

AS 7715:2016



Train Detection



Train Control Systems Standard



This Australian Standard® AS 7715 Train Detection was prepared by a RISSB Development Group consisting of representatives from the following organisations:

Aitken & Partners

Rio Tinto

Brookfield

ARTC

PTA WA

Queensland Rail

The Standard was approved by the Development Group and the Train Control Systems Standing Committee in June, 2016. On June 15, 2016 the RISSB Board approved the Standard for release.

This standard was issued for public consultation and was independently validated before being approved.

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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Contents

1	Introduction.....	7
1.1	Purpose	7
1.2	Scope	7
1.3	Exclusions	8
1.4	Compliance.....	8
1.5	Referenced documents.....	8
1.6	Definitions	10
2	General	11
2.1	General requirements for train detection systems	11
2.2	Reasons for the provision of train detection systems	13
2.3	Provision of train detection systems.....	13
2.4	Detectable rolling stock.....	14
2.5	Integrity and reliability of train detection systems	14
2.6	Suitability of train detection systems	15
2.7	Outputs from train detection systems.....	15
2.8	Additional requirements for train detection systems used to prove that a track section is clear of trains	16
2.8.1	Output states	16
2.8.2	Continuity of train detection.....	16
2.8.3	Minimum length of track sections	16
2.8.4	Clearances	16
2.9	Interface management	16
3	Requirements and types of rail based train detection systems.....	17
3.1	Purpose	17
3.2	General.....	17
3.3	Electrified areas "immunity to traction currents"	17
3.4	Non-electrified areas.....	18
3.5	Common detection systems.....	18
3.5.1	General.....	18
3.5.2	Coded track circuits	19
3.5.3	Track circuits (AC and DC)	20
3.5.4	High voltage impulse track circuits	20
3.5.5	Audio frequency track circuits	20
3.5.6	Overlay track circuits.....	22
3.6	Predictor systems	22
3.7	Proximity loops and switches	23
3.8	Treadles and "non-vital" wheel detectors	25
3.9	Axle counting systems	25
3.10	Automatic train protection (ATP) and cab signal	26
3.11	Bonding	26
3.12	Impedance bonds	29

3.13	Insulated rail joints	29
4	"On train" detection systems	29
4.1	Purpose	29
4.2	General	29
4.3	System types	30
4.3.1	Automatic train protection (ATP)	30
4.3.2	GPS / odometry systems	30
5	Design requirements	31
5.1	Purpose	31
5.2	Performance requirements	31
5.3	Suitability and selection of train detection systems	33
5.4	Power supply	34
5.5	Communications	35
5.6	Minimum configuration (examples of length and joints)	36
6	Interfaces to other systems and signals equipment	36
6.1	Purpose	36
6.2	Input / output requirements	37
6.3	Rollingstock and wheel interface	37
7	Track, civil and interface	37
7.1	Purpose	37
7.2	Performance requirements	38
7.3	Track	38
7.3.1	Rails	38
7.3.2	Sleepers	38
7.3.3	Rail Surface Contamination	39
7.3.4	Ballast Contamination	39
7.3.5	Flood mitigation	39
7.4	Civil	40
7.5	Infrequent use and track work changes	40
7.6	Processes for managing hazards such as rail surface contamination	40
8	Installation requirements	41
8.1	Purpose	41
8.2	Installation	41
9	Set up, test and commissioning requirements	43
9.1	Purpose	43
9.2	Performance requirements	43
9.3	Commissioning	43
9.4	Set up & configuration	44
9.5	Testing	44
10	Maintenance and monitoring requirements	44
10.1	Purpose	44
10.2	Maintenance requirements	44

10.2.1	General.....	44
10.2.2	Modification.....	46
10.3	Track and civil maintenance.....	46
10.4	"Rail based" train detection system maintenance.....	46
10.5	"On train" detection system maintenance.....	48
10.6	Reactivation of seasonal or out-of-service train detection systems	48
11	Fault finding requirements of train detection systems	48
11.1	Purpose	48
11.2	General requirements	49
11.3	Fault reporting and management	49
12	Decommissioning and disposal of train detection systems	50
12.1	Purpose	50
12.2	Performance requirements.....	50

1 Introduction

1.1 Purpose

The purpose of this standard is to provide the Australian rail industry with a set of mandatory and recommended requirements for the detection of all trains/rolling stock/rail vehicles to ensure that the signalling system receives reliable, accurate, sufficient and up-to-date information regarding the position and movement of all detectable trains/rolling stock/rail vehicles necessary for the safe control of the railway.

The standard addresses the requirements of the train detection system for the use of signallers and other operators. It spans accuracy and detail of train detection information and sufficiency of update frequency such that the signaller or other operator can safely control the movement of trains, including (so far as is reasonably practical) during periods of failure.

The use of this standard will allow a uniform approach to be applied to: the design, installation, set up, testing and commissioning, modification, use, fault finding and disposal of train detection systems.

The standard is intended to –

- provide a uniform basis for compliance with AS 4292 Railway Safety Management;
- be adaptable to different railway environments; and
- identify the risks (hazards) being controlled.

This standard specifies the accepted criteria to be employed when designing, procuring, installing, maintaining, fault finding and monitoring train detection systems to ensure technical and safety integrity.

1.2 Scope

This standard specifies the safety, functional, reliability, availability, maintainability requirements for any member or participant of the Australian rail industry that is involved in any phase of the life cycle (as per the structure of the standard) for train detection systems both rail based and on train.

This standard applies to all heavy railways over 600mm track gauge.

This standard provides the minimum requirements for the application design of train detection systems for both rail based and on train systems. 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 train detection systems standards, codes, guidelines and procedures of individual States or Rail Transport Operators).

A train detection system is equipment and systems forming part of, or providing input to, the Interlocking System to detect —

- (a) the presence or absence of detectable rolling stock within the limits of a track section; or
- (b) that a train has reached, is passing, or has passed a specific position.

Clauses in this standard relating to electrified networks are predominantly focussed on DC electrification. Clause 3.2.3 is intended to extend the scope to AC networks as well.

1.3 Exclusions

This standard is not intended for (although they are not prevented from using it) miniature railways and amusement railways, sugar cane, tourist, heritage and light rail networks such as urban tramways.

Competence relating to tasks within the standard. 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.

1.4 Compliance

There are two types of control contained within RISSB Standards:

- (a) Mandatory requirements
- (b) Recommended requirements

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

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 Rolling Stock Operator, Rail Infrastructure Manager and/or Rail Safety Regulator.

Recommended clauses are mandatory unless the RIM or RSO can demonstrate a better method of controlling the risk.

Recommended requirements are to be considered when compliance with the standards is being assessed.

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

Hazards addressed by this standard are included in an appendix. Refer to the RISSB website for the latest Hazard Register Guideline: www.rissb.com.au

1.5 Referenced documents

- (a) AS/RISSB 7505.1, Railway Rolling Stock - Signalling Detection Interface - Locomotive Rolling Stock standard
- (b) AS/RISSB 7505.2, Railway Rolling Stock - Signalling Detection Interface - Freight Rolling Stock standard
- (c) AS/RISSB 7505.4, Railway Rolling Stock - Signalling Detection Interface - Infrastructure Maintenance Rolling Stock standard
- (d) AS/RISSB 7658, Railway Infrastructure - Railway Level Crossing standard
- (e) AS/RISSB 7639, Railway Infrastructure - Track Structure & Support Systems
- (f) AS/RISSB 7640, Railway Infrastructure - Rail Management
- (g) AS4292.1, Railway Safety Management-General Requirements
- (h) I.S. EN 50125-3, Railway Application - Environmental Conditions For Equipment - Part 3: Equipment For Signalling And Telecommunications
- (i) I.S EN 50126-1, Railway applications. The specification and demonstration of reliability, availability, maintainability and safety (RAMS)

- (j) I.S. EN 50159-1, Railway Applications - Communication, Signalling and Processing Systems - Safety-related Communication in Transmission Systems
- (k) American Railway Engineering and Maintenance of Way Association (AREMA), Communications & Signals Manual
- (l) ARA Code of Practice. Train Detection Principles.
- (m) ARTC Track Circuits and Train Detection Devices Procedure ESM-07-02
- (n) ARTC Installation of Trackside Equipment Procedure ESC-07-01
- (o) ARTC Level Crossing Predictor Design Certification and Test standard ESD-03-02
- (p) ARTC Resetting Axle Counters Applicability ESI-06-02
- (q) ARTC Signalling Rollingstock Interface ESD-32-01
- (r) ARTC Signals - Decommissioning Specification Requirements
- (s) ARTC Failures standard SMP 04
- (t) Department of Infrastructure, European Train Control System (ETCS) Implementation Handbook
- (u) Elevated Mass Rapid Transit System, Manual of Specifications and standards Government of Andhra Pradesh
- (v) New Zealand Rail, Axle Counter Equipment CSS/EE 031
- (w) New Zealand Rail, Track Circuits: Recording of Inspection and Test Data CSSRRC 002
- (x) Office of Rail Regulation, Safe Movement of Trains Publication 3
- (y) Queensland Rail, Level Crossing Safety standard SAF/STD/0044/CIV/NET
- (z) Queensland Rail, Track Circuits, Bonding and Axle Counters SM.QMS.SC.SCP05
- (aa) Queensland Rail, Training of Staff SM.QMS.SC.SCP20
- (bb) Railway Group standards (RSSB), Infrastructure Based Train Detection Interface Requirements GKRT0028
- (cc) Railway Group standards (RSSB), Train Detection GKRT0011
- (dd) RISSB Level Crossing Standard Authoring Specification
- (ee) Shiv Mohan, Next Generation Train Positioning Systems, IRSE News Issue 202
- (ff) TfNSW Signalling Practice standard ESG 002
- (gg) TfNSW Signalling Operator Interface standard ESG 005
- (hh) TfNSW Rolling Stock Signalling Interface Requirements standard ESG 006
- (ii) TfNSW Signal Design Principles standard ESG 100.1 - Signals
- (jj) TfNSW Signal Design Principles standard ESG 100.17 - Track Circuits
- (kk) TfNSW Traction Return, Track Circuits and Bonding SPG 0709
- (ll) TfNSW ETCS Level 1 Trackside Equipment SPG 1610, Version 1.0
- (mm) TfNSW Environment Conditions SPG 1856
- (nn) TfNSW Inspection and Testing Principles SPG 0711.3
- (oo) Train Detection Principles, T Godber, IRSE Australasia Technical Meeting,
- (pp) VRIOGS 010.7 RevA - Track Bonding, Track Circuit Connections and Traction Interfaces

- (qq) VRIOGS 012.0 Rev B - Victorian Signalling Principles
- (rr) VRIOGS 012.5 Rev A - Testing and Commissioning of Safety Related Railway Signalling Systems
- (ss) WestNet Code of Practice for The Design of Active Level Crossing Warning Systems

1.6 Definitions

Automatic Train Protection (ATP): a system that supervises train speed and target speed, alerts driver of the braking equipment, and enforces braking when necessary.

Automatic Warning System (AWS): A system that provides audible and visual warnings to the driver on the approach to signals, certain level crossings and emergency, temporary and certain permanent speed restrictions. It supervises the driver's reaction to signal caution aspects and indicates to the driver the passing of a clear aspect. Mostly advisory, however it will cause a brake application to be made automatically if the driver fails to react when approaching a restrictive aspect.

Broken Rail: A fracture of the rail including a broken joint or weld, or detachment of a piece from the rail which necessitates an immediate stoppage of traffic or the immediate imposition of a speed restriction lower than that currently in force.

Detectable: Rolling stock ability to reliably activate track circuits.

Driver Machine Interface (DMI): A system by which drivers may interact via controls and indications within a machine. The interface includes hardware (physical) and software (logical) components. Interfaces exist for various systems, and provide a means of –

- (a) input: allowing the users to provide data to the control system;
- (b) output: allowing the system to indicate the effects of the driver's manipulation or action.

Fail-safe: The capability of an item of equipment or a system to ensure that any failure in a predictable or specified mode will result only in that item or system reaching and remaining in a safe condition.

Heavy railway: A passenger or freight railway with capacity for "heavy volume" traffic and characterized by exclusive rights-of-way, multi-car trains, high speed and rapid acceleration, sophisticated signalling, and high platform loading.

On Train: Systems located within the train.

Railway: A guided system designed for the movement of rolling stock having the capability of transporting passengers or freight, or both, on a railway track with a gauge of 600mm or more, together with its rail infrastructure and rolling stock and includes –

- (a) a heavy railway;
- (b) a light railway;
- (c) a monorail;
- (d) an inclined railway;
- (e) a tramway;
- (f) a railway within a marshalling yard or a passenger or freight terminal;
- (g) a private siding; and
- (h) a guided system, or guided system of a class, prescribed by the regulations to be a railway.

Rail Infrastructure Manager: The person who has effective management and control of the rail infrastructure, whether or not the person owns the rail infrastructure or has a statutory or contractual right to use the rail infrastructure or to control, or provide access to it.

Rail Transport Operator:

- (a) a Rail Infrastructure Manager; or
- (b) a rolling stock operator; or
- (c) a person who is both a Rail Infrastructure Manager and a rolling stock operator."

Railway operations:

- (a) The construction of a railway, railway tracks and associated track structures or rolling stock.
- (b) The management, commissioning, maintenance, repair, modification, installation, operation or decommissioning of rail infrastructure.
- (c) The commissioning, maintenance, repair, modification or decommissioning of rolling stock.
- (d) The operation or movement, or causing the operation or movement by any means, of rolling stock on a railway (including for the purposes of construction or restoration of rail infrastructure).
- (e) The movement, or causing the movement, of rolling stock for the purposes of operating a railway service.

SFAIRP: Abbreviation for So Far As Is Reasonably Practicable.

Train Detection System: Equipment and systems forming part of or providing input to the signalling systems to detect –

- (a) the presence or absence of vehicles within the limits of a track section; or
- (b) that a train has reached, is passing or has passed a specific position;
- (c) that all the ends of a train are always detected.

Train Protection and Warning System (TPWS): combines the elements of AWS with some train protection elements. This system will stop a train that passes a signal at danger within the overlap area beyond the signal

Rail Based: Within the rail easement, within the track right-of-way and relevant to Rollingstock Structure and Clearance Gauge.

2 General

2.1 General requirements for train detection systems

This section specifies the general requirements for train detection systems.

Train detection equipment should operate reliably with ambient free-air shade as a guide on temperatures between -10 °C and 60 °C, and equipment housing temperatures up to 70 °C. Within the relative humidity ranges from 20% to 100% condensing.

Where track flooding may be encountered, train detection and any subsequent system integration and or protection/control measures should be defined by the RIM, to ensure the system meets the specific RIM operational requirements which are generally based on the site-specific risks.

Train detection equipment shall be vandal and tamper resistant.

The performance of Train Detection equipment shall not be adversely affected by the use of enclosures and housings.

All train detection equipment, irrespective of the classification into which it fits, shall be provided with effective protection against electromagnetic interference where this is necessary to ensure correct and reliable operation and avoid permanent damage.

External sources of EMI may include 50 Hz AC mains, conducted and radiated electrical noise generated by rolling stock with electronically switched traction systems operating under 1500 V DC traction, and under body induced noise from 3-phase induction traction motors in both electric and diesel-electric rolling stock. Internal sources of EMI include noise generated by BRB 930 series relays, and high voltage impulse track circuits.

All electrical circuits and terminations used in train detection systems shall be of RIM approved corrosion resistant materials or protected from corrosion.

Systems should operate and perform the intended function without readjustment during normal weather variations, such as rain, sleet or snow.

Personnel engaged in installation, maintenance and decommissioning shall not be exposed to electrical hazards due to incomplete or faulty bonding or fault currents (step and touch voltages).

All train detection equipment shall be designed and installed to operate reliably in the environmental conditions in which it is to be located including additional stresses generated by weather events. In particular equipment may be situated in areas that may experience –

- (a) high temperatures
- (b) cyclonic wind conditions with associated heavy rainfall and water run-off
- (c) frequent lightning strikes
- (d) extended periods with little or no rainfall
- (e) airborne dust.

Where possible, train detection equipment should be modular in design, to facilitate rapid replacement of failed modules and restoration to normal operation:

- (a) Equipment modules of train detection equipment should have suitable coding to prevent insertion of any unit of incorrect frequency or type where such insertion would present a safety or functional risk.
- (b) Wiring terminations on rack-mounted modules should be provided with means to eliminate the possibility of incorrect connections being made when a module is replaced. Alternatively, modules should be so designed that no misconnection can render the train detection system less sensitive than before the change.
- (c) Modules should be so designed that no misconnection can render the train detection system less sensitive than before the change.
- (d) All modules of the same type and frequency should be interchangeable without adversely affecting location specific programming of the system. I.e. should be simple and require a minimum amount of reconfiguration.

Train detection systems shall provide for simple measurement and setting of correct operating levels, and any subsequent adjustments.

Train detection systems should provide consistent train detection performance throughout the range of environmental and operating conditions in which it is used, with minimum requirements for adjustment or recalibration required to compensate for varying environmental or track conditions.

Equipment and systems supplied and used for train detection systems shall be supported by the applicable procedure/maintenance manuals and Rail Transport Operator organizational policies.

Technologies used for detection of rolling stock shall be "fail safe" and be "type approved" by the RIM, based on proven technology and preferably in-service with other railway operators in high density traffic areas.

System performance shall not be adversely affected by other adjacent systems nor be adversely affected by normal track infrastructure, track supporting structures or non-metallic objects.

Systems shall not be adversely affected by any vehicle/rail car on an adjacent track.

Systems performing a speed measurement function shall be designed to provide vehicle/rail car detection down to zero speed within the limits of the detection system.

Train detection systems shall be designed to provide detection continuously when a vehicle/rail car is stopped within the limits of the detection system.

System design shall be such that any component failure shall not result in an unsafe condition and shall change the operation of the system so that the failure is evident and output is forced into a more restrictive state.

Detection of a vehicle/rail car presence using rail based train detection systems unless stated otherwise, shall occur within 1 second of occupancy within the designated area.

Detection systems shall be capable of detection when the vehicle/rail car enters the area protected by the system and shall maintain detection until the vehicle/rail car has passed beyond the limits of the protected area.

Unless it can be shown that the risk of a train becoming divided is acceptably low, the train detection system shall be capable of identifying and safeguarding against the effects of train division.

2.2 Reasons for the provision of train detection systems

Train detection systems perform a safety critical function providing the signalling system with timely information on the position of trains and the occupancy status of track sections. This is essential to perform its primary function of preventing collisions and derailments.

The principal reasons for providing train detection systems, as a sub-system within the train control system, are –

- (a) to maintain safe train separation;
- (b) to manage risk at level crossings; and
- (c) to assist with traffic management.

2.3 Provision of train detection systems

Train detection systems shall be provided where –

- (a) the safe operation of the train control system is dependent on accurate and up-to-date information on the position and movements of trains; or
- (b) information on the position and movements of trains is required for the control of level crossings, staff warning systems or other systems associated with safety of train operations; or
- (c) it is necessary for the signaller to know the position of trains for the safe operation of the railway.

2.4 Detectable rolling stock

The train detection system used shall take into account the operation of detectable and non-detectable rolling stock. Rolling stock is assessed using the process described in AS 7501.

Detectable (by track circuits) rolling stock is defined in AS 7505.

2.5 Integrity and reliability of train detection systems

The reliability with which train detection systems detect and indicate the presence, absence or passage of trains shall be consistent with the overall safety performance targets for the train control system of which they form part, taking account of –

- (a) the purposes for which the train detection information is required to be used and the possible consequences of an error in that information;
- (b) any additional features within the train control system which provide safeguards in the event of incorrect operation of the train detection equipment; and
- (c) any train-borne equipment provided to achieve (or assist in the achievement of) reliable actuation of the train detection systems (e.g. track circuit actuators).

Train detection systems shall be designed, applied and maintained in a manner which minimises the risk to trains, the public and railway staff, from failure of –

- (a) the train detection system;
- (b) the means of communication of train detection information to the Interlocking system or other systems; or
- (c) associated power supplies.

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

Train detection systems and equipment shall meet the reliability requirements set by the Rail Transport Operator.

- (a) The mean time between failures (MTBF) for train detection systems and equipment should not be less than 25 years.
- (b) All train detection systems shall be designed and implemented such that NO single component or single point of failure can result in unsafe operation.

All new train detection equipment shall be designed and meet safety integrity level equivalent to SIL 4, as defined in EN 50129 Railway applications — Communication, signalling and processing systems — Safety related electronic systems for signalling.

Train detection systems shall be fail-safe in design; application and operation, in such that If any component or connection in an operating train detection system fails in any mode, open circuit, short circuit or an intermediate condition, the track section itself and/or one or more of the two contiguous track sections shall immediately indicate a 'detected' state.

Train detection systems which rely on memory devices, e.g. axle counters, shall incorporate a safe means of bringing them back into use following any maintenance or other disruption or failure.

2.6 Suitability of train detection systems

The means of train detection, and the method of communication of train detection information to the interlocking system or other systems, shall be suitable for the purposes for which the train detection information is required to be used. Selection of a suitable system shall encompass, at a minimum, the following factors:

- (a) The requirements of the train control system and/or the signaller for train detection information.
- (b) The length of track sections over which detection is required.
- (c) The level of accuracy and detail of train position information required for the safe operation of the railway.
- (d) Permanent way layouts and associated critical dimensions.
- (e) Requirements for the control of level crossings and train activated warning systems.
- (f) The need for any directional and/or speed information.

The train detection system shall be compatible with the traction and detectable rolling stock.

- (a) Compatibility with rolling stock parameters required to ensure correct operation of the train detection equipment, including vehicle wheelbase, bogie length, wheel profile, wheel/rail contact and vehicle overhang.
- (b) Electromagnetic compatibility.

The train detection system shall be suitable for the conditions in which it is to be installed and operated. Consideration shall be given to the following, insofar as they are relevant to safety:

- (a) Environmental conditions.
- (b) Compatibility with electrification systems (where present).
- (c) Compatibility with other infrastructure systems.
- (d) Compatibility with infrastructure maintenance and renewal processes.
- (e) Ballast condition.
- (f) Rail section.
- (g) Other steel.
- (h) Guard rail.
- (i) The co-existence of any electric traction system.
- (j) Interference from other sources.

In determining the type of system to be used, any secondary safety benefits and/or disbenefits shall also be considered.

2.7 Outputs from train detection systems

Outputs from the train detection system shall be presented as defined states (e.g. track section occupied or clear; vehicle present or no vehicle present at a specific location).

Transitions between these defined states shall not give rise to unsafe conditions. The train detection system and/or the associated train control systems shall be designed so as to ensure that no permanent or transient unsafe effects or misleading indications can result from any change of state in response to the presence or movement of a train.

2.8 Additional requirements for train detection systems used to prove that a track section is clear of trains

2.8.1 Output states

Where a train detection system is provided for the purpose of proving that a section of track is clear of rolling stock, the state of each track section shall be presented as clear or occupied. An occupied output state shall be given by the train detection system whenever all or part of the track section is detected as being occupied by rolling stock.

2.8.2 Continuity of train detection

Where the safe operation of the train control system is dependent upon continuity of train detection, there shall be no loss of detection at boundaries between track sections. Where a track section is divided into portions (e.g. track circuits through switches and crossings), there shall be no loss of detection of entire vehicle for any time passing between different portions of the track section.

2.8.3 Minimum length of track sections

The train detection system shall be designed such that no track section can be detected as clear while straddled by any detectable rolling stock. Where the train detection system does not inherently provide this feature, this requirement shall generally be achieved by ensuring that track sections exceed a specified minimum length.

2.8.4 Clearances

Train detection systems for proving the track clear shall be applied so as to ensure that acceptable clearances as specified in AS 7633 are maintained at all points and crossings and converging tracks, taking account of any line curvature and the maximum vehicle overhang of permitted rolling stock. Where a track section contains points and/or crossings, train detection provision shall at minimum extend to all applicable clearance points. It is permissible for train detection controls within the interlocking system to be conditional upon the position of points provided there is no risk of a vehicle standing foul and remaining undetected.

2.9 Interface management

Where there exists a planned railway activity interface which involves other parties, other functional areas or other railway operators, if documented processes are not already in place, an interface agreement and co-ordination plan should be established.

Any agreed interface arrangements shall clearly delineate the responsibilities of each party or functional area involved.

Interface arrangements should include the following:

- (a) Determination of the functional areas inside each organization which will be involved and the interfaces across which coordination needs to be established.
- (b) Determination as to which party agrees to accept responsibility for each item of subject matter identified.
- (c) Procedures for the exchange of safety information and for regular review of the arrangements
- (d) Procedures for assessing and monitoring the compatibility of engineering and operational parameters.
- (e) Procedures for assessing and monitoring the compatibility of engineering and operational parameters.