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Level 2

Axle Counter System – Operational and Safety Principles

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Issue	Date	Comments
1	September 2009	First issue

Compliance

This Network Rail standard is mandatory and shall be complied with by Network Rail and its contractors if applicable from 5th December 2009.

When this standard is implemented, it is permissible for all projects that have formally completed GRIP Stage 4 to continue to comply with the Issue of any relevant Network Rail Standards current when GRIP Stage 4 was reached and not to comply with requirements contained herein, unless the designated Standard Owner has stipulated otherwise in the accompanying Briefing Note.

Reference documentation

GE/RT8000	Rule Book
GK/RT0025	Signalling Control Centres
GK/RT0064	Provision of Overlaps, Flank Protection and Trapping
GK/RT8217	Introduction and Use of Axle Counters – Managing the Risk
GM/RT2466	Railway Wheelsets
NR/SP/SIG/10067	VDU based Signalling Control System
NR/L2/SIG/30081	Axle Counter System Design Principles and Generic Rules
NR/L3/SIG/30082	Axle Counter System Handbook
NR/L3/OPS/30083	Line Clear Arrangements Following Engineering Works – Enhanced Process for Vehicle Management
NR/L3/SIG/30084	Line Clear Arrangements Following Engineering Works – Engineering Examination

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1 Purpose

This standard details the operational rules and safety principles for axle counter systems including the methods of reset following failure, provisions for engineering work and for trains which may fail to count correctly. The standard includes details of the core functionality to enable signallers to fulfil their responsibilities and identifies the core procedural steps to be enforced by the systems.

This is a high level standard to establish the operational and system principles required to safely manage train detection using axle counters.

2 Scope

This standard is applicable to all new axle counter installations and to alterations at existing axle counter installations.

The standard is based on multi-section axle counters, however the same principles may be applied to other configurations. The standard states the operational principles for all types of interlocking, display and control system irrespective of the technology of those systems or the axle counter type.

The standard covers system use, including facilities, reset methods, signallers display and control systems, maintenance facilities and key processes.

3 Definitions

A number of terms are defined for clarity in Appendix A. This meaning shall be assumed throughout the standard.

4 Introduction

This document is part of a suite of standards produced by Network Rail to establish the principles for design and implementation of axle counter systems and to provide axle counter application guidance for use on Network Rail managed infrastructure.

Figure 1 below shows the relationship of the documents that make up this new suite of axle counter standards. This provides an information hierarchy where further guidance or specific systems are described in separate documents, attempting to minimise duplication. It may therefore be necessary to consult more than one standard to obtain all information relevant to a particular topic.

It is recognised that axle counter systems manufactured by different suppliers are not the same and that they have different attributes which may influence the choice of axle counter system used for a particular application. This suite of standards is intended to be manufacturer neutral in stating requirements, desirable features and good practice for axle counter application on Network Rail's managed infrastructure. Where details or examples given in this standard are applicable to specific manufacturers system this does not preclude the use of axle counter systems, technologies and arrangements from other manufacturers provided that they satisfy the safety, operational and maintainability requirements specified by Network Rail.

Some non-mandatory guidance is provided to describe axle counter system functionality (Appendix B) and to provide guidance on engineering works in axle counter areas (Appendix C).

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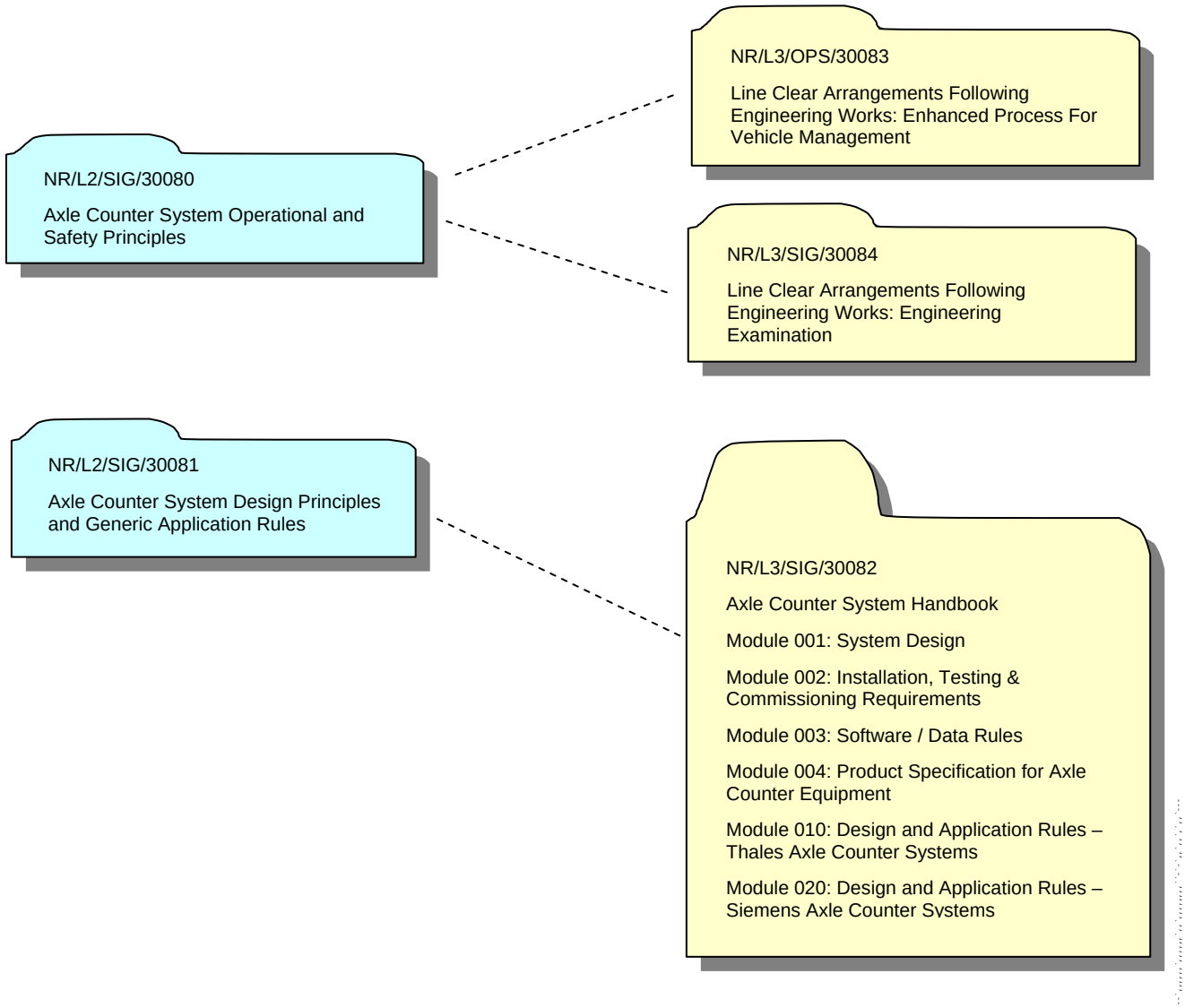

Figure 1 – Axle Counter Manual Document Suite

5 Axle Counters - Safety Principles

5.1 Vehicle Detection

The axle counter system shall provide guaranteed detection of all traction and rolling stock with wheel criteria and wheel / rail wear profiles specified as acceptable in GM/RT2466, including all vehicles listed in the Sectional Appendix route availability list.

NOTE Any traction and rolling stock not meeting these criteria will only be permitted to operate under engineering possession or special authorisation from Operations Planning on a route-by-route, or area, basis as appropriate.

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5.2 Introduction of Axle Counters

The Axle Counter Concept Safety Case and subsequent Addenda identify a number of key requirements for the introduction of axle counters which are to be achieved for all systems (in response to GK/RT8217). The main issues to be considered when introducing axle counters to a section of railway are:

- Sufficiency of line clear proving arrangements after reset;
- Rail break management and rail condition management;
- Communications and emergency protection requirements;
- Training and briefing of staff working or operating in axle counter areas.

If these requirements (now reflected in standards NR/L2/SIG/30080 and NR/L2/SIG/30081) are met there shall be no need for any separate Application Safety Case specifically for the axle counter system implementation. Where alternative mitigations are proposed, these shall be demonstrated to be at least as safe as the requirements stated in standards NR/L2/SIG/30080 and NR/L2/SIG/30081 or indicate how the residual risk is ALARP.

NOTE The intention is that compliance with these standards should be specifically confirmed, or any non compliance identified, as part of the project documentation reviewed by Network Rail's Project Review Group.

5.2.1

Axle counter systems and their application shall meet the requirements of Network Rail's Engineering Safety Management processes, appropriate to a high integrity safety system.

5.2.2

The effectiveness of the axle counter installation / implementation shall be reviewed to demonstrate the stated requirements and mitigation measures are effective. This review shall be documented and any non-compliance investigated and resolved within a timescale appropriate to the risk.

NOTE The Concept Safety Case specifies a documented review of effectiveness of the installation (and the mitigation measures) within six months of commissioning.

5.2.3

When any significant change in the volume, speed or type of rail traffic is proposed, or there is a change in any other factor that could affect the safe operation of train detection systems, the Infrastructure Manager shall review the train detection arrangements to demonstrate that the integrity of the application is maintained.

5.3 Sufficiency of Line Clear Proving Arrangements after Reset

The risk of a train being given a proceed aspect into an occupied section, as a result of an erroneous reset and restoration of an axle counter, shall be no higher than the risk which existed before the introduction of axle counters.

5.4 Rail Break Management and Rail Condition Management

The overall risk of derailment of a train on an axle counter fitted line (at the time of axle counter fitment or at any time in the future) due to a broken rail shall be no higher than the risk that existed before the introduction of axle counters.

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5.4.1

On lines where train detection was not previously provided by track circuits the arrangements for broken rail detection shall provide at least an equivalent level of safety to that provided by the previous arrangements for broken rail detection on the line concerned.

5.4.2

Where axle counters are introduced, the track maintenance regime shall be reviewed to demonstrate it is still able to meet the requirements for rail integrity.

NOTE Track maintenance regimes should not rely on the benefits of any train detection system to meet risk targets and any mitigation they may provide is a bonus. Track circuits may detect a clean rail break but this type of break is less likely to result in derailment. In many cases track circuits only operate over (and therefore detect) one rail and require the use of insulated block joints which are a major cause of rail breaks, especially around points and crossings.

5.4.3

The review shall include a documented plan for managing rail integrity that:

- Describes how rail integrity risk will be maintained at an equivalent or reduced level after the introduction of axle counters;
- Takes account of annual tonnage and line speed;
- Takes account of rail age profile;
- Takes account of rail breakage history (number and cause);
- Takes account of the number of rail joints (and addresses the removal of those no longer required);
- Takes account of rail welds (number and type, e.g. whether part of welded, former jointed track or long welded rail);
- Takes account of track condition (wet beds, dipped joints, etc);
- Considers enhanced inspection regimes, weld testing, grinding, etc.

NOTE It is expected that track maintenance regimes will be kept under regular review to ensure their sufficiency and effectiveness, not just at initial implementation of axle counters or time of significant change of use of the line. This should include reconsideration of the rail integrity management arrangements.

5.4.4

Insulated rail joints shall be removed within six months of the axle counter system being relied on for train detection unless alternative mitigation measures can be justified through risk assessment (as documented in the plan for managing rail integrity).

NOTE The maximum number of insulated rail joints possible should be removed during the commissioning phase. Risk assessments should be documented and records retained.

5.4.5

Unless specifically justified, new insulated rail joints shall not be installed as part of the staged introduction of revised track layouts where axle counters are planned to form the train detection system and these joints will later become redundant.

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NOTE Options such as clipping out points and removing sections of rail or removing a track circuit section to avoid the need for temporary joints should be considered. Any requirement for a temporary joint, in order to maintain track circuiting, should utilise existing rather than new rails.

5.5 Communications and Emergency Protection Requirements

The primary means of arranging emergency protection in the event of an incident involving a train shall continue to be to contact the signaller in accordance with Module M1 of the Rule Book.

5.5.1

Consideration shall be given to the adequacy of the existing communications systems, including radio, based on the likelihood of incidents and frequency of service to protect the line. When implementing axle counters in an area previously subject to track circuit train detection, the availability of suitable communications between driver and signaller shall be reviewed.

NOTE Since an axle counter only detects vehicles as they enter or leave a section, track circuit operating clips will no longer offer any protection in an emergency and, depending on the availability and suitability of any other means of communication, suitable alternatives may be necessary. The preferred method is a radio system between signaller and drivers, supplemented by lineside telephones where identified as necessary. The Operational Specification needs to state the level of communication coverage required (and the assumptions on which it is based).

5.5.2

The alternative measures for arranging emergency protection shall result in the overall risk of a secondary collision, or of a train running into an obstruction, being equal to or lower than it would be if track circuits and track circuit operating clips were in use.

5.5.3

On lines where train detection was not previously provided by track circuits, the arrangements for emergency protection shall provide at least an equivalent level of safety to that provided by the previous arrangements for emergency protection on the line concerned.

5.5.4

When implementing axle counters in an area previously without train detection, e.g. absolute block areas, no special action shall be required.

NOTE The change to axle counters causes no loss of protection (track circuit operating clips were not used or effective) and therefore has no detrimental effect on the driver in an emergency. No alternative arrangement therefore has to be provided. The change to axle counters is a positive change in safety as the axle counter will provide full train detection.

5.6 Training and Briefing of Staff Working or Operating in Axle Counter Areas

For any installation of axle counters, the Infrastructure Manager shall brief their staff and contractors on the resulting changes to the infrastructure and arrangements.

5.6.1

For any installation of axle counters, the Infrastructure Manager shall notify those Railway Group members that will be affected, of the need to brief their staff and contractors on the changes.

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5.6.2

The Infrastructure Manager shall make available to Railway Group members, any information they reasonably require for the purpose of completing these briefings.

5.6.3

Any staff whose duties will be changed as a result of the introduction of axle counters shall receive training/briefing and written instructions on the changes to their specific duties. A record shall be kept of staff that have received this training.

6 Axle Counters – Operating Principles

6.1 Overview

Network Rail requires the principles of operation to be the same across all axle counter systems as laid out in this standard. Any proposal for deviation from the requirements in this standard shall require to be supported by the appropriate derogation approved by the Professional Heads of Operations, Principles and Standards and Signal Engineering prior to any changes to existing applications and the commissioning of new applications.

NOTE The generic operational principles are detailed within the accompanying sub-sections of this standard. The specific means of achieving these operational principles for Network Rail applications is stated, where necessary, for each accepted axle counter system in standard NR/L3/SIG/30082

6.1.1

An axle counter section shall indicate as occupied when:

- Actually occupied by a vehicle which has been counted in but not out, or;
- The equipment detects something outside the designed wheel criteria, or;
- A failure of the axle counter system, due to equipment defect, is detected.

NOTE It is only when an axle counter section has been occupied for an unduly long time or becomes occupied unexpectedly that a signaller is likely to suspect that there is a problem. However, it may not always be possible to distinguish with absolute certainty between the three reasons listed above. Whenever a signaller suspects an axle counter section to be showing occupied, for reasons other than a legitimate vehicle occupancy, protection arrangements should be introduced immediately.

6.1.2

An axle counter section shall indicate as clear when:

- The section is not occupied by a vehicle, and;
- The axle counter system is not in a disturbed state.

6.2 Failures

If an axle counter section fails, suffers a miscount or the electronics need to be re-started, then the system can not be relied upon to correctly indicate the absence of a rail vehicle until the system has been reset and other checks have been completed. This in-service reset shall be under the control of the signaller and shall be a two stage process. (See section 7.1 for an overview of in-service reset and other reset options, and Appendix B for further explanation).

Figure 2 provides an overview of axle counter operation and the responses required to various operational situations and planned interventions.

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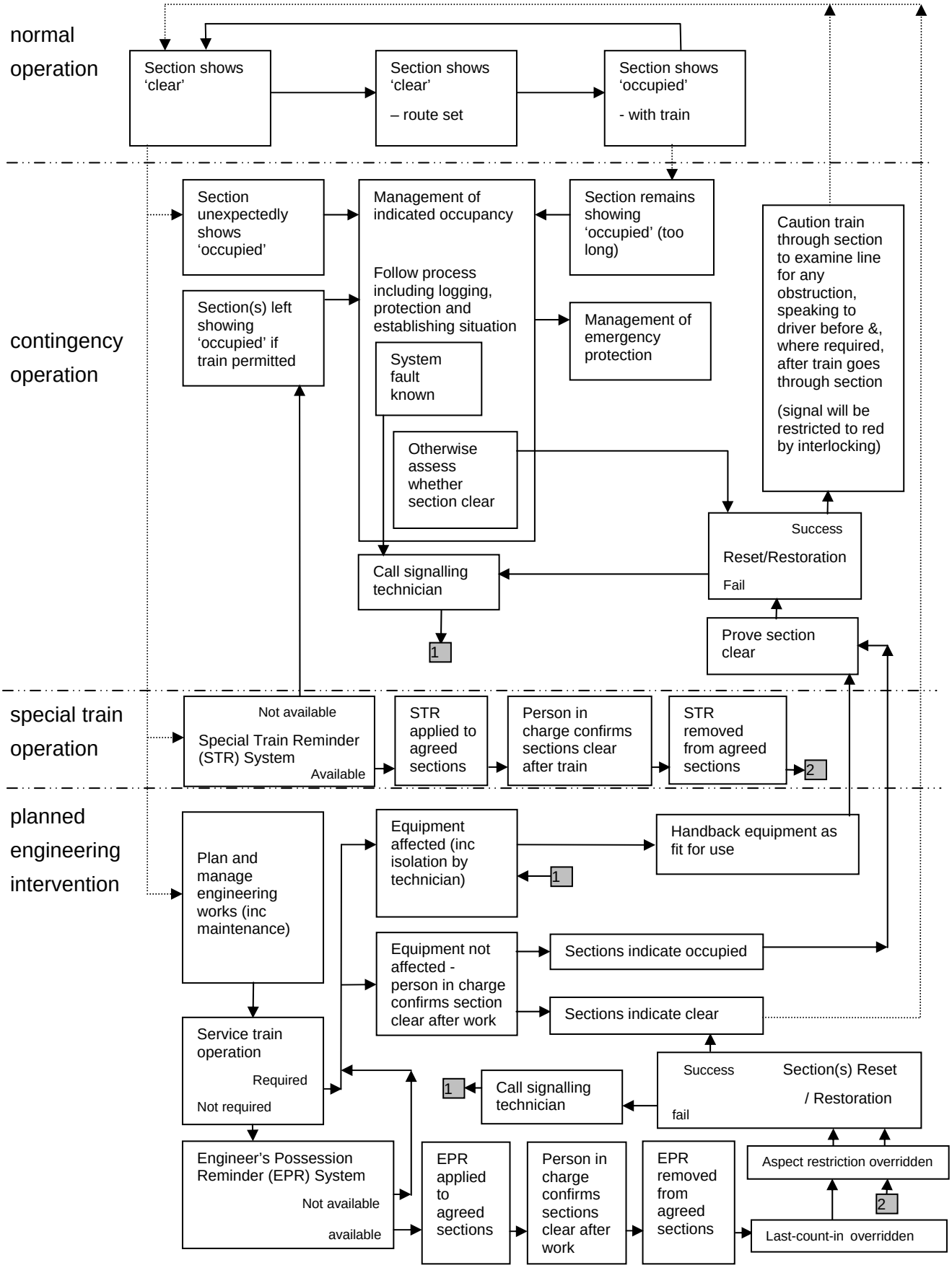

Figure 2 – Axle Counter System Operation Overview

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6.2.1

It shall not be necessary to physically examine the affected axle counter section before attempting an in-service reset as long as the signaller is sure that the last train has passed through, complete in accordance with the General Signalling Regulations.

NOTE Providing the axle counter system is working correctly (and, where applicable, the last count was out of the section), the reset will be successful, however the section will indicate that it is restricted pending the passage of a train (see section 7).

6.2.2

The second stage of the process shall be to restrict main aspects of protecting signals to danger until a route has been set and a train has been cautioned through all relevant parts of the section to check the line is clear of obstructions.

NOTE The requirements for aspect restriction are described in section 7.3.8. A route should not be set if the reset has been unsuccessful.

6.2.3

Passage of the train (supported by a report back from the driver) shall complete the restoration of the section to normal working. The expected extent of examination shall be advised to the driver, e.g. as far as a particular signal.

6.3 Axle Counters Over Points

Where release of points is required to allow a train through a section and enable in-service restoration to be completed, a facility shall be provided to release the route locking (and release the points) in the event of a train detection failure.

NOTE If an axle counter section includes a set of points and it fails, then the points will be locked in their current position. It may not be possible (or convenient) to run a train through the section in order to complete the in-service restoration process. The operational specification needs to identify whether the emergency release of route locking and of points is required, i.e. where other routes are affected which would otherwise not be able to be traversed. A successful conditional reset effectively provides this facility.

6.4 Clearance and fouling points

In areas of points and crossings, the rail contacts shall be positioned so as to maintain the critical dimensions required for passing clearances, fouling points and clearance points unless interlocking controls are applied.

NOTE Removal of aspect restriction is also a consideration when positioning rail contacts. Design principles for reducing the effect of aspect restriction on diverging routes and the maximum extent of an axle counter section beyond the clearance point(s) at a set of points or diamond crossing is covered in standard NR/L2/SIG/30081 section 5.7.8. The positioning can avoid the need to run additional trains over such stubs when examining the line.

6.5 Derailed vehicles

Where an axle counter section contains trap points or other means to intentionally derail unauthorised movements, the system shall continue to report the section 'occupied' in the event of a derailment (normally achieved by the use of a derailment detector device).

NOTE The axle counter system should, in combination with the interlocking, set sections to 'occupied' on adjacent lines that could have been fouled by the derailment (as required by GK/RT0064)

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6.5.1

Where a derailment detector device is not provided, any remote reset shall be inhibited, including any section subject to EPR.

6.6 Facilities to Support Engineering Works

An Engineer's Possession Reminder (EPR) facility shall be provided unless otherwise justified.

NOTE The non-provision of EPR should be an operational decision, based on the characteristics of the line and the extent of the axle counter sections.

6.6.1

The Operational Specification shall define the Standard Engineering Areas and their association with pre-defined EPR groups.

6.7 Requirements for Proceed on Sight Authority (PoSA)

Axle counter systems shall be capable of operating with degraded signalling controls and shall provide the facilities to support PoSA where this is specified.

6.7.1

Use of PoSA shall not change the existing principles, operational rules and requirements for reset and restoration but specifically:

- Any PoSA signal shall not be subject to aspect restriction following reset of an axle counter section in the route;
- Any PoSA signal shall not be able to clear into axle counter sections with EPR applied.

6.8 Requirements in European Rail Traffic Management System (ERTMS) Areas

In ERTMS areas without lineside signals, 'aspect restriction' shall be implemented by preventing a FS movement authority from being issued to a train for the route including the affected section until traversed. This shall require the driver to proceed in Staff Responsible (SR) mode, not exceeding the National Value speed, over a defined route section to inspect the line.

NOTE Use of SR mode is the currently used method however, where supported by a risk assessment, use of a speed restricted FS movement authority may be considered.

6.8.1

Where EPR or STR are applied, this movement authority restriction shall not apply, however no movement authority issue shall be possible into, within or out of a section with EPR applied and only a single movement authority issue shall be possible through a section with STR applied.

6.9 Wheel Skates and Special Trains

There are a number of maintenance or special vehicles which cannot be guaranteed to count in and out correctly. Similarly, a wheel skate cannot reliably be counted by an axle counter and this is liable to leave axle counter sections indicating occupied and in need of reset.

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Where a Special Train Reminder (STR) facility is provided for vehicles which cannot be guaranteed to count in and out correctly this shall be applied to axle counter sections liable to be affected before the train is signalled over them.

NOTE This allows one train to be signalled through and in the event of a miscount, removal of the reminder automatically resets the section and does not require aspect restriction.

6.9.1

An STR facility shall be provided unless otherwise justified.

NOTE Provision should be an operational decision, on an individual application basis, based on the performance risk of using the normal in-service reset arrangement with aspect restriction to manage recovery following any disturbance caused by a "special train" movement. The operational specification needs to identify whether this facility is required.

6.10 Requirements for Controls and Indications

Under normal working conditions the axle counter method of train detection shall not appear any different to any other train detection method on the signaller's display:

- With a VDU system, a clear axle counter section shall be indicated to the signaller by showing the associated section in grey (white if a route is set);
- With a VDU system, an occupied axle counter section shall be indicated to the signaller by showing the associated section in red.
- With a panel, a clear axle counter section shall be indicated to the signaller by showing the associated section indicator not illuminated (white if a route is set);
- With a panel, an occupied axle counter section shall be indicated to the signaller by showing the associated section indicator illuminated in red.
- With a blockshelf illuminated diagram, a clear axle counter section shall be indicated to the signaller by showing the associated section indicator not illuminated;
- With a blockshelf illuminated diagram, an occupied axle counter section shall be indicated to the signaller by showing the associated section indicator in red.

NOTE many TD or VDU systems also incorporate some form of "out of sequence" detection which may highlight (either directly or indirectly) to the signaller a section which remains occupied whilst the train proceeds.

6.10.1

A reset device shall be provided for each axle counter section and its operation shall require:

- A conscious act involving diverse tasks;
- Completion of the reset process within a restricted timescale, otherwise it shall fail;
- The axle counter system, its power supplies and data transmission links to all be operating within their designed tolerances;
- That all affected routes have been normalised and that automatic signals have been replaced.

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NOTE The reset of an axle counter section has the potential of releasing route locking ahead of a train, hence routes or automatic signals need to be replaced first. As the reset process enables the signaller to override the interlocking, and since in most cases the signaller is remote to the site, the process needs to be designed to reinforce that it is a conscious act which cannot be achieved accidentally. Reset controls should require the signaller to make a definite and sustained action, the combination of which allows the signaller time to think and realise an error before the action is taken. On VDU systems this may require the operation of icons followed by entry of a typed command/password or the operation of a sequence of icons within a given period of time. For panels or other interfaces, operation should include at least one action which it is not possible to achieve accidentally (e.g. "pull" or "twist") and a period of sustained operation, requiring the entire process to be completed within a given period of time.

6.10.2

The indications to the signaller associated with reset shall enable the state of the axle counter section to be determined and the progress of the reset process to be established:

- For a section specific reset control, the indications shall be 'normal state', 'section selected', 'reset requested', 'reset achieved (waiting for restoration condition)';
- For a shared reset control, the indications shall be 'normal state' and 'enabled/timing';
- For the axle counter section, the indications shall be 'occupied', 'clear' and 'waiting for train / aspect restriction'.

  NOTE Aspect restriction may only be indicated for a part of the axle counter section.

6.10.3

The indications and controls shall be in accordance with GK/RT0025 and NR/SP/SIG/10067 subject to the clarifications and additions in section 7.6 for specific types of MMI.

NOTE This standard supersedes standard NR/SP/SIG/10067 issue 2 for the purposes of axle counter controls and indications.

7 Management of Axle Counter Reset

7.1 Overview

There are four principal reset scenarios to be considered, the first two being applicable to any site, the last two only applying where specified for a particular section of railway:

- Single or multiple sections miscounting after passage of a train (requiring an individual conditional or preparatory in-service reset);
- Single or multiple section equipment failure (requiring an individual conditional or preparatory in-service reset);
- Single or multiple sections that may be disturbed following planned engineering work (unconditional reset utilising Engineers' Possession Reminder (EPR)).
- Single or multiple sections that may require reset following passage of a train known not to reliably operate the axle counters (conditional reset utilising Special Train Reminder (STR)).

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NOTE Unconditional reset shall only be applied as an engineering reset where Engineers' Possession Reminder (EPR) is provided. All methods of reset are explained further in Appendix B.

7.1.1

Co-operative reset (see Appendix B) shall not be used for any new applications without permission from the Head of Signal Engineering.

NOTE Use of co-operative reset may be acceptable where the new section being introduced represents a minor part of an extension to an existing application and where additional mitigating controls are implemented. In such circumstances the Head of Signal Engineering should be contacted for guidance.

7.1.2

Last count in override (see Appendix B) shall be enabled where provided and its use shall be subject to procedural controls.

NOTE Where a last count in override facility is provided it should be possible to disable it through data (though normally enabled) and it should only permit the technician to remove the last count in control (not to reset the section). The signaller should protect and initiate the reset, requiring the passage of a cautioned train before restoration of the section to normal working.

7.1.3

Axle counter systems for use on Network Rail managed infrastructure shall be able to deliver appropriate in-service and engineering reset facilities.

NOTE The most appropriate type of reset(s) should be determined and agreed during the GRIP 1 to 4 processes taking account of system availability, impact on points, data requirements, etc. Further explanation of the features of different methods of reset is provided in Appendix B (see B.4.1 and B.4.2).

7.1.3.1

Preparatory reset shall only be adopted for in-service reset application on:

- Plain line axle counter sections; or
- Axle counter sections containing points or crossings where all the stubs satisfy the rules for visual examination in a single pass.

NOTE Following a reset the evaluator will maintain the output to the interlocking as occupied (effectively restricting the signal aspect) until a train has entered the axle counter section and successfully left it, resulting in a 'clear section' count.

7.1.3.2

Conditional reset may be used for any in-service reset application.

NOTE Following a successful reset of the section resulting in a 'clear section' count, the interlocking will release any route locking or track locking of points previously held by the axle counter section and the interlocking will apply aspect restriction to the axle counter section.

7.1.3.3

To avoid confusion, it shall only be possible for one of the following to be in progress for a signaller's control area at any one time:

- Reset/Restoration (see also section 7.3.4);
- EPR Application;
- EPR Removal;

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- Group EPR Preview;
- STR Application;
- STR Removal.

7.2 Proving Section Clear

If an axle counter section has previously failed, been disconnected or engineering work has taken place within it, then a 'section clear' output from the axle counter cannot be regarded as proof that the section is clear and the restoration process shall incorporate extra checks that the section is clear to avoid a train being signalled into an occupied or obstructed section unintentionally. This shall involve:

- Transit of an examining train (having been instructed to pass the protecting main signal at red). It is important that any train used is confirmed to be physically clear of the limits of the axle counter section. Reminders shall remain in place until the driver has reported back and confirmed the line is clear;
- Immediate restoration provided the sections were subject to an Engineer's Possession Reminder or Special Train Reminder, that a site examination (or other approved means of proving vehicles or the area clear) has been undertaken, and that an authorised person has assured the signaller that the line is clear.

The safety premise for the three acceptable types of restoration to service is:

- In service – signaller's procedures used to establish that the section should be clear and then examination by a train (proceeding at caution) to independently establish that the axle counter section is clear;
- Special Train Reminder – a premeditated act by the signaller prior to the passage of a Special Train with all axle counters working and clear which only allows one train to be signalled through. Procedures require the signaller to obtain confirmation from the train crew that the complete train has passed through the defined section, before cancelling the reminder. This will initiate the reset of affected axle counters without aspect restriction;
- Engineer's Possession Reminder – a premeditated act by the signaller with all axle counters working and clear prior to handing the track over to engineers. Procedures require the person in charge to assure the signaller that the line is clear of obstructions and safe for the passage of trains prior to the removal of the reminder. This will initiate the reset of affected axle counters without aspect restriction.

7.2.1

A check of the signaller's action by a second person shall only be required where the need for extra vigilence has been identified as necessary by Operations, e.g. shortening back blocking points of a possession utilising EPR where there is a risk of incorrect removal. In other cases, use of a second person is considered good practice and shall be applied where available but not specially provided.

NOTE The principle of a second, independent mind to verify the action is well established. In service reset utilises the operator as a second check of the signaller decision, though the signaller remains responsible for that section. STR and EPR are generally pre-planned and subject to pre-meditated

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