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Preface

This standard was prepared by the Signalling Principles Development Group, overseen by the RISSB Train Control Systems Standing Committee.

Objective

The objective of this Standard is to provide the rail industry with a set of signalling principles that will ensure the safe and efficient operation of a railway.

Compliance

There are four types of provisions contained within Australian Standards developed by RISSB:

(a) Requirements.

(b) Recommendations.

(c) Permissions.

(d) Constraints.

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 recognize 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.

Permissions – conveys consent by providing an allowable option. Permissions are identified within the text by the term 'may'.

Constraints – provided by an external source such as legislation. Constraints are identified within the text by the term 'must'.

RISSB Standards address known hazards within the railway industry. Hazards, and clauses within this Standard that address those hazards, are listed in Appendix A.

Appendices in RISSB Standards may be designated either "normative" or "informative". A "normative" appendix is an integral part of a Standard and compliance with it is a requirement, whereas an "informative" appendix is only for information and guidance.

Commentary

Commentary *C Preface*

This Standard includes a commentary on some of the clauses. The commentary directly follows the relevant clause, is designated by 'C' preceding the clause number and is printed in italics in a box. The commentary is for information and guidance and does not form part of the Standard.

Table of Contents

Figures

Section 1 Scope and general

1.1 Scope

This document specifies the principles for railway signalling systems. This document is applicable to railways covered by AS 7630. This document is not generally applicable to light railways, inclined railways, tramways and other railways to which Rail Safety National Law does not apply, however the principles within this document can be applied.

This document is applicable to all aspects of the signalling system. Signalling systems comprise of various systems (e.g., train control, wayside systems, train-borne systems, etc.) including the procedures and technology that form the system of safeworking (including degraded mode working).

This document is applicable to autonomous train operations (ATO). Where a requirement relates to rail safety workers, the requirement equally applies to the autonomous train system.

This document is applicable to all systems of safeworking regardless of the train detection systems in use. This includes systems that use mechanical interlockings, whether they are released / locked by a signalling system or managed through the safeworking system.

This document is primarily designed for use with fixed block systems, where the block locations are fixed either physically (e.g., signals) or virtually. Systems using moving block can apply similar principles to those described in this document, however they could require modification.

Digital train control systems such as European Train Control System (ETCS) are not specifically covered by this document, however the principles contained within can be used for guidance when designing those systems.

This document does not address the processes and competences for the design, construction and implementation, commissioning, monitoring and maintenance, modification, or decommissioning and disposal of a signalling system.

Each principle within this document includes:

(a) Rationale - identification of risks that are mitigated through adherence with the principles;

(b) Requirements (if applicable) – specific requirements needed to comply with the principles; and

(c) Guidance (if applicable) – recommendations and guidance to assist in meeting the principles.

1.2 Normative references

No documents are indispensable for the application of this Standard.

NOTE:

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

1.3 Defined terms and abbreviations

For the purposes of this document, the following terms and definitions apply:

1.3.1
AoE
ATO over ETCS

1.3.2
ATO

automatic train operation

1.3.3
ATP
automatic train protection

1.3.4
AWS
automatic warning system

1.3.5
block
line between the departure end yard limit of one location and the arrival end yard limit of another location.

Note to entry 1: A block consists of one or more track sections. See Figure 1 for further information.

1.3.6
block section
line between opposing departure signals on bidirectional lines, or the departure signal and the home signal on unidirectional lines

Note to entry 1: See Figure 1 for further information.

1.3.7
digital train control
ETCS and CBTC systems

Note 1 to entry: Digital train control is a collective term for ETCS and CBTC systems.

1.3.8
ETCS
European train control system

1.3.9
graceful degradation
design principle where a system maintains essential functionality even when some components fail rather than shutting down completely

1.3.10
OSS
overspeed sensor system

1.3.11
PAE
proceed authority exceedance

1.3.12
rail transport operator (RTO)

As defined in Rail Safety National Law.

1.3.13
track section
portion of line between two signals

Note to entry 1: Refer Figure 1 for further information.

1.3.14
TISP

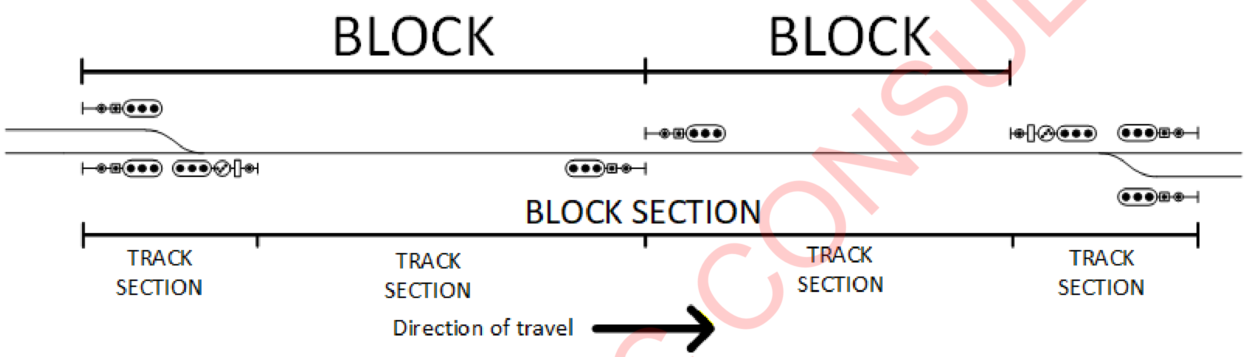
train in section proving

1.3.15
TORR
train operated route release

1.3.16
TPWS
train protection and warning system

1.3.17
TSS
train stop system

Figure 1 Example of block, block section and track section



General rail industry terms and definitions are maintained in the RISSB Glossary. Refer to: https://www.rissb.com.au/glossary/

Section 2 Signalling principles

2.1 Overview

The principal function of a signalling system, as part of a system of safeworking, is to communicate movement authorities from network control to rail traffic crews so as to allow the safe and efficient operation of a railway.

The basic principles of a safe signalling system are as follows:

(a) The route for the passage of rail traffic shall be clear, non-conflicting, set, and locked before a movement authority is issued.

(b) The signalling system shall prevent rail traffic collisions with other rail traffic.

(c) The signalling system shall prevent rail traffic collisions with road vehicles and pedestrians at level crossings.

(d) The signalling system shall prevent unintended rail traffic derailments.

2.2 Fundamental requirements for train control systems

The Institution of Railway Signal Engineers has developed the fundamental requirements for train control systems.

Alignment between the IRSE Fundamental requirements for train control systems and this document is shown in Appendix B.

Section 3 Movement authorities

3.1 Division of lines into blocks

3.1.1 Principle

Lines that are controlled by a signalling system shall be divided into blocks.

3.1.2 Rationale

To facilitate safe separation and management of rail traffic, the rail line is divided into blocks protected by locking the route to ensure non-conflicting rail traffic is authorized to enter a block in normal operations.

3.1.3 Guidance

Selection of an appropriate system of safeworking for a line, and hence whether a signalling system is required for that line, is based upon the rail operational requirements.

A block can consist of multiple track sections (i.e. track circuits or axle counter sections), to allow partial route release behind the rail traffic to enable subsequent rail traffic movements to enter the block up to a determined limit of authority (e.g., a permissive signal protecting the preceding rail traffic or a virtual limit of authority).

3.2 Movement authorities

3.2.1 Principle

Movement authorities shall provide a valid and safe route for the movement of rail traffic in a block or block section. Refer to Clause 4.3 and 4.4 for shunt and call on signals.

3.2.2 Rationale

Movement authorities are critical to the safe movement of rail traffic within the rail network.

3.2.3 Requirements

A movement authority shall only be issued once the network controller confirms that the block is clear of rail traffic and that no track work authorities have been issued.

The route granted by the movement authority shall be maintained (locked) until the movement authority is completed or cancelled.

Where rail traffic clears a block a new movement authority shall be issued before the rail traffic re-enters the block.

3.3 Communication of movement authorities to the network control officer

3.3.1 Principle

The signalling system shall provide the network control officer with unambiguous, consistent and timely information sufficient to safely and efficiently authorize rail traffic movements under both normal and degraded mode of operations.

3.3.2 Rationale

The principal function of a network control officer is to issue movement authorities to rail traffic crews. In order to do this safely and efficiently, the network control officer needs to know the current state of the railway, including:

(a) the location of rail traffic; and

(b) the movement authorities that have been issued to rail traffic within their area of control.

3.3.3 Guidance

This also includes track section occupancy, position of points or other movable infrastructure, ancillary information systems such as train describers, critical fault alarms and other data systems.

The system should clearly indicate the start and end of all movement authorities that have been issued to rail traffic. The indication should maintain real-time updates as the rail traffic progresses on its movement authority.

3.4 Limits of movement authority for a block

3.4.1 Principle

Limits of movement authority shall be provided to define the area within which the rail traffic can safely move.

3.4.2 Rationale

To ensure the safe separation of rail traffic and the safe passage of rail traffic within specified limits.

3.4.3 Requirements

Limits of movement authority include:

(a) signals capable of displaying a stop indication;

(b) buffer stops;

(c) stop signs;

(d) limit of authority signs, including ETCS marker boards;

(e) limit of shunt signs;

(f) other signs defined in the network rules and procedures; and

(g) points or other movable infrastructure that are operated locally.

Limits of authority shall be clearly demarcated for identification by rail traffic crew.

Where a wrong direction movement authority can be provided on unidirectional lines (e.g., shunt signals from a yard), the limit of authority shall be clearly defined.

Also refer to Clause 5.1 and 5.2 of this document.

3.4.4 Guidance

Points or other movable infrastructure that are operated locally (e.g., from a ground frame) should be released by the signalling system. When the release is not given, rail traffic is prevented from entering the block via movements that can only be achieved when the points are being operated locally (e.g., from a siding).

3.5 Inappropriate locations for limits of movement authorities

3.5.1 Principle

Limits of movement authority shall not be located where it would cause rail traffic to come to a stand at an undesirable location, so far as is reasonably practicable.

3.5.2 Rationale

If rail traffic is brought to a stand in a location where access and egress is unsafe, this could result in a greater risk of injury to rail traffic crew or passengers. This can include tunnels, viaducts, culverts, partially or fully off platforms, etc.

If an electric train with only one pantograph is brought to a stand with the pantograph in a neutral section or section gap, the train could be unable to restart.

If rail traffic is brought to a stand on a steep gradient, the rail traffic could be unable to restart.

If rail traffic is brought to a stand on a level crossing, it will cause frustration to road users.

If rail traffic is brought to a stand at a position where the next movement authority cannot be clearly conveyed, it could cause delays to the rail traffic and following traffic.

3.5.3 Guidance

The location of limits of movement authority is driven principally by:

(a) the need to prevent rail traffic from passing over points or other movable infrastructure when it is not safe to do so (see Clause 5.3); and

(b) the need to achieve the operational requirements (e.g., braking distances, signal sighting, overlap requirements, headways, joining/splitting, platform sharing, shunting, etc.)

For physical (as opposed to virtual) limits of movement authority (e.g., signals), maintenance access also constrains the location. See Section 13.

Where limits of movement authority are at undesirable locations (because it is not reasonably practicable to do otherwise), means of mitigating the risks identified in Clause 3.5.2 include:

(c) installation of repeater or subsidiary signals;

(d) requiring the limit of movement authority to be at proceed before the previous limit of authority is placed to proceed; and

(e) functionality within the train control system, such as confirming that the train identification number is of the correct type (e.g., not a passenger train, not an electric train) before allowing the route to be requested only up to the limit of movement authority.

3.6 Warning before limit of movement authority

3.6.1 Principle

Warning shall be provided to allow the rail traffic to come to a stop before the limit of its movement authority.

3.6.2 Rationale

The braking distance of rail traffic can be significant and beyond the sighting point of the limit of movement authority.

3.6.3 Guidance

Means of providing sufficient warning include:

(a) a signal displaying a warning indication at a sufficient distance before the limit of movement authority;

(b) a sign at a sufficient distance before the limit of movement authority; and

(c) a distance to go indication in an in-cab signalling system.

For signals and signs, the minimum distance before the limit of movement authority is the longest service braking distance of all types of rail traffic authorized to approach the limit of movement authority at their permitted speed.

3.7 Creation and issue of a movement authority

3.7.1 Unique identification of limits of movement authority

3.7.1.1 Principle

Each limit of movement authority which is also the entrance to another movement authority shall be uniquely identified. Only this unique identification shall be used.

3.7.1.2 Rationale

Rail safety workers (i.e. rail traffic crew, network control officers, protection officers, etc.) need to have a common understanding of the location of the various limits of movement authority on the rail network. Unique identification ensures there is no ambiguity when referencing the limit of movement authority.

3.7.1.3 Guidance

The identifier can consist of, for instance, a location abbreviation and a signal number. Alternatively, for automatic signals this may be a line abbreviation and a kilometrage number or other alphanumeric unique identifier for that line.

Signals that are not a limit of movement authority can also be uniquely identified.

3.7.2 Issue of movement authority

3.7.2.1 Principle

The issue or absence of movement authorities shall be conveyed to the rail traffic crew clearly, unambiguously, and with sufficient information to allow rail traffic crew to safely manage the rail traffic.

3.7.2.2 Rationale

Rail traffic crew need to be able to reliably read, interpret and act upon the information presented throughout the range of operational and ambient conditions applicable at that location, within the operational context and while performing their required duties.

3.7.2.3 Guidance

Means of conveying movement authorities/the denial of movement authorities include lineside signals and/or in-cab signals. Written or verbal communications can also be used in degraded mode situations.

In speed signalled areas, this can include the permitted speed.

In route signalled areas, this can include the destination and the status of the next authority indicator (e.g., signal).

Guidance on lineside signals is given in AS 7721.

Guidance on railway infrastructure sighting is given in AS 7631.

3.7.3 Creation of movement authorities

3.7.3.1 Principle

The signalling system shall provide the network control officer with facilities for requesting movement authorities.

3.7.3.2 Rationale

The network control officer requires the facilities for requesting movement authorities in order to safely and efficiently authorize rail traffic movements.

3.7.3.3 Guidance

Automatic signals and other automatic equipment do not require facilities for requesting movement authorities unless provided with functionality that enables the automatic equipment to be controlled by the network control officer in specific circumstances.

Commentary C3.7.3.3
Circumstances can include yards which are not regularly used and the mainline signals are set for automatic operation. Where there is a need to access the yard, control of the signals could be provided to a local signal control panel to enable rail traffic to enter the yard.

For movement authorities that extend over the boundary between network control officer jurisdictions, see Clause 3.12.

3.8 Modification or withdrawal of movement authorities by a network control officer

3.8.1 Principle

The signalling system shall provide the network control officer with facilities for withdrawing movement authorities.

3.8.2 Rationale

The network control officer could withdraw a movement authority:

(a) to stop rail traffic in an emergency; or

(b) during disrupted or degraded operations, when rail traffic needs to take a different path through the rail network than originally planned.

3.8.3 Requirements

All controlled movement authorities (e.g., from controlled signals) shall be capable of being withdrawn by the network control officer.

For movement authorities that extend over the boundary between network control officer jurisdictions, either of the network control officers shall be able to withdraw the movement authority in their area of control. This includes boundaries within the same control centre, the same RTO, and between RTOs.

When a movement authority has been withdrawn:

(a) conflicting movement authorities shall not be issued. See Clause 3.8; and

(b) points or other movable infrastructure within the movement authority or overlap should remain locked (see Clause 5.2) until:

  (i) it is proved that no rail traffic is approaching the new (shortened) limit of authority; or

  (ii) a reasonable assurance is obtained that any approaching rail traffic has come to a stand at or before the new (shortened) limit of authority; or

  (iii) rail traffic enters the route, for example, the rail traffic was too close to the new (shortened) limit of authority to stop.

If rail traffic enters the route, the route shall be held ahead of the train., This ensures the safety of the rail traffic in the same way as if the rail traffic used the route.

3.8.4 Guidance

Uncontrolled movement authorities (e.g., from permissive signals) can also be capable of being withdrawn by the network control officer.

For movement authorities that extend over the boundary between network control officer jurisdictions, either of the network control officers shall be able to withdraw the movement authority. This includes boundaries within the same control centre, the same RTO, and between RTOs.

The rail traffic could be closely approaching the new (shortened) limit of movement authority at the time and be unable to stop within the limits of the shortened movement authority.

3.9 Replacement of signal indications by passage of rail traffic

3.9.1 Principle

The signalling system shall replace a lineside signal indication to its most restrictive aspect once the first wheel of the leading rail vehicle has entered the track section protected by that signal or replacement track unless stipulated in Clause 3.9.3 or 12.7

3.9.2 Rationale

If a lineside signal remains at proceed after the leading end of the rail traffic has passed the signal, there is a risk that following rail traffic will read-through.

However, if the lineside signal indication is replaced after the leading end of the rail traffic has passed the signal but while the rail traffic crew can still see the signal (e.g., when the rail traffic crew are at the rear of the rail traffic in a propelling movement), rail traffic crews can become acclimatized to passing signals at stop.

3.9.3 Guidance

For shunting movement authorities (see clauses 4.3 and 4.4), the signal may be replaced to stop once the front of the rail traffic has passed the signal. However, where propelling movements are frequently undertaken, the signal may be replaced to stop once the rear of the rail traffic has passed the signal.

Preset shunting signals should use the same replacement style as the presetting signal, when in preset mode.

Distant signals should be replaced to their most restrictive aspect after the leading rail vehicle has passed that signal.

3.10 Permissive signals

3.10.1 Principle

Permissive signals shall be operated by the passage of rail traffic only.

3.10.2 Rationale

Permissive signals enable the efficient movement of rail traffic by operating only based on whether the track section in advance of the permissive signal is clear and safe or occupied.

3.10.3 Guidance

Absolute signals may be operated as permissive signals (e.g., train/signal fleeting).

Permissive signals may be capable of operation by the network control officer (see Clause 3.8)

Track sections with points are generally unsuitable for permissive signals.

3.11 Block sections with multiple blocks

3.11.1 Principle

For rail traffic to be authorized to enter a block section with multiple blocks:

(a) rail traffic travelling in the same direction shall be clear of the block;

(b) no rail traffic shall currently be moving in the opposite direction within the block section; and

(c) no rail traffic shall currently be authorized to enter the block section in the opposite direction.

Note: Where an opposing movement has been granted authority for the block, see Clause 3.8.

3.11.2 Rationale

If rail traffic travelling in opposite directions enters a block section, one of the rail traffic will need to reverse out of the section in order to let the other rail traffic pass.

3.11.3 Requirements

All rail traffic travelling in the block section shall have exited the block section before another rail traffic can be authorized to enter the block section in the opposite direction.

3.11.4 Guidance

A block section may consist of multiple blocks.

Where a block section has multiple blocks, rail traffic may follow each other through the block section provided not more than one rail traffic is in each block.

3.12 Blocks at interface boundaries

3.12.1 Principle

Where a block crosses over an interface boundary or provides permission to enter an interface, facilities shall be provided so both network control officers provide the movement authority.

3.12.2 Rationale

Network control officers shall be advised of any rail traffic entering their area of control to avoid conflicting movements and unnecessary delays to rail traffic.

3.12.3 Guidance

Routes into an adjacent network control area should be controlled by the adjacent network control officer. This may be directly (only by the network control officer controlling that area) or when the movement authority has been requested by the previous network control officer.

The adjacent network control officer may provide an authorisation for a movement authority to be issued into their area of control. This is commonly referred to as providing a slot.

On unidirectional lines signals controlling the entrance to an adjacent network may be set to permissive (i.e. fleeting).

Section 4 Preventing rail traffic from colliding with other rail traffic

4.1 Identification of position of points and other movable infrastructure

4.1.1 Principle

The position of each point end or other movable infrastructure shall be uniquely identified.

4.1.2 Rationale

Rail safety workers (i.e. rail traffic crew, network control officers, etc.) need to have a common understanding of the position of points and other movable infrastructure on the rail network.

4.1.3 Guidance

The position of points and other movable infrastructure is usually termed:

(a) normal; and

(b) reverse.

The position of points and other movable infrastructure should be identified both on the control panel and on the points or other movable infrastructure.

Point ends include:

(c) sets of points, including catch points;

(d) switchable V crossings; and

(e) switchable K crossings.

Other movable infrastructure includes:

(f) derailers;

(g) crowders;

(h) security gates;

(i) flood gates;

(j) lift bridges; and

(k) swing bridges.

Multiple point ends or other movable infrastructure could, for convenience, be grouped into a single interlocking function. Where rail networks controlled by other RTOs are adjacent, the point end and other moveable infrastructure identifier should be unique to the two networks.

4.2 Rail traffic foul of the block

4.2.1 Principle

A movement authority shall not be issued to rail traffic if another rail traffic is foul of the clearance point or kinematic envelope of the block.

4.2.2 Rationale

Rail traffic foul of an adjacent track can result in a collision with other rail traffic. Safe clearances are required to ensure rail traffic does not collide.

4.2.3 Guidance

In order to prevent side on collision between rail traffic track detection systems, train positioning systems should be interlocked with signals, digital train control systems, and points or catchpoints to stop trains entering the safety zone set by clearance points or overlap boundary.

Further guidance is given in Appendix D, AS 7715 and AS 7651.

At points and crossings, the clearance point can be beyond the track. The track sections between the track section within the block and the clearance point are foul track sections.

Also see Clause 4.5 of this document.

4.3 Shunting movement authorities – Conflicting movement authorities

4.3.1 Principle

For rail traffic to be authorized to enter a block for a shunting movement:

(a) no other rail traffic shall currently be authorized to enter or be foul of the block (except where limited by rail traffic or where opposing locking is omitted. See Clause 12.7); and

(b) if other rail traffic was authorized to enter or be foul of the block, but the movement authority has been withdrawn, the other rail traffic is able to stop, or has stopped, before entering the withdrawn movement authority.

4.3.2 Rationale

Shunting movement authorities allow rail traffic to enter an occupied block for purposes such as:

(a) platform sharing;

(b) coupling of rail traffic;

(c) permissive working; or

(d) shunting.

Shunting movement authorities allow rail traffic to enter a potentially occupied block:

(e) where there is no operational requirement to travel at a speed greater than would allow it to stop short of an obstruction, for example, sidings; or

(f) where allowed by the network rules and procedures, when elements of the train detection system have failed.

4.3.3 Guidance

Shunting movement authorities include all movement authorities that require the rail traffic to be able to stop short of an obstruction. In route signalling, this includes subsidiary signals and shunting signals (e.g., calling-on class routes and shunt class routes). In speed signalling, this includes low-speed caution aspects.

4.4 Shunting movement authorities – Occupancies

4.4.1 Principle

For shunting movements, the risk of rail traffic colliding with rail traffic currently within or foul of the block shall be mitigated so far as is reasonably practicable.

4.4.2 Rationale

Shunting movement authorities allow rail traffic to enter an occupied block for purposes such as:

(a) platform sharing;

(b) coupling of rail traffic;

(c) permissive working; or

(d) shunting.

Note that coupling of rail traffic and shunting require controlled collisions between rail traffic.

Shunting movement authorities allow rail traffic to enter a potentially occupied block:

(e) where there is no operational requirement to travel at a speed greater than would allow it to stop short of an obstruction, for example, sidings; or

(f) where allowed by the network rules and procedures, when elements of the train detection system have failed.

4.4.3 Guidance

Shunting movement authorities include all movement authorities that require the rail traffic to be able to stop short of an obstruction. In route signalling this includes subsidiary signals and shunting signals, for example, calling-on class routes and shunt class routes. In speed signalling this includes low-speed caution aspects.

Where a path from a signal is provided with both a running movement authority and a shunting movement authority, a separate control device (e.g., lever, switch, pushbutton, computer command) should be provided to allow the network control officer to specifically request the shunting movement authority.

For rail traffic to be authorized to enter a block for a shunting movement, any rail traffic currently within the block should have completed any opposing conflicting movements.

Means of proving that any rail traffic currently within the block was not authorized to undertake an opposing conflicting movement includes sectional route locking.

The sectional route locking should extend from the start of the conflicting route up to:

(a) the end of the conflicting route; or

(b) the end of the block, whichever comes first.

Where overlaps are provided, the sectional route locking should be extended. See Appendix C.

Means of proving that any rail traffic currently within the block that was authorized to undertake an opposing conflicting movement has completed any opposing conflicting movements include:

(c) the berth track section of the opposing conflicting route exit signal occupied for sufficient time that the opposing conflicting movement can be assumed to have come to a stand; or

(d) other track section where the rail traffic has an operational reason to stop (e.g., a platform) occupied for sufficient time that the opposing conflicting movement can be assumed to have come to a stand.

For rail traffic to be authorized to enter a block for a shunting movement, any rail traffic currently within the block should have completed all movements.

Means of proving that any rail traffic currently within the block has completed all movements include:

(e) proving that any rail traffic currently within the block that was authorized to undertake an opposing conflicting movement has completed any opposing conflicting movements, as above;

(f) the line is clear from the protecting signal to the nearest point where the rail traffic can legitimately be positioned; and

(g) the signal ahead of the rail traffic is at stop.

The signal ahead of the rail traffic could be required to be held at stop until the rail traffic has completed its shunting movement and can be assumed to be at a stand.

For rail traffic to be authorized to enter a block for a shunting movement, it could require that rail traffic is currently within the block.

Means of proving that rail traffic is currently within the block include proving that the track section where rail traffic can legitimately be positioned is occupied.

For rail traffic to be authorized to enter a block for a shunting movement, the rail traffic speed should be such that it can stop short of an obstruction.

Means of proving that the rail traffic speed is such that it can stop short of an obstruction include:

(h) the authorized speed on the approach to the signal is such that the rail traffic can stop short of an obstruction;

(i) the berth track section of the signal occupied for sufficient time such that the rail traffic speed can be assumed to be such that it can stop short of an obstruction; or

(j) enforcement systems. See Appendix E.

To minimize the risk that the rail traffic accelerates once it has passed the protecting signal, the distance between the protecting signal and the nearest end of the rail traffic should be minimized, as far as reasonably practicable, without compromising other requirements for signal positioning.

For rail traffic to be authorized to enter a block for a shunting movement, it could be required that no rail traffic is currently foul of the block.

A running movement authority can be allowed to step down to a shunting movement authority if:

(k) the conditions for the running movement authority are no longer available; and

(l) the conditions for the shunting movement authority are available; and

(m) the network control officer operates the separate control device for the shunting movement authority.

4.5 Exceeding the movement authority

4.5.1 Principle

Rail traffic shall be prevented from colliding with other rail traffic owing to exceeding its movement authority, so far as is reasonably practicable.

4.5.2 Rationale

Rail traffic can exceed its movement authority for many reasons, including:

(a) signal design and/or location;

(b) signalling system fault;

(c) geographical conditions;

(d) rail traffic crew competence, especially route knowledge;

(e) rail traffic crew personal factors, especially fatigue and health; and

(f) rail traffic crew workload.

Refer to *RISSB Guideline – Rail Traffic PAE Risk Management* for further information on causes of proceed authority exceedance.

4.5.3 Guidance

Means of mitigating the risk of rail traffic colliding with other rail traffic owing to it exceeding its movement authority include:

(a) proving that the exit signal is lit;

(b) approach clearing the entrance signal;

(c) overlaps;

(d) trapping;

(e) self-restoration of points;

(f) flank point protection;

(g) flank track protection; and

(h) enforcement systems.

Further information on the above methods is provided throughout this document.

4.6 Foul track locking of points

4.6.1 Principle

Points shall not move to a position that would allow rail traffic to collide with rail traffic that is foul.

4.6.2 Rationale

Under degraded mode conditions, rail traffic can pass over points without having a movement authority (via the signalling system).

Rail traffic is designed to withstand the end-on forces that are experienced during shunting and normal train operation. However, rail traffic is not designed to withstand the edge-on forces of a collision with rail traffic that is foul.

Rail traffic passing over points without a movement authority (via the signalling system) needs to be protected from colliding with rail traffic that is foul.

4.6.3 Guidance

Means of proving that no rail traffic is foul of a set of points include:

(a) track circuits;

(b) axle counters; and

(c) train-borne positioning systems.

Further guidance is given in AS 7715 and AS 7651.

Where there are track sections between the points track section and the clearance point these are foul track sections.

Points can be set towards an occupied foul track section. Points should not be set against the occupied foul track section in case the rail traffic occupying the track section moves towards the points track.

Foul track sections can be conditionally foul of the points, depending upon the lie of another set of points. Typically, the conditionally foul track section will contain the other set of points. However, for a conditionally foul track section over a diamond crossing, the other set of points can be within an adjacent track section. However, unless it prevents other permissible movement authorities (e.g., if route setting is prevented by rail traffic traversing a parallel route), the points can be unconditionally locked by the foul tracks, regardless of the state of the other set of points.

The points should prove that the other points are set and locked unless the foul track section is clear. The points do not generally require the other points to be detected.

Where a path through a junction requires multiple sets of points, the fouling track locking of points can be simplified (i.e. not all sets of points need to prove all fouling tracks), so long as the path through a junction cannot be aligned until the fouling tracks are clear.

4.7 Points protecting running lines

4.7.1 Principle

Points, derailers, catch points, etc. shall be provided where there is an identified risk of roll away or unauthorized moves of rail traffic entering the running line. The roll away prevention position (or derail position) should be the normal position.

4.7.2 Rationale

Uncontrolled movements of rail traffic can result in rail traffic entering a running line causing collisions with other rail traffic and/or damage to infrastructure.

4.7.3 Requirements

Points, derailers, catch points, etc. protecting running lines should be provided with a function to automatically restore the points to its safe (rollway prevention) position by the interlocking system when safe to do so. For automatic restoration, the following conditions shall apply:

(a) All track sections containing the points to be unoccupied.

(b) No movement authority is issued over the points.

(c) The points have not been manually locked by the controller.

(d) A pre-determined timeout has elapsed before the points are free to operate.

4.7.4 Guidance

The potential risks of automatic restoration shall be assessed to determine whether the automatic self-normalisation could inadvertently lead to an unsafe situation or hazard, such as harm to rail safety workers.

As a supplemental control, where this automatic self-normalisation is provided, an alarm can be provided to alert the controller if the points have failed to self-normalize.

As an alternative control, where this automatic self-normalisation is not provided, an alarm can be provided to alert the controller where the points have been left in the roll away position for an extended period.

Section 5 Preventing rail traffic from derailing

5.1 Preventing rail traffic from passing over points or other movable infrastructure

5.1.1 Principle

Points and other movable infrastructure shall be protected by safe design of movement authorities.

5.1.2 Rationale

Rail traffic needs to be prevented from passing over points or other movable infrastructure when it is not safe to do so, for example, whilst points are changing position.

5.1.3 Guidance

Points or other moveable infrastructure located on unidirectional lines could not require movement authority protection in the wrong running direction.

Where points or other movable infrastructure are operated locally, for example, from a ground frame, no limit of movement authority needs to be provided for movements that can only be authorized when the points are being operated locally. For instance, for points operated from a ground frame that allows access from a siding to a running line, no limit of movement authority needs to be provided for trains approaching the points from the siding.

For interlocked points, the movement authority should be provided by absolute signals.

Also refer to Clause 3.4 in this document.

5.2 Authorizing rail traffic to pass over points or other movable infrastructure

5.2.1 Principle

For rail traffic to be authorized over interlocked points or other movable infrastructure, the points or other movable infrastructure shall be:

(a) set to the correct position for the movement;

(b) locked in the correct position for the movement;

(c) detected in the correct position for the movement;

(d) facing point locked in the correct position for the movement (where fitted);

(e) the closed switch rail is in the correct position for the movement;

(f) the open switch rail is in the correct position for the movement;

(g) other movable infrastructure is in the correct position for the movement;

(h) not in manual mode (electrically operated points); and

(i) locked in position if locally operated (e.g., ground frames).

5.2.2 Rationale

Rail traffic needs to be prevented from passing over points or other movable infrastructure when it is not safe to do so, for example, whilst points are changing position.

5.2.3 Guidance

Points can be controlled indirectly via a ground frame/control panel that is released by the interlocking. Proof that the points are set and locked can be achieved within the interlocking by proving the status of the release rather than the status of the points themselves.

For convenience, all point ends controlled by a single interlocking function can be proved to be facing point locked, detected and/or not in manual mode in a movement authority, even if that movement authority does not specifically require one or more of the point ends to be facing point locked, detected and/or not in manual mode.

Where rollway protection as described in AS 7724 is provided, additional points or other movable infrastructure should be set, locked, facing point locked, detected and/or not in manual mode.

Where overlaps are provided, additional points should be set, locked, facing point locked, detected and/or not in manual mode. See Appendix C.

Where flank point protection is provided, additional points should be set, locked, facing point locked, detected and/or not in manual mode.

Guidance on points being facing point locked, the correct position for switch rails and manual mode is given in AS 7706 and AS 7659.

Also refer to Clause 3.4.4 of this document.

5.3 Communicating the permitted speed

5.3.1 Principle

The permitted speed for the route set shall be communicated to the rail traffic crew.

5.3.2 Rationale

The permitted speed varies depending upon which route is set. Rail traffic can derail if the permitted speed is exceeded.

5.3.3 Guidance

In speed signalled areas, the permitted speed is communicated via a signal aspect that advises the permitted speed.

In route signalled areas, the permitted speed is communicated via a signal aspect that advises the route set, combined with the rail traffic crew's route knowledge of the permitted speed for that route. This can include speed board information.

The permitted speed information should be communicated at the signal protecting the points and/or at the previous signal, to allow sufficient distance to reduce to the permitted speed.

5.4 Overspeed at points and other movable infrastructure

5.4.1 Principle

The risk of rail traffic derailing owing to over-speed at points and other movable infrastructure shall be mitigated so far as is reasonably practicable.

5.4.2 Rationale

Rail traffic can overspeed at points and other movable infrastructure for many reasons, including:

(a) signal design and layout;

(b) rail traffic crew competence, especially route knowledge;

(c) rail traffic crew personal factors, especially fatigue and health; and

(d) rail traffic crew workload.

5.4.3 Guidance

Means of mitigating the risk of rail traffic derailing owing to overspeed at points and other movable infrastructure include:

(a) for route signalling, proving that the route information on the signal protecting the points or other movable infrastructure is displayed before allowing the movement authority to be displayed;

(b) approach clearing or restricting the aspect of the signal protecting the points or other movable infrastructure; and

(c) enforcement systems. See Appendix E.

5.5 Overspeed on plain track

5.5.1 Principle

The risk of rail traffic derailing on plain track shall be mitigated so far as is reasonably practicable.

5.5.2 Rationale

Rail traffic can derail on plain track due to:

(a) rail traffic overspeed;

(b) rail traffic faults; or

(c) track faults.

Rail traffic can overspeed on plain track for many reasons, including:

(d) rail traffic crew competence, especially route knowledge; and

(e) rail traffic crew personal factors, especially fatigue and health.

Rail traffic can develop faults including:

(f) hot axle boxes;

(g) dragging equipment; and

(h) wheel profile faults, for example, flat spots.

Equipment installed as part of the signalling system, such as insulated rail joints and track circuit connections to the rail, create weak points in the rail which can develop into a track fault.

5.5.3 Guidance

Means of mitigating the risk of rail traffic derailing on plain track owing to overspeed can include enforcement systems. See Appendix E.

Means of mitigating the risk of rail traffic derailing on plain track owing to rail traffic faults include:

(a) hot axle box detectors; and

(b) wheel impact load detectors.

Means of mitigating the risk of rail traffic derailing on plain track owing to track faults include:

(c) track circuits; and

(d) ultrasonic broken rail detectors.

Track circuits and ultrasonic broken rail detectors are only able to detect some types of broken rail. Minimizing the amount of equipment installed as part of the signalling system, such as insulated rail joints and track circuit connections to the rail, that create weak points in the rail which can develop into a track fault should be assessed.

5.6 Maintaining the route over points or other movable infrastructure

5.6.1 Principle

Once rail traffic has been authorized over interlocked points or other movable infrastructure, the points or other movable infrastructure shall remain locked in the correct position for the movement until:

(a) the rail traffic has passed clear of the points or other movable infrastructure; or

(b) if the movement authority is withdrawn, the rail traffic is able to stop, or has stopped, before entering the withdrawn movement authority.

5.6.2 Rationale

Rail traffic needs to be prevented from passing over points or other movable infrastructure when it is not safe to do so, for example, whilst points are changing position.

5.6.3 Guidance

For rail traffic to have passed clear of points, it should have passed clear of the position where it would conflict with rail traffic moving over the points when set to the other position.

Requirements for the withdrawal of movement authorities are given in Clause 3.8.

Where rollway protection as described in AS 7724 is provided, additional points or other movable infrastructure should be locked.

Where overlaps are provided, additional points should be locked. See Appendix C.

Where flank point protection is provided, additional points should be locked.

5.7 Dead locking the points or other movable infrastructure

5.7.1 Principle

Interlocked points or other movable infrastructure shall be locked in the current position when rail traffic is passing over the interlocked points or other movable infrastructure.

5.7.2 Rationale

Under degraded mode conditions, rail traffic can pass over points or other movable infrastructure without having a movement authority (via the signalling system). Points or other movable infrastructure are not to change position unless it is safe to do so.

5.7.3 Guidance

Where rail traffic is authorized to pass over points or other movable infrastructure without having a movement authority (via the signalling system), controls that the signalling system is unable to detect (e.g., point clips) could be required.

If the points or other movable infrastructure have commenced, but not completed, changing position when the rail traffic starts to pass over the points or other movable infrastructure, the points or other movable infrastructure should attempt to complete changing position.

All sets of power operated points should be locked in both the normal and reverse positions by the occupation of the track section or sections immediately over the points. The limits of this track section or sections over the points should extend at least as far as the clearance point.

Further information is provided in AS 7659.

Section 6 Preventing collision at level crossings

6.1 Unique identification of level crossings

6.1.1 Principle

Level crossings shall be uniquely identified.

6.1.2 Rationale

Rail safety workers (i.e. rail traffic crew, network control officers, etc.) need to have a common understanding of the location of the level crossings on the rail network.

6.1.3 Requirements

As per the principle.

6.1.4 Guidance

The identifier for level crossings can consist of, for instance, a road name, a town or suburb name and a kilometrage.

Where rail networks controlled by other RTOs are adjacent:

(a) the adjacent rail networks should use the same identifier for the same level crossing; and

(b) for different level crossings, the identifier should be unique to the adjacent rail networks.

6.2 Road user stopping sight distance

6.2.1 Principle

A level crossing with activated active control shall provide sufficient sight distance to allow road users to stop before the level crossing.

6.2.2 Rationale

Road users require sufficient warning distance to be able to stop prior to the level crossing.

6.2.3 Guidance

Guidance on level crossing design regarding sighting distance and warning times is given in AS 1742.7 and AS 7658.

6.3 Warning road users before lowering booms or closing gates

6.3.1 Principle

Road vehicles and pedestrians shall have sufficient time to stop or clear a level crossing before an active level crossing booms and/or pedestrian gates close.

6.3.2 Rationale

Road users that are closely approaching a level crossing when it activates, in particular long and heavy vehicles that have just entered a level crossing from a standing start at the stop line, require time to clear the boom barriers or gates before the boom barriers start to descend or the gates start to close.

Road users that are closely approaching a pedestrian crossing (associated with a level crossing or standalone) when it activates, in particular those using mobility aids (e.g., wheelchairs, scooters) or walking with bicycles, baby carriages or animals, require time to clear the gates before the gates start to close.

6.3.3 Guidance

The required warning time for level crossings should assess:

(a) the length of the longest vehicle authorized to use the road;

(b) vehicle speed and vehicle deceleration rates;

(c) the average acceleration of the longest vehicle authorized to use the road;

(d) the gradient of the road; and

(e) the distance from the stop line to the obstruction (boom barrier or gate).

Where entrance boom barriers and exit boom barriers are provided at a level crossing, separate warning times should be provided for the entrance boom barriers and exit boom barriers.

Means of achieving the required warning times are given in AS 7658.

6.4 Speed of lowering booms or closing gates

6.4.1 Principle

When an active control level crossing obstructs a road, footpath or shared path, the risk of the obstruction colliding with road users or vehicles shall be mitigated so far as is reasonably practicable.

6.4.2 Rationale

At level crossings, injury to road users or damage to road vehicles can result if the rate of descent of boom barriers or the rate of closure of gates is too fast.

At pedestrian crossings (associated with a level crossing or standalone), injury to road users, pedestrians, or damage to road vehicles can result if the rate of closure of gates is too fast.

6.4.3 Guidance

Refer to AS 7658 for further guidance.

6.5 Clearance time for road users

6.5.1 Principle

An active control level crossing shall provide sufficient warning to allow road users that are not reasonably able to stop before entering the level crossing to clear the level crossing before the arrival of rail traffic.

6.5.2 Rationale

Road users that are closely approaching a level crossing when it activates, in particular long and heavy vehicles that have just entered a level crossing from a standing start at the stop line, require time to clear the level crossing before the arrival of rail traffic.

Road users that are closely approaching a pedestrian crossing (associated with a level crossing or standalone) when it activates, in particular those using mobility aids (e.g., wheelchairs, scooters) or walking with bicycles, baby carriages or animals, require time to clear the pedestrian crossing before the arrival of rail traffic.

6.5.3 Guidance

The required warning time for level crossings should assess:

(a) the length of the longest vehicle authorized to use the road;

(b) vehicle speed and vehicle deceleration rates;

(c) the average acceleration of the longest vehicle authorized to use the road;

(d) the gradient of the road;

(e) the angle of the road relative to the railway;

(f) the distance from the stop line to being safely clear of rail traffic on the other side of the railway; and

(g) a margin of safety such that under normal operation users of the crossing (road & pedestrian) are comfortably clear of the railway prior to the arrival of a train.

The required warning time for pedestrian crossings should include:

(h) walking or travel speed; and

(i) the distance from the gate or maze opening to being safely clear of rail traffic on the other side of the railway.

Calculation methods for warning times and other considerations are provided in AS 7658.

6.6 Excessive warning time

6.6.1 Principle

Excessive warning times shall be managed in the design to limit the time the level crossing is activated.

6.6.2 Rationale

If a crossing is activated for an excessive time before rail traffic enters the level crossing, road users will be tempted to enter the level crossing when it is not safe to do so.

Operational scenarios that could cause excessive warning include:

(a) rail traffic within the approach to the level crossing, but not authorized to pass over the level crossing;

(b) platforms within the approach to the level crossing, for example, stopping trains and express trains;

(c) rail traffic with widely differing permitted speeds, for example, 160 km/h passenger trains and 80 km/h freight trains; and

(d) rail traffic with widely differing authorized speeds, for example, 115 km/h through trains and 40 km/h trains departing a nearby yard.

6.6.3 Guidance

Where rail traffic is within the approach to the level crossing but has not been authorized to pass over the level crossing, that rail traffic should not activate the level crossing. If the rail traffic is subsequently to be authorized to pass over the level crossing and the level crossing is not already activated (perhaps by another train on an adjacent railway line), the level crossing will be activated once the level crossing has been open to road traffic for a sufficient time. Once the level crossing has been activated for sufficient time so that the rail traffic cannot enter the level crossing until the required warning time has been achieved, the rail traffic will be authorized to pass over the level crossing.

Where platforms are within the approach to the level crossing, a signal should be located between the platform and the level crossing. Before rail traffic enters the approach to the level crossing, it should be identified as either a stopping train or an express train. This identification is usually achieved either by manual selection by a network control officer or by a timing track at a previous station (before the start of the approach to the level crossing) where rail traffic has the same stopping/express pattern as the station within the approach to the level crossing. For an express train, the signal between the platform and the level crossing will clear without being constrained by the state of the level crossing. For a stopping train, the signal between the platform and the level crossing will remain at stop until the train has entered the platform.

Where there is rail traffic with widely differing permitted speeds, motion sensing detectors can be used. Where motion sensing detectors are used, the risk of rail traffic accelerating towards the level crossing after the level crossing has been activated should be mitigated. Typical methods for this are:

(a) signage that forbids acceleration; or

(b) signage that allows acceleration only if the rail traffic speed is above a nominated speed and increasing the warning time setting within the motion sensing detector.

Where possible, the network control officer should be notified by an alarm if excessive warning time has occurred at a crossing.

6.7 Maintenance of minimum warning time

6.7.1 Principle

The issue of a movement authority to rail traffic within the approach of a level crossing shall not result in a warning time less than the required minimum warning time for that crossing.

6.7.2 Rationale

A signal located within a level crossing approach provides protection for the level crossing when the signal is at stop and free of approach locking. This normally inhibits activation of the crossing warning, subject to the provision of any overrun controls provided to activate and subsequently cancel the crossing warning when a train has been timed to a stand at the signal.

When the signal is subsequently set for a movement over the level crossing there is a risk, if the signal is cleared at the same time as the crossing warning is activated, that a train could arrive at the crossing before the minimum warning time has elapsed. Additional controls are required to prevent this occurring.

6.7.3 Guidance

Typically signals within a level crossing approach should be provided with additional controls to activate the level crossing for a set time prior to clearance of the signal aspect. The crossing should only be activated once all the required aspect controls are present, to prevent an extended crossing activation. Once the crossing has been proved to be activated the signal can be allowed to clear after a set time delay, which should assess:

(a) the required minimum warning time;

(b) minimum crossing open time;

(c) the distance between the signal and the crossing;

(d) the highest acceleration rate for rail vehicles for the line involved; and

(e) the possibility of the signal clearance occurring when an approaching rail vehicle is not at a stand.

6.8 Overrun protection for level crossings

6.8.1 Principle

Rail traffic shall be prevented from colliding with road users or vehicles at level crossings owing to exceeding its movement authority, so far as is reasonably practicable.

6.8.2 Rationale

A signal located within a level crossing approach provides protection for the level crossing when the signal is at stop and free of approach locking. The degree of protection afforded by the signal reduces as the distance from the signal to the crossing reduces.

Where the position of a signal presents the risk of a significantly reduced crossing warning time in the event of the overrun of a signal, additional controls should be assessed to mitigate the risk.

6.8.3 Guidance

Typically, additional controls should be provided to activate the level crossing for the approach of a train towards a signal at stop, where there is a significant risk that an overrun of that signal will result in a reduced warning time at the crossing. Such controls should be released, and the crossing warning cancelled once an approaching train is timed to a stand at the stop signal.

Alternatively, predictive systems can be used to activate the crossing where overspeeding is detected on the approach to the stop signal or, where enforcement systems are in use to prevent an overrun onto the crossing, no controls need be provided.

Some level crossings have pre-emptive control sequences prior to the main crossing warning sequence being activated, typically for approach flashing yellow lights or road traffic lights at adjacent road intersections. In such cases, where the protecting signal is too close to the signal to allow the pre-emptive sequence to occur and provide adequate warning at the crossing, additional controls can be provided to immediately activate the main crossing warning sequence in the event of an overrun.

6.9 Minimum crossing open time

6.9.1 Principle

Adequate time should be allowed between successive level crossing activations by rail vehicles to allow road users to traverse and move clear of a crossing.

6.9.2 Rationale

Road users at a level crossing when its warning clears, in particular long and heavy vehicles starting from a standing start at the stop line or pedestrians traversing wide crossings, require adequate time to clear the level crossing before the next activation. Very short intervals between crossing activations can also result in the build-up of queues and subsequent frustration on the part of road users, which can lead to inappropriate action on their part.

6.9.3 Guidance

Controls should be provided to ensure that an adequate minimum crossing open time between successive crossing activations is provided. Typically, this is 20 seconds between the crossing warning fully cancelling (i.e. booms, where provided, fully up, pedestrian crossing gates, where provided, full open, and the flashing lights extinguished) and the crossing warning re-activating.

Where there is a second train on the approach to an activated level crossing, and the arrival of this train would cause the crossing to activate before the minimum crossing open time has elapsed, controls should be provided to maintain the crossing warning until the second train has passed over the crossing.

The need for additional controls generally applies to double (or more) line sections where closely spaced train arrivals can occur at a crossing. However, this could apply at other crossings, typically where the signalling arrangements allow a second train to be authorized to cross over a crossing immediately after the passage of a first.

Typically, additional level crossing approach sections (outer approaches) are provided beyond the normal crossing approach, to detect approaching trains within a distance equivalent to that which a train at the maximum approach speed would travel over the minimum crossing opening time. Approaching trains detected in an outer approach should not cause a crossing activation but should maintain any current activation until it has passed over the crossing.

Where signals lie within level crossing approaches additional controls should be provided to ensure that the minimum crossing open time is provided. These typically consist of a control to delay the activation of the crossing where the signal is at stop and there is a train at the signal. Before the movement can be authorized towards the crossing, the crossing controls should have been clear for the required minimum crossing open time. The delay in clearing the signal is not applied if the crossing has already been activated by another train.

Where signals lie within level crossing outer approaches similar controls can also be required when setting a signal where there is a train detected at the signal, which could reach the inner approach of the crossing before the minimum crossing open time elapses. The provision of such controls should assess:

(a) the distance between the signal and the inner approach point of the crossing;

(b) the highest acceleration rate for rail vehicles for the line involved; and

(c) the possibility of the signal clearance occurring when an approaching rail vehicle is not at a stand.

When setting minimum crossing open times, the clearance requirements for any interface with adjacent road traffic light intersections should be assessed.

6.10 Upstream traffic lights

6.10.1 Principle

Signalized road intersections immediately upstream of an active control level crossing shall not conflict with the activated level crossing.

6.10.2 Rationale

If the level crossing is activated and the traffic lights for road vehicle movements towards the level crossing are green, road users could react inappropriately to the activated level crossing.

6.10.3 Guidance

Where there are signalized road intersections immediately upstream of an active control level crossing that can direct road users towards the level crossing, traffic light coordination should be provided.

For traffic light coordination, the railway signalling system should provide the road traffic light system with sufficient warning of an impending activation of the level crossing to allow the road traffic lights to cycle through to the required railway phase.

6.11 Downstream traffic lights

6.11.1 Principle

Signalized road intersections downstream of an active control level crossing shall not cause traffic to queue across the activated level crossing.

6.11.2 Rationale

If the level crossing is activated and the downstream traffic lights for road vehicle movements away from the level crossing are red, road users could be trapped on the level crossing.

6.11.3 Guidance

Where there are signalized road intersections downstream of an active control level crossing that can cause road users to queue across the level crossing, traffic light coordination should be provided.

For traffic light coordination, the railway signalling system should provide the road traffic light system with sufficient warning of an impending activation (pre-emption) of the level crossing to allow the road traffic lights to cycle through to the required traffic light phase.

The pre-emption time should include the minimum road traffic phases required by the road authorities to switch the traffic lights to the clearance phase, and the required duration of the clearance phase taking into account the time needed to clear traffic that could have stacked onto the railway tracks.

Section 7 Preventing rail traffic from being incompatible with the infrastructure

7.1 Track and structure gauge

7.1.1 Principle

Rail traffic shall be prevented from entering a line where it is not compatible with the track gauge or lineside infrastructure.

7.1.2 Rationale

A dual gauge line can be either a third rail track or a gauntlet track of different gauges.

For a third rail track where there is a diverging junction using turnouts or active gauge splitters and one or more of the diverging routes is single gauge, if rail traffic of the wrong gauge enters one of the single gauge lines it will derail.

For a dual gauge line where one gauge terminates, if rail traffic of the terminating gauge enters the single gauge line it will derail.

For a third rail track with an active third rail transfer, if the active third rail transfer is set for one gauge and rail traffic of the opposite gauge passes through it, the rail traffic will derail.

For a third rail track where there is a diverging junction using passive gauge splitters, if the movement authority is for one gauge and rail traffic of the opposite gauge passes through the junction, the rail traffic will enter a line that has not been secured for that rail traffic by the signalling system.

For a third rail track used for shunting purposes, rail traffic of one gauge could be shunted onto a rail traffic of different gauge which can result in rail traffic damage.

At the end of a gauntlet track of different gauges (where it diverges into two non-gauntlet tracks each of a single gauge), if the movement authority is for one gauge and rail traffic of the opposite gauge passes through the junction, the rail traffic will enter a line that has not been secured for that rail traffic by the signalling system.

Some rail traffic can be at risk of collision with lineside infrastructure due to being outside the standard track envelop, such as double stacked container trains, infrastructure trains, and track machines.

7.1.3 Guidance

For rail traffic to be authorized from a dual gauge line to a single gauge line, the rail traffic should be identified as being of the same gauge as the single gauge line.

For rail traffic to be authorized over an active gauge splitter, the rail traffic should be identified as being of the same gauge as the position of the active gauge splitter.

The means of identifying the gauge of rail traffic include:

(a) separate train detection (i.e. track circuits or axle counters) for each gauge;

(b) proximity sensors on the outer rail and the inner rail;

(c) treadles on the outer rail and the inner rail;

(d) remembering the gauge of the single gauge line where the rail traffic entered the dual gauge line; and

(e) communications-based control systems where the rail traffic communicates its gauge to the signalling system.

The gauge of rail traffic should be identified prior to that rail traffic arriving at a point where it cannot proceed due to incorrect gauge.

Once the gauge of rail traffic has been identified that information should be remembered and progress with the rail traffic such that the gauge of each train in a series of following trains is known. This should allow for a series of following trains proceeding by (signalled) movement authorities. However, it is not usually required to cater for rail traffic of different gauges having entered the same block (for instance, owing to degraded mode working).

Gauge information can be lost, for instance owing to train detection failures or power failures. Where the network rules and procedures allow, gauge interpose controls can be provided that allow the network control officer to manually re-establish the gauge information.

The gauge of each line should be indicated to the network control officer via the control panel.

On dual gauge lines, the gauge of each rail traffic should be indicated to the network control officer via the control panel.

The gauge of the route set for the rail traffic should be indicated to the rail traffic crew.

In route signalled areas, the gauge of the route set is communicated via a signal aspect that advises the route set, combined with the rail traffic crew's route knowledge of the gauge for that route.

In speed signalled areas, the gauge of the route set is communicated via gauge indicators.

A gauge indicator is lit when:

(f) the signal is ready to display a movement authority;

(g) the gauge of the train has been identified; and

(h) the route set for the train is of the same gauge as the train.

For a signal with gauge indicators, the movement authority is displayed once the gauge indicator is proved alight.

Height detection systems or other out of gauge detection systems can be used to prevent movement authorities being issued where there is an identified risk of collision with lineside infrastructure.

Additional means of mitigating the risk of rail traffic entering a line where it is not compatible include:

(i) signage; and

(j) enforcement systems. See Appendix E.

7.2 Traction supply

7.2.1 Principle

Rail traffic shall be prevented from entering a line where it is not compatible with the traction supply system, so far as is reasonably practicable.

7.2.2 Rationale

If an electric train is routed onto a non-electrified line, the train will be stranded, which will cause operational delays.

If an electric train separates from the electrical supply system, this can cause damage to the rail traffic (e.g., the pantograph) and the electrical supply system (e.g., the overhead contact wire).

The electrical supply system for a line can be inadequate for some types of electric trains. For instance, on lines where there is only an operational requirement for passenger trains, the electrical supply system can be inadequate for electric freight trains.

Steam trains and/or diesel trains can be prohibited from entering some tunnels owing to their emissions in a confined space, particularly if there are passenger platforms within those tunnels.

7.2.3 Guidance

Methods of mitigating the risk of rail traffic entering a line where it is not compatible with the traction supply system include:

(a) indicating the traction type (e.g., steam train, diesel train and electric train) to the network control officer via the control panel (e.g., via the train identification number);

(b) indicating the non-electrified lines to the network control officer via the control panel;

(c) signage (e.g., end of electrified area signs);

(d) providing a route indicator on the signal protecting the points where an electric train could be routed onto a non-electrified line (and possibly also at the previous signal, to allow sufficient distance for an electric train to stop before entering the non-electrified line);

(e) enforcement systems (see Appendix E); and

(f) functionality within the control panel, such as:

  (i) confirming that the train identification number for the train approaching the signal is for the correct traction type before allowing the route to be requested;

  (ii) reminders that require network control officer acknowledgement before allowing routes to be requested from an electrified line to a non-electrified line; and

  (iii) timetable-driven automatic route setting (see Clause 12.5 of this document).

7.3 Other infrastructure

7.3.1 Principle

Rail traffic shall be prevented from entering a line where it is not compatible with other infrastructure, so far as is reasonably practicable.

7.3.2 Rationale

Other infrastructure limitations include:

(a) permissible rail traffic outline;

(b) permitted rail traffic axle load;

(c) permitted rail traffic weight;

(d) permitted rail traffic length;

(e) prohibited loads (e.g., passengers or dangerous goods); and

(f) required train-borne control sub-systems.

If rail traffic is routed onto a line where the rail traffic outline exceeds the permissible rail traffic outline, damage to the rail traffic and/or the infrastructure can occur.

If rail traffic is routed onto a line where the rail traffic axle load exceeds the permitted rail traffic axle load, damage to the track can occur.

If rail traffic is routed onto a line where the rail traffic weight exceeds the permitted rail traffic weight, damage to under-track structures (e.g., bridges) can occur.

If rail traffic is routed onto a line where the rail traffic length exceeds the permitted rail traffic length (e.g., overlength trains at crossing loops), operational delays can occur.

If rail traffic with passengers on-board is routed onto a freight-only line, operational delays can occur. Also, the level of safety of the line, whilst appropriate for freight trains, could not be appropriate for passenger trains.

If rail traffic with dangerous goods on-board is routed onto a line where dangerous goods are not permitted (e.g., tunnels with passenger platforms), there will be an unacceptable risk of damage to people, property or the environment.

For lines that use communications-based control systems, if rail traffic without the required train-borne control sub-system is routed onto the line, procedural controls will be required to allow this rail traffic to operate safely.

7.3.3 Guidance

Methods of mitigating the risk of rail traffic entering a line where it is not compatible with other infrastructure include:

(a) indicating the rail traffic type to the network control officer via the control panel (e.g., via the train identification number);

(b) indicating the location of changes in infrastructure limitations to the network control officer via the control panel;

(c) signage (e.g., <Train Type X> not to proceed past this point signs);

(d) providing a route indicator on the signal protecting a diverging junction where a route has a changed infrastructure limitation (and possibly also at the previous signal, to allow sufficient distance for rail traffic to stop before entering the line);

(e) enforcement systems (see Appendix E);

(f) detectors that provide an alarm to the network control officer; and

(g) functionality within the control panel, such as:

  (i) confirming that the train identification number for the train approaching the signal is for the correct rail traffic type before allowing the route to be requested;

  (ii) reminders that require network control officer acknowledgement before allowing routes to be requested to a line with a changed infrastructure limitation; and

  (iii) timetable-driven automatic route.

7.4 Safety of equipment and infrastructure

7.4.1 Principle

The signalling system and its equipment shall be designed, so far as is reasonably practical, so that known hazards associated with rail operations will not lead to damage to railway assets including rail traffic.

7.4.2 Rationale

There are known hazards including overloads or surges on electrical circuits, derailment of rail traffic at catchpoints/derailers, and interfaces with track, rail traffic and electrical distribution assets that can lead to damage to equipment. These should be designed to minimize the consequence of the hazard while still delivering the functional or other safety outcome.

7.4.3 Guidance

Infrastructure and equipment should not be located where there is a reasonable possibility of rail vehicles colliding with the infrastructure of equipment. For example, signalling location cases should not be located beyond catch points in case a rail vehicle derails through the catch points.

The location of track and signalling infrastructure should assess the geography of the location. Catch points that direct rail traffic towards embankments, bridges, or other railway infrastructure should be avoided where possible.

Section 8 Preventing rail traffic from colliding with rail safety workers or equipment in the rail corridor

8.1 Blocking facilities

8.1.1 Principle

The signalling system shall provide the network control officer with blocking facilities that, when applied, prevent the issue of movement authorities.

8.1.2 Rationale

Work on track can require rail safety workers and/or equipment to enter the danger zone.

Work on track authorities (e.g., local possession authorities, track occupancy authorities and track work authorities) and other methods of working in the danger zone (e.g., absolute signal blocking) authorize rail safety workers and/or equipment to occupy a defined portion of track.

Work on track authorities and other methods of working in the danger zone can require the network control officer to apply blocking facilities to prevent unauthorized rail traffic from entering the worksite.

8.1.3 Guidance

The signalling system can provide the network control officer with blocking facilities for:

(a) signals (i.e. when the blocking facility is applied, all routes from the signal are prevented from being requested);

(b) classes of routes from a signal (i.e. when the blocking facility is applied, all routes of a particular class, for example, main class or shunt class, from the signal are prevented from being requested);

(c) routes from a signal (i.e. when the blocking facility is applied, a specific route (path and class) from the signal is prevented from being requested);

(d) interlocked points or other movable infrastructure (i.e. when the blocking facility is applied, the interlocked points or other movable infrastructure are prevented from being requested to the opposite position);

(e) releases (i.e. when the blocking facility is applied, the release is prevented from being requested to the opposite state);

(f) tracks (i.e. when the blocking facility is applied, all routes that read over that group of track sections (typically from signal to signal) are prevented from being requested); and

(g) track sections (i.e. when the blocking facility is applied, all routes that read over that track section (track circuit or axle counter) are prevented from being requested).

The behaviour of the blocking facilities when a route is already set should be compatible with the network rules and procedures. For instance, if a route is already set and then a related blocking facility (signal, class of route from the signal, route from the signal, track or track section) is requested to be applied, the signalling system can:

(h) prevent the blocking facility from being applied;

(i) allow the blocking facility to be applied, but withdraw the movement authority; or

(j) allow the blocking facility to be applied and allow the movement authority.

The behaviour of routes when a track or track section not directly in the line of the route has its blocking facility applied should be compatible with the network rules and procedures. For instance, to request a route can require that:

(k) tracks or track sections foul of the route do not have their blocking facility applied;

(l) tracks or track sections in the overlap of the route do not have their blocking facility applied; and/or

(m) tracks or track sections foul of the overlap of the route do not have their blocking facility applied.

Blocking facilities should be resistant to inadvertent removal. For instance, this could be achieved by:

(n) magnetized button collars and switch collars for use on metal-faced control panels;

(o) friction fit button collars and switch collars for use on plastic-faced control panels;

(p) requiring more than one network control officer action (e.g., using a confirmation dialog box) before allowing the blocking facility to be removed;

(q) codes that are generated by the signalling system when the blocking facility is applied, requiring coordination and cooperation between the network control officer and the rail safety worker to remove the blocking facility; or

(r) lockout facilities (see Clause 8.2).

The signalling system should allow the network control officer to set and hold interlocked points or other movable infrastructure in each position (normal or reverse). For unit lever interlockings, this is usually achieved by asserting either the normal call or the reverse call. For route setting interlockings, this is usually achieved by asserting the normal call or the reverse call and withdrawing the centre call.

The signalling system should not allow applied blocking facilities to be bypassed within the signalling system. For instance:

(s) automatic route setting functionality (including route stacking, route storage, etc.) should be disabled for signalling functions (e.g., routes, points, etc.) where the blocking facility has been applied;

(t) where a route from a pre-set signal is blocked (e.g., via applied blocking facilities on the pre-set signal, on the route from the pre-set signal or on a track or track section within the route of the pre-set signal), the corresponding route from the pre-setting signal should also be considered to be blocked;

(u) where the control of a signalling function can be transferred (e.g., from a control centre to a ground frame, local control panel, key switches, etc.);

(v) signalling functions near the boundary between network control officer jurisdictions (including boundaries within the same control centre as well as boundaries between RTOs); and

(w) blocked points at route setting interlockings should not be able to be called to the opposite position by route calls, including movement of points due to flank point protection for a different route.

Blocking facilities should not be provided for tracks or track sections where the signalling system is unable to prevent rail traffic from entering that track or track section. Typically, this is tracks and track sections where not all of the entrance points to the track or track section for normal movements (i.e. excluding 'wrong direction' movements on unidirectional lines) are protected by an absolute signal. For instance:

(x) tracks and track sections protected by permissive signals;

(y) approach tracks and track sections (i.e. before the first controlled signal) from unsignalled running lines; and

(z) berth tracks for siding exit signals.

8.2 Lockout facilities

8.2.1 Principle

The signalling system can provide protection officers with lockout facilities that, when applied, prevent the issue of movement authorities.

8.2.2 Rationale

Work on track can require rail safety workers and/or equipment to enter the danger zone.

Work on track authorities (e.g., local possession authorities, track occupancy authorities and track work authorities) and other methods of working in the danger zone (e.g., absolute signal blocking) authorize rail safety workers and/or equipment to occupy a defined portion of track.

Work on track authorities and other methods of working in the danger zone can require protection officers to apply lockout facilities to prevent unauthorized rail traffic from entering the worksite. Where lockout facilities are provided, the network rules and procedures can require the lockout facilities to be used instead of the blocking facilities, in order to provide greater protection against inadvertent removal.

Work on track authorities and other methods of working in the danger zone require protection to be provided. The network rules and procedures can allow the amount of protection required on bidirectional lines to be reduced if bidirectional running can be prevented by applying lockout facilities.

Rail safety workers who are working on the outside of rail traffic could require protection against the rail traffic being moved. Lockout facilities can be used as part of this protection.

8.2.3 Guidance

The signalling system can provide protection officers with lockout facilities for:

(a) signals (i.e. when the lockout facility is applied, all routes from the signal are prevented from being set);

(b) paths from a signal (i.e. when the lockout facility is applied, all route classes for a particular path from the signal are prevented from being set);

(c) routes from a signal (i.e. when the lockout facility is applied, a specific route (path and class) from the signal is prevented from being set);

(d) interlocked points or other movable infrastructure (i.e. when the lockout facility is applied, the interlocked points or other movable infrastructure are prevented from being set to the opposite position);

(e) tracks (i.e. when the lockout facility is applied, all routes that read over that group of track sections (typically from signal to signal) are prevented from being requested); and

(f) bidirectional running (i.e. when the lockout facility is applied, all ‘wrong direction’ routes that read over that group of track sections (typically the entire single line section) are prevented from being requested).

Which of the above lockout facilities are provided for a particular site should be determined from the operational requirements and should be compatible with the network rules and procedures.

Each lockout facility can have multiple lockout devices (e.g., keys) so that multiple protection officers can separately provide protection to their own worksite. The number of lockout devices provided for each lockout facility should be determined from the operational requirements and should be compatible with the network rules and procedures.

The extent of each lockout area for tracks and for bidirectional running should be determined from the operational requirements so as to provide the protection required by protection officers.

Each lockout facility should require the cooperative action of the network control officer and the protection officer, both to apply the lockout facility and to remove the lockout facility.

To apply a lockout facility should require that there are no signalled movements to, from or within the lockout area that would be affected by operation of the lockout facility and also that the signals concerned are at stop and free of approach locking.

To remove a lockout facility should require that all of the lockout devices for that lockout facility have been reinstated.

The network control officer should have:

(g) controls for giving and withdrawing the lockout facility; and

(h) indications of the status of the lockout facility (e.g., normal, given, taken and withdrawn).

The protection officer should have:

(i) controls for taking and returning the lockout facility;

(j) a means to prevent the inadvertent return of the lockout facility. For instance:

    (i) a key that can be withdrawn only when the lockout facility has been given and prevents the lockout facility from being returned until the key is replaced; or

    (ii) the ability to padlock the control in the ‘taken’ position; and

(k) indications of the status of the lockout facility (e.g., normal, given, taken and withdrawn).

The following should be defined on or near lockout devices:

(l) the extent of the lockout area; and

(m) where the lockout facility protects against only certain movements (for example, only movements in one direction), the extent of protection.

Lockout devices should be located in a safe place and be able to be accessed safely.

Lockout devices should be secured against unauthorized use and vandalism, for example, locked cabinets or disabling the lockout device unless the network control officer has given the lockout facility.

The behaviour of routes when a track not directly in the line of the route has its lockout facility applied should be compatible with the network rules and procedures. For instance, to request a route could require that:

(n) tracks foul of the route do not have their lockout facility applied;

(o) tracks in the overlap of the route do not have their lockout facility applied; and/or

(p) tracks foul of the overlap of the route do not have their lockout facility applied.

Lockout facilities should not be provided for tracks where the signalling system is unable to prevent rail traffic from entering that track. Typically, this is tracks where not all of the entrance points to the track for normal movements (i.e. excluding wrong direction movements on unidirectional lines) are protected by an absolute signal. For instance:

(q) tracks protected by permissive signals;

(r) approach tracks (i.e. before the first controlled signal) from unsignalled running lines; and

(s) berth tracks for siding exit signals.

Section 9 Communications

9.1 Failure of communications systems

9.1.1 Principle

In the event of a failure of communication systems the signalling system shall remain in, or revert to, a state which preserves the safety of rail operations.

9.1.2 Rationale

A failure of a vital communications link between two interlocking systems will lead to loss of vital information required by the respective interlocking.

A failure of the non-vital link between the interlocking system and the control system will cause the network control officer to lose their visibility to all controls/indications.

9.1.3 Guidance

In the event of a failure of vital communications between interlockings, the signalling should revert to a more restrictive state.

In the event of a failure of non-vital communications, the interlocking should maintain all issued movement authorities for a predetermined time. On expiry of this time, the movement authority should be withdrawn automatically, when safe to do so.

Section 10 Signalling processes

10.1 Independence of task and check

10.1.1 Principle

The signalling system shall be checked and functionally tested by a person who was independent of the design and construction activities.

10.1.2 Rationale

This independence of the task and check ensures that there are no pre-determined views in the mind of the person doing the checking or testing. This reduces the possibility of errors not being identified in the signalling system.

10.1.3 Guidance

It is important for the safety and operational functionality of the signalling system that the designed and constructed systems perform as intended. The various processes acknowledge the possibility of human error in all of our actions. As protection against human error, each completed action should be checked by an independent person.

Signalling designs shall be checked by a person who was independent of the design process. The constructed equipment is inspected by a person independent of the construction activities and assessed against the construction standards. The completed equipment is tested against the design drawings and documents to ensure that the wiring and other outputs are strictly in conformance with the design by a person independent of the wiring activities.

Further information is provided in AS 7718.

10.2 No ambiguity.

10.2.1 Principle

The signalling system shall use common definitions, meanings and glossary of information.

10.2.2 Rationale

The signalling system is complex and there are many different ways that it can be described. There are many different stakeholders and users of the signalling system. Each of these different groups of people have a different perspective on the signalling system and the way that it operates. If there is ambiguity in understanding, there is a risk to the safe operation of trains and people undertaking work within the rail corridor.

10.2.3 Guidance

As part of the common understanding of the signalling system and its operation, it is important that there is no ambiguity in the system and its related documentation. This requires that there is no alternate meanings or deviation from common terminology, nomenclature and symbols.

The glossary and definitions shall form part of the signal engineering standards documents. The same definitions should be used in the operating rules for use by other stakeholders who are directly involved in railway operations.

New or amended terminology, definitions, nomenclature and symbols should be reviewed by all affected stakeholders prior to introduction for use. Changes should be managed in accordance with change management Standards, policies and procedures.

10.3 Null and wrong testing.

10.3.1 Principle

There shall be no unidentified or additional functions within the signalling system that are not documented.

10.3.2 Rationale

The signalling system is complex with many individual functions. These are tested to operate safely and as designed. However, there could be additional functions or included equipment that have been inadvertently added or has not been correctly removed when modifying existing systems. These hidden functions can directly cause unsafe situations.

10.3.3 Guidance

Checking and testing ensures that the signalling system performs each of the functions it is designed to do. The checking and testing also ensures that it does not perform and function or action that is not intended or designed. The null and wire count inspections ensure that there are no additional wires within the system. These additional wires, if present, could provide a bridge that allows the designed function not to operate correctly.

> Commentary *C10.3.3*
>
> An example of a hidden function test is the track circuit no feed test. The feed to a track circuit is turned off. The track circuit is tested to ensure that there are no other voltages or signals that have leaked onto the rails from a different source.

Similarly, detection for both point motors of a crossover is proved. This includes testing that breaking the detection individually for the point motors causes the loss of detection. It is also proved by the out of correspondence test for all of the possible permutations of the position of the point motor and detection contacts.

10.4 Documented records and action plans

10.4.1 Principle

The installed signalling system and all associated works shall be documented. These documents shall be managed under version control, configuration management and change management processes.

10.4.2 Rationale

The signalling system and any works undertaken can be complex. There is also a need to share the information between multiple users and stakeholders. Error caused through lack of documented systems could lead to a critical failure leading to an unsafe situation.

10.4.3 Guidance

The documented records and drawings use terminology, nomenclature and symbols that have a defined meaning for all stakeholders and users. The content and extent of the records and documents is also defined to ensure that it encompasses all of the required information. In this way it is possible to identify the current version of the drawings and documents that are applicable to the operating railway.

The complexity of the tasks to define system requirements, select implementation options, design the system, install the system, test & commission the system, operate & maintain the system require that any signalling system activities are documented into action plans covering the various phases of the system life cycle. These action plans contribute to the successful completion of the activities to achieve the safety and operational performance requirements. As such, the plans need to be treated as safety outputs and be independently checked. The content and extent of the plans is also defined (in standards and procedures) to ensure that it encompasses all of the required information.

10.5 Trained and competent

10.5.1 Principle

A person shall be trained and assessed as competent to perform the roles working on the signalling system.

10.5.2 Rationale

The signalling system and its technology is very complex. There are a number of different technologies and suppliers of systems that each operate in a different manner. A casual introduction to the systems will not provide the person with sufficient information to perform the role in a manner to ensure the safety and performance of the signalling system.

10.5.3 Guidance

People undertaking the tasks shall be trained and competent in the tasks and the technology that they are working on. The different roles can include designer, installer, tester and maintainer.

Training in the wide range of processes and technologies should be consistent. This is best achieved by a documented curriculum for the subject that includes the required outputs of what the person is able to undertake on completion of the training. The training should include an assessment of the persons knowledge and ability to perform the task. Completion of the training course does not automatically make the person competent to work on the task independently. They need to have experience in the application of the knowledge in real world situations.

A competent person has the knowledge of the technology and the processes and has the practical experience from undertaking the tasks. The assessment of the person’s competence needs to be a formal and consistent process that produces consistent records of the assessment. A person’s competence will include a wide range of skills from the very basic to the most complex. For the technically difficult skills, there needs to be a consistent use of the skills to maintain the competence levels. Thus, there needs to be a routine review and assessment of the person’s competence at regular intervals that are independently determined.

10.6 Operating rules consistent with the signalling system

10.6.1 Principle

The operating rules for the railway network shall be consistent with the operation of the signalling system.

10.6.2 Rationale

Operations staff and other discipline staff do not read the signalling standards and procedures for their knowledge of the signalling system, instead relying upon the operating rules to provide guidance on how the signalling system operates and how to interact with the signalling system.

10.6.3 Guidance

The signalling system is used by operational staff to operate the railway. The signalling system operation is also dependent on the other major engineering disciplines for the provision of the track, civil structures, electrical, communications and rail traffic assets. The operation of the whole railway system requires consistent and compatible operation of the equipment for each of the above asset groups. The operating rules detail the processes for operating the railway. These cover all of the engineering and operating staff activities under all operating conditions.

The operating rules shall be consistent with the intended operation of the signalling system as detailed within the signalling standards and procedures.

Signalling design shall conform with the operating rules.

10.7 Operating rules provide for safe degraded mode operation

10.7.1 Principle

The operating rules shall include provision for degraded mode of operations when the signalling system or other assets are not able to operate in the manner that they were designed for.

10.7.2 Rationale

There are many causes that can lead to scenarios where the railway and trains are not operating as designed or planned. These could include weather events, human error, engineering failure, malicious human intervention and geological events. These can result in the railway infrastructure being impeded or in disarray.

10.7.3 Guidance

The operating rules shall provide conditions and processes for managing rail operations in degraded mode. This should include scenarios where there is planned disarrangement of the railway infrastructure for maintenance, new installation activities, commissioning of new equipment, de-commissioning of existing equipment and special operations (e.g., Olympics, cultural events or travel by dignitaries). The operating rules ensure the safe operation of rail movements and the safety of staff and passengers during the degraded mode.

During construction and maintenance activities, signalling equipment that is out of service shall be clearly identified. New signals under construction or have been de-commissioned should be either covered with a bag, have a cross mounted on the signal or have the signal head turned at 90 degrees to the track. This provides a clear and unambiguous indication that the signal is not in use. Similarly, level crossing protection equipment that is out of service or the rail line has no rail traffic is shown as being out of service.

10.8 Interdisciplinary checks

10.8.1 Principle

Interdisciplinary checks shall be undertaken between the signalling system each of the other sets of assets and systems including track assets, civil assets, electrical assets, rail traffic assets and communications system assets.

10.8.2 Rationale

The signalling and control system is one part of the rail infrastructure that also includes track, civil structures, rollingstock and electrical assets. Each part of the infrastructure does not operate as a standalone system. Each part is dependent on the other assets that interface to it. To ensure that these interfaces are compatible and operate as designed, it is essential to undertake interdisciplinary checks with each of the other assets and systems.

10.8.3 Guidance

There are many roles involved in the design, construction, operation and maintenance of the signalling system and the other asset systems. It is unreasonable that an individual person is expert in all roles and has the knowledge of all of the equipment, systems and processes. It is important therefore that stakeholders covering the appropriate roles are involved to ensure that the full breadth of knowledge and experience is considered when determining the outcomes.

Checks should be carried out initially at the requirements and concept design phase. This ensures that major requirements are defined into the design requirements. At completion of the design phase there should be a further interdisciplinary check to ensure that the detailed design correctly manages the interfaces. After construction there should be additional interdisciplinary checks to ensure the equipment as implemented interfaces correctly.

Interdisciplinary checks and the outcomes shall be documented as a formal record of the process.

Section 11 Safety in design

11.1 Reliability, availability and maintainability

11.1.1 Principle

The reliability, availability and maintainability of the signalling system shall be sufficient for it to fulfil the operational requirements for which it is provided.

11.1.2 Rationale

The specification and attainment of appropriate levels of reliability and availability are essential to the delivery of the timetabled train service.

Reliability and availability also contributes to overall levels of system safety.

Maintainability is essential in order to ensure that the specified levels of reliability and safety continue to be met throughout the service life of the signalling system.

11.1.3 Guidance

Guidance on reliability, availability and maintainability is given in EN 50126 and *RISSB Guideline – Reliability, Availability, Maintainability (RAM)*.

11.2 Degraded mode facilities

11.2.1 Principle

Degraded mode facilities shall be provided.

11.2.2 Rationale

Degraded mode facilities enable rail traffic to move when elements of the signalling system have failed.

11.2.3 Guidance

Transitions to degraded modes of operation should be handled in a way that minimizes risk and can include graceful degradation as a means of facilitating this.

The arrangements for transitioning back to normal operation should also facilitate safe and timely recovery.

Power operated points can be provided with a manual points control mechanism.

Manually operated points that are controlled indirectly (e.g., via a ground frame) can be provided with an emergency release key.

Points should allow switch rails to be manually secured to the stock rail, for example, by using a point clip.

Where the network rules and procedures allow, shunting movement authorities can be provided that allow rail traffic to enter an occupied block when there is a failure of the train detection system. Note that shunting movement authorities should not be provided that allow rail traffic to enter a single line section.

11.3 Network rules and procedures

11.3.1 Principle

The signalling system and the associated network rules and procedures shall be compatible with each other.

11.3.2 Rationale

The signalling system, the associated network rules and procedures, and the users (e.g., network control officers, rail traffic crew and rail safety workers in the rail corridor) together constitute the wider train control system. The compatibility and completeness of these elements of the train control system is essential for the safe operation of the railway under normal, degraded and emergency conditions.

11.3.3 Guidance

Refer to *RISSB Operational Concept for the Australian Rail Network* for guidance of the fundamental operating principles for network rules and safeworking

11.4 Human factors

11.4.1 Principle

The human factors risks shall be mitigated so far as reasonably practicable.

11.4.2 Rationale

Even though the signalling system can be highly automated, there will always be a measure of dependence on human interaction, for instance during degraded mode operation or during maintenance.

Appropriate allocation of functions between the signalling system and network control officers and designing the signalling system to make it easy for network control officers, rail traffic crew and rail safety workers in the rail corridor to perform their actions safely, is vital.

11.4.3 Guidance

For further guidance, refer to AS 7470.

11.5 Failure of train detection

11.5.1 Principle

In the event of a failure of train detection, the signalling system shall remain in, or revert to, a state which preserves the safety of rail operations (i.e. fail safe).

11.5.2 Rationale

A failure of train detection to detect the presence of rail traffic could allow:

(a) a movement authority to be issued when it is not safe to do so;

(b) points or other movable infrastructure to move when it is not safe to do so; or

(c) rail traffic to enter a level crossing when it is not safe to do so.

A failure of train detection to detect the absence of rail traffic could allow:

(d) approach locking to release when it is not safe to do so;

(e) route locking to release when it is not safe to do so; or

(f) level crossing direction sticks to remain engaged when it is not safe to do so.

11.5.3 Guidance

In the event of a safety related failure of a track circuit, it should remain in, or revert to, the track occupied state. Further guidance is given in AS 7715.

In the event of a safety related failure of an axle counter, it should remain in, or revert to:

(a) the undefined state (where the axle counter system supports this state); or

(b) the track occupied state (where the axle counter system does not support an undefined state).

Further guidance is given in AS 7651.

Momentary failures of train detection to detect the presence of rail traffic can be mitigated by:

(c) providing a delay (e.g., four (4) seconds) to the transition to the track clear state;

(d) the release of sectional route locking to require [track section clear for a period of time (e.g., 15 seconds) OR track section clear with track section next in advance occupied];

(e) anti-preselection for points and signal routes that call points;

(f) for automatic level crossings, providing a stick control, i.e. for track sections within the level crossing control area, once occupied, initiate the level crossing operation until:

    (i) the rail traffic has been proved to clear the level crossing by sequential operation of track sections; or

    (ii) a suitable time has elapsed after the track section has cleared;

(g) for automatic level crossings, using track sections of the required length rather than track occupancy timers; or

(h) monitoring the sequential occupation and clearance of track sections and providing an alarm to signal maintenance workers if a sequencing error is detected.

Failures and faults of train detection should, so far as is reasonably practicable, be self-revealing to network control officers and signal maintenance workers, both to aid prompt and safe rectification, and to avoid situations where a fault is latent (hidden) and does not reveal itself until some other event occurs. For instance-

(i) for areas that are monitored by a network control officer (e.g., within or near an interlocked area), the train detection failure state (track occupied state or 'undefined' state) to be displayed to the network control officer via the control panel; and

(j) for areas that are not monitored by a network control officer (e.g., away from interlocked areas), the train detection failure will hold signals at stop. There should be a procedure for rail traffic crew to report the failure to signal maintenance workers (e.g., via a network control officer).

11.6 Failure of interlocking functions

11.6.1 Principle

In the event of a failure of an interlocking function, the signalling system shall remain in, or revert to, a state which preserves the safety of rail operations.

11.6.2 Rationale

A failure of an interlocking function that releases interlocking could cause rail traffic to:

(a) collide with other rail traffic;

(b) derail;

(c) collide with road users or vehicles at level crossings;

(d) enter lines where it is incompatible with the infrastructure; or

(e) collide with rail safety workers or equipment in the rail corridor.

11.6.3 Guidance

Interlocking functions include sectional route locking, point locking, release (e.g., for ground frames) locking, route locking and approach locking.

In the event of a safety related failure of an interlocking function, it should remain in, or revert to, a more restrictive state, for example, the locked state, rather than the released state.

Failures and faults of interlocking functions should, so far as is reasonably practicable, be self-revealing to network control officers and signal maintenance workers, both to aid prompt and safe rectification, and to avoid situations where a fault is latent (hidden) and does not reveal itself until some other event occurs. For instance, a failed interlocking function can cause a change to an indication displayed to the network control officer via the control panel, for example, extinguishes a points free indication.

11.7 Failure of points or other movable infrastructure

11.7.1 Principle

In the event of a failure of points or other movable infrastructure, the signalling system shall remain in, or revert to, a state which preserves the safety of rail operations.

11.7.2 Rationale

A failure that causes points or other movable infrastructure to move when it is not safe to do so could cause rail traffic to derail.

A failure that causes points to be incorrectly indicated as being facing point locked could cause rail traffic to derail.

A failure that causes points or other movable infrastructure to be incorrectly indicated as being in the correct position for a rail traffic movement could cause rail traffic to derail.

A failure that causes points or other movable infrastructure to be incorrectly indicated as being not in manual mode could cause rail traffic to derail.

11.7.3 Guidance

In the event of a failure, points or other movable infrastructure should not move away from the set position.

In the event of a failure whilst points or other movable infrastructure are moving, so far as is reasonably practicable, they should continue to move towards the set position.

In the event of a failure, points should not be incorrectly indicated as being facing point locked.

In the event of a failure, points or other movable infrastructure should not be incorrectly indicated as being in the correct position for a rail traffic movement.

In the event of a failure, points or other movable infrastructure should not be incorrectly indicated as being not in manual mode.

Failures and faults of points or other movable infrastructure should, so far as is reasonably practicable, be self-revealing to network control officers and signal maintenance workers, both to aid prompt and safe rectification, and to avoid situations where a fault is latent (hidden) and does not reveal itself until some other event occurs. For instance, a points or other movable infrastructure failure can cause a change to an indication displayed to the network control officer via the control panel, for example, extinguishes a points detection indication.

Further guidance is given in AS 7706 and AS 7659.

11.8 Failure of signals

11.8.1 Principle

In the event of a failure of a signal, the signalling system shall remain in, or revert to, a state which preserves the safety of rail operations (fail safe).

11.8.2 Rationale

If rail traffic approaches a signal displaying a less restrictive aspect than is safe (or a mutilated aspect that could be interpreted by the rail traffic crew as a less restrictive aspect than is safe), or displays no aspect, it could cause the rail traffic to:

(a) collide with other rail traffic;

(b) derail;

(c) collide with road users or vehicles at level crossings;

(d) enter lines where it is incompatible with the infrastructure; or

(e) collide with rail safety workers or equipment in the rail corridor.

11.8.3 Guidance

Where the failure of all or part of a running signal aspect or indication could lead the rail traffic crew to interpret the signal as less restrictive, aspects and indications should be proved. When the proving indicates that an aspect or indicator is not lit, or is mutilated such that it could be misinterpreted:

(a) the signal should step down to a more restrictive aspect (preferred option);

(b) the aspect of the preceding signal should be restricted; or

(c) supplemental indicators such as theatre indicators and stencil indicators can be lamp proved so far as is reasonably practicable.

The restriction on the preceding signal can be:

(d) most restrictive aspect only;

(e) shunting movement authorities only; or

(f) shunting movement authorities or the most restrictive aspect for a running movement authority (e.g., the yellow aspect) only.

The selection of the restriction should take into account:

(g) the probability that the failed signal will display no aspect; and

(h) the consequence of rail traffic passing the failed signal.

The probability that the failed signal will display no aspect should take into account:

(i) for signals that should always display at least two lights, the probability that all lights have failed; and

(j) for signals that should display at least two lights when at the most restrictive aspect, the probability that all lights have failed.

Common mode failures that would result in the signal displaying no aspect (e.g., the failure of a processor-based interlocking) should be mitigated (e.g., red retaining functionality).

The consequence of rail traffic passing the failed signal should take into account:

(k) the use of reactive enforcement systems and fully braked overlaps (hence if the rail traffic fails to stop at the failed signal, it will be enforced and remain within the overlap). See Appendix C;

(l) the use of predictive enforcement systems. See Appendix C; and

(m) if the failed signal would otherwise have displayed the least restrictive aspect (i.e. the green aspect).

Failures and faults of signals should, so far as is reasonably practicable, be self-revealing to network control officers and signal maintenance workers, both to aid prompt and safe rectification, and to avoid situations where a fault is latent (hidden) and does not reveal itself until some other event occurs. For instance:

(n) for areas that are monitored by a network control officer (e.g., within or near an interlocked area), filament failure and lamp out alarms to be displayed to the network control officer via the control panel; and

(o) for areas that are not monitored by a network control officer (e.g., away from interlocked areas), there should be a procedure for rail traffic crew to report the failure to signal maintenance workers (e.g., via a network control officer).

The use of LED lights in signals can provide challenges in indicating failures. These challenges should be carefully assessed and mitigations put in place to reduce risks of incorrect indications or failure to detect LED failures.

11.9 Failure of level crossings

11.9.1 Principle

In the event of a failure of an active control level crossing, the signalling system shall remain in, or revert to, a state which preserves the safety of rail traffic, road users and vehicles, so far as is reasonably practicable.

11.9.2 Rationale

A failure that causes an active control level crossing to not activate when it should, could cause rail traffic to collide with road users or vehicles at the level crossing.

However, when an active control level crossing fails to the activated state, road users can be tempted to enter the level crossing when it is not safe to do so.

11.9.3 Guidance

Active control level crossings are not inherently fail-safe, as the indication to the road user that it is safe to enter the level crossing is the absence of a warning (e.g., flashing signals extinguished and audible warning devices silent). Therefore, the availability of the active controls should be ensured, so far as is reasonably practicable. Means of achieving this are given in AS 7658.

In the event of a safety related failure of an active control level crossing, it should remain in, or revert to, the activated state. Further guidance is given in AS 7658.

For bidirectional approaches to active control level crossings, direction sticks can be used to prevent the level crossing from remaining activated after the rail traffic has passed across the level crossing. If one or more of the track sections within a direction stick fails to the occupied state whilst the rail traffic is within the direction stick track sections, the direction stick will remain engaged after the rail traffic has left the level crossing approach. If rail traffic were to then approach the level crossing from that direction, with the direction stick still effective, it would not activate the level crossing at the correct time and could enter the level crossing before it is safe to do so. To prevent this:

(a) movement authorities that allow rail traffic to enter or move along a level crossing approach should prove that the direction sticks for trains moving in the opposite direction are disengaged; or

(b) where a level crossing uses direction sticks, unless rail traffic can legitimately stand on the direction stick track sections (e.g., a station platform or signal), if a direction stick is engaged for longer than a moving train would legitimately occupy the direction stick track sections (e.g., four minutes), the level crossing should reactivate and remain activated until the direction stick track sections clear.

Failures and faults of active control level crossings should, so far as is reasonably practicable, be self-revealing to network control officers and signal maintenance workers, both to aid prompt and safe rectification, and to avoid situations where a fault is latent (hidden) and does not reveal itself until some other event occurs. Means of achieving this are given in AS 7658.

Failures and faults of active control level crossings should, so far as is reasonably practicable, reduce a movement authority to prevent rail traffic from occupying the level crossing. This may be achieved through approach locking signals on the approach to the level crossing.

11.10 Current taking an unintended path

11.10.1 Principle

Circuits shall prevent feedback from current taking an unintended path.

11.10.2 Rationale

If current takes an unintended path that causes feedback, a signalling function (e.g., a relay or a processor based interlocking input) could energize when it is not safe to do so.

Unintended paths could be caused by:

(c) design flaws in complex circuitry, such as meshed circuits feeding more than one relay;

(d) interfaces with electronic equipment where outputs could be conductive even when nominally de-energized;

(e) breakdown of insulation between circuit conductors; or

(f) breakdown of insulation between a circuit conductor and earth.

Breakdown of insulation could be caused by mechanical damage or insulation degradation. Wiring external to equipment housings, such as buried cables and cables to on-track equipment, is particularly susceptible.

11.10.3 Guidance

Where meshed circuits feeding more than one relay are necessary, they should be kept as simple as reasonably practicable.

Care should be taken when interfacing with electronic equipment where outputs could be conductive even when nominally de-energized.

Mechanical damage to and degradation of circuit conductor insulation can be controlled by:

(a) selection of cable materials (refer to AS 7663 for guidance); and

(b) design of the cable environment (refer to AS 7664 for guidance).

Earth faults can be prevented from causing a signalling function to energize when it is not safe to do so by:

(c) double cutting of all external safety-critical circuits;

(d) separate power supplies for certain groups of circuits;

(e) earth fault monitoring on vulnerable power supply busbars; and

(f) inclusion of earthing checks in regular maintenance schedules.

The following should be double cut:

(g) External line circuits in their entirety;

(h) all safety-critical trackside circuits in their entirety; and

(i) any other circuit fed from a power supply that feeds either of the above.

As signalling power supplies are not generally earthed, two earth faults would be necessary to create a hazardous failure, for example, by bridging out contacts, although the first fault could go undetected. By duplicating contacts in both legs of a circuit, four faults would be required to cause such a failure (and these faults would probably short circuit the supply and disable the circuit).

Common returns and earth returns should not be used for safety-critical line circuits.

Where practicable, contacts of the same relay should be used in each leg of the circuit in order to double cut. Where different relays are used in each leg, for consistency the first relay to operate and release should be placed in the feed leg.

The requirement to double cut does not apply to:

(j) contacts used solely to impose non-safety-related controls on safety-critical circuits;

(k) back contacts used solely for down proving;

(l) back contacts used solely for cross proving;

(m) contacts used solely for correspondence proving;

(n) contacts used solely to economize power consumption;

(o) contacts on the internal side of an isolating transformer, or transformer rectifier, feeding external circuits;

(p) signal lighting circuits, unless reasonably practicable;

(q) internal circuits on a dedicated power supply;

(r) non-safety-related circuits on a dedicated power supply; nor

(s) systems that use alternative equivalent measures to mitigate the risk of earth faults, such as earth fault disconnection devices, isolated power supplies for each function, or regular earth testing.

Circuits between adjacent equipment housings can be treated as internal, provided that measures are taken to sufficiently reduce the risk of earth faults, for example, by use of a protective non-conducting duct.

Where components of non-safety-related circuits are particularly susceptible to earth faults, such circuits should not share a common power supply with safety-critical circuits.

Where earth leakage detectors are provided, earth leakage detected alarms should be displayed to the network control officer via the control panel.

11.11 Transient conditions

11.11.1 Principle

Transient conditions shall not result in hazardous situations.

11.11.2 Rationale

Transient conditions are caused by concurrent changes in signalling logic.

Signalling logic includes relay circuits and logic implemented in processor based interlockings.

Transient conditions could cause confusing or unsafe conditions.

11.11.3 Guidance

Transient conditions should be assessed for all signalling logic.

For processor-based systems, the following should also be reviewed:

(a) scanning times for inputs;

(b) logic processing times;

(c) logic processing order;

(d) fleeting outputs;

(e) delays caused by communication systems;

(f) sequence changes caused by communication systems; and

(g) lost information caused by communication systems.

For instance, where short, fast trains can transition from an area controlled by a relay based interlocking to an area controlled by a processor based interlocking, transient conditions could cause:

(h) irregular behaviour of signals;

(i) the appearance to the network control officer that the train has briefly disappeared; and

(j) spurious alarms to be generated within the control panel.

To avoid this, the interlockings (and hence the control panels) should use a repeat function for the last track section in the relay based interlocking area that is a composite of:

(k) the direct track clear function (which has the quick to occupy characteristics of the relay-based interlocking); and

(l) a track clear function via the processor-based interlocking (which has the slow to clear characteristics of the processor based interlocking).

Cross proving can be used to avoid a confusing or unsafe condition from arising if complementary signalling functions are operated at the same time. Without cross proving, this condition could occur as a transient during an ordinary change of state (if the signalling function operate time is less than its release time).

Cross proving is the mutual down proving of signalling functions with complementary functions, such as normal/reverse, on/off, clear/occupied and left/centre/right.

To avoid transient problems, cross proving should be provided on complementary primary signalling functions and their subsequent repeats, unless one of the following applies:

(m) the time taken for the function to change state is inherently much greater than the release time of the de-energizing function;

(n) the provision of cross proving creates consequential problems; or

(o) the provision of cross proving is particularly complicated.

It is always necessary to assess the benefits and dis-benefits of cross proving.

Cross proving is not essential on intermediate functions that control the primary function.

An example of inherent delay that makes cross proving unnecessary occurs with the correspondence proving of points. The relay feed for the initial state of correspondence is disconnected when the interlocking starts to change and the relay feed for the new state of correspondence is dependent on the operating time of the point mechanism. This point operating time is significantly greater than any appropriate delay in the release of the initial relay and the transient problem is not a valid consideration.

An example of unnecessary complications that could be created by the excessive provision of cross proving occurs when complementary primary function relays are repeated in two or more interlockings. It is generally considered unnecessary to provide complicated cross proving between the relays in different interlockings, but the overall design should confirm that the omission does not lead to problems, transient or otherwise.

The integrity of interlockings requires functions to operate in the correct sequence. It is possible for this sequence to be interrupted, particularly if there is some delay inherent in the operation. Sequence proving should be used to prevent this occurrence and confirm that the interlocking is effective. Some examples of sequence proving are as follows:

(p) The local signal relay(s) that control the signal off (e.g., HR, DR) proved down before allowing the approach locking to release;

(q) The signal control relay (e.g., GR) proved down in the approach locking, to apply the approach locking by “controls off”;

(r) The approach locking (e.g., ALSR) proved down in the local signal relay(s);

(s) The first route stick relay (e.g., USR) past a signal proving all routes from that signal normal; and

(t) The last route stick relay (e.g., USR) to release when the route is set proved down in the signal control relay. This confirms that the route locking is correctly applied before the signal clears and prevents the momentary clearance of opposing signals.

11.12 Proving

11.12.1 Principle

For safety-critical functions, any credible failure of fail-safe equipment that could defeat its intended safety behaviour shall be identified and mitigated so far as is reasonably practical.

11.12.2 Rationale

If a safety-critical function fails in an unexpected mode it could cause rail traffic to:

(a) collide with other rail traffic;

(b) derail;

(c) collide with road users or vehicles at level crossings;

(d) enter lines where it is incompatible with the infrastructure; or

(e) collide with rail safety workers or equipment in the rail corridor.

11.12.3 Guidance

Proving should be used to confirm that equipment is in a safe state before another operation can be carried out.

Proving should automatically disable a potentially conflicting operation.

Proving is generally provided for safety-critical functions. For instance:

(a) to verify the state of trackside and on-track equipment (e.g., lamp proving, point detection);

(b) to verify correspondence between outputs from systems duplicated by diversity;

(c) to verify that certain safety-critical relays, repeat relays, latched relays, contactors and timers have reverted to the released position (i.e. down proving);

(d) to verify the removal of a bridge path in certain locking levels;

(e) to verify that two mutually exclusive safety-critical functions are not operated at the same time; and

(f) to verify that certain safety-critical events have occurred in the correct sequence.

Proving can be regarded as impracticable if the added complexity or reduced availability, etc., are considered to outweigh the benefits.

Fail-safe non-latched relays can generally be relied upon to release after the feed has been removed from the coil. The situations where the down proving of fail-safe relays is necessary are:

(g) magnetic stick or latched relays should be proved down to confirm correct operation, unless other precautions are taken to prevent hazardous failures;

(h) contactors should be proved down to confirm that their heavy duty contacts have not welded, unless other precautions are taken to prevent hazardous failures. For some types of relays it can be necessary to have both banks of contacts proved down together;

(i) timer relays used for safety-critical controls should generally be proved down to confirm correct operation;

(j) trackside and on-track equipment is vulnerable to circuit faults. As far as reasonably practicable, down proving should be used to confirm that the principal control and detection relays are appropriately released;

(k) cross proving (see Clause 10.10.3; and

(l) sequence proving (see Clause 10.10.3).

Down proving should be accomplished by including a back contact of the relay in a second circuit, so as to cause it to fail right side should the first relay fail to release. The second circuit should be chosen so that it will monitor every operation of the first relay. It is not required to be double cut by the back contact.

Correspondence proving is a means of confirming that a proving circuit for a function cannot give information that conflicts with the state of its respective operating circuit. It is generally provided for related outgoing and incoming polarized circuits and for point detection circuits.

Positively proving (i.e. handshaking) a function has been successfully received at another interlocking and confirmed back before it is acted upon.

11.13 Repeat functions

11.13.1 Principle

If a repeat function fails to operate when its primary function operates, it shall not result in a hazardous situation.

11.13.2 Rationale

Repeat functions include:

(a) repeat relays; and

(b) bits transmitted over communication links in processor based interlocking systems.

In a chain of repeat functions (e.g., TPR, T2PR, etc.), the primary function is the function (e.g., relay or bit) that is the first one to directly control safety-critical signalling functions, rather than just operate the next repeat function in the chain.

If a repeat function fails to operate when its primary function operates, different parts of the interlocking will see the function in different states, for example, parts of the interlocking will see a track section as clear and other parts of the interlocking will see the same track section as occupied.

11.13.3 Guidance

Back contacts (and the equivalent in processor based interlocking data) should not be used for control purposes except on primary functions. Back contacts of repeat functions give no positive information.

Repeat functions can be provided over a front or back contact (or the equivalent in processor based interlocking data) of the primary function.

When repeat functions of both front and back contacts (or the equivalent in processor based interlocking data) of a primary function are provided, they should be cross proved.

No function (e.g., relay or bit) should be operated directly in parallel with a primary function.

Back contacts of front contact repeats (or the equivalent in processor based interlocking data) of primary functions should only be used in the following circumstances:

(a) Where the sole function is to prevent feedback in meshed circuits, when used in conjunction with a front contact of the same function.

(b) For cross proving.

(c) For indication purposes, except for red signal indications.

(d) To economize power consumption or for other non-safety-critical purposes.

Back contacts of back contact repeats (or the equivalent in processor based interlocking data) of primary functions should only be used in the following circumstances:

(e) Where the sole function is to prevent feedback in meshed circuits, when used in conjunction with a front contact of the same function.

(f) For cross proving.

(g) For non-safety-related purposes.

Where repeat functions are used, the control panel indications should generally be controlled by contacts of the last repeat function, so that the failure of a repeat function to energize would be apparent to the network control officer.

11.14 Interactions with other railway systems and equipment

11.14.1 Principle

The signalling system shall not be subject to, nor be the cause of, unsafe interactions with other railway systems and equipment.

11.14.2 Rationale

The signalling system interfaces directly and indirectly with several other systems and equipment, i.e. other railway infrastructure and rail traffic.

11.14.3 Guidance

This includes both interactions where there is an intentional interface with other systems and equipment, and interactions where there is no intentional interface, such as electromagnetic interference.

11.15 Resilience to external influences

11.15.1 Principle

The signalling system shall be resilient to unwanted external influences that could adversely affect the safety and availability of the signalling system.

11.15.2 Rationale

The signalling system interfaces directly and indirectly with several other external systems and equipment.

11.15.3 Guidance

This includes addressing environmental/climatic effects, cyber-attacks on software-based subsystems, vandalism and unwanted electrical/radio interactions with non-railway systems.

For further guidance, refer to AS 7770.

11.16 Maintenance and modification

11.16.1 Principle

The arrangements for the maintenance and modification of the signalling system shall be appropriate for ensuring its continuing safe operation.

11.16.2 Rationale

Maintainability is essential in order to ensure that the specified levels of reliability and safety continue to be met throughout the service life of the system.

11.16.3 Guidance

The signalling system should be designed, so far as is reasonably practicable, to prevent the possibility of inadvertent errors during maintenance and repair work.

Plug couplers (or plugged connectors) and pre-formed cables can be used in place of direct terminations, where suitable.

They should be identified in a similar way to the manner that direct terminations are recorded in the cable termination analysis and wiring sheets, by referring to the plug coupler name and pin number.

It is preferable that connectors are keyed, or coded, to prevent incorrect re-connection.

The signalling system should include diagnostic systems for monitoring the health of the equipment.

It should be possible for the maintenance and modification activities to be performed on equipment without undue risk to either the operational railway or the personnel carrying out the work. This can have implications for the design of equipment and its physical location.

Section 12 Efficiency

12.1 Overview

Signalling systems are designed to safely separate trains and in the absence of human intervention, trains will reach a limit of authority and come to a stop unless action is taken to set routes and clear signals. This section describes processes and principles to reduce the network control officer's workload.

12.2 One movement authority

12.2.1 Principle

Setting a controlled signal to proceed, or issue of an in-cab movement authority shall apply to movement of a single rail traffic movement.

12.2.2 Rationale

To enforce safe separation of trains, with trains routed to predefined destinations as required by operations planning, and to reduce the need for the network control officer to monitor the rail traffic and manually restore the movement authority, some automation, under the control of the network control officer, can reduce operator workload where multiple non-conflicting train movements require the same signal set.

12.2.3 Requirements

Setting a controlled signal to proceed, or issue of an in-cab movement authority, shall only commence following a request for a route to be set by either:

(a) the network control officer operating the relevant control device(s), or

(b) where applicable, the automatic route setting system (see Clause 11.6).

When restored by passage of train or by the network control officer, the signal shall remain at its most restrictive aspect until the network control officer or automatic route setting system issues a fresh request for a route to be set.

Controlled signals can be set for a route and placed into automatic operation by the network control officer, to allow the signal to automatically clear for consecutive train movements. Cancelling the signal route shall also cancel the automatic working function.

Permissive moves past controlled signals (where permitted) into an occupied section require a further movement authority, and require the train to travel at reduced speed, prepared to stop short of any obstruction.

12.3 Automatic signals

12.3.1 Principle

Automatic signals operate by the passage of rail traffic, to safely separate successive trains.

12.3.2 Rationale

In the absence of intervention, trains will reach a limit of authority and come to a stop unless some process allows further movement authorities. Use of automatic signals can reduce operator workload.

12.3.3 Guidance

Where there are no opposing or conflicting routes, and no interlocking with movable infrastructure is required, signals can be allowed to operate continuously in automatic operation. As automatic signals do not require route setting, train control system tasks are simplified. Use of automatic signals can reduce infrastructure design and maintenance costs.

12.4 Route stacking/storage

12.4.1 Principle

The signalling system can provide the facility to select a route, which, if not available, can be placed into route storage to automatically set when available.

12.4.2 Rationale

The network control officer can plan a sequence of train movements, and rather than remember them for later execution, enter them in sequence into the signalling system as stored routes for later execution.

12.4.3 Guidance

Routes come out of storage and are executed in the order in which they were stored. If one of the stored routes cannot be executed due to an infrastructure fault or rail traffic issue making the route unavailable, then all remaining routes will be trapped in the route storage system and require attention from the network control officer to resolve. The reason for sequential execution of stored routes is to prevent a train from being routed to the wrong destination due to setting of an out-of-sequence route.

Routes that contain swinging overlaps could not be suitable for route storage, as operational delays can occur if a specific overlap, which conflicts with the further routing of the train, is automatically selected and held in the wrong lie while the train is proved at rest and the points become free to move.

12.5 Automatic route setting

12.5.1 Principle

Automatic route setting (ARS), where used, shall issue running movement authorities. Where the risks of doing so are acceptable, ARS can also be applied to shunting movement authorities.

12.5.2 Rationale

The primary function of ARS is to route rail traffic in a sequence which should minimize overall deviation from the timetable when a conflict occurs, i.e. reduce delays and reduce network control officer workload.

12.5.3 Guidance

ARS should perform this role even when rail traffic arrives in a sequence other than that defined in the timetable.

ARS should allow the network control officer to remain in charge. The network control officer should therefore be able to set routes ahead of ARS, restrict the area over which ARS works and restrict the types of rail traffic for which it works. The network control officer should also be able to interrogate ARS to explain routing actions (e.g., why it is routing any rail traffic in preference to another or why it is not setting a route for specific rail traffic).

ARS should not challenge the interlocking. Thus, it should not request routes which are unavailable, or which lead up to or from a blocked signal.

ARS is triggered by train describer steps which, within the area of control, are generated by the specific control system. When triggered, ARS predicts the times at which the train will arrive at subsequent points on its journey. By comparing this with the predictions for other trains, potential conflicts are identified. When a conflict is identified, the effect of routing the conflicting trains in different orders is evaluated and the optimum routing order is determined.

12.6 Train operated route release

12.6.1 Principle

Train operated route release (TORR) should be provided in the interlocking.

12.6.2 Rationale

TORR is provided to avoid the need for the network controller to cancel the route after the passage of each rail traffic movement.

12.6.3 Guidance

TORR should only release a route after the entry of rail traffic into that route.

The following conditions should be met for all routes for which TORR is to operate:

(a) The signal controls were OFF at the time the rail traffic passed the signal.

(b) The signal is disengaged and thus prevented from re-clearing after the rail traffic movement has taken place.

(c) The signal is not set to work automatically.

(d) The network traffic controller has not initiated the release of the route.

(e) Approach locking for the route has been released.

Automatic route setting systems require the provision of TORR.

TORR should be inhibited if a controlled signal is set to work automatically. If automatic operation is cancelled and the route remains set, TORR should operate for the next rail traffic movement.

Where a combination of short track sections, short trains and high speeds present a significant risk that a required sequence can not operate correctly (due to inherent delays in the train detection devices and their inputs into the interlocking), it is permitted for two adjacent track sections to be treated as a single-track section for TORR applications.

Sequential operation of train detection should require protection against irregular release due to power, transmission or other failure.

A possible approach is for additional requirements for running movements: One additional sequence of train detection, i.e. Train in Section Proving (TISP), or condition (over and above that required for release of approach locking) should be satisfied to initiate the release of the route if:

(f) the route or any route conflicting with it controls passenger movements; or

(g) the speed over any portion of the route which conflicts with other routes exceeds a speed defined in the network rules and procedures as low speed; or

(h) the speed of any conflicting route at the point of conflict exceeds a speed defined in the network rules and procedures as low speed.

The sequence or condition should be one of the following:

(i) Occupancy of two adjoining track circuits in the direction of travel followed by clearance of the first; or

(j) Occupancy of three adjoining track circuits in the direction of travel followed by sequential clearance of two track circuits; or

(k) Sequential train detection employing a treadle if track circuits are insufficient in number or are of such a length that the initiation of TORR would be unreasonably delayed; or

(l) Proof of no train approaching the signal at the time TORR is to be initiated.

All sequences or conditions should include checks wherever practical to ensure that an irregular sequence of events has not occurred between successive steps.

If an irregular sequence of events is detected, the operation of TORR for that signal should be inhibited for the current movement.

Special Operating Conditions: If a long train can come to a stand at the next signal without completing the TORR sequence, a sequence can also be provided which initiates TORR after the train has passed the signal and come to a stand.

This sequence should be provided in addition to the normal TORR and TISP sequences for movements which clear the route.

If the train stops before the whole train has passed the signal (but has not reached the next signal) TORR should not be permitted to operate, regardless of the time the train stands. If the train then sets back so that it clears the route originally set by moving behind the entrance signal, controls can be provided to permit the original route to release once the set-back move is proven to have taken place and the train is fully behind the signal.

12.7 Opposing locking omitted

12.7.1 Principle

Where opposing shunt signals exist over sets of points, it may be permissible to omit locking between them to allow both to be clear at the same time and so enable repeated forwards and backwards shunting movements.

12.7.2 Rationale

The workload on network traffic controllers can be reduced in instances where rail traffic performs multiple shunting movements over interlocked points by allowing opposing shunt signals to be cleared.

12.7.3 Requirements

Where specifically required, it is permissible to allow shunt signals for both directions to be clear at the same time to safely hold points in the route during repeated forwards and backwards shunting movements.

Where such opposing shunt signals have been cleared at the same time, the following criteria applies:

(a) Replacement of signals shall be by network traffic controller only.

(b) Release of approach locking shall be by expiry of time only.

(c) Release of route locking shall require all track sections between the opposing signals to be clear.

These constraints on route release are to control the risk of points being moved whilst shunting is still in progress.

12.7.4 Guidance

There can be a requirement for rail traffic crew performing the shunting moves to normalize a local device (i.e. replace a shunters key, detected by the interlocking) to prove that shunting has been completed.

12.8 Pre-set of shunt signals

12.8.1 Principle

The setting of main signals reading over facing shunt signals in the route shall require the shunt signals to be clear before the main signal clears. This can be achieved automatically.

12.8.2 Rationale

There are instances where it is convenient for operational reasons to subdivide a section of track into separate sections each bounded by shunt signals.

12.8.3 Requirements

Where a shunt signal requiring to be pre-set is equipped with a proceed on sight movement authority aspect, this shall not be used when the signal is used in a pre-set mode, instead the shunt signal shall clear to its usual OFF aspect.

12.8.4 Guidance

It would be unusual to use a running movement authority for rail traffic to enter such a section of track with an uncertain limit of authority, and therefore when a main signal is used, the facing shunt signals are pre-set to a proceed aspect. Where it is not possible to pre-set all the facing shunt signals, a shunting movement authority is used to enter the section of track.

12.9 Oversetting

12.9.1 Principle

A following route can be set to the same exit before a previous movement has cleared the route and/or overlap.

12.9.2 Rationale

Network traffic controller workload is eased if they are able to set a following route even though rail traffic is still within the route.

12.9.3 Guidance

A movement authority for rail traffic following preceding rail traffic requires no change to points in the route, and can be allowed to set and lock the route, and wait for the track circuit conditions to clear before allowing the following movement authority.

12.10 Storing a route

12.10.1 Principle

A route can be stored by the train control system to be affected once the route is safe for the issue of the movement authority.

12.10.2 Rationale

Network traffic controller workload is eased if they are able to store routes prior to the existing route being clear.

12.10.3 Requirements

Where multiple routes are stored the network control officer shall take care to ensure that the correct sequence of routes is stored correctly. If not rail traffic could be incorrectly given a movement authority resulting in service delays.

12.11 Fleeting

12.11.1 Principle

The train control system may enable fleeting so that absolute signals operate as an automatic signal.

12.11.2 Rationale

Network traffic controller workload is eased if absolute signals operate as automatic signals where most rail traffic follows the same route.

12.11.3 Guidance

Fleeting may be used on absolute signals at junctions or yard entries where most or all rail traffic is planned to follow the same route.

Section 13 Signalling lifecycle principles

13.1 Maintain signalling system against failures

13.1.1 Principle

A scheme of inspection and maintenance activities shall be implemented to address equipment issues before they lead to wrong side failures or right side failures.

13.1.2 Rationale

There are variations in the performance of signalling equipment over time (both mechanical and electrical) that can lead to the equipment operating outside of the designed parameters resulting in increased risks to railway operations.

In the event of a right-side (or safe) failure, there is not a direct safety impact. However, there could be an indirect safety impact when under degraded operations, manual actions are undertaken which are less safe than the engineered solutions.

13.1.3 Guidance

A scheme of preventative maintenance activities shall be documented and implemented to address this issue.

The plan should include a series of service schedules detailing the maintenance actions to be undertaken for each and every item of equipment. For each service item there is a nominated periodicity and latitude for completing the activity.

The system shall include an asset register that includes every item of the equipment and where it is located. The system should issue the work orders to perform the maintenance activity and keep a record of the tasks completed.

The service schedule for points inspections of detection and facing point locks is safety critical. This ensures that the opening of the point blade to the stock rail is within the safety limits. The service schedule requires adjustment of this parameter. The service schedule for track circuit inspection and testing is also safety critical. This ensures that the energisation levels of the track circuit will not lead to an over energisation of the track circuit and a wrong side failure.

13.2 Identify equipment performance variations during system life cycle

13.2.1 Principle

The performance of equipment and any variations shall be recorded and actions undertaken to rectify performance variations if required to maintain safety.

13.2.2 Rationale

The signalling equipment operates in a harsh environment and is subject to variations in performance. Some of these variations can exceed the safe limits for the equipment, including:

(a) mechanical wear and tear on the equipment;

(b) degradation of the equipment due to environmental exposure;

(c) degradation of the equipment performance due to weather (temperature and rainfall);

(d) changes to the equipment from the original set up due to ongoing operational impacts (includes vibration and shocks);

(e) impact of variations in electrical interfaces (surges, brown outs, failures and start up);

(f) equipment being operated outside of its designed range due to human error or manual intervention; and

(g) indirect physical impacts on the equipment (compression on buried cable route from vehicle traffic), removal of support for a structure due to excavation adjacent to the equipment.

13.2.3 Guidance

The impacts of variations to performance shall be identified and suitable controls implemented. Some of the changes in performance cannot be readily identified following the event. Some of the effects are cumulative over an extended period. In other cases, the impacts could occur sometime after the event.

A suitable control is the implementation of routine inspections, measurement of parameters on the equipment, undertaking preventative maintenance activities, recording of initial performance values and subsequent recording of current performance values. This later step allows for the maintenance staff to identify changes in the performance of the equipment over time.

When the equipment is operating outside of the required performance range, then adjustments should be undertaken. The actions are then recorded as part of either the routine preventative maintenance activities or as corrective maintenance activities.

13.3 Ensure the signalling system is safe during each phase of the system life cycle

13.3.1 Principle

The signalling system shall be safe during each of the phases of the system life cycle.

13.3.2 Rationale

The signalling system needs to operate safely not just on the day that it is commissioned into service. There are many scenarios during the system life cycle that are not covered by the final design of the signalling system.

13.3.3 Guidance

The system and the associated activities shall ensure the safety of the rail operations and of the people working on the railway infrastructure during the system life cycle. The lifecycle can be described as including design, construction, testing, commissioning, operation, maintenance and decommissioning.

During the construction phase there should be defined and documented practices to ensure that the operational signalling system is safe while items of equipment are being modified. This also ensures that people undertaking construction activities can safely perform their work.

During the testing phase, the signalling system could be disrupted to undertake a test. The signalling could also be stressed to conform the design performance. There should be defined and documented practices to ensure to be undertaken to ensure that the signalling is safe, that there is no impact on rail operations and that people undertaking the testing are safe.

During the decommissioning phase, the equipment is taken out of service. Processes should be put in place to ensure that the out of service equipment cannot adversely impact on the rail operations. These also ensure that there is no ambiguity as to what equipment is in service and what equipment is out of service.

13.4 Maintain safety of signalling system for variations in other railway assets

13.4.1 Principle

The signalling system shall be safe for variations in the other assets of the railway infrastructure due to the many interdisciplinary interfaces.

13.4.2 Rationale

The signalling system is dependent on other systems but does not have control over the other assets. The interface between the signalling system and these other assets could be safety critical to the operation of the signalling system. There needs to be processes and actions to ensure that the interfaces are operating as intended.

13.4.3 Guidance

Changes to the track, turnouts or related infrastructure, can have an impact on the signalling system. If there is re-railing or ballasting then the signalling equipment connected to the track (track circuits, axle counter heads, traction current bonds) should be inspected and certified. Changes to a turnout also require inspection, adjustment and certification.

There can be many types of changes to locomotives and rollingstock that affect the signalling system. New locomotives with different traction systems can have an impact on track circuits and need to be thoroughly tested and certified. New rollingstock should be checked for braking performance, headstock overhang from axle and rollingstock clearance outline.

Changes to electrical distribution infrastructure or the traction electrical system shall be checked for the impact on the signalling system. This could have a direct impact on the quality of the electrical power used to operate the signalling system or indirect impacts through the traction system and track circuits.

The communications system provides a backbone for voice and data communications for signalling and control systems and for control centres. Changes to the system could impact the performance and resilience of the signalling and control functions. There is also a need to check the cyber security of any changes to the data communications networks.

There could be other changes in assets including the installation of weighbridges, level crossings, bridge structures, loading facilities, unloading dump stations, rollingstock monitoring systems, environmental monitoring systems (land slip detectors and rainfall detectors) and other support infrastructure. Each of these will have a physical, functional or electrical interface to the signalling and control systems that shall be checked.

13.5 Ensure safety of signalling system for variations in train operations

13.5.1 Principle

Variations to train operations shall be reviewed against the signalling design to ensure that safety is covered by the system.

13.5.2 Rationale

The signalling system does not provide absolute safety. It provides safety for a nominated set of train operating conditions. The signalling system is initially designed to meet the performance requirements for a set of train operations requirements. These requirements will change over time. These changes could be with the individual types of trains or in the overall train timetable or the individual operating movements of trains.

13.5.3 Guidance

Each of these changes or new timetables should be checked against the capability and performance of the signalling systems. Some of these checks are for individual trains. Other checks could be for multiple trains or a day of timetable operations.

Appendix A Hazard Register (Informative)

Hazard number	Hazard
5.2.1.4	Rail traffic - Derailment causing collisions with wayside structures
5.8.1.9	Collision - Derailment causing side swipe by another train
9.30	Points and/or release failure (All)
5.9.1.7	Signal passed at danger – Wayside signal failure
9.12	Train detection failure (All)
9.34	Train detection failure (All)
9.38	Field equipment and/or enclosure failure (All)
9.44	Train detection failure (All)
9.54	Train detection failure (All)
5.18	Level crossing collision
6.11.1.1	Collision – Level crossing collisions

Appendix B Alignment with IRSE Fundamental Requirements for Train Control Systems (Informative)

The below table identifies sections within this document that align with the IRSE fundamental requirements for train control systems.

Core operational requirements for train control systems		AS 7711 Principle
1.1	The system should facilitate the safe, efficient and effective operation/use of railway infrastructure and rail traffic.	All principles
1.2	The intrusiveness of the system into the efficient and effective running of the railway in performing its safety function should be minimized.	3.5, 3.10, 3.11, 3.12, 4.2, 4.3
1.3	The reliability, availability and maintainability of the signalling system should be sufficient for it to fulfil the operational requirements for which it is provided.	3.2, 3.6, 10.1
1.4	Degraded mode facilities should be provided to enable trains to move when elements of the signalling system have failed.	10.2
Core functional safety requirements for train control systems		
2.1	Before a train is given authority to move along a section of line: a) the section of line should be proved to be secure (to prevent derailment and to avoid conflict with movement authorities given for other trains); and b) the section of line should be proved to be clear of other traffic (to prevent collision), except in circumstances where a train is permitted to enter an occupied section of line.	3.2, 3.7, 3.12, 4.1, 5.3
2.2	After authority to move along a section of the line has been given, the security of the line should be maintained for the movement until: a) the complete train has passed clear of the section of line; or b) the authority has been rescinded and the train has come to a stand as a consequence, without entering the section of line over which authority to move had been given; or c) the authority has been rescinded (and this information has been communicated to, and received by, the train) and the train has sufficient space to come to a stand safely before the start of the section of line over which authority to move had been given.	3.2, 3.4, 3.9, 4.1, 4.5, 5.7, 5.8
2.3	The train driver (or automatic train operation sub-system [ATO]) should be provided/equipped with unambiguous, consistent and timely information that enables safe control of the train.	3.6, 3.7, 3.8. 5.2, 5.4
2.4	Sufficient space should be provided between following trains to allow each train to brake to a stand safely.	3.1

2.5	Controls should be in place to prevent and/or mitigate the consequences of: a) trains passing the end point of their movement authority; and b) trains exceeding the maximum permitted speed; and c) trains (and individual vehicles) moving without authorisation.	3.2, 3.4 ,3.6, 3.8, 4.1, 4.4, 5.5, 5.6
2.6	Protection should be provided for the public and trains at level crossings.	Section 6, 10.9
2.7	The means should be provided for protecting trains, worksites and workers during engineering work.	3.1, 3.4, Section 8
2.8	The signaller should be provided with unambiguous, consistent and timely information, and suitable control facilities, to enable the safe authorisation of train movements.	3.3, 5.1, 11.2, 11.4, 11.5, 11.6, 11.7, 11.8, 11.9, 11.10, 11.11, 11.12
2.9	The system should have facilities for communication between signallers and others.	3.12
2.10	The means should be provided for preventing trains from being routed onto a line with which they are not compatible.	3.2, 7.1, 7.2, 7.3
2.11	Facilities should be provided to instruct a train to stop in an emergency.	3.8
Essential supporting safety requirements for train control systems		
3.1	The level of safety performance of the system should meet specified targets.	Section 10
3.2	The signalling system and the associated operating rules should be compatible with each other.	10.3
3.3	The human factors associated with the safe use/operation of the system should be taken into account in the specification and design of the system.	10.4
3.4	In the event of a failure of the signalling system, it should remain in, or revert to, a state which preserves the safety of trains.	9.1.2, 10.2, 10.4,10.5, 10.6, 10.7, 10.8, 10.9, 10.13
3.5	The signalling system should not be subject to, nor be the cause of, unsafe interactions with other railway systems and equipment.	3.12, 7.4, 10.10, 10.11, 10.12, 10.14
3.6	The system should be resilient to unwanted external influences that could adversely affect the safety and availability of the system.	10.15
3.7	The arrangements for the maintenance and modification of the signalling system should be appropriate for ensuring its continuing safe operation.	10.16
3.8	Personnel who use, operate and maintain the signalling system, or in any other way form part of the train control system, should be demonstrably competent to perform their tasks and duties.	13.5

Appendix C Overlaps (Informative)

C.1 Overview

Rail traffic which exceeds its movement authority should be prevented from colliding with other rail traffic or derailing so far as is reasonably practical.

Rail traffic which exceeds its movement authority can be due to a number of reasons; rail traffic crew inattention, wheel rail adhesion problems, rail traffic crew fatigue, or expectation, signal sighting obstructed, signal route hazard, inconsistent signal spacing, signal aspect sequence and train braking performance not compatible, etc

The mitigation is the provision of an overlap on the departure side of the signal which ensures a margin of safety beyond a stop signal.

The overlap should be unoccupied and locked before the approach or stop signal next on the approach side is permitted to show a proceed indication.

The overlap establishes and maintains a minimum separation distance between a train approaching or within the signal route and any other train authorized to occupy the line ahead of the signal route.

C.2 Overlap distance

The overlap distance is the length of the section of track which forms the overlap and is measured from the stop signal to a predetermined clearing point in advance of the signal.

This predetermined clearing point can be prescribed under these principles or measured dynamically resulting in sets of train braking tables appropriate for the train type and configuration which have been determined by testing or calculating using a train performance model.

> Commentary *CC.2*
>
> If an overlap is prescribed, then it is not calculated.

The safety of any prescribed or nominal overlap should be assessed to ensure that it is appropriate for the specific operational context. It can vary for the reasons detailed below. Train PAE and collision statistics can be used to determine that the prescribed 'overlap' provides safe operation.

Factors which influence the predetermination of the clearing point can be:

(a) historical precedents and experimental data;
(b) maximum line speed;
(c) permanent speed restrictions;
(d) service speed or attainable speed at the stop signal;
(e) service braking curves;
(f) emergency braking curves;
(g) impact of gradient;
(h) emergency brake tripping system;
(i) Automatic Train Protection system in some applications; and
(j) provision of conditional caution aspect clearance of signals.

If the operating conditions on the railway line change, then the basis for the prescribed values or the dynamically calculated values has changed, and theses should be reviewed and re-validated.

C.3 Overlap distance calculation

C.3.1 Overview

How the overlap distance is to be determined, and any minimum distance required should be recorded as part of the design standards or requirements documents for the railway.

A record should be kept as to how the overlap was determined for each and every specific instance on the railway. The overlap distances should be applied consistently throughout the railway.

In areas where permanent speed restrictions apply, i.e. exits from yards, stations or negotiating turnouts or junctions, the overlap can be reduced, this distance should be determined and recorded in accordance with the design processes and practices of the railway.

Special arrangements can be made for overlaps on lines fitted with enforcement such as train stops or equivalent.

Braking tables for different types of rail traffic for specific railway lines should be used to determine permissible service speed and the relevant overlaps required.

Where the train speed is proven to be at a speed lower than the line speed, the overlap distance determined can be in accordance with the lower speed.

The line speed should be generally used for determination of overlap distances. A risk-based approach should be used to assess the potential speed at line speed changes and when turnouts are involved. The following examples provide a guide to assist in determining the speed to be used for determining overlap length.

C.3.2 Turnout exists within the overlap

Where a low speed turnout exists in the overlap, the approach speed used to determine the overlap length need not exceed twice the turnout speed.

C.3.3 Train approaches through a turnout

Where a train approaches a signal at stop through a turnout, the overlap can be determined based upon the turnout speed (i.e. effectively the line speed for that approach).

C.3.4 Speed board increase prior to a signal

Where a speed board increases the speed in the block prior to the signal at stop, the lower approach speed leading to up to this board, providing it is within the restrictive aspect sequence, can be used.

C.3.5 Speed board decrease prior to signal

Where a speed board decreases the speed in the block prior to the signal at stop, the higher approach speed leading up to this board should be used, unless the track configuration physically limits the speed.

C.3.6 Overlap distance - Exit from single line

An overlap should be provided at the exit from a single line block immediately on the approach to the home signal.

This overlap should extend from the home signal as far as the opposing main and loop starting signals controlling the entrance to the single line block and should incorporate loop and flank protection.

If for operational reasons an outer home signal is provided at the exit from a single line block together with an opposing advance starting signal on the single line, then an overlap should be provided immediately in advance of the outer home signal. This overlap should extend from the outer home signal towards the opposing starting signal on the single line.

The overlap in advance of the outer home signal and the overlap in advance of the advance starting signal should not conflict with each other.

C.3.7 Overlap distance - Crossing loops

The home signal should be provided with an overlap immediately in advance and extending up the main and loop starting signals. The points should be set to be clear of any other existing signal route that has been cleared or is occupied.

The overlap from the main or loop starting signal extend into the single line section in advance as far as the opposing home signal.

If an outer home signal is provided, then an overlap should be provided for the caution aspect. This overlap should extend from the home signal to the main or loop signals leading into the single line block in advance.

If a main or loop exit signal is fitted with a subsidiary shunt signal, then the subsidiary shunt signal should be provided with an overlap which extends towards the opposing outer home signal.

The overlap distance should be determined in accordance with the requirements as detailed above.

C.3.8 Overlap distance - Train staff operation

For the requirements for the provision of overlaps on single lines operated under electric train staff or ordinary train staff regulations and where colour light home and starting signals are provided, an overlap should be provided at the exit from the single line section immediately in advance of the home signal.

This overlap should extend from the home signal to the opposing starting signal or signals controlling the entrance to the single line section or approved clearing point as required.

C.4 Conditional overlaps

If it is necessary for specific operational purposes or for general headway reasons for trains to be brought closer together than is permitted by the requirements for a full overlap as described above, then a conditional overlap can be provided enabling a running signal to show a conditional caution aspect.

Due to the increase in risk, conditional overlaps requiring a conditional caution aspect or timed clearance, should not be used with new infrastructure.

If a full overlap is not available, but an overlap of reduced distance is known to be clear and the train ahead occupying part of the full overlap distance is stationary or signalled away in the correct direction of running then the running signal requiring the full overlap should be cleared after a suitable time delay has elapsed ensuring that the speed of the following train has been reduced to be commensurate with the safety margin provided by the reduced overlap distance.

C.5 Route locking into or within an overlap

If a signal requires an overlap into which a route or overlap from an opposing/conflicting signal leads or in which the route from an opposing/conflicting signal is situated then the opposing route should be normal and any associated track circuit holding released, if applicable, before the particular route of the signal requiring the overlap is permitted to set.

If it is required to set the particular route of the signal requiring the overlap then the opposing/conflicting routes leading into the overlap or situated within the overlap should be locked normal until the particular route of the signal requiring the overlap is normalized and any associated approach locking, or route locking is released, if applicable.

If it is required to set a route from an opposing/conflicting signal leading into or situated within an overlap, then the particular route of the signal requiring the overlap should be locked normal until the route from the opposing/conflicting signal has been normalized and free of approach locking.

C.6 Point setting & locking within overlaps

C.6.1 Trailing points

If a set of trailing points situated within an overlap is available, then it should be set and locked in the appropriate position by the particular route of the signal requiring the overlap and remain locked until the particular route has been normalized or if provided an alternative overlap has been set.

If a train passes the signal requiring the overlap, then the trailing points should also become locked in position by track circuit occupancy until the train has come to a stand at the signal in advance and any time release provided has expired or the train has passed beyond the signal in advance and the trailing points have become directly locked by track circuit occupancy.

If alternative overlaps are provided, then a set of trailing points should be set and locked as described above subject to the particular lay of the overlap.

If a set of trailing points situated within an overlap is not available, then the particular route of the signal requiring the overlap should be inhibited from setting.

C.6.2 Facing points

If a set of facing points is situated within an overlap and each of the alternative overlaps is available, then no setting or locking of the facing points is required.

If a set of facing points is situated within an overlap and one of the alternative overlaps is not permitted or is not available, then the facing points should be set and locked in the direction of the available overlap by the particular route of the signal requiring the overlap and remain locked until the particular route has been normalized or until an alternative overlap has become available.

If a train passes the signal requiring the overlap, then the facing points should remain locked in position, if required, by track circuit occupancy until the train has come to a stand on the departure side of the signal, and any time release provided has expired or the train has passed beyond the signal in advance and the facing points have become directly locked by track circuit occupancy. Any swinging overlap should be locked when the train reaches the sighting point for the signal requiring this overlap.

If a set of facing points situated within an overlap is not available to be set, then the particular route of the signal requiring the overlap should be inhibited from setting.

C.6.3 Facing points providing flank point protection

If a set of facing points which provides flank point protection to an overlap is available, then it should be set and locked in the appropriate position by the particular route of the signal requiring the overlap and remain locked until the particular route has been normalized or if provided an alternative overlap has been set.

If a train passes the signal requiring the overlap, then the points should also become locked in position by track circuit occupancy until the train has come to a stand at the signal in advance and any time release provided has expired or the train has passed beyond the signal in advance and the points have become directly locked by track circuit occupancy.

If alternative overlaps are provided, then a set of facing points providing flank point protection should be set and locked as described above subject to the particular lay of the overlap.

If a set of facing points which provides flank point protection to an overlap is not available, then the particular route of the signal requiring the overlap should be inhibited from setting.

Under certain circumstances it can be permissible to provide special arrangements for the setting of overlap conditions. For example, the provision of dedicated push buttons to enable special arrangements to be invoked.

C.7 Preferential setting of points in the overlap

Preferential setting of facing points in an overlap can be provided to ensure that whenever possible an overlap is set in the direction of the most frequently used route ahead of the signal.

This reduces the probability of an overlap being set in the least used direction which can result in excessive or unnecessary overlap swinging if other routes, when setting, interact with the established overlap.

If an overlap contains a set of facing points that lead over a set of trailing points which are situated beyond the facing points, and the lay of the facing points is towards the trailing points and this is the most used direction of traffic and the trailing points are available to be set (or are already set) for the overlap then they should be set (if necessary) and locked as applicable for the overlap. If the trailing points are not available to be set for the overlap, then the facing points should be set and locked in the opposite lay towards the alternative overlap which should be the least used direction of traffic.

C.8 Automatic overlap setting of overlap by track circuit occupation

This form of automatic overlap setting is provided when the running signal has a choice of two or more overlaps beyond an inner signal and due to track circuit occupation one of the overlaps is not available. Under these conditions the facing points can be set towards the available overlap automatically when the route is setting.

If a choice of overlap exists beyond an inner signal at the time of setting the signal and the overlap in the direction in which the facing points are set is unavailable due to the occupation of track circuits, then the outer signal can set and lock the facing points in the direction of the available overlap.

These arrangements can become overly complicated if two or three sets of facing points are involved and multiple overlap choices are available, and care should be exercised to restrict the overlap swinging to the minimum to satisfy traffic conditions. Overlaps should not be swung across opposing roads.

C.9 Overlap swinging

Overlap swinging is provided to assist an operator to establish routes which should interact with one or more overlaps previously set for one or more routes. This avoids the operator from having to manually establish the alternative overlaps by individual point key movements before the route to be set becomes available. This can become a complex and time-consuming operation where two or more junctions overlap and several routes have already been set.

If one or more routes have already been set, the appropriate overlaps established and the signals are displaying proceed aspects and another route requires to be set which should alter the lay of one or more sets of points in the overlaps of the previously cleared signals, then the route which should be set should adjust the lay of the established overlaps progressively and prove that an alternative overlap is available before the facing points leading towards the alternative overlap are reset to opposite lay.

If several sets of points are involved, then this process of overlap swinging should be enforced by the setting and locking of the overlap points in sequence.

Signals already displaying proceed aspects should have their aspects maintained during the overlap swinging and should prove the appropriate alternative overlap conditions when the overlap movement is complete. The swinging overlap should be locked when the approaching train reaches the sighting point for the signal requiring the overlap.

C.10 Overlap maintenance

This addresses the requirements for the locking of facing points to ensure that a clear overlap is maintained while an alternative overlap is occupied, and a route is set or a train is occupying the route leading up to the home signal at the points.

This locking is provided when an outer running signal has a choice of two or more overlaps beyond an inner signal, and due to track circuit occupation, one (or more) of the overlaps is not available.

If a choice of overlap exists beyond an inner signal, then the clearing of an outer signal should lock any facing points beyond the inner signal to prevent the operation of those points towards the obstructed overlap.

The points should remain locked whenever a train is approaching the inner signal, and the alternative overlap remains obstructed.

This locking can be released when the alternative overlap becomes clear, or the route has been cancelled and the approach locking released, or the train has been time released at a stand at the inner signal.

If multiple overlaps exist, care should be exercised to ensure that overlap maintenance is properly applied through the various combinations of conditions.

Appendix D Flanking (Informative)

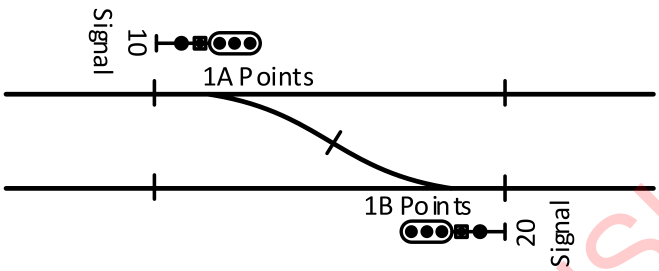
Flank protection can be divided into two types:

(a) Flank point protection; or

(b) Flank track protection.

Flank point protection uses points to provide the flank protection as per the below diagram.

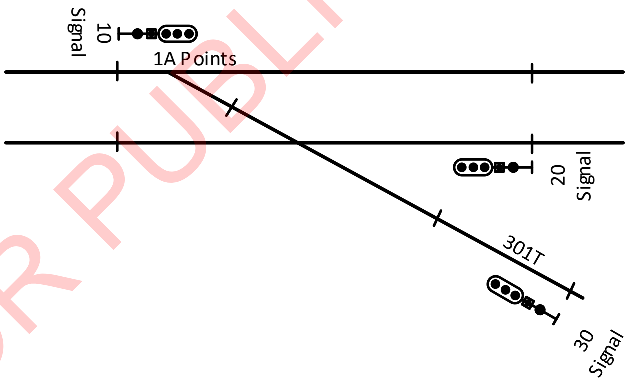
Figure D-1 Flank point protection



> Commentary *CD-1*
>
> For a movement authority to be issued from 10 signal 1B points need to be in the normal (straight) position.

Flank track protection uses track circuits to provide the flank protection as per the below diagram.

Figure D-2 Flank track protection



> Commentary *CD-2*
>
> For a movement authority to be issued from 20 Signal, Track 301T would have to be proved clear. 1A Points would also be required in the normal position (flank point protection).

Foul track sections can be conditionally foul of the block, depending upon the lie of points in the flank of the block. Typically, the conditionally foul track section will contain the flank points. However, for a conditionally foul track section over a diamond crossing, the flank points can be within an adjacent track section.

Unless it prevents other permissible movement authorities, the route may call these flank points to the lie where the track section is not foul of the block. Where the route does call the flank points, it should lock the flank points in that lie until the rail traffic has completely passed the place at which the track section would be foul.

Where the route does call the flank points, the movement authority should prove that the points are set and locked but does not need to prove the foul track section clear. Where the route does not call the flank points, the movement authority should prove that the points are set and locked unless the foul track section is clear. However, unless the movement authority would be withdrawn by rail traffic traversing a parallel route, the movement authority can unconditionally prove that the foul track section is clear. The movement authority should unconditionally prove that other foul track sections are clear.

For the purposes of foul track sections, the movement authority does not generally require the flank points to be detected. However, continuous detection or detection at the time of issuing the movement authority may be provided if the risk of a collision between a signalled movement and a handk signalled movement outweighs the risks associated with hand signalled movements owing to a detection failure of the flank points. Where multiple point ends are controlled by a single interlocking function, separate detection may be provided for each point end and only the relevant point end detected in the movement authority. Note that the movement authority can require the flank points to be detected for other reasons, for example, where flank point protection is provided.

Means of proving that no other rail traffic is currently authorized to enter or be foul of the block include:

(c) point locking;

(d) sectional route locking; and

(e) route locking.

Where a conflicting route:

(f) requires points in the opposite lie; and

(g) locks those points in the opposite lie at least until the conflicting movement has entered or is foul of the block; then

point locking is sufficient to prove that no other rail traffic is currently authorized to enter or be foul of the block via that conflicting route.

However, where an opposing conflicting route:

(h) requires points in the opposite lie; and

(i) locks those points in the opposite lie at least until the conflicting movement has entered or is foul of the block; but

(j) frees those points before the conflicting movement has exited or is no longer foul of the block; then

sectional route locking may be proved, for convenience, in addition to the point locking.

Where an opposing or intersecting conflicting route starts:

(k) before the block; and

(l) does not require points in the opposite lie; or

(m) requires points in the opposite lie but frees those points before the conflicting movement has entered or is foul of the block; then

sectional route locking should be proved, in addition to any point locking.

Where an opposing conflicting route starts at the edge of the block or inside the block and does not require points in the opposite lie, then route locking should be proved. Sectional route locking may be proved instead of or, for convenience, in addition to the route locking.

Sectional route locking may be configured so that it is not always applied as soon as the route is set. For instance, it may be configured to remain free until points have completed their movement. Where this is the case and sectional route locking is proved, then route locking should also be proved. This is to prevent a conflicting route from being set before the sectional route locking has been fully applied.

Where sectional route locking is proved, it should extend from the start of the conflicting route up to the last track section before the block or the last track section before the foul track section(s). It may, for convenience, extend onward to:

(n) the end of the conflicting route;

(o) the end of the block; or

(p) the last foul track section;

whichever comes first. Note that, where overlaps are provided, the sectional route locking should be extended further. See Appendix B for more information.

Means of proving that, where a movement authority has been withdrawn, the other rail traffic is able to stop, or has stopped, before entering the withdrawn movement authority include maintaining the point locking, sectional route locking and route locking until the approach locking releases. See Clause 3.9 for the requirements for releasing approach locking.

A shunting movement authority may be allowed to step up to a running movement authority if the conditions for the running movement authority become available.

Appendix E Enforcement Systems (Informative)

E.1 Introduction

The following appendix provides an overview of enforcement systems.

The objective of signal enforcement is to prevent a collision or derailment event. Enforcement systems should activate when the train makes an unauthorized movement, i.e. passing a signal at stop, or breaches any speed supervision.

Enforcement systems are defined as predictive, reactive or both. Predictive enforcement systems are those which control the speed or movement of the train when a potential hazard situation exists and manages the required speed of the train to eliminate the potential hazard. Should the train exceed the required speed then reactive enforcement will be activated to stop the train.

The signal enforcement system has two components, i.e. the train borne component that interfaces to the emergency brake system and a track side component that interfaces to the signalling system. The track side and train borne components work in tandem to force an emergency brake application when the train is likely to exceed its movement authority (predictive) or upon the train exceeding its signalled authority (reactive). The signal enforcement function is achieved through a combination of signal aspects and trackside components and in some cases track occupancy conditions.

Interfaces between different enforcement systems need to be carefully assessed and managed SFAIRP.

The application of the signal enforcement principles is considered to be the minimum necessary to mitigate the risk of a collision or derailment. Elements of enforcement systems, dependent on the application, can include:

(a) maintaining a safe distance between following trains on the same line so that, irrespective of train frequency, a train will not collide with a preceding train which has stopped or is running more slowly;

(b) permitting the issue of a movement authority only when the route is aligned and clear of obstruction;

(c) providing an adequate warning that the train is approaching the end of the movement permitted by the proceed authority;

(d) allow trains to run at the frequency demanded by the timetable to meet operational requirements; or

(e) be fail-safe, such that any predictable type of failure of an item of signalling equipment will lead to a more rather than less restrictive operating condition.

It is important that the implementation of enforcement systems assesses the types of rail traffic that will operate in the enforcement area. In most cases it is not practical to fit all rail traffic with the train borne component of the enforcement system (for example, freight services in a suburban system). The operation of non-fitted rail traffic could increase operational risk and render the installation of an enforcement system impractical.

E.2 Automatic warning systems

Automatic warning system (AWS) provides to the driver an audible and visual indication of whether a running signal was clear or at caution. If a driver fails to respond to a warning aspect, an emergency brake application will be initiated.

AWS does not relieve the driver of the responsibility of observing and obeying lineside signals and indicators.

Where a main signal which is capable of displaying a green aspect, a permanent magnet and an electromagnet is provided on the approach to the signal. The electromagnet is energized only when the signal is displaying a green aspect.

A suppressed permanent magnet can be provided in lieu of the permanent magnet if there is any signalled route which traverses the AWS equipment and does not end at the signal(s) to which the AWS equipment applies.

E.3 Train stop systems

As a means to reduce the consequence of a PAE and to ensure that a train sufficiently comes to rest within an overlap, train stops are implemented as mechanical devices co-located next to an end of authority that will activate a trip cock arm on a train causing an emergency brake intervention.

Train stops should be located at running signals capable of displaying a stop aspect on lines where rail traffic fitted with train stop trip gear operate.

Shunt signals can be provided with a train stop where a risk assessment has identified a hazard that can be mitigated or reduced through the provision of a train stop.

If a signal is displaying a stop aspect, then the trip arm of the train stop is in the raised position. If the signals display a proceed aspect, then the trip arm is in the lowered position.

Rising of the trip arm occurs after occupancy of the first track circuit in advance of the signal.

A train stop is lowered following the release of a shunt aspect, after proving the speed of the approaching train is suitably reduced to the define speed limits of a shunt route. Train stops should not be lowered for shunt routes into occupied sections of track.

The train stop is driven down when the signal is at proceed and is continuously proven down in the signals control and proceed aspects. Higher aspects of signals prove that the train stop at the signal in advance is reverse.

E.4 Train protection and warning system

Train protection and warning system (TPWS) is a brake enforcement system that utilizes the functionality of a train stop and speed checking on the approach. The system consists of a train stop system (TSS) at the signal and overspeed sensor system (OSS) on the approach. The system is activated by the signalling system in conjunction with the train-borne equipment to apply emergency brake intervention at the TSS and OSS (where an overspeed occurs).

The primary purpose of TPWS is to minimize the consequence of a train passing a TPWS fitted signal at danger and a train over-speeding at certain other locations.

TSS should be disarmed when the signal is at proceed.

TSS should be armed when the signal is at stop.

OSS should be disarmed when the signal is cleared for a normal speed aspect.

OSS should be armed when the signal is cleared for a medium speed or low speed aspect or is the stop aspect.

E.5 Automatic train protection

The system monitors train speed and brake operation. Information on permitted track speed, target speed, target distance and track gradient is transmitted periodically to the train from transponders on the track. This information is collected, verified and interpreted by the on-board ATP dual processors operating in a failsafe configuration. On the approach to a speed restriction or limit of authority, the system initiates warnings when it is time to apply the brakes and if the driver fails to brake or brakes insufficiently the ATP will automatically apply the brakes.

Rail traffic crew drive on sight using their route knowledge and observing trackside signals and signage, and the ATP system enforces track speed and limits of authority.

Transponders have no battery or external power supplies. A continuous 27 MHz radio signal is transmitted from an antenna mounted underneath the railcar to activate transponders, and provide the energy needed for a return radio signal. The transponders send a coded return signal at 4.5 MHz and continue sending it repeatedly as long as they receive enough energy from the 27 MHz transmission. Transponders used to provide track speed information are generally ‘fixed transponders’, pre-programmed with specific data. Transponders at signals get their information about the status of a signal from an encoder. The encoder receives information by a direct connection to the signal control system, either by interpreting the signal lamp current, or from a control relay. A transponder group consists of 2 or 3 individual transponders configured to provide target speed and target distance information, and on downhill gradients steeper than1:200m gradient information.

The system does not have continuously available information of the state of signal aspects. Pre-warning information is provided on the approach to a signal or speed restriction, to allow the train’s ATP system to calculate brake requirements, and at the signal or restriction to enforce the required speed profile. Update transponder groups are installed as required on the approach to a signal to allow trains to return to line speed if a restrictive signal upgrades to a proceed aspect.

Bibliography (Informative)

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- AS 7470, *Human Factors Integration in Engineering Design – General Requirements*
- AS 7505, *Signalling Detection Interface*
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- AS 7631, *Railway Infrastructure – Sighting*
- AS 7651, *Axle Counters*
- AS 7658, *Railway Infrastructure – Railway Level Crossings*
- AS 7659, *Point locking and detection*
- AS 7663, *Railway Signal Cables*
- AS 7664, *Railway Signalling Cable Routes, Cable Pit and Foundations*
- AS 7702, *Rail Equipment Type Approval*
- AS 7706, *Interface with Points*
- AS 7715, *Train Detection*
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- AS 7724, *Unauthorized movement protection - Operational requirements*
- AS 7770, *Rail Cyber Security*
- EN 50126 (all parts), *Railway Applications – The Specification and Demonstration of Reliability, Availability, Maintainability, and Safety (RAMS)*
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