.0	1.0	1.1	1.1	1.2	1.3	1.3	1.4	1.5	1.7	1.8	2.0	2.2	2.4	2.7	3.1	3.7	4.4	5.5	7.4	11.1
40						0.8	0.9	0.9	1.0	1.1	1.1	1.2	1.3	1.4	1.6	1.7	1.9	2.2	2.5	2.9	3.5	4.4	5.9	8.9

Notes: Effective Length (metres) = TC Length + Minimum Train Length. Where exact train length is not known allow 20 metres per vehicle. E.g. Two car DMU (40 metres long) travelling over a TC section 80 metres long at a line speed of 60 mph (120M @ 60mph) ='Minimum Occupied Time' of 4.4 Seconds. It is advisable to set the 'Clear-Occupied-Clear' Upper Limit 0.5 secs lower than 'Minimum Occupied Time'; E.g. 4.4s.- 0.5s =3.9s. For shortest occupied times set the upper limit no lower than 0.5 secs.

Table 3 - TC Minimum Occupied Time Matrix

END

Includes:	EBI Track 400
Excludes:	All other types

1. General

1.1 This module defines the required calibration thresholds for assets that are to be migrated to the RCM2 method of maintenance. The thresholds defined within this module are also to be used to specify the baseline condition for any asset.

1.2 It applies only to assets that have been migrated across to the EBI Track 400 RCM2 method of remote maintenance.

2. Calibration

<u>EBI Track 400 – RADAR or Centrix</u>

2.1 The shunting characteristics are set in respect to the 'Threshold Current' (ITHR) set during the commissioning of the Digital Rx or if changed during maintenance visits.

3. Track Circuit Current Levels

<u>Track Occ Level (ITHR)</u>

3.1 This value is automatically pulled from the Digital Rx and is therefore not configurable. The ITHR value is the point at which the Digital Rx becomes occupied and clear, so is effectively the drop away and pick up current of the track circuit.

3.2 A track current that drops below ITHR becomes occupied, whilst a track circuit current above ITHR remains clear.

NOTE: *A track current exactly at ITHR might be in either an occupied or clear state.*

3.3 It is important to check that if ITHR has changed, the reason is understood, and that the asset has been correctly recalibrated.

<u>High Occ Level</u>

3.4 In normal operation, the track current at the Digital Rx is 0mA when the track is occupied. The intention of this value is to give pre-warning of potential WSF conditions, typically during leaf fall or on known railhead contaminated areas (i.e. low usage lines / sidings etc).

3.5 This level shall be set no higher than 50% of ITHR. 50% is the default value to prevent spurious Alarms during the transition between clear and occupied states.

<u>Track Clear Level</u>

3.6 The track clear level shall be set to 1mA higher than the value of ITHR, (for example if ITHR is 40mA then the track clear level shall be set to 41mA).

<u>Excess Current Level</u>

3.7 This level shall be set to Alarm if the current in the track circuit goes too high and there is a danger that the presence of a train on the track circuit might not divert enough current away from the Digital Rx to allow it to drop.

3.8 The Excess Current Level shall not be set to greater than 2.79 times ITHR.

3.9 Where practical, the Excess Current Level should be set as per Tables 1 and 2.

Range at set-up to permit this Alarm Setting (ITHR / INOW)	Alarm Setting for Excess Current (× ITHR)	
> 63.5%	Out of expected Range	
59.5% to 63.5%	2.45	16.0% to 23.8%
55.5% to 59.4%	2.50	16.6% to 24.7%
50.1% to 55.4%	2.55	12.7% to 24.7%
45.5% to 50.0%	2.60	13.8% to 25.0%
41.7% to 45.4%	2.65	14.7% to 24.9%
38.5% to 41.6%	2.70	15.5% to 24.8%
35.8% to 38.4%	2.75	16.4% to 24.8%
33.0% to 35.7%	2.79	15.5% to 25.0%
< 33.0%	Out of expected Range	

Table 1 - *Permissible setting for Excess Current Levels based upon set-up conditions (1.0 to 1.5Ω set-up shunt).*

Out of Range	Investigate TC, remedy any faults and repeat set-up. If TC set-up remains out of range consult Alstom with details for further analysis.
Marginal	Check TC, drop-shunt and repeat set-up if necessary, before changing alarm setting. Then continue to monitor TC as per normal process.
Typical	Permissible, change alarm setting, then continue to monitor TC as per normal process.

Table 2 – Key to Table 1

<u>Low Clear Level</u>

3.10 The Low Clear Level shall be set no lower than 130% of ITHR for Open Line frequencies and 120% of ITHR for Station Area frequencies.

3.11 Setting this level too high results in false Alarms, for example, if the track circuit current is known to fall during wet weather. Setting the level too low (too close to the Track Occ Level) increases the risk that Alarms are not generated until the track circuit is very close to failing right side.

4. Setting the Times (RADAR ONLY)

NOTE: *Centrix does not require any dead-bands to be set manually.*

4.1 There are a number of time “Deadbands” to be set. These allow the monitoring system to differentiate between events that are normal (i.e. the passage of a train) and those that, due to the time they last, are not normal.

Low Clear Level (Deadband)

4.2 This is the time after which an event is generated if the track clear current is low.

4.3 Setting this too short risks false Alarms, due to the current value passing through this band as it is going from clear to occupied or vice versa.

4.4 This time should normally be set to 20 seconds; This is acceptable for most track circuits.

High Occupied Level (Deadband)

4.5 This is the time after which an event is generated if the current (when the track circuit is occupied) rises above the High Occ Level.

4.6 Setting this too short risks false Alarms, due to the current value passing through this band as it is going from occupied to clear or vice versa. Setting the time too long risks missing a Poor Shunt event.

4.7 This time should normally be set to 5 seconds. This is acceptable for most track circuits.

4.8 This time may be increased to >5 seconds for example where the track circuit has a centre-fed arrangement and the passage of a train over these sections can be slow (for example, due to being on the approach to a junction or station).

NOTE: *This value has additionally been derived with a High Occ Level value set at 50% of ITHR. If any other value is used for this threshold, this Deadband time needs to be changed.*

Excess Current (Deadband)

4.9 The purpose of this Deadband is to prevent an Alarm being generated during the transition from clear to occupied (or vice versa) where the track current level might briefly spike as the train enters/leaves the tuned zone.

4.10 This time shall be set to 5 seconds; This is acceptable for most track circuits.

<u>Clear-Occupied-Clear Flick Range (Lower Limit)</u>

4.11 This time shall be set to 0.3 seconds to prevent an Alarm count during the initial occupation of the track circuit where the current might briefly occupy then clear.

<u>Clear-Occupied-Clear Flick Range (Upper Limit)</u>

4.12 If a track circuit is occupied for less than the time set in this value (nominally 5 seconds), a track flick event is generated. The value shall be set to less than the time for which the shortest, fastest train occupies the track circuit. Any occupation shorter than this shall treated as a genuine fault.

<u>Occupied-Clear-Occupied Flick Range (Lower Limit)</u>

4.13 This time shall be set to 0.3 seconds to prevent an Alarm count during the initial occupation of the track circuit where the current might briefly occupy then clear.

<u>Occupied-Clear-Occupied Flick Range (Upper Limit)</u>

4.14 If a track circuit is clear for less than the time set in this value, a track Flick event is generated. The value should be set to less than the minimum time between trains. Any clearance shorter than this should be treated as a genuine fault.

4.15 This time shall be set to 20 seconds; This is acceptable for most track circuits.

4.16 This time may need to be reduced for track circuits near busy junctions where the time between trains is <20 seconds.

5. Setting the Counters (RADAR ONLY)

NOTE: *Centrix does not require any counters to be set manually.*

5.1 Each time an event (such as a track Flick or a Poor Shunt) is detected, it increments a counter. When the counter reaches a set value, an Alert is generated, and when further increments take it over a second threshold, an Alarm is generated.

5.2 The counters reset at approximately 05:00 each morning to clear the previous day's events. For perfectly behaving track circuits, the Alert and Alarm thresholds can be low, but they might need to be increased (with authority), where the track circuit displays a background level of events every day. Any issues that require the Alert/Alarm thresholds to be increased should be recorded locally for reference when calibrating.

5.3 The default value for the Alert (Hi) threshold is 1, meaning that the first event of the day (after 05:00) generates an Alert. The default for the Alarm (HiHi) threshold in most cases is 5 (Unstable Clear Current is set at 25), so that a single event does not initiate a response, but a repetitive event is highlighted for investigation.

6. Other Alarms Associated with EBI Track 400

Power Supply Voltage

6.1 The Digital Rx is powered by a 48v power supply; This power supply has limits of 46v – 50v, as defined within the SMS.

6.2 Powering the Rx outside of these limits might have a detrimental effect and as such Alarm thresholds have been set accordingly to give forewarning of such events.

6.3 The thresholds for the Power Supply Voltages shall be set as follows:

- 46.0v (LoLo)
- 50.0v (HiHi)

New ITHR Ratio (RADAR ONLY)

6.4 This is a reference Alarm to end users to see where a Digital Rx has been re-setup with an ITHR value greater than 20% (1.2:1 or 0.8:1) of the original value.

NOTE: *If the ITHR value is found to have changed, all other thresholds should be reviewed.*

Communications Status

6.5 This indication gives warning that the communications on the RS485 bus between the Rx and datalogger has become disturbed (i.e. D-Type disconnected / damaged twisted pair cable / loose termination etc) and requires investigation).

Receiver Status

6.6 A review of the error codes can be seen on the RADAR / Centrix application and a description of each can be found within the NR/SMS/Appendix/10 (General Information on EBI Track 400 Audio Frequency Track Circuit Equipment) – Appendix J – Receiver Operational Error Codes.

Relay Output Voltage and Current

6.7 To give forewarning of potential faulty coils within Track Relays, an Alarm is generated where the relay drive voltage is greater than 40v but less then 20mA current is drawn.

6.8 A fixed Deadband time of 2.5s is applied to suppress Alarms being generated during Clear-Occupied and Occupied-Clear transitions (RADAR ONLY)

6.9 The Relay Voltage shall be set to 48v.

Unit Internal Temperature

6.10 The internal temperature of the Digital Rx is logged as part of the RS485 data stream and displayed within the application.

6.11 This level should be set to a maximum of 70 degrees Celsius to generate an Alarm if a temperature greater than this value is recorded.

Total Current (Wideband)

6.12 The total current (ITOT) presented to the Digital Rx is logged as part of the RS485 data stream and displayed within the application.

6.13 This level should initially be set to a maximum of 500mA then tailored to the circuit's usual characteristics to monitor for increase.

APPENDIX A - EBI Track 400 Track Circuit Calibration and Setup Guide

The table below gives a summary of the initial calibration levels for an EBI Track 400 track circuit. Ideally 14 days of data is required to allow for accurate setting / verification of threshold levels and limits.

Before any asset is migrated to the RCM^2 method of maintenance, the following pre-checks shall be undertaken:

1. Check in the ‘Logger Offsets’ tab (RADAR) or ‘Edit Asset’ (CENTRIX) as appropriate to confirm that the TC asset is mapped correctly.
2. In the ‘Details’ tab (RADAR) or on the Asset page (CENTRIX) check that data is being received for train shunts; a valid current value and track circuit occupation count is displayed.
3. Allow at least 24 hours, then review the asset for any Alerts/Alarms. Any Alerts/Alarms present should be investigated to ascertain the cause.

Spec	EBI Track 400	Centrix Notes	RADAR Notes
Track Occ Level (ITHR)	This value is obtained from ITHR on the Digital Rx (ITHR)	‘Occupied Level’ is defaulted to the ITHR value within the Digital Rx. Centrix will raise Alarm if ITHR changes – this will require acknowledging. Centrix also captures ITHR Last Changed.	‘Occupied Level’ is defaulted to the ITHR value within the Digital Rx.
Track Clear Level	This value is set to 1mA >ITHR		
High Occ Level	This value is obtained from a derivative of ITHR (**<u>0.5 * ITHR</u>**)	Set to 50% of the drop away value (ITHR). There should be no need to adjust this figure.	Set to 50% of the drop away value (ITHR). There should be no need to adjust this figure. *Note: If the value used is different from that shown above, then the High Current – Occupied Deadband time may need to be amended.*

Spec	EBI Track 400	Centrix Notes	RADAR Notes
Low Clear Level	**Open Line** This value is obtained from a derivative of ITHR and set no lower than (**1.3 * ITHR)** **Station Area** This value is obtained from a derivative of ITHR and set no lower than **(1.2 * ITHR)**	**Open Line** This value shall be set no lower than 130% of the drop away value (ITHR) **Station Area** This value shall be set no lower than 120% of the drop away value (ITHR)	**Open Line** This value shall be set no lower than 130% of the drop away value (ITHR) **Station Area** This value shall be set no lower than 120% of the drop away value (ITHR)
Excess Current Level	This value is obtained from a derivative of ITHR no greater than **2.79 * ITHR**	Where practicable, the excess current level should be set as per the tables A & B as per clause 3.8	Where practicable, the excess current level should be set as per the tables A & B as per clause 3.8
Occupied – Clear – Occupied (Lower Limit)	Nominally 0.3 Seconds	Not applicable to Centrix	This value should not be set higher than 0.3s. If it can be reduced, then it should be
Occupied – Clear – Occupied (Upper Limit)	Nominally 20 Seconds	Not applicable to Centrix	Requires reducing if time between trains is less than 20s
Clear – Occupied – Clear (Lower Limit)	Nominally 0.3 Seconds	Not applicable to Centrix	This value should not be set higher than 0.3s. If it can be reduced, then it should be
Clear – Occupied – Clear (Upper Limit)	Nominally 5 Seconds - usually, requires to be reduced for short track circuits	Not applicable to Centrix	Should be set to less than the time for which the shortest, fastest train occupies the track circuit
Low Clear Level (Deadband)	Nominally 20 Seconds	Not applicable to Centrix	Might require adjustment to suit specific TC characteristics
High Occupied Level (Deadband)	Nominally 5 Seconds	Not applicable to Centrix	Might require adjustment to suit specific TC characteristics
Excess Current (Deadband)	Nominally 5 Seconds	Not applicable to Centrix	Might require adjustment to suit specific TC characteristics
VOUT	48V		
Temp Hi Alarm Threshold	Defaulted to 70ºC	Might require adjustment to suit specific Location / REB characteristics.	Might require adjustment to suit specific Location / REB characteristics.
Power Supply Voltage	Defaulted to 46v / 50v		
Total Current ITOT	Default 500mA		

END

1. General

1.1 Repairs or alterations to signalling equipment shall be tested prior to entry into operational service.

1.2 Testing shall be in accordance with one of the following:

a) Signal Maintenance Testing Handbook.

b) Signal Intermediate Testing Handbook.

c) Signalling Works Testing Handbook.

1.3 The flowchart in Appendix A shall be used to select the relevant testing process.

2. Signal Maintenance Testing Handbook

2.1 The Delegated Authority for the assurance of the Signal Maintenance Testing Handbook is with the role of Route Engineer [Signalling], Principal Route Engineer [Signalling] or equivalent.

2.2 The Signal Maintenance Testing Handbook (SMTH) procedures shall apply to:

a) Testing after the like for like replacement of equipment.

b) The temporary diversion of circuits.

c) The replacement of missing equipment.

d) The removal and re-instatement of infrastructure and there is an approved SMTH test plan.

The Signal Maintenance Testing Handbook (SMTH) procedure has a limitation on the number of extensive and simultaneous testing activities that can be carried out.

In addition, where the volume and/or complexity of the testing requires more structured planning, including the management of interfaces between multiple parties, then the use of SMTH might not be appropriate. Refer to the flowchart in Appendix A.

3. Signal Intermediate Testing Handbook

3.1 The Delegated Authority for the assurance of the Signal Intermediate Testing Handbook (SITH) is with the role of Route Engineer [Signalling], Principal Route Engineer [Signalling] or equivalent.

3.2 The Signal Intermediate Testing Handbook (SITH) procedures shall apply to:

a) Testing of like for like replacement of equipment, where the limitations in SMTH with respect to extensive and simultaneous are exceeded, and no dispensation has been granted.

b) Functionally Equivalent Works.

3.3 The Signal Maintenance Testing Handbook (SMTH) procedures are to be applied with the additional procedures contained in the Signal Intermediate Testing Handbook.

3.4 This procedure shall be based on methods of risk assessment, planning, review, briefing, and consensus between all involved disciplines (Network Rail and external contractors, Project Management and Engineering, Design, Construction, Test and Maintenance).

3.5 Where the volume and/or complexity of the testing is in excess of that which might reasonably be managed and controlled by a G110 Lead Tester, then the use of G110 might not be appropriate. Refer to the flowchart in Appendix A.

3.6 Where a new Test Plan is required, the acceptance of the Test Plan and Test Schedule shall be undertaken by a Network Rail Testing & Commissioning Engineer.

4. Signalling Works Testing Handbook

4.1 The Delegated Authority for the assurance of the Signalling Works Testing Handbook is with the role of the Network Rail Testing & Commissioning Engineer.

4.2 Signalling Works Testing Handbook (SWTH) procedures shall apply to all signalling works, to new or amended signalling design drawings and work that has not been limited to Functionally Equivalent Works.

4.3 As part of a project being managed using Signalling Works Testing Handbook, it is permissible for a small package(s) of work to be carried out using the processes described in SMTH and/or SITH. Where this approach is taken, the Tester in Charge and Network Rail's Test and Commissioning Engineer shall jointly agree which testing process shall apply to each work package.

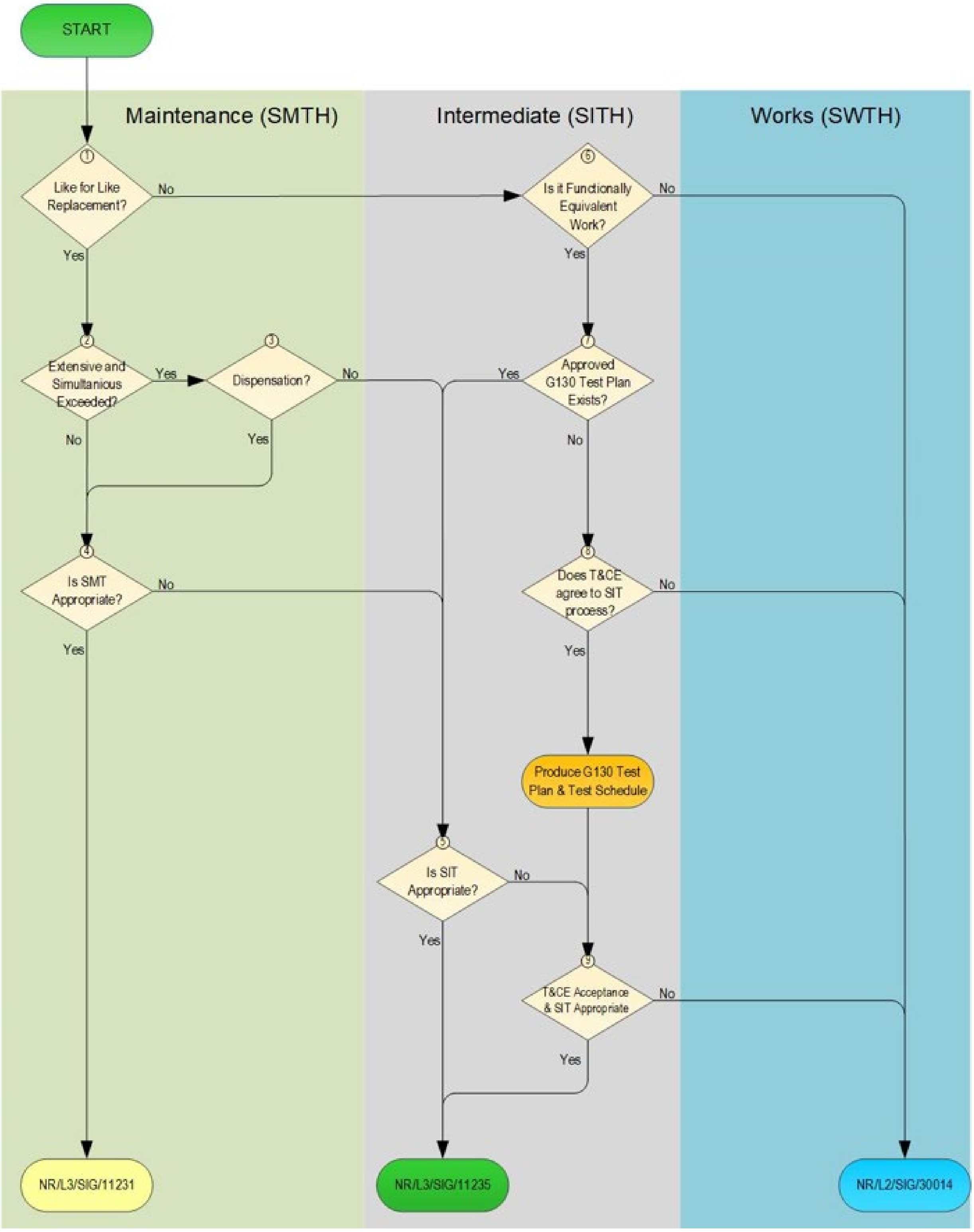
4.4 Where testing processes are intermixed, the Tester in Charge and Network Rail's Test and Commissioning Engineer shall jointly agree which testing process shall apply to each work package.

Any such testing shall be documented in the SWTH Test Plan identifying the details and extent of each work package and how each package of testing is to be certified as complete.

5. Definitions

Functionally Equivalent Works	Functionally Equivalent Works are equipment renewals, campaign changes or alterations that do not change the operation of the control system or application logic of the system.

APPENDIX A - Testing Selection Flowchart



END

1. General

1.1 Work shall be classed as an emergency only if one or more of the following criteria are met:

a) The safe operation of trains is at risk.

b) The requirements for the work are a result of an accident or incident.

c) Operation of the railway in a degraded mode will result in an unacceptable reduction of safety and/or an unacceptable increase of risk.

2. Authorising Emergency work

2.1 The emergency work shall have been authorised by a Route Engineer [Signalling], Principal Route Engineer [Signalling] or equivalent to maintain the safety of the railway or the integrity of interlocking and/or control systems.

3. Selecting the correct Testing process

3.1 The selection process in Module T001 shall apply.

T001 also gives guidance on the intermixing of testing processes.

3.2 Selecting the correct testing process confirms that the infrastructure and/or equipment is rigorously tested and returned to operational service.

3.3 Large and major emergencies usually require the use of Signalling Works Testing procedures, although it might be appropriate to supplement this with Signal Maintenance Testing procedures or Signal Intermediate Testing procedures where extensive and simultaneous or Functionally equivalent applies, to expedite Entry into Service.

3.4 Route Engineer [Signalling], Principal Route Engineer [Signalling] or equivalent shall be responsible for determining the Testing procedures required.

4. Managing Risks

4.1 Emergency works might necessitate deviation from the standard testing requirements, and variation approval is still required from Route Engineer [Signalling], Principal Route Engineer [Signalling] or equivalent.

4.2 The hazards associated with changing the standard testing requirements shall be identified, assessed and eliminated or mitigated before work commences. The assessment shall verify that all credible risks that could lead to ineffective or insufficient testing are eliminated or mitigated so far as is practicable.

END

1. Correct Equipment

1.1 Only the correct tools, gauges, test equipment etc., should be used for the work. Tools should be well cared for and all measuring instruments carefully handled and maintained in good condition.

1.2 A detailed list of test instruments that you need can be obtained from the SM(S).

2. Calibration

2.1 When using a test or a measuring instrument (gauge, meter, insulation tester, etc), check that the instrument has been calibrated, is within date, is undamaged and is fit for purpose.

2.2 A valid calibration certificate is required before using a measuring instrument to record test results. Instruments should be returned to the service/calibration centre for re-calibration at the specified intervals, or whenever there is any reason to suspect the accuracy of the readings.

2.3 If an instrument is not calibrated (labelled on the instrument), the seal is broken or the instrument is faulty, the test is not valid. Where there is any doubt about a meter or test instrument, the SM(S) be consulted before use.

END

1. Live Working

1.1 All tools used for voltages in excess of 175 volts, or where the current capacity exceeds 25 amps, are to be approved for the task and are to be inspected prior to use for any damage before undertaking any work.

1.2 Rubber gloves, mats and shields are to undergo an insulation test to 1000V. (Gloves are to be examined before use to confirm that they have been tested within the previous 12 months).

2. Percussion Tools

2.1 On each occasion before use, every punch, chisel and hammer are to be inspected for signs of damage. Damage or defective items are not be used. Only the correct type of punch or chisel is be used.

3. Powered Plant

3.1 Typically includes:

a) Bonding machine.

b) Drilling machine.

c) Disc cutters.

d) Angle grinders.

e) Chain saws.

f) Cartridge propelled stud fixing.

g) Hot work processes.

3.2 All equipment is to be uniquely numbered and registered for ownership and maintenance purposes. It shall be maintained in accordance with manufacturer's recommendations.

3.3 Only trained operators with a powered plant proficiency certificate can use this equipment. The use of powered plant requires a safe system of work to be defined and implemented.

3.4 Hazards from burns, fire, explosion, eye damage, hose rupture, manual handling, flying objects and noise should be mitigated against, as applicable. Do not expose other staff and members of the public to risk.

3.5 Head, eye, ear, foot and hand protection is be used.

3.6 All plant is subject to statutory reporting procedures. Any accident or dangerous occurrence shall be reported via the SM(S) and the accident shall also be reported to Infrastructure Fault Control.

4. Ladders

4.1 Every portable ladder and pair of steps is to have the next test date marked on them, after which they shall not be used. Ladders should be checked before use and inspected at least 6 monthly.

5. Protective Equipment for Working at Height

5.1 These requirements are covered by NR/L2/OHS/022.

6. Loose Lifting Tackle

6.1 Loose lifting tackle shall be marked with a unique identification number. The Safe Working Load is also to be indicated and shall not be exceeded.

6.2 Swivels and shackles, etc. shall be kept clean and oiled at all times.

6.3 Keep ropes and slings in a cool, dry and well-ventilated environment. The use of loose lifting tackle requires a safe system of work to be defined and implemented.

6.4 All ropes and slings are to be thoroughly examined at least three-monthly. Other loose lifting tackle should also be inspected at least 6 monthly.

7. Inspection

7.1 The equipment in sections 1 to 6 is to be inspected, maintained and shall also be identified by an inspection label. An inventory is to be kept. The tools are to be inspected at least annually (unless otherwise stated).

7.2 Staff shall check that the equipment is within the serviceable date before use. Defective tools and equipment are to be returned to the issuing point and marked as ‘defective’, quarantined and not used. Arrangements should be made for their prompt replacement.

END

1. Types

1.1 Examples of various patterns and types of nuts, bolts, screws and washers are shown in Figures 1 to 5. They also come in different materials and might be plated to avoid corrosion.

1.2 Use the correct type, material, and plating.

2. Threads

2.1 Modern practice calls for the use of Metric threads. Several others are still in use. Examples include:

a) Whitworth (Whit).

b) Unified Fine or Coarse (UNF or UNC).

c) British Association (BA).

2.2 Spanners for most Metric and Unified thread nuts and bolts are sized by their "across the flats" (A/F) dimension, and this is shown on the spanner. A Metric size is given as a number of millimetres relating to the body of the bolt (e.g. 15mm) and a Unified thread as a number, or fraction, of inches across the flats (e.g. 5/8).

2.3 Whitworth spanners are marked with their size as a number, or fraction, of inches followed by "W" (e.g. 3/4 W).

2.4 BA spanners are marked with a number. Sizes "0" and "2" are often used for cable and link terminals, but smaller sizes (e.g. "4" and "6") might be found on older electrical and electronic equipment.

NOTE: *The 0BA nut used in signalling is actually larger than the standard one.*

2.5 Confirm that the nuts and bolts you are using match each other. If in doubt, try screwing them together gently by hand before using tools.

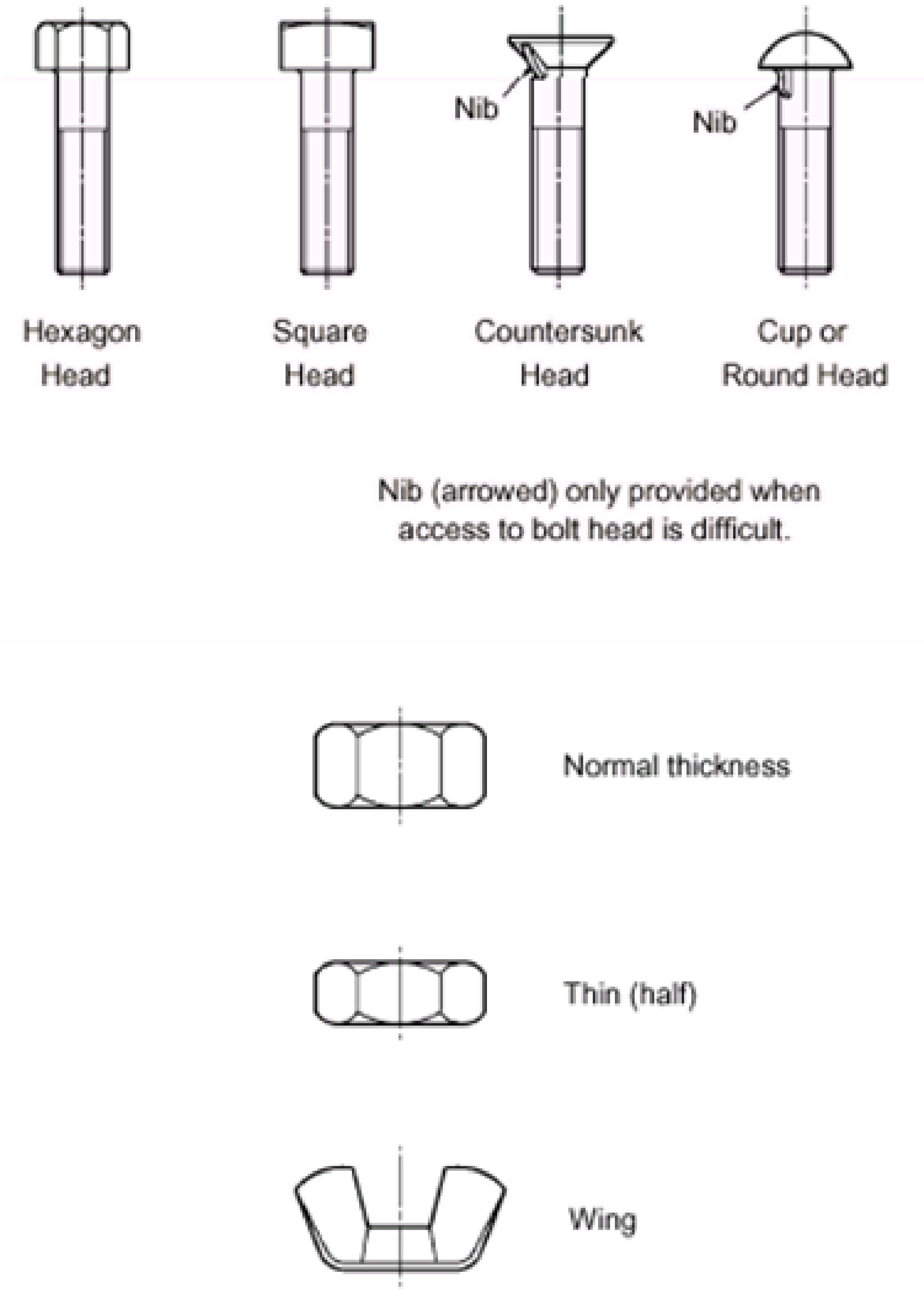


Figure 1 – Bolts and Nuts

3. Tools

3.1 Use only tools of the correct type and size. A spanner that only loosely fits is not good enough and damages the flats of the nut.

3.2 Check that fixings are tight, but not overtight. If a torque is specified, then use a torque wrench. (See module U005).

3.3 Do not use pliers for tightening nuts, as this damages any protective plating on the nut.

3.4 Box or ring spanners are preferable to open ended ones.

3.5 If possible, rotate the nut and keep the screw or bolt fixed, rather than the other way around.

3.6 When a single nut is used, at least two turns of screw thread should project through the nut.

4. Washers

4.1 Various types of washers are shown in Figure 3.

4.2 Flat washers are used to protect surfaces, wires and tags from damage.

4.3 Washers also improve electrical contact.

4.4 See Section 5 for information on locking washers.

5. Locking Methods

<u>Locking Nuts</u>

5.1 Use only the specified type of nut. The bolt thread should project at least one full turn through the locking nut.

5.2 Locking nuts shall not be used more than once. If an all metal type nut has been removed, the bolt shall be inspected before fitting a new locking nut.

5.3 Refer to Figure 2. Locking nuts have inserts of plastic or metal, or are specially shaped, to give a high friction between thread surfaces.

5.4 Bolts showing signs of damage shall not be re-used.

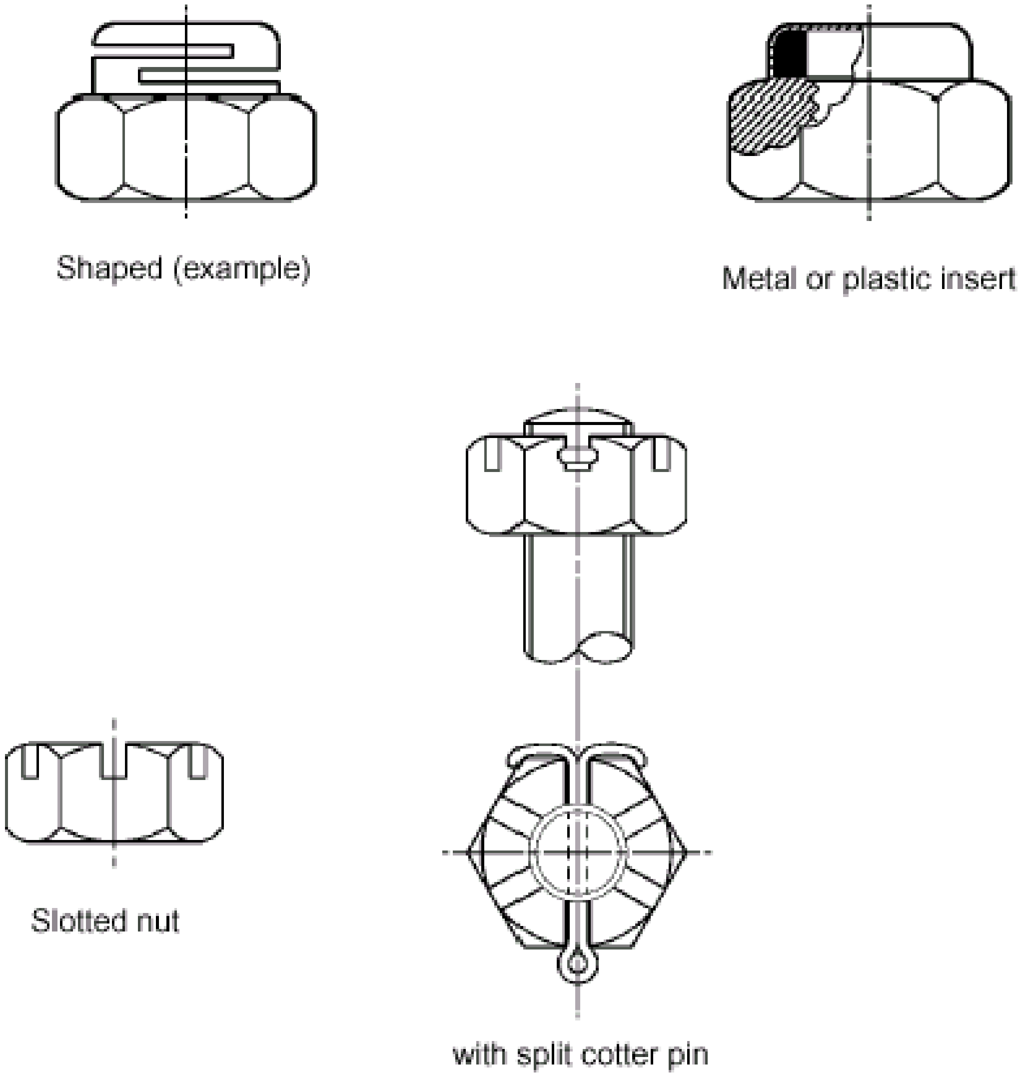


Figure 2 – Self Locking and Slotted Nuts

NOTE: *Alternative arrangement with split pin rotated through 90° is permissible.*

Lock Nuts

5.5 After one nut has been screwed down fully tight, a second nut can be tightened against it. The second nut is known as a lock nut. Where one nut is thicker than the other, unless otherwise specified, the thinner nut should be the lock nut on the outside. The arrangement with Hardlock nuts is different (see module U004).

5.6 Lock nuts shall be tightened to the correct torque.

5.7 See the relevant SMS, such as NR/SMS/PartC/PF01 (Point Fittings).

Lock Washers

5.8 Refer to Figure 3. There are three basic types of lock washer:

a) Crinkle (or wavy) washers.

b) Grover (or spring) washers.

c) Tab washers.

5.9 The first two of these increase the friction between threads. In vital situations they shall not be re-used. When tightening down confirm that the lock washer is fully compressed, but do not overtighten.

5.10 Washers with tabs are also used to prevent nuts turning. This is achieved by bending the washer tab over one of the nut flats and the edge of the fitting. Do not re-use tab washers.

5.11 Shake proof washers have internal or external teeth. They are sometimes used for confirming electrical contact on painted or aluminium surfaces in non-vital situations. Because they do damage to the surfaces either side of them, they shall only be used where specified.

Slotted (or Castellated) Nut and Split Pin

5.12 Refer to Figure 2 for an example of a slotted nut.

5.13 Confirm that the pin sits squarely into the slot.

5.14 Use the specified diameter and length of pin. It shall be a free (but not slack) fit in the hole and should not be excessively long.

5.15 For outside use, grease the pin before insertion. This allows easy extraction when necessary.

5.16 After insertion, open up both legs of the split pin.

Locking Compounds

5.17 These are special adhesives applied to the screw thread before assembly. Use locking compounds only where specified. Follow the instructions precisely as to how much to use and where to apply it.

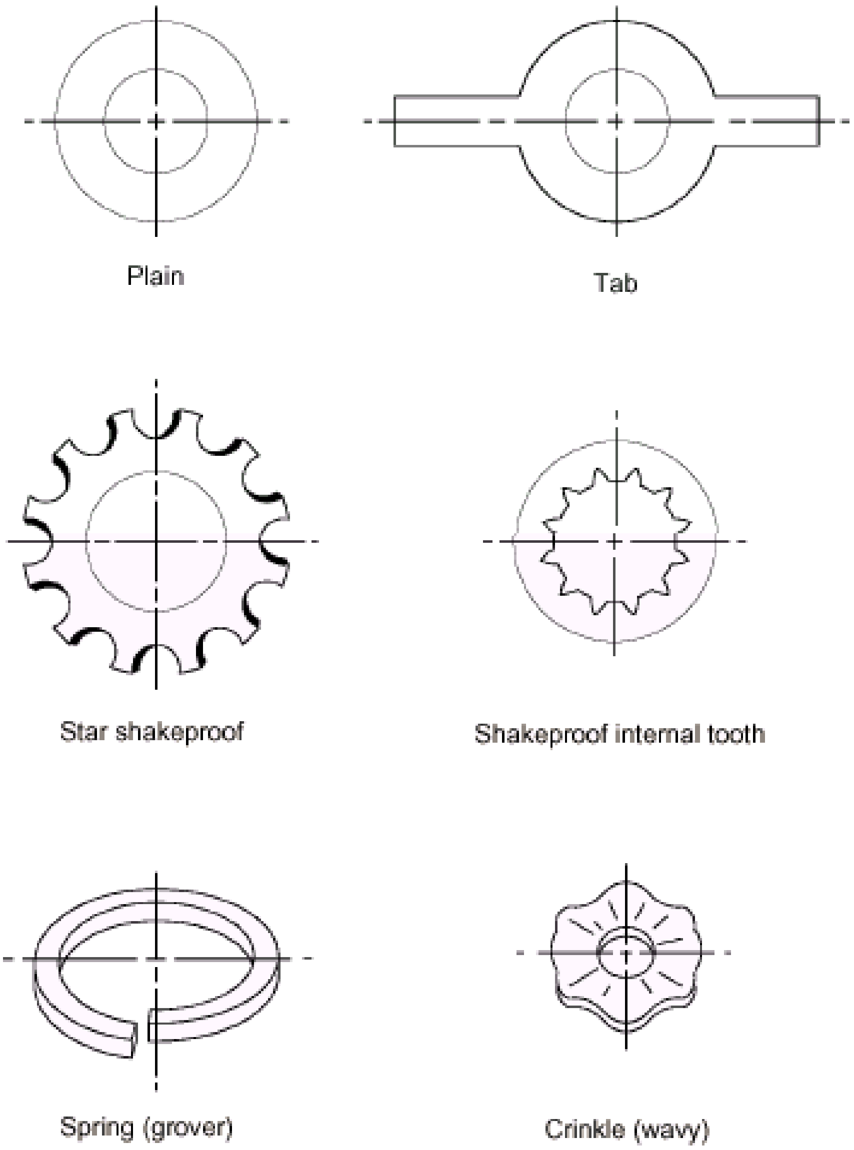


Figure 3 - Washers

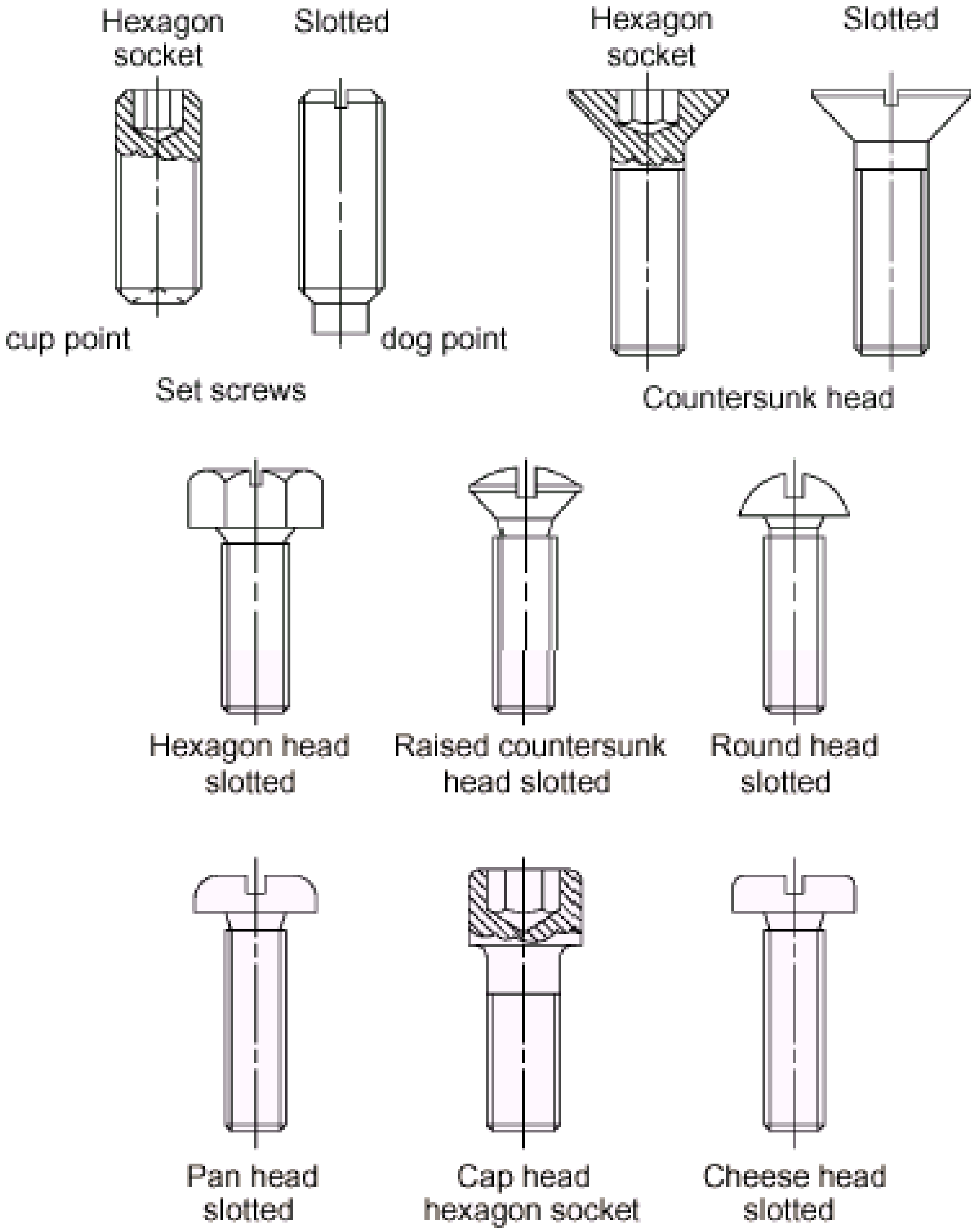


Figure 4 - Screws

6. Split Pins

6.1 Split pins in all signalling apparatus shall always be properly opened out so that they are tight and cannot be moved from end to end.

6.2 Tappet pins, if withdrawn, shall not be reused.

6.3 In the case of locking frames and other equipment where it is difficult to obtain replacement split pins only broken or damaged pins need be replaced.

6.4 When split pins are used as a retaining device for crank or similar pins (as at connections between cranks and rodding), the split pin should be greased before passing it through the hole in the end of the pin and then the legs of the split pin should be opened equally to make an angle of between 60 and 90 degrees.

7. Fixing to Hollow Surfaces

7.1 When fixing to hollow surfaces, special fixing methods are available (See Figure 5).

7.2 They are available in bolt sizes from 3 to 6mm, and in different lengths to suit the wall thickness.

7.3 It is usually better to use the hollow wall fixing device to secure to the wall a batten or rail which then carries what needs to be fixed.

7.4 Always make sure that the wall to which the fixing is secured can withstand the weight or pull of the fixture. Plasterboard is not a very strong material and only supports a light weight.

7.5 Beware of hidden cables and pipes when drilling into hollow surfaces. Handheld detectors can be obtained to help seek out any unknown metalwork, cables, or partition studding.

7.6 Relocatable Equipment Buildings are designed with special inserts to carry fixings for standard equipment rails. Refer to the building drawings for details.

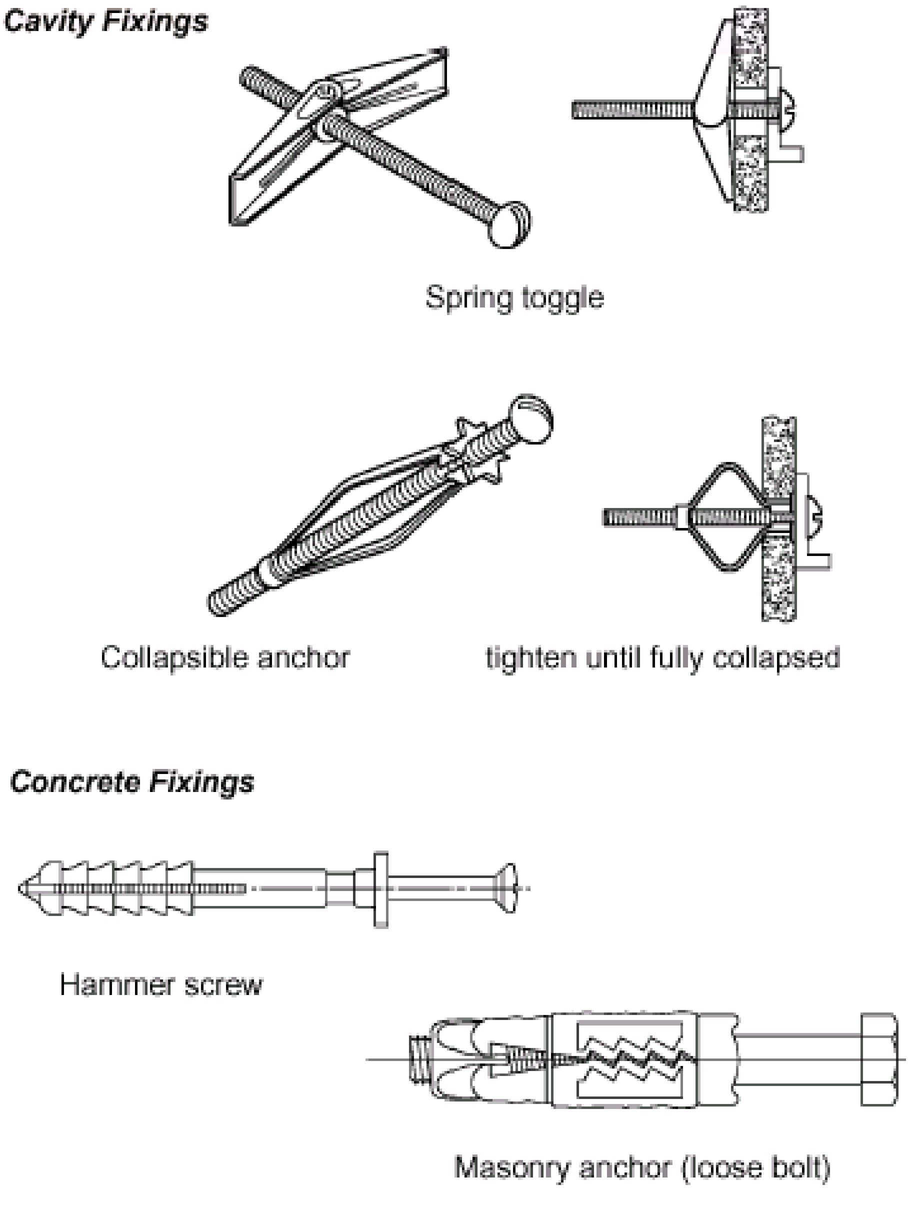


Figure 5 – Cavity (Hollow Surface) and Concrete Fixings

8. Fixing to Concrete

8.1 Fixings should be built in at the production stage of the concrete. This is done for most standard fixings to concrete sleepers.

8.2 Concrete bases for signalling equipment shall have rag bolts set into the correct positions at the concrete pouring stage.

8.3 When existing concrete needs to have fixings added, two common types are illustrated in Figure 5.

8.4 The masonry anchor (commonly known as a Rawlbolt) is used for heavier fixings. The concrete is drilled with the correct size hole (sometimes marked on the anchor itself) and the anchor inserted. Tightening the bolt secures the anchor in the concrete. Manufacturer’s documentation gives the required tightening torque and maximum load for each size of anchor.

8.5 The hammer screw is for light fixings (e.g. cable clips on concrete sleepers).

8.6 After drilling the correct size hole, the insert is placed in it. The screw part of the fixing is then hammered in to fix down the cable clip. The screw can only be removed with a screwdriver.

8.7 When drilling concrete, the positions of any reinforcing wires or bars should be known so that they can be avoided. Never attempt to drill pre-stressed concrete.

END

1. Hardlock Nuts Fitted to Point System Stretcher Bars

1.1 For Hardlock nuts fitted to stretcher bars on point systems, the information in NR/L2/TRK/6100 (The Installation and Maintenance of Stretcher Bars) shall be followed.

1.2 HPSS point systems do not use Hardlock nuts as they Phillidas and Binx nuts. For further information refer to NR/L2/SIG/11400 (HPSS Handbook)**.**

2. Hardlock Nuts not fitted to Point System Stretcher Bars

2.1 It has been found that concave Hardlock nuts are being tightened to normal torque values for standard nuts causing the threads to strip during installation and maintenance. Table 1 specifies the torque values that should be applied for the different sizes of outer (female/concave) hard-lock nuts for all points and point fittings (not fitted to Point System Stretcher Bars).

Hard Lock Nuts	Torque Value for Outer Nut (Lock Nut) Nm
M6	4 to 5
M8	9 to13
M10	18 to 24
M12	27 to 39
M16	70 to100
M20	120 to 200
M30	270 to 440
1¼”	270 to 440

Table 1 – Torque Values for Outer Nut

NOTE: *M30 is yellow finish for adjustable bar only. All other Hardlock nuts are Zinc Plated Finish.*

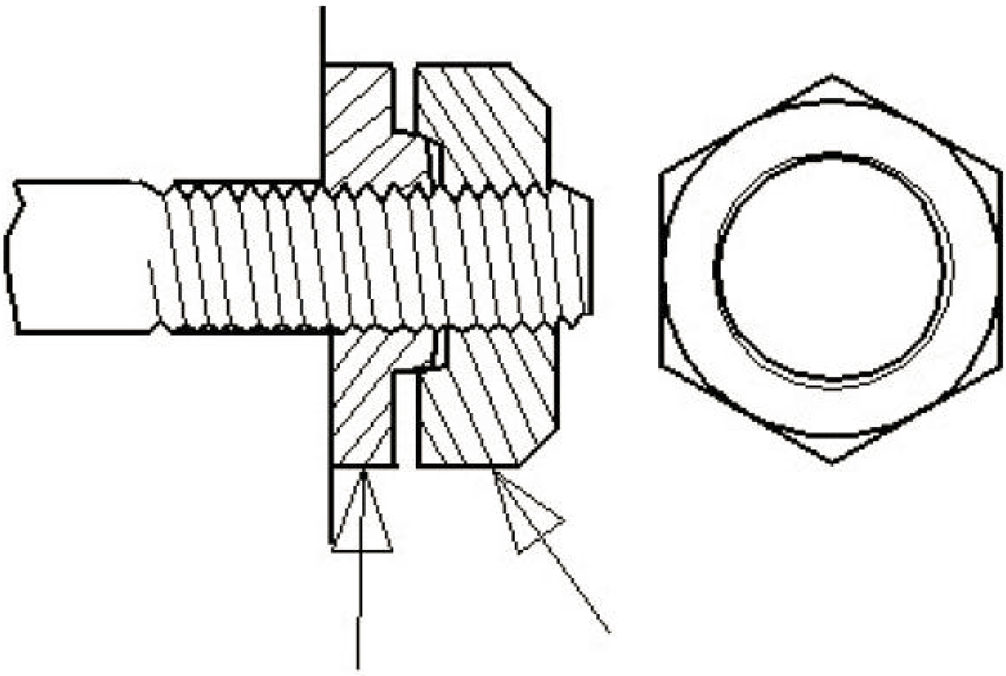


Figure 1 - Hardlock Nut Configuration

3. Installation Procedure for Hardlock Nuts (not fitted to Point System Stretcher Bar):

3.1 Pass the bolt through the components to be attached and screw the Inner nut onto the bolt.

3.2 Tighten the Inner nut against the component with a torque wrench using the torque value for the required application as specified.

3.3 Screw the outer nut onto the bolt by hand.

3.4 Hold the Inner nut with a spanner. With a torque wrench, tighten the Outer nut onto the Inner nut using the relevant torque value from the table in Section 2 for the correct nut size. This completely locks the nuts.

Both nuts shall be tightened to their correct torque values otherwise the locking feature does not engage.

END

1. Torque

1.1 In certain applications, fastenings need to be tightened to an accurate torque. If the fastening is under torqued it will be insecure and can fail in service, if over torqued it could result in damage by distortion and might shear under operating conditions. To confirm that a fastening is correctly torqued, tools known as torque wrenches and torque drivers are used. These devices are able to be pre-set to the required torque and will 'click over' when used, to indicate that the correct torque has been reached.

1.2 Most of the applied torque is used up in overcoming friction: at the bearing face of the nut and between the mating threads. Only about 10% of the torque is used in applying an axial load to the bolt. Use only clean and undamaged nuts, bolts, and washers as dirt or damage will greatly affect the friction and thus alter the desired load in the bolt.

1.3 If accurate torque control of fastenings is required, the figure that a particular fastening needs to be tightened to will be specified in design drawings, installation instructions or maintenance documents. This is the figure to which the torque wrench should be set with reasonable visual accuracy; it is not a measure that has to be obtained to a very close tolerance. Torque is measured in units of either Newton metres (N m) or pounds feet (lbf ft). If torque is specified, then obtain a calibrated tool for the torque range required and fit it with the correct sized bit or socket.

2. Use of Torque Wrench

To tighten a nut to a particular torque:

2.1 Confirm that the torque wrench to be used covers the correct range for the torque required.

2.2 Set the torque wrench to the torque specified. (The exact method of setting the torque can vary with different types of wrench, but generally involves rotating a section of the handle until the required torque is indicated on a scale. Often a locking device has to be released before adjustment and then re-locked afterwards).

To enable the setting of the torque, adjustable torque tools have a graduated scale on them. Confirm when setting a torque tool that the correct units (Nm or lbf ft) are used. Once set, the tool is ready for use.

2.3 Fit the correct size of socket to the drive shaft of the wrench to fit the nut to be tightened.

2.4 Place the wrench over the nut. Pull the wrench steadily in the required direction to tighten the nut until the wrench clicks.

When using torque tools, stop turning as soon as the 'click' is felt, this is most important at low torque settings as the click can be missed and the fastening over torqued. After completion of the task, reset the torque tool to its lowest setting. This takes the strain off the internal spring so not to affect the accuracy of the tool.

Torque tools shall be calibrated (section U001) to conform they are working accurately and producing the correct tightening torque. They might also need re-checking if the tool is damaged at any time. If you have any reason to doubt the accuracy of the setting, return the torque wrench immediately for checking.

Some torque wrenches might not be graduated in both metric Newton metres (Nm) and Pounds force Feet (lbf ft). Table 1 gives approximate equivalents of imperial and metric units of force.

Newton metre (N m)	Pounds force Feet (lbf ft)
1	0.7
2	1.5
3	2.2
4	3.0
5	3.7
6	4.5
7	5.2
8	6
9	6.7
10	7.4
11	8.2
12	8.9
13	9.6
14	10.4
15	11.0
16	11.8
17	12.6
18	13.3
19	14.0
20	14.8

Newton metre (N m)	Pounds force Feet (lbf ft)
21	15.5
22	16.3
23	17.0
24	17.7
25	18.5
30	22.2
35	25.8
40	29.5
45	33.2
50	36.9
55	40.6
60	44.3
65	48.0
70	51.7
75	55.3
80	59.0
85	62.7
90	66.4
95	70.0
100	73.8

Table 1 - Units of Force Conversion Table

END

1. FPL Checking Gauge (Metric)

1.1 The gauge widths and the length to the shoulder of the narrow end of the gauge are for lock notch sizes cut for use with mechanical facing point locks. (See Figure 1)

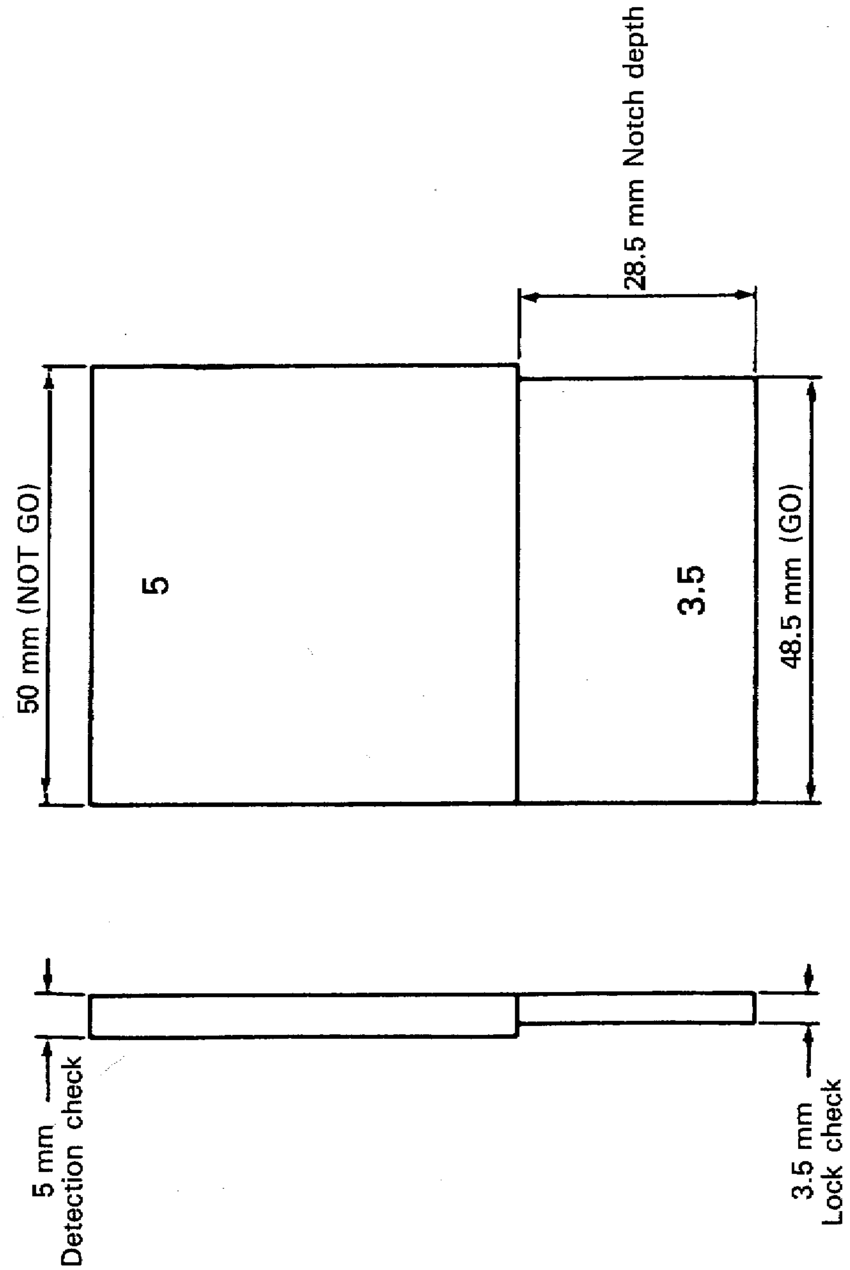


Figure 1 - FPL Checking Gauge (Metric) (BRS-SM 225)

2. Clamp Lock Limit Switch Gauges

2.1 The 1.5mm and 2mm microswitch gauges are shown in Figure 2 and 3.

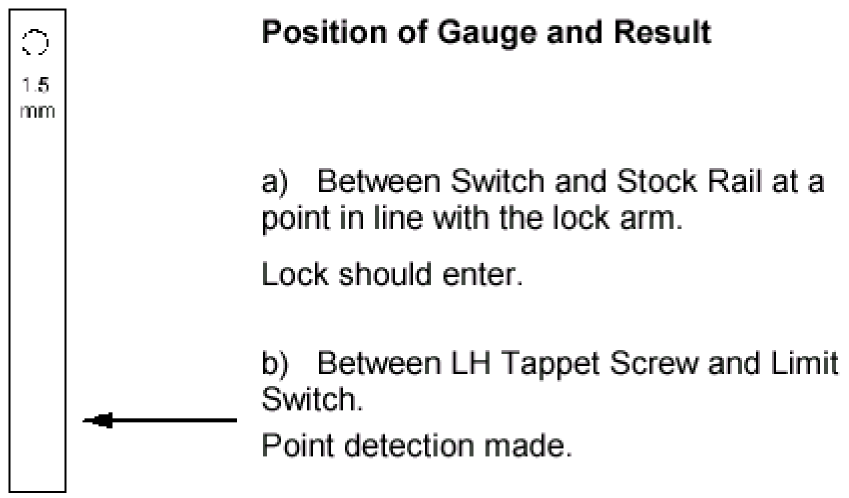


Figure 2 - 1.5mm Microswitch Gauge (BRS-SM 528\1)

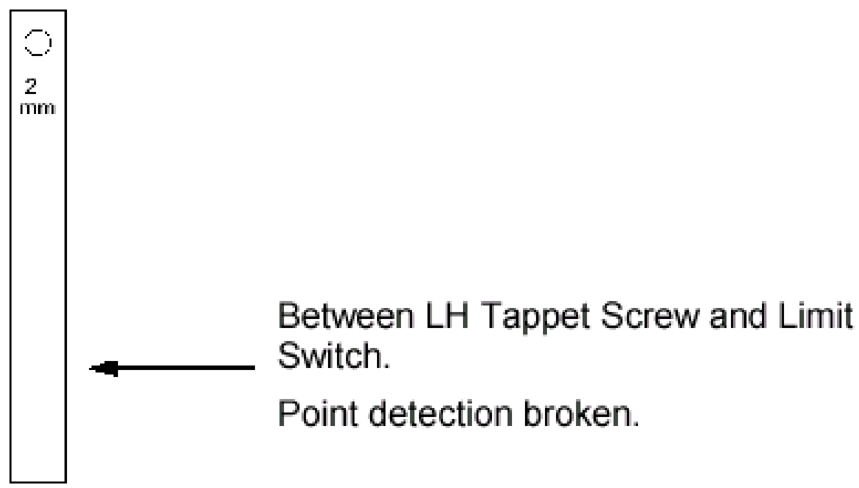


Figure 3 - 2mm Microswitch Gauge (BRS-SM 528\2)

3. Clamp Lock Detection Setting Gauges

3.1 The 2.5mm and 4mm detection gauges are shown in Figure 4 and 5.

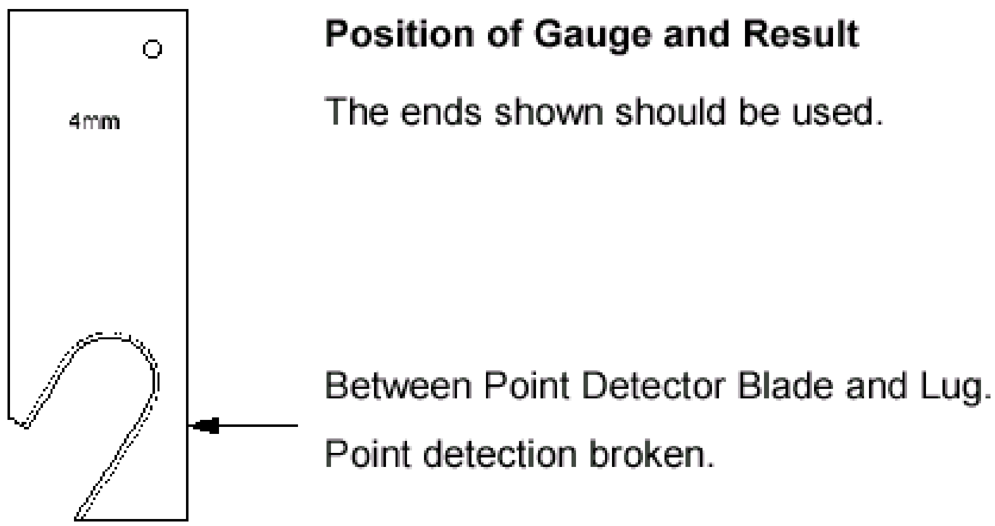


Figure 4 – 4mm Clamp Lock Detection Gauge (BRS-SM 527\2)

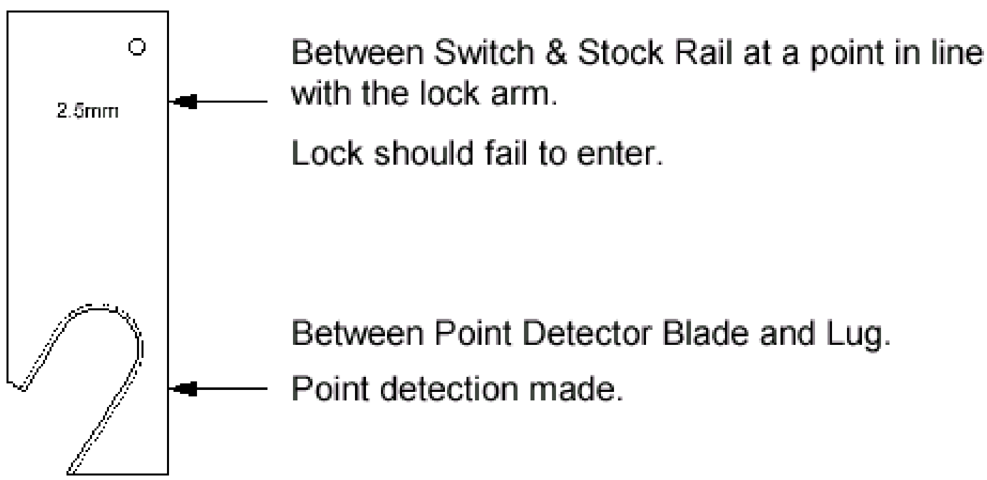


Figure 5 - 2.5mm Clamp Lock Detection Gauge (BRS-SM 527\1)

END

1. Extractor Tools

1.1 When removing spades from relay plugboards use the correct extractor tool to suit the type of spade used. The four most commonly used spade extractor tools are shown in Figure 1.

1.2 Extractor tools should be used carefully, especially when a relay from a working circuit is plugged into the plugboard. When using the Westinghouse type, check that it is inserted squarely between the flat side of the spade and the plugboard. Push the tool fully home and then withdraw the spade and extractor together. When using the single pronged types, insert the prong only sufficiently far to be able to lift the locking tab to allow withdrawal.

1.3 Extractor tool shall not be used as a substitute for test straps.

1.4 When work has finished, that has involved the use of extractor tools, each extractor tool used shall be accounted for.

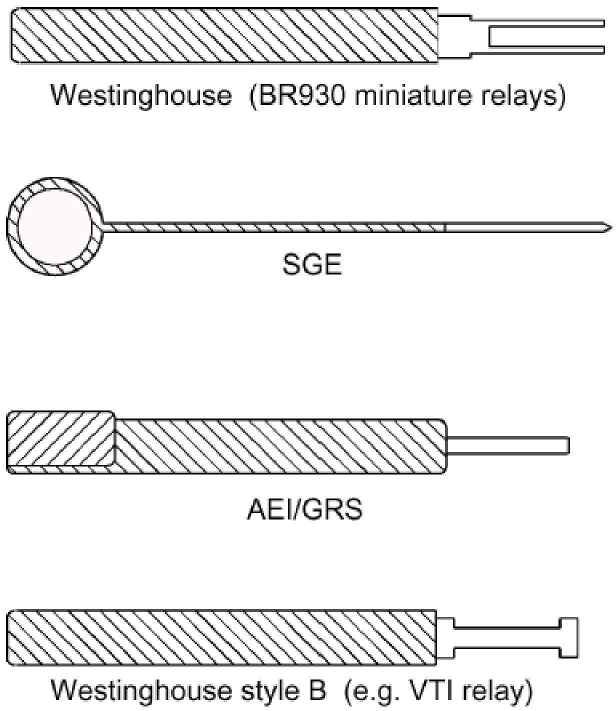


Figure 1 Spade Extractor Tools

END

1. Principle

1.1 This type of connection is used in the telecommunications and electronics industries and can be found on allied equipment used within the signalling field. Examples are telephone, train describer, and computer systems. Wiring that uses this type of connection is usually of small diameter, PVC insulated, and either in single core or multicore form, or as a ribbon cable.

1.2 Where such wires have to be fixed to strip connectors within junction boxes, plugs, or sockets, the connectors are designed so that the wire end can be laid into the top of a slot and when the wires are pressed down into position, sharp metal edges within each connection cut into the insulation and make contact with the conductor. The slot is usually shaped to grip the insulation as well.

1.3 The method of making the connection varies according to the connection system. The most common systems are those for pluggable telephone and cord connectors (PTC and PCC), and Krone connection boxes and strips.

2. PTC/PCC Plugs and Line Jacks

2.1 PTC/PCC plugs require two hand tools. One is a stripping tool for the cable and the other is a terminating tool for making the actual connection to the plug. For terminations in the PTC/PCC line jack units (sockets), alternative tools are available for the wire insertion into the terminations. For frequent use, one tool incorporates an insertion head and cutters which cut the conductor to correct length after insertion in one operation. A low-cost tool for occasional use merely inserts the wire to be trimmed later if necessary.

3. Krone Connectors

3.1 Krone connectors require their own special insertion tool for pressing each wire down into its termination.

NOTE: *Porta System UD10/3 connection strips, which look very similar to Krone connection strips, are also used at telecoms locations. A Krone insertion tool must not be used on a Porta System module or visa versa, as this will often lead to a poor connection being made.*

3.2 Connectors for 0.4mm to 0.65mm solid wires can accept two identical wires of the same diameter.

NOTE: *Telecoms cables are often 0.63mm diameter, therefore care should be taken not to insert a 0.65mm wire and a 0.63mm wire together onto the same connector, as a poor connection will result.*

3.3 The following variants of Krone strips are most common:

a) Type 237A (10 pair disconnection module) incoming and outgoing wires are connected via closed spring clip connections. The insertion of a “Krone test lead” allows the circuit to be tested without disconnection. Plastic plugs are available to provide circuit disconnection if required.

b) Type 237B (10 pair connection module) incoming and outgoing wires are connected via a one piece contact which provides a continuous link with the provision of monitoring.

4. Special Connectors

4.1 Special connectors are required for ribbon cables, and although some also require correct tools for making the connection, others have in-built devices for making the insulation displacement connection.

4.2 Follow the manufacturer’s instructions for the particular type of connector.

5. Making the Connection

5.1 The general rules for making any of these connections is:

a) Use only the correct tool for that connector.

b) Confirm the wire is correctly positioned before pressing it home into the termination.

c) If necessary, cut off surplus projecting wire. Some insertion tools do this automatically.

d) Test all connections for continuity and insulation.

e) Check cable or wire clamps are effective.

END

NR/L3/SIG/10064 General Instructions to Staff Working on S&T Equipment		
NR/GI/U019		
Use of the Volt Stick		
Issue No: 01	Issue Date: 04/09/2021	Compliance Date: 04/12/2021

1. General

Figure 1 - Volt Stick

2. Volt Stick

2.1 Only an NR approved Volt Stick shall be used, these are available through the iStore.

2.2 The Volt Stick detects the presence of an AC voltage greater than 50V.

2.3 When using, hold the blue body of the Volt Stick only - do not hold the white tip.

2.4 The unit is to be tested before use. This can be done by placing the white tip against the front of a live household socket. If AC voltage is present the white tip glows red. If the tip fails to illuminate it shall be considered to be defective.

2.5 Any damaged/Defective Volt Stick shall not be used and is to be replaced.

2.6 Apply only the tip of the Volt Stick only to the metal Metalwork being checked.

2.7 Do not touch any other metalwork with any part of the body during the test.

2.8 A Volt Stick does not do the following:

a) Prove a circuit is dead.

b) Detect Direct Current.

2.9 Do not use a Volt Stick to prove a circuit is “live or dead”.

3. Sensitivity

3.1 Due to the sensitivity of the Volt Stick it might illuminate on some statically charged materials e.g., plastics, aluminium, etc.

3.2 The Volt Stick might or might not illuminate through the insulation of electrical cables. Illumination does not indicate an unsafe situation but does indicate that the cable is energised.

4. Users Working Close to OHL

4.1 Under certain circumstances the LV50 can give false indications due to the electric fields generate by overhead line equipment. See Figure 2.

Figure 2 – A False Indication

4.2 But when positioned near or touching an earthed metallic structure the illumination STOPS and this indicates the metallic object is safe to touch. See Figure 3.

Figure 3 – True Indication

END

1. General

1.1 This module gives details of the tools and meters available for general use.

2. Types of Meter (General Purpose)

2.1 Fluke 77, Fluke TPWS, AVO M2007, or similar approved digital meter.

Figure 1 - Fluke 77

Figure 2 – Fluke TPWS

Figure 3 – AVO M2007

For general purpose installation, maintenance, faulting and testing work.

Advantages:

- Robust.
- Auto-Ranging.
- Built-in continuity tester.

Disadvantages:

- Not reliable for recording fluctuating measurements.
- Might not work properly when wet.
- Requires battery power which can fail.
- Current protection by fuse.

2.2 Digital Meter Peripheral Equipment

Digital meters usually require a loading resistor of 150k ohm fitted to the meter so that load current is drawn when used on voltage tests.

NOTE: *The 150k ohm shunt should not be left plugged into the meter as it is not required for all types of measurement.*

2.3 D.C. Clamp Ammeter.

This instrument is used for current measurement without disconnection of the cable. The instrument clips around the cable and the current measurement is read directly from the meter, it only works on single-core cables.

Figure 4 – Fluke I30 Current Clamp

Figure 5 – Fluke 374

Figure 6 – LEM Flex 3000A

Figure 7 – i410

2.4 AC Clip-on Ammeter.

Used to measure A.C. without requiring any connection to the circuit, it only works on single-core cables.

2.5 Special Frequency Meters.

Specially made frequency selective volt meters, e.g. for EBI track type track circuits.

Figure 8 – TI21 Test Meter

Figure 9 – Frequency Selective Volt Meter

2.6 Special Use Meters.

Other special use meters are described in other parts of this section (U).

2.7 “Lineman’s” Avo (Avo Model 6 Heavy Duty).

Advantages:

- Robust.
- Good for fluctuating measurements.
- Has a cut-out that trips on overload and can be reset.

Disadvantages**:**

- Not very sensitive.
- No good for “electronic” measurements.
- No longer available and costly to repair.

2.8 Avo Model 8 (analogue).

Advantages:

- More sensitive than “Lineman’s” Avo.
- (can be used for “electronic” measurements and earth testing).

Disadvantages:

- Not so robust.

3. Use of Meters

3.1 Choose the correct meter for the measurements to be taken and confirm that you know how to operate it.

3.2 If the meter does not have an internal fuse, the leads shall be equipped with HRC fuses in each lead. These lead fuses typically introduce a resistance of 1.5 ohms per lead which, whilst measuring current or resistance, can have a significant effect on the accuracy of the readings. The actual value can be established by taking a reading with the two leads connected together.

3.3 Prods shall be equipped with finger barriers to prevent slippage onto live equipment. Bare metal at the ends of prods shall not exceed 2mm measured across any surface. Meter leads and prods shall be carefully checked for security and insulation before use.

3.4 For a meter which is not auto-ranging, make sure the correct range is selected before applying the meter to any circuit. If the voltage or current is uncertain, select a higher range than is probably required and change to a lower range if necessary.

3.5 Remember that most meters give a virtual short circuit across the probes when connected or switched for current measurement. In the type of meter where the leads are plugged into special sockets for current measurement, this short circuit remains even when the meter is switched to "off", so always remove the leads from the meter sockets immediately on completion of current measurements.

3.6 When a meter is not in use, always switch it to the highest AC voltage range, unless a special “off” position is provided.

3.7 It is false economy to fit unsealed dry cells in relatively expensive instruments. Sealed, leak-proof cells should always be used.

3.8 Check that meters are returned to the service/calibration centre for re-calibration at the specified intervals, or whenever there is any reason to suspect the accuracy of the readings. If replacement of meter batteries or internal fuses involves breaking a calibration seal, re-calibration is required. If a meter is likely to remain unused for long periods of time it is advisable to remove the batteries before storing it.

4. Meter Shunts and their Uses

Shunt Value or Attachment	Usage	Remarks
1 Ohm	Cell on-load test	Applied for 10 second period to intermittently loaded primary (dry), or secondary (alkaline / lead acid) cells. Must not be used for batteries of several cells in series due to the possibility of high current.
220 Ohm	Insulated rail joint testing	Applied to D.C. track circuit joints to determine whether the fishplates of an insulated joint are in electrical contact with either rail. (See NR/SMS/PartB/Test/041).
33k Ohm (within the A.C. Busbar Earth Test Adaptor unit)	Earth leakage testing	Applied instead of the 150k ohm shunt for A.C. busbar tests where no Earth Leakage Detector is present. (See Section U042).
150k ohm	Earth leakage testing	Applied to D.C. busbars where no Earth Leakage Detector is present.
2.2M ohm (within HVI integrator unit)	HVI track circuit testing	Used to determine rail voltage.

END

1. Megger

1.1 These produce a high voltage for testing the insulation of cables

1.2 It is important that the insulation rating of the cable is not exceeded.

Particular care should be taken in the case of telecoms cables.

1.3 Confirm that the voltage produced by the megger is correct for the test to be carried out.

1.4 The insulation testing requirements for new cables are given in the Signal Works Testing Handbook and for existing cables in the Signalling Maintenance Testing Handbook.

Figure 1 – Typical Megger

1.5 Resistance values are given in NR/SMS/PartZ/Z05.

1.6 If the insulation resistance of an altered cable has changed appreciably, investigate the cause.

1.7 The insulation tester shall not be used with equipment connected to the cable.

1.8 Insulation testers shall not be connected to live circuitry.

1.9 Check that all equipment containing electronic components is disconnected from wires to be tested.

2. Sleeper Insulation Tester (SIT)

2.1 Primarily for use with EBI Track type track circuits, it also works with Aster and other ac track circuits up to 3 kHz. It is a hand-held non-contact unit which senses the track circuit signal, allowing leakage paths to be detected.

Figure 2 - Sleeper Insulation Tester

END

1. Instrumentation

1.1 The objective of this module is to define the safe and controlled use of test instrumentation. It is particularly concerned with the connection of measuring instruments to circuitry which has the potential to create wrong side signalling failures via unwanted, and not always obvious, connections through the internal wiring of the instruments.

1.2 This module applies to all test and monitoring instrumentation which is temporarily connected to equipment directly responsible for the integrity of the signalling (safety-critical equipment), such as interlocking or trackside functions. The instrumentation can either have direct electrical connection to some part of the safety-critical equipment or its power supply, or be in close proximity (no direct electrical connection but some part of the instrumentation is sufficiently close as to constitute a potential hazard, e.g. monitoring spare relay contacts).

1.3 This module covers two particular categories of work:

a) Short duration attended tests

b) Temporary unattended monitoring.

This includes connection to working systems which shall not be isolated to perform monitoring and testing activities.

1.4 Wherever applicable, the principles of Maintenance Testing shall be applied during the application of the instrumentation, e.g. disconnection of wires, plug couplers or links.

2. Competence Requirement

2.1 The use of specialised test instrumentation, including any mains powered device, requires training appropriate to the equipment involved and specific competence assessment. This includes:

a) The ability to select the correct instrumentation.

b) Types of instrumentation.

c) Understanding the risks and limitations associated with use.

d) The importance of instrumentation calibration.

e) Short duration attended tests.

f) Temporary unattended monitoring.

g) Methodology of testing including connection.

h) Non-intrusive measurements.

i) Likely effects on the circuits under test.

j) Instrumentation power supplies and fusing.

k) Assessment of existing equipment and systems.

2.2 Those assessing this competence shall themselves have been assessed as competent in instrumentation theory/discipline.

3. Guidelines for Short Duration Attended Tests

3.1 Short duration attended tests are defined as the use of test instrumentation where the competent person who is using the equipment is present throughout the period of time when the equipment is connected to the working system.

3.2 Each AC powered instrument shall be supplied via its own dedicated isolating transformer, unless the equivalent is provided internal to the instrument.

3.3 Instruments requiring external DC supply shall not derive that supply from any DC safety signalling supply. Acceptable methods are a separate dedicated battery or rectification of an AC supply, the latter incorporating an isolating transformer.

3.4 The connection of instrumentation shall not permit safety-critical signalling circuits to function in any other way than their intended manner.

4. Guidelines for Temporary Unattended Monitoring

4.1 Temporary Unattended Monitoring is defined as the connection of test instrumentation to the working system where the equipment might remain connected for up to six months without a competent person being continuously present. The S&TME may approve extended retention of the monitoring arrangements if required, including permanent connection.

4.2 The requirements for short duration attended tests (Section 3) also apply to temporary unattended monitoring. Additionally, the connection and disconnection of the test instrumentation shall be under the control of an Engineer, who shall confirm that the requirements set out below are followed;

a) An overlay wiring diagram shall be prepared and independently checked. This diagram is additional to the existing site diagrams and shall show the instrumentation and all its connections along with the name and contact details of the Engineer responsible for the work. A copy shall be kept in a prominent place on-site for reference with the site diagrams.

b) Wiring provided for monitoring purposes shall use a coloured insulation or sleeving, other than red, distinctive to the installation concerned. Wires shall, as far as possible, use existing wire routes and be securely positioned to avoid being pulled or otherwise damaged. All terminations shall be of a standard acceptable for permanent installations.

c) Where spare conductors in lineside cables are jumpered through for monitoring purposes the jumpers shall be the same colour as the rest of the monitoring wiring and have a durable label attached giving details of where the overlay diagram is located.

d) Where monitoring is confined solely to spare relay contacts or data outputs, and provided that any power source connected to those spare contacts is completely separate from any safety signalling supplies, direct connection between instrument inputs and the spare contacts is permitted.

e) Other than where an instrument has been specially examined and declared suitable by a competent Engineer, all connections to safety-critical signalling circuitry shall incorporate a series connected device intended to protect the signalling against an instrument fault. The device can be either a fuse or resistor, the value being selected to limit current to a level incapable of malfunctioning the signalling equipment.

f) Where all test wiring is confined to a single apparatus case or relay room and installed using single wires, the protective devices can be inserted adjacent to the instrument. Where test wiring utilises cables, the protective devices shall be inserted between the signalling connection and the cable. Where a number of protective devices are assembled into one enclosure, steps shall be taken to provide physical and electrical separation between individual circuits so as to preclude crosstalk.

g) The direct measurement of current shall be avoided wherever possible. The preferred method of current measurement is clip-on probes or voltage measurement across a known resistance.

h) The installation work shall be independently checked before implementation, by the Engineer responsible for the work.

i) On completion of the monitoring, the Engineer responsible for the work shall confirm that the system is returned to its original state.

j) Where temporary monitoring arrangements are subsequently to be made permanent, the requirements NR/SMTH/Part01/Module/14 (Site and Testing Records) shall be complied with.

5. Guidelines for Permanent Fixed Monitoring Systems

5.1 Clause 4 for Temporary Unattended Monitoring shall be followed, except for the use of distinctive wire insulation colours and the provision of an overlay diagram.

5.2 Where a particular design of monitoring instrumentation has been assessed by a competent Engineer, and guidelines produced for its use, design staff can use these guidelines for design purposes.

5.3 Permanent monitoring schemes are to be included in the site wiring diagrams, installed and tested to the same standard as the signalling system itself. No distinction is required in the colour of wiring insulation.

5.4 Where such permanent systems monitor voltages via protective devices, arrangements shall be made to periodically verify the effectiveness of these devices.

END

Includes:	Test Straps, Unattended Temporary Straps
Excludes:	Test Wiring (see NR/L2/SIG/30014/A110) Use of straps in non-operational relay rooms / location cases (see NR/L2/SIG/30014/A110) Other Simulation Equipment / Devices / Products (see NR/L2/SIG/30014/A110) Temporary Wiring (see NR/L2/SIG/11201/A2-13)

1. Definitions

Term	Definition
Authorised Manager	The manager authorised to control and manage straps. For Network Rail maintenance organisations this is the SM(S); For Instrumentation Engineers this is the S&TME. For SITH this is the Responsible Signal Engineer. For SWTH this is the Tester in Charge. For work / organisations outside of the above, the Authorise Manager appointment shall be defined in the organisation's Quality Management Plan. The Authorised Manager can delegate these responsibilities in accordance with appropriate delegation arrangements but remains accountable for the control and management of the straps.
Cable Insulation Test Strap	A Test Strap that consists of multiple wires (usually 25) terminated together at one end with connectors fitted at the other, that is used to connect conductors together in a cable for insulation testing purposes.
Competent Person	A Competent Person shall hold either: SMTH Tester Competency; or SITH G110 Tester / Lead Tester Competency; or SWTH 3C Verification Tester Competency or above; or Instrumentation Engineer certification.
Test Strap	A wire strap for momentary, short term use, that remains in the custody of the Competent Person to whom it is issued. Test Straps include Cable Insulation Test Straps. Test Straps shall not be left unattended on-site at any time.
Tester	A Tester shall hold either: SMTH Competency; or SITH G110 Tester / Lead Tester Competency; or SWTH 3BL/4 Functional Tester Competency.

Term	Definition
Unattended Temporary Strap	A strap for longer term use, that is connected in a secure manner. This can be by using the correct connector type for the termination point where it is to be used, or other suitably secure connector that is unlikely to be dislodged while unattended.

2. Introduction

2.1 Only an Authorised Manager shall issue straps for use in testing signal circuits.

2.2 It is forbidden to use any straps that have not been authorised for use by an Authorised Manager; unauthorised devices such as extractor tools shall not be used as a substitute for straps.

2.3 Authorised Managers shall authorise the purchase or construction of straps as required.

2.4 Authorised Managers shall keep Strap Register(s) that have entries for:

a) Details of the identities of all Test Strap containers if applicable and all individual straps.

b) The purpose for which they have been purchased / constructed, including for Unattended Test Straps, the location and the dates / times the straps are to be applied on site and removed from site.

c) The name of the Competent Person / Tester to whom it / they are issued.

d) The signature of the Competent Person / Tester to confirm receipt.

e) The date / time of issue.

f) The signature of the Authorised Manager to confirm return.

g) The date / time of return, and, in the case of damaged Test Straps or Unattended Temporary Straps, of destruction.

NOTE: *The identities of individual straps may be recorded using a copy of the Test Strap Record Card attached to the Register.*

2.5 The Authorised Manager shall check their Strap Register(s) at periodic intervals.

2.6 Care shall be taken not to cause damage when applying straps; the connector type shall be compatible with the termination point such that the risk of damage is minimised.

3. Test Straps

3.1 All Test Straps shall be removed immediately after the work is completed and before leaving site. No Test Strap shall be left unattended.

3.2 GERT8000 Rule Book Handbook 19 "Work on signalling equipment - duties of the signalling Technician" disconnections shall be in place before Test Straps are used.

3.3 Only Competent Persons shall be issued with and / or use Test Straps, apart from SWTH testing, when a Module 5 Assistant Tester can use Test Straps under supervision of the Competent Person.

3.4 Test Straps shall only be used for:

a) Release of controls as specified in module B003.

b) Resetting of block systems as specified in module B003.

c) Testing for faults, when all other methods of testing have been exhausted.

d) Cable testing.

e) SITH testing in accordance with the SITH Test Schedule.

f) SWTH testing in accordance with the SWTH Test Plan.

3.5 During faulting work, Test Straps shall only be used as a last resort when all other testing methods have failed to identify or rectify the fault.

3.6 Test Straps shall not be daisy chained (linked) to extend their reach, apart from use during SWTH testing.

3.7 Test Straps shall be constructed of yellow wire to allow easier identification amongst other wires.

3.8 Each Test Strap shall carry a firmly attached label(s) that contains the following information:

a) The unique Test Strap identity.

b) Information that allows the strap to be traced back to the issuing organisation, e.g. organisation name / Competent Person's name / location / telephone number, etc.

3.9 Test Straps shall not be stored loose in a tool bag, but shall be stored in a clearly defined container, avoiding containers that are likely to be crushed or damaged.

3.10 The container holding the Test Straps shall include a Test Strap Record Card recording the unique identity of all Test Straps in the container, see Appendix A for an example.

3.11 Test Strap containers can be provided with an identity, if required, which shall be recorded on the Strap Register and Test Strap Record Card.

3.12 Test Strap Record Cards shall also provide a record of usage of each Test Strap, apart from use during SWTH testing.

3.13 The Authorised Manager shall issue the Test Straps to the Competent Person, and record on the Strap Register the Competent Person's name and the container identity if applicable and the identities of all Test Straps.

3.14 On receipt of the Test Straps, the Competent Person shall check the Test Straps for damage and correct identities and confirm receipt by signing the Strap Register and adding the date and time.

3.15 The Authorised Manager, or representative, shall periodically check the Test Straps they have issued as part of routine surveillance.

3.16 The Competent Person to whom the Test Straps are issued shall keep them secure and check them regularly.

3.17 Test Straps shall only be used by the Competent Person to whom they have been issued, unless authorised otherwise by the Authorised Manager, apart from use during SWTH testing.

3.18 For SWTH testing, the Competent Person can supervise use of Test Straps by a Module 5 Assistant Tester.

3.19 Before work starts, and at the start of each shift, if Test Straps are required the Competent Person shall check the contents of the container matches what is recorded on the Test Strap Record Card.

3.20 After work is completed, and at the end of each shift, all Test Straps used are to be returned to the container.

3.21 The Competent Person shall again check the entire contents of the container matches what is recorded on the Test Strap Record Card, to confirm all Test Straps have been removed from site and returned to the Test Strap container.

3.22 The Competent Person shall also record the use of the Test Strap(s) on the Test Strap Record Card, apart from use during SWTH testing.

3.23 The Competent Person shall also record on the Test Strap Record Card if any Test Straps need to be withdrawn due to damage, etc.

3.24 When Test Straps are no longer required or are withdrawn, the Competent Person shall return them to the Authorised Manager.

3.25 The Authorised Manager shall check the Test Strap(s) for damage and correct identities and confirm their withdrawal by signing the Strap Register and adding the date and time.

4. Unattended Temporary Straps

4.1 Only Unattended Temporary Straps provided specifically for the purpose shall be left unattended. Test Straps shall not be used.

4.2 GERT8000 Rule Book Handbook 19 “Work on signalling equipment - duties of the signalling Technician” disconnections shall be in place before Unattended Temporary Straps are used.

4.3 A Method Statement, SITH Test Schedule or SWTH Test Plan shall be produced prior to the construction or application of any Unattended Temporary Straps.

4.4 Only Testers shall be issued with Unattended Temporary Straps.

4.5 Unattended Temporary Straps can be used and be left in situ unattended for works such as:

a) Emergency works, in accordance with the method statement.

b) Engineering works, e.g. temporary linking out of circuit functions such as point detection, ground frames and track circuits occupied, in accordance with the method statement.

c) SITH works in accordance with the SITH Test Schedule.

d) SWTH works in accordance with the SWTH Test Plan.

NOTE: *The use of temporary straps for the diversion of circuits in a defective cable is not covered by this instruction as their use is specified in* NR/SMTH/Part01/Module/13 (Procedure for Monitoring a Damaged Cable).

4.6 All Unattended Temporary Straps should normally be constructed of bright pink wire to allow easier identification amongst other wires, or in another distinctive colour where this colour has already been used for temporary wiring in the relay room / location case.

4.7 Red wire shall not be used as this is reserved for temporary cable core diversion.

4.8 Each Unattended Temporary Strap shall carry a firmly attached label that contains the following information:

a) The unique Unattended Temporary Strap identity.

b) The purpose and location of the Unattended Temporary Strap.

c) Information that allows the strap to be traced back to the issuing organisation, e.g., organisation name / telephone number, etc.

4.9 Unattended Temporary Straps shall not be stored loose in a tool bag, but shall be stored in a clearly defined container, avoiding containers that are likely to be crushed or damaged.

4.10 The Authorised Manager shall record on the Strap Register the details of the purpose and identity of any Unattended Temporary Strap(s).

4.11 Due to the nature of this type of work bespoke straps would normally be produced; Unattended Temporary Straps shall not be re-used except where a strap is required to be applied, removed, and then reapplied multiple times in the same position in the same circuit.

4.12 Design is required for the application and the subsequent removal of any Unattended Temporary Strap(s). This shall be produced and checked by persons assessed as competent to do so, including Testers.

4.13 The Design can be in the format of a register or schedule, red / green design diagrams or another appropriate format as agreed.

4.14 As a minimum the Design shall detail the location / relay room, the circuit in which the Unattended Temporary Strap is being applied, and the precise position of the strap in that circuit.

4.15 The Authorised Manager instructing the construction of the Unattended Temporary Straps shall provide a copy of the Design and the Strap Register specifying the unique identity for each strap to the person constructing the bespoke straps.

4.16 The Authorised Manager shall issue the Unattended Temporary Strap to the Tester, and record on the Strap Register the Tester's name.

4.17 On receipt of the Unattended Temporary Strap, the Tester shall check the strap for damage and correct identity and confirm receipt by signing the Strap Register and adding the date and time.

4.18 A copy of the Strap Register entries and the Design shall be provided to the Tester.

4.19 When the Unattended Temporary Strap is in position and ready to be applied, the position of the strap shall be independently checked by a Tester prior to application.

4.20 The Tester shall positively confirm that the Unattended Temporary Strap is operating correctly by checking the control or function is correctly bypassed as the strap is applied, and then complete any wire counting or other checks as required.

4.21 The testing of the Unattended Temporary Strap shall be recorded on the Design by the Tester, along with their initials and the date / time.

4.22 A temporary maintenance copy of the Design detailing the position of the Unattended Temporary Strap(s) shall be left in the location / relay room until the straps are removed.

4.23 When the Unattended Temporary Strap is removed, the Tester shall test the control or function is now operating normally and complete any wire counting or other checks as required.

4.24 The testing of the removal of the Unattended Temporary Strap shall be recorded on the Design by the Tester, along with their initials and the date / time.

4.25 The Unattended Temporary Strap, the marked-up Design and the temporary maintenance copy shall now be returned to the Authorised Manager.

4.26 On the return of Unattended Temporary Strap, the Authorised Manager shall check the identity of the strap and confirm receipt of the Unattended Temporary Strap by signing the Strap Register and adding the date and time.

4.27 The Authorised Manager shall destroy the Unattended Temporary Strap; it shall not be reused for another purpose or in another location or circuit without a new identity being allocated and a new label with the new identity being applied.

APPENDIX A - Test Strap Record Card

Test Strap Container Identity *(if applicable)*:	

Name:	

Test Strap Container Contents		
Item	**Unique Item ID**	**Notes**

Test Strap Use *(not required for SWTH testing)*				
Item	**Unique Item ID**	**Location**	**Checked-Out**	**Checked-In**

END

1. Telegram Error Rate Test Set

1.1 Is used on SSI systems to measure the telegram messages sent over the datalink. This device is available for use under controlled conditions which shall be documented and authorised by the S&TME. Subject to this authority, it may be connected directly to SSI current loop test points, but power shall be supplied using a mains adapter which incorporates an isolating transformer.

2. SSI TFM Input Tester

2.1 The TFM Input Tester has been developed to enable testing of transient suppression devices fitted to inputs of later types of SSI Point Modules and Signal Modules only. This testing, not done by any existing TFM Go/NoGo tester, can detect input degradation before a signalling failure occurs.

2.2 Only Point and Signal Modules of the following types can be tested: WRSL Mk3A; Alstom Mk3; and Alstom Mk4 or higher. Earlier versions of SSI TFM do not contain the same input transient suppression devices and cannot be tested by this device. TFMs can be tested on site using their own power supply, or in the workshop using the Power Adaptor Cable.

3. Portable Digital Oscilloscopes

3.1 Used for measurements to locate SSI data link faults where the Technician's Terminal cannot provide sufficient information.

3.2 Essential features are digital storage, external triggering (an external trigger pulse should be generated using a Data Link Interrogator), variable pre-trigger, word length greater than 2K, sampling rate greater than or equal to 1 Megasample/second and having at least two channels. Differential inputs, battery operation, cursor measurement and the ability to print or plot are desirable.

3.3 The two data links shall never be connected.

4. Portable Diagnostic Devices

4.1 Systems, such as HPSS points and axle counters use pluggable diagnostic computers or handsets, to assist in fault finding, set-up and testing.

5. TCAID Test Set

5.1 This device can be used for all three types of TCAID, but due to the differing input impedances, different meter readings will be obtained for each type. The meter is used to determine whether the TCAID system is capable of shunting the track circuit given the presence of a TCA fitted train. Different test procedures need to be undertaken for all three different types of system.

END

1. AC Busbar Earth Test Adapter

1.1 This device (Figure 1) is used in conjunction with an electronic measuring meter to determine that non-earthed a.c. equipment and power supplies up to 110V, 50Hz are earth free. Earth tests are undertaken and the earth leakage is compared against a calculated figure. If any of the results show a voltage higher than that permitted, then methodical disconnections are to be made until the earth is located.

Figure 1 - AC Earth Test Adapter

2. FDM Earth Test Adapter

2.1 The Non-Intrusive Earth Leakage Test Adapter for Reed FDM Systems is a live tester for use on Reed FDM systems.

2.2 Further information is available in Operation and Maintenance Specification, NR/SP/SIG/10029.

END

1. Types

1.1 There are two types of Strength and Polarity (S&P) Indicator (Figure 1) used for testing the strength of the magnetic field (flux). Each meter is coloured to correspond with the type of inductor/permanent magnets for which it is calibrated. Yellow for a standard strength inductor and green for an extra strength inductor.

Figure 1 – Yellow AWS Strength and Polarity Meter

2. Before Use

2.1 Before using either meter, check that the pointer is against its end stop in the red sector and no letter (P or E) is shown in the display window. If the position of the needle is incorrect or a letter is displayed the meter might have been dropped or misused and the control spring damaged. The meter will not be reliable and should be returned for inspection, repair and re-calibration.

2.2 To confirm a true indication of the strength of the magnetic field is obtained, move the S&P meter over the nominal centre of the magnet until the pointer is at its maximum deflection.

3. Green S&P Meter

3.1 The green S&P meter is used for testing extra strength inductor/permanent magnets. A 46mm wooden block shall be placed under the S&P meter, if it is not built into the S&P meter case.

4. Extra Strength Suppressor Inductor

4.1 The extra strength suppressor inductor/permanent magnets should be tested with a Gauss meter or similar device.

END

1. Introduction

1.1 All plant, tools, materials and equipment etc, are to be securely stored and locked when not in use. This is to prevent vandals from placing unsecured plant or materials on the track and putting trains at risk.

2. Fire Prevention and Tidiness of the Line

2.1 Extensive damage can be caused by fire, so flammable substances such as paper, wood shavings, scrap timber, cotton waste and litter are not to be left near any equipment.

2.2 Points, signals and their connections, cable routes and locations are to be kept free of ballast, weeds, rubbish and any other obstructions which prevent the correct operation of equipment. Branches of trees are not to be allowed to foul or interfere with the sighting of signals.

2.3 All redundant recoverable equipment is to be removed from site as soon as possible.

3. Plant

3.1 Unless stored in a secure depot or building all wheeled/portable plant and hand trolleys are to be chained to a substantial fixed object. Purpose made security chain is to be used and secured by a high security padlock. The chains are to be secured by the padlock in such a way as to prevent the possibility of using the momentum of the plant or trolley to assist in breaking it free.

4. Material

4.1 Materials and equipment which have been supplied for work and not used, are not to be left on or near the line but are to be returned to the depot as soon as the work is completed. Valuable materials are to be secured.

4.2 Materials and tools are not to be left foul of the running line, any walking routes, level crossing or on station platforms.

4.3 All other movable objects weighing under 500kg (1100lb) which constitute a possible derailment hazard if placed on the track are to be secured with purpose made security chain and high security padlocks to a substantial fixed object. If this is impractical items should be stored in a locked container, such as a Portastor 'Vault Tool', or building, or removed from site immediately work has ceased.

4.4 Concrete cable route materials should be laid out as close as practically possible to the date of installation. Where there is a delay between the installation of the route and the installation of the cable, the route should be lidded up as final as it is completed and de-lidded for cable installation. Lids should be installed as final immediately following cable installation.

5. Staff Safety

5.1 When secured, items of plant, equipment or materials are not to obstruct refuges, recesses, walkways or walking routes.

6. Redundant Material

6.1 Scrap or surplus material should be stacked in an orderly manner and cleared away as soon as possible. Valuable surplus material such as copper wire and cable are to be kept secured until returned to the depot.

6.2 Different categories of potentially hazardous waste should be segregated so that it can be removed by an approved contractor.

6.3 Skips for scrap are an important weapon in the fight to keep the railway safe, neat and tidy, but a skip is itself a source of potentially dangerous materials. They should be positioned well away from any area to which the public have right of access and preferably where they can be left under surveillance, i.e. in well-lit surroundings near staff accommodation, signal boxes, etc.

7. Strategic Spares

7.1 Certain equipment, regarded as strategic by Network Rail, is not to be scrapped when recovered, but dispatched to a central holding point, as directed by the SM(S).

8. Temporary Works, Plant and Materials on Platforms

8.1 Always advise the senior member of station staff before starting work.

8.2 The following shall not be completed closer than 1.8m from any open part of a station platform without a safe system of work:

a) Use of ladders and scaffolding, including mobile scaffold towers.

b) The storing of plant or materials.

c) Or the use of portable plant.

If in any doubt, ask the SM(S).

8.3 Where the working area is between 1.0m and 1.8m from the edge platform, a safe system of work shall be set up. This allows a warning to be given so that the ladders, steps or plant etc, can be moved to a position where no part of the equipment is less than 1.8m from the platform edge. The equipment shall remain clear until the train has passed.

8.4 Before constructing, using, or storing, any equipment, plant, or materials anywhere on a platform open to the public, the SM(S) shall consult with the manager responsible for the station.

9. Working near OLE

9.1 Take extreme care when using or carrying long items, make sure they do not come within 2.75 metres (9 feet) of the OLE. Long items shall be carried horizontally, if necessary, get other people to help you.

9.2 No work can take place anywhere without a safe system of work being already in place.

9.3 Additional line protection shall be put in place while using ladders, scaffolding or mobile scaffold towers.

9.4 When using ladders near OLE, you shall only use ladders that are made of wood or other safety-approved non-conducting material. Do not use ladders that are reinforced with metal attachments running along the sides.

END

1. General

1.1 These common hazards are often encountered in the worksite, but this module is not exhaustive.

2. Handling Cable Drums

2.1 Staff handling cable drums shall wear protective gloves and keep fingers and hands clear of moving parts.

2.2 Specifically, designed cable jacks shall be used, rather than improvised lifting methods.

2.3 Drums shall not be dropped off vehicles, unless there is no alternative and adequate cushioning is provided, in which case staff shall stand well clear.

2.4 Advise the SM(S) of any damaged cable drums.

2.5 When rolling drums, whether full or empty, staff shall take the following risks into account:

a) The mass of the drum.

b) The condition of the drum.

c) The visibility in the direction in which the drum is being rolled.

d) The condition of the ground such as smooth, hard, flat and gradient.

e) Plan the route to destination.

f) Always keep the drum under control.

g) Roll only in the direction of the markings, if provided, such as 'Roll this way only'.

h) Always keep a lookout.

i) Never pull the drum with their back to the direction of travel.

j) Keep fingers clear of drum bolt heads.

2.6 Drums must be chocked to prevent their accidental movement when not in use and examined for rot or deterioration every three months.

2.7 When steel binding straps are cut, they should be restrained from springing upwards and eye protection shall be worn.

2.8 When removing battens, they should be stored safely, due to the danger of protruding nails.

2.9 If the drum is stored on its side, regardless of the size, then the rolling bar shall always be removed and never stored in the centre hole.

3. Occupational Dermatitis

3.1 See NR/GN/OHS/00150 - Infection Control.

4. Leptospirosis

4.1 See NR/GN/OHS/00150 - Infection Control.

5. Contaminated Cable Insulation

5.1 Substances leaking from degraded cables and wiring do not normally present a hazard to health provided they are not swallowed or allowed to come into contact with the skin.

5.2 Impermeable gloves and overalls should be worn when dealing with a leaking substance and should be disposed of correctly at the end of each shift. Refer to the relevant Task Risk Control Sheets in NR/L3/MTC/RCS0216.

6. Sharps and Needles Injuries

6.1 See NR/GN/OHS/00150 - Infection Control.

7. Noise

7.1 Ear defenders are to be worn wherever the ear defender sign is exhibited also when identified in the Task Risk Control Sheets. If noise levels whilst undertaking a work task make it difficult to talk without shouting, you should stop work until the noise level has reduced and inform your SM(S).

8. Lead Work

8.1 All staff shall be trained in the safety aspects of lead work before carrying out work.

8.2 Personal protective equipment shall need to be used.

9. Cadmium

9.1 Cadmium is a bright anti-corrosion finish often found on nuts, bolts and washers. Unless proven otherwise the plating of metal components should be assumed to be cadmium. Always wash your hands after handling plated components particularly before consuming food.

9.2 No flame cutting or burning of plated nuts, bolts or washers is permitted without protection. Fumes and dust containing cadmium are potentially very harmful and care should be taken to not inhale the fumes.

END

1. General

1.1 Asbestos is a strong, durable and non-combustible fibrous mineral, which is known to be harmful when inhaled. Asbestos has been used extensively throughout the railway. Advantage was taken of its engineering properties as a fire-resistant insulating material.

1.2 Legislation covering the use and treatment of asbestos is provided in the current Control of Asbestos Regulations (CAR) and associated approved code of practice and guidance L143.

1.3 If damaged asbestos is found or suspected, staff shall stop work and report the fact immediately to the SM(S) who will escalate the discovery.

1.4 Asbestos Containing Materials (ACMs) shall not be subjected to drilling, machining, brushing, scraping, dusting, cleaning, wiping, sanding, filing, sawing/cutting or any other activity which could release asbestos fibres into the atmosphere.

1.5 The current asbestos information held in Asbestos Risk Management System (ARMS).

1.6 Before carrying out any activity, the Signalling Technician shall check the Asbestos Risk Management System (ARMS) for the current status of the worksite/equipment and any action that may need to be taken.

1.7 If Asbestos Containing Materials (ACM) are sound, undamaged and are unlikely to be damaged, no action is necessary.

1.8 If available, check and sign the onsite Operational Site-Specific Asbestos Management Plan (OSSAMP) which explains any precautions that need to be taken at the worksite/equipment.

1.9 Further information can be found in NR/L2/CIV/168 – Asbestos Management.

2. Asbestos on the Railway

2.1 Typical applications included:

a) Insulating material, sprayed on structural steelwork.

b) Lagging material for pipework, boilers, etc.

c) Insulating boards for noise and heat, mixed with a bonding agent like cement.

d) In insulating materials used in electrical equipment.

e) In rope form, to provide fire protection packed around pipework passing through walls.

f) A fire protection overwrap for electric and signal cables.

g) Mixed with bitumen for coating corrugated sheets.

h) Asbestos cement products for rainwater goods, tanks and roofing material, etc.

i) A component of brake lining material or clutch fiction plates.

j) Arcing fire protection materials in rolling stock.

k) Paper gaskets in some signal heads, AWS and point machine

2.2 Predicting where to find asbestos in the railway environment is not simple. Some locations have been surveyed and the residual asbestos stabilised.

2.3 There are still locations which have not yet been surveyed, and many inaccessible areas such as behind false walls and ceilings which require investigation and risk assessment before work can be performed safely.

3. Application to S&T Equipment

3.1 In the first instance refer to the ARMS entry and review any OSSAMP for an asset or asset type, if no OSSAMP is available refer to NR/WI/ELP/00110 for guidance.

3.2 Method statements will be incorporated into generic OSSAMPs (Operational Site-Specific Asset management Plan) which will be in ARMS outlining what work can be undertaken without specialist training, typically covering assets as listed below.

a) Low voltage fused isolators (interior compartment lining).

b) Equipment and relay rooms (shelves).

c) 650V Switchgear for signalling supplies (door seal using fibrous rope, flash guard).

d) Standby generators (asbestos wrapping on exhaust pipe).

e) Cable troughing (non-concrete types).

f) Location cases (door seals, cable entry baseboards).

g) Points machine types M3, M3A, HA, HB, HW (bevel gear bearing and thrust washer, friction clutches, fibrous rope seals, paper gaskets.

h) Signal Heads - AEI-GRS (door seal), filament lit CLS may contain paper gaskets or putty, used to retain lens or used as to seal a cable entry point.

i) Signal relays types QJ1, QJN1, PTT1, PTT2, TT1B, TT3B, TT6B and TT5 (asbestos covered thermal timing elements).

j) Pump gaskets.

k) Asbestos covered cables.

END

1. PCBs in S&T Equipment

1.1 PCBs are environmentally toxic, man-made organic compounds that were historically used in a wide range of industrial applications. Since being classified as persistent organic pollutants (POPs) under the Stockholm Convention in 2001, PCBs have been heavily regulated in the UK under the legislation cited above.

1.2 Under the legislation, there is also a requirement to register any contaminated equipment of unconfirmed PCB status where it is reasonable to assume that PCBs may be present on grounds of its age.

1.3 PCBs are a known hazard used as the oil in old type capacitors and transformers. It is known that they were used in limited S&T applications, mainly in capacitors since their use in transformers is usually found only in higher power equipment.

1.4 If PCBs are known or suspected to exist in capacitors or transformers, hazard warning signs shall be affixed on or immediately adjacent to the equipment. If you see the PCB warning label on a piece of equipment, do not touch it.

1.5 See Table 1 for component identification. Note that transformers to BR 924A (air cooled only) or to BS 148 (conventional oil filled) do not contain PCBs.

2. Spillage

2.1 If you find any leaking components, you shall inform the SM(S) as soon as possible. Do not touch the equipment.

2.2 If there is any possibility of contact, full impervious protective clothing should be worn, including gloves, overshoes, goggles and respirator.

2.3 Any contaminated clothing shall be disposed of as in Section 4.

2.4 Decontamination from spillage shall only be undertaken by a specialist contractor.

3. Replacement

3.1 Equipment containing PCB's that are in good condition do not need to be immediately replaced. Whenever such equipment is found, guidance should be sought.

3.2 If a component is known to contain or be suspected of containing PCBs and is found to be leaking, the component should be considered as failed and arrangements made for replacement. Do not touch the equipment.

Trade names using PCBs at one time				
Aceclor	Apirolio	Aroclor	Asbestol	Askarel
Auxol	Bakola 131	Biclor	Chiorextol	Chloroxotol
Clophen	Clophenharz	Cloresil	Delor	Delorene
Diaclor	Discanol	DK	Ducanol	Dychlor
Dykanol	Elaol	Electrophenyl	Elemex	Fenclor
Fenocloro	Gilotherm	Hivar	Hyvol	Inerteen
Interteen	Kanechlor	Kaneclor	Kennechlor	Leromoll
No-Flamel	Olex-sf-d	Orophene	Phenoclor	Prodelec 3010
Pydraul	Pyralene	Pyranol	Pyrochlor	Pyroclor
Saf-T-Kuhl	Sof-T-Kuhl	Santosol	Santotherm	Siklonyl
Solvol	Sovol	Sovtol	Terphenychlore	Therminal
Turbinol				

Known manufacturers and dates	
BICC	1958-1979
Hunts Bryce (now ASEA/BICC)	1964 -1979
Capacitors Ltd. (HWAR)	1962 -1975
Johnson & Philips	1970 -1977
Dubilier 'DUCONOL'	-1974
Claude Lyons (aluminium cans with pink or green cement at connector end)	

Equipment containing PCB-filled components	
Harmer & Simmons	Power supply units 'HS2T', 'CYCLOSTAT', 'FIXED CURVE' (prior to 1973 and up to serial number 129000)
GEC - General Signal (prior to 1980)	Constant voltage transformers for: Type D Remote Control, Train Describers and Reed RR 9110, RR 9121, RR 9131, RR 9181. Power supplies NT 1202, NT 1212, NT 1302
Gourock/ Ladybum	Track circuit capacitors H 2007A and reference KP on drg CD 14312.
G4 relays	Catalogue numbers 88/30516 and 88/30833
Gould Voltstat	Sine wave output type no.15 O/C capacitor marked: Sprague Chlorinol 5.0 - 66AC, 60Hz 200P66005KC36P4X made in USA
Rediffusion	Automatic voltage stabiliser model MCA220 200VA, 50Hz capacitor marked: DF capacitor 4mF 1600TV AC 197 4.24
Transformers to BS 171 with coolant classification 'L' on the nameplate contain synthetic coolants which might be PCBs.	

Table 1 – PCB Types

4. Disposal

4.1 This shall be carried out by a specialist contractor.

END

1. General

1.1 This module concerns the handling of Cathode Ray Tubes (CRTs) and the servicing and maintaining of equipment containing CRTs such as TV monitors, Visual Display Units (VDUs) and Oscilloscopes.

1.2 Throughout this module reference to CRT includes any equipment containing CRTs.

2. Hazards

2.1 There are two main hazards associated with working with CRTs:

a) **Implosion**: The violent collapse of the glass due to the vacuum within it.

The implosion of a CRT will cause the tube to shatter leaving glass shards exposed, it also releases toxic chemicals associated with the phosphor contained within the tube.

b) **Electric shock**: This can be as high as 30kV. Shocks can be due to:

- High Voltage Power Supply; the supply to the CRT is at high voltage when the equipment is switched on.
- Charged Capacitors - capacitors can take a long time to discharge after the power supply has been switched off.

3. Electric Shock

3.1 All adjustments to CRT equipment shall be carried out in accordance with the supplier's instructions.

3.2 Where possible the power supply shall be switched off.

Remember that high voltage can be present for some time after the equipment is switched off.

3.3 Circuit alterations and component changing shall be carried out at recognised service centres.

3.4 The use of a rubber mat to stand on can reduce the risk of electric shock.

3.5 Rings, watches, bracelets, etc. are to be removed or taped.

3.6 When working with the power supply off, the Extra High Tension (EHT) shall be discharged.

The CRT acts as a capacitor and holds a charge. As a result, the EHT terminal of a CRT can still be charged at several thousand volts after the power is switched-off.

Since such high voltage charges have little energy, they are unlikely to be lethal in themselves, but they could lead to serious injuries due to involuntary muscle action.

3.7 CRTs shall always be discharged before they are handled. They can re-establish a charge even though they are not connected to a supply. New tubes shall also be discharged before removing them from their packaging.

3.8 To discharge a tube which is connected to an EHT supply carry out the following:

a) The supply to the unit shall be switched off.

b) A probe rated at 30kV shall be connected to the tube metallic frame using a crocodile clip.

c) The probe shall then be inserted under the protecting shroud of the tube EHT terminal making contact with the terminal.

d) After discharge the probe lead shall be removed and the EHT connection to the tube disconnected from the tube.

e) A specially made strap shall now be connected between the tube EHT terminal and the tube metallic frame to prevent the tube recharging. This strap shall be left in place until the EHT lead requires reconnecting.

3.9 Tubes which have been stored disconnected from their associated circuitry shall be discharged using the 30kV probe between anode and all other pins shorted together.

3.10 Small CRTs such as those used in train describers which do not have a separate anode connection can be discharged by means of a socket which has all connections shorted.

END

1. General Precautions

1.1 All normal electrical precautions shall be taken when installing and operating battery charging equipment. Battery chargers connected to outside supplies shall be correctly earthed.

1.2 Before working near a battery, remove all metallic items such as wrist watches, rings, neck chains, etc.

1.3 Suitable insulated spanners which are in good condition shall be used.

1.4 Use the protective equipment. Electrolytes, whether acid or alkaline, are corrosive and toxic.

1.5 Keep sources of ignition – such as flames, sparks, electrical equipment, hot objects and mobile phones – well away from batteries that are being charged, have recently been charged, or are being moved.

1.6 Keep area well ventilated, whilst working in the battery room.

1.7 Wash your hands thoroughly after working with batteries, especially before eating, smoking or going to the toilet.

2. Equipment

2.1 The following safety equipment should be available at all battery rooms:

a) Goggles, Grade 1 Impact, Chemical, Dust and Molten Metal.

b) Gauntlet, Rubber, Type 'J', Medium Weight, 400mm long.

c) Apron, Rubber.

d) Eye Wash Solution, in 500 ml sealed container.

3. Notices and Signs

3.1 The following notices should be available at all battery rooms:

a) Electric Shock Notice.

b) Battery Charging Precautions Notice.

c) "No Smoking, No Naked Lights".

d) "Eye Protection Must be Worn".

e) "Caution: Risk of Electric Shock".

END

Standard and control document briefing note

Ref: NR/L3/SIG/10064	**Issue:** 13
Title: General Instructions to Staff Working on S&T Equipment	
Publication date: 07 June 2025	**Compliance Date:** 06 September 2025
Standard/Control Document Owner: Network Technical Head Signalling	
Standard change lead/contact for briefings: Chris Cresswell	**Tel:** 07702 914534
Purpose: This Handbook covers personal safety issues and the essential features of S&T equipment. The Handbook also includes information not covered by the Rule Book which is necessary for any S&T staff involved in lineside or technical work.	**Scope:** This Handbook applies to signal engineering staff.

What's new, what's changed and why:

This is the continuing update to the General Instructions to Staff Working on S&T Equipment, to confirm the most update to date is provided.

A new module has been added as part of continuous improvement due to changes in procedures and feedback from end users. A summary table below gives the high-level numbers of documents / modules.

Detail of change

Module(s)/Section(s)/clause(s)	Title	Summary of changes
R004	Remote Maintenance – EBI Track 400 Calibration Guide	New document for RCM2 method of remote maintenance to be expanded to include EBI Track 400.

Affected documents

Reference	Issue	Impact	Document type
NR/L3/SIG/10064	12	Superseded	Standard
NR/GI/R004	1	New	Module

Briefing requirements:

Briefings are given to those who have specific responsibilities within, or are directly affected by, this standard/control document.

A copy of briefings may be available from the Standards & Controls site.

Requirements to cascade briefings are described within any implementation plans.

Briefing *(O-Overview/ D-Detailed)*	Post	Function	Responsible for cascade briefing? Y/N
O	Chief Control, Comm & Signalling Engineer	Technical Authority	Y
O	Network Technical Head Switches & Crossings	Technical Authority	Y
O	Head of System Authority	Technical Authority	Y
D	Regional Engineer [Signalling & Telecoms]	Regions (Eastern)	Y
D	Regional Asset Manager [Signalling]	Regions (Scotland)	Y
D	Regional Engineer [Signalling & Telecoms]	Regions (NW & C)	Y
D	Regional Engineer [CCS]	Regions (Western & Wales)	Y
D	Regional Engineer [Signalling & Telecoms]	Regions (Southern)	Y
O	Engineering Expert [Control, Command & Signalling]	Technical Authority	Y
O	Head of System Authority	Technical Authority	Y
O	Senior Programme Manager (F-CCS)	Technical Authority	Y
O	Programme Engineering Manager [Test & Commissioning]	Route Services	Y
O	Principal Engineer (Design) [Signalling]	Route Services	Y
O	Principal Innovations Engineer [Signalling]	Route Services	Y

Briefing (O-Overview/ D-Detailed)	Role	Function	Responsible for cascade briefing? Y/N
D	Workforce Development Specialist	Route Services	N
O	CCS Engineer	Technical Authority	N
O	S&C Engineer	Technical Authority	N
D	Route Engineer (Signalling)	Regions	Y
D	Asset Engineer	Regions	N
D	Signal Sighting Engineer	Regions	N
D	SINCS Engineer	Regions	N
D	Signal & Telecoms Maintenance Engineer	Regions (Maintenance)	Y
D	Section Manager (Signals)	Regions (Maintenance)	Y
D	Signalling Technical Support Staff	Regions (Maintenance)	N
D	S&T Maintenance Test Engineer	Regions (Maintenance)	N
D	Signals Team Leader	Regions (Maintenance)	N
D	Technician (Signalling)	Regions (Maintenance)	N
D	Operative (Signalling)	Regions (Maintenance)	N
D	Works Delivery Manager (Signals)	Regions (Works Delivery)	Y
D	Works Delivery Supervisor (Signals)	Regions (Works Delivery)	N
O	Project Engineer	Regions (Works Delivery)	N
D	Technician	Regions (Works Delivery)	N
D	Operative	Regions (Works Delivery)	N
O	Programme Engineering Manager	Regions (Capital Delivery)	Y
O	Project Engineer (Signalling)	Regions (Capital Delivery)	N
O	Test and Commissioning Engineer	Route Services	N
O	Designer (Signalling)	Route Services	N
O	Innovation Engineer	Route Services	N
D	Workforce Development Specialists	Route Services	N

NOTE: *Contractors are responsible for arranging and undertaking their own Detailed and Overview Briefings in accordance with their own processes and procedures.*