

Signalling Principles and Practices for the Adelaide Metropolitan Passenger Rail Network

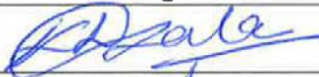



Engineering Standard

Rail Commissioner

PTS-AR-10-SG-STD-00000068

DOCUMENT CONTROL

Document Status

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Document Review Schedule:		This document is due for review as required.	

Document Amendment Record

REVISION	CHANGE DESCRIPTION	DATE	PREPARED	REVIEWED	APPROVED
0	Initial Issue	Sept 11	James Wong	Mayank Jain Simeon Cox	
1	Updated to PTS O&M comments	Mar 12	Simeon Cox	Mayank Jain	Brian Green
2	Updated to include CBI and Axle Counter content	Sep 17	Kuldeep Zala	Oluwole Odusanya Keith Charlton	Mayank Jain

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1. Introduction

The Department of Planning, Transport and Infrastructure (DPTI) owns and operates the Adelaide Metropolitan Passenger Rail Network (AMPRN) under the Rail Accreditation assigned to the Rail Commissioner. This Signalling Principles and Practices Standard forms part of the engineering management system (EMS) and is intended to ensure that the signalling system is not subject to any risks not deemed to meet the So Far As Is Reasonably Practicable (SFAIRP) principles under Rail Safety National Law (RSNL).

This standard is intended to be read and applied by signal designers familiar with the principles and terminology generally employed by signalling design engineers when performing tasks based on, or broadly complying with, signalling design practice.

It has been assumed that all signal designs undertaken in relation to the implementation of these principles shall be based on, and adopt processes which comply with, the requirements of AS.4292.4-2006 "*Railway safety management - Signalling and telecommunications systems and equipment*" or the most recent version of the South Australian Rail Safety National Law Act (South Australia) 2012.

This standard has been developed to clarify the implementation of standard railway signalling design practices as applied within the AMPRN. Where considered appropriate it also details the interpretation and application of specific design measures and practices required to be implemented to meet the operational needs of the AMPRN railway.

1.1. Action in the Event of Design Conflict

The primary and overriding requirement of this standard is to design and implement solutions which support the safe operation of the AMPRN. Where this standard appears to conflict with the requirements of any other DPTI standard or where the applying designer is concerned that the principles described do not satisfactorily address safety "So Far As Is Reasonably Practicable" (SFAIRP) the matter shall be referred to the Unit Manager Signal and Control System Engineering for resolution.

2. Purpose

The purpose of this standard is to describe signalling principles as applied to the design and application of signalling infrastructure installed within the AMPRN.

3. Scope

This standard describes the general principles to be adopted when designing signalling infrastructure for application within the AMPRN and is to be used by:

- DPTI Rail Maintenance functional areas,
- DPTI Rail Operations functional areas;
- DPTI Rail Projects; and
- DPTI contractors to the extent specified in their contract.

These principles shall be applied to all new works within the AMPRN. Where significant alterations to existing works are required these principles shall be followed wherever possible unless agreed otherwise in writing by the Unit Manager, Signal, and Control System Engineering. The Unit Manager, Signal and Control System Engineering may direct the preparation of a waiver in accordance with the PR-AM-GE-807 *Approval of Technical Standards and Waivers*.

This standard does not apply to the following rail infrastructure found within or adjacent to the AMPRN:

- The Adelaide light rail (tram) network;

- Non-signalled rail yards, depots and stabling yards.

Application of this Standard must consider that a limited number of broad gauge freight movements do operate on the AMPRN under the control of other rail operators and that at selected locations standard gauge freight and passenger movements cross the AMPRN.

Where there is a contradiction between Signalling Principles & Practices and AMPRN Rules and Procedures, the AMPRN Rules and Procedure shall predominate.

This standard does not detail the principles associated with the European Train Control (ETCS) Automatic Train Protection (ATP) system. These requirements are detailed in the separate document, *SG1-DOC-000928 Automatic Train Protection: Signalling Principles*.

4. Related Documents

DOCUMENT NAME	DOCUMENT NUMBER
Adelaide Metropolitan Passenger Rail Network Rules and Procedures	
Approval of Technical Standards and Waivers Procedure	PR-AM-GE-807
Rail Revitalisation –Signalling & Communications Project – Signalling Principles Specification (KNet #10289326)	AR-WS-EM-SPC-03100093
Axle Counter Reset Procedure	PR-OS-GE-344
Axle Counter Sweep Bypass	WI-EM-CTC-856
Axle Counter Corrective Maintenance	WI-EM-SP-333

5. References

- Rail Safety National Law Act (South Australia) 2012
- AMPRN Rules and Procedures
- AS7658 *Level Crossings*
- AS1742.7 *Manual of Uniform Traffic Control Devices. Part 7 Railway Crossings s*
- AREMA Communications & Signals Manual of Recommended Practices
- AS.4292.4-2006 “*Railway safety management - Signalling and telecommunications systems and equipment*”
- SG1-DOC-000928 Automatic Train Protection: Signalling Principles.
- CS4-DOC-000446 Standard for Railway Pedestrian Crossings
- PR-AM-GE-807 *Approval of Technical Standards and Waivers*.

6. Definitions and Acronym

TERM	DEFINITION
See Appendix 1	

7. Introduction to AMPRN Signals

7.1. Signal Types & Classifications

All main line signals on the AMPRN are of the single head, multi-aspect, incandescent or LED type. All low speed and ground shunt signals are of the position light type.

Signal aspects are used to provide speed and movement authority; these are augmented by route indicators to identify each unique destination. All signals displaying a main aspect with a route indicator are classified as Medium Speed Aspects.

Red, yellow, flashing yellow, green are provided for main aspects and white for subsidiary signals). See section 7.2 for full details of the aspect definitions.

All signals are classified as either:

- Absolute, or
- Permissive.

Route indicators are also used in conjunction with the signalled aspect to convey additional routing information to the driver. All signals displaying a route indicator either Junction Route Indicator (JRI) or Theatre Route Indicator (TRI) are considered to be Medium Speed aspects no matter what proceed aspect the main signal head is displaying.

7.1.1. Absolute Signals

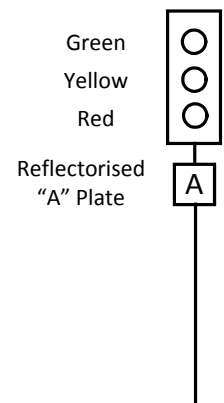
Absolute signals are defined as any signal which shall not be passed while it is displaying a stop (Red) aspect, without the driver first obtaining formal authority to do so from Train Control.

A signal is designated as Absolute if any part of its routes or overlap allowances contain any condition which may result in a potential conflict between two or more rail movements or other object, or where it is operationally advantageous to do so.

Absolute main aspect signals are distinguished by a white, square reflective marker plate with a black letter 'A' positioned vertically below the main signal aspect on the same post.

Absolute main aspect signals may display Red, Yellow, Flashing Yellow or Green aspects which may, under some circumstances, be accompanied by either:-

- Multi-lamp Junction Route Indicator (JRI) or
- Theatre Route Indicator (TRI)
- A Low Speed Subsidiary aspect and
- Stencil Route Indicator



7.1.2. Ground Shunt Signals

Ground shunt signals are standalone Absolute signals provided to control departures from sidings and shunting movements on the mainline and within yard areas. Ground shunt signals display either a stop aspect (one red and one white light) or a proceed aspect (two white lights in a diagonal



configuration). Ground shunt signals may be displayed in conjunction with a stencil route indicator where more than one route exists.

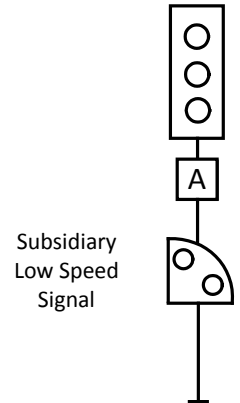
Ground shunt signals provide authority to the driver to proceed at low speed being prepared to stop clear of any obstruction. All ground shunt signals are designated Absolute signals.

7.1.3. Low Speed Subsidiary Signals

Absolute main aspect signals may be fitted with a position light subsidiary signal mounted directly below the “A” marker plate, on the same post.

These signals display two white lights in a diagonal configuration and provide authority to the driver to enter an occupied section of track at low speed being prepared to stop clear of any obstruction. The normal state for a subsidiary signal is both white aspects extinguished.

Low speed signals are only illuminated in conjunction with a stop (red) aspect being displayed in the main signal head once an approaching train is proven to be at a stand and may be displayed in conjunction with a route indicator.



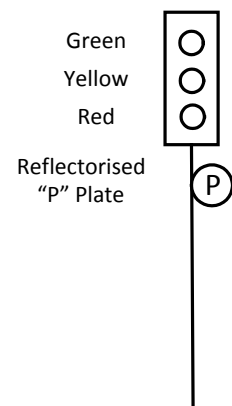
7.1.4. Permissive Signals

A Permissive signal is defined as a main aspect signal which may be passed while it is displaying a stop (red) aspect without the driver first obtaining formal permission to do so from Train Control. Regulations require the train must be brought to a stand at such signal for at least 1 minute and then proceed to pass the stop signal in accordance with the AMPRN Rules & Procedures.

A signal may be designated Permissive if its route or overlap allowance does not incorporate any condition which may result in a potential conflict between two or more rail movements or other object, and it is not designated an Absolute signal for any other reason.

AMPRN Permissive signals are distinguished by a round, white reflectorised marker plate with a black letter ‘P’ positioned diagonally below the main signal aspect. AMPRN Permissive signals may display either red or yellow, flashing yellow or green aspects. Permissive signals are generally automatic signals with no control facility but under location specific operational requirements, Train Controller at Operations Control Centre (OCC) is able to replace some selected permissive signals.

Where Permissive signals are driven directly from a computer based interlocking, a replacement control will be provided to allow the Train Controller to control the signal to a stop (red) aspect.



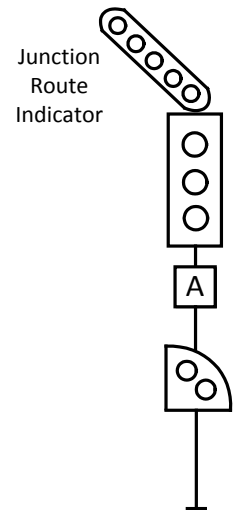
7.1.5. Supplementary Indicators

Junction Route and Stencil Route Indicators are supplementary indicators positioned above the main or ground shunt signal to provide

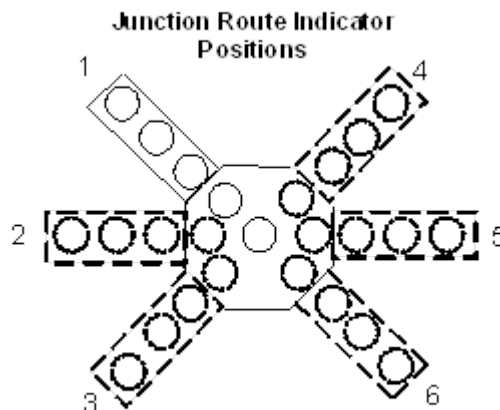
additional routing information to the train driver where there is more than one route ahead of the signal.

7.1.5.1. Junction Route Indicators

Multi-Lamp Junction Route Indicators provide the driver with information through the use of 5 illuminated white lights which provide a long distance indication of the direction and sequential number of diverging route set. The indication is considered correctly displayed if at least 3 of the 5 aspects are lit (therefore a JRI with 2 or less aspects lit is considered invalid). All JRIs when lit, will be proved continuously in the main signal aspect controls. See section 7.1.5.1.1 below for details of the lamp proving application



Junction Route Indicators are presented in one or more of six possible positions on each signal to which they are fitted. Junction Route Indicators are used primarily for a diverging route on the main line with Position 1, 2 and 3 for the 1st, 2nd and 3rd diverging route to the left and 4, 5 and 6 for the 1st, 2nd and 3rd diverging route to the right as shown in the figure below. Where the possible combinations of route are more complex than achievable with this number of indications then a Theatre indicator must be used.



7.1.5.1.1. LED Junction Route Indicator Lamp Proving

On the Seaford line, LED lamps are used to provide the JRI indications, the adopted practice is to have the lamp closest to the main aspect (pivot) equipped with a wide angle module. All other lamps are generally fitted with intermediate range modules.

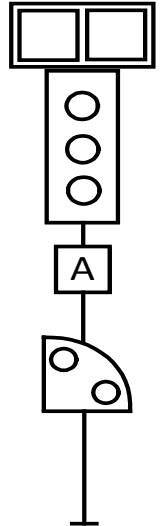
The wide angle LED modules have a current consumption approximately twice the value of the intermediate range module. Therefore proving the exact number of modules lit can be impossible using conventional current detection. In these cases the lamp proving threshold will be set to a value just below the sum of the current with all five modules lit subtracted by two times the value of the lowest module current draw. This means that the loss of any combination of three modules will be proved; however, this will result in some failures where the loss of only two modules will result in the loss of lamp proving.

In the WESTRACE Object Controller areas (as exist on the Seaford line), where two or more JRI indications are provided, the common pivot light are driven from a separate CBI output; the lamp proving of these are directly cut into the signal aspect controls as well as the proving of at least two modules lit in the remaining four. However, within SSI TFM areas, the pivot light is driven by a separate output, but is lamp proved in combination with the other lamps.

7.1.5.2. Theatre Route Indicators

Theatre Route Indicators provide a function similar to a junction route indicator except that they provide the driver with information through the use of one or more illuminated alpha numeric characters to convey information regarding the destination authorised for the train movement. Designed to be visible at long range, Theatre Route Indicators are used for main line signals where more complex route information is required than can be delivered with a Junction Route Indicator. A Theatre indication is lamp proved within the signal aspect controls.

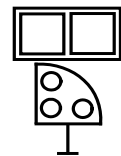
Theatre Route Indicator



7.1.5.3. Stencil Indicators

Stencil Route indicators are associated with shunt signals or subsidiary signals where there is more than one route available from the signal. The stencil indication is not lamp proved within the signal aspect.

Stencil Route Indicator



7.2. Signal Aspect Information

The physical form of the mainline signals used within the AMPRN signalling system comprises a single signal head unit with one to three aspects depending on the characteristics of destination route requirements, to provide the driver with authorised signal route information. The meaning and interpretation of the signal aspects is contained within the *AMPRN Rules and Procedures*.

SIGNAL ASPECT	TITLE	TRAIN CREW ACTION
Red	Stop	Must only be passed in accordance with the Rules.
Red with two white Lights (may be displayed in conjunction with a Route Indicator)	Caution Low Speed	Proceed at Low Speed to the next fixed signal, expecting the line ahead to be occupied. Prepare to stop at the obstruction or next fixed signal.
Yellow	Caution Normal Speed	Proceed at Normal Speed and prepare to stop at the next signal
Green	Clear Normal Speed	Proceed at Normal Speed, expect the next signal to indicate (Caution or Clear) Normal Speed
Flashing Yellow	Reduce to Medium Speed	Proceed at Normal Speed and prepare to pass the next signal at Medium Speed

Yellow plus Route Indicator	Caution Medium Speed	Proceed at Medium Speed and prepare to stop at the next signal
Green plus Route Indicator	Clear Medium Speed	Proceed at Medium Speed, expect the next signal to indicate a caution or clear aspect for either Normal or Medium speed

Note: Where a number of medium speed aspects directly follow on from each other, (such as through a complex series of junctions), then only a single Reduce to Medium Speed aspect is provided before the first Medium Speed aspect. Therefore, two successive signals cannot display a Flashing Yellow aspect. Similarly, no signal can display a Flashing Yellow + RI simultaneously.

7.3. Signal Spacing and Headway Requirements

Consecutive signals shall be located a minimum of service braking distance apart. Braking distance shall be determined from the worst case service braking performance of all traffic types and rolling stock operating at the maximum permissible speed along the section of track in which the signal is located.

A 10% tolerance shall be added to any calculated service braking distance to allow for braking inaccuracies. Where it is considered impractical or prohibitive to provide the full 10% tolerance, a reduction may be considered, provided all of the following requirements are satisfied:

- The risks associated with a reduction in the calculated braking distance are demonstrated to be within acceptable levels.
- Design assumptions are clearly stated and recorded
- All operational and signal sighting requirements can still be satisfied.
- DPTI approval is obtained

Calculation of braking distance shall include consideration of differences in maximum allowable route speeds where there is more than one signalled route from the signal.

Calculation of braking distance shall include consideration of falling or rising track grades which may occur over the length of the track section in question. In addition to that, it shall also include driver reaction time for signal reading and braking and rail car braking delay time.

Unless specified otherwise within project documentation, signalling arrangements shall be developed to support the following green aspect headway requirements:

Network Area	Maximum Theoretical Green Aspect Headway
Inner Area (The area bounded by Torrens Junction, Adelaide Yard, Mile End, Keswick and Goodwood, incl.)	2 minutes (Express) 3 minutes (Stopping)
Outer Area (All other parts of the AMPRN not classified as Inner Area)	3 minutes (Express) 4 minutes (Stopping)

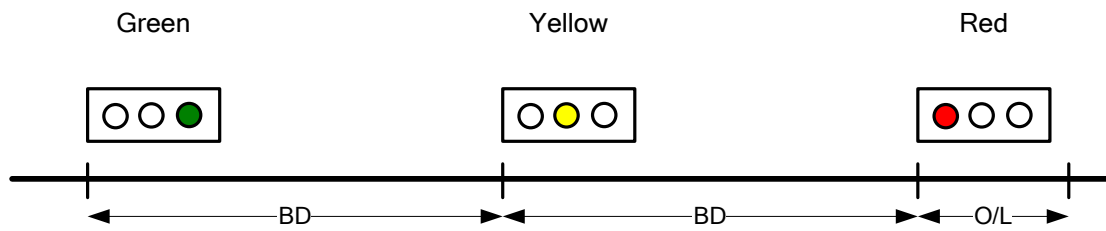
Unless advised otherwise by DPTI all signal braking and headway design calculations shall be based on the following:

- AMPRN Service Acceleration Rate - Refer to Appendix 2
- AMPRN Service Braking Rate - Refer to Appendix 3
- Minimum Sighting Distance - 8 seconds at maximum section line speed
- Overlap Distance - Refer to signal plans (180 m nominal).
- Stopping Dwell Time - 20 seconds (nominal).
- Train length - 3000 class (per 1 car set) = 26 m
4000 class (per 3 car set) = 75 m

7.4. Signal Spacing / Aspect Sequencing

The following sections provide illustrative examples of the application of signal aspect and junction signalling information for the AMPRN.

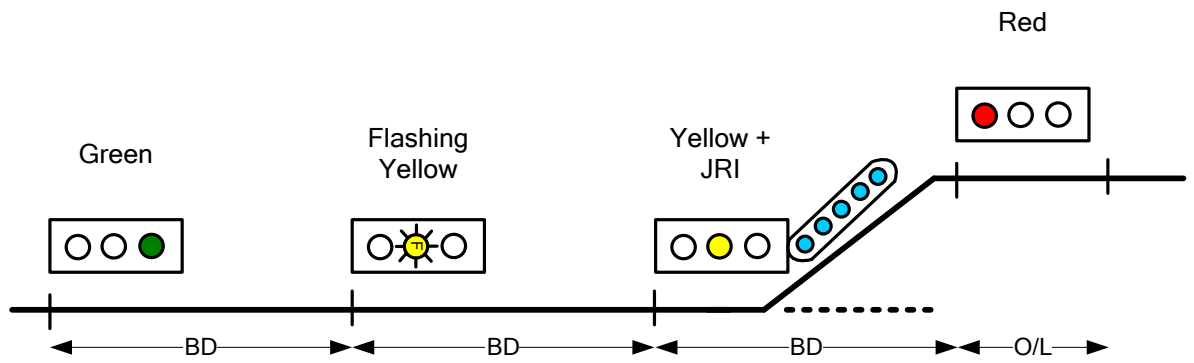
7.4.1. Non Divergent Track



Where BD = Braking Distance (minimum)

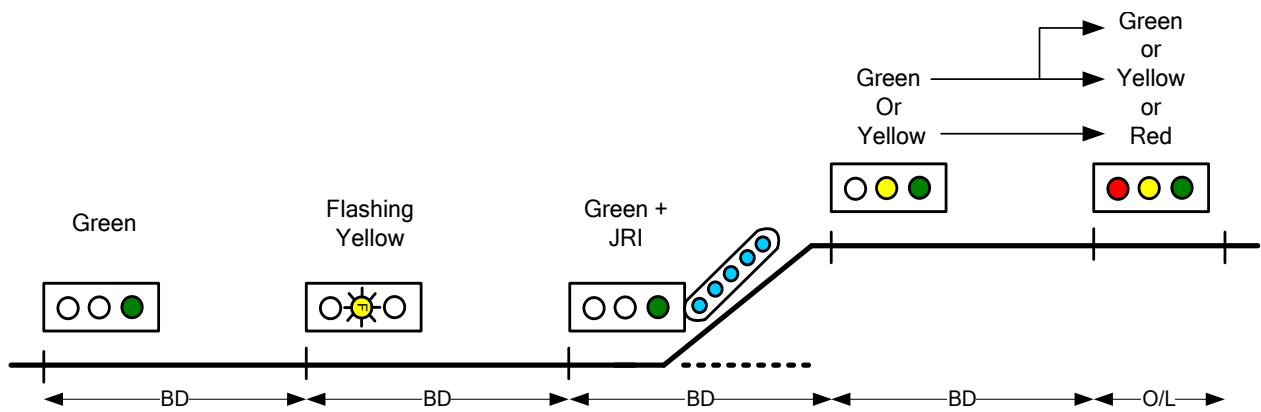
O/L = Overlap Distance

7.4.2. Divergent Track



Where BD = Braking Distance (minimum)

O/L = Overlap Distance



8. Track Section Detection Requirements

8.1. General

Every signalled route including the overlap shall be provided with an appropriate means for detecting the occupancy of each track section. This excludes those portions of shunt or low speed routes where track section detection does not need to be proven prior to displaying an aspect giving a movement authority.

The number and locations of track sections shall be selected to maximise the operational flexibility and availability of the railway asset (refer Section 8.10 below).

Design and installation of all detection equipment shall be in strict accordance with the manufacturer's recommendations.

The following Train Detection systems are deployed on AMPRN:

- Medium voltage DC track circuits
- Axle counters.
- Audio Frequency Jointless track circuits (TI21).

There can be significant differences between the drop-away and pick-up times of different types of track circuit due to tolerances in manufacture and set-up of the same type of track circuit. In extreme cases this can be such that the rear track may register clear before the forward one registers occupied. The detection of the vehicle is therefore momentarily lost, resulting in a wrong side failure, which could permit the irregular release of vital interlocking.

Care shall be taken when designing to ensure that different response times of adjacent track detection equipment of different types do not increase the risk, as significant differences in response times can be seen between different types of track circuit and when passing from one type to another.

To overcome this, additional time delays must be built into the pick-up time of track repeats, the precise requirement being dependent upon the combination of track circuit types involved.

These issues should be managed by:

- the addition of one or more slow to operate relays when DC track circuits are used with relay interlockings, or;
- additional delay incorporated into the Computer Based Interlocking(CBI) interlocking system in accordance with manufacturers application guidelines, or;
- the use of train detection equipment featuring inherent activation delays (Jointless track circuits TI21).

The primary detection relay shall not be used directly within interlocking circuitry or functions unless it incorporates the minimum delay using one of the above methods.

All indications of track vacancy status shall be derived from the last repeat function for the relevant track section.

The use of axle counter tracks puts additional requirements on the interlocking and the following sections detail these requirements.

8.2. Axle counter Function Use

All new axle counter installations shall have two inputs per track section:

- Track clear (TPR) and
- Track occupied (TCR)

The TPR function proves the track clear input high and the track occupied input low.

Internal to the object controller or interlocking shall be a second track repeat (T2PR) that includes the Aspect Restriction data. Use of these track functions shall be as follows.

The TPR is used for all track clear functions in the approach locking look back, TORR and route locking (sub routes and sub overlaps). This function also indicates track clear with aspect restriction imposed on the panel.

The T2PR is used in the aspect control of main signal aspects and route locking (sub routes and sub overlaps). This function also indicates track clear on the panel.

The TCR function will prove the TCR input high and the TPR input low. This function is used for the release of approach locking and to start timers for the release of route locking.

Back contacts of the TPR and T2PR functions are not to be used in the release of any locking functions.

8.2.1. Timing Constraints

The axle counter system has a number of timing delays which must be considered within the design of the interlocking data. In particular where the serial communications network is used to transmit changes in status.

Typically, the communications network is designed to have a high availability to ensure the system can cope with the loss of individual messages. Therefore following a communications failure the interlocking will declare the link failed only after a nominated timeout during which no messages were received from the axle counter. In this situation the interlocking memory will declare the track section undefined with both the TPR and TCR bits set low.

During the nominated delay, there is an opportunity for a track section to remain clear in the interlocking, once occupied by a train for the communications link timeout period; therefore if the train is short and moving fast, the train may effectively disappear from the interlocking and potentially release route locking etc.

This issue is a particular problem where adjacent tracks are reported to the interlocking from different Axle-Counter Evaluators, as the communications failure may only affect the second evaluator.

Therefore careful consideration is required in the application data to ensure no opportunity exists for the false release of locking or any other unsafe situations to occur during a communications failure. This is achieved by defining the likely failure modes and the maximum delays likely to be experienced during failure conditions. Suitable mitigation will

then be required to ensure these delays do not provide opportunity for an unsafe situation. Such mitigations may include:-

- Sequential proving of track sections (not allowing a track to clear unless the next section is proved occupied).
- Increasing the pick-up delay of track sections to ensure this is longer than the maximum delay to the occupation of the next section. Which is the approach used within this area but only between object controller boundaries.

8.3. Axle Counter & Axle Counter Resetting

The interlocking system must be designed to allow axle counter sections to be reset safely in the event of failure and during initial setup and commissioning.

There are typically a number of failure modes that will require an axle counter to be reset. These different modes each need to be dealt with following a safe procedure that ensures a track section is clear before a main aspect movement authority can be given by the signalling system.

Failure modes and maintenance or testing modes that require axle counters to be reset can be summarised as follows:

- Failure Mode 1: System operational with different count and last count was out of section
- Failure Mode 2: System operational with different count and last count was into section.
- Failure Mode 3: System in service, not operational and power restart.
- Failure Mode 4: System not in service, not operational and power restart.
- Failure Mode 5: Object controller start up during commissioning.
- Failure Mode 6: Object controller start up during maintenance or failure.

8.3.1. Axle counter Reset Requirements

The following requirements are defined for the resetting of an axle counter section:

- All unplanned resets are to be a co-operative process i.e. the process is a two stage event of reset followed by restoration to service. Such a reset can only occur with the cooperation of more than one party. These parties can mean train controller, train driver or technician. Where a disruption to the axle counter system is planned such as the operation of a high-rail vehicle, then the reset may be performed by a single person through the use of an operational procedure.
- All unplanned resets of in service tracks require a sweep through the section before any Main signal aspects over the section can be displayed.
- A train undertaking a sweep through must not be allowed to turn-back without covering full extent of track- (covered by operating procedures)
- Where multiple paths are available on an axle counter track section (such as over a set of points), each path will require to be swept before normal operation commences. However, where the extremities of the diverging tracks remain foul of each other (i.e. where the rail centres are less than 4-metres apart), a single sweep can be used.

- Release any route locking held by the occupied track section 60-seconds after the track is reset. This route locking release does not require a track sweep therefore enabling alternative routes to be set following the reset. However, any associated aspect controls from the track section will still require a sweep.
- Release of any level crossings closed by the occupied track section 25-seconds after the track is reset. This release does not require a track sweep.
- Reset is only possible from the control centre.
- Reset is initiated by two separate train control commands.
- Need to be able to commission an interlocking area without the need to run a train over every train path.
- Be able to shut down an object controller and re-start without the need to run a train over every track section or train path.
- The technician is able to by-pass the train sweep requirements using the technicians workstation

8.3.2. Failure Modes 1 & 2, Count Mismatch

System operational with a mismatch between the count in and count out. Note, if the count out is greater than the count in; the axle counter will fail, but can be reset using the Reset procedure as detailed in DPTI document *PR-OS-GE-344 Axle Counter Reset Procedure*.

8.3.3. Failure mode 3, Non-operational power restart

System in service, not operational and power restart.

This procedure requires a technician to attend site.

The Reset procedure shall be as detailed in DPTI document *PR-OS-GE-344 Axle Counter Reset Procedure*.

8.3.4. Failure Mode 4: System Commissioning

During system commissioning setup and during controlled closures it is not always practical to sweep every track as large areas of the railway would be affected and this would take considerable time.

The test engineer will need a system that is cleared up to enable through testing of routes and correspondence of line side equipment including points and main aspects. Until all tracks are full cleared up the interlocking will have route locking applied to all track sections and routes and points will not set and aspects will not clear.

During the commissioning or closures all resets shall be as detailed in DPTI document *PR-OS-GE-344 Axle Counter Reset Procedure*.

8.3.5. Failure Mode 5: Object Controller Commissioning

When an object controller is started with a track section occupied a full reset of the axle counter is required together with a track sweep as described in section 8.3.2. The technician sweep bypass can be used to sweep the track section providing the technician has assured themselves the track section is clear.

8.3.6. Failure Mode 6: Object Controller/Maintenance/Failure

When an object controller is restarted with the associated axle counter sections clear, a train sweep is required over the entire track section, including separate diverse paths where required. Driver cautioned or

given a low-speed signal, and verbally verifies section is clear. The technician sweep bypass can be used to sweep the track section providing the technician has assured themselves the track section is clear.

8.4. Axle Counter Sweep Bypass

When completing signalling/track works it is not always practical to sweep tracks. A special control shall be provided to enable the DPTI technicians/Electronic Signal Tradesperson (EST) to bypass the sweep under these circumstances.

The procedure shall be as detailed in DPTI Axle Counter Reset Procedure - PR-OS-GE-344

8.5. Axle Counter Sweep Bypass Road-Rail Vehicle

A facility is provided to allow for the operation of Road-Rail Vehicles on the network, providing facilities to place or remove vehicles from nominated track sections without requiring the sweep function to restore the track sections to normal operation following the disturbance to the track sections caused by such operations. The nominated locations are at all Road-Rail Vehicles level crossings and any other sections required by DPTI.

8.5.1. Placing of Road-Rail Vehicle on Track

Prior to the placement of the Road-Rail Vehicle the Train Controller must put protecting signals to stop or place the bi-directional block into the no-direction set position (if applicable). The section must be clear of trains. This is a manual operational procedure.

Train Controller then selects the appropriate track and clicks on command "Place Road-Rail Vehicle on Track."

The Road-Rail Vehicle is then placed online and allowed to depart the crossing.

The crossing track will fail due to the count out without an associated count in.

The interlocking verifies the Island track failure occurs within 5-seconds of the valid occupancy of the next track section to prime the reset of the failed track.

The Train Controller is free to reset the failed track using the reset procedure. The sweep will be bypassed providing the interlocking has proved that the only two tracks were occupied in sequence with the crossing track occupied first with no train approached the crossing.

8.5.2. Removal of Road-Rail Vehicle

When a high-rail vehicle is removed from the track at a nominated location, the axle counter will remain occupied with a positive count.

The Train Controller will be provided a "Remove Road Rail Vehicle" control for all nominated locations.

This control is enabled when the nominated track section is occupied together with the adjacent track sections clear.

The operation of this control will provide a dialogue box which reads "Confirm Road-Rail Vehicle track reset"

The acceptance of this reset will enable the axle counter reset execute command to be enabled. The operation of which will clear the track section for normal operation without the need for a sweep.

8.5.3. Cancellation of Road Rail Vehicle

If either place Road Rail Vehicle or remove Road Rail Vehicle have been selected it is possible to manually cancel the control by selecting the "Cancel Road Rail Vehicle" from the train control system.

8.6. Axle Counter Sweep Aspect at Absolute Signals

Once a track section has been reset, the Train Controller will be prevented from clearing a signal to a main aspect over the reset section until a sweep has taken place. (This also applies to a signal where the reset section is an overlap). During the operation of this sweep, the driver will proceed on sight after being authorised to pass the signal at danger and being advised to inspect the route and flanks.

Where a position-light aspect is provided on the signal, this will be used to give the driver the authority to proceed. Alternatively, the driver will be cautioned using the current procedure for calling a driver past a signal at stop with a route set but signal displaying a red aspect.

8.7. Axle Counter Sweep Aspect at Permissive Signals

Once a track section has been reset, the signal will be prevented from clearing over the reset section until a sweep has taken place. (This also applies to a signal where the reset section is an overlap). During the operation of this sweep, the driver will proceed on sight after being authorised to pass the signal at danger and being advised to inspect the route.

8.8. Axle Counter Sweep of Terminal Tracks

A terminal track is a single track section which is evaluated on the basis of a single counter head. Such sections typically exist in storage roads or terminal platforms, equipped with a buffer stop at one end of the section.

In this case, a train cannot be expected to traverse the entire track section as part of the sweep procedure.

In these cases, a train sweep will not fully pass over the full the track section, therefore only a technician sweep bypass will be used to fully restore these sections. The sweep bypass must only be undertaken after the technician has satisfied themselves that the track section is clear.

It is recommended all signals which read over terminal tracks shall be equipped with a low speed aspect, to allow restricted signalled moves into the section prior to the technician attendance.

8.9. Axle Counter Sweep over Points

Where multiple paths are available on an axle counter track section i.e. over a set of points, consideration should be given as to which paths will require to be swept before normal operation commences. In some instances the track could be proven clear by sweeping over a single lie of the points, this is where the sweep movement would satisfy that no vehicle is foul in the other lie of the points, generally this is where the other counting head is in close proximity to the clearance point; or where the tracks are within 4m of each other and a train driver can observe the track on the opposite lie of the points.

Where the other counting head is beyond the clearance point the track should be swept over both lies of the points prior to the re-engagement of the aspect disconnect function. The different scenarios are detailed in the following subsections:

8.9.1. Simple Points with Axle Heads at Clearance

In this example the axle heads are installed within 10 m of the clearance point and all paths over the points can be observed clear of obstructions when either path is swept (i.e. tracks are 4m or less apart). In this case only one sweep is required

8.9.2. Points with Long Section in at Least One Path

In this example both of the axle counter heads are installed greater than 10m from the clearance point of the turnout. After an axle counter reset a train will be required to transverse both paths before the sweep is completed

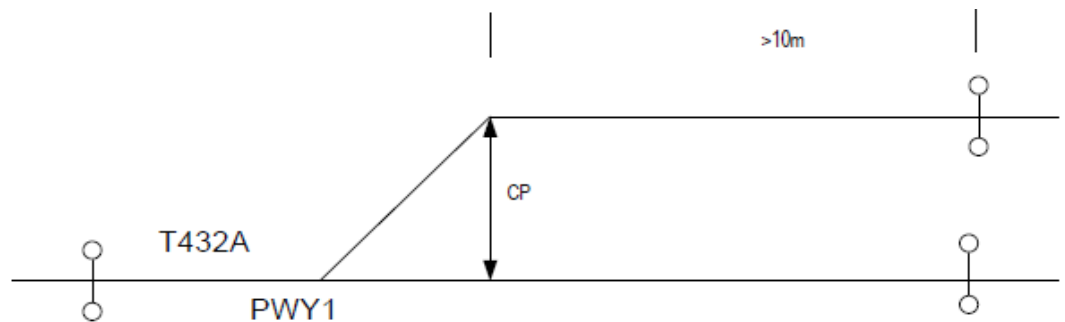


Figure 1 Points with long sections

In the case where only one head is more than 10m away from the clearance point then the sweep is only satisfied with a train passing through the long leg

So in the example below the sweep is only removed when the train travels over the points with PWY1 point left hand switch closed.

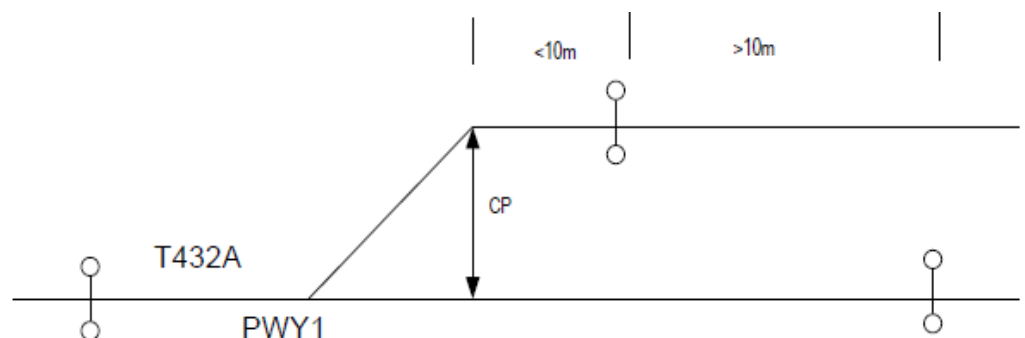


Figure 2 Points with one long section

8.9.3. Axle Counters in Crossovers

In this situation the axle counter head in the middle of the crossover will be foul.

Additional measures are introduced to protect routes against possible conflict with an undetected obstruction if the points are not normal at the time of failure.

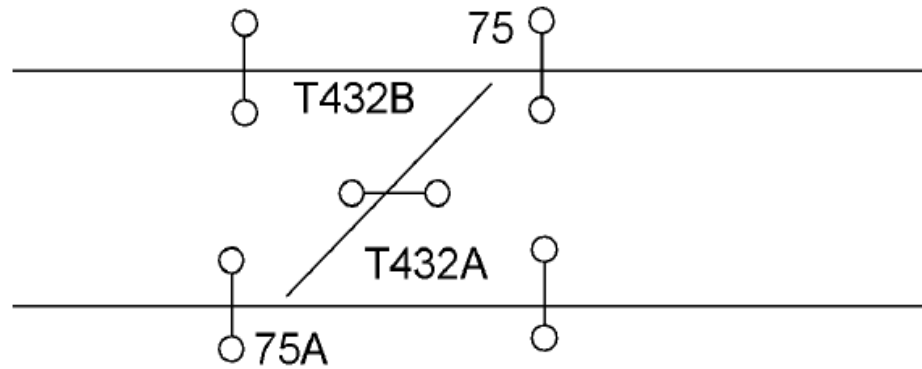


Figure 3 Axle Counters in Crossovers

Following the failure of the axle counter sections over the points, two scenarios need to be considered:

- Axle counter failure with the points set normal
- Axle counter failure with the points not normal

For scenario 1 the normal sweep provisions are acceptable

For scenario 2 there is a risk that an undetected vehicle over the points reverse will obstruct flank moves. To mitigate against this risk, initiating a reset of a failed axle counter initiates controls to force the adjacent , flanking track section false (T2PR down), restricting movements over the flank track until the sweep process has been completed.

So in the example above a reset following a failure of 432A track with 75A not normal causes the T2PR of 432B track to drop.

Consideration should also be given to the positioning of the axle counter heads in the parallel paths of the crossover to avoid the need for multiple sweeps.

Where the two ends of a set of points are separated at a distance where the intermediate joint is clear of the straight ahead route, two sweeps may be required as described in section 8.9.2.

8.9.4. Axle Counters in Ladder Point Arrangements

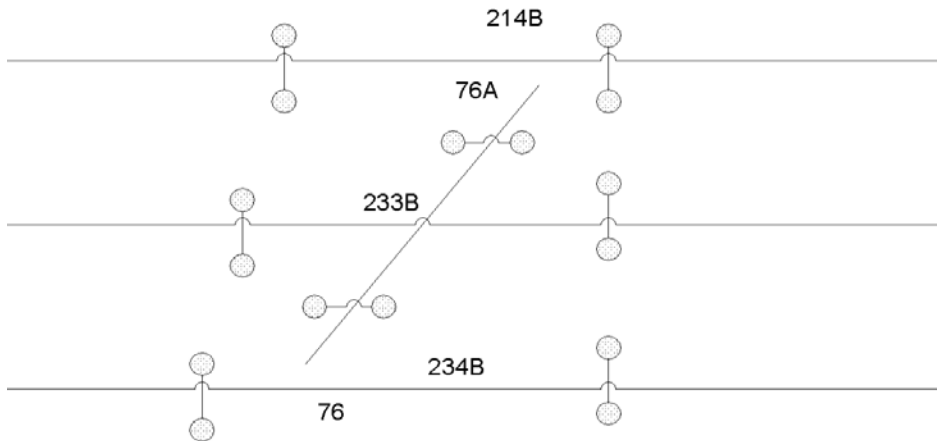


Figure 4 Axle Counter in Ladder Points

Based on the axle counters in the parallel lines being installed close to the clearance points the following conditions shall be met:

- 214B when reset causes the T2PR for 233B to drop with 76A not normal
- 233B when reset causes the T2PR for 214B and 234B to drop with 76A/76 not normal
- 234B when reset causes the T2PR for 233B to drop with 76 not normal

8.9.5. Complex Point Examples

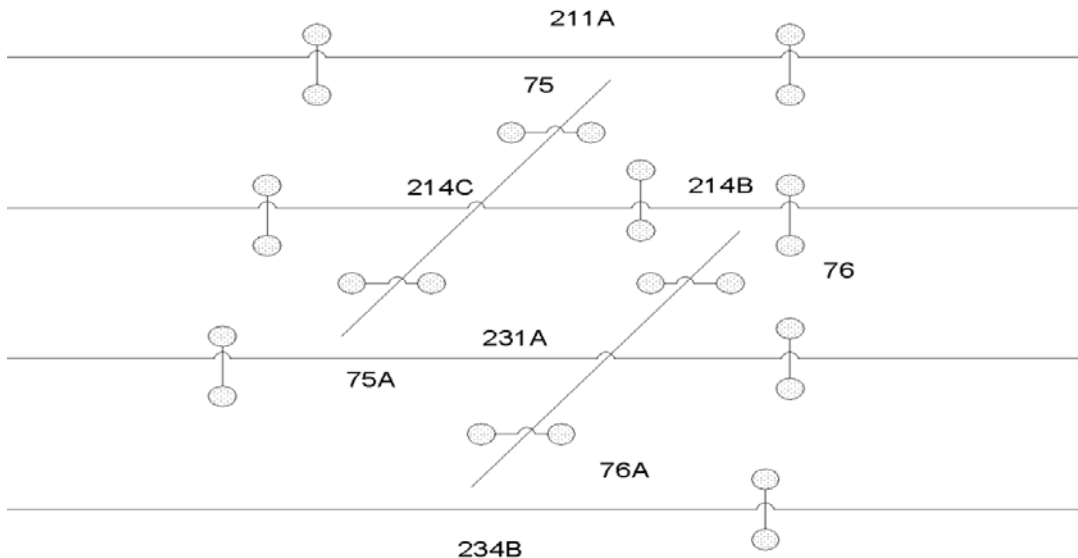


Figure 5 Complex Point

In this example Track section T231A is a flank track for multiple paths so:

- 214C is reset with 75/75A not normal or
- 234B is reset with 76A not normal or

- 214B is reset with 76 not normal

To remove the aspect disconnection it is necessary to sweep the track over 75 and 76 normal

8.9.6. Axle Counters in Crossovers with Track Circuits

In some cases axle counters are only used for half of the train detection for a set of crossovers or ladders. For example:

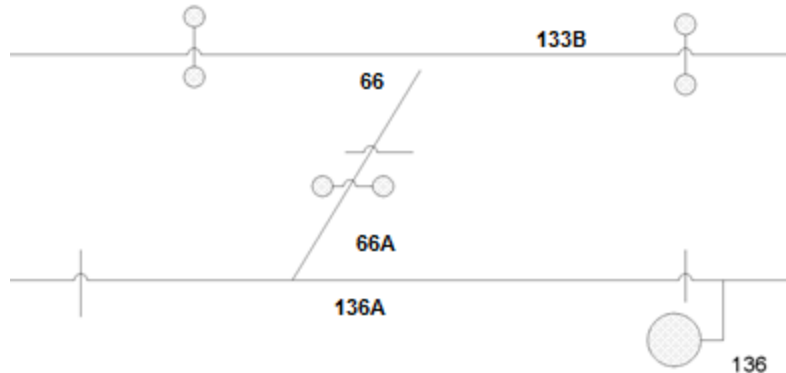


Figure 6 Complex Point

In this case the failure and resultant reset of the axle counter with 66/66A not normal will hold 136 at red until 133B track has been swept.

8.10. Track Sections

8.10.1. Approach Track(s)

Route Track sections located in rear of the entrance signal to a route and generally extending to the berth track to the previous signal or to a point at which the driver has seen or may have seen a proceed aspect at the signal or a previous signal that would indicate to the driver that the former signal is displaying a proceed aspect.

8.10.2. Level Crossing activation

Track sections located between the strike-in point for the level crossing and the start of the level crossing island track section.

8.10.3. Route Track(s)

Track sections that extend from the entrance signal of a route directly to the exit signal, or exit point, of that same route over which a train will traverse.

8.10.4. Overlap Track(s)

Track sections that extend from the exit signal of a route to a point identified as the “overlap distance” for that route.

Unless otherwise specified, overlap distance shall be 180 m. Reduced overlap shall be considered only as a last resort if standard overlap cannot be provided and signal position is constrained by the layout. In such cases, a documented risk assessment shall be conducted and mitigation applied e.g. approach release controls applied to the signal in arrears to control the speed of the train approaching the signal with reduced overlap.

8.10.5. Point Track(s)

Track sections that are located over each set of points that dead-lock the points when occupied and represent the extent of any sectional route locking. Depending on the complexity of the track layout, point tracks shall be subdivided as necessary to maximise the operational flexibility and availability of each set of points by the provision of multiple track sections.

8.10.6. Flank Protection by Points and Tracks

Flank protection will be provided where a risk assessment determines the track layout warrants additional protection.

When setting a route, facing points that are not in the line of route shall be set to divert any overrunning trains away from conflict with the correctly authorised train. When designing flank protection it is important that the consequence of any diverted train is considered. For example, it would not be acceptable to mitigate a potential side impact by diverting a train towards a potential head-on collision.

Where it is not practicable to provide flank protection by setting flank or trap points, and a significant safety benefit would arise, the provision of flank track section overrun detection at vulnerable signals should be considered. It may be initiated by overlap track section, or treadle, occupied without signal having cleared, or by sequential operation of track sections (e.g. overlap track occupied after berth track occupied). It may effect automatic replacement of conflicting signals and/or actuation of a signaller's SPAD alarm.

Where ETCS is provided, the system shall ensure all fitted trains will come to a stand within the overlap following a SPAD. Therefore on lines where the majority of trains will be ETCS fitted flank protection will not be required.

The Adelaide Yard area is provided with flank track protection continuously, with route-away controls. In axle counter areas the flank protection proving in the aspect control will require the track clear, route away (sub route de-latched) or the track clear for 60 seconds after being reset.

Note. Within the Adelaide yard area, some flank points are not locked within the interlocking, therefore when swung towards a failed track section, may cause the restoration of a clear signal aspect. However, where this track occupancy is the result of a valid occupancy of a track section by a signalled train, either the route locking will lock the points or the route-away controls will bypass the track control. This is a retained feature from the earlier control systems where the setting of flank points was undertaken non-vitally.

8.10.7. Fouls Track(s) and Fouling Points

A Foul track is a section of track not in the direct wheeled path of a signal route but with one of its extremities infringing the required clearance points for the signalled route. A vehicle standing on this track circuit is likely to be foul of a train on an adjacent line. In this case, the Foul track shall be proved clear in the signal aspect.

Fouling point is a point between two converging, or diverging, tracks beyond which the encroachment of any part of a vehicle would infringe the required passing clearance of a vehicle on the other track.

8.10.8. Other Track(s)

Track sections over which a train traversing a given route will not travel and which cannot be classified by any of the preceding definitions and which are not required to be proved or detected within the signal aspect.

8.10.9. Track Sectioning Examples

The following diagram and table are provided to illustrate the application of track sectioning as applied within the AMPRN.

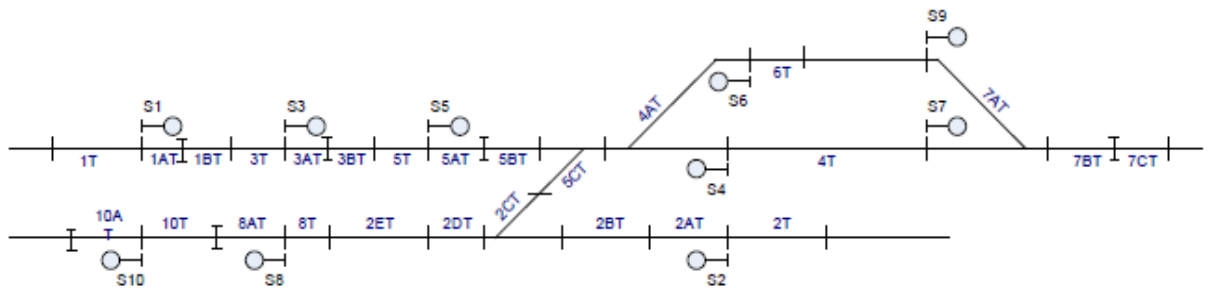


Figure 7 Track Sectioning

Entrance Signal	Exit Signal	Approach Tracks	Route Tracks	Overlap Tracks	Point Tracks	Flank Tracks	Other Tracks
S2	S8	2T	2AT, 2BT, 2CT, 2DT, 2ET, 8T	8AT	2CT	N/A	All other track sections.
S3	S5	1T, 1AT, 1BT, 3T	3AT, 3BT, 5T	5AT	N/A	N/A	All other track sections.
S5	S7	1BT, 3T, 3AT, 3BT, 5T	5AT, 5BT, 5CT, 4AT, 4T	7AT, 7BT	5CT, 4AT, 7AT	N/A	All other track sections.
S6	S8	6T	4AT, 5CT, 2CT, 2DT, 2ET, 8T	8AT	4AT, 5CT, 2CT	5AT, 5BT, 2AT, 2BT	All other track sections.

8.10.10. Track Section Lengths and Considerations

In addition to any specific design and installation requirements advised by the supplier of the equipment all track detection equipment shall address the following requirements:

1. The absolute minimum track circuit length shall be 25m, subject to specified minimums in the track circuit manufacturer’s specification (e.g. TI21 has a minimum of 50m). This distance is based upon the maximum inter-bogie wheelbase of existing rolling stock to ensure

that no vehicle can stand over a short track circuit without being detected.

2. An allowance shall be made for railcar overhang and the fouling point. At least an allowance of 3.5m shall be allowed for the overhang. The fouling point is defined as where diverging tracks meet a track centre distance of 4m and therefore the clearance point shall be defined at a location not less than 3.5m away from the fouling point in the direction of increasing clearance.
3. For DC track sections, the polarity of the track feed shall be staggered between adjacent tracks in an alternate fashion to eliminate false energisation by adjacent track feed due to a faulty IRJ. The ideal installation will seek to have a train, running in the normal direction of operation, enter each track circuit at the relay / receiver end to provide the most efficient shunt. This is subject to achievement of all other requirements associated with providing staggered polarities, frequencies etc.
4. Where seasonal (e.g. falling leaves) or environmental (e.g. rail contamination) conditions are known to exist which may adversely impact on the shunt characteristics and operation of the proposed track circuit equipment, the selection, design and installation of the equipment must incorporate measures to eliminate or protect against incidence of these conditions preventing the equipment operating reliably and safely.
5. In so far as is reasonably practicable, each track circuit shall be designed and installed to operate as a series circuit.
6. Where parallel operation is unavoidable, the DPTI preferred option is to install a second track circuit relay in the parallel leg of the track circuit. Due diligence must be exercised to ensure that there is no dead section longer than the distance between the leading and trailing bogies.
7. Track sections shall be arranged such that failure of any single component within a track section shall not result in a reduction in the protection normally provided by the track section equipment.
8. Where axle counters and track circuits interface the axle counter heads shall be placed so that there is an overlap over the track circuited area.
9. Axle counter heads shall not be placed in locations where trains come to a stand.
10. Based on 110Km/h operation the minimum axle counter section length between count-in and count-out heads is 27.5m (900mS travel time).
11. For new installations consideration should be given to the placement of axle counter heads in divergent paths. Wherever possible the axle counter heads shall be installed within 4m of the divergence. Where this is not possible separate sweep paths will be required over the track section.

9. Signals

9.1. Mainline Signals

9.1.1. Route Requirements

Interlocking circuitry (or logic) for all mainline signals shall incorporate the following requirements before displaying a proceed aspect:

1. The relevant commands from the Control Centre or Local Control Panel, as evidenced by operation of local non-vital controls (where provided) shall be proved to have been operated and effective (Note: This requirement does not apply for Permissive signals operating in an automatic re-clearing mode of operation).
2. Any subsidiary low speed signal mounted on the same mast as the mainline signal shall be proved normal and free of approach locking.
3. All directly opposing and conflicting routes shall be proved normal. This includes opposing routes on single line sections and any sections of the network subject to bi-directional working.
4. All route points shall be proved to be in correspondence, locked and continuously detected in the lie required for the route.
5. Except where the requirements of (6) below apply, all facing points in the overlap shall be proved to be in correspondence and continuously detected in their present lie unless called to swing to an alternate overlap. In this case, the loss of detection/correspondence shall not cause the reversion of the signal aspect so long as it is completed within the defined time for the type of interlocking/points operating equipment. Refer also Section 11.2.3.
6. Where the points are facing in the overlap and it is not deemed operationally advantageous for the lie of those points to be changed after the signal route in question has been cleared, or where an alternative overlap is not available, the points shall be proved to be in correspondence, locked and continuously detected in the lie required for the route.
7. Trailing points in the overlap shall be proved to be in correspondence, locked and continuously detected for the lie consistent with the route being requested.
8. Flank points shall be requested and proved in correspondence at time of clearing, to minimise the risk of any parallel movement overruns resulting in a direct conflict with the route being requested.

Flank points shall be locked and remain locked until the train has progressed to a point determined as clear of the last point track applicable to that point set or clear of the fouling point where protection is required to be maintained.
9. Any moveable structures (e.g. gates) shall be proved in correspondence and locked in the position required for the route.

10. All Route Tracks clear.
11. All Overlap Tracks clear.
12. All Point Tracks clear.
13. Where flank controls are provided, all flank tracks will be proved clear or route away set.
14. All Emergency Point Crank Handles applying to points located within the route, overlap and/or flanks of the route detected in their normal (i.e. housed) position. In the case of dual control point machines, the machine must be detected in the motorised position.
15. All approach clearing, approach locking and/or route locking functions applicable to the route being requested proved effective.
16. All secondary functions related to the control and resetting of any approach clearing, approach locking and/or route locking functions (e.g. approach clearing and approach release timers, track stick relays, inverse track repeats, etc) have been reset
17. All applicable level crossing conditions are satisfied including detecting the automatic gates in a horizontal position at locations where signals are positioned within a short distance on the approach to the crossing.
18. All lamp proving requirements satisfied in accordance with Section 9.1.6.
19. Where a route crosses the approach tracks within sighting distance of a signal that is not associated with the route, consideration shall be given to maintaining the aspect of that signal at stop where there is a possibility of the driver misreading the signal aspect¹.
20. On single lines and bi-directionally signalled areas, Automatic Warning System (AWS) equipment shall be suppressed for signalled movements to which the AWS equipment does not apply.

9.1.2. Signal Replacement

All mainline signals shall be restored to display their most restrictive aspect as soon as practicable after the front bogies of the train pass the signal. This requirement must be balanced with further requirements to ensure that the driver of the train cannot see the signal being replaced by their own train and to allow a practical construction tolerance (e.g. positions of IRJ relative to rail welds or positioning of axle counter head).

Where DC tracks are used, the IRJ that provides the boundary between the berth and overlap track circuits shall be located a minimum of 1M ahead of the signal and a maximum of 5M.

¹ Where the application of special controls are proposed by the designer, these shall be made known to the signal sighting committee prior to the signal sighting meeting being convened. If, following site inspection, alternate controls or mitigation measures are recommended by the signal sighting committee, the signal sighting committee recommendations shall take precedence.

Axle counter heads are generally placed in line with the signal but they should be at a maximum of 5m in front of the signal.

The route normalisation process for Absolute mainline signals shall be initiated once the first route track has been occupied and cleared and the second route track has been occupied. Where conditions prevent this from occurring (i.e. no second route track) the route normalisation process shall be initiated by the last approach track clear and the first route track occupied and clear.

Unless an absolute signal is capable of automatic, 'fleeting' operation and this is in use, once restored to "red" an Absolute signal shall not attempt to re-clear to display a proceed aspect again until such time as the route normalisation process has been completed and all approach locking and stick relay functions applicable to the signal have been released or reset and a subsequent command to clear the signal has been received from the Control Centre or Local Control Panel.

9.1.3. Replacement of Permissive Signals

All permissive signals in the WESTRACE Object Controller area shall be provided with a replacement facility. The Control centre sends a replacement request which shall replace the signal to red. The signal shall remain at red until the replacement cancellation request is received from the interlocking.

9.1.4. Approach Locking

Approach locking shall prevent the changing of the route ahead of a signal once the driver has seen or may have seen a proceed aspect at the signal or a previous signal that would indicate to the driver that the former signal is displaying a proceed aspect.

Approach locking shall be effective immediately once a signal has been called to display a proceed aspect and shall be applied consistently to all signals in a particular locality.

Comprehensive approach locking shall be applied to all mainline Absolute signals within the AMPRN that are approached by a main aspect route (i.e. approach locking paths will be appropriately conditioned by the lie of points and applicable signal aspects).

Within the WESTLOCK controlled area, standard SSI comprehensive approach locking look-back data has been provided, which is only tested for an approaching train at time of route cancellation. Within the WESTRACE areas, the comprehensive approach locking is continuously tested, and once activated for any occupancy of a track within the signal approach will result in the operation of the approach locking time out when the signal is cancelled.

9.1.4.1. Determination of Approach Tracks

Comprehensive approach locking track sections (i.e. Approach Tracks) shall extend to a point not less than sighting distance in rear of any signal aspect which would be altered if the signal for which the approach locking is to apply were to be placed at stop (Refer Section 9.2.1).

Once effective, approach locking shall apply to the entire route for which the signal route was cleared, including locking of any points in the overlap and locking of any opposing or conflicting routes.

Where an approach track section is in rear of another signal, itself in rear of the signal for which approach locking is applied, then that approach track section may only be excluded from the comprehensive approach locking path if the signal in rear is proved to be displaying a “red” stop aspect and is itself free of approach locking.

Approach locking shall remain effective until the approach release conditions are satisfied (refer 9.1.4.2).

9.1.4.2. Approach Locking Release

Approach locking shall be released when all the following conditions are satisfied:

- (i) A route cancellation request has been received from the OCC or local control panel.
- (ii) All signal aspect control functions have been proved inactive (i.e. the signal is displaying a “red” stop aspect).
- (iii) All signal route checking logic has been proved inactive (i.e. all signal route request logic not operated).
- (iv) All applicable approach track sections (i.e. comprehensive locking track sections) are proved unoccupied.

or any of the following has occurred:

- (i) Proof that the train has passed the signal as determined by the first route track section past the signal being occupied, the second route track occupied (where layout permits) and the first track subsequently cleared.
- (ii) Where i) above is not practicable then proof that the train has passed the signal shall be determined by the approach track section nearest the signal being cleared after itself and the first route track past the signal have been simultaneously occupied.
- (iii) Where ii) above is not practicable, alternate conditions shall be considered, subject to risk assessment and agreement with DPTI.
- (iv) The predetermined approach locking release time has elapsed (refer Section 9.1.4.3).

In track circuit areas, to protect against the inadvertent release of approach locking due to out of sequence track clearing following the restoration of power after a power failure, the release of approach locking through the passage of a train shall not be possible until a time period, of not less than the maximum approach locking time

applicable to the interlocked area, has elapsed after power has been restored.

Wherever practicable, additional measures shall be incorporated to ensure protection against irregular sequences of events resulting in the premature release of the approach locking.

9.1.4.3. Approach Locking Release Times

Approach locking release time shall be determined by the approximate travel time of a train, having witnessed a change in aspect, applying service braking to bring the train to a stop, from the maximum permissible operating track speed over the applicable approach distance plus a 30 second margin. For the purposes of achieving standardisation all approach locking release times within the AMPRN are rounded to the next highest 30 second increment

Where comprehensive approach locking is not provided (such as at a starting signal from a terminal platform or a shunt class route / Low Speed route), the approach locking release time shall be 30 seconds.

9.1.4.4. ETCS Section Timers

Where the ETCS system provides an authority past the next signal (such as for a proceed normal speed aspect), the authority is only valid for a calculated time. This time is based on trains observing temporary speed restrictions, station stops or any other parameter which may delay the passage of a train. On expiration of the section timer, the train is immediately given authority to the next balise group (at the next signal), with a very low fixed release speed.

In some cases, the section timer will be longer than the approach locking release, in which case consideration may be given to extending the approach locking timer to the same value as the ETCS section timer. However this may have operational impacts through the additional delays associated with an extended timed release.

The existing rule book requires the signaller to verbally communicate with the driver of a train which has a signal restored in its path to ensure the train has come to a stand before setting an alternative or conflicting route associated with the restored signal. Therefore no approach locking times have been extended to match the ETCS section release timer on AMPRN.

9.1.5. Route locking

9.1.5.1. General Rules

All signal routes within the AMPRN shall protect against the possibility of any of their route or overlap track sections being required for, or accessed by, any other route at the same time. All route locking shall be achieved by either direct or indirect means and shall be maintained until such time as any potential conflict or sharing of the route has been either eliminated or determined no longer required.

Route locking shall become effective as soon as a route sets and shall remain effective until the release conditions have been satisfied (refer Section 9.1.5.2.1).

Route locking shall be applied to all routes that directly or indirectly conflict with the route being set or its overlap.

Once route locking is applied, it shall not be possible to set a conflicting route until the route release conditions have been satisfied (refer Section 9.1.5.2.1

To maximise the operational flexibility and availability of the railway asset, route locking shall be released sequentially and in logical sections which reflect actual train movement patterns (i.e. "Sectional Route Release").

Separate route release sections shall be provided for each opposing or conflicting route and for each set of points, (including catch or trap points) located within the route or flank of a route. It is acceptable to combine or consolidate these release sections provided such an action does not result in a reduction of the safety, operational flexibility and/or availability of the railway asset.

Each in-route set of points shall be locked by all the in-route track sections up to and including the points track.

Each set of points providing flank protection to the route (including catch or trap points) shall be locked by all the in-route track sections up to and including the last route track which a train could occupy and still require the protection by those flank protecting points; unless that flank protection is conditioned out by a route-away.

Where there is more than one route class from a signal (e.g. Main and Low Speed) towards the same destination, setting one route shall lock all of the others normal.

Where directly opposing signals have no intervening route tracks between them (i.e. back to back signals) each signal route shall require all routes of the opposing signal to be proved normal prior to being called reverse. Once reverse all routes of the opposing signal shall be locked normal.

Where directly opposing signals are separated by intervening route tracks but one or more of those signals will not fully normalise until the whole of a train movement from one signal has travelled beyond (i.e. in rear of) the opposing signal then each signal route shall require all routes of the opposing signal to be proved normal prior to being called reverse. Once reverse all routes of the opposing signal shall be locked normal.

In CBI areas sub routes and sub overlaps are used for locking conflicting routes as well as for locking points. Sub routes perform both the locking and route holding function. They are also indicated back to the control centre to generate the route light indications and overlap indications. Sub overlaps provide the locking of the overlap beyond the destination signal and are used to ensure conflicting routes and associated overlaps together with associated points are locked.

Each track section shall have a latched sub route for each direction of travel. Point tracks have separate sub routes for each direction of travel and for each lay of the points where signal paths are provided.

Tracks that form overlaps will have a sub overlap for each overlap direction. Points tracks in overlaps have a sub overlap for each direction and each lie of the points.

Sub routes and sub overlaps are engaged (de-latched/locked) by the Signal Route Normal function when a route sets (i.e. All relevant sub-routes are engaged when the route is not normal).

9.1.5.2. Route Locking Release

Route locking shall be released sequentially in that the release of route locking is only enabled when the previous track section's locking is released and that the train has fully passed onto the next track section. This is referred to as Sectional Route Release in Relay Interlocking and Sub-Route Release in CBI. Route locking shall also be released when all the following conditions are satisfied:

- (i) the entrance signal is normal and free of approach locking and
 - (ii) the train has progressed to a point determined as clear of the locked section or conflicting junction.
- a) Route locking shall be released for the entire route (including it's overlap and opposing signals) when all the following conditions are satisfied:
- (i) the entrance signal is normal and free of approach locking, and
 - (ii) a train has not occupied any of the route tracks.
- or
- (iii) the entrance signal is normal and free of approach locking, and
 - (iv) a train has occupied one or more of the route tracks, and
 - (v) The train has progressed to the last route track and has come to a stop and occupied that track section for 60 seconds.

9.1.5.2.1. Sub Route Release

There are typically two types of sub routes, first, and, those subsequently in-route. The sub routes are released sequentially as below:

- (i) First in Route, applied to the first track section in route past the signal. The sub routes is released with signal route normal, (typically the signal red and free of approach locking) together with the track section clear.
- (ii) In Route sub routes, applied to all subsequent track sections after the First in Route. These sub routes are released when

the previous sub route in rear is normal together with the track section clear.

9.1.5.2.2. Sub Overlap Release

There are typically two types of sub overlaps, first, and (where required) subsequent.

- a) First, this is the first sub overlap beyond the destination signal. It is released when the section is clear and either:-
 - (i) the final in-route sub route (berth track section) clear, or:-
 - (ii) The destination signal is normal and the approaching train has been proved to a stand at the signal, based on the berth track section being occupied for a time greater than the calculated value of the train traversing the berth track at an average of 25km/h.
- b) Subsequent sub overlaps are provided where required between the First sub route and the end of the overlap. Subsequent sub overlaps (where provided) are released sequentially following the release of the first sub overlap together with the track section clear.

9.1.5.2.3. Axle Counter Section Route Release

In axle counter areas sub-routes and sub overlaps are released using a combination of 1st and 2nd repeats of the track section, the first repeat proves the axle counter clear following a reset, with the second repeat proving the track section clear after being swept. The sub route or sub overlap release will prove either the 1st repeat clear for 60-seconds or the 2nd repeat clear. This will effectively allow any route locking held by a failed axle counter section to be released 60-seconds after the track section has been reset.

9.1.5.3. Indirect Locking

Where an opposing signal route shares some or all of the same route tracks but the opposing route is prevented from being called reverse due to a conflicting requirement (i.e. point position) it is not necessary to prove or maintain the opposing route normal between signals provided the conflicting condition is maintained through route locking until such time as the whole of any train movement from one signal has travelled beyond the point of potential conflict.

9.1.6. Lamp Proving

The aspect controls for all main proceed aspects require the continuous lamp proving of the signal in advance.

Where lit, JRIs shall be proved alight continuously, in the main proceed aspects, proving at least three of the lamps lit. See section 7.1.5.1.1 for details.

Where lit, Theatre Route Indicators shall be proved alight continuously in the main proceed aspects. See section 7.1.5.3 and 7.5.1.4 for details.

The energisation of AWS inductor electro magnets will lamp prove the Normal Speed green aspect of the associated signal.

In SSI TFM areas, the lamp proving of individual LED aspects requires a small time to establish when initially illuminated. Therefore a five-second timer is used to maintain the signal lamp proving during aspect changes.

Diagnostic information shall be provided for any LED failure.

9.1.7. Red Retaining

All signals shall be forced to display their most restrictive aspect (normally red) in the event of an object controller or TFM failure or a loss of communication with the interlocking.

9.2. Subsidiary and Ground Shunt Signals

9.2.1. Route Requirements

Interlocking circuitry (or logic) for all subsidiary and ground shunt signals shall incorporate the following requirements before displaying a proceed aspect:-

1. The relevant commands from the Control Centre or Local Control Panel, as evidenced by operation of local non-vital controls (where provided) shall be proved to have been operated and effective.
2. Any mainline signal mounted on the same mast as a subsidiary signal shall be proved normal.
3. All directly opposing and conflicting routes shall be proved normal. This includes opposing routes on single line sections and any sections of the network subject to bi-directional working.
4. All route points shall be proved to be in correspondence and locked in the lie required for the route.
5. Flank points shall be controlled, proved in correspondence and locked for the lie which minimises the risk of any parallel movement overruns resulting in a direct conflict with the route being requested.
6. Any moveable structures (e.g. security gates) shall be proved in correspondence and locked in the position required for the route.
7. The signal berth track has been occupied for 30 seconds and the first route track is unoccupied.
8. All flank tracks clear (at time of clearing only).
9. All Emergency Point Crank Handles applying to points located within the route and/or flanks of the route detected in their normal (i.e. housed) position. In the case of dual control point machines, the machine must be detected in the motorised position. Within the Adelaide Yard area, the crank handles are not proved Normal in the signal aspects, but their removal is indicated to the train controller.
10. All approach clearing, approach locking and/or route locking functions applicable to the route being requested shall be proved effective.
11. All secondary functions related to the control and resetting of any approach clearing, approach locking and/or route locking functions

(e.g. approach clearing and approach release timers, track stick relays, inverse track repeats, etc.) have been reset.

12. All applicable level crossing conditions satisfied including detecting the automatic gates either in the progress of descending or fully in the horizontal position depending on the approach distance the signal location from the crossing.
13. Within a depot which has train detection, the shunt signal route design requirements shall generally be similar to those on the main line with any exceptions to suit the local operational requirements. Shunt signal routes shall not include any overlap track.

9.2.2. Signal replacement

Ground shunt and subsidiary signals reading into dead end roads or sidings shall be restored to display their most restrictive aspect as soon as the first route track is occupied.

Where a subsidiary signal shares the same route destination as a mainline signal mounted on the same mast, the subsidiary signal shall be restored to display a stop aspect in the same manner as the mainline signal for all shared route destinations.

The route normalisation process for ground shunt and subsidiary signal routes shall be initiated once one of the following occurs:

- a) The first route track has been occupied and cleared and the second route track has been occupied.
- b) Where there is no second route track, the route normalisation process shall be initiated by the last approach track clear and the first route track occupied.
- c) Where a subsidiary signal shares the same route destination as a mainline signal mounted on the same mast, the subsidiary signal shall adopt the same route normalisation requirements as the mainline route, for all shared route destinations.

Once restored to the stop aspect, a subsidiary or ground shunt signal shall not attempt to re-clear to display a proceed aspect again until such time as the route normalisation process has been completed and all approach locking and stick relay functions applicable to the signal has been released or reset and a subsequent command to clear the signal has been received from the Control Centre or Local Control Panel.

9.2.3. Approach Locking

Comprehensive look back controls are not required for ground shunt or subsidiary signals.

Approach locking shall be effective immediately once a signal has been called to display a proceed aspect and shall be applied consistently to all signals in a particular locality.

Once effective, approach locking shall apply to the entire route for which the signal route was cleared, including locking of any opposing or conflicting routes. Where route locking is necessary and implemented for

a signal route, approach locking shall apply initially to the entire route until approach locking release conditions are satisfied and route locking is effective and maintained (see 9.1.4.3) for the route section after the last approach release path.

Approach locking shall remain effective until it the approach release conditions are satisfied (refer Section 9.2.3.1).

9.2.3.1. Approach Locking Release

Approach locking for subsidiary and ground shunt signals shall be released when all the following conditions are satisfied:

- (i) A route cancellation request has been received from the OCC or local control panel.
- (ii) All signal aspect control functions have been proved inactive (i.e. the signal is displaying a “red” stop aspect).
- (iii) All signal route checking logic has been proved inactive (i.e. all signal route request logic not operated).

Or any of the following has occurred:

- (i) For all shared route destinations where a subsidiary signal shares the same route destination as a mainline signal mounted on the same mast - proof that the train has passed the signal as determined by the conditions applicable to the main route.
- (ii) For ground shunt signals and subsidiary signals reading to dead-ends or sidings, the last approach track (i.e. the berth track) has been cleared and the first route track occupied.
- (iii) The predetermined approach locking release time has elapsed (refer Section 9.2.3.2 below).

In track circuit areas, to protect against the inadvertent release of approach locking due to out of sequence track operation following the restoration of power after a power failure the release of approach locking through passage of a train shall not be possible until a time period, of not less than the maximum approach locking time applicable to the interlocked area, has elapsed after power has been restored.

Wherever practicable, additional measures shall be incorporated to ensure protection against irregular sequences of events resulting in the premature release of the approach locking.

9.2.3.2. Approach Locking Release Times

The approach locking release time for subsidiary and ground shunt signals shall be 30 seconds.

9.2.4. Route Locking

Requirements for route locking and the release of route locking shall be applied in the same manner as for main signals (refer Section 9.1.4.3) except route locking for subsidiary and ground shunt signals shall extend

to the last set of route points only and shall not include any overlap track and overlap points

9.2.5. Lamp Proving

Lamp proving is not required for all subsidiary and ground shunt signals on the AMPRN.

Within the WESTRACE areas diagnostic information shall be provided for any LED failure

9.2.6. Red Retaining

Ground shunt red aspects shall be forced to display a red aspect in the event of an object controller or TFM failure or a loss of communication with the interlocking.

10. Bidirectional Operation

Bidirectional operation is provided on nominated lines between interlocked areas. This is provided using conventional route locking applied between the interlocked areas.

10.1. Automatic Signals in Bi-Directional section

Where automatic signals are provided within a bi-directional section the aspect controls will be enabled by the locking of their associated berth sub route by the setting of a route from the last controlled signal up to the automatic signal.

Following the passage of a train, the automatic signal will be replaced by the track controls, and will be maintained at red until the aspect controls are met together with the setting of a second route up to the signal.

11. Points

11.1. Points Types

11.1.1. Power Operated

11.1.1.1. Standard Operation

All power operated points used on the AMPRN shall be operated remotely via command issued from the Operations Control Centre or Local Control Panel (where provided).

All point control circuits shall be designed to eliminate storage of commands, such that the command must be reissued if they do not respond within a predetermined time period.

11.1.1.2. Emergency Operation

Points machines installed within the AMPRN are combined into logical groups which correlate with their geographic proximity, operational influence and consideration of the time with which an individual operator can physically access and manually operate the machines to support the operational movement of trains. Grouping of point machines for the purpose of manual operations in the event of a machine malfunction, shall be agreed with DPTI prior to finalisation of the circuit designs.

Each group of electric point machines shall be provided with at least one device (e.g. crank/pump handle) suitable for the manual operation of any power operated points of the same type that is installed on the AMPRN.

The device for manually operating the power operated points shall be provided with housing suitable for its long term storage. The housing shall be located in a position easily accessible from the location of each of the machines in the group and shall be agreed with DPTI to maximise the efficiency of emergency operation of points within the group.

For all areas outside of the Adelaide Yard area, removal of the manual operating device from its associated detection housing shall result in the following:

- (i) Disabling of any proceed aspects from being displayed for any signal routes which read over or are required to detect the position of any of the point machines contained within the associated operating group.
- (ii) Initiation of an alert or alarm message on the Operator Control Workstation (Control Centre or Local Control Panel) notifying of the removal of the particular device

Within the Adelaide Yard area the removal of the manual operating device will initiate an alert alarm message on the Operator Control Workstation (Control Centre or Local Control Panel) notifying of the removal of the particular device.

Use of the device to manually operate power operated point shall isolate the power to the associated point machine and disable the electric operation of the machine.

11.1.2. Self-Restoring Operation

On the AMPRN, self-restoring operation applies to some points on the entry route leading into or on the exit route from a marshalling yard/siding. Points to which self-restoring operation to be applied shall be identified and approved by the Unit Manager Signal and Control System Engineering. Generally self-restoring points shall be identified and determined in the User Operational Requirements Specification.

Where self-restoring points are specified the Designer shall ensure that the risk of early release of locking, allowing the points to restore, takes into account poor track circuit shunting due to rust on the rail head.

The self-restoration of points will prove the point's key in the centre position, once the locking has released the points shall commence restoration after 20 seconds. Self-restoration will occur after the points have been reversed following a route setting command or after a point's key switch operation.

11.1.3. Manually Operated

Unless requested or specified otherwise, manually operated point mechanisms are not normally detected by, or interlocked with, the AMPRN signalling system. In this case they are suitable only for use in non-CTC territory where a suitable safe-working system exists.

11.2. Points – Interlocking Requirements

11.2.1. Points Setting & Detection

Interlocking circuitry (or logic) for all point mechanisms that are required to be interlocked with the signalling system shall incorporate the following requirements before the interlocking function controlling the movement of the points is generated:

1. The relevant command from the Control Centre or Local Control Panel requesting the points movement to the desired position, as evidenced by operation of local non-vital controls (where provided) shall be proved to have been operated.
2. The opposing movement commands from the Control Centre or Local Control Panel, as evidenced by non-operation of local non-vital controls (where provided), shall be proved to have not been operated.
3. Relevant point track(s) (i.e. deadlocking tracks) not occupied.
4. All routes requiring the points set in their current position, normal and free of approach locking.
5. The points not subject to any route locking as the result of any incomplete previous signalled train movements.
6. All fouling tracks unoccupied.

7. Conditional locking controls are not effective (e.g. point-to-point locking)
8. Where point sequencing is in operation, any other points that are required to be moved to an alternative position are available.

The successful movement and detection of a set points requires the following:

1. The relevant manual operation device is detected within its housing if fitted and the manual power isolation reset mechanism within the machine if fitted is reset.
2. Point control circuitry shall allow a maximum movement period of 10 seconds from the time of a request being received by the point machine control circuitry.
3. Points shall continue to attempt to achieve their requested position until such time as the requested lie has been successfully reached or the 10 second operational time limit has expired.
4. At the expiration of the 10 second operational time limit the supply to the point mechanism shall be cut and the points indicated as out of correspondence. A second request to move the points shall not be allowed until the points have been returned to their original lie (or manually operated to the desired lie) and all controls reset to correspond with their position.
5. Points operating circuits shall not draw more than 60% of the maximum continuous rated current of their allocated supply fuse, as measured with the points operating under full load conditions. Where necessary, point sequencing may be implemented to prevent excessive power draw provided all points within a route can complete their movements within a time not exceeding 15 seconds.
6. The lie of all points shall be continuously detected in correspondence with their last requested position until such time as a request for their movement to the opposite lie has been made.
7. All timers and logic involved in the movement of the points from one lie to another shall reset upon successful detection and correspondence of the points.
8. Successful detection of an operational set of points (i.e. more than one point machine operating as part of a co-ordinated set) shall require all points within the set to be fully detected.

11.2.2. Points Locking

When one of the point mechanisms within an operational set is locked then the same locking controls shall also apply to all other points in the same operational set.

Points shall be unconditionally locked by occupation of any of the point track(s) (i.e. dead locking).

Fouling track(s) shall directionally lock the points for the lie leading toward the foul track.

Points shall be locked by any route which incorporates those points within its route or overlap or where the points provide flank protection to the route (refer Section 9.1.5 above and Section 9.2.4 above). This locking will be achieved by the use of the route locking applied as part of the controls.

Points shall be locked by any route which incorporates those points within its overlap and where those points are in the trailing orientation for the route.

Points shall be locked by any route which incorporates those points within its overlap and where those points are in the facing orientation for the route, unless the points may be used to select an alternative overlap and the alternative overlap is available.

11.2.2.1. Time of Operation Locking

Time of operation locking shall be applied to all facing points in the overlap where the toe of points is located less than 100m from the start of the overlap. Time of operation locking requires that to move the facing points in either direction the signal berth track circuit must be proved clear, or occupied for a time sufficient to ensure that an approaching train has come to a stand at the signal.

11.2.2.2. Points Locking Release in Route

Route locking of each set of points within, or protecting, a signalled move shall be released when all the following conditions are satisfied:

- (i) The entrance signal is normal and free of approach locking, and
- (ii) The train has progressed to a point determined as clear of the point where protection is required to be maintained.

In CBI areas, Sub routes (see section 9.1.5 and 9.2.4) will provide the locking of all points within a route. These sub routes are provided for each direction and lie of points over each track section.

The locking of the points Normal or Reverse will be applied by the relevant sub route, therefore the route locking of the points will be released when the appropriate sub route is normal.

Catch points and/or trap points, where provided at sidings and/or stabling tracks to protect against unauthorised entry of vehicles onto the mainline, shall self-restore to their normal position (i.e. protecting the mainline) 10 seconds following the release of all point and route locking applicable to them. Self-restoration shall not be applied to other point's mechanisms unless specifically requested by DPTI and stated in the control tables.

Catch points shall be fitted with a track interrupter or similar approved device to maintain the track section in the occupied state in the event that a train is derailed by the catch point.

11.2.2.3. **Points Locking Release in Overlap**

Route locking of each set of points within, or protecting, the overlap of a signalled move shall be released once all the following conditions are satisfied:

- (i) The entrance signal is normal and free of approach locking, and
- (ii) A train has not occupied any of the route tracks; or
- (iii) A train has occupied one or more of the route tracks, and
- (iv) The train has progressed to the last route track and has occupied that track section for the predetermined route release time (refer Section 9.1.5.3).

In CBI areas, Sub overlaps (see section 9.1.5 and 9.2.4) will provide the locking of all points within an overlap. These sub routes are provided for each direction and lie of points over each track section where required.

The locking of the points Normal or Reverse will be applied by the relevant sub overlap, therefore the route locking of the points will be released when the appropriate sub overlap is normal.

11.2.3. **Swinging Points in the Overlap**

Facing points within the overlap that provide for alternative overlaps are generally not set or locked.

Facing points in the overlap will be conditionally locked when an alternative overlap is not available.

Facing points are continuously detected in the signal at aspect level of main signal aspects. This detection will be conditioned out when the points are operated, either by the operation of the point key, setting the forward route or the setting of a flank overlap. The signal will revert to stop should the detection fail to make up after 15 seconds (i.e. 150% of the points run time of 10 seconds).

It shall not be possible to change the lie of facing points in the overlap that are subject to Time of Operation locking

11.2.3.1. **Simple Swinging Overlaps**

A simple swinging overlap would typically have one set of facing points.

The points may be keyed at any time or swung by setting the forward route.

Time of operational locking as detailed in section 11.2.2.1 shall be applied.

Points will be detected as described in section 11.2.3

When the facing points are swung, the alternative sub overlap will be locked at the same time as the existing sub overlap is released.

11.2.3.2. Complex Swinging Overlaps

A complex swinging overlap would typically have one or more sets of facing points in the overlap that have conditional locking and setting interlocked with trailing points.

Facing points within the overlap will be set and locked to an available overlap should the alternative overlap be unavailable. This will be a one shot call at time of setting.

Time of operational locking as detailed in section 11.2.2.1 shall be applied.

The route will set should the overlap be available at locking level when the overlap is occupied by the preceding train travelling away from the forward route.

When the facing points are swung towards a set of trailing points, both sets will swing at the same time. The signal will be replaced to stop should either set fail to make detection as described above.

When there are track sections in the overlap beyond the facing points track locking, the following rules shall apply:

- (i) Should the current overlap be clear, the facing points will not be called unless the route has a preferred overlap, in which case it shall be set to the preferred overlap.
- (ii) The facing points shall be free to swing to an occupied overlap providing the signal has not cleared.
- (iii) The facing points will lock and be prevented from swinging to an occupied overlap after the signal has cleared.
- (iv) In the event of a track failure in the overlap after the signal has cleared, the facing points will remain locked unless an alternative overlap is clear.
- (v) All requests to call facing points in the overlap will be of a one-shot type, with no pre-selection allowed.

11.3. Manual Points Control

Where a set of points is controlled by a route-setting system, the points can be individually operated by a key switch provided with three positions:-

- Points Normal
- Points Reverse
- Points Centre

The operation of the points normal or reverse key will generate a one-shot request to move the points to the selected position. If free to move the points will be controlled to this position and locked in that position by the key switch.

Although the points are locked in position by the key switch, routes can still be set over the points if they are controlled to the position required by the route.

The Points Centre position, allows the points to be controlled by the interlocking as part of the route setting operation, and will be controlled (providing they are free) to the position required by each route.

The points normal or points reverse key switch operations can only be undertaken from the key centre position; therefore preventing the operation of the switch directly from points normal to the points reverse position (and vice versa). However, within the WESTLOCK controlled areas, the SSI data does not have a memory for the key centre position, preventing the switch being proved in the centre position. Therefore movements can be made directly between points normal and points reverse (and vice versa)

12. Interlockings

12.1. Background Information

There are two styles of interlocking in use within the AMPRN, as outlined in the following sections.

12.1.1. Relay Interlocking

Relay interlockings consist of logic circuits to control and monitor the installed signalling asset using electro-mechanical relays wired together to form a mixture of vital (i.e., safety critical) and non-vital (non-safety critical) control circuits.

In general relay interlockings consist of a Distributed interlockings contained in relay rooms which control and monitor trackside equipment via a number of location cases distributed throughout a predetermined geographic area. Location cases provide the primary interface between the Relay interlocking and its associated field devices (i.e. track circuits, signals, points, etc) and are connected to the relay interlocking by large numbers of line circuits in multicore cables.

12.1.2. Computer Based Interlocking(CBI)

Computer based interlockings (CBI) consist of an arrangement of computer processors, communication or data network switches and software to control and monitor the installed signalling asset. AMPRN currently deploys two types of CBI; Westlock Interlocking with trackside SSI modules and Westrace Interlocking with associated trackside Object Controllers

12.1.3. Associated Telemetry System

Unless otherwise authorised by the Train Control, all the signalling equipment within AMPRN are controlled remotely from the Operation Control Building. Under emergency circumstances, the signalling equipment within Relay Interlocking areas can be controlled locally from the Local Control Panel.

12.2. Signalling Power Supply Arrangements

In addition to the requirements detailed herein, power supply and distribution system design associated with signalling systems within the AMPRN shall comply with the requirements of all relevant Australian Standards and any relevant local supply authorities.

If a conflict in requirements is identified, the issue shall be elevated to DPTI for determination based on consideration of a recommended course of action by the designer which addresses the following issues:

- a) Prevention of wrong side signalling failures.
- b) Provision of a safe working environment for all personnel authorised to work on or near signalling system assets or associated infrastructure.
- c) Protection against electrical transients.
- d) Immunisation against 25kv and isolation requirements.
- e) Voltage surge diversion/protection and Earth leakage detection.

12.2.1. AMPRN Distribution Voltages

Unless otherwise specified and approved by DPTI, the following voltages shall be used within the AMPRN signalling system

- a) 650V AC. Used as the primary power distribution backbone throughout the rail corridor.
- b) 110V AC. Used as the secondary power distribution backbone, main supply voltage within relay rooms and location cases and for connection of field equipment requiring 110V AC supply.
- c) 50V DC. Used as the main supply voltage of interlocking logic circuits, including non-vital logic, located internally or externally to each relay room or location case.
- d) 24V DC. Used to power AWS equipment and 24V DC relays throughout the AMPRN.
- e) 16V DC. Used to power level crossing gates where fitted with gravity drop booms.
- f) 12V DC. Used as the main supply voltage for level crossing flashing lights, electronic equipment and ancillary devices (communications equipment, telemetry, CCTV, etc.)
- g) All mains distribution shall be designed such that, with the system functioning within normal expected operating parameters, the minimum voltage is within $\pm 10\%$ of the nominal voltage at any point within the distribution network at all times.
- h) 110V AC secondary power supply and all DC supplies within AMPRN shall be floating supplies

12.2.2. System capacity

- a) Unless otherwise specified and approved by DPTI, each individual power supply component (i.e. transformer, DC supply, mains power distribution cable, etc.), but excluding loading elements (i.e. signals, points, local cables, etc.) shall have at least 15% spare capacity at the time of its initial commissioning.
- b) Generally in AMPRN, the power supply in the relay room and the associated distributed track side local boxes are back up with a standby generator set and UPS.
- c) As an integral part of the power supply design, comprehensive load and fuse discrimination calculations shall be provided to support the proposed power design and demonstrate to DPTI that the supply is adequate for the purposes including an agreed margin for future expansion.

12.2.3. Separation of Supply Systems

No direct interconnection shall be permitted between the AMPRN signalling system supply and the Supply Authority's MEN system. Separation shall be ensured by providing:

- a) Minimum 5 metre separation between the Electrical Authority Entry Point of Supply and the signalling installation supply.
- a) Isolation transformers at an appropriate point on the supply feed between the Point of Supply and the signalling system supply.
- b) No direct or indirect connectivity between non-vital communications equipment and the signalling power supply.

12.2.4. Reliable Design

AMPRN signalling power system design shall provide a high level of fault tolerance. Minimum requirements for power system fault tolerance include:

- a) Failure of a single active power supply within the signalling power supply system shall not result in all signals within an interlocking area reverting to displaying a “red” stop aspect or black-out (even momentarily). However, individual signals may be affected.
- b) The design of all power supply system and sub-systems shall incorporate robust defences against lightning or other forms of surge event:
 - (i) entering or damaging any component of the signalling system via external cables or connections
 - (ii) resulting in a reduction in the safety integrity of the signalling system
- c) The design of all power supply systems and sub-systems shall incorporate robust defences against the failure of any component of the power supply system resulting in a reduction in the safety integrity of the signalling system. In particular, systems that rely on the ‘storage’ of safety critical states or information shall enforce a safe state if power is lost and subsequently restored.
- d) The design of all equipment, and particularly those containing electronic components, forming part of the signalling power supply or signalling system (e.g. computer based interlockings, processor based equipment, telemetry systems, track circuit transmitters/receivers, etc.) shall incorporate robust protection of electronic equipment against electrical transients on incoming power feeds, and against the effects of lightning.
- e) The designer shall incorporate sequential, staged protection measures such that the presence of a fault within any downstream circuit shall be disconnected as soon as possible to protect personnel and equipment (i.e. protection discrimination).
- f) Each battery backed supply shall be sized to provide sufficient capacity to fully maintain the normal operating load for at least 12 hours.
- g) Each battery charger shall be sized to provide sufficient capacity to support the normal standing load of the equipment supported by the batteries plus the maximum charge current required to

recharge the battery supply from a fully depleted condition. The battery charger shall have temperature compensation and remote monitoring facility.

- h) Where any element of the total signalling system, including operationally critical communications systems, are duplicated to achieve redundancy for reasons of reliability and/or availability, consideration shall also be given to duplication of any associated components of the power supply system.
- i) For any reasonably foreseeable or anticipated circumstance, all systems or sub-systems within the signalling system shall be capable of fully recovering from a power failure without any additional manual intervention.
- j) Earth Leakage Detection (ELD) devices shall be provided for:
 - (i) All 650V power distribution supplies leaving the Relay Room or primary interlocking supply point and on the secondary side of any subsequent isolation transformers
 - (ii) All floating power supplies of nominal voltage greater than or equal to 110V within the Relay Room or primary interlocking supply point.
 - (iii) Each DC power supply originating from within the Relay Room or primary interlocking supply point (excluding power supplies provided exclusively for communications equipment).
- k) The status of the following power supply and protection and charging equipment within the AMPRN shall be monitored and indicated such that its condition can be determined from the Central Control Centre:
 - (i) Mains Power Supply
 - (ii) UPS Power Supply
 - (iii) UPS Power Supply Battery Condition
 - (iv) Standby Power Supply
 - (v) Battery Charger Supply
 - (vi) High Voltage Earth Leakage Detection Status (in this context supplies greater than 110V)
 - (vii) Low Voltage Earth Leakage Detection Status (in this context supplies equal to, or less than, 110V)
 - (viii) Fire Alarm (if provided)

12.2.5. General Power Supply Requirements

- a) The use of voltages greater than 140V (nominal) shall be restricted to power supply distribution and shall not be used for switched signalling control functions.

- b) The requirements of AS/NZS 3000 shall be implemented for all supplies where an MEN system is implemented and to the extent applicable where floating (IT) distribution is specified.
- c) All wiring installed in signalling control equipment racks shall be double insulated.
- d) The potential for direct exposure to live terminals within equipment cases and buildings where the terminal may become live with a current of significant magnitude to cause an electric shock, shall be avoided or minimised through the use of suitable enclosures and/or protective screening, etc., in accordance with AS/NZS3000.
- e) Each relay room and location case shall be provided with isolation links and circuit breaker functionality to allow electrical isolation of either an individual relay room or location case or isolation of that relay room or location case and all other downstream equipment, such that personal are not required to work on live equipment
- f) Separate transformers/rectifiers and protection circuits shall be provided such that the power supplies required to support the operation of equipment located within a relay room or location case are electrically isolated and segregated from those which support the operation of equipment located outside of each relay room or location case.
- g) Separate transformers/rectifiers and protection circuits shall be provided such that the power supplies required to support the operation of external equipment located on the UP side of the relay room or location case are electrically isolated and segregated from those support the operation of equipment located on the DOWN side of the relay room or location case.
{Note: - this requirement may also be required to be extended in circumstances where external power supplies from a relay room exceed the normal UP and DOWN directions (i.e. EAST, WEST, NORTH, SOUTH, etc). This requirement may be relaxed subject to approval by DPTI and where it is demonstrated that total power supply feed lengths are within electrical limits and the 25kv immunisation requirements.
- h) All connections between a circuit and its associated power supply shall be made to a fuse terminal.
- i) Separate transformers/rectifiers and protection circuits are required to be provided such that the power supplies required to support the operation of equipment located within the jurisdiction of any third party rail authority (e.g. ARTC, etc) or other party (e.g. DPTI Roads, etc.) such that those supplies are electrically isolated and segregated from those support the operation of AMPRN equipment.
- j) Connections between each 110V AC or 50V DC power supply available within a relay room or location case and its associated

equipment or control circuitry shall be via fuse or disconnect terminals located on separate, clearly marked busbars. Busbars shall be arranged in descending order on supply voltage supported by further classification as required (e.g. Internal, External, UP, DOWN, etc.).

- k) The positive leg of all circuits shall be fused at the busbar. The designer shall determine fuse sizing appropriate to the equipment and such that the presence of a fault within any downstream circuitry shall be disconnected as soon as possible to protect personnel and equipment and result in the minimum disruption to the operation of the total signalling system (i.e. fuse discrimination).
- l) Connections to all busbars shall be arranged such that only one side of a terminal is used for connections to equipment or control circuitry and such that a logical allocation of terminals is achieved. Hard wiring between busbar terminals is to be avoided.
- m) Power supply to all internal control circuitry within a Relay Room shall be separated from any external power supply.
- n) All installations containing signalling power supply equipment shall be secured such that normal access is restricted to only authorised personnel.
- o) A separate standalone 650 power location case must be installed to house and contain the associated 650/110 power equipment. The segregated power location is not to be incorporated into the track location case.

12.2.6. General Earthing Requirements

- a) The signalling system earthing shall be isolated or separate from, and independent of, earthing arrangements relating to any incoming power supply sourced from an electrical supply Authority or other external source.
- b) Isolation between the incoming Authority supply and the signalling power system shall be achieved by an isolating transformer. A UPS system may also provide isolation but consideration should be given to failure modes and the operation of any bypass switches that may interconnect the two systems
- c) Each equipment room, location case or signalling control equipment housing shall have a single local earth system for the purposes of personnel protection and for fast transient protection.
- d) The single local earth system shall consist of an equipotentially bonded earth mat consisting of 4 earth rods installed around the corners of the building / cabinet that are interconnected by a purpose designed earth ring. The earth mat shall be connected to a single main earth bar within the installation via duplicated bonds of an appropriate size.
- e) The Electrical Supplier's earth conductor shall be terminated and gapped at the Point of Supply which shall be located a minimum

standard touch potential distance between any steelwork bonded to the signalling earth.

- f) Duplicated equipotential bonds shall be provided between the signalling installation's Main Earth Bar and all metal work within that installation.
- g) The design shall ensure that the removal or isolation of any board (and its associated earth bar) shall not disconnect the safety earth bond of any equipment supplied from another board.
- h) Where lightning or surge arrestors are required to be installed within an equipment housing Arrestor Earth Bar(s) (AEB) shall be provided. Each AEB shall be bonded to the installation's earth mat via the main earth bar. The connection between the AEB and the main earth terminal bar shall be as short and as straight as practically possible.

12.3. Interlocking Interfaces

12.3.1. Interfaces to Field Equipment

- a) Disconnection terminals shall be provided at the connections between all wiring internal to a relay room or location case and wiring or equipment external to that relay room or location case.
- b) Connections between any equipment that interface directly to the rails shall be terminated on appropriately sized lightning or surge arrestors prior to being electrically connected to disconnection terminals. These terminals should be electrically shielded to prevent contact with differing touch potentials.
- c) Where control circuitry is used to switch any power supplies to signalling equipment located wholly or in part outside of the relay room or location case the switching shall interrupt both the positive and negative portions of the circuit (i.e. double cutting) where practicable. This requirement also applies to circuits wholly within the relay room or location case where the circuit is fed from power derived from a power supply that is connected to an external circuit.
- d) Line circuits shall be limited to a maximum length of 2000m. Where control circuits are required to extend greater than this distance the circuit must be terminated and repeated (i.e. cut-sectioning) as often as required to achieve the required circuit length. Where a common supply is provided to supply feeds in more than one direction, the maximum length 2000m applies to the total distance between the extremities of all line circuits that are fed from the same supply.
- e) Control circuitry used to switch any 110V AC power supplies to track side signalling equipment located outside of the relay room or location case shall be limited to a maximum length of 200m. 110V AC switched supplies shall not be extended beyond this maximum distance without consideration of the impact of likely induced voltage on the safety / operability of the circuit. Where a common supply is provided to supply feeds in more than one

direction, the maximum length 200m applies to the total distance between the extremities of all circuits that are fed from the same supply.

- f) Where it is proposed that either of the limits given in d and e above are to be exceeded then calculations of the likely induced voltage for both normal operation and during short circuit of the AC traction supply shall be provided.
- g) AC immune relays shall be used for all DC external circuits or internal circuits that are fed from power derived from a power supply that is connected to an external circuit. (This requirement does not apply where an isolating transformer is used to connect the line circuit to the relay coils.)
- h) In general, and with the exception of power supply busbars, all terminal allocations associated with a single circuit shall be arranged such that consecutive terminals correspond to the positive and negative legs of that circuit.

12.3.2. Interfaces to Telemetry

All interfaces between telemetry systems and the signalling system shall be achieved by either of the following methods:

- a) Voltage free contacts derived, or created, from control circuitry. Connection to these contacts shall be via disconnection terminals specifically provided for, and physically separate from, any other termination points; or
- b) Optical isolation connection; or
- c) Dedicated serial link data connection.

12.4. Train Control Interfaces

Train Control requirements and provisions vary from site to site depending on consideration of operational requirements and facilities. In broad terms CTC control is provided at all sites while Local Control is provided at some sites only. The following sections detail the minimum requirements for indicating and controlling the AMPRN via either a Local Control Panel (LCP) or from Centralised Traffic Control (CTC) at the main Operational Control Centre (OCC). Other requirements beyond those listed may be required at specific sites or in special circumstances to effect adequate control of the network.

Within the context of this document reference to the OCC is inferred to mean the provision of equivalent functionality at the second point of operation.

Communications bearers and nodes for all Train Control Interfaces must be designed to be fully redundant with diverse communications nodes and paths free of any single point of failure.

12.4.1. Train Control Commands

Nomenclature for the controls used for initiating specific commands to initiate specific actions to support operation of the signal infrastructures network wide within the AMPRN shall reflect the existing practice. Any new controls nomenclature that is not currently used in AMPRN but is required to accommodate the introduction of new signalling system and

technology into AMPRN is subject to prior approval by the Unit Manager Signal and Control System Engineering or his representative.

12.4.2. Train Control

Nomenclature for the indications commonly required to indicate the status of the trackside signal infrastructures shall reflect the current practice within AMPRN. Any new nomenclature that is not currently used within AMPRN but is required to accommodate the application of new signalling system and technology is subject to the prior approval of the Unit Manager Signal and Control System Engineering or his representative.

Local control panels shall be supplemented by the provision of appropriate levels of fixed information to assist the operator to assess the physical arrangement of the controlled area and the relevance of any information being presented. Designers shall consult with operations staff to determine what, if any, indications beyond, or different to the current practice, are required to adequately support the operation of any installation or control area.

Circuits should be designed such that, if a repeat relay fails to energise when it's primary relay is energised, it will not result in a hazardous situation. As repeat relays can cause various problems, care should be exercised in their use.

As a general principle, indications associated with detection of safety critical functions such as track occupancy status, point positions, signal aspects, etc. shall be generated from the last repeat circuit associated with that function. In this way, the failure of a repeat relay to energise anywhere in the chain will be indicated to the signaller.

12.4.3. Other External Interfaces

In addition to its internal command interfaces the AMPRN network is, under some circumstances, also required to interface to a range of external parties including the Australian Rail Track Corporation (ARTC), Great Southern Railway (GSR), and DPTI Road Traffic Lights controls etc. As the exact requirements for interfacing to these external systems vary depending on the application and equipment to which the interface applies it is the responsibility of the Designer to make the necessary enquiries regarding the required functionality and requirements of these interfaces.

With regard to Metro Road Traffic Lights controls, DPTI generally provide three control circuit inputs to the road traffic light controller. Depending on the model and make of the traffic light controller, the input/output supply voltage to the road traffic light controller varies. It is the designer responsibility to ascertain the design parameters with the Metro Road Department.

12.5. Automatic Operation

- a) Where specified and subject to the operational requirements included in project documentation, interlockings shall support the provision of automated setting of preferred routes on the main running line.
- b) Automatic operation of preferred routes is provided for two purposes:

Maintain the ability of the AMPRN to support limited service patterns in the event of major control system and communications failure.

- (i) Provide a mechanism by which train control staff, located at either CTC or the LCP, can reduce their immediate workload in order to deal with other critical events without ceasing the operation of train services.
- c) Interlocking design must provide facilities by which an interlocking supports the provision of automatic operation of preferred routes under the following circumstances:
- (i) An interlocked area is switched to Auto Mode operation by the CTC Operator during a period when LCP is Switched Out.
 - (ii) An interlocked area is switched to Auto Mode operation by the LCP Operator during a period when LCP is Switched In.
- d) Switching of an interlocking into Auto mode shall have no effect whatsoever on any routes already set within the interlocking and shall only take effect once any conflicting routes have been restored and fully normalised.
- e) Auto mode operation shall automatically request points to the required lie, request applicable signal routes to clear and enable signals to re-clear once the standard route normalisation requirements have been achieved.
- f) Once an interlocking has been switched to Auto mode it shall remain in that mode until cancelled by the following methods:
- (i) Auto Mode is cancelled by the CTC Operator during a period when LCP is Switched Out.
 - (ii) Auto Mode is cancelled by the LCP Operator during a period when LCP is Switched In.
- g) Cancellation of Auto Mode operation shall have no effect whatsoever on any routes already set within the interlocking.
- h) Terminal stations shall be operated with a simple 'first come, first served' route setting based upon train detection occupancy so that an arriving train has a route set into a standard platform, once the train has entered the platform and the route is normalised, the route back out again is immediately set to allow departure. Exact details of the operation shall be agreed with DPTI as part of project development.

13. Vehicular Level Crossing & Pedestrian Crossing Protection

13.1. General Requirements

The layout and configuration of all road/rail (vehicular crossings) and pedestrian crossings shall comply with the requirements of Australian Standard AS 1742.7-2007 - *Manual of uniform traffic control devices - Railway crossings and CS4-DOC-000446 Standard for Railway Pedestrian Crossings*, inclusive of any amendments and updates. The following sections provide additional requirements specifically relevant to the application of level crossings on the AMPRN. In addition to the above, all new and altered vehicular level crossing and pedestrian crossing protection control circuit design parameters shall be compliance with the AS/RISSB 7658 Railway Level Crossing Standard and AMPRN practices where applicable. The following sections are an interpretation of these standards and provide guidance as to DPTI requirements for the application of new or renewed level crossings.

Any areas of conflict between this standard and the Australian or other rail operator's Standards shall be referred to DPTI for clarification.

13.2. Train Performance Characteristics

Where signal controls are provided which provide interlocking with a level crossing, the worst case train acceleration and braking characteristics should be used. These consist of the worst case braking characteristics and best acceleration characteristics of any trains which will pass over the crossing.

13.2.1. Braking Tables

The following tables provide the braking characteristics for the 3000 series trains:-

Speed		Time	Distance
Km/h	m/s	s	m
120	33.3	37.1	651
110	30.6	34.2	553
100	27.8	31.2	462
90	25.0	28.3	379
80	22.2	25.4	304
70	19.4	22.5	238
75	20.8	23.9	270
70	19.4	22.5	238
60	16.7	19.5	180
55	15.3	18.1	153
50	13.9	16.6	129
40	11.1	13.7	87
30	8.3	10.8	53
25	6.9	9.3	39
20	5.6	7.8	27
15	4.2	6.4	17
10	2.8	4.9	10

3000 Series Braking Characteristics.

This table is based on a braking rate of 0.95m/s², with a brake delay of 2s. The performance of the 4000 series train can be assumed to be identical or better than that of the 3000 series train (above).

13.2.2. Acceleration Tables

The following tables demonstrate the best performing acceleration performance of the 4000 series trains based on an acceleration rate of 0.8m/s². This is an accurate characteristic for speeds up to 50Km/h which is largely a linear acceleration rate. At higher speeds the acceleration performance degrades, therefore the 0.8m/s² value is still valid as a worst case, but for an accurate prediction of the actual performance above 50Km/h it is recommended the actual train acceleration curves are utilised.

Speed		Time	Distance
Km/h	m/s	s	m
5	1.4	1.7	1
10	2.8	3.5	5
15	4.2	5.2	11
20	5.6	6.9	19
25	6.9	8.7	30
30	8.3	10.4	43
35	9.7	12.2	59
40	11.1	13.9	77
45	12.5	15.6	98
50	13.9	17.4	121

Time & Distance at nominated Speeds (4000 Series trains)

Time	Speed		Distance
	m/s	Km/h	
1	0.8	3	0
2	1.6	6	2
3	2.4	9	4
4	3.2	12	6
5	4.0	14	10
6	4.8	17	14
7	5.6	20	20
8	6.4	23	26
9	7.2	26	32
10	8.0	29	40
11	8.8	32	48
12	9.6	35	58
13	10.6	37	68
14	11.2	40	78
15	12.0	43	90
16	12.8	46	102
17	13.6	49	116
18	14.4	52	130
19	15.2	55	144
20	16.0	58	160
21	16.8	60	176
22	17.6	63	194
23	18.4	66	212
24	19.2	69	230
25	20.0	72	250

Speed & Distance at nominated Times

The figures in yellow refer to those speeds above 50Km/h which are based on a linear acceleration, which can be considered to be higher than the actual braking curves. (See note above).

13.3. Vehicular Level Crossing Types

Vehicular Level Crossings are classified as either passive or active and consist of a number of alternate configurations as identified in the following sections.

13.3.1. Passive Crossings

13.3.1.1. Open Crossings

Open crossings are not permitted within the AMPRN unless within a yard area to which public access is prohibited or within a temporary work site. In such cases, or in any other situation where an Open Crossing is being considered, the appropriate protection requirements of the site shall be determined on a case by case basis.

Crossings of this type are not covered by this standard.

13.3.2. Active Crossings

13.3.2.1. Flashing Lights Only

Flashing Light Only installations are not permitted within the AMPRN.

13.3.2.2. Flashing Lights with half boom barriers and gongs

Flashing lights with half boom barriers and gongs represent the minimum level of protection provided within the AMPRN except where the requirements of Section 13.3.1 apply.

13.4. Operational Requirements

13.4.1. Warning Time

Warning time is defined as the time interval between the protection warning device commencing to operate and the front of a train travelling at maximum permissible track speed reaching the crossing, with the roadway or pedestrian pathway edge as the reference point.

The warning time shall be calculated in accordance with the requirements specified in AS 7658 Level Crossing Standard.

The operating sequence for active level crossing protection with boom barriers in AMPRN will be based upon the following timings:

- The boom barriers should commence to lower 6 to 8 seconds after the flashing light signals have commenced to flash.
- The boom barriers should reach the horizontal position 10 to 13 seconds after they have commenced to lower.
- The boom barriers should be fully horizontal for at least 6 seconds before train arrival
- The boom barriers should be in the vertical position approximately 10 seconds after they have commenced to rise.
- The warning period between the flashing lights commencing to flash and a train, travelling at the maximum permissible approach speed, arriving at the level crossing shall be at least 25 seconds.
- A minimum road opening time of 10 seconds shall be provided.

- Where traffic light coordination (TLC) is involved, desirably at least 35 seconds warning should be given to enable the traffic lights to complete their cycle and the level crossing to be cleared.
- For road trains, including B-doubles and B-triples, and special vehicles, the durations of each component of the warning and operating times shall be designed to ensure that timings are consistent with safe operating requirements. The route will be identified by DPTI as being subject to this form of traffic.
- The warning time shall take into consideration the road interface width at the level crossing and the clearance time for road vehicles.

13.4.2. Level Crossing Operation Time & Design Speeds

Level crossings within the AMPRN shall be designed to achieve the nominated warning times for each mode of operation based on the maximum authorised speed of a train operating within the approach warning area of the level crossing. Use of attainable speed is generally not acceptable, however where there are significant speed restrictions on the approach to a level crossing (such as may be caused by track curvature), consideration may be given to adjustment of the approach warning distance, providing:

- (i) The approach speed used in calculations is no less than the calculated attainable speed
- (ii) Use of maximum authorised speed would result in a maximum 30% increase in approach warning time.
- (iii) DPTI acceptance is obtained prior to the commencement of any detailed design.

Under no circumstances shall unusual but planned operations (e.g. shunting) or degraded mode operation result in reduced level crossing warning times.

Where there is a station platform situated on the approach to a level crossing, the designer shall calculate the approach times for both stopping and non-stopping services.

The approach warning time shall be increased by 0.35 seconds for each metre of crossing width over 10 metres.

Level crossings on multi-tracked sections will be equipped with a holding section prior to the approach to maintain the crossing closed in the event of a second train approaching the crossing after the crossing has been activated.

The Holding section must be of sufficient length to ensure the booms are raised for a minimum of 10 seconds before operating for a second train. Separate Express and Stopper holding sections can be provided where a platform starting signal is equipped with express/stopper selection.

Where track vacancy detection equipment or other signalling equipment response times introduce time delays into the activation of the level crossing warning equipment devices these shall be taken into account within the design such that the target operation warning times are achieved.

Where road traffic lights are installed at a level crossing, the road traffic lights shall be coordinated with the operation of level crossing warning equipment such that the road traffic lights do not display a green toward flashing level crossing lights. The response times of the road traffic signal equipment shall be taken into account and incorporated within the design such that the target operation warning times are achieved. Typical interface requirements are detailed in section 13.4.12 however the actual times may vary depending on road/crossing width, alignment and road layout; changes from the standard will be nominated by the roads authority.

Separate Control Sections and Holding Sections shall be provided for each operational approach to each protected level crossing. Each approach shall be designed to reflect the operational characteristics and requirements of that section of track.

Where a level crossing features both Up and Down direction approaches on the same track then the design shall incorporate measures to ensure that a departing train does not extend the duration for which level crossing protection is activated or modify the normal sequence of operation in any way (i.e. Runaway Ringing).

Where Runaway Ringing measures are adopted they shall be designed to protect against false masking of an approaching train due to equipment failure (e.g. track circuit failure) or normal train operation (e.g. signalled shunting movements).

13.4.3. Wrong Direction Operation

Where a crossing is designed for unidirectional operation, simple facilities will be provided to automatic level crossing operation for a train traversing the crossing in the wrong-direction. In such circumstances, trains will approach the crossing on the wrong road at a reduced speed.

A single track section approach (minimum distance 100m) will be provided in the wrong direction. The occupying of this track will initiate the crossing, until the train is proved clear at the first available track joint after traversing the crossing. Where the approach track section is longer than practical for a simple approach, consideration can be given to delaying the crossing operation by a timer.

No additional controls or equipment will be provided to:-

- Maintain minimum open time
- Minimise ring-away

Unless specified.

Wrong Direction controls will not be provided within complicated interlocking areas where such controls would be complex to reliably apply.

13.4.4. Signal Interfaces and Interlocking

Where signals are located within the approach section of a level crossing then the operation of the level crossing and the signal(s) shall be interlocked and coordinated as necessary to achieve safe operation of the railway and protection of public roadway users in accordance with the following sections.

If the signal is located on the approach with a station platform, the interlocking requirements shall be in accordance with the design principles for a stopper and express as described in Section 13.4.5 below.

13.4.4.1. Controlled Signal Routes

The following interlocking requirements shall be applied where a controlled signal is located within the Approach section of a level crossing:

- a) If the controlled signal route is requested prior to an approaching train occupying any part of the approach which may impact on the proper operation of the level crossing (i.e. control or holding) then the signal shall clear immediately once the signal route & aspect requirements have been achieved (e.g. tracks clear, opposing routes locked etc.) and the level crossing warning approaches shall operate without any further interaction with the signal.
- b) If the controlled signal route is set with a train already detected on the approach to the level crossing (control or holding) the clearing of that signal shall be inhibited until such time as the target warning times and standard operational sequence is achieved.

The proving of the level crossing controls in the signal shall be in the aspect level at time of clearing. These controls will ensure the following conditions are met before the signal is allowed to display a proceed aspect to an approaching or stopped train with the signal at red:-

- a) A minimum warning time is provided by the locking before the arrival of the train onto the crossing (generally using the worst braking or best accelerating characteristics of all trains using the line);
- b) A minimum opening time of 10-seconds is provided;
- c) Where express/stopper selection has been provided, the shortened approach section has been enforced. (Generally by maintaining the platform starting signal aspect at red –which in some cases may be a signal to the rear of a level crossing signal).

These signals shall have an additional aspect level controls that proves the level crossing controls effective. The crossing shall operate with the signal ready to clear and the proving of the crossing will occur at an additional level.

A signal is deemed to be ready to clear when the following conditions are met:-

- (i) Route Set
- (ii) Points set, locked and detected
- (iii) Tracks in route and overlap clear.

In certain cases, the overlap tracks should be moved from the first to second level (i.e. with the crossing proving). This will cause the crossing to operate when a train ahead is moving through the overlap, thus preventing delay to the clearing up of the signal concerned.

If a train has been proved stationary at a controlled signal which has been restored from a proceed indication to stop, the interlocking will allow the crossing to release and open for road traffic, once the approach locking normalises.

13.4.4.2. Automatic Signal Routes

Automatic signal shall not inhibit the operation of a vehicular level crossing under any circumstances

Where an Auto signal is located within the approach section of a level crossing the following interlocking requirements shall apply:

- a) If there is no train detected on the approach to the level crossing (control or holding) at the time at which the signal is ready to clear, the signal shall clear immediately (i.e. pre-clear) once all other relevant requirements have been achieved (e.g. tracks clear, etc.)
- b) If a train is detected on the approach to the level crossing (control or holding) at the time at which the signal is ready to clear, the aspect change of the signal shall be inhibited until such time as the target warning times and standard operational sequence of the level crossing is achieved.

13.4.4.3. Interlocking Requirements for Signals Associated with Level Crossing

The interlocking requirements to clear a signal will prove sufficient warning time will be given at the crossing prior to a train arriving from a cleared signal.

The clearing of a signal (controlled or automatic) must take into account:-

- a) The proximity of the train to the crossing;

- b) The maximum achievable speed of the train approaching the signal when it clears;
- c) The train's maximum acceleration and worst case braking rate;
- d) The current state of the crossing and traffic light coordination if provided.

These conditions are evaluated for each crossing approach to establish how long it will take to reach the crossing once accelerating from the cleared signal. Standard interlocking treatment options under these circumstances include, but are not limited to, the following:

- (i) Boom Barriers proved Up (i.e. Level crossing Open) for Minimum Road Opening times.
- (ii) Level Crossing Barrier Cycle Initiated (i.e. Lights Flashing) prior to Signal clearing.
- (iii) Level Crossing Warning Lights Flashing. Boom Barriers Commenced Falling prior to Signal clearing.
- (iv) Level Crossing detected closed (i.e. Booms proved down) prior to Signal clearing.
- (v) Train proved stationary at signal (track for time).
- (vi) Traffic light coordination (where provided) has had sufficient time to cycle to the railway phase.

Depending on the position of the signal relative to the crossing, several of the above tests may be required to be proved before the signals can clear.

Where more than one signal is located on a single level crossing approach, the above controls will generally be applied to the closest signal, therefore preventing the train being held at the signal in rear.

13.4.5. Stopper and Express Selection

Where a station platform exists within the approach of a level crossing special controls to reduce the road closure time for stopping trains shall be provided unless instructed otherwise by Signals Engineering.

The provision of Express/Stopper selection, requires the departure signal from the platform to be nominated as a controlled signal, and a separate Stopping approach to be provided for the level crossing. This approach will be enforced by the interlocking to ensure the requirements for the minimum warning time are enforced for the shorter approach.

When a stopping approach is provided, this will be used as the default approach used for the crossing, this shall be the approach for all new works. The Automatic Route Setting (ARS) or Train Controller can upgrade this approach to the full express approach providing either, the approach and holding sections are clear or the crossing protecting

signals is proved normal (however, the signal will not clear until the requirements for the minimum warning time are met).

Some existing interlocking areas use the Express as the default strike in for level crossings, or require a positive express or stopper input before the route over the crossing will set. These shall be converted to default stopping approach during a re-signalling project. Once the stopping or express mode is set, the mode cannot be changed.

Where a stopping approach is provided, a separate 'stopping holding' section will be provided; this will take into account the enforcement of the station stop.

The enforcement of the stopping control will be through the approach clearing of the platform starting signal once the train is proved to a stand (this timing shall consider station dwell time, 20 seconds shall be used). Typically, platform track circuits are approx. 150m in length; therefore a train is proved to be at a stand if the track is occupied for more than 25 seconds.

The running time to the crossing is based on a linear acceleration rate of 0.8m/s². This value will be subtracted from the level crossing minimum warning time to establish the point at which the crossing should commence operating before the signal clears. This will typically be a function of the signal berth track circuit occupied for time. The objective of the design is to allow the signal to safely clear while optimising the level crossing closure so as to limit the impact on road users.

Note: In some cases where the crossing is significantly beyond the station platform, a track control past the platform starting signal may be used to start the crossing. In such cases, consideration of the achievable speed of a train accelerating at the strike in point must be taken into consideration when calculating the minimum warning time; this assessment would include the likely stopping position of the shortest train in the platform.

The stopping control is separate to the interlocking signal controls described in section 13.4.4.3, which will enforce the minimum warning time if required (eg. when the booms have not been proved up long enough to establish the minimum crossing open time).

When an intermediate signal is located between the platform starter and the level crossing, generally the stopping control will be applied to the platform starter and the level crossing interlocking controls applied to the signal closest to the crossing. In this case, the level crossing protecting signal will also prove the platform starting signal clear or the train having passed the starter signal in its aspect conditions at time of clearing only.

13.4.6. Minimum Opening Time

Minimum opening time guarantees that the crossing is open for a sufficient time to ensure a second operation cycle can be safely achieved once road traffic has started moving following a previous crossing operation.

In all approaches where the crossing operation is detected within a signal aspect controls; these controls will prove the crossing open

(Booms Up) for the minimum open time before activating the crossing warning in preparation for the clearing of the aspect.

Minimum Opening Time is not enforced in the interlocking for any other situation, for example, the holding track section must be of sufficient length at line speed to ensure a minimum warning time is achieved.

13.4.7. Local Operation Facilities

Level crossing controls shall be provided with a Manual Operation Switch located external to the level crossing location casess to enable authorised operational and maintenance staff to initiate and terminate operation of the level crossing.

Where a level crossing incorporates more than one operational jurisdiction (i.e. DPTI and ARTC) separate Manual Operation Switch pushbuttons shall be provided for each jurisdiction with different locking arrangements.

13.4.8. Remote Operation Facility

The Train Controller will be provided with a control to operate the level crossing from the control panel.

13.4.9. Level Crossing Retaining

Level Crossing Retaining is provided on nominated crossings; it provides a facility to maintain the crossing operating after the passage of a train.

Typically, it is provided where a crossing is located at one end of a passing loop on a single-line railway. In such a case the retaining will be provided to maintain the operation of the crossing after the first train has arrived into the passing loop (over the level crossing), allowing a second train to immediately depart over the crossing without having to wait for the crossing to sequence after normalising from the passage of the first train.

The crossing retaining function can only be applied if it meets the following criteria:-

- A route is set for the arriving train;
- The crossing is operating for the arriving train;
- Departing train is proved berthed at the departure signal.

Once applied, the control will maintain the crossing operating until:-

- The departure signal clears (therefore maintaining the crossing operation by the occupied berth track circuit);
- Or until 60-seconds following the normalisation of the arrival signal, therefore releasing the crossing allowing it to open.

13.4.10. Remote Manual Operation (Vital Blocking) of Level Crossing Controls

All crossings in WESTRACE Object Controller areas (eg Seaford line) shall be provided with a remote manual function.

This latched function is applied from the control centre and will disable the standard crossing approach controls. Therefore, allowing an

interlocking shutdown or other maintenance work to take place without operating the crossing.

The blocking control shall be stored in the object controller.

The application of the blocking control shall prove all protecting signals red and free of approach locking together with all track circuits clear between the signal and the Level crossing (including any portion over the crossing). In station areas where there are multiple routes over the crossing, all relevant routes will be proved normal with no route locking applied over the portion of the crossing in manual control; these routes will be locked normal by the manual control

13.4.11. Presentation of Road User Warnings

Level crossing flashing lights shall be arranged such that each and every approaching road user pathway is presented with a clear and unobstructed view of at least two alternate sources of visual warning lights. The signage and clearance of flashing lights installations from edge of road shall conform to AS 1742.7.

Units providing the power supply to level crossing flashing lights shall be duplicated and of a failsafe design type approved for use on the AMPRN. These supplies shall be arranged such that at least one full indication shall be maintained for each approach to the level crossing in case of failure of one of the flashing power supplies.

Visual warnings such as Flashing Lights shall operate continuously throughout the entire level crossing operational period from initiation (i.e. strike-in) to completion (i.e. crossing normal).

In addition to visual warnings each Level Crossing shall also be provided with one or more audible warnings. Audible warnings shall be in the form of an automatically operated mechanical bell or an approved electronic equivalent.

13.4.12. Traffic Light Coordination

Traffic Light Coordination is provided at level crossings where an interface is required into the adjacent road traffic light system. An interface is provided to provide advanced warning to the traffic light controller to prepare the road lights for the level crossing operation.

The following outputs are provided to the crossing controller:-

Function Name	Description	Output Contacts
Force to red (FTR)	Prevents conflicting road traffic signals display with the level crossing.	Normally Closed. Opened when crossing lights are flashing.
Advance Warning	Used to inhibit pedestrian movements and for clearance strategy.	Normally Closed. Opened 30-50 seconds before the FTR activation
Minimum Green	Used to Inhibit traffic lights changing to green.	Normally Closed. Opened 10 seconds before the FTR activation.
Boom Gates Rising	Advanced warning of	Normally Open. Closed

	the intersection being released for traffic	as booms start to rise until the booms are vertical.
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Each output is provided by a single-cut circuit between two outgoing terminals.

13.4.13. Red Light Camera Interface

In preparation for the possible fitment of red light cameras at nominated crossings, a suitable voltage free single-cut circuit is required at each crossing between two outgoing terminals to indicate when the road lights are flashing.

13.5. Pedestrian Crossing Types

Pedestrian Crossings are classified as either passive or active and consist of a number of alternate configurations as identified in the following sections.

13.5.1. Passively Protected Crossing

All passive pedestrian crossings within the AMPRN are protected by the use of signs and mazes in accordance with DPTI Standard CS4-D0C-000446 *Standard for Railway Pedestrian Crossings*.

13.5.2. Active Pedestrian Crossings

The minimum level of protection for new active pedestrian crossings shall be provided through the use of audible warning devices, swing gates & fencing.

If the pedestrian level crossing is co-located with a vehicular level crossing, it shall have a common approach sections and warning time as the road crossing.

All new re-signalling projects shall ensure that passive pedestrian crossings adjacent to Active level crossings are converted to Active pedestrian crossings. Where this is not possible, as a minimum the project shall make provision for a separate pedestrian crossing control and indications from the interlocking to facilitate future upgrade to active pedestrian crossing.

At an actively controlled pedestrian crossing with pedestrian lights, the warning period between the pedestrian lights commencing to display a red light and the front of a train travelling at the maximum permissible approach speed, arriving at the pedestrian crossing shall be based on the time required for pedestrians to traverse the level crossing and shall be at least 20 seconds.

The following sections provide additional requirements relevant to the application of actively protected pedestrian crossings on the AMPRN.

13.5.3. Sequence of Operations

Pedestrian crossings fitted with automatic electric pedestrian barrier gates, audio alarm and flashing "Red Man" signs shall operate as follows:

Gate Closing time:

- (i) Commencement of warning sequence Lights start flashing red.
- (ii) 5 to 8 seconds after the warning lights have been displayed the gates should commence to close and the lights display steady red.
- (iii) 5 to 7 seconds after the gates have commenced to close they shall reach the fully closed position.
- (iv) In all cases the gate should be fully closed for at least 11 seconds before the train reaches the level crossing.
- (v) On opening the gates, the red indication is extinguished.
- (vi) 5 to 7 seconds after the gates have commenced to open they should be fully open

If the distance between the clearance points on either side of the pedestrian crossing is greater than 10m, the timing outlined in (i) above shall be increased by a value commensurate with a pedestrian walking speed (including provision for universal access to people with a disability) of 0.8 m/s.

Where necessary, allowance for the response and processing time of control equipment shall be included in the approach warning time.

Assumptions are to be stated in the design calculations.

Pedestrian gate installations shall incorporate a Test Switch within the nearest location case to facilitate operation of the gates by maintenance personnel

Pedestrian gate facilities shall incorporate failure alarms, repeated to the train control system in OCC, which indicate:

- (i) Power supply failure,
- (ii) One or more of the gates have been in the closed position for longer than 5 minutes and,
- (iii) One or more of the gates has remained open 26 seconds after the flashing "Red Man" signs have started operating for the passage of a train.

Each pedestrian gate shall be fitted with an approved audible alarm which operates for the entire period that the gates are operating.

Each actively protected pedestrian gate shall be fitted with an approved flashing "Red Man" sign capable of displaying a visual warning to pedestrians approaching from either side of the gate and shall operate for the entire period that the gates are operating.

13.5.3.1. **Caution More than One Train**

Caution More than One Train is not preferred for any new pedestrian crossings on the AMPRN.

However, where directed by DPTI Rail Signals Engineering, selected passively protected pedestrian crossings within the AMPRN may be fitted with illuminated "CMTOT" warning lights and siren.

Numbers of "CMTOT" flashing signs required at each selected pedestrian crossing to be protected shall be determined on case by case depending on the layout and alignment of the crossing with the front of each of the respective "CMTOT" signs facing the oncoming pedestrian traffic. A minimum of one in each direction, positioned on the opposite side of the crossing and reading back towards the white line shall be provided.

AS1742.7 refers to this type of crossing control as 'Another Train Coming', refer to this standard for requirements regarding positioning of warning lights.

CMTOT operation is where a warning is currently in progress for one train and coincidentally a second train strikes into a holding track section and will therefore arrive at the crossing within the same warning cycle. Designers shall ensure that all combinations of train arrivals are correctly warned for both trains located on the opposite road to the one initiating the crossing warning and for following trains in the same direction.

The system shall fail safe and shall default to a warning state under failure of the CMTOT control equipment and shall operate independently of the level crossing with which it is associated.

A local test switch is provided in the location to enable the signalling technician test the operation of the warning lights.

13.6. Level Crossing Indications/Alarms/Controls

The following indications, alarms & controls will be provided on the control centre workstation:-

13.6.1. Indications

- Booms Up
- Booms Down
- Booms Lowering
- Booms Raising
- Pedestrian Crossing Inactive (Standalone Pedestrian Crossing Only)
- All Pedestrian Crossing Gates Closed (Standalone Pedestrian Crossing Only)
- Pedestrian Crossing Gates Open (Standalone Pedestrian Crossing Only)
- Local Test Switch Operated
- Remote Test Switch Operated
- Remote Manual Operation
- Crossing Alarm Present (see alarm list)

13.6.2. Alarms

- Booms Fail to Raise
- Booms Fail to Lower
- Pedestrian Gates Fail to Close
- Pedestrian Gates operating for excessive time (Fail to Open)

- Power Supply Failure
- Booms Down

Note, the activation of any of the first four alarms will provide a 'Crossing Alarm Present' indication.

13.6.3. Controls

- Remote Test Switch
- Remote Manual Operation

14. Other Requirements

14.1. Cross Operational Boundary Interfaces (Slots)

Where signalled routes, or operation of an item of equipment (e.g. points, releases, etc) forming part of the AMPRN main central control centre at OCC, may have a direct or indirect impact on operation of railway infrastructure which is not part of the AMPRN, or where the operation of equipment outside of the AMPRN main central control centre at OCC may have a direct or indirect impact on the operation of railway infrastructure which does form part of the AMPRN, then special arrangements shall be provided to ensure a formal "Request & Accept" acknowledgement process is provided within the associated control circuitry and logic (i.e. Slots).

Slotting arrangements shall be developed to meet the operational objectives and constraints of the particular circumstance. In general terms however the establishment, maintenance and cancellation of Slots shall be performed in a manner similar to those applied to a signal route.

Slots shall be initiated by the party primarily responsible for initiating the train movement which may impact on the operation of the other jurisdiction.

It shall not be possible to "Ask" or request a slot if all conditions and local interlocking requirements relevant to the asking jurisdiction are not in place and secured (i.e. locked).

Slots shall be completed by the party whose operations are impacted by proposed operation.

It shall not be possible to "Accept" or acknowledge a slot if all conditions and local interlocking requirements relevant to the acknowledging jurisdiction are not in place and secured.

Once the Slot has been acknowledged it is considered "Set". The associated operation shall only be cancelled by passage of a train or appropriate cancellation procedures. Cancellation procedure may include consideration of issues such as Approach Locking, Route Locking, Route Release times, etc.

Once a Slot has been provided it shall be proved within the signal aspect at time of clearing only.

15. Automatic Warning System

The Automatic Warning System (AWS) is provided to mainline signals on the AMPRN. This system presents the driver of a suitably equipped train with an audible and visual alert to warn that the train is approaching a caution or stop aspect. If the driver does not acknowledge this alert within a specified time frame, emergency braking is automatically applied. This standard considers the trackside elements of the AWS system only.

Activation of the train borne equipment is performed by magnets positioned between the rails at strategic locations. The system features 3 magnet types:

- A permanent magnet used to “arm” the on-board equipment.
- An electro magnet used to “cancel” arming of the on-board equipment when the protected signal is displaying a Green aspect.
- A suppressed permanent magnet energised only when required to prevent arming of the on-board equipment when a train traverses a permanent magnet (i.e. bi-directional running) in an opposite direction to which the permanent magnet applies.

The AWS system shall be provided to all mainline signals with the following exceptions:

- At bay and terminal platforms or lines, the starting signal nearest the buffer stop does not need to be fitted.
- Signals provided at the exit of a siding or stabling yard need not be fitted provided that the train always starts from rest, or trap points are provided to protect the main running lines.

There is no requirement to fit AWS magnets on the approach to buffer stops.

AWS magnets shall be nominally located at a distance of 125m on the approach to the associated signal for all line speeds up to 110km/h. The exact positioning of the equipment must take into consideration that the driver shall be able to sight the signal aspect at the time the warning is received by the train borne receiver but shall not be less than 4 seconds at the permissible track speed. For example, where sighting is poor and line speeds are lower the AWS shall be positioned closer to the signal, at the point where the signal becomes visible but this shall not be less than 4 seconds at the prevailing line speed at that location.

Existing AWS' are located approximately 75m on the approach to the associated signal on the Belair, Outer Harbour and the Gawler Lines. AWS' are positioned at approximately 125m on the Seaford line, however, in Adelaide Yard where trains are operating at Medium Speed, the AWS is located 75m on the approach to the signal. If it is required to be disconnected and removed to facilitate track or signalling work or to be replaced, then it shall be re-installed in accordance with the new standard as described above.

Where the location of the signal is such that it is not possible to install the AWS equipment in its optimum position, the signal position takes precedence. The final position of the AWS equipment shall be subject to approvals by DPTI.

Where a mainline signal cannot display a green aspect a permanent magnet only shall be provided.

On bidirectional lines, AWS shall be provided for both directions of movement.

Where a permanent magnet fitted for a mainline signal may be passed by a train travelling in the opposite direction (i.e. bi-directional movements) which would result in an incorrect

activation of the on-board equipment, a suppressed magnet shall be fitted in place of the permanent magnet. The magnet shall only be suppressed for routes reading in the opposite direction to which the AWS is required to provide a warning to the driver.

Where a mainline signal is capable of displaying a Green aspect an electromagnet shall be provided on the signal side of the permanent magnet. The electromagnet shall be energised only when the signal is continuously lamp proved and displaying a Green (Proceed Normal Speed) aspect.

Note: Green aspects associated with divergent routes (Medium Speed) will not energise the electromagnet.

Where a platform line has running signals at either end reading in both directions then it is acceptable to adopt an electromagnet, permanent magnet, electromagnet arrangement positioned midway between the two signals. In this situation only the electromagnet applying to the signal displaying the Green aspect shall be energised. Since this is likely to introduce an AWS position at a non-standard distance from the signal, this arrangement is subject to endorsement by the signal sighting committee who will consider if any risk is introduced due to this arrangement. If not considered acceptable then two separate, suppressed AWS fitments will be required.

In CBI areas, AWS electromagnets and suppressors will be provided with economiser controls to only activate the magnet while the associated track section is occupied. In other areas, where suppression of a magnet is required, suppression shall remain in the energised state until such time as the train has traversed the suppressed magnet.

Economisation of the AWS shall be provided such that the track which applies to the magnet has to be occupied before the magnet or suppressor is energised. However, when the joint is close to a rail joint, the effect of the CBI delay must be taken into consideration and may require the control to be initiated by more than one track section.

Except where directed otherwise by DPTI, AWS Test Magnets shall be installed at each point where a stabled train may re-enter the mainline network (i.e. depot and stabling areas).

16. Technician's Controls

Standard controls shall be made available for technicians to apply and remove restrictions. The application and removal of these control is applied by a technicians workstation

These controls will be:

- Route disconnect
- Points disconnect
- Temporary approach Control
- Aspect Disconnect
- Track circuit occupied.

17. Control Centre Pegging

Blocking of signalling functions is provided by the control centre for the following items:-

- Signals (entrance and exits)
- Points

The pegging of individual functions is proved free in the operation of routes and points. The pegging functions are not proved free by the interlocking in the aspect controls of signals. Pegging will be proved at the time of route setting only for signals, or when any attempt to move points with a key-switch or route setting is undertaken.

Points can only be pegged when keyed Normal or Reverse, i.e. They cannot be pegged in the centre position.

For all new areas controlled by CBI (such as Clarence Park to Seaford), the pegging will be treated vitally within the interlocking (or other vital processing systems).

18. Patrolperson's Lockout Device (PLOD)

Lockout Devices shall be provided at locations where additional protection is required for maintenance worker. The PLOD may be applied to single or multiple track sections.

Each PLOD section can have two blocks applied:-

- Block of Line –preventing signalled moves through the PLOD section
- Temporary Speed Restriction –preventing ETCS fitted trains exceeding 25Km/h within the PLOD section.

In both cases, the route locking on the approach to the destination signals at the end of the PLOD section will be proved normal to ensure no routes are set into the PLOD area or that any signalled train is traversing the PLOD area at the time of release.

A lockable Switch Box shall be provided at each end of the nominated section which will contain a detailed track diagram clearly identifying the limits of the protected section.

Each lockout box shall consist of three push button switches, a key-switch and three indications. The push buttons will have the following functions

- Apply TSR
- Apply Block of Line
- Cancel

The indications respectively provided for each of these buttons are as follows:

- TSR Applied (Yellow)
- Block of Line Applied (Red)
- Normal (Green)

Operation of the system will be as follows:-

To apply a block for a nominated section, the signaller must be contacted and asked for a specific release. The signaller will grant this by operating a suitable control on the panel. This will extinguish the Normal (green) indication, and flash the appropriate block indication (TSR or BOL). This will be accepted on site by the pressing of the appropriate button within 5-seconds. The release is similarly a cooperative process, where the signaller initiates the cancel, which is confirmed by the operation of the cancel switch at either end of the section; which will result in normal operation and the illumination of the green lamp if both TSR and BOL are normal.

Both blocks can be applied simultaneously with the Block of Line having a higher priority than the TSR; this will enable the transfer of block from say BOL to TSR without having to fully normalize the system.

The key-switch will have two positions (Normal & Disable). The movement of either of the two key-switches at each end of the section to the disable position will prevent the operation of the cancel facility at either end of the section. This key can be removed from the key-switch in the Disable position. Therefore, this can be utilised to prevent unauthorised cancellation of the protection; however, normal operation can only be resumed from the same end as the control was applied (ie. The insertion of the key, and placement of the keyswitch to the Normal position).

Control centre indications shall be provided to indicate the status of each lockout, with suitable controls provided for release and cancelling of each type of block (TSR or BOL). Indications will also be provided for the key-switch to enable the signaller to identify at which end of the section the switch has been placed into the Disable position.

19. Exit from CTC Territory

Signals located at the boundary of the AMPRN CTC territory provided for the purpose of indicating authority to proceed into an alternate form of train working territory shall display a Yellow proceed aspect or shall be a low speed signal.

APPENDIX 1 - GLOSSARY

Abbreviation	Meaning
AC	Alternating Current
AMPRN	Adelaide Metropolitan Passenger Rail Network
AREMA	American Railway Engineering and Maintenance-of-Way Association
ARO	Accredited Rail Operator (RCom acts as ARO for the AMPRN)
ARS	Automatic Route Setting
ATC	Automatic Train Control
AWS	Automatic Warning System
BI	Banner Indicator
BOL	Block of Line
CBI	Computer Based Interlocking
CTC	Centralised Traffic Control
CMTOT	Caution More Than One Train
DC	Direct Current
DRR	Disaster Recovery Room
DPTI	Department for Planning, Transport and Infrastructure.
EMU	Electric Multiple Unit
ETCS	European Train Control System
FWR	First Wheel Replacement
GCP	Grade Crossing Predictor
GRN	Government Radio Network
RRV	Road-Rail Vehicle
IRJ	Insulated Rail Joint
LHS	Left Hand Side
LOS	Limit Of Shunt
LWR	Last Wheel Replacement
LX	Level Crossing
MTMV	Mobile Track Maintenance Vehicles
NX	Entrance-Exit System
OCC	Operation Control Centre
OHLE	Overhead Line Equipment
PLOD	Patrolpersons LockOut Device
PSR	Permanent Speed Restriction
RCom	Rail Commissioner (Accredited Rail Operator for AMPRN)
RHS	Right Hand Side
RR	Relay Room
RRI	Route Relay Interlocking
SER	Signal Equipment Room
SLAS	Single Line Automatic Signalling
SLW	Single Line Working
SPAD	Signal Passed At Danger
SPT	Signal Post Telephone
SR	Stick Relay
SSI	Solid State Interlocking (a proprietary product – a type of CBI)
TC	Track Circuit
TFM	Trackside Functional Module (a sub-system of SSI)
TORR	Train Operated Route Release
TSR	Temporary Speed Restriction
URX	Under Road Crossing
UTX	Under Track Crossing
VDU	Visual Display Unit

Abbreviation	Meaning
VPI	Vital Processor Interlocking (a proprietary product – a type of CBI)

DEFINITIONS

Term	Meaning
Absolute (Signal)	A signal that when displaying a stop aspect is an absolute restriction and the signal shall not be passed unless formal permission is obtained from train control.
Active (Level Crossing)	A level crossing that is provided with active protective and/or warning devices to warn a crossing user of an approaching train. May include lights, sirens & barriers or gates.
Advanced Starting Signal	A main signal placed in advance of a starting signal to control the entry to a section ahead.
Anti Pre-selection	The prevention of pre-selection of a signalling control function.
Approach Control/Clear	The delay clearing of the aspect of a signal in order to control the speed of a train for a warning route or home signal with a reduced overlap.
Approach Locking (Comprehensive)	The locking of any route from a signal, which is applied when the driver has seen or may have seen a proceed aspect at the signal or a previous signal that would indicate to the driver that the former signal is displaying a proceed aspect. If the signal is replaced to danger, the approach locking prevents the immediate release of the route.
Approach Locking When Cleared	The approach locking is applied as soon as the signal controls have been operated for the signal to display a proceed aspect.
Aspect	A visual indication of the status of a signal that is given to the driver.
Authorised Movement	An alternative term for movement authority that is issued by train control or a qualified safe working person.
Auto Normalising Points	Points which are automatically returned to the Normal position by the interlocking after it has been traversed by a train movement.
Automatic Route Setting	A system for setting routes without requiring action by the signaller.
Automatic Signal	A signal where the aspects are controlled by the passage of train movements only. (Except where provided with emergency replacement).
Automatic Warning System (AWS)	A system used to provide audible and visual warnings to the driver on the approach to a restrictive aspect.
Axle Counter	A form of train detection equipment provided in place of the conventional track circuit
Block Section	A section of line between the starting signal and the home signal of the adjacent stations with turnouts. A Block Section may contain multiple Track Sections.
Blocking Facility	A command used by an authorised person (mainly Train Control or signaller), to maintain signal(s) at stop thereby preventing a proceed authority being inadvertently issued.
Bond and Bonding	Generic term for electrical connections and cabling for track circuit feed and relay end connections. Also used for connections and cabling associated with the traction system in electrified areas (including cross bonds, structure bonds and impedance bonds).
Catch Points	A set of points usually comprising a single switch, the normal position of which provides an open trap to a movement in the facing direction resulting in enforced derailment. Catch points are interlocked with the set of points giving access to the track on which the catch points are installed.
Checking & Aspect Level	Controls that are required to be satisfied before a signal may display a proceed aspect.

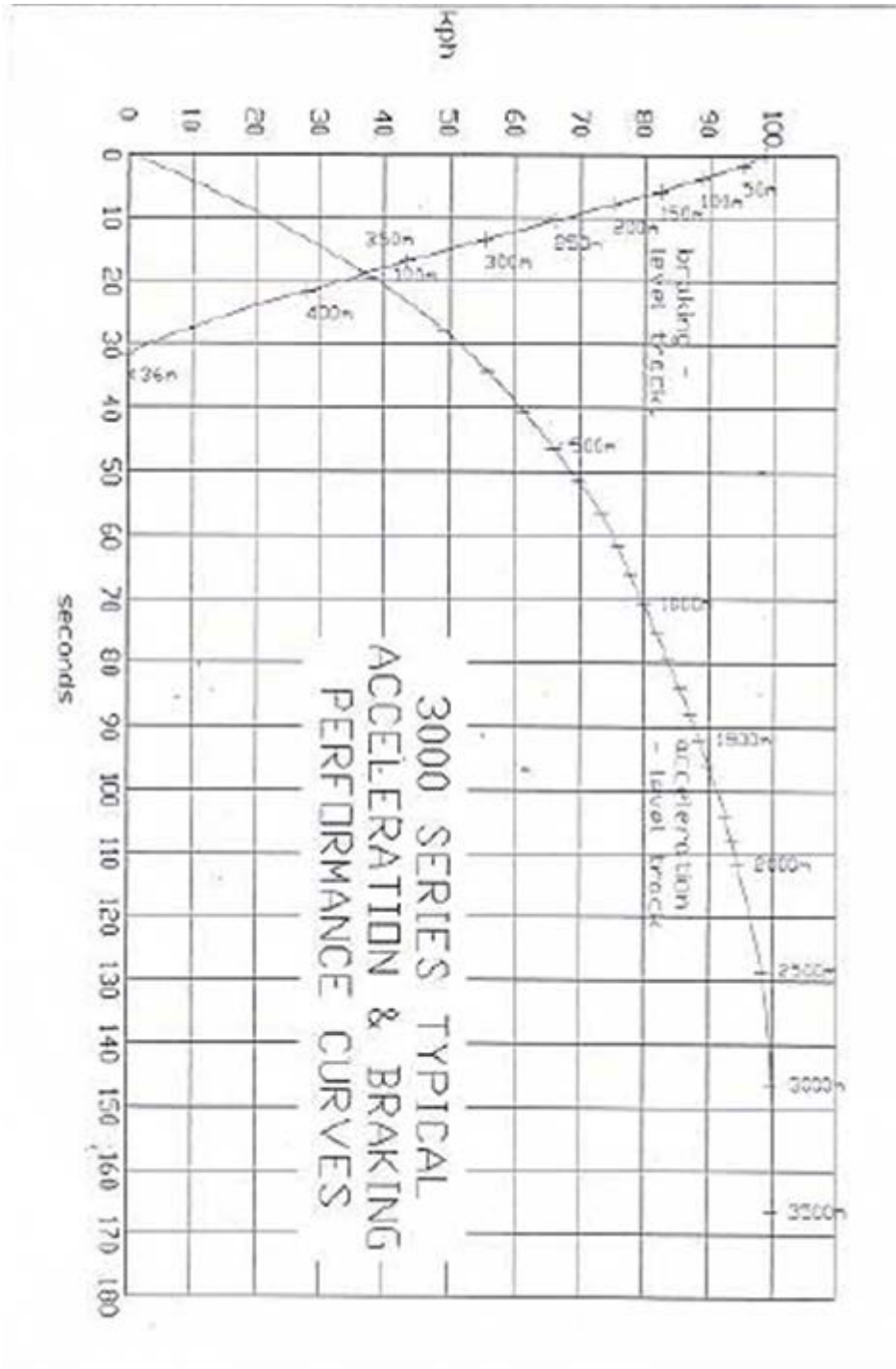
Term	Meaning
Clearance Point	The minimum distance beyond points or crossings to ensure sufficient clearance between lines so that a vehicle positioned on one track is clear of any movement on the other. The clearance point is defined as the position at which there is 4 metres between the centre lines of adjacent tracks. Generally the clearance point shall be located at least 4 metres from the fouling point (i.e. 4m from the centre of IRJ to FP) to allow for overhang at the end of rail car.
Co-acting Signal	An additional signal that is provided in exceptional circumstances for sighting purposes. It is located either on the same mast as the main signal or on a separate mast adjacent to the main signal in the same transverse plane.
Conditional Locking	Interlocking between two signalling functions that is dependent upon the state of other interlocking functions.
Control Device	A switch, button, key, or icon on a Signaller's control panel or work station used to control signal functions.
Crossover	A pair of turnouts either facing or trailing situated between two parallel tracks, allowing a train to cross from one track to the other.
Dead Locking	Locking which is not conditional on any other control.
Degraded Situation	A failure of the signalling system that prevents the signaller from giving the desired lineside aspect to a train, resulting in the display of a more restrictive aspect.
Derailer	A two position mechanical device attached to the rail. When seated over the rail head in the "tripping" position it will deflect a low speed movement off the rails resulting in an enforced derailment.
Direct Opposing Locking	Opposing locking applied by two routes that do not require points in a different position.
Double Line	Two adjacent, parallel, running lines.
Entrance	The start point of a route or movement authority.
Exit	The end point of a route or movement authority.
Facing Points	Points which join two diverging routes.
First Wheel Replacement	A control applied to a signal that replaces it to its most restrictive aspect immediately after the front/first axle of the train has passed the signal.
Fleeting	An automatic mode of an interlocked signal in which the route remains in a locked state and the signal works like an automatic signal. This only applies to the main running lines.
Fouling Point	The point whereby a vehicle standing on one converging or diverging line would come into contact with a vehicle on the other line.
Fouling Track	A track circuit near where lines converge or cross and where a train (including the overhang of the train) on the track circuit could be within the clearance point of the other line(s)
Headway	The minimum time interval (or distance) that can be maintained between two successive trains running at normal operating speed without being restricted by signal aspects.
Heel (Point)	The end of the Switch Rail which is fixed in position
Home Signal	A signal that controls the exit of a block section and entry into a station or junction. A Home signal is an Absolute signal.
In Advance	A term indicating a point beyond a specific location on the track.
In Rear	A term indicating a point on the approach to a specific location on the track.
Indirect Opposing Locking	Opposing locking between two conflicting routes that require one or more sets of points in a different position.

Term	Meaning
Interlocking	A general term applied to the function of setting and releasing signals and points to prevent unsafe conditions arising. This term also applies to the equipment performing this function.
Intermediate Section	Any division of the single-line block section the entrance to which is governed by an intermediate signal. A block section may be divided into two or more intermediate sections. Sometimes referred to as a half block section when the block section is divided into two intermediate sections.
Intermediate Signal	A signal positioned within a block section which is used to accommodate following moves.
Last Wheel Replacement	A control applied to a signal that replaces it to its most restrictive aspect after the rear/last axle of the whole train has passed the signal.
Locked	Where a function of the signalling system is prevented from changing state by another part of the signalling system.
Locking Release	Controls that are required to be satisfied before the locking on a route or section of a route can be released.
Low Speed Signal	A signal that enforces a speed not exceeding 25km/h and at which will enable a train to be stopped within half the distance the line is seen to be clear ahead
Main Route	A class of route from one main signal to the next and which requires the route and overlap proved clear.
Mainline Signal	A signal provided to control the through movement of trains on the main running lines.
Marshalling Yard	A yard consisting of a system of tracks, crossings, points etc., used for the purpose of receiving and dispatching trains, shunting and stabling of railcars or wagons.
Movement Authority	Permission for a train to run to a specific location within the constraints of the infrastructure.
Normal (Function)	Position of a function when in its unoperated state.
Normal Direction	The direction that trains travel on a section of track for all regular movements. For a unidirectional double track the normal direction would usually follow the left hand running rule where a train travels on the left hand track (as viewed in the direction of travel).
On Sight (Movement Authority)	A method of operation whereby the train travels at such a speed that it can be stopped short of any obstruction.
Outer Home Signal	A signal that is placed in rear of a home signal to extend the station limit in some situations. Outer home signals are normally provided where there are points within the overlap. Outer home signals are Absolute signals.
Overlap	The section of line in advance of a signal that must be unoccupied and, where necessary, locked, before the preceding signal may display a proceed aspect.
Oversetting	Selecting a following route to the same exit before the previous movement has cleared the route or overlap.
Passive (Level Crossing)	A level crossing which has no active warning devices to warn the crossing user of an approaching train.
Permanent Way	The part of the railway formed by the rails and all associated elements required to hold the rails in position (typically consisting of the ballast, rails and sleepers).
Permissive (Signal)	A signal when displaying a stop aspect that may be passed, subject to and in accordance with the rail operating rules and procedures.

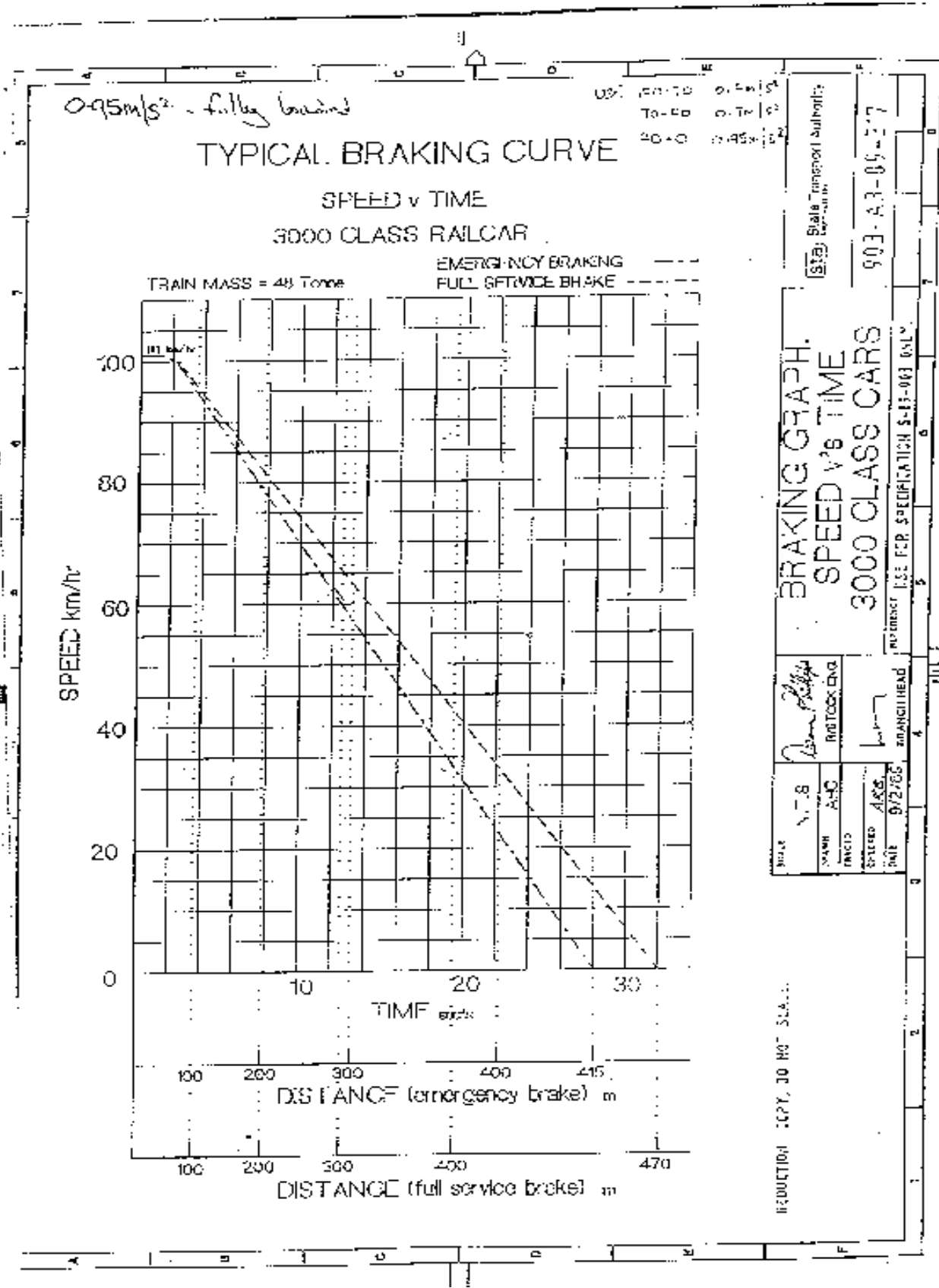
Term	Meaning
Permissive (Working)	A method of working whereby a movement authority is given into an occupied section of track.
Points	Items of permanent way which may be aligned to one of two positions to guide the train towards either the straight (Normal) or divergent (Reverse) track.
Pre Set Shunt	A shunt signal that is located within a main route and reading in the same direction which is cleared automatically by the main route.
Pre-selection	The selection of a signalling function prior to the function becoming available, so that it is automatically set when some other function is restored.
Proceed Aspect	Any signal aspect other than stop which permits the driver to pass the signal.
Proceed on Sight Aspect	See On Sight.
Proved	Evidence that a physical part or interlocking logic of the signalling system is in the required state.
Reciprocal Locking	The provision of locking between functions to ensure that the inverse is also true hence the conditions cannot be broken down, that is if 1 locks 2, then 2 must lock 1.
Reduced overlap	An overlap that is shorter than the minimum permitted length of a full overlap.
Reverse (Function)	Position of a function when in its operated or activated state.
Reverse (or Wrong) Direction	The opposite direction of travel to the normal direction. For a double track the reverse (or wrong) direction would usually be where a train travels on the right hand track (as viewed in the direction of travel).
Route	A path used for an authorised movement along a section of track which has a defined start and end point.
Route Locking	A form of interlocking which maintains the locking associated with a route in use until after the train has traversed clear of the equipment being locked.
Set (Route)	Successful completion of the route setting process (i.e. all conditions required by the route locking are satisfied and in correspondence).
Set (Points)	Interlocking functions that control the movement of the points to its intended position.
Shunt Signal	A signal provided for shunting movements.
Siding	A portion of railway track used for stabling and storage of vehicles away from the main running line.
Sighting Distance	The distance from a signal to its sighting point.
Sighting Points	The furthest point from a signal, at which the driver can reliably read the displayed signal aspect.
SIMBIDS	Abbreviated term for simplified bidirectional signalling. A method of working that allows a single train travelling in the reverse direction into a block section. The term SIMBIDS relates to a specific set of historical principles and rules which are generally accepted not to be relevant to modern signalling practices.
Single Line	A section of single track over which bidirectional running of trains is authorised.
Starting Signal	A signal that is placed at the entry into a block section. The starting signal is an Absolute signal.
Stop Block	A block of hardwood or steel which, when placed across any running rail, will either stop a vehicle or derail it away from the mainline or crossing loop.

Term	Meaning
Switch Rail (or Point Blade)	The moving portion of rail in a set of points.
Time of Operation Locking	Locking that is applied to facing points in an overlap that are positioned close to the exit signal such that the points would not be expected to complete their movement if a train overran the signal.
Toe (Point)	The front end of a Switch rail.
Track Circuit	An electrical circuit where current is carried through the rails and used to detect the absence of trains.
Track Interrupter	A device fitted to a catch point to maintain the track circuit in an "occupied state" in the event of a derailment to provide warning to train movements.
Track Locking	The locking of a signalling function when a track section over the movable object (e.g. point machine) is occupied.
Track Section	A portion of the railway with fixed boundaries for which the train detection system provides information on its state of occupancy to the signalling system.
Trailing Points	Points which join two converging lines.
Unit Lever (Control)	A method of control that provides a separate lever or switch for each set of points and signal. When setting a route, the signaller is required to operate each set of points to the required position before operating the switch or lever to clear the signal.
View Line (Level Crossing)	Line of sight from the driver of a road vehicle to a loco headlight.
Warner Route	A class of controlled route that has a reduced overlap or reduced braking.

APPENDIX 2 - ROLLING STOCK ACCELERATION CHARACTERISTICS

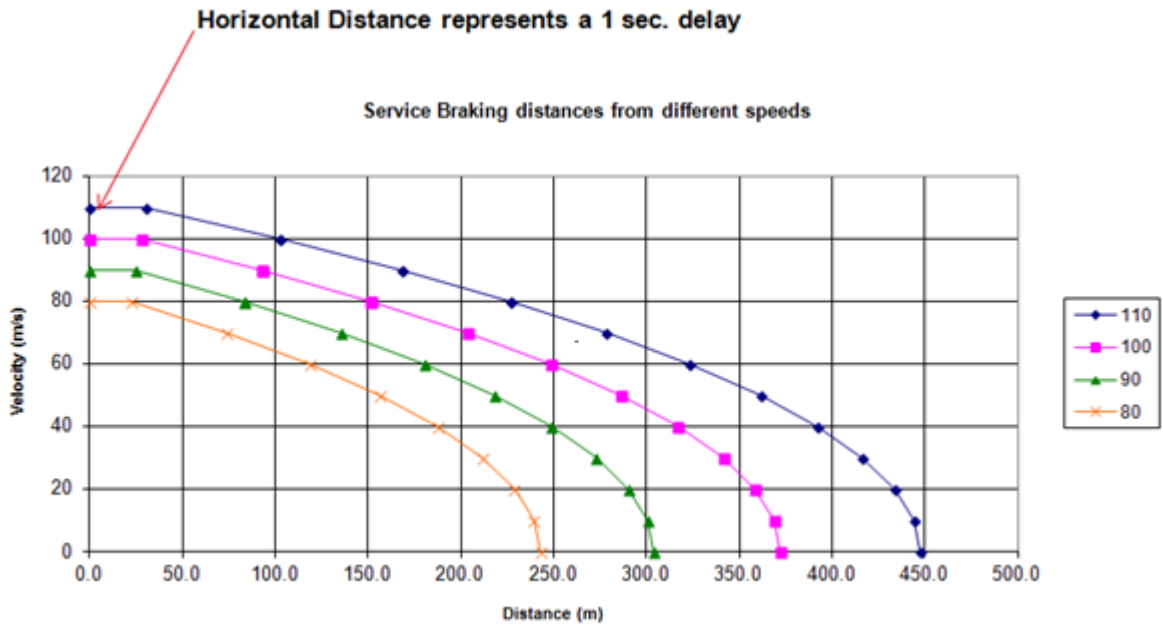


APPENDIX 3 - ROLLING STOCK BRAKING CHARACTERISTICS



1. Adelaide EMU (4000 Class) – Service Brake

The below graph represents the stopping distance required for the Adelaide EMU, with a 1.12 m/s deceleration rate



1. Adelaide EMU (4000 Class) – Emergency Brake

The below graph represents the stopping distance required for the Adelaide EMU, with a 1.2 m/s deceleration rate

