AS 7711:2018

Australian STANDARD®

# Signalling Principles

RISSB
RAIL INDUSTRY SAFETY AND STANDARDS BOARD

Train Control Systems Standard

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**AS 7711 Signalling Principles – Public Comment Draft**


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This Australian Standard® AS 7711Signalling Principles was prepared by a Rail Industry Safety and Standards Board (RISSB) Development Group consisting of representatives from the following organisations:

| | | |
|---|---|---|
| RioTinto | BHP | Transport for NSW |
| Metro Trains Melbourne | VicTrack | Aurizon |
| Arc Infrastructure | KiwiRail | Wabtec |
| Queensland Rail | ARTC | |
| ONRSR | Passenger Transport Authority of Western Australia | |

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

Choose the type of review

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

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

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

**Paul Daly**
Chief Executive Officer
Rail Industry Safety and Standards Board

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# AS 7711:2018

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## 1.1 Document control

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## 1.2 Contents

# 1 Introduction

## 1.1 Purpose

The objective of this Standard is to provide the Australasian rail industry with a set of mandatory and recommended signalling principles to be incorporated in the design of new signalling systems. Major modifications to signalling systems shall consider the principles of this Standard so far as is reasonably practicable.

These signalling principles support the safe application of a Rail Transport Operator's (RTO) signalling-based safeworking system, promote a consistent application of signalling principles throughout Australasia and should–

(a) detail the underlying principles of signalling system design;

(b) be independent of specific RTO's requirements;

(c) be independent of technology used; and

(d) identify the risks (hazards) being controlled.

## 1.2 Scope

This Standard provides details on underlying signalling principles commonly used to control rolling stock operational risk. It does not preclude the application of higher performance standards (e.g. based on local experience and good engineering practice which may be contained in the management of Standards, Codes, Guidelines and procedures of individual Australia States or RTOs).

This Standard covers the engineering controls for signalled movement authorities. It does not cover procedural controls in yard working areas.

## 1.3 Exclusions

This Standard is not specifically intended to cover urban on-street tramway or light rail networks, cane railways, or heritage railways operating on private reservation, but items from this Standard may be applied to such systems as deemed appropriate by the relevant RTO.

Competence relating to tasks within this Standard assumes that the tasks within it are being carried out by personnel, in accordance with the competence requirements of RTO safety management systems.

These signalling principles do not specifically cover token or block working.

## 1.4 Compliance with this Standard

There are two types of control contained within RISSB Standards:

(a) Mandatory requirements.

(b) Recommended requirements.

Each of these types of control addresses hazards that are deemed to require controls on the basis of existing Australian and international Standards and Codes of Practice.

A **mandatory** requirement is a requirement that the Standard provides as the only way of treating the hazard.

Mandatory requirements are identified within the text by the term “shall”.

A **recommended** requirement is one where the Standard recognises that there are limitations to the universal application of the requirement and that there may be circumstances where the control cannot be applied or that other controls may be appropriate or satisfactory, subject to agreement with the Rail Transport Operator(RTO)and/or Rail Safety Regulator.

Recommended clauses are mandatory unless the RTO can demonstrate a better method of controlling the risk.

Recommended requirements are identified within the text by the term “should”.

In adopting all or part of this Standard, the RTO shall undertake a safety assessment to ensure that the resulting system achieves the safety requirements so far as is reasonably practicable.

Hazards addressed by this Standard are included in Appendix A. refer to the RISSB website for the latest Hazard Register Guideline: www.rissb.com.au.

## 1.5 Definitions

Refer to RISSB Glossary of Terms.

## 1.6 Abbreviations

| | |
|---|---|
| ARS | Automatic Route Setting |
| ATP | Automatic Train Protection |
| ATWS | Automatic Track Warning System |
| BR | British Rail |
| CBI | Computer Based Interlocking |
| CBTC | Communication Based Train Control |
| ELD | Earth Leakage Detector |
| EP | Electro-Pneumatic (Points) |
| LED | Light Emitting Diode |
| NX | Entrance - Exit (Panel Control) |
| OCS | One Controlled Switch (Panel Control) |
| OSS | Overspeed Sensor (TPWS) |
| PLS | Position Light Shunt Signal |
| RTO | Rail Transport Operator |
| SAS | Start Against Signal (SPAD) |
| SOY | Start on Yellow (SPAD) |
| SPAD | Signal Passed At Danger |
| TORR | Train Operated Route Release |
| TPWS | Train Protection & Warning System |
| TSS | Train Stop Sensor (TPWS) |

| | |
|---|---|
| WBS | Westinghouse Brake and Signal |

## 2 Signalling system

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

The principles generic to movement authorities are given in Section 3.

The safe management of movement authorities principally involves preventing rail traffic from–

(a) colliding with other rolling stock – refer to Section 4;

(b) derailing – refer to Section 5;

(c) colliding with road users or vehicles at railway crossings – refer to Section 6;

(d) being incompatible with the infrastructure – refer to Section 7; and

(e) colliding with rail safety workers or equipment in the rail corridor – refer to Section 8.

The safe management of movement authorities also needs to mitigate failures of the signalling system – refer to Section 9; and

The efficient management of movement authorities principally involves aids to the network control officer– refer to Section10.

## 3 Movement authorities

### 3.1 Running lines and sidings

#### 3.1.1 Principle

The rail network shall be divided into running lines and sidings.

#### 3.1.2 Rationale

Running movement authorities allow rail traffic to travel faster than would allow it to stop within the sighting distance of the rail traffic crew.

#### 3.1.3 Guidance

Running movement authorities provide warning to the rail traffic crew to allow them to stop rail traffic short of an unseen obstruction. This allows heavy rail traffic and fast rail traffic to operate safely.

In sidings the use of simpler shunting systems allows rail traffic which is operating at lower speeds to stop short of visible obstructions.

### 3.2 Limits of movement authority

#### 3.2.1 Principle

A movement authority for a running line shall have a limit of authority defined by dividing the running line into one or more blocks.

### 3.2.2 Rationale

Blocks are provided to maintain a safe distance between rail traffic on the same track.

### 3.2.3 Guidance

The length and location of each block is determined by the operational requirements.

## 3.3 Unique identification of limits of movement authority

### 3.3.1 Principle

Each limit of movement authority shall be uniquely identified.

### 3.3.2 Rationale

Rail safety workers (rail traffic crew, network control officers, etc.) need to have a common understanding of the location of the various limits of movement authority on the rail network.

### 3.3.3 Guidance

The identifier may consist of, for instance, a station abbreviation and a signal number.

Where rail networks controlled by other RTOs are adjacent–

(a) all of the adjacent rail networks should use the same identifier for the same limit of movement authority; and

(b) for different limits of movement authority, the identifier should be unique to all of the adjacent rail networks.

## 3.4 Assignment of a safeworking system

### 3.4.1 Principle

Each block shall be designed to be compliant with the selected safeworking system.

### 3.4.2 Rationale

Rail safety workers (rail traffic crew, network control officers etc.) need to have a common understanding of which rules, for both normal and degraded operation, are applicable to the block.

The safeworking system includes the methods by which the occupancy of the block is determined.

The safeworking system determines the means for issuing a movement authority to rail traffic.

### 3.4.3 Guidance

Details of safeworking selection criteria will consider operational requirements.

## 3.5 Communication of movement authority

### 3.5.1 Principle

Movement authorities/ the denial of movement authorities shall be conveyed to the rail traffic crew clearly and unambiguously, and shall provide sufficient information to allow rail traffic crew to safely handle the rail traffic.

### 3.5.2 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.

### 3.5.3 Guidance

Means of conveying movement authorities /the denial of movement authorities include lineside signals and/or in-cab signals.

Guidance on lineside signals is given in AS 7721.

Guidance on railway infrastructure sighting is given in AS 7631.

## 3.6 Warning before end of movement authority

### 3.6.1 Principle

Sufficient warning shall be provided to allow rail traffic to stop within the limits of its current movement authority.

### 3.6.2 Rationale

The mass and speed of rail traffic may require considerable stopping distance beyond the sighting distance of the rail traffic crew. This can also be impacted by track curvature, undulations and local conditions.

### 3.6.3 Guidance

Means of providing this warning include–

(a) distant signal or sign - fixed or operating;

(b) warning aspects based on adequate sighting and braking distance; and

(c) distance to go indications on in-cab displays.

Where the signal has sufficient sighting distance for the required braking distance, no warning aspect is required. For instance–

(a) starting signals from terminal platforms; and

(b) where rail traffic can only approach the signal at low speed – e.g. exit signals from sidings.

Guidance on signal sighting is given in AS 7631 and AS 7721.

## 3.7 Unique identification of lines

### 3.7.1 Principle

Each line (or part of a line) shall be uniquely identified at a granularity sufficient to support train operations.

### 3.7.2 Rationale

Rail safety workers (rail traffic crew, network control officers, etc.) need to have a common understanding of the location of the various stations and tracks on the rail network.

### 3.7.3 Guidance

The identifier may consist of, for instance, a station name and a track name.

Where rail networks controlled by other RTOs are adjacent –

(a) all of the adjacent rail networks should use the same identifier for the same track; and

(b) for different tracks, the identifier should be unique to all of the adjacent rail networks.

# 4 Prevent rail traffic from colliding with other rolling stock

## 4.1 Running movements

### 4.1.1 Principle

For rail traffic to be authorised to enter a block for a running movement–

(a) no other rail traffic shall currently be within or foul of the block; and

(b) no other rail traffic shall currently be authorized to enter or be foul of the block; and

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

### 4.1.2 Rationale

Running movement authorities allow rail traffic to travel unobstructed to the limit of the authority.

### 4.1.3 Guidance

Means of proving that no other rail traffic is currently within or foul of the block include–

(a) train detection – track circuits or axle counters; and

(b) electronic authority systems.

Means of proving that no other rail traffic is currently authorized to enter or be foul of the block include all opposing signals or movement authorities are at normal.

Requirements for the withdrawal of movement authorities are given in Appendix F.

## 4.2 Shunting movements

### 4.2.1 Principle

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

(a) opposing movement authorities shall be normal or limited by rolling stock; and

(b) rail traffic on occupied track sections shall be proved at stop; and

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

### 4.2.2 Rationale

Shunting movement authorities allow rail traffic to enter an occupied block for the purposes of–

(a) coupling up to other rail traffic;

(b) where the vacancy of the block is unable to be determined, e.g. sidings; or

(c) failures of the train detection system (if permitted by the operating rules).

### 4.2.3 Guidance

Shunting movement authorities include shunt and subsidiary aspects in route signalling, and low speed caution aspects in speed signalling.

Means of proving that rail traffic on occupied track sections is at stop include–

(a) the berth track of the exit signal (for the rail traffic within the block) occupied for a time sufficient to prove that the rail traffic is at a stand; and

(b) direct observation of the rail traffic by the network control officer.

The shunting movement authority should be approach cleared to ensure that the rail traffic is able to stop short of any obstruction.

Requirements for the withdrawal of movement authorities are given in Appendix F.

## 4.3 Enforcing the end of movement authority

### 4.3.1 Principle

Rail traffic which exceeds its movement authority shall be prevented from colliding with other rolling stock so far as is reasonably practicable.

### 4.3.2 Rationale

The interaction of rail safety workers and various technologies may result in the railway system not working as intended.

### 4.3.3 Guidance

Means of mitigating the risk of rail traffic colliding with other rail traffic that has exceeded its movement authority include–

(a) roll-out protection – including automatic normalisation of points;

(b) overlaps – refer to Appendix B;

(c) proving the exit signal alight;

(d) reactive enforcement systems – refer to **Error! Reference source not found.**; and

(e) predictive enforcement systems – refer to Appendix C.

## 4.4 Route locking

### 4.4.1 Principle

Once a train has entered the route and the signal has been returned to stop, the route shall be locked until the train has been proven to have exited the route.

The route in the rear of the train can be released if required by sectional route releasing.

#### 4.4.2 Rationale

This is necessary to prevent a conflicting route being set.

#### 4.4.3 Guidance

The train is passing along the route, having passed the route entrance signal, and all points and opposing routes should be locked.

For route locking –see Appendix E

For approach locking – see Appendix F.

### 4.5 Normalisation of the route

#### 4.5.1 Principle

Following the passage of a train, the route shall be able to return to normal status.

#### 4.5.2 Rationale

The route is required to return to its normal state to enable the passage of the next train or opposing trains through the route.

#### 4.5.3 Guidance

Route releasing is detailed in Appendix G.

### 4.6 Release of route locking

#### 4.6.1 Principle

The restoration of the signaller's control device, or operation of TORR, shall initiate the normalisation of route locking behind a rail vehicle passing through the route.

#### 4.6.2 Rationale

The route is reset behind the rail vehicle with the signal on and free of approach locking.

#### 4.6.3 Guidance

It is possible to release the route in stages, the first section released when the train detection proves that the section is clear, once the signal has been proved normal and free of approach locking.

Subsequent route sections can be released when its own track section is proved clear, provided that the previous route section has already been released.

Route releasing by track circuit operation should consider the risk of a wrong side failure (track circuit bob) giving a premature release. The use of track circuit timers or sequential track circuit operation should be considered to mitigate this risk.

# 5 Prevent rail traffic from derailing

## 5.1 Unique identification of points and other movable infrastructure

### 5.1.1 Principle

Each point end or other movable infrastructure shall be uniquely identified.

### 5.1.2 Rationale

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

### 5.1.3 Guidance

Point ends include –

(a) sets of points;

(b) switchable V crossings; and

(c) switchable K crossings.

Other movable infrastructure includes –

(a) derailers;

(b) crowders;

(c) security gates;

(d) lift bridges; and

(e) swing bridges.

Multiple point ends or other movable infrastructure may, for convenience, be grouped into a single interlocking function.

The identifier may consist of, for instance, a station abbreviation, an interlocking function number and a point or other movable infrastructure end letter.

Where rail networks controlled by other RTOs are adjacent, the identifier should be unique to the two networks.

## 5.2 Identification of position of points and other movable infrastructure

### 5.2.1 Principle

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

### 5.2.2 Rationale

Rail safety workers (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.

### 5.2.3 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.

## 5.3 Preventing rail traffic from passing over points or other movable infrastructure

### 5.3.1 Principle

Limits of movement authority shall be provided that can prevent rail traffic from passing over points or other movable infrastructure.

### 5.3.2 Rationale

Rail traffic needs to be prevented from passing over points or other movable infrastructure when it is not safe to do so – e.g. whilstpoints are changing position.

### 5.3.3 Guidance

On unidirectional lines, no limit of movement authority needs to be provided to prevent 'wrong direction' rail traffic from passing over the points or other movable infrastructure.

Where points or other movable infrastructure are operated locally, e.g. 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 tobe provided for trains approaching the points from the siding.

For interlocked points, the limits of movement authority should be absolute.

## 5.4 Authorizing rail traffic to pass over points or other movable infrastructure

### 5.4.1 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; and

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

(c) facing point locked in the correct position for the movement; and

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

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

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

(g) not in manual mode.

### 5.4.2 Rationale

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

### 5.4.3 Guidance

Points may be controlled indirectly, via a ground frame / control panel that is released by the interlocking. Proof that the points are set and locked may 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 may 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 overlaps are provided, additional points may need to be set, locked, facing point locked, detected and/or not in manual mode – refer to Appendix B.

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

## 5.5 Communicating the permitted speed

### 5.5.1 Principle

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

### 5.5.2 Rationale

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

### 5.5.3 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 may include speed board information.

The permitted speed information may need to be communicated at the signal protecting the points and also at the previous signal, to allow sufficient distance to reduce to the permitted speed.

## 5.6 Mitigations for over speeding rail traffic

### 5.6.1 Principle

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

### 5.6.2 Rationale

Rail traffic may 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.

### 5.6.3 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 the signal protecting the points or other movable infrastructure - refer to Appendix C;

(c) reactive enforcement systems – refer to **Error! Reference source not found.**; and

(d) predictive enforcement systems– refer to Appendix C.

## 5.7 Maintaining the route over points or other movable infrastructure

### 5.7.1 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.

### 5.7.2 Rationale

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

### 5.7.3 Guidance

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

Where overlaps are provided, additional points may need to be locked – refer to Appendix B.

## 5.8 Dead locking the points or other movable infrastructure

### 5.8.1 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.

### 5.8.2 Rationale

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

### 5.8.3 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) may 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 circuit or circuits immediately over the points. The limits of this track circuit or circuits over the points should extend at least as far as the clearance point.

If the track layout and train movements permit, then the track locking should be extended as far as each signal which reads over the point either in the normal or reverse position.

If the track layout and train movement do not permit the track locking to be extended then route holding should be provided.

# 6 Prevent rail traffic from colliding with road users or vehicles at railway crossings

## 6.1 Unique identification of railway crossings

### 6.1.1 Principle

Each railway crossing shall be uniquely identified.

### 6.1.2 Rationale

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

### 6.1.3 Guidance

The identifier may consist of, for instance, a road name, a town or suburb name and a kilometreage.

Where rail networks controlled by other RTOs are adjacent–

(a) all of the adjacent rail networks should use the same identifier for the same railway crossing; and

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

## 6.2 Road user stopping sight distance

### 6.2.1 Principle

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

### 6.2.2 Rationale

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

### 6.2.3 Guidance

The road designer is responsible for determining the sufficient warning distance.

Guidance on active advance warning lights is given in AS 1742.7.

## 6.3 Upstream traffic lights

### 6.3.1 Principle

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

### 6.3.2 Rationale

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

### 6.3.3 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 needs to 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.

## 6.4 Warn road users before lowering booms or closing gates

### 6.4.1 Principle

An active control level crossing shall not obstruct the road, footpath or shared path until road users that are not reasonably able to stop before entering the level crossing have passed the obstruction.

### 6.4.2 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.

### 6.4.3 Guidance

The required warning time for level crossings should take into account–

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

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

(c) the gradient of the road; and

(d) 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.

## 6.5 Speed of lowering booms or closing gates

### 6.5.1 Principle

When an active control level crossing obstructs a road, footpath or shared path, it shall do so in a safe manner.

### 6.5.2 Rationale

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

### 6.5.3 Guidance

Nil.

## 6.6 Clearance time for road users

### 6.6.1 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.

### 6.6.2 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.

### 6.6.3 Guidance

The required warning time for level crossings should take into account–

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

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

(c) the gradient of the road; and

(d) the distance from the stop line to being safely clear of rail traffic on the other side of the railway.

The required warning time for pedestrian crossings should take into account–

(a) walking or travel speed; and

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

## 6.7 Downstream traffic lights

### 6.7.1 Principle

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

### 6.7.2 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 may be trapped on the level crossing.

### 6.7.3 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 needs to 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 traffic light phase.

## 6.8 Clearance time for rail traffic crew

### 6.8.1 Principle

An active control level crossing shall provide sufficient warning so that rail traffic authorized to pass over the level crossing will not brake on account of road users that have not yet cleared the level crossing.

### 6.8.2 Rationale

If rail traffic is approaching the level crossing and, if it continues at its authorized speed, it will enter the level crossing just as the last road user clears the level crossing, this will–

(a) cause the rail traffic crew to unnecessarily apply the brakes; or

(b) cause stress to both the rail traffic crew and the road user.

### 6.8.3 Guidance

A safety margin should be added to the level crossing warning time.

## 6.9 Excessive warning time

### 6.9.1 Principle

An active control level crossing shall not provide excessive warning before rail traffic enters the level crossing.

### 6.9.2 Rationale

If excessive warning is provided 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– stopping trains and express trains;

(c) rail traffic with widely differing permitted speeds– e.g. 160 km/h passenger trains and 80 km/h freight trains; and

(d) rail traffic with widely differing authorized speeds– e.g. 115 km/h through trains and 40 km/h trains departing a nearby yard.

### 6.9.3 Guidance

Where rail traffic is within the approach to the level crossing, but has not been authorised to pass over the level crossing, that rail traffic should not activate the level crossing except as per Clause 6.11.

Many scenarios exist; for further information refer to AS 7658.

## 6.10 Minimum warning time

### 6.10.1 Principle

Setting authority to pass and clearance of a signal or other device shall ensure the appropriate minimum warning time is achieved.

### 6.10.2 Rationale

If the rail traffic is subsequently to be authorised to pass over the level crossing, if 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.

### 6.10.3 Guidance

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 authorised to pass over the level crossing.

## 6.11 Protection of road users against rail vehicle SPAD

### 6.11.1 Principle

When a level crossing within the overlap of a signal is conditioned, then protection against a SPAD causing level crossing short warning time shall be implemented.

#### 6.11.2 Rationale

Protection for road users to be provided for a rail vehicle entering the level crossing without a movement authority

#### 6.11.3 Guidance

If a train is approaching the signal at red, the crossing will activate for a period of time until the train is proved to a stop.

### 6.12 Another train coming

#### 6.12.1 Principle

Once the rail traffic has passed completely over the active control level crossing–

(a) if other rail traffic has been authorised to pass over the level crossing and that rail traffic would cause the level crossing to activate again before the level crossing has been open to road traffic for a sufficient time, the level crossing shall remain activated;

(b) otherwise, the level crossing shall deactivate.

#### 6.12.2 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.

#### 6.12.3 Guidance

There may be two trains approaching a level crossing. It is required to have a minimum time when the boom gates have lifted before they operate for the second train. A Holding track is used to extend the approach activation for the second train to include this additional time.

Pedestrian crossings may use an illuminated 'another train coming' sign to minimise the risk of pedestrians entering the pedestrian crossing when it is not safe to do so.

## 7 Prevent rail traffic from being incompatible with the infrastructure

### 7.1 Track gauge

#### 7.1.1 Principle

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

### 7.1.2 Rationale

A dual gauge line may 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.

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.

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.

### 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 (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 before it impedes the progress of the rail traffic.

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 may be lost, for instance owing to train detection failures or power failures. Where the network rules and procedures allow, gauge interpose controls may 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–

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

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

(c) 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.

Additional means of mitigating the risk of rail traffic entering a line where it is not compatible with the track gauge include–

(d) signage;

(e) reactive enforcement systems – refer to Appendix A; and

(f) predictive enforcement systems – refer to Appendix C.

## 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 may cause damage to the rolling stock (e.g. the pantograph) and the electrical supply system (e.g. the overhead contact wire).

The electrical supply system for a line may 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 may be inadequate for electric freight trains.

Steam trains and/or diesel trains may 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

Means 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) reactive enforcement systems – refer to **Error! Reference source not found.**;

(f) predictive enforcement systems – refer to Appendix C; and

(g) functionality within the train control system, 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.

## 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 rolling stock outline;

(b) permitted rolling stock 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 rolling stock outline exceeds the permissible rolling stock outline, damage to the rolling stock and/or the infrastructure may occur.

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

If rail traffic with passengers on-board is routed onto a freight-only line, operational delays may occur. Also, the level of safety of the line, whilst appropriate for freight trains, may 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

Means 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) reactive enforcement systems – refer to **Error! Reference source not found.**;

(f) predictive enforcement systems – refer to Appendix C;

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

(h) functionality within the train control system, 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 setting.

# 8 Prevent 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 may 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 may require the network control officer to apply blocking facilities to prevent unauthorised rail traffic from entering the worksite.

### 8.1.3 Guidance

The signalling system may 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, e.g. 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 may–

(a) prevent the blocking facility from being applied; or

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

(c) 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 may require that–

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

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

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

The behaviour of interlocked points and other movable infrastructure when the related track or track section blocking facility is applied should be compatible with the network rules and procedures. For instance, if the blocking facility is applied to the track or track section containing the interlocked points or other movable infrastructure, the signalling system may–

(a) allow the interlocked points or other movable infrastructure to change position (unless prevented from changing position by another condition); or

(b) prevent the interlocked points or other movable infrastructure from changing position.

Blocking facilities should be resistant to inadvertent removal. For instance, this may be achieved by–

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

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

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

(d) codes that are generated by the signalling system when the blocking facility is applied and need to be entered into the signalling system to remove the blocking facility.

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–

(a) 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;

(b) 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;

(c) 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.);

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

(e) 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 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–

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

(b) approach tracks and track sections (i.e. before the first controlled signal) from un signalled running lines; or

(c) berth tracks for siding exit signals.

## 8.2 Lockout facilities

### 8.2.1 Principle

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

### 8.2.2 Rationale

Work on track may 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 may require the protection officer to apply lockout facilities to prevent unauthorised rail traffic from entering the worksite.

Work on track authorities and other methods of working in the danger zone may require protection (e.g. hand-signallers) to be provided. The network rules and procedures may 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 required to work on the outside of rolling stock require protection against the rolling stock being moved. Lockout facilities may be provided for this purpose.

### 8.2.3 Guidance

The signalling system may 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 requested);

(b) 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 requested);

(c) 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 requested to the opposite position); and

(d) 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).

The behaviour of the lockout 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 lockout facility (signal, route from the signal or track) is requested to be applied, the signalling system may–

(a) prevent the lockout facility from being applied; or

(b) allow the lockout facility to be applied, but withdraw the movement authority; or

(c) allow the lockout 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 lockout facility applied should be compatible with the network rules and procedures. For instance, to request a route may require that–

(a) tracks foul of the route do not have their lockout facility applied; and/or

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

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

# 9 Safety in design

## 9.1 Reliability, availability and maintainability

### 9.1.1 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.

### 9.1.2 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.

### 9.1.3 Guidance

Guidance on reliability, availability and maintainability is given in EN 50126.

## 9.2 Degraded mode facilities

### 9.2.1 Principle

Degraded mode facilities may be provided.

### 9.2.2 Rationale

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

### 9.2.3 Guidance

Transitions to degraded modes of operation should be handled in a way that minimises risk, and may 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 may be provided with a manual points control mechanism.

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

Points should allow switch rails to be manually secured to the stock rail – e.g. by using a point clip.

Where the network rules and procedures allow, shunting movement authorities may 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.

### 9.3 Network rules and procedures

#### 9.3.1 Principle

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

#### 9.3.2 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 safeworking system. The compatibility and completeness of these elements of the safeworking system is essential for the safe operation of the railway under normal, degraded and emergency conditions.

#### 9.3.3 Guidance

Nil.

### 9.4 Human factors

#### 9.4.1 Principle

The human factors associated with the safe use/operation of the signalling system shall be taken into account in the specification and design of the signalling system.

#### 9.4.2 Rationale

Even though the signalling system may 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.

#### 9.4.3 Guidance

Nil.

### 9.5 Failure of train detection

#### 9.5.1 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 traffic.

#### 9.5.2 Rationale

A failure of train detection to detect the presence of rolling stock 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 railway crossing when it is not safe to do so.

A failure of train detection to detect the absence of rolling stock could allow-

(a) approach locking to release when it is not safe to do so – refer to Clause <the approach locking clause that I still need to write for Section 3>;

(b) route locking to release when it is not safe to do so – refer to Clause <the TORR clause in Section 10>; or

(c) railway crossing direction sticks to remain engaged when it is not safe to do so – refer to Clause 9.10.

### 9.5.3 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 7715.

Momentary failures of train detection to detect the presence of rolling stock may be mitigated by:

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

(b) 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];

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

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

   i. the rail traffic has been proved to clear the railway crossing by sequential operation of track sections; or

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

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

(f) 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 possible, 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) 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

(b) 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).

## 9.6 Failure of interlocking functions

### 9.6.1 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 traffic.

### 9.6.2 Rationale

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

(a) collide with other rolling stock;

(b) derail;

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

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

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

### 9.6.3 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 – e.g. the 'locked' state, rather than the 'released' state.

Failures and faults of interlocking functions should, so far as possible, 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 may cause a change to an indication displayed to the network control officer via the control panel – e.g. extinguishes a points free indication.

## 9.7 Failure of points or other movable infrastructure

### 9.7.1 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 traffic.

### 9.7.2 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.

### 9.7.3 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 possible, 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 may cause a change to an indication displayed to the network control officer via the control panel – e.g. extinguishes a points detection indication.

Further guidance is given in AS 7706.

## 9.8 Failure of signals

### 9.8.1 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 traffic.

### 9.8.2 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 rolling stock;

(b) derail;

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

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

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

### 9.8.3 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); or

(b) the aspect of the preceding signal should be restricted.

The restriction on the preceding signal may be-

(a) most restrictive aspect only; or

(b) shunting movement authorities only; or

(c) 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-

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

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

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

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

(b) 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-

(a) 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);

(b) the use of predictive enforcement systems; and

(c) 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 possible, 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) 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

(b) 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).

## 9.9 Failure of railway crossings

### 9.9.1 Recommendation

In the event of a failure of an active control railway crossing, the signalling system shall remain in, or revert to, a state which preserves the safety of rail traffic, road users and vehicles.

### 9.9.2 Rationale

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

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

### 9.9.3 Guidance

Active control railway crossings are not inherently fail safe, as the indication to the road user that it is safe to enter the railway 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 railway crossing, it should remain in, or revert to, the activated state. Further guidance is given in AS 7715.

For bidirectional approaches to active control railway crossings, direction sticks may be used to prevent the railway crossing from remaining activated after the rail traffic has passed across the railway 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 railway crossing approach. If rail traffic were to then approach the railway crossing from that direction, with the direction stick still effective, it would not activate the railway crossing at the correct time and could enter the railway crossing before it is safe to do so. To prevent this-

(a) where a railway crossing uses direction sticks, unless rail traffic may 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 railway crossing should reactivate and remain activated until the direction stick track sections clear; and

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

Failures and faults of active control railway crossings should, so far as possible, 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.

## 9.10 Current taking an unintended path

### 9.10.1 Principle

Circuits shall prevent feedback from current taking an unintended path.

### 9.10.2 Rationale

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

Unintended paths could be caused by-

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

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

(c) breakdown of insulation between circuit conductors; or

(d) 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.

### 9.10.3 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-energised.

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 energise when it is not safe to do so by-

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

(b) separate power supplies for certain groups of circuits; and

(c) earth fault monitoring on vulnerable power supply busbars.

The following should be double cut, except where covered by items (a) to (j) below:

(a) all safety-critical line circuits in their entirety;

(b) all safety-critical trackside circuits in their entirety (including external loop inputs to electronic devices and their external outputs); and

(c) 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, e.g. 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:

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

(b) back contacts used solely for down proving;

(c) back contacts used solely for cross proving;

(d) contacts used solely for correspondence proving;

(e) contacts used solely to economise power consumption;

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

(g) signal lighting circuits, unless reasonably practicable;

(h) internal circuits on a dedicated power supply;

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

(j) 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 may be treated as internal, provided that measures are taken to sufficiently reduce the risk of earth faults, e.g. 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.

## 9.11 Transient conditions

### 9.11.1 Principle

All transient conditions shall be taken into account..

### 9.11.2 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.

### 9.11.3 Guidance

Transient conditions should be considered for all signalling logic.

For processor based systems, the following should also be considered:

(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-

(a) irregular behaviour of signals;

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

(c) spurious alarms to be generated within the train control system.

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

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

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

This is commonly known as ‘Tollerton control’.

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:

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

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

(c) 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. Examples of sequence proving are:

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

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

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

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

(e) 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.

(f) The proving of bridge path removal in the aspect level.

## 9.12 Proving

### 9.12.1 Principle

For safety-critical functions, the residual risk of a fail-safe item of equipment failing in an unexpected mode shall be mitigated so far as is reasonably practicable.

### 9.12.2 Rationale

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

(a) collide with other rolling stock;

(b) derail;

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

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

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

### 9.12.3 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 (i.e. cross proving – refer to Clause 9.12); and

(f) to verify that certain safety-critical events have occurred in the correct sequence (i.e. sequence proving – refer to Clause 9.12).

Proving may 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:

(a) Magnetic stick or latched relays should be proved down to confirm correct operation, unless other precautions are taken to prevent hazardous failures.

(b) 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 may be necessary to have both banks of contacts proved down together.

(c) Timer relays used for safety-critical controls should generally be proved down to confirm correct operation.

(d) 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.

(e) Cross proving – refer to Clause 9.12.

(f) Sequence proving – refer to Clause 9.12.

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 polarised circuits and for point detection circuits.

## 9.13 Repeat functions

### 9.13.1 Principle

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

### 9.13.2 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 – e.g. 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.

### 9.13.3 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 may be provided fed 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; or

(d) to economise 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:

(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; or

(c) 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 energise would be apparent to the network control officer.

## 9.14 Repeat relays

### 9.14.1 Principle

Repeat relays shall be used to duplicate the function of, and provide additional capacity to the primary relay.

### 9.14.2 Rationale

Repeat relays are used for four basic purposes:

(a) To delay the response of the primary function relay.

(b) To provide electrical isolation.

(c) To overcome limitations on circuit length.

(d) To provide additional contacts when it is impracticable to directly control all circuits by the primary function relay.

A single repeat relay may provide any or all of the first three functions, but a repeat relay provided to supply additional contacts will not generally perform any other purpose.

### 9.14.3 Guidance

To avoid momentary loss of train detection to the interlocking, or to the signaller, when a vehicle moves from one track circuit to another, some types of track circuit require one or more slow to operate repeat relays.

Electrical isolation between certain trackside equipment and the interlocking environment is desirable.

The physical length of line circuits is limited by consideration of voltage drop within the circuit and also the external effect of electromagnetic interference with other circuits, necessitating line circuits to be terminated within the length limit and intermediate repeater circuits created.

Related outgoing and incoming polarized circuits should, wherever practicable, be repeated at a common lineside location. Correspondence proving should then be provided between the associated circuits in order to protect against an untoward change in the polarity of the power supply. This protection is particularly relevant to point circuits as an incorrect polarity can convert an outgoing normal control into reverse and also convert the associated reverse detection back to the expected normal. The repeater location circuits should therefore confirm that the incoming detection matches the outgoing control.

Back contacts should not be used for control purposes except on primary function relays. Back contacts of repeat relays give no positive information.

A relay may be required to hold up while its feed changes over from one path to another. The relay required to hold up should be slow to release.

Where required, up to three repeat relays may be provided in parallel, so long as all the front contact repeat relays are cross proved in all the back-contact repeats (if any), and vice versa.

Where repeat relays are provided, consideration should be taken to avoid the risk of hazardous situations as a result of repeat relays failing to energise when the primary relay is energised.

## 9.15 Safety in design for railway crossings

### 9.15.1 Principle

Consideration should be given when designing railway crossings to including aids to maintenance/failure investigation.

### 9.15.2 Rationale

The ability to be able to diagnose failure modes and specific failure points on railway crossing systems will enable faults to be rectified quickly, thus reducing road closure time for road traffic and increasing railway availability.

### 9.15.3 Guidance

Typical additional functionality at railway crossings could include–

(a) test switches to function railway crossing lights & booms;

(b) healthy state indications, both locally or remotely displayed;

(c) excessive railway crossing operating time alarms – locally and remotely;

(d) comprehensive level crossing monitors at control centers; and

(e) data logging to log and identify failure and incident scenarios and failure trends.

## 9.16 Interactions with other railway systems and equipment

### 9.16.1 Principle

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

### 9.16.2 Rationale

The signalling system interfaces directly and indirectly with several other systems and equipment – i.e. other railway infrastructure and rolling stock.

### 9.16.3 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.

## 9.17 Resilient to external influences

### 9.17.1 Principle

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

### 9.17.2 Rationale

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

### 9.17.3 Guidance

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

## 9.18 Maintenance and modification

### 9.18.1 Principle

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

### 9.18.2 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

### 9.18.3 Guidance

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

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 may have implications for the design of equipment and its physical location.

# 10 Efficiency

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 signaller's workload.

## 10.1 One movement authority

### 10.1.1 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.

### 10.1.2 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.

### 10.1.3 Guidance

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.

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 may 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 a controlled signal (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.

## 10.2 Automatic Signals

### 10.2.1 Principle

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

### 10.2.2 Rationale

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

### 10.2.3 Guidance

Where there are no opposing or conflicting routes, and no interlocking with movable infrastructure is required, signals may 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.

Generally, no rail traffic may pass an automatic signal without permission from the network control officer. Where the network rules and procedures allow, certain automatic signals may be designated as allowing permissive moves, and allow that signal to be passed at danger at reduced speed, with the rail traffic crew prepared to stop short of any obstruction, providing that the train stops at the signal and waits for a period, usually ‘section time’, before proceeding past the stop signal.

## 10.3 Route Stacking/storage

### 10.3.1 Principle

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

### 10.3.2 Rationale

The network control officer may 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.

### 10.3.3 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 rolling stock 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 prevent a train from being routed to the wrong destination due to setting of an out-of-sequence route.

Routes that contain swinging overlaps may not be suitable for route storage, as operational delays may 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.

## 10.4 Automatic route setting

### 10.4.1 Principle

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

### 10.4.2 Rationale

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

### 10.4.3 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 to 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.

## 10.5 Train operation route release

### 10.5.1 Principle

Train Operated Route Release (TORR) may be provided in route setting control centres.

### 10.5.2 Rationale

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

### 10.5.3 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 may 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.

Additional Requirements for Running Movements: One additional sequence of train detection (TISP – Train in Section Proving) or condition (over and above that required for release of approach locking) should be satisfied to initiate the release of the route if:

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

(b) 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

(c) 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:

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

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

(c) 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

(d) 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 may come to a stand at the next signal without completing the TORR sequence, a sequence may 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 may 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.

## 10.6 Opposing locking omitted

### 10.6.1 Principle

Locking between opposing shunt signals reading over sets of points may be omitted to allow signals for both directions to be clear at the same time, and so enable repeated forwards and backwards shunting movements.

### 10.6.2 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.

### 10.6.3 Guidance

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 shall apply:

(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.

There may be a requirement for rail traffic crew performing the shunting moves to normalise a local device (for instance, replace a ‘shunters key’, detected by the interlocking) to prove that shunting has been completed.

## 10.7 Preset of shunt signals

### 10.7.1 Principle

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

### 10.7.2 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.

### 10.7.3 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 preset to a proceed aspect.  Where it is not possible to preset all the facing shunt signals, a shunting movement authority is used to enter the section of track.

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

## 10.8 Oversetting

### 10.8.1 Principle

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

### 10.8.2 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.

### 10.8.3 Guidance

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

# Appendix A Hazard Register

| Hazard Number | Hazard | Applicable section |
|---|---|---|
| 1 | Unsafe issue of movement authorities. | 3 |
| 2 | Rail traffic colliding with other rail traffic. | 4 |
| 3 | Rail traffic derailing. | 5 |
| 4 | Rail traffic colliding with road users at road crossings. | 6 |
| 5 | Rail traffic not being compatible with the infrastructure. | 7 |
| 6 | Rail traffic colliding with rail safety workers or equipment in the rail corridor. | 8 |
| 7 | Prevent degraded mode from causing harm to persons, rolling stock or infrastructure | 9 |
| 8 | Ensure signalling system is safe while being commercially viable | 10 |
| | | |
| | | |
| | | |

# Appendix B Overlaps

Rail traffic which exceeds its movement authority shall be prevented from colliding with other rolling stock or derailing so far as is reasonably practical.

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Rail traffic which exceeds its movement authority may 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.

Note. A common convention is that the overlap belongs to the signal that had the movement authority and is named after this signal/route and not to the stop signal. Thus, the overlap limit is also the clearance point for this signal.

## B.1 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 may 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.

Comment - If an overlap is Prescribed then it is not calculated.

A Prescribed or nominal overlap should be safety assessed. It may vary for the reasons detailed below. Train SPAD and Collision statistics may be used to determine that the Prescribed 'overlap' provides safe operation.

Factors which influence the predetermination of the clearing point may 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.

## B.2 Overlap distances

How the overlap distance is to be determined and any minimum distance required shall be recorded as part of the design standards or requirements documents for the railway.

A record shall 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 may be reduced, this distance should be determined and recorded in accordance with the design processes and practices of the railway.

Special arrangements may be made for overlaps on lines fitted with enforcement such as train stops or equivalent. The RTO should determine special
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 may 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.

### B.2.1 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.

### B.2.2 Train approaches through a turnout

Where a train approaches a signal at stop through a turnout, the overlap may be determined based upon the turnout speed (i.e. effectively the line speed for that approach).

### B.2.3 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, may be used.

### B.2.4 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.

## B.3 Overlap distance single lines

### B.3.1 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.

### B.3.2 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.

### B.3.3 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.

## B.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 may 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.

## B.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 normalised 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 normalised and free of approach locking.

## B.6 Point setting & locking within overlaps

### B.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 normalised 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.

### B.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 normalised 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.

### B.6.3 Facing points providing flank protection

If a set of facing points which provides flank 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 normalised 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 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 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 may 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.

## B.7 Preferential setting of points in the overlap

Preferential setting of facing points in an overlap is 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 may 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 trailingpoints 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.

## B.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 may 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 may set and lock the facing points in the direction of the available overlap.

These arrangements may 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.

### B.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 may 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.

### B.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 may 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 C Route locking

## C.1 General locking between route and overlap

If a route from a signal conflicts with another route on the same signal or leads over one or more sets of points or ground frames or reads up to one or more opposing signals (routes) then it should –

(a) lock normal any conflicting routes leading away from the same signal.

(b) lock normal any opposing signal routes which lead into the route or its overlap.

(c) lock normal or reverse as required any sets of points in line with the direction of the route together with any points providing trap or flank protection to the route or its overlap.

(d) lock any ground frames normal in the route or its overlap.

(e) lock any trailing points in its overlap in the appropriate direction for which the overlap is set.

Alternatively, there may be situations (particularly in yards) where trailing points or catch points in the overlap are not aligned with the route to reduce the impact of points failure, or provide flank protection. In this case, all conflicting signals should require to be locked.

Lock normal or reverse any facing points in its overlap only if other locking conditions within or leading into the overlap make this necessary.

Converse locking should always be applied except in special cases.

The overlap should be the overlap applicable to normal speed movements, and not conditional low speed overlaps, unless there is a speed supervision system which enforces the movement to keep below the specified restricted speed. In other words, the overlap distance for locking is the overlap distance applicable to the highest signal indication which can be displayed when the next signal is at stop, generally the “caution” signal indication.

## C.2 Flank protection

Flank protection is the setting of points (often not directly within the route) to protect the signalled movement whether or not other routes are set.

## C.3 Holding of locking between opposing routes

If opposing routes are situated such that the occupation of an intervening track circuit is insufficient to maintain the aspects of opposing signals at stop, then this should be enforced by the provision of route holding between the signals concerned.

This should be required between main and main signals and between main and shunt signals. Route holding between opposing main and shunt routes may be necessary even where there is no direct locking between the signals.

Generally, no route holding is applied between shunt and shunt signals, however, in special circumstances, such as where the shunt signals are widely spaced, the route holding may be applied.

### C.4 Holding of route to point locking

If a set of points is located within the route section or overlap of a signal then the points should be route held by the occupation of any one of the intervening track circuits within the signal route section between the signal and the set of points concerned (except for points in the overlap of home signals entering single line crossing loops without outer homes).

Releasing of route holding of points within the route should not be permitted, except for points locally operated via a releasing switch.

Generally, no route holding is applied between shunt signals and points operated by ground frames however, in special circumstances, such as where the shunt signal and the ground frame points are widely spaced apart, the route holding may be applied.

# Appendix D Enforcement systems

## D.1 General

The following appendix describes enforcement systems used in Australia and how they are implemented in their respective signalling system. The application of the enforcement systems have been derived in order to meet the requirements of the signalling principles defined in the main body of the Signalling Principles standard.

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 appendix looks at the specific application of the enforcement system but does not include the application for any associated approach release of signal aspects as part of the overall enforcement system architecture.

## D.2 Introduction

The objective of signal enforcement is to prevent a collision or derailment event. Enforcement systems will be activated when the train makes an unauthorized movement, i.e. passing a signal at stop, or breaches any speed supervision.

The signal enforcement system has two components – 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 upon the train exceeding its signalled authority. The signal enforcement function is achieved through a combination of signal aspects and trackside components and in some cases track occupancy conditions.

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, may include:

a) maintain 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) permit the issue of a proceed authority only when the route is aligned and clear of obstruction

c) Provide 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 commercial requirements

e) be reliable

f) 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.

## D.3 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. Should a driver fail 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.

### D.3.1 Control & operation of AWS

Both the green aspect and the signal lit shall be proved in the operation of the AWS electromagnet.

Where a main signal which is capable of displaying a green aspect, a permanent magnet and an electromagnet shall be provided on the approach to the signal. The electromagnet shall be energised only when the signal is displaying a green aspect.

A suppressed permanent magnet shall 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.

Suppressed permanent magnets shall be energised for traffic using a route which does not lead to a signal associated with the suppressed permanent magnet. The suppression function shall be energised when any route is set, applying into the track containing the suppressed permanent magnet and does not lead to a signal for which the suppressed permanent magnet is provided. The suppression function shall remain in the energised state when the entry signal is placed at stop by the passage of a train and shall be maintained in that state by the sequential occupation of the tracks between the signal and the suppressed permanent magnet, including the track containing the magnet.

Once a suppression function has been initiated it shall be maintained in the suppressed state whilst the route holding function for the track containing the suppressed permanent magnet remains in the route used state. Where a suppressed permanent magnet is located in a track for which timed out route holding is required for other purposes, the suppression shall be maintained whilst the time released route holding is in the route used state. Where the signal to which a suppressed permanent magnet applies can be cleared behind a train holding that magnet suppressed, the suppression function shall be cancelled when the signal clears.

To prevent spurious operation of the automatic pantograph control (APC) receiver on vehicles equipped with electric traction when passing close to but not over AWS equipment the following equipment and controls shall be provided:

(a) Where a permanent magnet must be located where it could spuriously operate the APC receiver a suppressed permanent magnet shall be provided. The suppressed permanent magnet shall be energised when any route is used which traverses the running rail but does not traverse the AWS equipment.

(b) Where an electromagnet must be located where it could spuriously operate the APC receiver, it shall not be energised unless a route which traverses the AWS equipment is being used.

## D.4 Trainstop Systems

As a means to reduce the consequence of a SPAD and to ensure that a train sufficiently comes to rest within an overlap, trainstops 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.

All main line stop aspects shall be enforced through a trainstop co-located with the signal.

Trainstops should be located at running signals capable of displaying a stop aspect on lines where rolling stock fitted with trainstop trip gear operate.

Shunt signals may be provided with a trainstop where a risk assessment has identified a hazard that may be mitigated or reduced through the provision of a trainstop.

At end of electrified areas, a permanently raised trainstop shall be installed.

Trainstops shall be required on tracks on which trains may be authorised to leave the electrified area. The trainstop shall be:

(a) Permanently raised.

(b) Detected as raised and failures alarmed and indicated on the signalling panel.

(c) Installed in line with the “End of Electrification” sign.

### D.4.1 Control & operation of trainstops

If a signal is displaying a stop aspect, then the trip arm of the trainstop shall be in the raised position. If the signals displays a proceed aspect, then the trip arm shall be in the lowered position.

Rising of the trip arm shall occur after occupancy of the first track circuit in advance of the signal.

A trainstop shall be 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. Trainstops should not be lowered for shunt routes into occupied sections of track, unless specifically requested by the Operational RIM.

At locations where reduced overlaps are provided and a full/normal overlap is not available, the trip arm of the trainstop shall be lowered after the signal has cleared to low speed and the approach of the train has been timed on the berth track circuit. Additional trainstops shall be provided for speed proving/checking on the approach.

The trainstop shall be driven down when the signal is at proceed and continuously proven down in the signals control and proceed aspects. Higher aspects of signals are to proe that the trainstop at the signal in advance is reverse.

If a particular signal is to display a stop aspect but the trip arm on the trainstop associated with the signal fails to go normal after the passage of a train, then any running signals immediately in rear shall be maintained at stop until enabled to re-clear by the particular running signal re-clearing.

Trainstops shall be proved to be in the raised position in all signal normal indications. When required to be suppressed for opposite direction movements to avoid back tripping, this proving may be temporarily qualified. The qualification shall be removed and the trainstop raised as soon as practicable.

If a signal is displaying a proceed aspect that requires the trainstop to reverse and the trip arm of the trainstop fails to lower, then the signal shall display a stop aspect.

The normal and reverse positions of the trainstop shall be proved in the signal normal indicating relay and signal reverse repeaters respectively.

Higher aspects of signals are to prove that the trainstop at the signal in advance is reverse.

Shunt signals are not to prove the trainstop lowered (reverse). The reverse signal repeater shall prove the signal reverse only; however, the normal repeater and signal normal indicating relay shall prove the trainstop normal.

Suppressed trainstops shall not be proved reverse when cleared for train movements in the other direction, however shall be proved in higher aspects.

Trainstop should be proved to be down for running low speed moves; however, the trainstop is not required to be proved to be down for low-speed aspects where the train is already proved at rest.

Direction control for a single line section shall not prove state of trainstops associated with automatic signals.

Approach locking (if applicable) should retain ability to time-release even in the event of a trainstop cycling failure.

Trainstop failure shall be indicated to the traffic management system, either as an independent indication or combined through signal indication.

If a trainstop associated with a running signal is located in a situation where train movements from other running signals or subsidiary signals or shunt signals pass over it in the opposite direction of running, then the trainstop shall be suppressed (lowered) for the opposite direction movement.

If an opposing direction signal displays a proceed aspect then the trip arm of the trainstop to be suppressed shall be lowered and maintained lowered by the occupation of any of the track circuits between the initiating opposing direction signal and the suppressed trainstop.

The trip arm of the suppressed trainstop shall rise when the opposing direction train movement has cleared all these controlling track circuits.

If the trip arm of the suppressed trainstop fails to rise after the opposite direction movement is clear then the running signal with which it is associated shall be maintained at stop.

Where trainstops are provided at shunt signals in yards, and there is a risk that a driver may observe a suppressed trainstop and mistake it for authority to proceed, trainstop suppression shall not be provided.

Where there is a risk of a SPAD, the consequence of the SPAD shall be reduced SFAIRP by the means of providing trainstops at defined ends of authority.

### D.4.2 Speed checking/proving

Where it is necessary to provide running low speed and conditional aspects with reduced overlaps then one or more intermediate trainstops may be provided to check the speed of a train as it approaches the reduced overlap.

Intermediate trainstops (or timed trainstops) shall be provided on the approach to an end of authority for operational reasons and where a reduced or no overlap exists.

If a running signal route is set with a minimal overlap available, then the running signal shall display a conditional low speed aspect and the trainstop associated with the running signal and the intermediate trainstop shall remain raised.

As the train approaches the intermediate trainstop, its speed shall be determined during a time expiry period. If the average speed of the approaching train is in excess of the designated low speed, then it will engage the raised trip arm of the intermediate trainstop and be subject to a brake application.

If the speed of the approaching train is satisfactory, then the trip arm of the intermediate trainstop shall be lowered allowing the train to continue up to the running signal in advance at low speed.

If it is necessary to close up trains and the overlap conditions improve then the trip arm of the intermediate trainstop provided to facilitate minimal overlap conditions shall be lowered when the improved overlap is available.

The intermediate trainstop shall be proved to return normal, before a signal leading to it that requires it normal, is cleared.

Intermediate trainstops shall be proved reverse before the associated signal displays a proceed aspect that requires the intermediate trainstop reverse.

Where an intermediate trainstop is used for line speed control, and a full overlap is available from the intermediate trainstop for the speed the train is approaching at, the signal in rear of the intermediate trainstop may clear unconditionally (trainstop down) to low performed by the intermediate trainstop.

### D.5 TPWS

A TPWS loop (TSS) shall be co-located at main signals capable of displaying a stop aspect.

OSS loop shall be provided in lieu of any approach release timing, positioned at the warning signal (where medium speed overlaps are implemented). Reduced overlaps are enforced through an OSS device in rear of the stop signal.

Where there is a significant difference between the line speed and the speed of a turnout, the turnout shall be protected by an enforced speed approach in order to mitigate the risk of derailment. The method shall be by an OSS at the junction signal and where required OSS(s) on the approach to the junction signal. The specific difference in speed between turnout speed and line speed and the applicable protection shall be defined by the RIM.

#### D.5.1 Loop placement

The arming loop shall be positioned in rear of the trigger loop.

The distance between an arming loop and trigger loop for an OSS, shall be commensurate to the applicable target speed.

TSS loops located at signals shall be positioned in rear of the signal at a distance to ensure enforcement occurs at the signal. Time delays may be introduced where placement issues exist.

Where both a TSS and OSS has been co-located with a signal, they shall share the same trigger loop.

A TSS shall be located such that when a train starts from a regular stopping location (possibly after a turnback move); it is not positioned in the vicinity of the TPWS trainborne aerial.

### D.5.2 Control & operation

TSS should be disarmed when the signal is at proceed.

TSS should be armed when the signal is at stop.

OSS shall be disarmed when the signal is cleared for a normal speed aspect.

OSS shall be armed when the signal is cleared for a medium speed or low speed aspect, or is the stop aspect.

The speed setting for the OSS applicable to each aspect shall be determined by the RIM.

The allocation of frequencies for arming and trigger loops shall be rationalised and remain unique, but with consideration to avoid unwanted enforcement applications due to closely spaced and overlapping loops using the same frequency.

### D.5.3 OSS placement on the approach to a reduced overlap

A brake application shall be enforced prior to a stop signal for a train approaching at excessive speed such that the train will stop within the provided (reduced) overlap.

The placement of the OSS shall be at EB distance from the authorised speed to the end of the overlap.

The OSS speed value shall be set according to either the maximum authorised speed profile or the operational speed profile (where a train is expected to pull up before a signal at stop. An additional speed margin may be implemented to provide for operational flexibility, as per the direction of the RIM.

Based on trackside calculations, more than one OSS may be required to achieve the adequate approach speed control. In lieu of providing additional OSS's, other infrastructure changes should be considered such as:

(a) Extension of the reduced overlap distance,

(b) Review of the approach control timing to achieve a lower approach speed,

(c) Review of permitted line speeds.

### D.5.4 OSS placement on the approach to a junction

The speed of a train approaching a turnout shall be suitably controlled to mitigate the risk of a derailment.

As defined by the RIM, a target speed for the turnout shall be determined. The target speed shall consider the maximum track designed speed through the turnout, including any tolerances and safety margins. The target speed shall be enforced at the turnout.

For diverging junctions, the target speed reference location is the toe of the turnout; for converging junctions the reference location is the toe of the turnout less a nominal 50m.

Trackside calculations may determine that adequate approach speed control is implemented through the OSS provided for the signal protecting the turnout, and additional OSS loops are not required.

The OSS unit(s) shall be placed and the speed value set to the maximum authorised.

Based on trackside calculations, more than one OSS may be required to achieve the adequate approach speed control. In lieu of providing additional OSS's, other infrastructure changes should be considered such as:

Review and upgrade of the turnout speed,

Relocating the junction signal further from the junction,

Review of the approach control timing to achieve a lower approach speed,

Review of permitted line speeds.

### D.5.5 Proving

Direction control for a single line sections should not prove state of TSS and OSS units associated with automatic signals.

When a TSS or OSS is commanded to an on status but the proving contact remains open, or commanded to an off status and the proving contact remains closed then an alarm shall be generated and indicated on the signalling panel.

OSS shall be continuously proven to be armed in the junction signal's control for medium speed aspects.

OSS' proving contact shall be continuously proven open in the junction signal's control for normal speed aspects.

### D.5.6 TSS proving requirements

For the signal to display a proceed aspect, the proving of the TSS is required as follows:

TSS proving contact should be continuously proven open in the signals control for main arm (normal and medium speed) aspects,

Failure of the TSS should not prevent clearing of a low speed aspect,

The TSS should be proved to be armed for all opposing entrance signals into the same single line section,

The TSS should be proved to be armed in the signal in the rear where specifically requested by the RIM.

After passage of each train signalled with a main arm aspect, the TSS should be proved to have re-armed. That is, signal should not re-clear if the TSS fails to re-arm.

Approach locking (if applicable) shall retain ability to time-release even in the event of a TSS cycling failure.

### D.5.7 OSS proving requirements

For the signal to display a proceed aspect, the proving of the OSS is required as follows:

OSS proving requirements for the signal to display a proceed aspect are as follows:

OSS shall be continuously proven to be armed in the signal's control for medium speed aspects.

OSS' proving contact shall be continuously proven open in the signal's control for normal speed aspects.

Failure of the OSS shall not prevent clearing of a low speed aspect.

Where specifically requested by the RIM, the OSS shall be proved to be armed in the signal in rear.

## D.6 Automatic train protection

### Regional application – Perth transport authority of Western Australia

All PTAWA passenger trains are fitted with Automatic Train Protection (ATP). Drivers drive on sight using their route knowledge and observing trackside signals and signage, and the ATP system enforces track speed and limits of authority.

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.

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.

Trains approaching a signal at STOP are permitted by the ATP to pass the signal at the 'release speed' (generally 40 km/h or where needed, 10 km/h). If the signal is still at STOP, an emergency brake application is applied and the train is stopped within the overlap. Protection against damaged or vandalised transponders is provided using 'linking' principles. A brake application is initiated if the train's ATP system does not find an expected transponder group within a prescribed distance. Incorrect train wheel diameter settings can result in target distance errors, and protection against accumulated odometer errors is provided using update groups in the approach to a restriction or limit of authority to minimise accumulated errors.

### D.6.1 WESTECT ATP

WESTECT is a continuous ATP system that uses radio broadcasts to update the train with changes in signal status. The radio messages are broadcast from trackside equipment.

The system provides a tolerance to interference, where up to 3 messages can be lost with no degradation to system performance.

The train has full information from the trackside for the track ahead and beyond its braking curve. The stopping distance required is based on the actual train performance.

The system provides absolute speed supervision based on signal infrastructure and the aspect signalling type.

The system provides protection against the following key risks:

(a) Passing a signal at stop

(b) Exceeding current track speed limit

(c) Exceeding the trains specific speed capability

(d) Shunting past limits of authority

(e) Train rolling away

### D.6.2 Warning and protection levels

The system provides two levels of warning prior to a brake application (service or emergency). Where a train exceeds its limit of authority, an emergency brake application is activated. The emergency brake is applied based on the assumption that the service brake has failed if the required drop in pipe pressure has occurred. The traction power supply is cut and sand is applied to ensure the train slows as quickly as possible to maintain wheel to rail adhesion with the brakes applied.

## D.7 European Train Control System

### D.7.1 Full supervision

Full supervision mode shall be used for all movement authorities issued in conjunction with a main signal proceed aspect (including caution aspects– yellow and flashing yellow), a medium speed proceed aspect, when a main warning route is set or a green aspect from a shunt signal (where the shunt signal is fitted with ETCS).

### D.7.2 ETCS Levels and level transitions

Areas not fitted with ETCS trackside equipment are classed as ETCS level 0. Areas fitted with ETCS trackside equipment are classed as ETCS level 1 or level 2.

All level transitions shall be pre-announced. Transition borders should be located to ensure there is full braking distance between the transition signal and the next.

Where there is a transition from an area to an area with a lower form of protection, the transition shall be acknowledged by the driver.

### D.7.3 Movement authorities

When a route is set and a signal is cleared for the normal running direction, a movement authority (MA) shall be provided for the block that is longer than the longest braking distance.

For a failed signal aspect, a MA shall be revoked and the ETCS shall enforce a stop aspect.

### D.7.4 Release Speed

For each end of authority for a MA, a release speed (RS) shall be associated. The RS provides a manageable speed at which a train may approach an end of authority before the balise group is reached.

Release speeds should be configured to be as a high as possible to reduce operational constraints following an aspect clearing from stop. Equally, release speeds shall be commensurate to the length of the overlap provided or before any potential point of conflict.

Based on varying overlap lengths and different train types, the majority of release speeds shall be calculated by the on-board equipment. Other exceptions to having an on-board calculated release speed are:

Where trailing points exist in an overlap and the overlap may time out to permit a converging route being set through the trailing end,

(a) Reduced overlaps (approach cleared aspects)

(b) Level crossings in the overlap,

(c) Buffer stops,

(d) Other infrastructure where the release speed may be managed by a fixed speed.

Release speeds are calculated based on the emergency brake parameters, with the brake application applied at the end of authority.

### D.7.5 Danger Points and Overlaps

The danger point is a defined point (distance) in advance of the end of authority before the first possible conflict. Releases speeds shall also consider odometer error in the calculations based on the danger point distance.

Where points exist in an overlap, the danger point shall be defined at a location that permits alternate overlaps to be set or the shortest overlap distance (where multiple overlaps exist). An interlocking is designed to release its locking on the overlap beyond a controlled signal when it has timed the train to a stand on the berth track; this permits other routes to be set.

Where a level crossing is located in an overlap and the signal route approaching the crossing qualifies the crossing activation controls, a danger point shall be defined at the leading edge of the crossing; otherwise the overlap of the signal protecting the crossing shall be defined as the danger point.

### D.7.6 Section timers

Similar to approach locking functionality in an interlocking, where a route can be cancelled and an alternate route set based on certain conditions of the signalling system; ETCS section timers are provided to shorten a movement authority after information has been received by the train.

MA's shall be split into sections where a timer is provided to reduce a MA if the start of a section has not been reached before the timer expiry.

The timer value of the section timer should typically align to the approach locking timer.

### D.7.7 Signals at stop

A fitted train under a MA shall be tripped at a signal at stop unless override has been selected to be able to pass the signal. Where a train is in staff responsible (i.e. under no movement authority) mode, to mitigate a driver passing the signal at stop, 'Stop if in staff responsible' information shall be sent to the train.

### D.7.8 Infill

Where required for operational improvements, Infill balise groups may be provided to refresh a MA on the approach to a signal where the signalling route information has been updated but the on-board MA is still restrictive.

### D.7.9 Buffer stops

The ETCS system shall ensure that the maximum impact speed should a train erroneously be driven into buffer stops will be limited to a speed less than or equal to that of the designed ‘absorption’ speed of the buffer stop.

As the actual distance from the normal stopping point to the buffer stops is likely to be less than the ETCS odometer error safety margin, it is necessary to introduce a danger point beyond the buffer stop. This shall be configured at a distance past the normal stopping point before the buffer stop to avoid the train entering release speed supervision until very close to the buffer stop for optimum performance.

### D.7.10 Train suitability

Where applicable, the ETCS shall be configured to turn off the main circuit breaker but to maintain the pantograph prior to approaching traction neutral zones. Balise groups shall be provided at either end of the neutral sections.

To prevent electrified trains from exiting the electrified areas, the ETCS trackside shall send a special Static Speed Profile (SSP) which contains different speed information for EMUs from all other trains within the International Train Category. The trackside will send the special SSP packet to the on-board system which will enforce the speed profile according to the International Train Category preventing any electric train from entering non-electrified lines and sidings.

### D.7.11 Correct side door opening

The ETCS may be configured to mitigate the risk of a driver incorrectly opening train doors, either:

(a) At an equipped platform and/or,

(b) Opening the train doors when the train is not fully within the limits of the platform.

Balises shall be provided at either end of the platform with the specific platform data and the defined distance from balise to the platform leading edge.

### D.7.12 ETCS Level 1 - Limited supervision

ETCS Level 1 is a cab signalling system that can be overlay or used in conjunction with existing signalling systems. Lineside signals are generally retained and block control is achieved in the conventional manner by the interlocking, based on the information detected by track circuits or axle counters.

It is a system based on intermittent track-to-train communication. Balises, which are linked to the signals or interlocking's via the Lineside Electronic Unit (LEU); transmit route data as movement authority to the trains. The on-board computer continually monitors and calculates the maximum permitted speed and the braking curve.

ETCS on-board equipment receives information related to the track ahead from ETCS trackside equipment and together with train parameters uses this information to determine speed and distance supervision parameters. If a supervision limit is exceeded, then the on-board equipment triggers one or more of the following:

(c) Audible and visual warnings to the driver

(a) Traction cut-off

(b) Service brake application

(c) Emergency brake application

### D.7.13 Scope & application

The following supervision and protection is provided by the ETCS application:

(a) Celling speed monitoring

(b) Target speed monitoring

(c) SPAD mitigation

### D.7.14 Ceiling speed monitoring

A balise group shall be positioned at all permeant track speed signs and is used to enforce the permitted line speed.

The balise group shall transmit various information packets to the on-board equipment, such as:

(a) Movement authority information

(b) Gradient information

(c) ETCS level information

(d) Lowest speed supervision within the movement authority

(e) Linking information

(f) Speed profile information (inc speed information for the drivers display)

(g) ETCS on-board mode information

### D.7.15 Target speed monitoring

Target speed monitoring (TSM) is where train speed is supervised to an on-board calculated braking curve, braking to a target speed at a target point. The TSM target information is transmitted by balise groups in rear of the target.

Target speed monitoring shall be used for the following applications where risks have been identified:

(a) approaching buffer stops,

(b) reductions in line speed

(c) turnouts

(d) deficient overlaps

(e) protection of level crossings

(f) protecting wrong direction moves

### D.7.16 Buffer stop protection

Target speed monitoring shall be used when approaching a buffer stop or the end of the line on a running line, with release speed monitoring (RSM) used in the vicinity of the end of authority (EOA).

A balise group shall be provided to initiate the target speed monitoring. The balise group shall be positioned no closer than the calculated permitted braking curve in rear of the EOA.

Additional balise groups may be provided where setting back moves are provided in advance of the operational stopping location. These balise groups shall initiate an emergency brake intervention prior to the buffer stop.

The release speed depends on the length of the confidence interval at a position just before reaching the EOA and the distance between the EOA and the buffer stop. Where this distance is relatively long at least 30 m greater than the confidence interval, the release speed shall be 15 km/h; otherwise it shall be 10 km/h

### D.7.17 Speed reductions

Where a significant risk has been identified of a train travelling faster than the new speed following a speed reduction, the change in speed shall be protected by using target speed monitoring provided by the ETCS.

Specific hazards within the deceleration distance from the speed sign shall be considered, such as:

(a) Timed level crossing

(b) Level crossing already protected through ETCS

(c) Manually controlled level crossing

(d) Station platform

(e) Curvature in the track

### D.7.18 Turnout protection

To minimise the risk of a derailment at a turnout, a balise group shall be provided to initiate target speed monitoring on the approach.

Where there are multiple or consecutive turnouts from the same signal, each turnout shall be separately assessed. The most restrictive case shall be transmitted by the redundant TSM balise group.

The balise group protecting the turnout shall consist of one controlled balise and one fixed balise. The preferred position of the balise group is at the ‘permitted distance’ obtained from the braking tool, using the turnout as the target point and the published turnout speed as the target speed.The balise group may be positioned farther than the ‘permitted distance’, including at an outer signal that is one or more blocks in rear of the home signal of the turnout.

Signalling information shall be obtained via Lineside Electronic Units interfaced to the signalling system.

### D.7.19 Overlap& Level crossing protection

A risk assessment shall be carried out to determine whether the existing SPAD mitigations are SFAIRP or whether ETCS enforcement is required for the following hazards:

(a) Existing overlap deficient against the current emergency braking distance requirements.

(b) Catchpoints

(c) Level crossings

A balise group shall be provided at the ‘permitted distance’ obtained from the braking tool, using the protecting signal as the target point.

The target speed shall be the safe overrun speed, that is, the maximum speed that allows a train that has tripped at the protecting signal to stop before the hazard point.

The hazard point for a deficient overlap shall be at the end of the signalling overlap.

The hazard point for catchpoints shall be the nearest end of the throw-off rail.

The hazard point for a level crossing shall be the nearest edge of the crossing.

The balise group may be positioned farther than the ‘permitted distance’, including at an outer signal, one or more blocks in rear of the protecting signal.

### D.7.20 Wrong running

Wrong running refers to train movements on running lines in the unsignalled direction. All wrong running movements shall be supervised to the maximum speed as per the operational rules.

The wrong running entry point shall be assumed to be at the point where there is no signalled move in the applicable direction over that portion of track.

A wrong running entry balise group shall be placed at a nominal 10m in advance of the wrong running entry point. However, the distance may be extended based on train length to allow the wrong running entry function to be combined in a balise group performing another function, provided there is no additional safety risk.

### D.7.21 SPAD mitigation – ETCS Trainstops

An ETCS trainstop is an alternative to the trip arm style trainstop.

For all signals currently not provided with a trip arm style trainstop, an ETCS trainstop is to be provided.

When an ETCS trainstop balise group is required to trip a train, for example when a signal is displaying a stop aspect, the balise group shall transmit a trip order to command the emergency brake. ‘Stop if in SH mode’ and ‘Stop if in SR mode’ shall also be transmitted.

When an ETCS trainstop balise group is required to provide no trip, for example, when a signal is displaying a proceed running aspect, the balise group shall not transmit a trip order. ‘Stop if in SH mode’ and ‘Stop if in SR mode’ shall not be transmitted. The balise group shall transmit the standard maximum length MA.

A shunt route may allow the balise group to provide no trip where there is an operational need, subject to a risk assessment. The risk assessment shall consider whether it is necessary to prove the speed of the approaching train has suitably reduced, and whether it is necessary to prove the section clear.

#### D.7.22 Movement authority

Permission for a train to run to a specific location within the constraints of the infrastructure.

A movement authority shall contain information for the limit and end of authority, including distance and overlap/danger point definition.

#### D.7.23 Linking

Linking is the announcement of balise groups in advance. The aim of linking is:

(a) to determine whether a balise group has been missed or not found within the expectation window and take the appropriate action

(b) to assign a coordinate system to balise groups consisting of a single balise

(c) to correct the confidence interval due to odometer inaccuracy

#### D.7.24 Train position confidence Interval

The on-board computer's estimated position of an announced balise group may not be at its actual position, mainly due to inaccuracies in the odometer. The actual position can be up to one half of the confidence interval distance, either side of the estimated position.

For any trackside design calculation that requires an estimation of the confidence interval, it shall be assumed as:

± (10 m + 5% * distance travelled from the last reference location).

The 10 m encompasses the location accuracy national value of 5 m (Q_NVLOCACC) plus 5m for the balise reading accuracy.

How odometer error can have an impact on the positioning of the train in terms of the train not knowing its exact location.

The distance interval within which the ERTMS/ETCS on-board assumes the actual train position is, with a defined probability.

It comprises the odometer over-reading and under-reading amounts, plus twice the location accuracy of the reference balise group.

### D.8 Enforcement systems with train operation

In addition to enforcement systems and to achieve improved capacity and on time running, automatic train operation (ATO) may be configured over the ETCS enforcement (AoE).

The ATO can only function when a train is in Full Supervision mode.

The AoE provides the following functionality and benefits:

(a) Braking enforcement,

(b) Speed control,

(c) Door opening and closing

(d) Enhance timetable adherence,

(e) Traction system energy saving,

(f) Improved operational management,

(g) Interoperability between on-board and trackside

In addition to enforcement systems and to achieve improved capacity and on time running, automatic train operation may be configured over the ETCS enforcement (AoE).

The ATO is adaptable to the specific characteristics of the rolling stock for which the ATO is fitted.

To avoid the risk of a driver having no control of the train operation, the ATO shall stop the automatic driving if the driver manually activates the brake. Should a driver manually activate the traction sub-system whilst in automatic operation, a warning shall be given by the ATO and the ATO shall remain engaged.

When approaching powerless sections (i.e. traction neutral zone), the trackside shall command the on-board to dis-engage the ATO.

A driver shall only engage the ATO when satisfied and is safe to do so, such as if the track ahead has any hazards or obstacles.

Where there is a risk of a train partially occupying a platform due to stopping point information not being available and the EOA is in advance of the platform, the on-board shall stop the train at the leading edge of the platform.

## D.9 Journey profiles

The trackside shall send to the on-board specific operational data and trackside infrastructure data required to enable ATO, in the form of journey profiles.

The journey profiles shall consist of segment profiles, these profiles shall consider:

(a) Static speed profile,

(b) Gradient profile,

(c) Track curve profile,

(d) Traction system information,

(e) Permitted current consumption

The journey profile shall include all relevant timing points for the purpose of assessing train performance.

Prior to entering sections of track where low adhesion exists, the on-board shall consider the restriction from the front of the train, and the rear of the train when leaving her low adhesion areas.

## D.10 Driving functionality

The automatic driving operation includes three functional features:

To ensure energy efficient on time running, the speed profile shall be computed based on energy efficient consumption as defined in the journey profile.

To ensure on time running following operational delays, the speed profile shall establish the maximum speed the train can achieve avoiding ETCS enforcement.

To ensure correct alignment at stations, the speed profile shall be configured to stop the train accurately at stopping points.

To ensure correct traction and brake control, the speed profiles generated from the above features shall be used

### D.10.1 Stopping point management

The ATO shall consider when a stopping point has been reached by the train.

Stopping point locations shall be used for the ATO to manage the train door operation. Train door operation shall consider the following features:

(a) Manual door operation initiated by train crew

(b) Door operation (following passenger request)

(c) Centralised door operation

(d) Dwell time

(e) Interface with Platform screen door systems (where provided)

Dwell times shall be displayed to the train crew. The dwell time shall be calculated based on the requested departure time and the time at which the train has come to stand within the stopping point locations. Where requested by the journey profile, a train may be held at the stopping point and the dwell time set to hold.

To avoid early departure from a station, train departure may be requested from the trackside only after the dwell time has expired. In addition, a train may be held at a station for operational reasons via an update to the journey profile.

Additional stopping points may be added to the journey profile only where the train operation can safely stop at the stopping point.

## D.11 Low adhesion management

For sections of track where low adhesion occurs, the feature of the train operation that establishes the maximum speed the train can achieve without intervention, shall consider the adhesion factor (low adhesion information) as part of the traction and barking commands.

Low adhesion may be selected by the train crew or sent by the trackside.

## D.12 Data consistency

The ATO shall be able to detect inconsistencies in data, either through balise linking errors or segment and journey profile information. Where an inconsistency has been detected, the ATO shall be disengaged.

## D.13 Driver machine interface

When the ATO is active, information shall still be displayed to train crew.

The following information may be shown to train crew:

(a) Ceiling speed information

(b) Target speed information

(c) Permitted speed information (including warning speed limits)

(d) Stopping points and departure/dwell time information

(e) Stopping accuracy information

(f) ATO status information

(g) Train door operational information

### D.14 ATO operational states

ATO shall only be available and engaged after the following conditions have been met:

(a) Operational mode is in Full Supervision or automatic driving

(b) The emergency or service brake has not been applied

(c) Journey profile permits ATO

(d) No inconsistencies in data detected

(e) Train is at a standstill at a valid MA allows the train to move (in a platform area, allows the train to leave the platform area completely)

(f) When a train is manually driven and engaging the ATO would permit the train to stop before a defined stopping point.

(g) Train doors closed and locked.

# Appendix E Route locking

## E.1 General locking between route and overlap

If a route from a signal conflicts with another route on the same signal or leads over one or more sets of points or ground frames or reads up to one or more opposing signals (routes) then it should–

(a) lock normal any conflicting routes leading away from the same signal.

(b) lock normal any opposing signal routes which lead into the route or its overlap.

(c) lock normal or reverse as required any sets of points in line with the direction of the route together with any points providing trap or flank protection to the route or its overlap.

(d) lock any ground frames normal in the route or its overlap.

(e) lock any trailing points in its overlap in the appropriate direction for which the overlap is set.

Alternatively, there may be situations (particularly in yards) where trailing points or catch points in the overlap are not aligned with the route to reduce the impact of points failure, or provide flank protection. In this case, all conflicting signals should require to be locked.

Lock normal or reverse any facing points in its overlap only if other locking conditions within or leading into the overlap make this necessary.

Converse locking should always be applied except in special cases.

The overlap should be the overlap applicable to normal speed movements, and not conditional low speed overlaps, unless there is a speed supervision system which enforces the movement to keep below the specified restricted speed. In other words, the overlap distance for locking is the overlap distance applicable to the highest signal indication which can be displayed when the next signal is at stop, generally the “caution” signal indication.

## E.2 Flank protection

Flank protection is the setting of points (often not directly within the route) to protect the signalled movement whether or not other routes are set.

## E.3 Holding of locking between opposing routes

If opposing routes are situated such that the occupation of an intervening track circuit is insufficient to maintain the aspects of opposing signals at stop, then this should be enforced by the provision of route holding between the signals concerned.

This should be required between main and main signals and between main and shunt signals. Route holding between opposing main and shunt routes may be necessary even where there is no direct locking between the signals.

Generally, no route holding is applied between shunt and shunt signals, however, in special circumstances, such as where the shunt signals are widely spaced, the route holding may be applied.

## E.4 Holding of route to point locking

If a set of points is located within the route section or overlap of a signal then the points should be route held by the occupation of any one of the intervening track circuits within the signal route section between the signal and the set of points concerned (except for points in the overlap of home signals entering single line crossing loops without outer homes).

Releasing of route holding of points within the route should not be permitted, except for points locally operated via a releasing switch.

Generally, no route holding is applied between shunt signals and points operated by ground frames however, in special circumstances, such as where the shunt signal and the ground frame points are widely spaced apart, the route holding may be applied.

# Appendix F Approach locking

## F.1 General

The approach locking should become effective if a proceed aspect has been displayed in the approach locked signal and the rail traffic crew of an approaching train has sighted any signal showing a proceed aspect which would be altered by replacement of the approach locked signal to stop.

The approach locking once initiated should be maintained by the occupation of the track circuits over the appropriate approach locking distance in rear of the signal which is approach locked. If the first signal to be sighted can be seen for a reasonably long distance then the approach locking point should commence a suitable sighting point agreed by the RTO.

If a running signal is situated such that the number of aspects which can be displayed in rear are restricted due to physical or operational constraints of the system then the extent of the approach locking may be reduced accordingly.

If a running signal is situated such that no track circuit is provided in rear then it should be approach locked immediately it displays a proceed aspect.

## F.2 Approach locking release

The approach locking should be released by the normal passage of the train over the track circuits before and immediately past the approach locked signal and in the direction for which the route is set or following a time release which should commence timing immediately the approach locked signal has been replaced to stop.

If a full approach locking distance is provided in rear of the running signal then the time release period should be a minimum time as determined by the RTO.

Additional time may be required if the signals are widely spaced. Reduced time may be agreed with the RTO for Subsidiary or Ground Shunt Signals.

To prevent the possibility of approach locking being pre-released by the releasing track circuits effectively becoming occupied due to a loss of power a power-off time expiry feature should be provided in each track circuit release path.

This should cause a period of time as determined by the RTO, to elapse following the loss and subsequent restoration of power after which the approach locking track release should again become effective.

Where automatic normalising is provided by occupancy of track circuit alone (e.g. OCS type systems) the simple track occupied release of approach locking should not be provided for main running aspects.

Where there is a need for a track occupied release (e.g. on certain subsidiary signals) selection should be incorporated to ensure that the track occupied release is not effective for main running aspects.

Alternatively, a quick release of approach locking may be provided by a suitable track circuit logic sequence that is proven to avoid a high risk failure mode that may simultaneously place the signal at stop, release the approach locking and auto-normalise the route.

# Appendix G Route releasing

## G.1 General

Route Release is the return of the interlocking and signal controls to normal functionality following the passage of a train or train, or resetting of the signalled route by the signaller or system before the passage of the train past the route protecting signal.

## G.2 Route normalising

Automatic route normalisation is provided to reduce the work load on an operator by avoiding the need to manually normalise routes after the passage of a train and enable the operator to concentrate on the setting of routes ahead of trains and undertake this task more efficiently. It is also required to enable any automatic route setting functionality.

All controlled signals should be provided with automatic route normalisation.

### G.2.1 NX systems

If the signal is provided with a berth track circuit, then automatic route normalisation should be initiated provided the approach locking has been released and following the concurrent occupation of the berth track circuit and the first track circuit past the signal and the subsequent clearing of the berth track circuit.

If the signal is not provided with a berth track circuit, then automatic route normalisation should be initiated provided the approach locking has been released and following the occupation and clearance of the first track circuit past the signal. The sequencing for normalising signals is first track circuit occupied and cleared with second track circuit occupied.

The objective in either case should be to ensure that the sequence of track releasing for auto normalisation is different from that for the release of approach locking such that full normalisation of the interlocking can only occur after the two different sequences have been executed. This reduces the probability of situations under which for example, insulated block joint failures could pre-release approach locking simultaneously with normalisation.

Special arrangements should be required if last wheel replacement is applicable to the signal.

### G.2.2 OCS systems

Automatic route normalisation should be initiated immediately the first track circuit past the signal is occupied. In this case the first track circuit on the departure side of the signal is occupied and cleared with the second track circuit occupied release in the approach locking should not be permitted for main running signal aspects.

Special arrangements may be required if last wheel replacement is applicable to the signal.

### G.2.3 Other methods of route normalisation

In some systems, the automatic route normalisation may be initiated by a software algorithm and the subsequent transmission of a normalising bit to the interlocking. Special approval is required.

### G.3 Route Releasing

If permitted route holding should be released after the expiry of a time release.

Instances where a time release may be permissible are–

(a) If a train has come to a stand and it is required that an opposing signal be cleared.

(b) If a train has come to a stand at a signal and it is required that a set of points in the overlap be moved to the opposite position to facilitate the same or some other train movement.

(c) If a train has come to a stand and it is required to operate a releasing switch which is in the route.

The period of time release expiry should be determined by the length of the controlling track circuit or circuits and the average speed of the approaching train over the controlling track circuit or circuits.

Releasing arrangements are to consider the method of operation of the interlocking and shunting arrangements. For main line movements timing should require berth track occupancy, however, for locations where ground frames are provided, the timing track should be local to the ground frame and extend approximately 100m either side.

Long timing over a number of track circuits (e.g. in a loop) may be necessary to meet operational needs.

Direct release of route holding by track occupancy should be avoided.

# Appendix H Aspect clearance and lamp proving

## H.1 Aspect clearance

If all the track circuits are clear from a running signal to the end of its caution overlap then subject to any other controls the running signal may display a caution aspect.

If it is required to move a train beyond a running signal into an occupied section as far as the line is clear or perform a shunting movement then generally a shunt aspect should be displayed unconditionally although it may be desirable to clear certain shunt signals conditionally.

### H.1.1 Track occupancy

Track occupancy should be proven by train detection system which should return and hold the signal aspect at Stop. The signal should be held at this aspect until the train or train clears the overlap of the next signal. If the first signal is an automatic signal, it may return to a proceed aspect, or is available for a new route to be set if a controlled signal.

### H.1.2 Point detection

Detection of points in the route to the next signal and the overlap are to be included in the signal aspect control. Loss of detection should return the signal aspect to Stop.

### H.1.3 Aspect ahead

The aspect of the signal ahead should follow the signalling types and aspects as defined by the Infrastructure Controller, and should meet the RTO's requirements for signal aspect sequence. With main line signals it is a requirement to prove that the signal in advance is lit and showing the required aspect. Lamp proving controls are required in order to achieve this requirement.

### H.1.4 Trainprotection system proving: train stops

For proceed aspects the train stop should be continuously proven to be down in the signal's control for main-arm (normal and medium speed) aspects.

The trainstop should be proved to be in the raised position for all opposing entrance signals into the same single line section.

### H.1.5 Trainprotection system proving: TPWS – TSS

For proceed aspects the TSS' proving contact should be continuously proven open in the signal's control for main arm (normal and medium speed) aspects.

Failure of the TSS should not prevent clearing of a low speed aspect.

The TSS should be proved to be armed for all opposing entrance signals into the same single line section.

The TSS should not be proved to be armed in the signal in the rear unless the RTO directs otherwise.

### H.2 Lamp proving

Where provided this feature enforces a fail-safe control to be exercised on the signal (or signals) in rear of the signal at which a running signal lamp has failed thus restricting the movement of a train towards the “dark” signal.

Consequently, the potential for a derailment on a turnout or a rear end collision caused by an approaching train running past the “dark” signal is reduced to an extent depending on the nature of the vital controls exercised and the spacing of the signals in the system.

A fail-safe method of monitoring the integrity of the filaments in a running signal lamp, such that a total failure of the signal lamp which should be operating, should result in a change-of-state of a fail-safe lamp proving function.

Lamp proving which detects that the lamp filament is intact when the normal operating current is passing through the filament is known as hot proving.

Lamp proving which detects that the lamp filament is intact when the lamp is not operating using current sensing method is known as cold proving.

Lamp proving and controls should follow these rules as applicable:

(a) For signals with incandescent lamps, lamp proving should be provided on all single light colour light signals and new double light colour light signals.

(b) For LED signals, lamp proving should be provided on all single light signals but only on the first three double light signals at interfaces between single and double light signals. (Exception: where lamp proving is part of the type of CBI interlocking used).

(c) If a signal lamp which should be operating is proved to be out then the aspect of the running signal in rear should be restricted to caution or caution turnout if applicable.

(d) On single light signals, if a signal lamp which should be operating is proved to be out then the marker light on the signal should be illuminated.

On single light signals, if a signal lamp which should be operating is proved to be out and it is the lamp for the stop aspect of the first home signal controlling movements off a single line section in C.T.C. territory, then, to avoid a possibility that the subsidiary signal might be initially interpreted as a running signal proceed indication, any subsidiary signal fitted to the first home should not display a proceed aspect until a train is closely approaching the signal whereby it’s speed should have reduced to a speed commensurate with that required for the subsidiary signal movement.

# Appendix I Single lines and bi-directional signalling

## I.1 Single lines

The following requirements should be met before a signal controlling the entrance to a single line block is permitted to clear and continuously thereafter–

(a) The directly opposing signal(s) controlling the entrance to the single line block at the opposite end should be proved normal.

(b) Intermediate directly opposing signals within the single line block controlling movements in the opposite direction, should be proved normal.

(c) The track circuits between the overlap clearance point of the signal to be cleared and the directly opposing signal(s) controlling the entrance to the single line block at the opposite end, should be clear unless occupied by a train being signalled through diverging points which prevent it from proceeding onto the overlap track or unless occupied by a preceding train travelling in the same direction.

(d) If provided, the half-pilot staffs at each end of the single line block should be proved normal.

(e) Any releasing switches situated in the single line section should be proved normal.

(f) Any trapping protection on points operated from ground frames situated in the single line section should be proved normal.

(g) Other point detection should be proved normal as applicable.

(h) Directional controls associated with operation of railway crossing equipment within the single line section should be proved normal.

(i) The block control circuit closed for a period of t immediately before the signal controlling the entrance to the single line block clears to show a proceed aspect.

## I.2 Bi-directional signalling

### I.2.1 Signalling arrangements

Generally, the number of signals provided for the reverse direction of running is considerably less than for the normal direction of running.

Care should be exercised in ensuring that the signals provided for the reverse direction of running are situated so as not to be confused with the signals provided for the normal direction of running, on the adjacent track. Where provided, reverse direction running signals are to be paired with the normal direction running signals on the adjacent track.

### I.2.2 Signalling controls

If a train is signalled into a bi-directional section from one end then the signal controlling the entrance into the section should lock the signal controlling the entrance into the section at the opposite end and prove that all intermediate automatic signals controlling movements in the opposite direction to which the train is running are at stop.

In addition, the signal controlling the entrance into the section for the reverse direction of running should prove that the maintenance releases are normal.

If a train is in the bi-directional section then its direction of travel should be detected by the signalling system and constantly monitored at intermediate signals in order to allow a second train running in the same direction as the first train to enter the bi-directional section as soon as the first train has cleared the overlap beyond the first automatic signal in the section.

The signal at the opposite end of the bi-directional section controlling the entrance to the bi-directional section should not be able to be cleared until all trains in the opposing direction have cleared the bi-directional section. (Opposing shunt signal moves may be permissible up to a train proved at stop at the home signal at the exit to the bidirectional section, where required).

### I.2.3 Maintenance releases

Maintenance releasing switches may be provided where necessary for maintenance staff protection and should enable maintenance staff to block the reverse direction movements.

The routes controlling the reverse direction movements should be proved normal and the section proved clear of all trains travelling in the reverse direction before the maintenance release can be operated and the reverse direction block enabled.

The location of the releasing switches should be subject to their on-track accessibility with respect to the maintenance crew requirements.

## Bibliography

The following documents are informative references in this Standard:

(a) AS 1742.7 Manual of uniform traffic control devices. Part 7: Railway crossings

(a) AS 7631 Railway Infrastructure Sighting

(b) AS 7658 Level Crossings

(c) AS 7666 TCP Interoperability

(d) AS 7706 Interface with Points

(e) AS 7715 Train Detection

(f) AS 7721 Lineside Signals

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