Technical Requirements for Axle Counters

Synopsis
This document mandates the technical requirements for the design of train detection systems using axle counters.

Submitted by
Paul Woolford
Standards Project Manager

Authorised by
Anne Blakeney
Acting Controller, Railway Group Standards

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# Technical Requirements for Axle Counters

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Part A

A1 Issue record

<table>
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<tr>
<th>Issue</th>
<th>Date</th>
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<tr>
<td>One</td>
<td>February 2003</td>
<td>Original Document</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Supersedes GK/RC0527</td>
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</table>

This document will be updated when necessary by distribution of a complete replacement.

A2 Implementation of this document

The publication date of this document is 1 February 2003.

This document comes into force on 5 April 2003.

The dates by which compliance with the requirements of this document is to be achieved are set out in Part B2. Where those dates are later than the date on which this document comes into force, this is to give Railway Group members additional time to plan and commence implementation so as to achieve full compliance by the dates set out in Part B2.

This document supersedes the following Railway Safety Approved Code of Practice, either in whole or in part as indicated:

<table>
<thead>
<tr>
<th>Railway Group Standard</th>
<th>Issue No.</th>
<th>Title</th>
<th>RGS sections superseded by this document</th>
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<tr>
<td>GK/RC0527</td>
<td>1</td>
<td>Axle Counters: Resetting and Restoration to Service</td>
<td>All</td>
<td>5 April 2003</td>
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</table>

GK/RT0027 sets out high-level requirements for resetting and restoration to service of signalling systems and is supported by specific recommendations for axle counters in GK/RC0527, which are replaced by the requirements in GK/RT0217.

GK/RC0527 will be withdrawn in full with effect from 5 April 2003.

A3 Scope of Railway Group Standards

The overall scope of Railway Group Standards is set out in Appendix A of GA/RT6001. The specific scope of this document is set out in Part B2.

A4 Responsibilities

Railway Group Standards are mandatory on all members of the Railway Group* and apply to all relevant activities that fall into the scope of each individual’s Railway Safety Case. If any of those activities are performed by a contractor, the contractor’s obligation in respect of Railway Group Standards is determined by the terms of the contract between the respective parties. Where a contractor is a duty holder of a Railway Safety Case then Railway Group Standards apply directly to the activities described in the Safety Case.

* The Railway Group comprises Railtrack PLC, Railway Safety, and the train and station operators who hold railway safety cases for operation on or related to infrastructure controlled by Railtrack PLC.
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Railtrack PLC is known as Railtrack.

A5 Health and safety responsibilities

In issuing this document, Railway Safety makes no warranties, express or implied, that compliance with all or any documents published by Railway Safety is sufficient on its own to ensure safe systems of work or operation. Each user is reminded of its own responsibilities to ensure health and safety at work and its individual duties under health and safety legislation.

A6 Technical content

The technical content of this document has been approved by:

Richard Evans, Principal, Operations, Railway Safety
Jeff Allan, Principal Signalling and Telecoms Engineer, Railway Safety

Enquiries shall be directed to Railway Safety – Tel: 020 7904 7518.

A7 Supply

Controlled and uncontrolled copies of this document may be obtained from the Industry Safety Liaison Dept, Railway Safety, Evergreen House, 160 Euston Road, London NW1 2DX.
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Part B

B1 Purpose
This document mandates the technical requirements for the design and operation of train detection systems using axle counters, including the measures necessary to ensure an orderly restoration to normal working after an interruption or failure.

B2 Application of this document

B2.1 To whom the requirements apply
This document contains requirements that are applicable to duty holders of the infrastructure controller category of Railway Safety Case.

B2.2 Compliance requirements
The requirements of this document are mandatory for new Railtrack controlled infrastructure and for alterations to existing Railtrack controlled infrastructure for which Approval in Principle is given on or after 5 April 2003.

When Approval in Principle is given before 5 April 2003, but the infrastructure has not yet been brought into service, the design shall be reviewed and, where reasonably practicable, brought into line with the requirements of this document. Where it is not reasonably practicable to do so, the situation shall be regularised by means of a non-compliance or derogation.

Where it is known, or becomes known, that existing axle counters do not comply with the requirements of this document, action to bring them into compliance is only required when an axle counter installation is renewed as a whole.

Compliance with the requirements for record keeping (section D3) is mandatory in respect of new and existing axle counter installations with effect from 5 April 2003.

Until the compliance date, or the date by which compliance is achieved (if earlier), the applicable requirements of GK/RT0027 shall continue to be met (see Part A for details). This can be achieved by applying the recommendations of GK/RC0527.

After the compliance date, or after the date by which compliance is achieved (if earlier), Railway Group members shall not deviate from the requirements set out in this document.

Where it is considered not reasonably practicable to comply with the requirements set out in this document, authorisation not to comply shall be sought in accordance with GA/RT6001, GA/RT6004 or GA/RT6006.

B2.3 Related requirements in other documents
Operational safety requirements for managing the risk arising from the introduction and use of axle counters are set out in GE/RT8217.

The general requirements for train detection systems are set out in GK/RT0011.

Interlocking principles are set out in GK/RT0060.

B3 Definitions

Axle counter installation
All the axle counters being installed within the geographic limits of a scheme.
Clearance
For the purposes of this document, the minimum distance from points and crossings at which track section boundaries are required to be positioned, such that a vehicle on one track is in a position clear of a movement on the other.

Counting head
Wheel presence detection equipment that is fixed to the rail. Each counting head assembly consists of two counting heads and determines the number and direction of axles passing it.

Destructive testing
Testing or inspection that alters the electrical, mechanical or physical state of signalling equipment. This disturbance could destroy evidence or make a repetition of a fault impossible.

Evaluator equipment
Computing equipment provided to compare the outputs from counting heads located at the extremities of an axle counter section.

High-risk signalling failure
A signalling equipment or system failure that is not protected by any other item of signalling equipment. Otherwise known as a ‘wrongside failure – unprotected’.

Isolation facility
Equipment or software logic provided to isolate an axle counter section from the interlocking.

Miscount
Residual number of axles remaining in an axle counter evaluator, due to over or under counting, after the passage of a train through a track section.

Non-resettable counter
A counter (mechanical or electronic) that is provided for recording operations of the restoration facility. It is non-volatile and cannot be reset.

Permissible speed
The highest permitted speed (including any enhanced permissible speed) of a train authorised to run on the line.

Protection arrangements
Procedures set out in the Rule Book (GO/RT3000) and the Signalling General Instructions (GO/RT3062) for the protection of rail traffic during the failure of signalling equipment.

Reset
The action of setting the number of axles registered in a track section to zero.

Resetting facility
Equipment provided for each axle counter section to enable a signaller or technician to reset the section count to zero after a failure, disturbance or miscount.

Restoration
The final action in accepting an axle counter back into service after maintenance, failure, disturbance or miscount.

Restoration facility
Equipment provided for each axle counter section to enable a signaller to restore the section to service after maintenance, failure, disturbance or miscount.

Track section
A portion of railway track having fixed boundaries and for which the train detection system provides information on its state of occupancy.
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The output of an axle counter track section to the interlocking can have the following states:

- **Clear**
  The track section is clear of axles.

- **Occupied**
  The track section contains one or more axles.

- **Disturbed**
  An interruption has occurred in the ability of the axle counter system to record the passage of axles. Although the equipment has returned to working order, it cannot determine whether, or to what extent, the track section is occupied.

- **Failed**
  The axle counter system is not in working order.

- **Isolated**
  Disconnected from the interlocking during repair or maintenance work, or during the reset and restoration process.

- **Undefined**
  Some computer-based interlocking systems can accept the disturbed or failed states of an axle counter section as ‘undefined’. In other systems, such states are treated as ‘occupied’.

- **Wheelset**
  An assembly comprising a pair of wheels fixed to an axle. One of the wheels actuates the rail-mounted heads of the axle counter.

Other terms are as defined in GK/RT0002.

**B4 Principles**

This document supports HM Railway Inspectorate Safety Principle 20.

‘The signalling system should provide for the safe routing, spacing and control of trains.’
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Part C
Design requirements

C1 Functional requirements

C1.1 Primary functions of an axle counter
Within defined limits of specified track sections, axle counter systems and equipment shall be designed to detect the number of axles passing each counting head and from this to determine the state of each track section.

Equipment shall be designed to register and evaluate the passage of wheelsets in either direction.

C1.2 States of axle counter sections
Permissible states of each axle counter track section output shall be recognised by the interlocking as:

a) clear
b) occupied.

Disturbed and failed states of an axle counter track section shall be reported to the interlocking as ‘occupied’, unless the interlocking is configured to accept a state of ‘undefined’, when they shall be so reported. The isolated state shall be reported as ‘occupied’. The disturbed state shall be indicated to the signaller as ‘occupied’.

The transition of a track section from a clear to an occupied state shall be by the passage of the first axle of a train into the track section, and the transition from an occupied to a clear state shall be by the subsequent passage of the same number of axles out of the same track section as have been detected as entering.

In areas of points and crossings counting heads shall be provided at each extremity of each track section.

C1.3 Loss of train detection
The duration of transition from clear to occupied and vice versa shall be such that the passage of a single vehicle at permissible speed over a counting head does not result in a loss of train detection to the interlocking or to the signaller’s display.

C1.4 Continuous monitoring
Monitoring of the counting heads associated with a track section and the associated data transmission, power supply and evaluator equipment, shall be continuous. Any interruption to the continuous monitoring shall cause that track section to adopt the ‘disturbed’ state until successful completion of the restoration process. It is permissible for the data transmission arrangements to include polling of track section equipment, provided that robust arrangements are made to avoid loss of data.

C1.5 Isolation facility
A facility shall be provided to isolate the axle counter equipment for each track section from the signalling system.

The isolation facility shall:

a) when operated (to the isolated state) ensure that the track section is reported to the interlocking and signaller as ‘occupied’

b) when operated (to the isolated state) enable the reset function to be operated
c) when returned to the normal, (not isolated) state, enable the restoration process to be initiated.

It is permissible for the isolation facility to be operated remotely.

Where evaluator equipment is common to multiple track sections, it shall be possible to isolate each track section without affecting any other track section.

C1.6 Resetting facility
A resetting facility shall be provided for each axle counter section to enable a signaller or technician to reset the section count to zero after a failure, disturbance or miscount. It shall be enabled by isolation of the track section.

The resetting facility shall be disabled by the isolation facility being returned to the normal (not isolated) state.

Where evaluator equipment is common to multiple track sections, it shall be possible to reset the count in each track section to zero without affecting any other track section.

C1.7 Restoration facility
A restoration facility shall be provided to enable the axle counter equipment for each track section to be reconnected to the interlocking.

Where evaluator equipment is common to multiple track sections, it shall be possible to restore each track section without affecting any other track section.

C2 Non-functional requirements

C2.1 System integrity
Axle counter systems and equipment are safety-critical and shall be designed to avoid failure modes that give rise to unsafe conditions, for example loss of train detection. This shall apply to:

a) counting heads and other trackside equipment
b) data transmission links
c) evaluator equipment
d) power supplies
e) common mode failures.

The safety requirements for signalling and operational telecommunications systems are set out in GK/RT0206.

C2.2 Multi-section evaluators
Systems having evaluator equipment that is common to multiple track sections shall be deployed (for example by up and down lines being managed by separate evaluators) so as to minimise the effect of secondary hazards (for example due to handsignalling or temporary block working) accruing from failures of such equipment.

C2.3 Reliability target
The reliability of the complete axle counter system, including trackside equipment, communication links, evaluator equipment and resetting/restoration facility shall be better than one failure per track section in 10^5 hours.

C2.4 Safety target
High-risk signalling failures of the complete axle counter system shall not occur more frequently than once per track section in 10^9 hours.
The above safety target does not include the risks accruing from the irregular restoration of axle counter sections by the signaller.

C2.5 Maintainability requirements
Equipment and systems shall be configured so as to optimise maintenance and fault finding, with due regard to the safety of the overall system. In particular, counting heads shall be configured and located so as to minimise the risk from working on or near the line. Other trackside equipment is, wherever reasonably practicable, to be located in a place of safety.

Test equipment and facilities, including separate indications, shall be provided to enable the system to be interrogated for maintenance or fault-finding purposes, without interruption to normal working.

Test equipment shall also be provided to enable the passage of axles to be simulated electronically from the trackside for each counting head and direction of travel. It shall not be possible to connect this equipment without interrupting normal operation of the counting head.

The axle counter system shall be designed so that the mean time to repair the complete system, including trackside equipment, communication links, evaluator equipment, and resetting/restoration facility shall not exceed five hours.

C2.6 Communication
Communication for maintenance and testing purposes shall be available between the location of the axle counter trackside equipment, the associated evaluation equipment and the signaller.

C2.7 Configuration control
Management systems shall be in place to ensure that the configuration and modification states of all axle counter equipment and documentation are recorded. This shall apply, as a minimum, to the following:

a) hardware
b) software (where used)
c) system and detail drawings, plans and modification advices
d) test equipment
e) installation, testing and maintenance procedures
f) training procedures.

Requirements for the control of design documentation are set out in GK/RT0207.

C2.8 Reference documentation
Documentation shall be provided for design, installation, testing, maintenance, failure investigation and reset and restoration purposes. This shall include, as a minimum, the following:

a) functional description
b) installation instructions
c) operation and maintenance manuals
d) site and control centre diagnostics
e) drawings and ordering particulars for components
f) off-line and depot testing routines.
C2.9  Environmental factors
For each axle counter installation, the infrastructure controller shall undertake and document an assessment of the range of environmental conditions under which axle counter rail mounted and other equipment is required to operate. The assessment shall include, but not be limited to, consideration of the following:

a) temperature range
b) humidity
c) immersion (in fresh and/or sea water).

The infrastructure controller shall be satisfied that the equipment provided for each installation is environmentally fit for purpose.

C3  Interface requirements

C3.1  Compatibility
The infrastructure controller shall demonstrate that the axle counter system is compatible with (and does not introduce either permanent or temporary deterioration in) the operation or physical condition of other equipment and systems.

Requirements for achieving electromagnetic compatibility (EMC) between trains and infrastructure and for provision of EMC information are set out in GE/RT8015.

C3.1.1
In respect of vehicles that are authorised to operate over the line, compatibility shall include, as a minimum, the following:

a) wheel construction
b) wheel diameter
c) flange depth and profile
d) axle spacing
e) electromagnetic susceptibility, for example due to emissions from traction systems
f) speed of trains passing counting heads.

C3.1.2
In respect of rails to which the counting heads are attached, compatibility shall include, as a minimum, the following:

a) fixings of counting heads
b) proximity of other track components, for example rail joints (including insulated), welds, breather switches, check rails and switches and crossings.
c) vibration due to the passage of trains or otherwise, transmitted via the mountings
d) electromagnetic susceptibility, for example due to traction return currents.

C3.1.3
In respect of other signalling systems, compatibility shall include as a minimum the following:

a) electromagnetic emissions and susceptibility
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b) transition between axle counters and other forms of train detection.

C3.1.4
In respect of the local environment, compatibility shall include, as a minimum, the following:

a) electromagnetic emissions and susceptibility

b) acoustic interference.

C3.2 Interface with the signaller
C3.2.1
Where train detection is achieved by axle counters, the appropriate track sections shall be clearly identified as such on the signalling centre diagram or visual display unit (see GK/RT0025).

C3.2.2
A separate control device and indication for use during the resetting and restoration procedure shall be provided for each axle counter track section. Such controls and indications shall be clearly identified.

Requirements for the operational use of axle counter systems are set out in GE/RT8217.

C3.2.3
All states of axle counter sections other than clear shall be indicated to the signaller as occupied.

C3.3 Interface with track maintenance
Axle counting heads shall be installed in such a way as to ensure that the risk of damage due to mechanised and manual track maintenance and renewal operations, including those in the vicinity of rail joints, welds, breather switches, points and crossings, is minimised.

Where particular vehicles or plant (for example rail grinders and other on-track machines) are liable to foul rail mounted axle counter equipment, the infrastructure controller shall have in place technical procedures for the removal and subsequent replacement of such equipment.

C4 Application requirements

C4.1 Minimum length of track sections
The minimum length of an axle counter track section length shall be 18.3 m, (see GK/RT0011).

C4.2 Maximum length of track sections
There is no technical limit to the length of a track section, subject to the capability of the data transmission system.

C4.3 Clearance and fouling points
In areas of points and crossings, the counting heads shall be positioned so as to maintain the critical dimensions required for passing clearances, fouling points and clearance points (see GK/RT0011).

The distance that an axle counter track section can extend beyond the clearance point on each of the diverging routes of a turnout shall not exceed approximately 10 m. This restriction shall not apply where the diverging routes run parallel, for example where accessing a loop line. This requirement avoids the need to run additional trains over such spurs when examining the line.

C4.4 Derailed vehicles
Where a track section contains trap points or other means provided intentionally to derail unauthorised movements, no loss of train detection shall occur in the
event of a derailment. The train detection system shall alarm any adjacent line that could have been fouled by the derailment (see GK/RT0064).

C4.5 Conductor rail systems
On lines electrified by conductor rail systems, axle counting heads shall be positioned, where reasonably practicable, on the rail opposite the conductor rail.

C5 Control of incidental risk
The infrastructure controller shall design all installations to manage the risk arising from the displacement or removal of one or more counting heads, for example due to:

a) route crime (especially vandalism)

b) rail replacement

c) use of mechanised plant and machinery

d) derailed vehicles.

C6 Testing and commissioning
The general requirements for testing and commissioning of safety-critical signalling systems are set out in GK/RT0209.

C6.1 Definition of extremities of track sections
The axle counter test specification shall require determination of the extent of each track section to be tested by operation of the counting head at every extremity. The test documentation shall be set out to facilitate this.

C6.2 Determination of clearance points
The axle counter test specification shall require tests to determine whether the counting heads at the extremities of track sections that have been designed to be at clearance to an adjacent line are in fact at clearance (see section C4.3). The test documentation shall be set out to facilitate this.

C6.3 Critical parameters
Test documentation shall be available for recording critical parameters associated with:

a) counting heads

b) transmission systems

c) evaluator equipment.
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Part D
Resetting and restoration to service of axle counters

D1 General

D1.1 Principle
The circumstances in which an axle counter track section requires the reset and restoration process to be implemented are as follows:

a) passage of a train through a track section resulting in a miscount
b) an irregular operation of a counting head that results in a non-zero count (due to, for example movements of road/rail vehicles during an engineering possession), or accidental/deliberate simulation of a wheelset over a counting head
c) any interruption of the power supply to any part of the system (for example counting heads, trackside equipment, evaluator) or to the data transmission link that causes loss of train detection capability (ie affects the system’s ability to continuously monitor the passage of axles over the counting heads or to operate the required algorithms).

D1.2 Isolation
As a prerequisite to any attempt at failure investigation, resetting or restoration, the track section output shall be isolated from the interlocking. When isolated, the track section shall present an ‘occupied’ state to the interlocking. It is permissible for the isolation to be undertaken:

a) by the technician, before commencing destructive fault-finding activities
b) automatically, when the signaller commences the reset and restoration process.

The track section shall not be reconnected to the interlocking, even though the isolation has been returned to the normal state, until the signaller’s restoration device has been operated.

When an axle counter track section has been isolated by the technician, it shall not be possible for the isolation to be cancelled by the signaller.

D1.3 Resetting
Operation of the ‘reset’ device shall set the count of the isolated track section to ‘zero’. Resetting is necessary:

a) as a prior activity to restoration
b) as part of a failure investigation routine. It is permissible for the technician to operate the reset device a number of times during the faulting process.

D1.4 Restoration
Provided that the axle counter section has been reset, operation of the ‘restoration’ device for the appropriate time shall reconnect the track section to the interlocking. (As the track section has a zero count following reset, the state returned to the interlocking will be ‘clear’.) Restoration shall not be possible unless the power supplies and data transmission links are all operating within their designed tolerances.
D2 Restoration protocol

D2.1 The restoration device
The signaller shall be provided with a device to restore each axle counter section. The device shall be clearly labelled and arranged so as to guard against inadvertent operation, and shall comprise one of the following:

a) a button, located at an appropriate position on the panel or blockshelf
b) one or more icons or text, located on the appropriate workstation display.

In either case, it shall be necessary to:

i) operate the device continuously, or

ii) carry out diverse actions

for a minimum period of 10 seconds to effect restoration. It is permissible for the restoration device to involve text entry or displays.

The purpose of the 10 second minimum interval is to give the signaller a period of thinking time within which to decide to abort the restoration before it becomes effective.

It is permissible for the restoration device to incorporate a form of password protection or other means of gaining secure access.

It shall not be possible to simultaneously operate the restoration device for more than one track section at any signaller’s control area.

A non-resettable counter, which increments by one at each operation of the restoration device (successful or otherwise), shall be provided for each signaller’s control area.

The signaller’s restoration device shall not be capable of pre-selecting a restoration operation.

D2.2 Restoration device indications
D2.2.1 Indications to the signaller
An indicator shall be associated with the restoration device. It shall display the indications set out in section D2.3.1.

D2.2.2 Indications to the technician
It is permissible for separate indications to be provided to enable the signalling technician to monitor the progress of failure investigation and restoration.

D2.3 The restoration process
D2.3.1 Restoration of track section from the ‘disturbed’ state
When the signaller has confirmed that the track section is clear, the signaller shall operate the restoration device in the required manner, as set out in section D2.1.

The effect of operating the restoration device shall be to:

a) isolate the track section
b) commence the restoration process
c) cause the restoration indication to flash.

The reset and restoration shall be successful if one of the following conditions apply:

d) either the last data input to the axle counter evaluator registered a count of at least one axle ‘OUT’ of the track section, or
e) the technician has reset the axle counter section in accordance with section D2.3.2.

If the restoration is successful, the effect shall be to:

i) cancel the isolation

ii) change the track section indication to ‘clear’

iii) extinguish the restoration indication

thus confirming the reconnection of the axle counter to the signalling system.

Failure to complete the operation shall cancel the restoration process.

A main running signal shall be permitted to display only a position light or other caution aspect upon a route being set through the restored section.

After the axle counter evaluator has registered an ‘IN’ count of at least two axles, followed by an ‘OUT’ count of the same number of axles and the count is again zero, the effect shall be to allow signals to display proceed aspects as determined by the aspect displayed by the signal in advance.

Operation of the restoration device (whether successful or not) shall cause the recording device to increment by one. Particulars shall be recorded in the signalling control centre log or occurrence book.

Where the track section continues to indicate ‘occupied’, the laid down faulting procedure shall be carried out by the signalling technician before the restoration process is again attempted.

D2.3.2 Restoration of failed track section

Before starting testing or any other work on an axle counter track section that has failed, the signalling technician shall speak with the signaller to arrange to isolate the track section. This action shall be recorded by both signaller and signalling technician.

On completion of the work, the signalling technician shall advise the signaller before finally resetting the axle counter section and cancelling the isolation. This event shall also be recorded by both the signaller and signalling technician.

The technician shall then authorise the signaller to proceed with the restoration process as set out in section D2.3.1.

If the axle counter installation is configured so as to require the technician to perform the reset operation in all circumstances, the procedure set out in this section D2.3.2 shall be followed.

D2.4 Procedures

The procedures detailing actions required of the signalling technician shall be documented in the appropriate signal engineering instructions.

D3 Records

An auditable record of each restoration operation shall be made by electronic or manual means. This shall include:

a) date

b) time

c) axle counter track section

d) confirmation that the line was clear at the time of restoration
Technical Requirements for Axle Counters

e) restoration counter incremental reading after incrementation

f) identity of signaller

g) (where the signalling technician is involved in the restoration process) - identity of technician.

In cases where a signalling technician is involved in the restoration process, a similar record shall be maintained by the technician.
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References

Railway Group Standards and other Railway Group Documents

GA/RT6001  Railway Group Standards Change Procedures
GA/RT6004  Temporary Non-Compliance with Railway Group Standards
GA/RT6006  Derogations from Railway Group Standards
GE/RT8015  Electromagnetic Compatibility between Railway Infrastructure and Trains
GE/RT8217  Introduction and Use of Axle Counters – Managing the Risk
GK/RT0002  Glossary of Signalling Terms
GK/RT0011  Train Detection
GK/RT0025  Signalling Control Centres
GK/RT0027  Resetting and Restoration to Service of Signalling Systems
GK/RT0060  Interlocking Principles
GK/RT0064  Provision of Overlaps, Flank Protection and Trapping
GK/RT0206  Signalling and Operational Telecommunications. Design: Safety Requirements
GK/RT0207  Signalling Design
GK/RT0209  Testing and Commissioning of Signalling and Operational Telecommunications Systems
GO/RT3000  Master Rule Book
GO/RT3062  Signalling General Instructions