Australian STANDARD®

Axle Counters

RISSB
RAIL INDUSTRY SAFETY AND STANDARDS BOARD

Train Control Systems Standard

AS 7651:2020 Axle Counters Draft for Public Comment

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This Australian Standard® AS 7651 Axle Counters was prepared by a Rail Industry Safety and Standards Board (RISSB) Development Group consisting of representatives from the following organisations:

Sydney Trains	United Goninian Limited	Queensland Rail
Aldridge	Transport for NSW	Metro Trains Melbourne
ARC Infrastructure	Mott MacDonald	Frauscher Australia
Thales	PTV	Siemens
PTA WA	NJT Rail Services	

The Standard was approved by the Development Group and the Enter Standing Committee Standing Committee in Select SC approval date. On Select Board approval date the RISSB Board approved the Standard for release.

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Development of the Standard was undertaken in accordance with RISSB's accredited process. As part of the approval process, the Standing Committee verified that proper process was followed in developing the Standard

RISSB wishes to acknowledge the positive contribution of subject matter experts in the development of this Standard. Their efforts ranged from membership of the Development Group through to individuals providing comment on a draft of the Standard during the open review.

I commend this Standard to the Australasian rail industry as it represents industry good practice and has been developed through a rigorous process.

Deb Spring
Exec. Chair / CEO
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This Standard was prepared by the Rail Industry Safety and Standards Board (RISSB) Development Group AS 7651 Axle Counters. Membership of this Development Group consisted of representatives from the organisations listed on the inside cover of this document

Objective

The objective of this Standard is to provide a consistent approach to the use of axle counters within the Australian and New Zealand railway industry.

This standard should be read in conjunction with AS 7711 Signalling Principles.

Compliance

There are two types of control contained within Australian Standards developed by RISSB:

1. Requirements.
2. Recommendations.

Requirements – it is mandatory to follow all requirements to claim full compliance with the Standard. Requirements are identified within the text by the term 'shall'.

Recommendations – do not mention or exclude other possibilities but do offer the one that is preferred. Recommendations are identified within the text by the term 'should'.

Recommendations recognise that there could be limitations to the universal application of the control, i.e. the identified control is not able to be applied or other controls are more appropriate or better.

For compliance purposes, where a recommended control is not applied as written in the standard it could be incumbent on the adopter of the standard to demonstrate their actual method of controlling the risk as part of their WHS or Rail Safety National Law obligations. Similarly, it could also be incumbent on an adopter of the standard to demonstrate their method of controlling the risk to contracting entities, or interfacing organisations where the risk may be shared.

Controls in RISSB standards address known railway hazards are addressed in appendix A.

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1 Scope and general

1.1 Scope

This standard provides mandatory requirements and recommendations for the design, installation, maintenance and operation of axle counters systems in safety critical applications.

The scope of this standard includes the following:

(a) Design.

(b) Network and operational requirements.

(c) Track maintenance considerations.

(d) Testing and maintenance requirements.

Where the safety requirements of an axle counter system do not require a SIL 4 rating this standard may be adopted in part or in full if appropriate to do so.

1.2 Exclusions

1.2.1 Exclusions

The following items are excluded from this standard:

(a) Specific applications and uses for axle counters.

1.2.2 Broken Rail Detection

Track circuits provide a limited form of broken rail detection which is not provided by axle counters. This standard does not provide designers or RIMs with guidance regarding the provision or management of broken rail detection.

Further guidance regarding management of broken rails is provided in AS 7640.

1.3 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document:

- AS 7505 Signalling detection interface
- AS 7514 Wheels
- AS 7517 Wheelsets
- AS 7640 Rail management
- AS 7663 Railway signal cables
- AS 7702 Rail equipment type approval
- AS 7711 Signalling principles
- AS 7702 Rail equipment type approval
- IEC 61508 Functional safety of electrical/electronic/programmable electronic safety-related systems

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- EN 50126-1 Railway Applications – The specification and demonstration of reliability, availability, maintainability and safety (RAMS) – Part1: Generic Rams Process
- Configuration management for railway contractors guideline

NOTE: Documents for informative purposes are listed in a Bibliography at the back of the Standard.

1.4 Terms and definitions

For the purposes of this document, the terms and definitions given in RISSB Glossary: https://www.rissb.com.au/products/glossary/ and the following apply.

1.4.1
axle counter
vital (SIL rated) wheel presence detection system which encompasses wheel sensors, evaluation systems and associated hardware used to prove track vacancy

1.4.2
count in
number of wheels entering a section

1.4.3
count out
number of wheels exiting a section

1.4.4
OEM
original equipment manufacturer

1.4.5
RAMS
reliability, availability, maintainability and safety

1.4.6
shadow mode
a system that is operational but not providing vital inputs to a signalling system[1]

1.4.7
SIL
safety integrity level

1.4.8
metallic free zone
area around the wheel sensor, as defined by the manufacturer, that should be clear of ferrous materials from both stationary objects and rolling stock

[1] Often used to validate an axle counter system prior to commissioning. Failure of a system in shadow mode will not affect the live signalling system.

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1.4.9
wheel sensor
sensor mounted to rail that detects either wheels[2]

2 General requirements

2.1 General

Axle counter systems are used to detect the number of axles that enter and/or exit a defined section of track using wheel sensors mounted to the rail.

When placed at the entrance and exit to a track section axle counters can be used to identify whether a track section is clear of detectable rail vehicles.

An axle counter system typically comprises of the following items:

(a) Wheel sensors (including trackside cabling).
(b) Counters and evaluators.
(c) Communications and Interfaces.

Axle counter systems used for vital signalling purposes shall be SIL 4 rated.

Axle counter systems used for other purposes may be rated at a lower SIL where it is justified by a risk assessment.

2.2 Safety performance

2.2.1 General safety requirements

Axle counter systems and equipment used for safety-critical vital signalling purposes shall be designed to avoid failure modes that give rise to unsafe conditions. This shall apply to:

(a) wheel sensors and other trackside equipment;
(b) communication and communication links;
(c) evaluator equipment;
(d) electrical interfaces.

All risks to safety associated with the operation of the system shall be eliminated or minimized so far as is reasonably practicable.

2.2.2 Demonstration of safety

Axle counter systems used for signalling and train control systems shall be independently assessed to meet SIL 4 rating in accordance with IEC 61508-1 or EN 50129 (referred to in AS 7715).

Safety conformance of the complete axle counter system design shall be demonstrated by systematic and structured safety analysis and risk assessment.

The above safety target does not include the risks arising from the irregular restoration of axle counter sections.

[2] Also known as a flange or wheel detector.

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2.2.3 Design for whole system life cycle

The complete axle counter system shall be designed to ensure that it can be constructed, tested, commissioned and subsequently operated, maintained, modified, decommissioned and disposed of in accordance with RIM's policies and procedures.

2.3 Approval of axle counter equipment

Axle counters shall be approved in accordance with AS 7702 and RIM's policies and procedures.

When type approving axle counters a RIM should consider:

(a) rail interfaces;
(b) communications;
(c) power supplies;
(d) tunnels and bridges (with respect to access);
(e) reset operational procedures;
(f) signalling interlocking interfaces;
(g) absence of broken rail detection;
(h) rolling stock interfaces;
(i) track maintenance;
(j) local ferrous metals (structural steel, etc);
(k) electromagnetic compatibility / traction return;
(l) remote logging and monitoring.

3 Standard architecture

3.1 Wheel sensor

Wheel sensors shall detect the presence of wheel as it passes by the wheel sensor. The RIM shall nominate the applicable wheel specifications that can be detected by the wheel sensor.

The wheel sensor shall be securely mounted to the rail in accordance with the OEM requirements and in agreement with the RIM. Any adjustment required to the wheel sensor shall be possible without modification to the rail to which it is attached.

Wheel sensors shall be suitable for mounting between sleepers.

Wheel sensors may be mounted above non-ferrous sleepers.

Wheels sensors should allow for a 35 mm flange as permitted in AS 7514.

The external wheel sensor cable should avoid being located where damage can occur.

3.2 Counters and evaluators

Counters and evaluators form the core of an axle counter system. These components are typically deployed trackside in equipment rooms or in trackside junction boxes. Counters and evaluators should have the following functionality:

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(a) Analogue processing of the signal from the wheel sensor.
(b) Digital processing of the wheel counts (track section evaluation).
(c) Determination of count in and count out.
(d) Determination of track status.
(e) Evaluator to evaluator communications.
(f) Evaluator to interlocking interface.
(g) Evaluator to TCS interface.
(h) Internal health monitoring.
(i) Reset processing.
(j) Interface to diagnostic system.
(k) Securely configurable.
(l) Calibration management.
(m) Local status indication.

4 Design

4.1 General requirements

Axle counters shall meet design requirements for the detection of rolling stock in accordance with AS 7715.

Axle counters shall be suitable for the environmental conditions that can be reasonably considered to occur. These conditions can include:

(a) high or low temperatures;
(b) flooding;
(c) shock and vibration;
(d) high dust levels;
(e) electrical storms;
(f) contamination;
(g) pollution degrees;
(h) minor incidental contact by persons or plant.

Axle counters should be designed as modular systems to aid maintenance and replacement of individual components. Mean time to repair should be in accordance with RIMs requirements.

4.2 Location considerations

Wheel sensor location design should consider the hazards listed in table 4.2.

Table 4.2: Consideration for axle counter location

Consideration	Hazard	Mitigators
Maintainability	Repair and replacement of equipment	Place in easy to access areas

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Consideration	Hazard	Mitigators
Vehicle overhang	Rolling stock shows clear of track circuit, however the outer extremity of the vehicle is foul of preceding section or converging route	Place wheel sensor back from fouling point sufficiently to avoid overhang hazard
Line speed	Short track sections	Meeting the minimum processing time
Short track sections	Long vehicles can straddle wheels sensors, giving a false indication that the track section is clear	Ensure wheel sensors are not placed closer than the longest allowable wheelbase on RIM network
Civil locations	Wheels sensors placed on embankments, in cuttings, segregated rail corridors etc can be difficult to access for maintenance	Where possible, place in location with easiest access
Dual gauge track	Detection requirements can fail to be met due to the wheel sensor only being placed on one rail	Reassess detection requirements. If unable to be met consider alternate detection methods (track circuits or fitting to all rails)
Track interface	Track maintenance can affect or be affected by wheel sensors	Place away from welds, complex geometry and insulated rail joints. Avoid high wear rail where possible i.e. outer rail on curves
Electrical interface	Electrical interference from traction bonding cables, traction return, EMI from rolling stock	Compliance with applicable Standards
Entry / exit points	Large numbers of entry / exit points for a single track section can be difficult to manage operationally and under degraded working	Minimize number of entry / exit points to reduce operational impact when degraded working in force
Stopped rolling stock	Wheels stopped directly over wheel sensors can cause miscounts within the axle counter system	Wheel sensors should avoid known stopping locations where possible
Safe maintenance	Person to vehicle contact.	Compliance with AS 7664
Safe maintenance	Impact to operations due to overly restrictive track access arrangements	Locate axle counter equipment in easily accessible areas

4.3 Interfaces with rolling stock

To function correctly, wheels sensors require the electromagnetic field generated locally by the wheel sensor to be influenced by a certain amount of metallic mass passing over or between them.

RIMs shall ensure wheel sensors are capable of detecting rail vehicles and traffic reasonably expected to pass over them (excluding track maintenance vehicles and machines). This assessment shall include:

(a) likely speeds of passing rail vehicles;

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(b) likely maximum number of axles required to be counted;

(c) minimum distance between axles on permitted rolling stock;

(d) permitted wheel dimensions and material.

Wheels sensors shall detect new and worn wheels compliant with AS 7514, and wheelsets that are compliant with AS 7517.

The OEM shall provide the RIM with minimum requirements for reliable detection of rolling stock.

Rail vehicles, including track maintenance vehicles and machines, that do not comply with this section shall be managed in accordance with section 7 of this Standard.

4.4 RAMS requirements

4.4.1 General

RAMS is a characteristic of the complete axle counter system's long-term operation and is achieved by the application of established engineering concepts, methods, tools and techniques throughout the life cycle of the axle counter system. The RAMS of an axle counter can be characterised as a qualitative and quantitative indicator of the degree that the axle counter can be relied on to function as specified and to be both available and safe. Axle counter RAMS in the context of EN 50126-1 is a combination of reliability, availability, maintainability and safety (RAMS).

EN 50126-1 shall be applied systematically throughout all phases of the lifecycle of the axle counter to develop railway specific RAMS requirements and to achieve compliance with those requirements.

Safety is incorporated throughout the document and is not specifically listed here.

4.4.2 Reliability target

The reliability of the complete axle counter, including trackside equipment, communication links, evaluator equipment and resetting/restoration facility shall be in accordance with the RIMs requirements.

The analogue front end signal of a wheel sensor can drift over time due to age, rail wear, loosening of fixtures or damage. Axle counter systems shall be designed to detect changes to quiescent wheel sensor output. When drift is detected, the axle counter system shall produce a diagnostic message that suggests the wheel sensor has degraded.

Conditional failures shall be identified by the diagnostic system.

Safety critical functional failures shall result in a failure of the system and the track section showing occupied.

4.4.3 Availability target

The availability of the axle counter to perform its intended functions shall meet the availability target as determined by the RIM.

Axle counters may have the ability to self-heal faults as determined by the RIM.

Additional configurations may be used to improve the availability of the axle counter, such as:

(a) built in redundancy;

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(b) axle counter or interlocking initiated resets;

(c) condition monitoring;

(d) strategic deployment of track sections, such as separate evaluators for multiple lines.

4.4.4 Maintainability requirements

4.4.4.1 General design

The complete axle counter system shall be configured to optimise maintenance and fault finding, with due regard to the safety of the overall system.

To reduce the risks to personnel working on axle counter systems and the impact to operations axle counter systems should:

(a) be configured and located to minimise working on or near the line;

(b) have easily replaceable equipment.

The axle counter system should be designed so that the mean time to repair the complete system, including trackside equipment, communication links, evaluator equipment and resetting/restoration facility, does not exceed the operational requirements of the RIM.

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. This may be provided locally and/or remotely for local or full system analysis.

4.4.4.2 Logging

Axle counter systems shall create a log of all reset events. These logs should be routinely examined by maintenance personnel.

Inspections and maintenance systems should be designed to allow ease of diagnostic analysis. The diagnostic system should identify conditional failures of the system.

The axle counter diagnostic system should be able to:

(a) identify when equipment is not within specific range and automatically alert maintainer before failure;

(b) automatically alert maintainer that a redundant piece of the system has failed to ensure it is replaced before second unit fails;

(c) log vital functions of the axle counter system so that it can be interrogated during and after failures and/or incidents. This may include:

i. track section occupancy;

ii. type of reset;

iii. equipment settings;

iv. error codes/messages;

v. time and date stamped to 100th's second;

vi. communication errors;

vii. counting of axles.

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4.4.4.3 Documentation

To enable RIMs to accurately assess system maintenance requirements OEMs shall provide:

(a) product specific user guides;

(b) routine and reactive maintenance guides;

(c) information regarding equipment failure modes and fault finding;

(d) equipment failure rates.

4.5 Electromagnetic compatibility

Axle counter equipment, including wheel sensors and evaluator hardware, can be affected by rolling stock, currents in the rail, radio frequency antennas mounted close to the rail and from other sources of electromagnetic radiation. Axle counter equipment shall be designed in accordance with EN 50617. This should include operating reliably adjacent to:

(a) traction return currents;

(b) track circuit rail current;

(c) transmission systems between train and track;

(d) track circuit assistor fitted vehicles;

(e) ultrasonic testing vehicles;

(f) train borne radar.

Wheel sensors shall be tested and proven to not be affected by harmonic content in the traction return rail and other trackside and rollingstock emissions in accordance with EN 50617 and EN 50238-3.

Rolling stock equipped with eddy current brakes can affect the operation of wheel sensors. Where it is reasonably expected that such vehicles are likely to be used, the RIM shall confirm the suitability of wheel sensors for use with eddy current braked vehicles.

Axle counters shall be immune from expected electrical noise generated inside the equipment room or appropriate measures taken.

4.6 Interface to rail

Wheel sensors shall be designed to suit rail sizes as described in AS 7460.1. The design shall include allowances for rail wear as permitted in AS 7460.1.

Where wheel sensors are installed in slab track a pit shall be provided in the slab for the wheel sensor and associated cables. The pit shall be sufficiently large to allow for the bending radius of the cables.

Wheel sensor pits shall have drainage to avoid accumulation of water and frost around the wheel sensor.

4.7 Signalling design

4.7.1 General design considerations

Axle counter systems shall be designed to interface with signalling systems designed in accordance with AS 7711.

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Axle counter systems shall meet the requirements for train detection in accordance with AS 7715.

4.7.2 Minimum track section lengths

Track section lengths shall consider:

(a) longest wheel span between axles and between bogies;

(b) axle counter system latency, including processing time and delays in communication links;

(c) train speeds.

A safety margin shall be documented and included in design calculations as per RIM requirements.

4.7.3 Cables

Cable characteristics shall meet the axle counter manufacturer's requirements. Manufacturer's requirements should include:

(a) cable specifications;

(b) shielding;

(c) earthing;

(d) laying / installation.

These cables should be compliant with AS 7663.

Cable routes should be designed in accordance with AS 7664.

4.7.4 Lightning and surge protection

Axle counter systems shall have earthing and surge protection provided that complies with AS 1768 and AS 7708.

4.7.5 Power requirements

Axle counter systems rely on a continuous power supply to function correctly.

Axle counter systems shall have a suitable power supply provided in accordance with AS 7703.

4.7.6 Axle counter outputs

Axle counter outputs shall have the following statuses:

(a) Clear. The track section is clear of axles.

(b) Occupied. The track section is not clear of axles.

(c) Disturbed. The axle counter system is working correctly however it is unable to verify whether the track section is clear or not.

Axle counter outputs shall be recognised by the interlocking as either clear or occupied. Where a serial interface is used, disturbed may also be a recognised output.

4.7.7 Interlocking interfaces

Interface between the axle counter system and the signal interlocking may be either via a serial interface or voltage free failsafe contact.

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Where an option is provided the RIM should consider the serial interface so that the full features of the axle counter system can be comprehensively utilized, including but not limited to advanced resetting, diagnostic maintenance and predictive faulting capabilities.

4.7.8 Dual gauge track and check rails

Where dual gauge track or check rails are installed the RIM shall follow the OEMs installation specifications.

4.8 Communications

Axle counter systems rely on a continuous flow of information between the wheel sensors (and other trackside equipment) and the evaluator, evaluator to evaluator, and evaluator to the interlocking. Failure of the communication link shall result in the track section showing occupied. When the communications link is restored within an agreed timeframe the axle counter system should be capable of self-healing and return to its previous state.

The communications system shall be designed so that it meets the requirements of the axle system that is being installed.

Axle counter communication links shall be configured in accordance with the OEM's parameters, and as required to meet the parameters of the RIM's interlocking requirements.

Where the axle counter system uses a data communication link the OEM shall specify the protocol requirement details to support communications network design and cyber risk assessment in accordance with Table 4.1 below.

Table 4.1: OEM protocol requirements

Network Communications Requirements	Data Protocol Details
EN50159 Network category	Poll Rate
Limitations on routing	Local and Remote ports i.e. TCP or UDP port numbers
Reconvergence time	Packet Size
Latency / Delay / Jitter	Configurability (e.g. of timings)
Throughput / Bandwidth	Presence of Security features (e.g. Authentication or Encryption)
Packet error rate	

4.9 Suppressing counts / disturbances

If required, the axle counter may be configured to supress counts / disturbances.

This function shall be a SIL4 rated function.

This function shall not cause an unsafe scenario.

4.10 Interface to adjacent systems

When designing an axle counter system a RIM shall design the system to suit interfaces including:

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(a) axle counter to track circuit;
(b) axle counter to different OEM axle counter;
(c) timing differences between train detection systems.

4.11 Resetting system design

Axle counter system shall include a reset functionality. The requirements of this reset design shall be defined by the RIM. The design should consider:

(a) axle counter application logic;
(b) interlocking application logic;
(c) configuration of evaluators;
(d) configuration data;
(e) operational requirements;
(f) maintenance requirements;
(g) track works;
(h) existing interlocking;
(i) location and accessibility of the axle counter system;
(j) use of road rail vehicles;
(k) location of Hi-rail pads;
(l) sweep requirements in relation to the resetting axle counter sections over turnouts.

Resetting may be carried out using any combination of local and remote-control system configurations as determined by the RIM.

5 System faults and resetting of axle counters

5.1 General

Axle counters can require resetting for various reasons. RIMs shall develop procedures and safeworking rules that allow for the resetting of axles counters in case of:

(a) equipment failure;
(b) communication failure;
(c) miscount;
(d) fault caused by track works or track machines;
(e) power failure;
(f) interlocking failures;
(g) TCS failures;
(h) re-connection to TCS system;
(i) replacement of faulty components;
(j) replacement of software;

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(k) occupations or possessions;

(l) commissioning.

Axle counter resets should be designed to minimize the need for qualified personnel to carry out manual resets where possible. RIMs should specify situations where a manual reset shall be carried out.

Resets following large scale possessions or passage of non-compliant rollingstock is complex due to the number of resets required and the distance or area involved. The RIM should consider developing a process to manage large scale resets.

5.2 Safety

Axle counter resets changes the track occupancy status to clear. This is a significant safety risk because interlocking controls around track occupancy can be bypassed.

Risk considerations associated with axle counter resets shall be assessed by the RIM and reduced SFAIRP.

5.3 Failures and degraded modes of operation

The complete axle counter system shall be designed so that a RIMs accepted risk levels are not exceeded when a system failure occurs.

So far as is reasonably practicable, in the event of a failure the system shall behave in a controlled, predictable and pre-determined manner.

So far as is reasonably practicable, degraded modes of operation shall be provided in order to minimise the need, under failure conditions, to rely upon human action for safety-critical tasks that are performed by the system itself in normal operation.

The design of the complete axle counter system shall facilitate safe recovery from credible failure conditions and degraded modes.

5.4 Resetting axle counter systems

5.4.1 General requirements

Axle counters may be reset by system initiated or manual processes.

Prior to any reset being carried out all wheel sensors associated with the track section being reset shall be clear of influence i.e. clear of wheels and other metals.

The RIM shall have a defined process to confirm the track section is safe for an axle counter reset to occur.

Rail vehicles shall not be moving within or towards the track section being reset prior to and during the reset process.

5.4.2 System initiated resets

System initiated resets shall be initiated by the axle counter or interlocking. i.e. no manual involvement is required. System initiated resets may be used for any of the axle counter reset as defined by the RIM.

System initiated resets shall not be possible where:

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(a) a wheel sensor is under the influence of a wheel or other metal;

(b) there is a failure of the communications link between the wheel sensor and evaluator, or evaluator and interlocking; or

(c) the RIM deems the risk of an incorrect reset cannot be reduced SFAIRP.

System initiated resets may include the use of supervisory sections or via the interlocking / evaluator.

5.4.3 Manual reset

Manual resetting axle counter track sections is a safety critical process. The reset process shall be risk assessed and the risk reduced to a level safe SFAIRP.

Manual resets shall be carried out by suitably authorised and competent personnel only.

Depending upon requirement, manual reset of an axle counter track section may be of any of the types shown in Table 5.1.

Table 5.1: Types of axle counter reset

Type of reset	Description	When used	Considerations
Unconditional reset	The track section shall become clear immediately after application of the reset command.	Axle counters used for overlay applications. Where visual confirmation that the track section is clear is possible e.g. yard environment, standalone level crossings.	Limited protection against human failure.
Conditional reset	On application of conditional reset, the track section shall become clear if the last count is a count-out from the section. In other words, a track section shall not accept conditional reset if the last count is a count-in into the section.	Where interlocking or procedures can provide a restricted proceed authority. Failure of axle counter e.g. miscount.	Section could be occupied. Can be used for an engineering reset.
Preparatory reset	After receipt of the reset command, the track section shall remain in “occupied” state. A train – having at least 2 axles – shall pass through the section. The section shall be cleared when the numbers of axle counted into the section equals the numbers of axle counted out from the section.	Where interlocking or procedures can provide a restricted proceed authority.	Need to confirm all ends are clear. Can be difficult where multiple ends are present e.g. entrance to yard.
Cooperative reset	It shall require two commands and be used to reset section without train movement. The operator shall command a reset. The maintenance personnel shall command acknowledgement without train	Clear section that was disturbed during maintenance work or after equipment failures	Section shall be clear of rail traffic when undertaking a cooperative reset. Time for personnel to attend site. Could be unsuitable for remote

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Type of reset	Description	When used	Considerations
	passing. The section shall become clear.		areas or where time is a critical operational consideration.

Reset types shall comply with the safety application requirements of the OEM.

5.5 Documented records

A RIM should consider the retention of records of all axle counter resets. These records should include:

(a) reason for reset;

(b) action taken to reset the axle counter;

(c) whether further investigation into the reason is required.

6 Testing and certification

The OEM shall provide the RIM with all requirements to test and commission an axle counter system.

Testing and commissioning shall be conducted in accordance with AS 7717. The RIM should provide specific commissioning requirements for each individual system installed.

Testing of axle counter systems shall include:

(a) calibration of axle counters;

(b) correspondence testing between axle counters;

(c) verification of interface with interlockings;

(d) physical and system configuration installation;

(e) data configuration;

(f) control table testing;

(g) communications testing, including change over to standby links.

Axle counter systems may be tested and commissioned in shadow mode.

7 Operation of non-compliant vehicles

7.1 General requirements

Introduction of axle counters could improve detection of rail vehicles and track machines which are classified as not detected by conventional track circuits. Some machines and road rail vehicles (RRVs) will be reliably detected and this could improve operational safety outcomes.

Whilst axle counters can provide reliable detection for the smaller wheel sizes on track machines the operation cannot be guaranteed to the same safety integrity as for rail vehicles with larger wheels.

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Rail vehicles with non-compliant wheelsets or with vehicle protuberances within the metallic free zone can be incorrectly detected by wheel sensors. Track machines and smaller work trolleys are likely to disturb axle counter sections when traversing the axle counter heads.

Axle counter systems may be configured to improve sensitivity to track machines or to alternatively ignore them.

The RIM shall specify whether it intends to detect or ignore track machines, RRVs and smaller vehicle wheels.

The RIM shall have documented processes for the operation of non-compliant rollingstock through axle counter sections.

7.2 Rail vehicles

Rail vehicles with wheelsets that do not comply with section 4.3 of this Standard are not reliably detected by axle counter systems. RIMs shall have operating procedures to manage the operation of rail vehicles that are not reliably detected.

RIMs should have a documented list of all accredited rail vehicles that are either non-compliant or will not reliably be detected by wheel sensors.

Non-compliant vehicles shall not be permitted to operate over axle counter track sections unless in accordance with the documented procedures for the operation of non-compliant rail vehicles.

7.3 Road Rail Vehicles

Management of RRVs use in axle counter systems requires careful consideration. This is due to the likelihood of RRVs on or off tracking within an axle counter section[3].

To reduce the requirements to reset axle counter systems where RRVs are used the RIM should consider:

(a) axle counter system design, such as to intentionally detect or to not detect RRVs;

(b) location of on/off tracking pads, such as complex axle counter sections or where automated resetting controls are used;

(c) operational procedures.

The RIM shall provide documented procedures for the operation of and on / off tracking of RRVs within a track section. Where it is safe to do so a local reset option may be provided for RRV operators.

8 Track maintenance

8.1 General considerations

Track maintenance can cause damage to or failure of axle counter systems. This can be caused by:

[3] On tracking can lead to the section being left occupied due to a miscount. Off tracking can lead to the section being occupied with a 'last-count-in' status that won't permit a conditional reset. RRV wheels can be unreliably detected by axle counters.

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(a) tamping or regulating over wheel sensors;
(b) rail grinding;
(c) rail replacement;
(d) removal of wheel sensors to enable work;
(e) incorrect replacement of wheel sensors after work completed;
(f) track maintenance vehicles or machinery contacting wheel sensors.

RIMs shall have documented processes to reduce the risk of damage or failure of axle counter systems during track maintenance SFAIRP.

8.2 Safeworking

Axle counters could affect the implementation of safeworking rules which assume other types of train detection (for example, dropping a track circuit by placing a shorting device across the rails). RIMs shall assess the risk of trackwork within axle counter sections and amend safeworking procedures as necessary to reduce the risk SFAIRP.

8.3 Removal of wheel sensors

The RIM shall provide track maintenance personnel with training and instruction on the safe removal and replacement of wheel sensors.

Axle counter systems shall be recalibrated where a wheel sensor is removed then replaced after track maintenance activities.

8.4 Track maintenance activities

8.4.1 Hot work

Hot work near axle counters should only be carried out outside the safe distance specified by the OEM. Where hot work is conducted within this distance the wheel sensor shall first be removed.

8.4.2 Grinding

Wheel sensors could require removal prior to grinding depending on the OEM requirements.

Following grinding of rail adjacent to a wheel sensor the calibration of the axle counter system shall be confirmed.

8.4.3 Tamping

Rail tamping machines typically have a wheel which lifts the rail. This wheel is likely to foul wheel sensors. Wheel sensors should be removed for this type of work regardless of selected mounting arrangements.

8.4.4 Rail replacement

Wheel sensors shall be removed and stored prior to removal of the rail to which they are attached.

Following rail replacement, the wheel sensor shall be reinstalled as per design and then re-calibrated to ensure the correct operation of the system.

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9 System maintenance

9.1 General requirements

Maintenance, including testing and examination shall include:

(a) the axle counter system;

(b) wheel sensor;

(c) interfaces to interlocking;

(d) power supply, including surge protection

(e) communications system;

(f) all track leads and cables;

(g) preventative activities and reviews of the logs.

A RIM shall provide training, including maintenance and diagnostic instructions, to allow personnel to maintain the axle counter equipment safely and effectively.

Records of all maintenance carried out shall be maintained in accordance with the RIMs requirements.

9.2 Removal of wheel sensors

Wheel sensors that are bolted to the rail provide maintenance personnel with a defined location as to where the wheel sensor is placed, reducing the risk of incorrect reinstallation.

Wheel sensors that are clamped to the rail are often preferred as they do not require drilling through the rail. However, this has a higher risk of the wheel sensor being replaced incorrectly on the rail after the work is completed.

Where a wheel sensor is removed from the rail the wheel sensor shall be reinstalled as per design. The axle counter system shall then be recalibrated to ensure the correct operation of the system.

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Appendix A Hazard register

Hazard number	Hazard
5.9.1.10	Failure in wayside detection equipment so that trains are not detected
5.9.1.22	Wheels being too small to trigger axle counters resulting in trains not being detected
5.9.1.28	Bogies axle spacings being too short for axle counter detection at speed so that the axle spacing is not compatible with detection system resulting in trains not being detected
6.6.1.11	Wheel flange striking switches, check rails & crossings and axle counters
9.25.1.1	Axle counter wheel sensors not detecting every or any wheel
9.25.1.3	Inappropriate positioning of train detection equipment in relation to other physical hazards

Appendix B Bibliography

The following referenced documents are used by this Standard for information only:

(a) RIS-0728-CCS:2016 Infrastructure Based Detection System

(b) GK/RT0217:2003 Technical Requirements for Axle Counters

(c) EN 50121-4 Electromagnetic compatibility

(d) EN 50124-1 Electrical safety

(e) EN 50125-3 Environmental conditions

(f) EN 60529 Degrees of protection provided by enclosures

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