WestNet Rail Pty Ltd

CODE OF PRACTICE:

SIGNALLING DESIGN PRINCIPLES

FOR PROCESSOR BASED INTERLOCKINGS

THIS REVISION PREPARED BY	REVIEWED BY	AUTHORISED BY
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1 Introduction

This document is intended to identify the principles and practices applicable to Processor Based Interlockings (PBI) on the WestNet Rail freight rail network.

The principles are constrained by existing signalling layout conditions and are therefore specifically tailored to accommodate these constraints. New signalling schemes may provide potential for utilisation of differing or modified principles and therefore these principles should be reviewed for new projects. This version of the principles reflects a review of the principles prior to design of the proposed Mid-West CTC project between Geraldton and Mullewa.

New signals shall normally be three aspect (Red/Yellow/Green) LED type and shall normally be provided with a 200 metre overlap. At crossing loops Home signals will be restricted to approach clearance up to the Departure signals if the opposing block is not free, and the loop points beyond the Departure signal shall be set so as to deflect any train approaching the opposing Home signal away from the train approaching the Departure signal.

For new projects eNtrance – eXit (NX) route setting shall be provided, and route locking with sequential route release shall be provided within interlocked areas. Alterations to existing installations shall normally use the existing standards for that installation except where otherwise specified by the Signal Manager Projects & Standards.

2 Signals

2.1 General

The following conditions apply to signals generally: -

a) Main routes shall apply for movements up to Main signals only (i.e. a Main route shall not have a Ground Shunt signal as the limit of authority; a Subsidiary Shunt route shall be provided for this situation).

   A Main route shall also apply for movements into terminal platforms, but will be limited to a maximum yellow aspect.

b) If a Ground Shunt signal is contained within a Main route (i.e. it “reads over” the Ground Shunt signal), all interlocking shall be performed in the Main route with route locking applied for the entire Main Route and the Ground Shunt signal aspect set and proved prior to the Main signal aspect setting.

   The Ground Shunt Signal shall not be able to be manually cancelled (other than by cancellation of the Main signal leading to it) and shall remain OFF until the replacement track for the Ground Shunt signal is occupied.

   If the Main signal is cancelled (i.e. not replaced by a train entering the route) the “in route” Ground Shunt signal will also cancel; in which case, approach locking from the Main signal for the entire Main route shall apply (i.e. approach locking of the Ground Shunt signal is not applicable).

c) Shunt routes shall not apply to movements onto Main lines beyond Station Limits.

d) Ground Shunt routes may apply to movements on to a running line within an interlocked area where a Main signal is provided as the limit of authority.

e) Shunt signals shall normally be last wheel replaced unless special circumstances dictate otherwise.

2.2 Main Signals

2.2.1 Types of Signals

Main signals in new installations shall be three aspect (Red/Yellow/Green) LED type. Main signals in existing installations may be 3 aspect searchlight or multi-aspect colourlight. No specific speed conditions apply to Main signal aspects.

Signals applicable to diverging routes may be: -

a) Configurations of individual searchlight signals with a separate head applicable to each route. The straightest route typically has the applicable head mounted on top of the mast; divergent route heads being bracket-mounted from the side of the mast corresponding to the direction of the divergence at a lower level than the main head.

b) A single searchlight signal in more recent installations with (BR style) position light junction route indicator(s) (JRI) mounted above. No JRI applies to the straightest route – even where this route applies to a divergence.

c) A single multiple aspect colourlight signal with (BR style) position light junction route indicator(s) (JRI) mounted above. No JRI applies to the straightest route - even where this route applies to a divergence.

d) Stencil route indicators may be fitted to multiple route divergent signals in lieu of JRI's.

2.2.2 Controlled Main Signal Categories

The following types of controlled Main signals are used. Each type of signal has specific safeworking regulations applicable to it. For further information, refer to the WestNet Rules and the General Appendix.

Controlled Main signals have a square reflectorised marker plate mounted centrally on the mast which includes the signal number and an arrow and route information for each route (where applicable).

2.2.2.1 Home Signal

Defines station limits within which certain rules apply.

In the event of failure, trains may be "talked past" Home signals in accordance with the WestNet Rules.

Existing Home signals are typically located within 2m of the toe of the facing points entering an interlocked area; or at or close to clearance point from the converging track where a trailing junction is encountered. New or relocated Home signals shall normally be placed a minimum of 200m from opposing Departure signals for overlap provision and not closer than 20m to the toe of points for track maintenance requirements.

2.2.2.2 Outer Home Signal

Outer Home signals are used to provide additional (2-signal) protection where a flanking move is possible within close proximity to the Home signal. This typically applies where routes converge or a diamond crossing is located within a nominal "overlap". A nominal distance of 400m and a minimum distance of 200m should apply between the Home and Outer Home signals for provision of an overlap.

Outer Home signals may also be provided in conjunction with an Advanced Starting or common Departure signal provided for the purposes of enabling shunt movements towards a block section without inhibition of approaching trains in the block. A minimum distance of 400m shall normally be provided between the Outer Home and the Advanced Starting or common Departure signal for provision of independent overlaps.

2.2.2.3 Directing Signal

A Directing signal is any signal within an interlocking area which is not controlling the entry into or exit from a block section.

2.2.2.4 Starting Signal

A Starting signal is a signal controlling the entry into a double line (unidirectional working) section from an interlocked area.

An alternative safeworking system between stations is not normally provided in the event of "wrong way" working being required.

2.2.2.5 Advanced Starting Signal

An Advance Starting signal may be provided ahead of a Starting signal to enable shunting where necessary.

2.2.2.6 Departure Signal

A Departure signal is a signal controlling the departure from an interlocking into single line signalled territory.

Pilot key facilities are normally provided as an alternative safeworking system between adjacent stations.

Typically, there are Departure signals applicable to each converging road entering the block section. Occasionally, Directing signals or Ground Shunt signals may control movements toward a common Departure signal located in the block section ahead, to enable shunting movements to occur without inhibiting opposing train movements. A Home or Outer Home signal must be located at a suitable distance further into the block section under such circumstances, to provide protection from opposing movements in the block.

2.2.3 Automatic Signal Categories

The following types of Automatic Main signals are used. Each category of signal has specific safeworking rules applicable to it. For further information, refer to the WestNet Rules and the General Appendix thereto (Appendix A).

a) Intermediate Signal
b) Approach Signal
c) Semi Automatic

Automatic Main Signals have a reflectorised marker plate which includes the signal number and is offset to the right from the mast. Signals which divide the block have a square plate, whereas signals which do not divide the block have a triangular plate.

2.2.3.1 Intermediate Signal

Intermediate signals are provided in permissive block sections and are used to divide the Block to enable following train movements.

In the event of signal system failure, a train is required to stop and request permission to pass the signal at STOP. If, however, communication cannot be established with Train Control, the Driver may "wait section time" and proceed with caution being prepared to stop short of any obstruction.

2.2.3.2 Approach Signal

Approach signals are used in absolute block sections to provide advance warning of the Home signal ahead. This enables entry to the block section to be via a green signal – provides for less restrictive train running.

Approach signals may also be used as a repeater for a Home signal in permissive block sections or to provide aspect sequencing for less restrictive train running.

Approach signals do not divide the block and therefore do not enable a following train movement from the signal in rear.

Approach signals on existing installations are provided with red aspects although these cannot be seen by an approaching train under normal operating conditions. For new installations

Approach signals shall not be provided with a red aspect, i.e. they shall normally display a yellow aspect.

2.2.3.3 Semi Automatic Signal

A Semi Automatic signal is provided for a specific purpose in special circumstances where it usually works in "Automatic Mode" as an Intermediate signal but is required under some circumstances to revert to a Controlled signal where it would not be acceptable to "wait section time" and then proceed. An 'A' light is fitted which, when extinguished, signifies that it must not be passed without permission from the Train Controller.

Examples of the application of Semi-Automatic Signals and 'A' lights are:

a) If a switchlocked siding within a block section is being accessed, an Intermediate signal fitted with an 'A' light would revert to STOP with the 'A' light extinguished.

b) A station, siding or other interlocking may be "switched out of use" with signals reverting to automatic operation with 'A' lights illuminated.

2.2.4 Main Signal Aspects

Aspect sequences for main signals are normally Green → Yellow → Red with certain exceptions as set out below.

2.2.4.1 Controlled Repeating (or Repeater) Signals

A Controlled Repeating signal operates in conjunction with the signal being repeated, has a Red aspect and is typically used to avoid a train stopping at the repeated signal (e.g. to avoid standing across a level crossing or where there is restricted visibility for the repeated signal). Aspects are typically: -

Repeated Signal Aspect	Repeating Signal Aspect
Red	Red
Yellow	Yellow or Green - Dependent on other requirements
Green	Green

Table 1 - Typical Controlled Repeating Signal Aspects

2.2.4.2 Non-Controlled Repeating Signals

A non-controlled Repeating Signal is similar to an Approach Signal, does not divide the block and merely provides additional aspect sequencing for the signal in advance when poor sighting conditions prevail. Aspects are typically: -

Repeated Signal Aspect	Repeating Signal Aspect
Red - or Yellow set for diverging route	Yellow
Yellow (non diverging)	Yellow or Green - Dependent on specific requirements
Green (non diverging)	Green

Table 2 - Typical Non-Controlled Repeating Signal Aspects

2.2.4.3 Diverging Junctions

The signal in rear of a signal controlling entry to a diverging junction shall display a maximum Yellow aspect when the signal ahead is set for the divergence.

A maximum Yellow aspect shall also be displayed by the junction signal when set for a divergent route where the junction signal is equipped with a Junction Route Indicator (JRI) (even though the JRI indicates a diverging route anyway). Note that a JRI is not usually

provided for the "main or straightest" route even if a divergence is involved. Aspects are typically: -

Junction Signal Aspect	Signal in Rear Aspect
Red – or Yellow or Green on a divergent head or yellow + JRI	Yellow
Yellow (non diverging)	Yellow or Green – Dependent on other requirements
Green (non diverging)	Green

Table 3 – Typical Aspects at Diverging Junctions

2.2.4.4 Restricted Braking Distance

Where signal spacings are such that braking distance is unavailable for the worst case train at the maximum speed (either line speed or train speed) between consecutive signals, the aspect displayed on the second signal in rear of the signal displaying a Red aspect must be restricted to Yellow.

This often applies between an Outer Home signal (or Repeating signal), Home signal and the signal in advance of the Home signal (typically the Departure signal). The longest stopping distance on the Eastern Goldfields Railway (WestNet Rail's Standard Gauge mainline) for a train with worst case braking characteristics is 2000m. The Outer Home in these situations may be a "Repeater" of the Home with a common control whereby all aspects of the Home are repeated in the Outer Home; or it may have a separate control and only be allowed to display a Green when the Home is also displaying a Green.

{Note: To meet this requirement, where there is less than braking distance available between Home and Departure signals, the Approach or Intermediate signal must now display a maximum Yellow aspect unless routes are set through the Main line with the Departure signal Off. This is consistent with the operation of Home Signal aspects which will be approach cleared whenever the Departure signal (or other Directing signal within an interlocked area) in advance of the Home is at Red. }

The aspects shown are typically: -

Departure Signal Aspect	Home Signal Aspect	Intermediate, Approach or Outer Home Signal Aspect
Red	Approach Cleared to Yellow	Yellow (as Home signal is Red)
Yellow	Green	Green
Green	Green	Green

Table 4 – Typical Aspects for Restricted Braking Distances

2.3 Subsidiary Signals

The only form of subsidiary signal that may currently be fitted to a Main Signal mast is a single Yellow aspect, short-range shunt signal (often referred to as a "Low Speed Shunt").

2.4 Ground Mounted Shunt Signals

Existing Ground Mounted Shunt (Ground Shunt) signals are typically 2 aspect (R/Y) searchlight signals fitted with a blanking ring to create a 162mm nominal diameter aperture.

For new projects Ground Shunt signals shall be 2 aspect (R/Y) LED type.

3 Track Circuits

3.1 Primary Track Circuits

3.1.1 Preferred Types

Preferred types of new track circuits are: -

a) DC "High Voltage" using 6 – 10V (average) output to track with fixed feed end and adjustable relay end resistors. Either 4 or 9 Ohm relays are acceptable for track circuit lengths up to 2km;

b) AFO of approved types – may be used as an overlay on DC or coded track circuits (generally for level crossing approaches) may also be used with specific approval as primary track circuits for signalling purposes;

c) Coded (Electrocode or Microtrax).

AC/DC diode track circuits (Westrak) are not preferred in interlocked areas and are not to be used for other than "indication" tracks (typically the berth track to signals controlling entry to signalled territory) unless specifically approved otherwise.

3.1.2 General Design Criteria

The general design criteria for track circuits are: -

a) 0.5 Ohm shunt (0.25 Ohm track shunt is accepted under certain conditions and for some types of track circuits on main lines);

b) 3 – 3000 Ohms/km ballast;

c) 1.5 Ohms maximum lead resistance at each end for DC tracks, 0.5 Ohm for AFO and Coded track circuits.

Reed track circuits will be retained where currently installed in existing block sections. No new reed track circuits are to be installed due to obsolescence.

3.2 Repeats

Track circuits used in signalling functions shall have a slow to operate (pick up) repeat within the interlocking of not less than 1 second operate time.

Where used in conjunction with inherently slow to operate and slow to release type track circuits, coordinated track circuit repeat delays shall be implemented on track circuits of other types to ensure continuity of track circuit occupancy. For example, DC track circuits on points tracks between coded track circuits shall have operate timers longer than the maximum drop time and not shorter than the maximum pick time of the adjacent tracks.

Track circuits used in level crossing controls shall normally use repeats with a 2 second pick up delay to reduce the risk of the crossing controls clearing due to any short term loss of train detection.

4 Train Control System Operation

4.1 Controls

4.1.1 Routes

Entrance – Exit (NX) route setting is required whereby the route entry point, class of route (i.e. Main or Shunt move) and exit point (destination) are selected to generate a route call. Individual route calls are to be provided from the Train Control System (TCS) for each route and class of route.

Confirmation of a Route's availability is required at the TCS before a route call can be placed.

Receipt of a route call in the interlocking will set points in the route (and beyond as required for overlap provision) provided the route remains available.

Note that some existing installations encompass individual controls for points, signals, etc. These interlockings have Train Control System emulation of NX route setting so as to provide common Train Controller interfaces. This necessitates the TCS separating points and signal calls to set and confirm points prior to transmission of a control to clear a signal. In some cases this emulation is contained within field-located equipment provided for protocol conversion between the TCS and the existing interlocking.

4.1.2 Points

Controls for manual selection of point position are required. Setting of points by calling of a route will only be available when the points are not manually selected in the normal or reverse position.

Controls (especially for route calls) shall generally be a momentary transmission which is latched in the field interlocking. Such operation precludes the necessity for emulation of the interlocking in the TCS and enables vital implementation of such features as “last wheel replacement” and self-restoration of points independent from the TCS.

Should the controller desire cancellation of the control, specific cancellation or overriding controls and transmission of consequent specific control data to the interlocking shall be utilised rather than merely removing the call.

Route calls shall not be released from the TCS automatically (eg. by monitoring of train movement). Automatic route cancellation upon train movement shall only be performed vitally in the field interlocking application by removal of the latched condition when the Approach Locking release requirements are satisfied.

Switchlocks and electrically released ground frames require latching of a releasing control until receipt of an overriding control to remove the release. With the release removed, the switchlock or ground frame will become locked upon restoration to Normal.

4.1.3 Blocking

Blocking facilities are to be implemented vitally in the interlocking in response to appropriate controls from the TCS. Application of a block within the interlocking shall prevent route setting over the affected track section.

4.2 Indications

Indications shall generally be determined from the interlocking system states transmitted to the TCS rather than from data generated from within the TCS.

The following indication data bits are generally required: -

4.2.1 Routes

a) Route Availability (UAK) – active HIGH when route available. Provided for each route and each class of route which includes all “in route” requirements to be met. Overlap conditions are not required in route availability indications for routes that have a mode of operation for which the particular condition in the overlap is not required to be met. (e.g. Where an approach cleared aspect is provided for limited overlap conditions).

4.2.2 Signals

a) Red Signal (RGK) – active HIGH when signal confirmed at Red.

b) Caution Signal (HGK) – active HIGH when signal confirmed at Yellow or Green.

c) Shunt Signal Cleared (SHGK) – active HIGH when low speed shunt aspect on a Main signal is cleared.

d) Approach Locking Clear (ALK) – active HIGH when signal free of approach locking. Indications are given for both Main and Shunt class of routes where signals have both.

4.2.3 Points

a) Points Normal Detection (NWK) – active HIGH when points are detected Normal and are in correspondence with the locking.

b) Points Reverse Detection (RWK) – active HIGH when points are detected Reverse and are in correspondence with the locking.

c) Points Free (WZK) – active HIGH when the points are free to be operated (i.e. are not locked by some interlocking requirement).

d) Points Locked (LK) – active LOW (repeat of LR) when points are locked and detected in correspondence with the required lie.

4.2.4 Switchlocks & Ground Frames

a) Switchlock Normal Detection (NLK) – active HIGH when points detected Normal, release not given and lever or frame locked and detected Normal.

b) Switchlock Reverse Detection (RLK) – active HIGH when points are detected Reverse. Some lever detection and locking conditions may be included (as appropriate for the circumstances) where signalled moves are required over the switchlock points Reverse. This indication may not be provided where there are no signalled moves over the switchlock points reverse.

c) Switchlock Free (WZK) – active HIGH when the points are able to be released (i.e. are not locked by some interlocking requirement).

4.2.5 Track Circuits

a) Track Circuit Clear (TK) - active HIGH when track circuit is not occupied (i.e. LOW state indicates track circuit occupied).

b) Route Locking Clear (DNULSK and UPULSK) – active HIGH when no routes are set onto the track circuit from the relevant direction. (i.e. ULS's clear – LOW state used to indicate route lock applied whilst track not occupied). This indication is not normally provided for track circuits in block sections, although it may be provided where appropriate data is available.

c) Track Circuit Blocking Set (BK) – active HIGH when vital blocking is applied in the interlocking preventing routes setting over the track circuit.

4.2.6 Block Sections

a) Block Clear (DNBK and UPBK) - active HIGH when the Block is clear for the applicable direction (i.e. LOW state indicates that the block is occupied).

4.2.7 Miscellaneous

The following miscellaneous indications/alarms may be provided: -

a) GEALM - active LOW indicates signal lamp failure;

b) WCBPK – active LOW indicates point contactor blow-out;

c) NPOK – active HIGH indicates normal power supply in use;

d) SPOK – active HIGH indicates standby power supply in use;

e) FIREK – active LOW indicates smoke or fire alarm activated;

f) CHARGERK – active LOW indicates battery charger failure;

g) CPS – active HIGH indicates Microlok internal CPS (Conditional Power Supply) status healthy;

h) PORTn – active HIGH indicates that comms port n is active.

4.3 Data Link Failure

Upon detection of failure of the TCS data link, the following action is required: -

a) Signals that control entry into a single line block section (either absolute or permissive) shall revert to STOP after 30 seconds of continuous failure of the link unless there is a train detected within the limits of approach tracks included in the signal approach locking, and;

b) All other signals (including those which control entry into double line unidirectional blocks) which are set at the time of failure shall remain OFF until replaced by a train; or for a maximum period of 30 minutes of continuous failure after which time all signals shall revert to STOP unless there is a train detected within the limits of approach tracks included in the signal approach locking at the time of expiry of the 30 minutes.

Implementation of certain automatic route setting operations in response to track circuit occupancies may be considered for signals which do not control entry into single line blocks. For example, Home signals may be set automatically to allow entry into a station when a train occupies the Home signal berth track for an appropriate time. Generally, however, such operation requires the provision of a local means for cancellation of the signal in case the route set is not applicable. Consideration of Safeworking regulations (WestNet Rules, etc); including any requirement for provision of 'A' Lights; is required before any such implementation.

4.4 Fleeting

Fleeting operation – the automatic setting of routes for following trains – should be provided from within the TCS. Fleeting (or "Auto working") functionality shall not be provided within the interlocking.

5 Approach Locking

Approach locking shall be comprehensive wherever possible. It shall normally commence from track circuit occupancy on the berth of the signal in rear of the signal in question. Upon cancellation of a signal this will provide approach locking from the approach to any changed signal aspects displayed. For certain aspect sequences (such as controlled repeating signals and where sequential yellows are applied for braking considerations) which require extension of approach locking to the berth of the second signal at rear to achieve approach locking from the point at which aspect changes are displayed.

Where full information on track occupancy in rear is not available the signal shall be approach locked "When Operated". This condition requires a timed release of the approach locking regardless of occupancy or otherwise of track circuits on the approach. Comprehensive approach locking also requires implementation of a timed release, but applies only if any track circuit within the defined approach is occupied, otherwise release is instantaneous. In either case the release time is set so as to ensure adequate time for a train to either stop at the signal or proceed into the route ahead.

For trains entering the route ahead of the signal approach locking normalisation shall be by the first track circuit in the route occupied and cleared and the second track circuit in the route occupied. The first track circuit occupied is maintained by a Lock Stick (LS) function. The LS is restored only after the approach locking is normalised.

Cancellation of a signal route call shall initiate the cancellation of the signal approach locking automatically.

Approach locking time release operation shall be determined from the following tables with the "track length" being the distance from the start of the first track circuit in the comprehensive approach locking to the signal. The same times shall apply to signals which are approach locked when operated, the "track length" being determined from the distance to the signal in rear plus 250m.

Where a very long track circuit exists on the approach to the signal in rear an alternative approach locking time release condition may be applied. This condition will ensure that the signal at rear has been downgraded for sufficient time to be definitely observed before a train passes it. Provided that the track circuits between the signal and the signal in rear remain clear then the approach locking may be released with the berth of the signal in rear occupied once 30 seconds have elapsed from cancellation of the signal route.

The basis for calculation of release times related to distance is: -

Standard Gauge:

a) Allows a margin of 30s;

b) Allows for a worst case braking distance of 2000m (regardless of train speed);

c) Assumes a 100km/h maximum speed (related to 2000m) to determine an average braking rate (deceleration) of 0.2ms-2;

d) Assumes that the sighting distance is sufficient to accommodate brake dwell (say 250m @ 100km/h = 9s);

e) Assumes that longer approaches are traversed at the average speed that a braking train traverses the stopping distance.

Narrow Gauge:

a) Allows a margin of 30s;

b) Assumes that the worst case braking distance is 1300m (at applicable line speed based on current signal spacing);

c) Assumes a 100km/h maximum speed (related to 1300m) to determine an average braking rate (deceleration) of 0.3ms-2;

d) Assumes that the sighting distance is sufficient to accommodate brake dwell (say 250m @ 100km/h = 9s);

e) Assumes that longer approaches are traversed at the average speed that a braking train traverses the stopping distance.

Approach Track Length (m)	Approach Locking Release Time (s)
<= 1600 #	150
1601 – 2000 #	180
2001 – 2400	210
2401 – 2900	240
2901 – 3300	270
3301 – 3700	300
3701 – 4100	330
4101 – 4500	360
4501 – 5000	390
5001 – 5400	420
5401 – 5800	450
5801 – 6000	480

Table 5 - Approach Locking Times

 # - a minimum approach track length of 2000m applies to dual and standard gauge lines.

Main signals that are not approached from another main signal shall have an approach locking release time of 120 seconds except where the track length is less than 400m, where 60 seconds may be used.

Ground shunt signals shall normally have an approach locking release time of 30 seconds.

6 Interlocking Requirements

6.1 Route Locking/Holding

Interlocking shall be provided between opposing and conflicting routes and maintained using route locking.

Routes from the same signal using the same point setting (e.g. main and shunt routes to the same destination) shall be interlocked to prevent both routes setting or attempting to set at the same time.

Individual directional route locks shall be applied for each track circuit, or composite track circuit where tracks are divided for purposes other than pure signalling requirements (e.g. for level crossing protection or switchlock releasing). The route locks shall be applied in turn (cascaded) from the route entry point as the route conditions are set or otherwise satisfied (e.g. as points become set and detected) to the last in-route track. Route locks shall be released in turn when the route is normalised, approach locking on the entry signal is released and the associated track circuit is or becomes clear. The use of individual route locks for each in route track circuit provides for inherent sectional release of points, etc.

Timed route lock releasing shall be applied to the destination track circuit, or sometimes an intermediate track circuit within the route for special circumstances. The release time shall be set so as to ensure that a train will come to a stand within the applicable track circuit(s) before the set time elapses. The times set out in the following table shall normally be used.

Track Circuit Length (m)	Route Locking Release Time (s)	Track Circuit Length (m)	Route Locking Release Time (s)
<= 200	45	2001 – 2200	140
201 – 300	50	2201 – 2600	160
301 – 400	55	2601 – 3000	180
401 – 500	60	3001 – 3400	200
501 – 600	65	3401 – 3800	220
601 – 700	70	3801 – 4200	240
701 – 800	75	4201 – 4600	260
801 – 900	80	4601 – 5000	280
901 – 1000	85	5001 – 5500	300
1001 – 1100	90	5501 – 6000	320
1101 – 1200	95	6001 – 6500	340
1201 – 1400	100	6501 – 7000	360
1401 – 1600	110	7001 – 7500	380
1601 – 1800	120	7501 – 8000	400
1801 – 2000	130		

Table 6 - Route Locking Release Times

6.2 Overlaps

6.2.1 Main Signals

Main signals shall normally be provided with a minimum 200m overlap at the exit signal except where: -

a) the exit signal is an automatic signal, as for these types of signals the probability of a train standing within 200m of the signal is very low, or;

b) there is no signal at the exit, e.g. at a terminal platform.

Overlaps shall not be shared; however a common track circuit may be used provided that this is of sufficient length to provide the minimum value overlap for each exit signal.

Where a full overlap is not available signals may be approach cleared from red. To ensure that trains are under control the aspect release point shall be arranged such that the driver would see the change of aspect from red to yellow. The times set out in the following table shall normally be used.

Track Circuit Length (m)	Approach Clearing Release Time (s)	Track Circuit Length (m)	Approach Clearing Release Time (s)
500	0	2300	88
600	3	2400	93
700	8	2500	98
800	13	2600	103
900	18	2700	108
1000	23	2800	113
1100	28	2900	118
1200	33	3000	123
1300	38	3100	128
1400	43	3200	133
1500	48	3300	138
1600	53	3400	143
1700	58	3500	148
1800	63	3600	153
1900	68	3700	158
2000	73	3800	163
2100	78	4000	168
2200	83	3900	173

Table 7 – Approach Clearing Times

6.2.2 Shunting Signals

Ground shunt signal routes and shunt routes from Main signals shall normally be provided with the same overlaps and controls as Main signals. Exceptionally reduced length overlaps may be provided in yards for operational reasons where authorised by WestNet Rail's Access Manager.

6.2.3 Overlap Track Circuits

Track circuits in the overlap shall be proved clear for all routes and class of routes. For shunt routes this proving is conditioned by the occupancy of an intermediate permissive track section,

and in such cases the controls should be arranged so that the overlap is proved at time of clearing only (the provision of the time of clearing control prevents the forward movement of the train on the permissive section onto the overlap track circuit causing an aspect reversion).

6.2.4 Points in the Overlap

6.2.4.1 Trailing Points

Trailing points in the overlap shall normally be set by, locked and detected by the route setting, the points remaining locked until the route is cancelled or a train has been timed to a stand at the exit signal. However, in certain situations it is desirable for this locking not to be applied and an approach cleared condition applied instead (typically applicable to the entry points for passing loops).

Where an approach cleared condition is to be applied the approach control shall normally be automatically applied unless the exit signal is cleared. The control shall apply at time of clearing only so that normalisation of the exit signal will not cause a reversion of the entry signal to red in front of a train as it reverts to the approach cleared condition.

Note that a full minimum 200m overlap shall always be provided between an exit signal and any other signalled movement (i.e. an approach cleared condition may be used to allow the sharing of a points track circuit as an overlap but not to allow a movement to be signalled over the points ahead of the exit signal) except where authorised for shunt movements in yards.

6.2.4.2 Facing Points

Facing points in the overlap shall not normally be set or locked or detected other than where there is no valid route from the exit signal over the points in the other position.

6.3 Crossing Loop Operation (Single Line Territory)

Operation of single line crossing loops shall be as follows: -

a) Simultaneous opposing entry onto Main and Loop tracks is not permitted, except where there are either intermediate signals or 200m minimum length overlaps providing protection for both movements;

b) Entry or exit to the Main or Loop track with a signalled movement toward the Departure signal on the other road is not permitted where the points track circuit is used as a shared overlap by the departure signals (i.e. there is not a minimum 200m between the departures and the turnout clearance point). Conversely movement towards a Departure signal (without a 200m minimum clear overlap) is not permitted with a signalled movement set into or out of the other road;

c) Approach clearing of Home signals for entry to either the Main or Loop shall apply unless the Departure signal ahead is clear or a minimum 200m overlap clear of the turnout clearance point is provided at the Departure signal;

d) If the block is set for or occupied by a train heading towards a crossing loop then the setting of a signalled movement up to a Departure signal shall cause the entry points to be set and locked away from the movement. Conversely if a signalled movement up to a Departure signal is set with the entry points set towards the departure signal then the block for the opposite direction shall be rendered unavailable unless the entry points are manually set and locked away from the signalled movement.

e) If signalled movements are set up to both Departures at the same time the block in the opposite direction shall be rendered unavailable.

6.4 Interlocking Between PBI's

Interlocking between PBI's where distributed interlocking is performed shall be achieved in the following manner: -

a) Route availability data from the route exit PBI shall be continuously transmitted over a vital serial link to the PBI controlling the route entry signal.

b) Provided route availability is confirmed at the time a route call is received by the route entry PBI, route setting shall be initiated and route lock cascading commenced.

c) Transition of the route lock applicable at the PBI interface to FALSE shall be repeated continuously across the vital serial link from the route entry PBI to the route exit PBI.

d) Confirmation of route locking being applied up to the route exit shall then be transmitted continuously back to the route entry PBI on the vital serial link. This information may be sent separately or in conjunction with other locking requirements (e.g. track circuits, points detection/locking) as a common route condition.

e) The receipt of the confirmation that the route locking is applied at the route exit at the route entry PBI will allow the signal aspect to be cleared, provided that all other required aspect conditions are met.

A similar means of operation shall also apply to block circuit implementation between PBI's where achieved through a vital serial link.

7 Block Operation

7.1 Relay Block Circuits

Relay block circuits shall be of 4-wire type with separate Up and Down circuits, i.e. 2 wires for each direction.

Hard wired block circuits between PBI's shall have a time delay added to Departure signal clearance to ensure the block has dropped within the destination PBI and opposing signals are therefore disabled. The delay shall be sufficient to ensure that the opposing block has applied locking in the worst case scenario considering all PBI timing, input scanning, any serial link data transfers within an interlocking, stale data timeout provisions, etc. (It is expected that 10s will normally suffice but this must be confirmed in the design and testing process.)

Where suitable communications circuits are available, it is preferred that block controls are implemented via a vital serial link between adjacent PBI's as defined in section 6.4 above.

Block circuits shall not rely upon a searchlight signal mechanism for absolute block control, i.e. any block controls using searchlight HDG contact (directly or indirectly) shall prove the mechanism to be in correspondence with the controls.

7.2 Coded Track Circuit Blocks

7.2.1 General

Coded track circuit equipment shall be microprocessor based and shall incorporate direct signal interfacing including lamp proving and full mechanism correspondence (for searchlight signals).

Coded blocks shall operate as follows: -

a) Block entry shall initially require the block to be indicated as available. If the block is available route setting from a Departure signal may be initiated which shall transmit a claiming code to the remote end. Once received the remote end shall transmit a confirming code which, when received, shall allow the Departure signal to be cleared.

b) Intermediate and Approach signals in the block shall normally be approach lit.

c) Intermediate and Approach signals shall be set to display the appropriate proceed aspect when the block is not set for either direction.

d) Opposing Intermediate and Approach signals shall be set to Red and Yellow respectively upon receipt of a block claiming code. These settings shall be confirmed before passing back the confirming code from the remote end.

e) For permissive block sections Intermediate signal controls shall be arranged to generate a block available code after a train has passed the signal. If a subsequent block claiming code is received for the same direction a confirmation code shall be sent back allowing the block to clear up to the Intermediate signal. Once the block is cleared ahead the block claiming code shall be forwarded to the next intermediate signal or the remote end, which shall generate an appropriate confirming code thus allowing the block to be upgraded progressively as trains move through the section.

7.2.2 Electrocode Block Codes

The following codes shall normally be used with Electrocode controlled block circuits: -

Code	Function
1	Track Clear
2	Yellow Aspect
3	Green Aspect – Unidirectional Blocks, e.g. Avon Valley
4	Green Aspect
5	Non-Vital, Not Normally Used
6	Block Claim
7	Block Free
8	Special, Not Normally Used

Table 8 – Electrocode Block Codes

7.2.3 Microtrax Block Codes

The following codes shall normally be used with Microtrax controlled block circuits: -

Code	Function
A	Track Clear
B	Block Claim (SLOTn.xT.TDOUT, n is slot # & x is track ID)
C	SLEEPOUT – Maintains Block Claim (SLotn.xT.SLEEPOUT)
D	AM Track Clear
E	Block Free
F	Section Ahead of 1st Intermediate Signal Occupied by Train Proceeding Away
G	Red Aspect (Signal Ahead at Red with Lamp Failure)
H	Red Aspect with Block Claimed (Signal Ahead at Red with Lamp Failure)
I	Yellow Aspect (Signal Ahead at Red & Alight or Controls for Yellow or Green)
J	Yellow Aspect with Block Claimed (Intermediate Ahead at Red & Alight)
K	Green Aspect (Signal Ahead at Yellow or Green & Alight)
L	Repeater or Overlap Track Ahead Occupied by Train Proceeding Away
M	Overlap or Approach Track of Home Signal Failed
N	Repeater Track Ahead of Intermediate Failed
O	Track Ahead of Intermediate Failed
P	Dummy Code – Used when no other code applies

Table 9 – Microtrax Block Codes

7.3 Pilot Key System

A ½ Pilot Key shall be provided at each end of single line block sections. The ½ Pilot Key when removed from its switch inhibits the Departure signal aspects (but not the opposing Block circuit). Both ½ Pilot Keys are required to be joined by screwing them together to constitute the Pilot Key "token". Pilot Keys are uniquely identified and coded to prevent unmatched ½ Keys from being inadvertently joined.

Pilot Key Working is instituted as an alternative form of safeworking to the signalling system with the first ½ key being carried on a Proceed Order to the other end of the section for joining with its matching ½ key. The Pilot Key then constitutes the authority for the section. Following moves are enabled by Proceed Order with the last train in that direction carrying the Pilot Key. Cancellation is performed by insertion of the correct ½ key into its switch and traversing the section "on signals" to reinstate the other ½ key and thereby the signals for the other direction.

8 Gauge Discrimination

Gauge discrimination is essential for mixed gauge turnouts where either Narrow Gauge (NG) or Standard Gauge (SG) lines diverge from a dual gauge line.

A short section (nominally 50m) of track circuiting with separate circuits applicable to the NG and SG rails is required to establish the gauge of a train. A NG train is established by shunting of the NG track circuit whilst the SG track circuit remains energised and vice versa.

Signals applicable to gauge divergences shall not be cleared unless the correct gauge is established. Gauge discrimination for Main Signals should normally be established from a point 2 signals in rear of the junction signal to preclude the viewing of any adverse aspect due to the lack of gauge information (this may need to be further back in the case of extended aspect sequences). The gauge information shall be cascaded forward from signal to signal as the train progresses towards the junction signal.

Ground shunt signals should normally be provided with gauge discrimination track circuits at their berths unless the gauge information has been cascaded and maintained from a previous movement.

Care must be taken in design to ensure that a following train does not establish the wrong or override the previously established correct gauge information. Similarly, gauge information must be established and maintained for a train within a permissive track section to ensure that a train of the other gauge is not able to shunt onto the 1st train.

9 Points

9.1 Controls

The PBI shall provide controls for points incorporating the following, as applicable: -

a) Selection and locking of the points by the Train Control System (TCS) to either the normal (N) or reverse (R) positions. Where no selection is made by the TCS (i.e. points in the centre or C position) the points will be free to move to either position as required by route setting, provided that the points are not subject to other locking conditions;

b) Route and track circuit locking by the point track circuit(s) that will prevent any movement of the points from their current position whilst either direction of route locking is effective or the track circuit(s) are occupied;

c) Conditional locking that will prevent any movement of the points from either Normal to Reverse or Reverse to Normal as required. Conditions that may apply conditional locking include point to point locking, track circuit locking, route locking and time released route locking;

d) Anti-preselection controls that will prevent the storing of a point call, i.e. the points may only be operated for a short time period following a setting control being applied by either a manual (N or R) call or a route setting call.

Note that care shall be exercised in the design of anti-preselection controls to: -

i) ensure that points which have conditional setting or locking requirements do not become locked when not in correspondence with the route (e.g. trailing points in an overlap), and;

ii) ensure that where distributed interlocking is applied, time delays inherent in data transfer between PBI's is accommodated.

e) Controls that, upon power-up or re-boot of the PBI, set the points locking to correspond with the current point lie where detection is made. If detection is unavailable at power-up or re-boot, and provided that the points Centre position is enabled after establishing communication with the TCS (thus ensuring blocking is not applied), generate a Normal call after points are free of all interlocking requirements for a period of 30 seconds;

f) Controls to remove the power from points drive circuits whilst they are locked and have completed their movement, and provide an indication of this locked status to the TCS;

g) Controls to remove the power from points drive circuits if detection for the called position (Normal or Reverse) is not received within a nominal 12 seconds;

h) Point to point locking between points where this is desirable for a given layout;

i) Self restoration controls for catch points and selected crossovers restore these to Normal after having become free of locking for a minimum of 20 seconds;

j) Point drive sequencing controls to limit the maximum power draw where there is a limit on the available power at an interlocking site.

9.2 Operation

Point operating circuits shall be designed so as to present a standard interface between point drive and detection circuitry and the PBI, irrespective of the type of point machine to be used.

The following requirements generally apply to the interface and drive/detection circuits: -

a) Point drive circuits shall normally use biased ac immune contactor relays with 2 heavy duty front, 4 front and 4 back contacts to BRB Specification 966 Appendix F4;

b) Point drive contactors shall be down proved in each other to eliminate the risk of momentary shorting of the power supply; Provide electrical interlocking of contactors (each down-proved in the other, which may be achieved within the Interlocking Processor);

c) Down proving of both A and D contact banks of contactors shall be provided in accordance with the requirements of BRB Specification 966 Appendix F4;

d) 2 wires shall be provided to each side of each heavy duty front contact in a loop configuration in accordance with the requirements of BRB Specification 966 Appendix F4;

e) Protection shall be provided against momentary erroneous PBI outputs possibly releasing lock mechanisms – see section 9.4.

f) Polarised point control circuits shall not be derived from the same power supply as polarised point detection circuits unless power supply polarity proving is performed.

9.3 Power Arrangements

Point machines shall normally be of 110V a.c. single phase or 120V d.c. type. The choice of machine is generally dependent upon the power supply and standby arrangements available at specific sites.

A 2 pole motor protection device shall be provided for each point machine circuit which is specifically designed to provide both short circuit protection and motor thermal overload protection with adjustable thermal trip setting. A suitable range of devices is Sprecher & Schuh KTA3. Thermal trips shall be adjusted to tolerate the duty cycle of three consecutive "stall/time-out/restore to the original lie" operations. Indication of a tripped/off condition shall be provided via an input to the PBI and passed to the Train Control system.

9.4 Prevention of Lock Release

In order to guard against an individual output bit failure causing an erroneous point movement all point drive circuits shall require a minimum of two output functions to energise any point contactor.

A proven method is the use of a common point LWR output to drive an LWR relay which is then detected energised in the Point NWR and RWR outputs.

9.5 Directly Fed Machines

Where point machines are fed directly from a PBI housing and the contactors are directly operated from the PBI outputs without interposing relays, points detection shall be input to the PBI to cut off the drive when correspondence is achieved with the call.

An additional input shall be provided to prove both contactors are de-energised prior to considering the points as locked. Any additional output relay or contactor provided for prevention of lock release in accordance with the previous clause shall be included in this input.

9.6 Indirectly Fed Machines

Where point machines are fed from a location case remote from the controlling PBI, the detection/repeats shall either be in accordance with the above clause or alternatively, detection relays shall be provided in the location to cut off the feed to the contactors and the contactors shall be down proved in the outgoing detection repeat circuits.

The former arrangement is preferred to the latter, however requires additional line circuits.

10 Switchlocks

Switchlocks have 12V release coils. Switchlock release circuits shall normally be operated directly from the PBI, and where this operates at a higher voltage shall use suitably rated resistors to drop the voltage to a suitable level at the Switchlock location.

Switchlocked points detection circuits shall be double cut for Normal (and Reverse where required).

Where shunt signals apply to routes over Switchlock points set Reverse, the Switchlock shall be closed to lock the points (or separate FPL lever where provided) in the R position by re-engaging the handle mechanism. A push button shall be provided to enable the signal to be cleared. The pushbutton shall be maintained in the depressed condition to maintain the signal Off until the first track in the route is occupied. The switchlock shall then be route and track locked in accordance with control table requirements.

Where non-signalled moves apply to routes over switchlocked points set Reverse, certain circumstances require track locking to be applied to a lever or levers. This is typically achieved by a "forced-drop" lever lock and is applied for example to sets with K blades to prevent premature restoration.

11 Electrically Released Ground Frames

Ground frames shall include an electrically released locking device on the frame-releasing lever, which includes a positive locking action (e.g. “forced-drop” lever lock). Ground frames shall have suitable interfacing circuits provided including double-cut detection.

Mechanical interlocking shall be provided in accordance with approved Locking Tables.

Where signalled moves are associated with ground frames and the signals are controlled from the PBI, all facing points shall be mechanically locked and detected. The following functionality shall be included as a minimum:-

a) Point detection (Normal and/or Reverse as necessary) from a 2-arm circuit controller driven separately from each blade;

b) FPL lever (Normal detection) essential for facing moves and optionally provided for trailing moves. Locked N by signal lever(s) for facing moves;

c) Signal control levers shall be electrically locked and proven locked in the ER position, and detected in the full R position for signal releasing. Movement of the lever to the E position (from full R) shall cancel the signal and initiate approach locking time-out, after which time the lever lock is released from the E position;

d) Switches may be provided in lieu of levers for signal selection if lever detection is provided on all independent releasing conditions and such levers are electrically locked in those positions and proved locked in the last stage signal (aspect) control. (e.g. Locked by ALS down in signal aspect circuits). Cancellation of the switch shall initiate approach lock time-out, after which time the levers required to release the signal are themselves unlocked;

e) Route locking shall be applied to the signal lever; or the signal releasing lever(s) where switches are used; in accordance with control table requirements.

All lever and points circuit-controller detection circuits shall be double cut.

Where a separate facing point lock lever is provided from the points lever, this lever shall either be included in signal releasing lever mechanical locking or be detected Normal in facing moves. FPL detection may be input to the PBI separately from points lie detection, in which case it is not necessarily required to be included in aspects for signalled trailing moves.

12 Searchlight Signal Mechanisms

Searchlight signals mechanisms carry an inherent risk of wrong-side failure and shall be proven in the PBI to be in the position called before the signal lamp is lit. This applies both to Main and Ground Shunt signals.

A combined yellow and green aspect proving input (HDGP) may be provided for indirectly fed signals where there are no signal controls requiring individual aspect information.

13 Blocking

Blocking facilities shall be provided on the berth track circuits of all signals. When applied blocking shall prevent a route being set in either direction over the blocked track section.

Blocks may be set or cancelled upon request from the TCS at any time, and shall be stored vitally within the interlocking. Application of a block shall not cause any route already set through the track section to be cancelled.

14 Track Stick Relays

A Track Stick Relay shall be provided for automatic signals which are not directly controlled by a PBI, in order to confirm that signals have properly restored after having been used. That is, where an automatic signal is controlled by lineside circuits via relays or directly to a searchlight

mechanism, all aspect control relays, red signal repeat relay (RGP) (or searchlight mechanism contacts) and Pole Change Relay (PCR) contacts as applicable shall be proved in their correct positions in the TSR pick-up path.

15 Power Off & Communications Link Protection

Any locking functions or other controls that may be irregularly released, either by a power failure or the failure of a communications link, shall be protected by disabling the function or control when a failure is detected. For example: -

a) The irregular release of the approach locking two track release feature shall be prevented by proving that the power has been on for sufficient time to allow all track circuit repeats to energise;

b) Proving communications links are active where track circuit occupied conditions are used where the track circuit clear condition is transmitted over the communications link, in order to ensure that the track circuit occupancy is real and not caused by a communications link failure.

16 Level Crossings

16.1 Introduction

Actively protected level crossings on WestNet Rail are normally operated automatically, and depending on their location may require to be fully or partially integrated with a PBI. This section sets out the requirements for this integration, which includes the interface with the crossing itself and the requirements for signal controls where these lie within the approaches to a level crossing.

The design requirements for active level crossing warning systems on WestNet Rail are set out in code of practice W190-600-011, which should be read in conjunction with this code of practice. The level crossing code of practice sets out the controls required for different types of crossing, and gives values for timed releases for crossing controls and signal delay timers etc.

16.2 Controls

The PBI shall normally provide control outputs that incorporate all the required track circuits on the approaches to a crossing including any signal and point conditioning and the provision of directional stick circuits as required. Fully integrated flashlight crossings shall be initiated by the de-energisation of a Flasher Control Relay (FCR) output, whereas fully integrated boomgate crossings shall be initiated by the de-energisation of a Motor Control Relay (MCR) output. Partially integrated crossings are initiated by the de-energisation of a Down or Up Approach Relay (DAR/UAR) output as required.

Outer warning controls are required to maintain the minimum road open time (MROT) for crossings that can be activated by more than one train movement at a time. The controls keep the crossing warning activated, if already activated, when a second train has occupied the outer approaches of a crossing. For fully integrated crossings these controls are normally incorporated in the FCR or MCR output, but for partially integrated crossings separate Down or Up Outer Approach Relay (DOAR/UOAR) outputs are required. Some crossings are interlinked with road traffic lights and require an additional Early Call Relay (ECR) output to initiate the road traffic clearance phase prior to the main crossing warning sequence being initiated.

An additional output or outputs may be required to immediately initiate the main level crossing warning sequence in the event of a signal overrun on a crossing with a pre-emptive warning sequence (e.g. Advance Flashing Warning Signs), where the signal is positioned within 460m of the crossing.

16.2.1 Signals in Level Crossing Approaches

The controls required for protecting signals within the approach to a crossing are set out in detail in the level crossing code of practice W190-600-011. Generally the controls required, dependent on the position of the protecting signal, are: -

a) If a signal is displaying a proceed aspect or is approach locked the crossing warning shall be activated by a train approaching the signal;

b) If a signal is at red and free of approach locking the crossing warning shall be activated by a train approaching the signal if the signal is 200m or less from the crossing;

c) If a signal is at red and free of approach locking the crossing warning shall not be activated by a train approaching the signal if the signal is greater than 200m from the crossing;

d) A crossing warning activated by a train approaching the signal shall be cancelled by the timing out of the signal approach locking (where the signal is greater than 200m from the crossing) or a berth track circuit timer, whichever occurs first, provided that the train does not pass the signal. The berth track circuit timer values to be used are given in Appendix C of the level crossing code of practice W190-600-011;

e) Delayed release of a signal's aspects when the approach is already occupied by a train when the signal is set, to allow the crossing warning to be activated first and prevent a short warning time. The signal release times applicable for a range of signal positions are set out in Appendix D of the level crossing code of practice W190-600-011;

f) Prevention of a signal setting for the required minimum road open time for the period immediately after the cancellation of a warning.

The controls applicable to an individual signal above shall be conditioned out by any other signal lying between the signal and the crossing being at red and free of approach locking (provided that the other signal is itself greater than 200m from the crossing) or where the detected position of facing points between the signal and the crossing will divert the train away from the crossing.

16.2.2 Signals in Level Crossing Outer Approaches

The controls required for protecting signals within the outer approach to a crossing are set out in detail in the level crossing code of practice W190-600-011. Generally the controls required, dependent on the position of the protecting signal, are: -

a) If a signal is displaying a proceed aspect or is approach locked the crossing outer warning shall be activated by a train approaching the signal;

b) If a signal is at red and free of approach locking the crossing outer warning shall not be activated by a train approaching the signal;

c) A crossing outer warning activated by a train approaching the signal shall be cancelled by the timing out of the signal approach locking or a berth track circuit timer, whichever occurs first, provided that the train does not pass the signal. The berth track circuit timer values to be used are given in Appendix C of the level crossing code of practice W190-600-011;

d) Delayed release of a signal's aspects when the outer approach is already occupied by a train, to prevent a train reaching the warning point early resulting in a reduced road open time. The signal release times applicable for a range of signal positions are set out in Appendix D of the level crossing code of practice W190-600-011.

The controls applicable to an individual signal above shall be conditioned out by any other signal lying between the signal and the crossing being at red and free of approach locking (provided the other signal is itself greater than 200m from the crossing) or where the detected

position of facing points between the signal and the crossing will divert the train away from the crossing.

16.3 Inputs

Repeats of various levels of crossing operation are required to implement the required controls. The usual repeats provided are:

a) FCRP or MCRP – Repeat of crossing FCR or MCR – used to confirm that the controls are clear at the crossing.

b) FCZP or MCZP – Back contact repeat of crossing FCR or MCR – used to confirm lights are flashing at either flashlight or boomgate crossing.

c) BDNP – Common (parallel) repeat of crossing Boom Down Relays – used to confirm that either boom has reached the horizontal position (0º - 5º) and therefore that the crossing closing cycle has been completed.

16.4 Level Crossing Logging

All WestNet Rail active level crossings are equipped with data loggers at the crossing location. In some cases additional outputs may be required to provide inputs for the logging system.

17 Interlocking Processor Interfacing

17.1 Interlocking Processor Inputs and Circuit Isolation

17.1.1 Nomenclature

PBI internal variables should be named similarly to that of relay interlocking systems to retain familiarity to Signal Engineers.

17.1.2 Input Circuit Isolation

All input circuits to a PBI shall follow the general guidance given in this section, subject to any product specific requirements set by the PBI manufacturer. In general input circuits shall: -

a) be double cut, as far as is practicable;

b) be provided with dedicated and separate power supplies for internal and external inputs;

c) where external, be limited to a maximum length of 200m. Input functions at a distance greater than 200m and any aerial line circuit shall be interfaced via repeat relays at the PBI location;

d) where input from functions external to the PBI housing, be fused and provided with transient protection at both the outgoing and incoming terminals.

17.1.3 Polarised Input Circuits

Polarised input circuits, typically for point detection, may be provided either by the use of a dedicated polar input or by two independent cross-connected inputs, provided these are polarity sensitive. Where two independent cross-connected inputs are used the internal PBI functions associated with these inputs shall be cross-proved internally to ensure that both inputs are not energised at the same time.

Any pair of relays that provide the polarity switching for a polar input shall be cross-proved to ensure that the PBI input power supply cannot be subject to a short circuit under any circumstances.

The design of polarised relay repeat circuits shall minimise the risk arising from the possible reversal of supply polarities leading to a potential wrong-side failure condition. In particular the use of the same supply for both control and indicating functions (e.g. point control & detection)

is not permitted unless there is also a supply detection circuit that will isolate the supply from the busbar in the event of a reversal of the supply.

17.2 Interlocking Processor Outputs and Circuit Isolation

17.2.1 Nomenclature

PBI output variables should be named similarly to that of relay interlocking systems to retain familiarity to Signal Engineers.

17.2.2 Output Circuit Isolation

All output circuits from a PBI shall follow the general guidance given in this section, subject to any product specific requirements set by individual PBI manufacturers. In general output circuits shall: -

a) be provided with dedicated power supplies;

b) where feeding equipment external to the PBI housing, be limited to a maximum length of 200m;

c) where feeding equipment external to the PBI housing, be fused and provided with transient protection at the outgoing terminals;

d) not be fed directly via aerial circuits.

17.2.3 Polarised Control Circuits

Polarised control circuits fed from PBI output relays, typically for point control, shall be cross-proved to ensure that the outgoing power supply cannot be subject to a short circuit under any circumstances.

The design of polarised relay repeat circuits shall minimise the risk arising from the possible reversal of supply polarities leading to a potential wrong-side failure condition. In particular the use of the same supply for both control and indicating functions (e.g. point control & detection) is not permitted unless there is also a supply detection circuit that will isolate the supply from the busbar in the event of a reversal of the supply.

17.2.4 Searchlight Signals – Directly Fed

Searchlight signals located less than 200m from a PBI housing may be fed directly from the PBI. The PBI shall provide control outputs for the searchlight mechanism and lamp.

Correspondence of the mechanism position with the set condition shall be provided in the PBI logic, using mechanism detection inputs for all aspects used (i.e. RGP, HGP & DGP as required). The lamp output shall be switched off in the event of a correspondence failure.

Lamp proving shall be provided, normally as part of the PBI lamp driver circuit, or via a lamp proving relay.

17.2.5 Searchlight Signals – Indirectly Fed

Searchlight signals located greater than 200m from a PBI housing shall be indirectly fed. Interfacing relay circuits shall be provided as required to control the searchlight mechanism and lamp circuit. The lamp circuit should preferably be a.c.

Correspondence of the mechanism position with the set condition shall be provided via relay control, using mechanism detection inputs for all aspects used (i.e. RGP, HGP & DGP as required). The lamp output shall be switched off in the event of a correspondence failure.

Signal RGP, HGP, DGP (or combined HDGP) and lamp proving inputs to the PBI shall be provided as required.

17.2.6 Colourlight Signals

Two types of multiple aspect colourlight signals are used, LED type and incandescent lamp type. The LED type is the preferred type of signal.

17.2.6.1 LED Type

LED multiple-aspect colourlight signals with a nominal working voltage of 12V a.c. or d.c. are to be used. Signals located within 200m of a PBI housing shall be directly fed from the PBI. Lamp proving shall be provided, ideally as part of the PBI lamp driver circuit, or via a lamp proving relay.

Signals located greater than 200m from a PBI housing shall be indirectly fed via interfacing relays for control, indication and lamp proving purposes.

Signal RGP, HGP, DGP (or combined HDGP) and lamp proving inputs to the PBI shall be provided as required.

17.2.6.2 Incandescent Lamp Type

Incandescent multi-aspect colourlight signals are fitted with 12V 25W + 25W SL35 dual filament lamps fed via 110/12V signal housing mounted transformers. Proving of the main filament alight is performed by a relay mounted in the head, which when de-energised switches the auxiliary filament into use. A main filament failed input shall be provided into the PBI, which may be grouped for signals in the same location.

As these signals are fed at 110V interface relays are required for control, indication and lamp proving purposes irrespective of their location, and hence they are non-preferred for use with PBI's.

Signal RGP, HGP, DGP (or combined HDGP) and lamp proving inputs to the PBI shall be provided as required.

17.2.7 Junction Route Indicators

Junction Route Indicators are used to provide routing information for colourlight signals at junctions. Two types are available, LED type and Incandescent lamp type. The LED type is the preferred type of indicator.

Lamp proving of junction route indicators shall always be provided and shall be arranged so that a minimum of 3 LED units or lamps are lit before the main signal aspect is permitted to clear from red to a less restrictive aspect. Lamp proving arrangements where 4 LED units/lamps are required to be lit before lamp proving is made but maintained with 3 LED units/lamps lit are also acceptable.

17.2.7.1 LED Type

LED multiple-aspect Junction Route Indicators with a nominal working voltage of 12V a.c. or d.c. shall be used.

Indicators located within 200m of a PBI housing shall be directly fed from the PBI using three independent outputs to light the Pivot and inner and outer pairs of LED units. Lamp proving shall be provided, ideally as part of the PBI lamp driver circuit, or via a lamp proving relay.

Signals located greater than 200m from a PBI housing shall be indirectly fed via interfacing relays for control, indication and lamp proving purposes.

17.2.7.2 Incandescent Lamp Type

Incandescent Lamp Junction Route Indicators using a SL17 lamp with a nominal working voltage of 12V a.c. or d.c. shall be used.

Indicators located within 200m of a PBI housing shall be directly fed from the PBI using three independent outputs to light the Pivot and inner and outer pairs of lamp units. Lamp proving shall be provided, ideally as part of the PBI lamp driver circuit, or via a lamp proving relay.

Signals located greater than 200m from a PBI housing shall be indirectly fed via interfacing relays for control, indication and lamp proving purposes.

17.2.8 Shunt Signals

The following two types of shunt signals may be required: -

a) Subsidiary Shunt signals with a single short range Yellow aspect, associated with a Main signal, and;

b) Two aspect Ground Shunt signals displaying short range Red or Yellow aspects.

Signals located within 200m of a PBI housing shall be directly fed from the PBI. Lamp proving shall not normally be provided unless specified in the control tables.

Signals located greater than 200m from a PBI housing shall be indirectly fed via interfacing relays as required for control, indication and, where specified, lamp proving purposes.

17.2.8.1 Subsidiary Shunt Signals

LED subsidiary shunt signals with a nominal working voltage of 12V a.c. or d.c. are the preferred type of signal. However incandescent SL28 lamp type signals working at a nominal 12V a.c. or d.c. are also used in some areas.

For indirectly fed signals the controlling (S)HR (or repeat) shall be down proved in the main signal's RGP input.

17.2.8.2 Colourlight Ground Mounted Shunt Signals

LED type Ground Shunt signals with a nominal working voltage of 12V a.c. or d.c. are the preferred type of signal.

For indirectly fed signals RGP, HGP and lamp proving inputs (where specified) to the PBI shall be provided as required.

17.2.8.3 Searchlight Ground Shunt Signals

Searchlight Ground Shunt signals consist of a searchlight mechanism contained within a standard searchlight signal housing mounted on a concrete base or a post. A blanking ring is fitted to the housing to present a smaller diameter aspect to the Driver. Only Red and Yellow aspects are displayed.

Interfacing requirements are similar to searchlight type Main Signals. For indirectly fed signals RGP, HGP and lamp proving inputs (where specified) to the PBI shall be provided as required.

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