Signalling and Safeworking

A guide to NSW standards of signalling and safeworking for Trainz

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Introduction

Signalling can seem a daunting task. Such a variety of signals to use, such a myriad of track layouts to signal, not to mention AI drivers who seem so easily confused. Then throw in multiple methods of signaling and safeworking and you're about ready to give up on signals altogether.

But don't give up! Signalling and safeworking can be the difference between an enjoyable, prototypical route and a frustrating, confusing time. Signals that work as you want them to work mean you can concentrate on your train and not why the signal seems to show the wrong aspect, or why there's suddenly another train in your path!

This document hopes to lift the fog on signalling and safeworking. While focusing on systems used in NSW (Australia) and in particular the NSW Signals Pack created by Cardiff Workshops, the same basic methods are used around Australia and the world. We hope that after studying this guide you will have the information and knowledge to create from the most basic of signal systems to systems that incorporate several methods of safeworking, shunting signals, manual signals...whatever your route needs.

While this document covers so much, it is not the definitive guide to signalling and safeworking. There's always some method, signal or system that breaks from the norm. Furthermore, this document condenses volumes of information into a much smaller volume.

Well, enough waffle. Time to gain some knowledge and enjoyment.

Cardiff Workshops — August 2005

Signals and Signs

A Quick History

A document on signaling (like any subject) really should start with a history on the subject, so this will be no exception. However this won't put you to sleep - it will be brief :).

Legend states that the first signal was a candle placed in a Station Master's window at night on the Stockton - Darlington railway in England, to advise the driver to stop.

Later, railwaymen, called "policemen", used flags (by day) and lamps (by night) at stations to stop trains. This was followed in 1840 by a signal on a pole (possibly the first fixed signal), using a disc and a cross-bar at right angles to tell the driver to proceed or stop. This was introduced by the Great Western Railway in England.

These signals were superseded by the semaphore signal, of which variants are still in use today. Early versions were up to 60ft high, and used an arm in 2 positions - horizontal (with red lamp at night) meaning stop and vertical down (with white lamp at night) meaning proceed. When vertical, the arm actually disappeared into a slot in the post, necessitating the need for "Finials", the decorations on top of the semaphore signal, to make them appear different from a normal post. Soon after, a caution aspect was added, with the arm at 45

degrees and a green lamp at night.

These were the first signals introduced into New South Wales. Being a colony of England, the NSW railways were a reflection of British railways, with the exception that, after a very short period of time, NSW railways were government owned, unlike the private railways of England.

Later semaphores retained the horizontal arm for stop, but used the dropped diagonal arm (at between 45 and 60 degrees) with a green or blue lamp for proceed. Distant signals were introduced as increased train speeds necessitated a warning of the indication of the next signal. These signals became known as “lower quadrant” signals.

“Upper quadrant” signals are very similar to the early signals in that they can show a stop, caution or proceed aspect with the same arm. The arm moves upwards (hence the name “upper quadrant”), with horizontal (and red lamp) indicating stop, 45 degrees (and green lamp) indicating caution and 90 degrees (and green lamp) clear.

Lastly comes the coloured light signal. These were introduced into the NSW system in 1924 and were used in locations where semaphore signals were impractical due to a lack of room for the arm - due to the overhead structures involved in the electrification of the

Sydney network and in the Sydney underground. The early signals had 2 light heads and copied the lights used by upper semaphore signals of the time (red/red - stop, green/red - caution, green/green - clear). Shortly after, yellow was introduced, with green/yellow indicating a “medium” aspect (the next signal is caution).

This lead to the single light signals - with red, yellow and green lights. These were introduced during the electrification of the Main Western Line over the Blue Mountains as the distance between signals could be further than in the Sydney area, negating the need for the medium aspect.

Today, a variety of signals, both semaphore and coloured light, are used on the NSW railway network. Signals may have from 2 to 6 lights, plus additional lights indicating diverging routes, aspects for shunting, stencils indicating lines and a variety of other information. Globes are gradually being replaced by LED lights and technology is placing signaling information at the drivers seat.

And all this started from a candle in a window!

The Purpose of Signalling

Now that we have the history out of the way, lets look at what signals do and why we place them on our routes and layouts.

The simplest answer to this is this…

A signal is placed to prevent an accident or derailment.

If you place signals on your route or layout for only one reason, that should be your reason.

A signal prevents an accident or derailment from happening by…

- Maintaining a safe distance between trains that are traveling on the same line
- Giving the driver of a train an indication of the state of the track ahead (whether any points ahead are set for or against his route) and, where the points are facing points, an indication of the route which has been set.

That seems pretty simple right? While reading this document, and when signalling your route, keep that basic fact in your mind (even write it on a piece of paper and stick it to your monitor) and you're already well on your way to successfully signaling your route.

Categories of Fixed Signals

This document focuses on fixed signals. Signals such as flags are at the time of release beyond the scope of the document (but in all reality it shouldn't take much grey-matter to work out how to use them too). While it's not essential to learn the categories and designations, they definitely add more depth to your route and helps you make an informative decision as to where your signals will be placed.

A fixed signal is a signal which is located in a permanent position near a railway line, for the use of "that statement" we have stuck to our monitor - to prevent accidents.

There are a wide variety of fixed signals, and this is where some people start to become confused. Firstly, there are 2 categories of fixed signals; **running** signals and **shunting** signals.

- **Running Signals** are used for "running" movements between 2 signals on a main or branch line. When a running signal shows clear, it indicates that a train can proceed to the next signal because the line is clear of other trains* and all points are set for the correct route. These are the most commonly used signals in Trainz.

*an exception to this is in sections using "Staff and Ticket" and "Electric Staff" safe working, where a train may follow another in the same direction at a safe distance. This is covered later.

- **Shunting Signals** are used for slow speed movements, normally for the purpose of shunting within a station yard or siding and often for travel in the opposite direction of traffic on a line. When a shunting signal shows clear, it indicates that all points are set for the required route, however the line may **not** be clear. Obviously this may be because the wagon a locomotive is shunting to is along the route, but it may also be because the train is required to shunt on a line on which another train is traveling (at a safe distance and/or traveling away from the shunting train). Shunting movements are normally undertaken at low speeds of around 20kph.

At the time of writing, Cardiff Workshops are working on operating shunting signals, but have not yet been released.

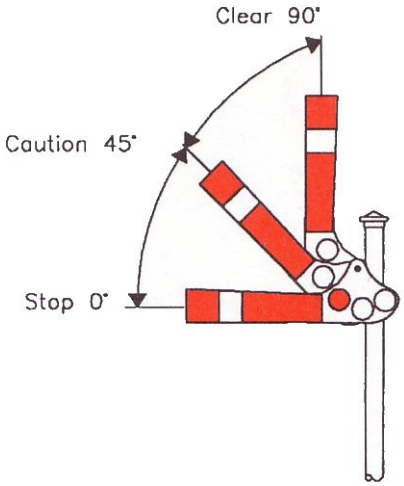
Forms of Signals

Running and shunting signals can be further split into 2 different forms of signals; **Colour Light Signals** and **Semaphore Signals**.

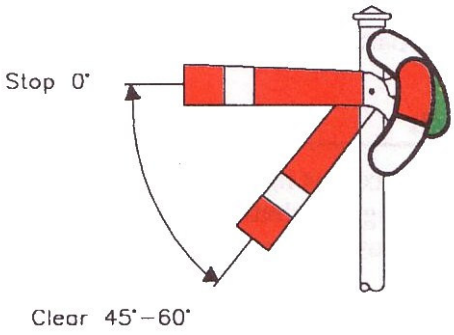
- **Colour Light Signals** use a coloured light or several coloured lights to display the required aspect. Colours used are red, yellow, green and "lunar white" (almost a pale blue). The lights are visible both day and night. The lenses are normally 2 sizes - large for the main running aspect and small to show additional information (such as shunting, a diverge route etc) and to provide

a marker light.

- **Semaphore Signals** use an arm during the day and a lamp during darkness to display the required aspect. The arms are normally painted red with a white band and the lamp displays a red and a green or blue light. The rear of the arm is painted white with a black band (vertical for running signals and horizontal for shunting). There are 2 types of semaphore signals:
  - Upper Quadrant - has 3 arm positions; horizontal, 45 degrees above horizontal and 90 above horizontal.
  - Lower Quadrant - has 2 arm positions; horizontal and 45-60 degrees below horizontal.



Upper Quadrant



Lower Quadrant

*at the time of release Cardiff Workshops had not yet released semaphore signals.

Designation of Signals

The designation of a signal depends on where the signal is located and what the signal is protecting. Running signals have a variety of

designations which will be described below, however shunting signals have only 3 designations:

- **Single route** - the signal covers one shunting route.
- **Multi route** - the signal can cover 2 or more routes.
- **Intermediate** - the signal is located between 2 running signals in the same direction.

As stated above, running signals have a variety of indications. Firstly, running signals can be divided into 2 main designations:

- **Automatic** - the signal is operated automatically by circuits in the track. To put it simply, when a train passes over the track next to the signal, it automatically shows a stop (red) aspect. When that train passes the next signal, that signal shows stop aspect and the first signal shows caution (yellow) and so on. These signals are not used to protect points or areas where shunting may occur. Automatic signals are also known as ***permissive*** signals, meaning that if the signal shows a stop aspect, the train may proceed past the signal to the next signal, aware that there may be another train in front.

Automatic signals can be identified by the way the lights are placed on their mast - single light versions have their marker light staggered to the right of the mast (when viewed); double light versions have the upper and lower lights on opposite sides of the mast.

3 Aspect Automatic Signal

5 Aspect Automatic Signal

Automatic signals can be further split into 2 designations:

- **Automatic** - signal protects the line ahead to the next signal (a block). Signal will only show a proceed indication if the line ahead is clear.
- **Distant** - signal normally only shows a caution or clear aspect, giving an indication of the next signal ahead. Distant signals do not protect the line ahead as it cannot display stop.

- **Manual (controlled)** - the signal is operated by a signalman or a combination of a signalman and circuits in the track. A manual signal can be set and held at stop by a signalman, and are used to protect points and areas where shunting may occur. Manual signals are also known as ***absolute*** signals, meaning a train may not pass the signal if the signal shows a stop aspect.

Manual signals have their lights vertically in line.

3 Aspect Manual Signal

5 Aspect Manual Signal

To further muddy the waters, some manual signals may be switched to automatic by the signalman if so equipped. These signals have a white "A" light that is illuminated when the signal

is set to automatic mode. The light is located under the lowest light of the signal.

Manual signals can be split into a further 8 designations:

- **Distant** - signals normally only shows a caution or clear aspect, giving an indication of the next signal ahead. Distant signals do not protect the line ahead as it cannot display stop (in areas with double track some distant signals can show stop). A distant signal is located no less than the minimum braking distance from the next signal that can indicate stop. On seeing a distant signal at caution, a driver must be prepared to stop at the next signal and must not increase speed until he passes a signal at clear.

  Where there is more than one distant signal in succession, the signals are named in the order in which a train passes them:

  Outer Distant - Inner Distant

  Outer Distant - Intermediate Distant - Inner Distant

- **Accept** - signals are controlled signals provided at the entry to an interlocking (set of interlocked points and signals) which is at the end of a double line automatic section e.g. approaching a station with a yard. Accept signals are used by the signalman to control the approach of trains from the automatic section to the interlocking. An accept signal is fitted with an “ACCEPT” sign below the lights.

- **Accept/Home** - are similar to accept signals, but are used where protection is required between this signal and the interlocking, such as another set of points, a level crossing or shunting.

- **Outer Home** - signals control the movement of trains on the line between this signal and the next signal where the risk to be protected is not permanent such as a shunting movement. An outer home signal is fitted with an "OH" sign below the lights.

- **Home** - signals directly protect a permanent risk within an interlocking e.g. a set of points or a level crossing. They can either be controlled by a signal man or permanently set at stop.

  Where there is more than one home signal in succession, the signals are named in the order in which a train passes them:

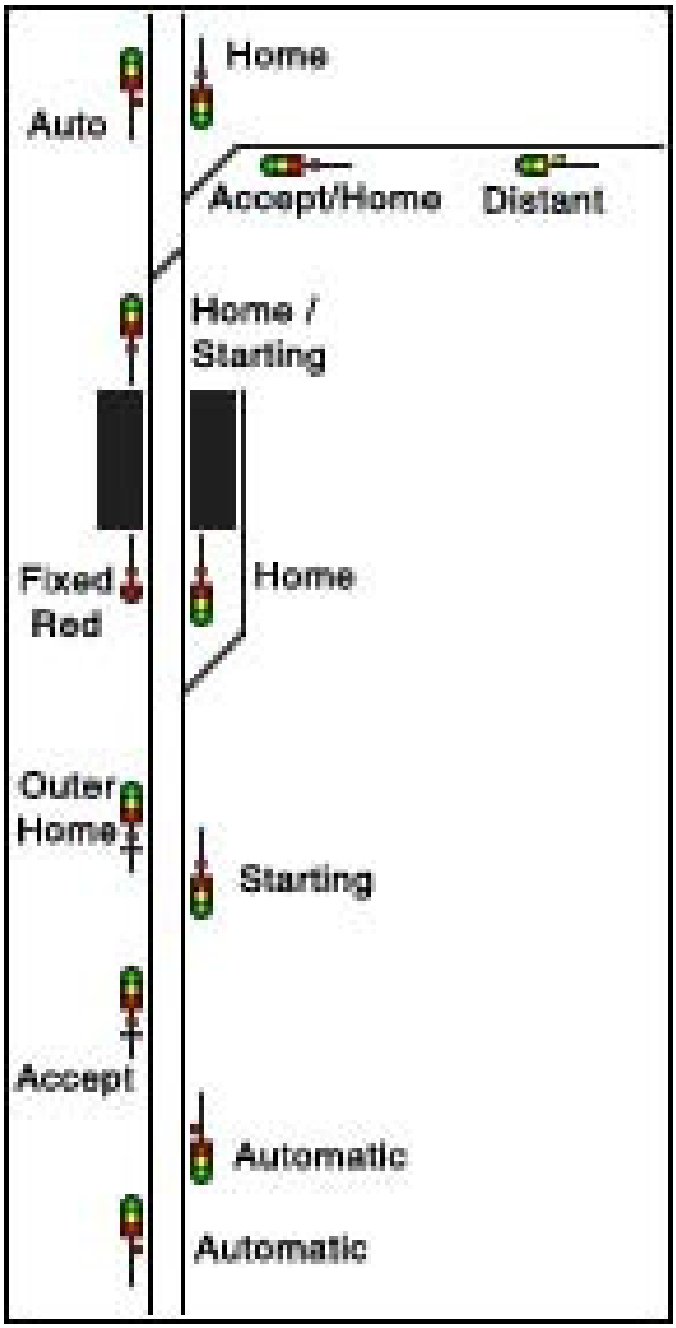
  Home - 2nd Home - 3rd Home etc

- **Starting** - signals give a driver authority to enter the next section.

- **Home/Starting** - signals directly protect points, level crossings or other permanent risks and also give a driver authority to enter the next section.

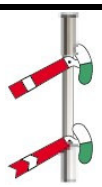
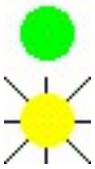
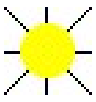
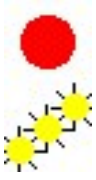
- **Fixed Stop** - signals...ummm...are permanently at stop :). They are used on double track to mark where trains running in the "wrong" direction must stop.

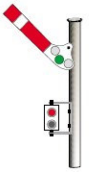
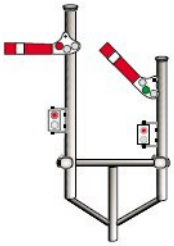
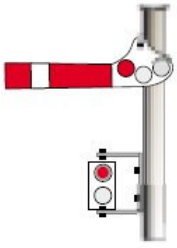
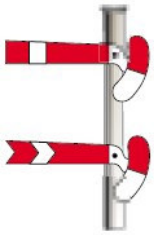
The diagram below shows how the signals may be used in an inter-locking. Obviously this is just an example, but it should at least give you an idea on what goes where.



Signal Aspects

We all know a signal tells the driver what to do by its' aspect. But what do these aspects mean? The following table displays the aspects used in NSW and how the driver should respond.

Meaning and required action	*Single Colour*	*Double Colour*	*Upper Quadrant*	*Single Lower Quadrant*	*Double Lower Quadrant*
CLEAR PROCEED. Next signal displays a PROCEED aspect.					
CLEAR PROCEED. Next signal may be at STOP or PROCEED.					
PRELIMINARY MEDIUM PROCEED. Next signal displays at least a MEDIUM aspect.					
MEDIUM PROCEED. Next signal displays at least a CAUTION or CAUTION TURNOUT Aspect.					
MEDIUM TURNOUT PROCEED on turnout route. Next signal displays at least a CAUTION or CAUTION TURNOUT aspect.					

Meaning and required action	*Single Colour*	*Double Colour*	*Upper Quadrant*	*Single Lower Quadrant*	*Double Lower Quadrant*
CAUTION PROCEED. Next signal may be at STOP.					
CAUTION TURN-OUT PROCEED on turnout route. Next signal may be at STOP.					
LOW SPEED PROCEED at 25km/h ready to stop at the next signal. NOTE: The line immediately beyond the next signal may be occupied.					
CLOSE UP PROCEED ready to stop at the next signal. NOTE: The line immediately beyond the next signal may be occupied.					
STOP					

Lights with radial lines represent flashing/pulsing lights.

*not all aspects are available at time of document release.

Along with those aspects, the following also show aspects that the driver must respond to.

Repeater Signals show the driver in advance the aspect (normally proceed and stop) of the next signal. It may be a coloured light signal (in which case the signal aspect repeats the same aspect as the next signal) or it may use white lights. A driver is not required to stop at a repeater signal.

White light repeater aspects are as shown below:

Required action	*LED lights*	*Position lights*
PROCEED. Next signal shows PROCEED.		
PROCEED. Next signal shows STOP.		

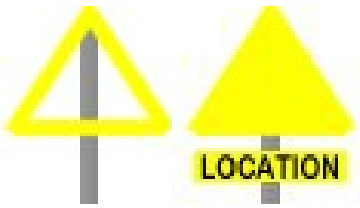
Landmark and Location Signs warn the driver that he is approaching a location at which he may be required to stop due to a signal and/or sign. They can be considered signals that are fixed at caution - especially in the case of a landmark sign.

Landmark signs are used mainly on single track lines in sections using “Staff and Ticket” and “Electric Staff” safe working and are lo-

cated no less than braking distance from the next home signal or sign at which the train may need to stop.

Location signs are used mainly on single track lines in sections using "C.T.C." safe working and are located before the distant signal (within 2.5km of the specified location).

The signs and the required action are shown below:

Safe Working Territory	*Meaning and Required Action*	*Sign*
Signalled (C.T.C.)	**WARNING** Train is approaching a signalled location. Proceed being prepared to respond to the next signal. If the next signal is clear, train can continue at normal track speed.	
Token (Staff & Ticket and Electric Staff)	**CAUTION** Proceed ready to stop at the next signal or stop sign.	
Train Order	**WARNING** Approaching a Train order location. Proceed according to the Train Order.	

Signs and Indicators

Signals are not the only trackside items that are used to tell a driver what to do and the condition of the track ahead. A variety of signs

and indicators also inform the driver of the condition of points, hazards and dangers, speed limits and other information.

Within the game, many of these signs and indicators have no real impact on the game other than to provide more depth to your experience. Some however do have a direct impact and may act as substitute signals or speed boards. These will be identified in the text.

Route Indicators - Many single and double light signals that indicate a diverge route also have a route indicator that displays (with a letter or number) the route set. The route indication appears when the signal displays a proceed indication, and is located above the signal (in a large box).

Route indicators can also be used with shunting signals. These are smaller than the indicators mentioned above, and are located below the signal's marker light. Again, a letter (or 2 letters) or a number may be used to indicate the route. These route indicators are also used with 2 aspect diverge signals to show the route set when the signal is displaying a low speed aspect.

Examples of route indicators above the signal (multi-lamp route indicators).

Example of a small route indicator used to indicate a main line diverge route.

Example of a small route indicator used to indicate a shunt route.

The letter/s or number displayed indicates the route set - letter/s indicating the track and numbers the platform.

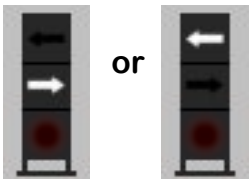
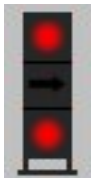
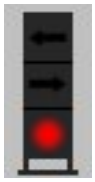
Examples of the letters most commonly used are as follows:

STENCIL	*MEANING*
M	Main Line
L	Loop Line
S	Siding
P	Platform or Perway Siding
B	Branch Line or Back Platform
R	Refuge
N	North
S	South or Shunting Neck
E	East
W	West

STENCIL	*MEANING*
UM	Up Main Line
DM	Down Main Line
US	Up Siding
DS	Down Siding
UR	Up Refuge
DR	Down Refuge
PL	Platform
BP	Back Platform
PW	Perway Siding
GS	Goods Siding
SN	Shunting Neck
LL	Loop Line

Of course, custom letters are used in various locations e.g. UC and DC for Up North Coast Line and Down North Coast Line.

Point Indicators - Point indicators are used to show the driver the position of a set of points or catch points. Point indicators may be mechanical or use coloured lights. In the game, the coloured light indicators act as signals.

Indication	Mechanical Catch Point Indicator	Coloured Light Trailing Point and Catch Point Indicator	Coloured Light Facing Point Indicator
Points set for the route or catch points are closed.			 or
Points not set or catch points are open.			

Mechanical point indicators have a white bar on a black background.

Indication and Required Action	Mechanical Point Indicator
Points are set and locked in the normal position. Train may proceed past the points.	
Points are unlocked or are not set for the normal route. Driver must stop and check the state of the points.	

Guard's Indicator - A guard's indicator is placed on a platform if the guard of a train stopped at a station's view of the signal at the exit

end of the station is blocked from view. They act just like a repeater in that they indicate what the next signal displays. If the next signal displays a proceed aspect, the guard's indicator displays a lunar blue light, telling the guard he may allow the train to depart. If the next signal displays stop, the light is off and the guard knows to keep the train at the platform.

In the game, guard's indicators act as repeater signals.

Indication	*Guard's Indicator*
Next signal displays proceed. Guard can allow train to continue.	
Next signal displays stop. Guard must hold the train at the station.	

Clearance Posts - Clearance posts are used in areas using "Staff and Ticket" and "Electric Staff" safe working. They are normally placed at the ends of a passing loop between the 2 tracks before the lines merge, and mark the point at which a train must stop before proceeding past the points.

Dead-End Lights - Dead-end lights are used at the terminus of a line, indicating stop. Theoretically they are considered a 1 aspect signal permanently at stop (for obvious reasons). They come in two varieties - single red light and a two light version with a white light above the red light. These are used when the light is located near a running line and the driver may mistake the light as a signal.

Single and Double Dead-End Light

These are most commonly used in busier locations. Most country locations make do with a sleeper acting as a buffer without the benefit of a light.

"U" Indicators - "U" Indicators are used at locations in areas using staff and ticket and electric staff where the signal box may be unattended. The indicator displays a white illuminated "U" which informs the driver that the signal box is unattended, all points are set for the correct route and are locked and any warning equipment is operating.

"A" Indicators - "A" Indicators may be placed on signals that can be switched between automatic and manual control. A white illuminated "A" informs the driver the signal is set to automatic control and the signal is considered to be a permissive signal. If the "A" is not illuminated the signal is manually controlled and is considered to be an absolute signal.

Stop Signs - Stop signs can be considered as stop signals as they mean the same thing. In fact, stop signs in the signal pack are released as both a non-functional trackside object and a functional 'signal'.

All trains must stop at a Stop sign and must not pass until directed to do so by an authorized person such as a signalman.

Limit Of Shunt Signs - Limit of Shunt signs indicate the limit on a running line a train may travel while shunting. They are often customized to suit local conditions (e.g. "Shunting Limit on Down Road" indicates the shunting limit on the down line).

Shunting signs are commonly used for shunting on the wrong running direction, providing a safety margin between the sign and the next signal. They may also be used for shunting in the normal direction in such situations as to prevent the train from crossing a level crossing, to tell the driver the maximum distance he can travel to clear the points for a siding or indicate the maximum shunt distance on some bi-directional single track lines.

At present the sign included in the pack is a standard "Limit Of Shunt" sign.

Catch Point Signs - Catch Point signs are used to indicate the presence of a facing catch point that isn't protected by a signal or catch point indicator. They are located on the approach (facing) side of the catch point.

The sign is provided to remind the driver to check if the catch point is closed before moving over the point.

Protected Crossing Signs - Protected Crossing signs are located on the approach side of a "Type F" crossing (a level crossing provided with either warning lights and alarm or warning lights, alarm and boom). The crossing may be for road traffic and/or pedestrians. The signs are located at the point at which the crossing's alarm/lights are operated.

A driver is to sound the horn on approach of a protected crossing.

The following table specifies the recommended distance the signs are required to be from the crossing for the specified speeds.

MAXIMUM TRACK SPEED KPH	DISTANCE (FROM CROSSING TO SIGN)	DISTANCE WHERE CROSS-ING USED BY B-DOUBLES AND/OR ROAD TRAINS.
40	280	340
45	320	375
50	360	420
55	390	460
60	420	505
65	460	545
70	490	585
75	520	630
80	560	680
85	600	710
90	640	750
95	660	800
100	700	840
105	740	880
110	780	920
115	800	960
120	840	1010
125	880	1045
130	920	1190
135	950	1130
140	980	1170
150	1040	1260
160	1120	1360

Begin Single Light Indication and End Single Light Indication Signs - Begin Single Light Indication and End Single Light Indication signs advise the driver of a change of signals from single light to double

light and vice-versa.

A Begin Single Light Indication sign indicates the end of either:

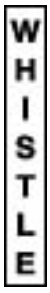
- lower quadrant semaphore signals
- **or** double light semaphore signals
- **or** double light colour light signals

and the beginning of single light coloured light signals.

An End Single Light Indication board indicates:
the end of single light colour light signals
and the beginning of either:

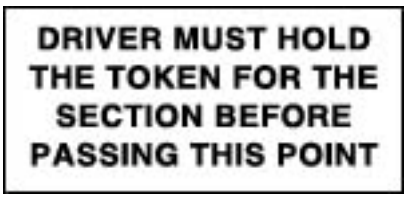
- lower quadrant semaphore signals
- **or** double light semaphore signals
- **or** double light colour light signals

Whistle Sign - Whistle signs inform the driver to sound the train's horn or whistle before the front of the train passes the sign. They are often used for unprotected crossings (such as private crossings) where visibility for the train driver and/or car driver is restricted.



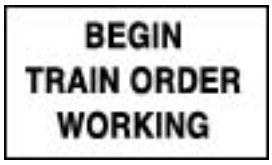
Whistle signs are often accompanied with a sign that states the sign applies to daylight only, due to a combination of reduced road traffic at night and the car driver being able to see the train's headlights. They are also used to reduce noise at night for houses located near the crossing.

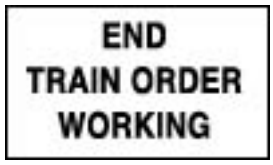
Token Territory Sign - Token territory signs inform the driver that he must be in possession of the token for the next section before proceeding. Information on tokens can be found in the "Safe Working" chapter.



They are sometimes used where CTC safe working territory ends and a form of token safe working territory begins, to remind the driver of the change of safe working before he proceeds.

Train Order Working Sign - Train order working signs indicate the beginning and end of train order safe working territory. The "Begin Train Order Working" sign informs the driver he must not pass that sign until he has received a "train order".





Information on train orders can be found in the "Safe Working" chapter.

Yard Limit Sign - Yard limit signs define the limits of a yard. Trains may not proceed past a yard limit sign without permission, which may be from a signalman or other qualified officer, or authorization from safe working rules.

Track Speed Signs - Track speed signs inform the driver of the speed limit of the track. If the next speed limit is slower than the current speed limit, the driver must bring the speed of the train to the new speed limit before the front of the train passes the sign. Likewise, if the new speed is faster, the driver may not increase speed until the rear of the train passes the sign.

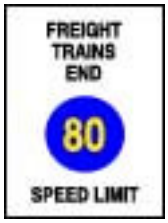
Track speed signs can indicate speeds for all trains, freight trains or XPT, Xplorer and Endeavour trains. They may also specify the speed limit through a turnout.

A single track speed sign with a yellow background applies to all rail traffic. A track speed sign with a white background by itself or under a yellow background sign applies only to XPTs, Xplorers and Endeavours. A track speed sign with the letter '**X**' before the speed displays the speed limit for the turnout. A turnout speed limit sign may also have a white background for XPTs, Xplorers and Endeavours.

If no turnout speed sign is supplied, a 25km/h speed limit applies to the turnout.

Freight train speed limit signs indicate a maximum speed limit of

80km/h applies to freight trains, and are used in an area bounded by Ourimbah, Westmead, Casula and Unanderra.



Advisory speed signs are used when there is insufficient visibility distance between signals for a train to stop. They may be for XPTs, Xplorers and Endeavours only, all trains except XPTs, Xplorers and Endeavours or for freight trains longer than 1150m.

XPTs, Xplorers & Endeavours

All trains except XPTs, Xplorers & Endeavours

Freight trains longer than 1150m

Temporary speed restriction signs are used when a lower speed limit is required due to a non-permanent condition, such as track work, damage to a bridge etc. They always take precedence over a normal track speed limit, and may apply to passenger trains only or all trains.

The white background speed limit applies to all passenger trains and

the yellow background speed limit applies to freight trains. A sign with a single yellow background speed limit applies to all trains.

Speed restriction signs are placed as follows:

- Warning sign is placed 2500m before the affected portion of track, and warns of the approaching speed restriction.
- Caution sign is placed 50m before the affected portion of track. As per a normal speed limit sign, the train must be at the speed limit before the front of the train passes the sign.
- Clearance sign is placed 50m after the affected portion of track. Train may resume normal track speed once the rear of the train has passed the sign.

Signal Signs - Signals may have a variety of signs attached for various reasons, such as to identify the signal or to provide special instructions for a driver.

Signal Identification - Signals are identified using numbers and letters, depending on the signal's location. Generally, signals with an odd number are for 'down' direction signals and signals with even numbers are for 'up' direction signals. The numbers may identify the number of the signal at a particular location or the distance the signal is from a particular location (normally Sydney Terminal). The letters may identify the signal's location or the line the signal is on.

Signal '03', facing the 'down' direction at Wyong (WG).

Signal '04', facing the 'up' direction on the Main Line (M) at interlocking location '18'.

Signal facing the 'down' direction located 116.63km from Sydney Terminal.

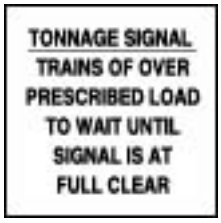
Signal facing the 'up' direction at distance 12.26km on the North Shore (NS) line.

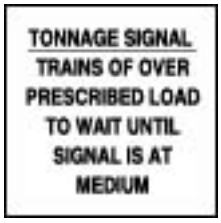
Signal identification varies depending on the location, type of safe working and type of line. Lines that do not use CTC safe working generally do not have a signal identification sign. Signals within the CityRail network on dual track lines are generally similar to the first example for manual signals, using a two letter code for the location and numbers to identify the signal; and a distance (similar to the third and fourth example) to identify automatic signals. Signals on single track lines generally use signs similar to the second example, with the location given a number (with 01 being closest to Sydney), then the number of the signal and, if required, a letter to identify the line it is on (e.g. M for Main, L for Loop).

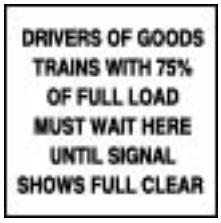
Signals are numbered so the lower numbered signals are generally closer to Sydney - so signal 04 is closer to Sydney than signal 12. Signals that face the down direction are given odd numbers and signals in the up direction are given even numbers.

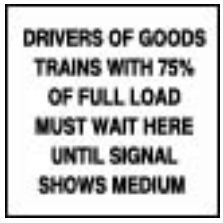
At this time, signals by Cardiff Workshops only support a single line of text.

Tonnage Signs - Tonnage signs may be fitted to a signal before a rising grade. The sign is to prevent a freight train from having to stop at any signals on the grade, which may cause the train to stall or cause damage to the track.









In the first two examples, the prescribed load is the load stated in the working timetable. In the second two examples, the full load is the load stated in the working timetable. With a bit of information (such as information on a loco's maximum load) you can work out the prescribed and maximum loads for trains on your route.

Prohibitive Instruction Signs - Some signals may be fitted with a prohibitive instruction sign. They are used to prevent any unwanted or unsafe movements and provide a safety margin between opposing train movements.

Signal Designation Signs - Signal designation signs are used on signals that perform a function.

Safeworking

A Very Brief Introduction

If signals are used to prevent accidents and derailments, then safeworking can best be described as the method in which they work. In fact, there are methods of safeworking that doesn't use signals at all.

Safeworking is the combination of sets of rules and physical equipment (such as signals) that combine to prevent accidents. Believe it or not, everyone who plonks a signal on his route is using a method of safeworking. By understanding the different methods used, you can go beyond simply placing signals on the line, and start to incorporate rules and procedures in your sessions. Different methods of safeworking also incorporate different placement of signals and this will be discussed in a later chapter.

Methods of Safeworking

As per NSW railway standards, there is no one standard method of safeworking in use in the state. In fact, some methods have been in use for over one hundred years, and still provide a safe (if slightly uneconomical and impractical) service. Newer methods are slowly replacing the older methods and in the near future we can expect to see at least the main interstate lines all utilizing modern methods of safeworking.

There are 6 methods of safeworking in use in NSW. These are:

- CTC or Centralized Traffic Control
- Staff and Staff & Ticket
- Electric Staff
- Block Telegraph
- Train Order
- Yard Working

CTC (Centralized Traffic Control) is the 'standard' method of safeworking in Trainz. Put simply, it works via track circuits that detect the passage of trains and sets the appropriate signals to the appropriate aspect, which is why the CTC method is also called Rail Vehicle Detection System. Circuits can even recognize individual trains and can set the required route in advance without human intervention. Overall control of the network is by signalmen at a central location who can control manual signals and points via remote control, permitting trains to enter sections. Often signalmen are also located at particularly busy locations with interlockings to provide local control of that section.

In practice, almost the entire CityRail network is under CTC, along with most of the Main Southern Line, the North Coast Line as far as Casino, the Main Northern Line to South Werris Creek and the Main Western Line to Orange. Control buildings are at Sydney, Broadmeadow, Orange and Junee.

As previously stated, CTC is basically the standard method of safe

working within the game. Signals automatically change to stop as a train passes, changing the previous signal to caution and, if permitted, clears the next signal.

Staff & Ticket safe working has its origins over a hundred years ago. The system works on the idea that a 'token' (the staff) cannot be in two places at the same time. Staff & Ticket is only used on single track lines.

Under this system, a section of track has a 'staff' - a rod approximately 38cm long with a colour (red, blue, green or white) and a shape (square, circle, triangle or heart) at the staff's end, along with the name of the two stations at each end of the section. Each adjoining section's staff has a different colour and shape combination to ensure staffs cannot be mistaken.

For a train to proceed through a section, the driver must be in possession of the staff. Once at the other end of the section, the driver leaves the staff at the last station, and then picks up the staff for the next section. If the staff isn't present, another driver must have the staff, which means another train is already in that section, so the train must wait for the train with the staff to arrive.

Of course a problem arises if the next train to travel through a section is traveling in the same direction as the first. To solve this prob-

lem, tickets were introduced. The tickets for a section are sealed in a box at the station (normally in the signal box or station masters office) which is the same colour as the colour on the staff, has a plaque with the rod's shape and has the name of the two stations at the ends of the section. The tickets are also the same colour as the staff. A bracket under the box holds the staff. There is normally two such boxes at each station (or staff location), one for the previous section and one for the next. The boxes are locked, with the key being at the end of the section's staff. This way the box can only be opened if the staff is present.

Here's how the system works. If there are two trains to travel in the same direction, the first train arrives at the first station. The driver sights the staff as being present, takes the staff and uses a key at the end of the staff to open the ticket box. He removes the book of tickets, fills out the form (which leaves a copy in the book), takes the ticket and replaces the book. He then locks the box and replaces the key. Prior to departure he contacts the train control officer for that area, who may inform him of any changes that need to be made to points or signals for later trains, or may hold the train at that location. He also leaves details of his departure in a register book. As there is a train following, the driver would have traveled through the previous section with a ticket, which he leaves at this location. On the train control officer's ok, and with the staff being seen by the driver, and with a ticket in hand, the train may proceed.

The next driver arrives with the staff, which he places in its' respec-

tive bracket. He then takes the next staff, fills out the register book (in which he can see the departure time of the previous train) and then contacts the train control officer. After the train control officer's ok, and with staff in hand, the train may proceed.

Example of a staff and a ticket box. The staff's shape is a triangle and the colour is white. The section is Bellata - Edgeroi, which is between Narrabri and Moree.

If a train is to travel to an intermediate location within the section and either shunt or return to the first location, the driver must take the staff and not a ticket to prevent another train from entering the section from behind (which may lead to a collision).

The key at the end of the staff is also used to unlock lockable points in that section, allowing for shunting at interlockings.

In practice, this system is still used on most branch lines in NSW, such as between South Werris Creek and Armidale, Narrabri and Walgett, most between Narrabri and Moree, and around Mudgee, Cobar and Griffith.

Any signals located at stations or staff locations must be operated

manually at that location, either by a signalman or by the crew on the train. A later chapter will display the signaling used at such locations.

In game, this system would require some imagination and manual checking unless the system was integrated into a session. The use of rules could certainly create a realistic simulation of staff and ticket.

Electric Staff is basically a more modern version of the earlier staff & ticket system. This system uses two 'staff instruments' at the two end stations or locations of a section. These machines hold up to 50 staffs for the section, and are electrically linked so that only one staff can be removed at a time from either location, and another cannot be removed until the first is returned. The machines are equipped with a needle that shows whether a staff is already removed and a bell that sounds when a staff is returned. To prevent the wrong staff from being returned to the wrong instrument, the staffs have a 'gauging ring' that will only fit into the correct machine.

Some locations were equipped with a 'divisible staff', which allowed a slower train to follow a fast train through a section. When the fast train arrives at the first station, the divisible staff is removed and is divided in two, with one half going to the driver. This is called the 'ticket' portion of the staff. When the slower train arrives, the driver is given the remainder of the staff (which normally also had the key for points along the way), and a written notice that there is a train

ahead. Another staff cannot be removed from either machine until both halves are re-attached and returned to a machine.

Electric staff also allows for a train to pull into an intermediate siding and, if equipped with an 'intermediate staff instrument', the driver can place the staff into that machine and allow for rail traffic to re-commence in that section while he perhaps loads or shunts. Once finished and ready to move through the section again, the driver waits until the staff can be removed again, locking the other machines and giving the train safe passage.

Like staff & ticket, electric staff is used on many single track rural lines in NSW, including the main line between Sydney and Brisbane north of Casino.

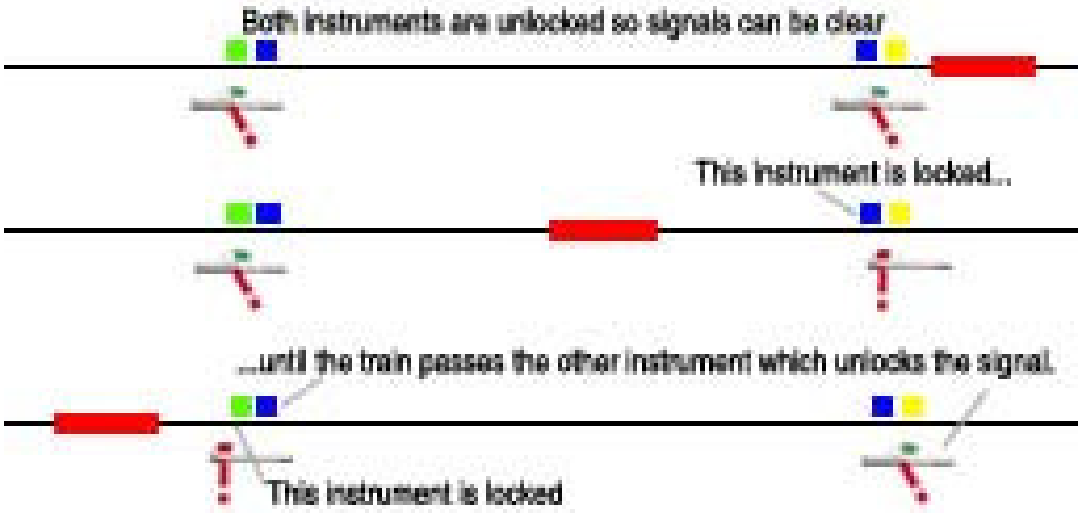
In game, electric staff would need to be used similarly to staff & ticket and would best work within a session.

Block Telegraph is a dying method of safe working. It has its' origins in the mid 1800s, with the first system in NSW in 1878. Block telegraph is only used on double track lines.

Block telegraph operates via two 'block telegraph instruments' at either end of a section, which are linked via telegraph line. When a train enters the section, a switch at the track senses the train's passing and the instruments lock the starting signal so it cannot be cleared until the train has passed the end of the section.

Once the train has passed the end of the section, the instruments will show 'line clear'. The signalman at the end of the section must also indicate that the line is clear. This unlocks the instruments and allows the first signalman to clear the starting signal.

Block telegraph instruments



The instruments have a needle that shows the status of the line and a bell that indicates when a train passes the instrument and when the system is unlocked again.

As stated before, block telegraph is disappearing from NSW railways, with the only sections being Exeter to Wingello and Harden to Jindalee on the Main Southern Line.

In game, there isn't much difference between this system and CTC, however by using rules that control signals, block telegraph can be simulated.

Train Order safe working is the latest form of safe working, requiring a computer in each train to operate. This system combines orders given by a train controller to a train with signals and points to avoid conflicting movements and accidents. In this system, the train order is the authority to proceed past a location - just as a signal is in most

other systems. It is only used on single track lines.

Here's how it works. If a train is to depart a 'train order location' (station, passing loop etc), the driver waits for a train order from the train controller. The train controller enters the train order into the computer, which assesses the order and compares it to current orders already in use. If a conflicting order is given, the computer will not send the order to the train and can block the train's movement.

If no conflicting movement is detected, the order is sent to the train, along with a security code for that location. Once the driver enters the security code, blocking facilities are removed and the train may proceed, as per instructions in the train order, to the next train order location.

Train order safe working is used mainly in the west of the state, between Orange and Broken Hill, Orange and Dubbo, and Bogan Gate to Tottenham.

In game, this system would require extensive use of rules to operate. Having an html of the train order appear would nicely simulate train order safe working.

Yard Working is the simplest method of safe working. It is normally only undertaken within yard limits, sidings etc and is used for general shunting and short movements within yards. Yard working is undertaken under the control of a shunter and/or signalman who is in con-

tact via radio or hand signal with the driver.

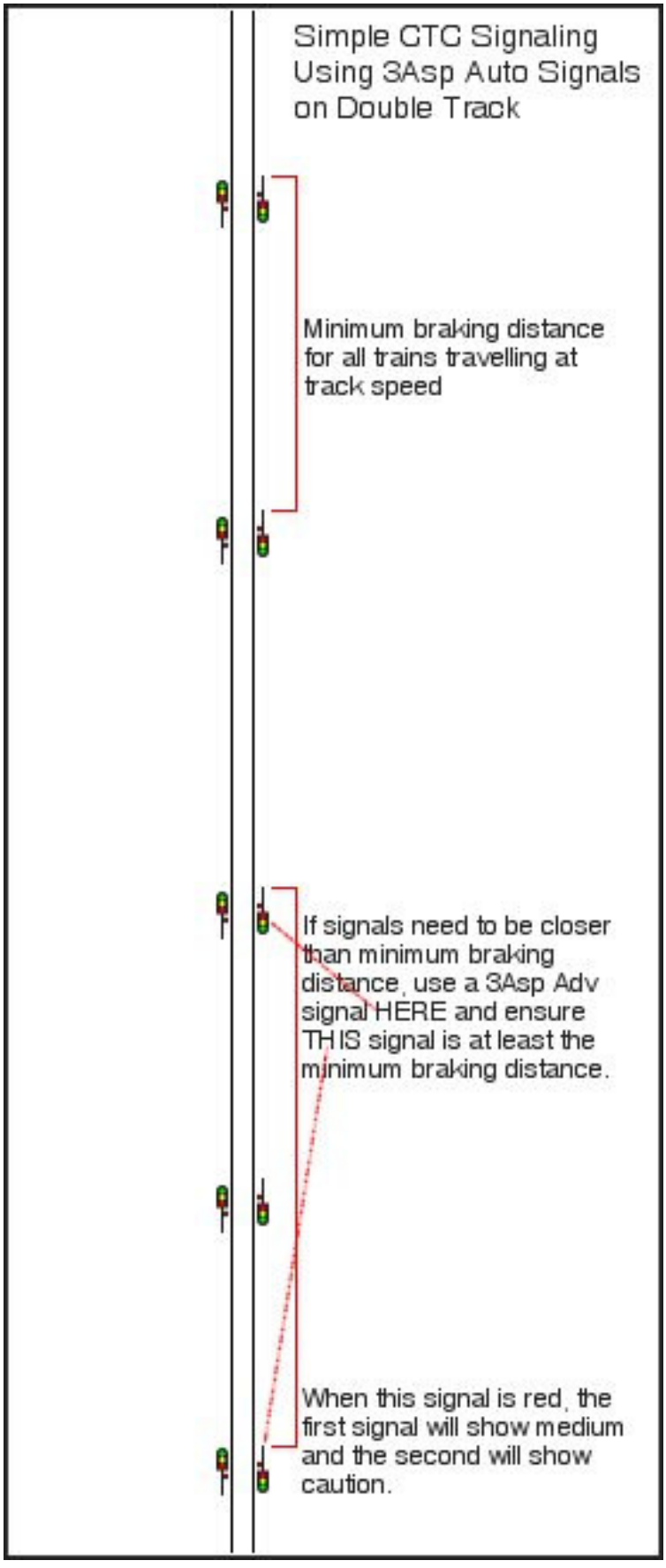
Some short sections of track are also operated under yard working. Normally the local signalman is in control and he ensures no conflicting movements are made. Many coal loops in the Hunter Valley operate this way, as well as the many short lines that lead to industries such as at Port Kembla, the Manildra Mills at Bombaderry and Agri-Park near Moree. Other lines that operate under yard working are the suburban line to Bondi Junction and the western line at Parkes.

In game, most users operate via a simple form of yard working while shunting. More complex methods can involve triggers and rules and are best undertaken in a session.

Putting it all Together

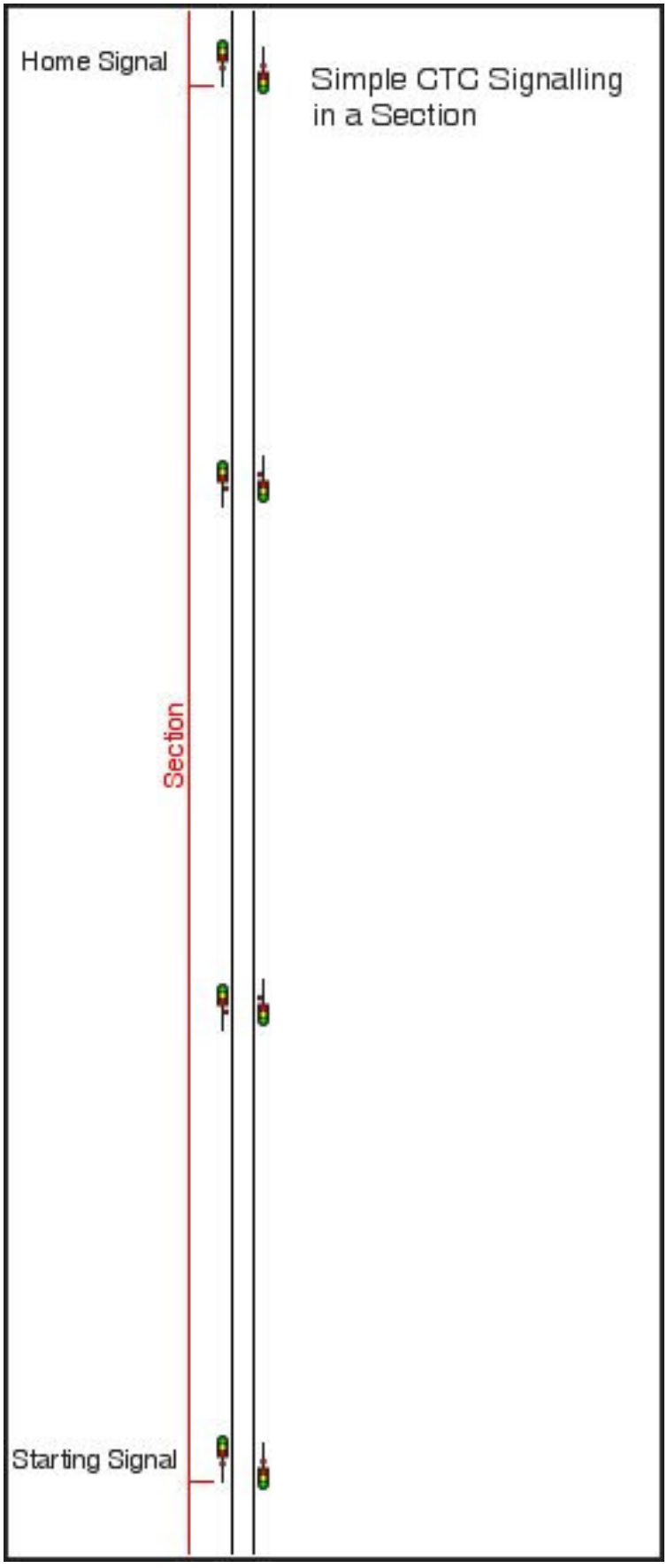
Ok, so we know a bit about signals and safe working, but how do we use them in Trainz? This chapter will feature examples of common methods of signaling for the different methods of safe working, and explain briefly the best way to use them in your game.

Like every other bit of information in this document, it isn't the definitive guide - there's always somewhere that breaks the rules. This is meant to be a guide that will hopefully provide you with enough information to be able to signal your route following the 'normal' practices used in NSW. All signals used in the descriptions are Cardiff Workshops signals, however not all have been released as yet. With all the information you have soaked up, you should be able to find another signal to substitute where required. Note that in most examples, shunting signals have not been included.



This is the simplest method of signalling. Prototypically this is found within a section. A station with no sidings may be placed anywhere along the line.

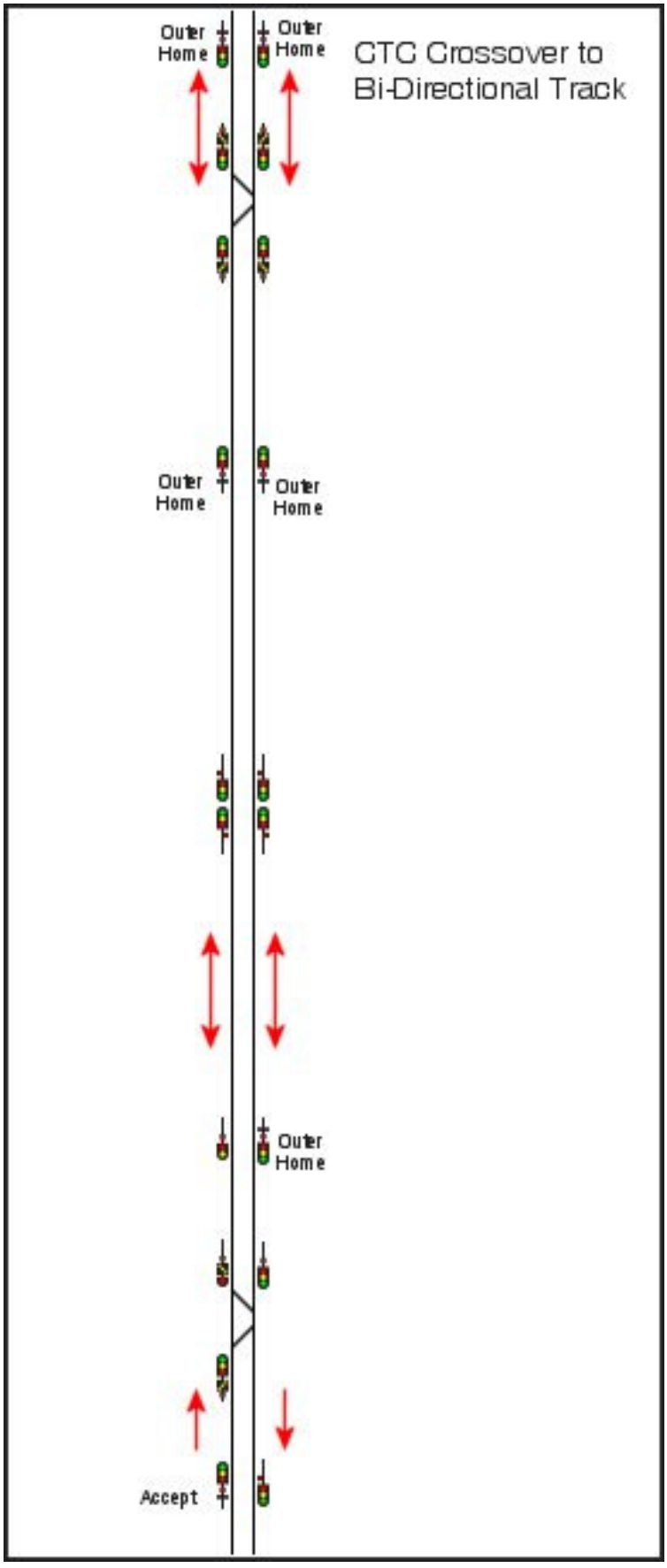
5Asp Auto signals can be used in place of 3Asp signals.



Here we introduce sections. A section is entered and exited via a controlled signal, in this example 3Asp Home. Within the section are automatic signals (3Asp Auto) which allow more than one train to be in the section at a time.

The first signal in a section is the starting signal and the last signal is the home signal. If there is no interlocking (points) after the home signal, then that signal will be a home/starting signal. A signalman can control entry into and exit from a section.

As per the previous example, all signals are spaced to ensure all trains can stop between them, or signals that can show medium are used. Likewise, 5Asp signals can substitute the 3Asp signals.

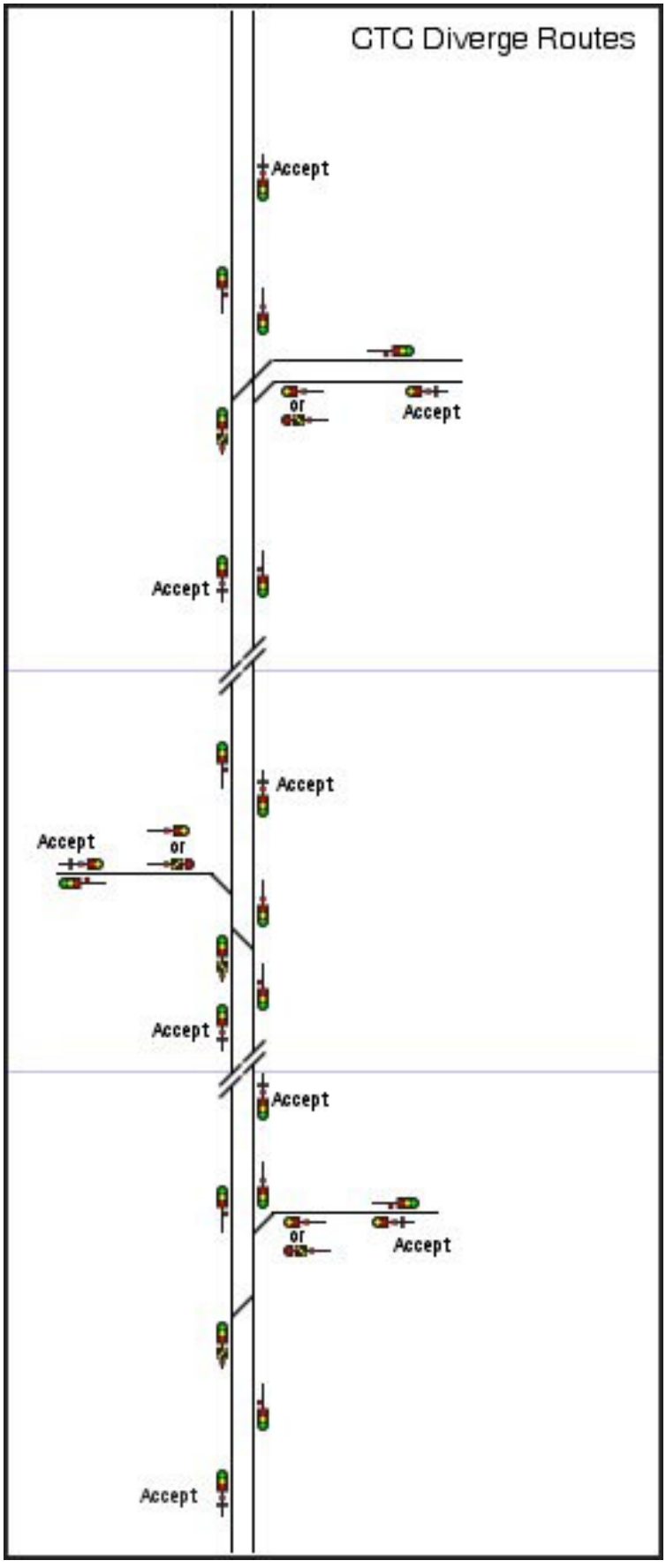


This example shows how to convert single direction double track to bi-direction double track.

5asp signals can be used in place of the 3asp signals and 6asp signals can replace the 3asp diverge signals.

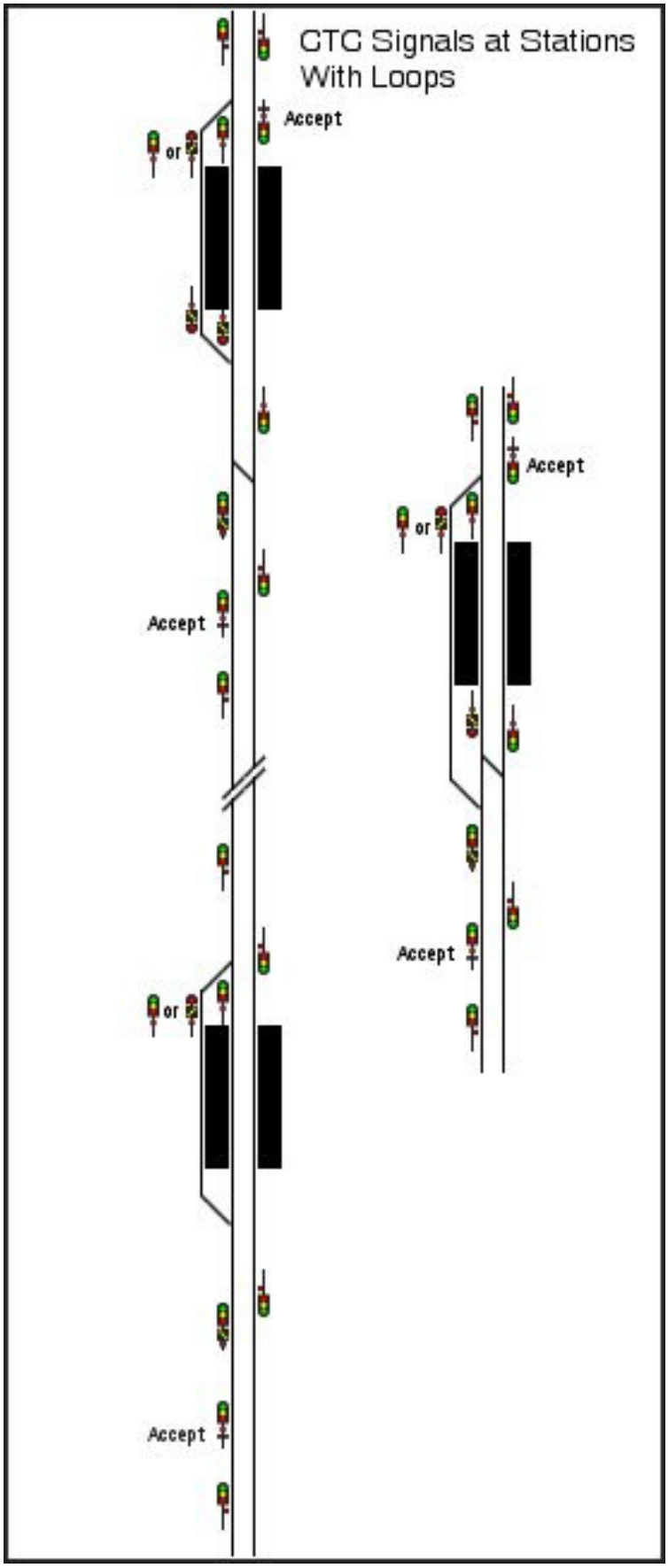
Notice that there is only one 'ACCEPT' signal in this example. This is because the Accept signal doesn't protect anything. The Outer Home signals however provide protection from opposing movements.

To provide complete protection in this set up, triggers can be placed along side the diverge signals. Then by using rules that set signals and points, the signals and points at the other end of the bi-directional section can be locked as a train passes a trigger.



These three examples show diverge routes. As before, 5 and 6 aspect signals can replace the 3 aspect signals.

In all examples, the 'ACCEPT' signal should display a MEDIUM aspect when the diverge signal displays a clear aspect for the diverge route. This can be achieved by using session rules that control signals, and using either the 3Asp Home Adv signal or 5Asp Home signal.



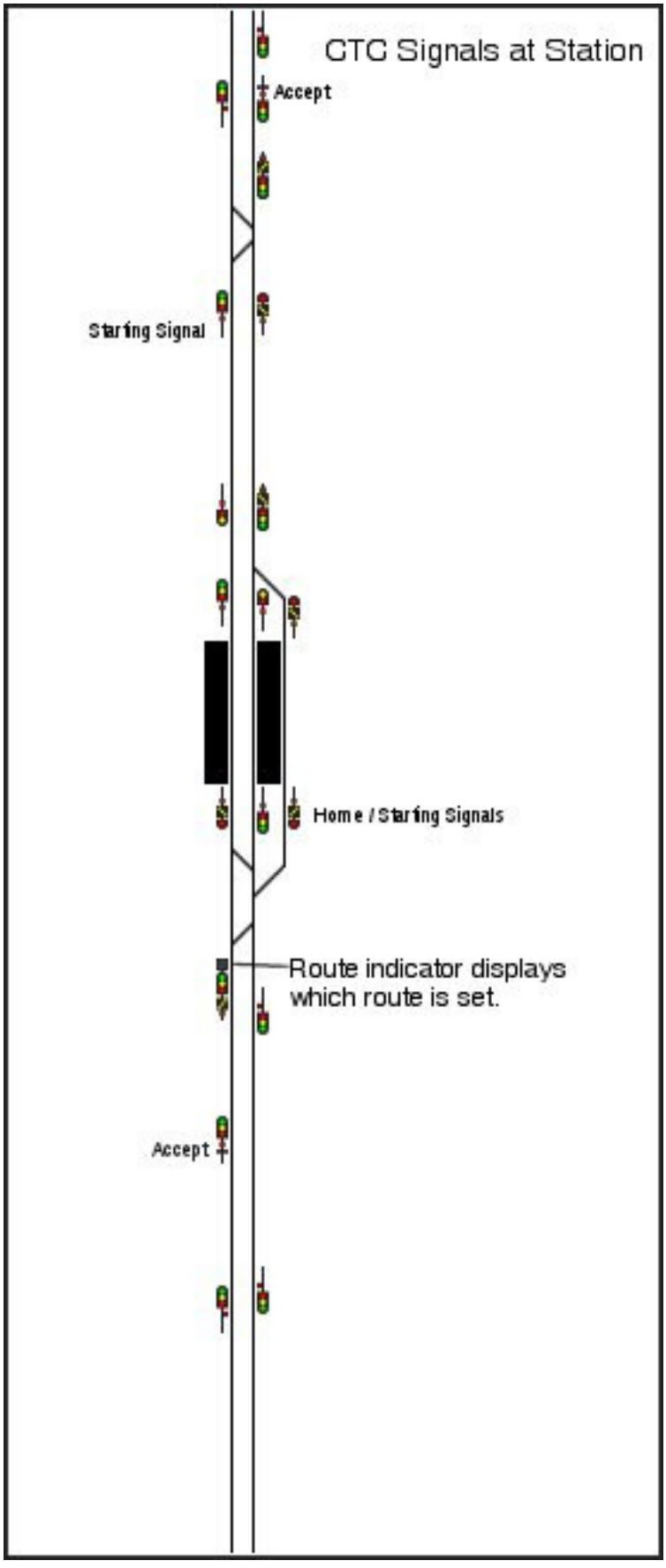
These three examples show some simple signaling at stations with loops.

In the first example, a train can terminate on both the loop or the up through line and then return on the down line.

In the second example, a train can terminate only on the up through line and return on the down line.

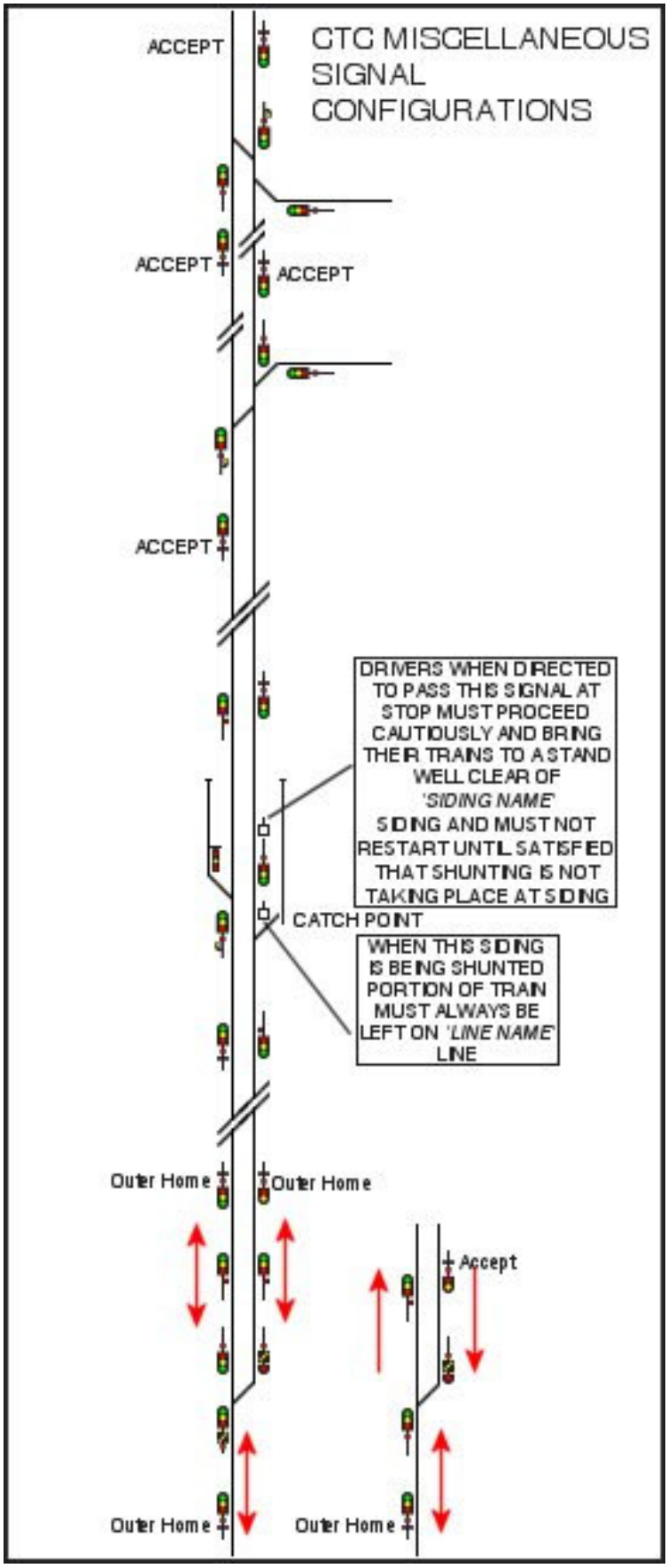
The third example is a non terminating station.

In each example, the 1Asp signal at the up end of the loop can be replaced with a 3Asp Home (or 5Asp Home) if the junction with the through line is a high speed junction. An example of this is at Berowra, the terminus of the North Shore Line and on the Main Northern Line (which follows the second example).



Here is a slightly more complicated station yard. This is a simplified version of Wyong, on the Main Northern Line. As can be seen, it has three platforms, and all three tracks through the station are bi-directional. Trains can terminate on the loop line.

The diverge signal on the up line has a route indicator as a train may be diverted to either the down line or the loop.

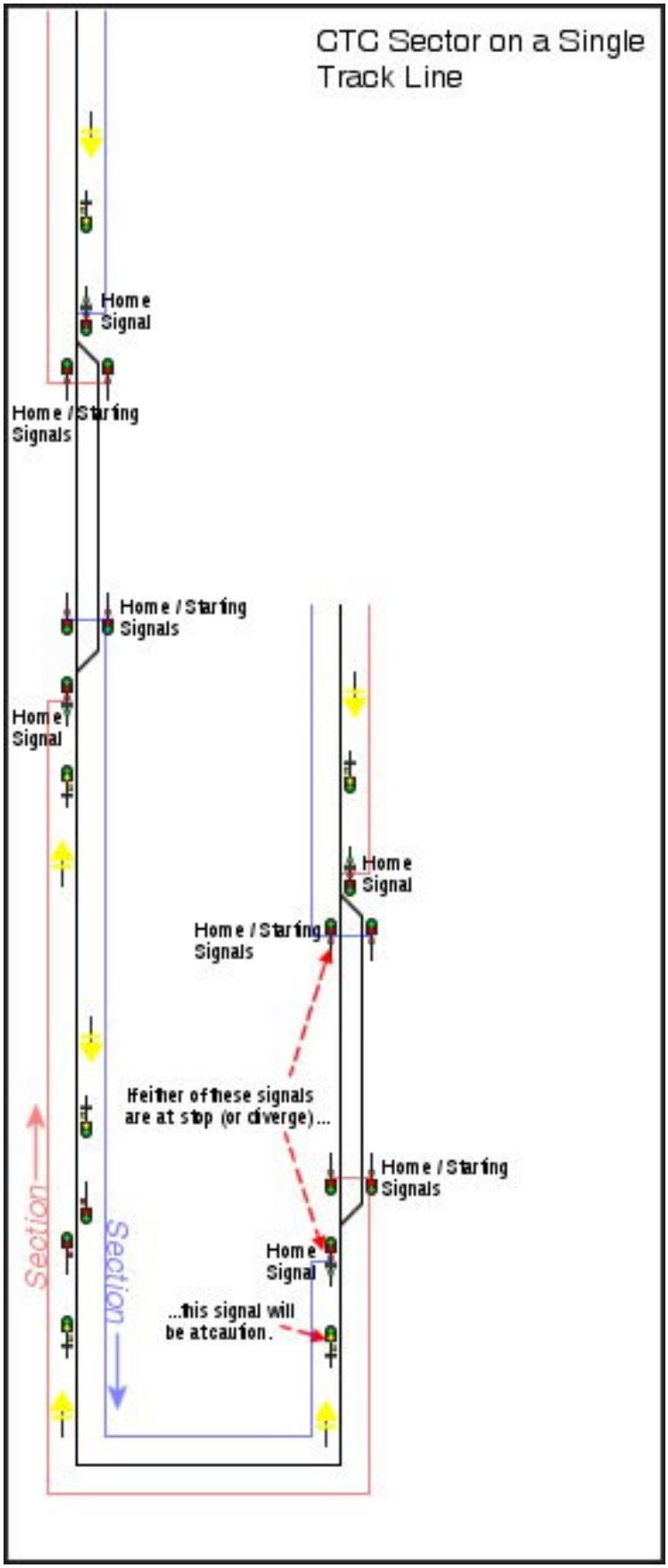


These are a few miscellaneous examples of CTC signaling.

The first example shows the entry and exit of a major yard or a coal loop.

The second example shows signaling for entry and exit to a yard or siding. The example on the left uses a shunting signal for exit and a train can be left in that siding, allowing traffic to pass. The example on the right must be shunted with the main line closed to traffic. To prevent a runaway wagon from accidentally entering the main line, it has a catch point which will derail the wagon. Other shunting signals maybe used but there are far too many combinations to show them all.

The third example shows signaling where two lines merge into one; the left example being bi-directional double track and the right example single directional double track.

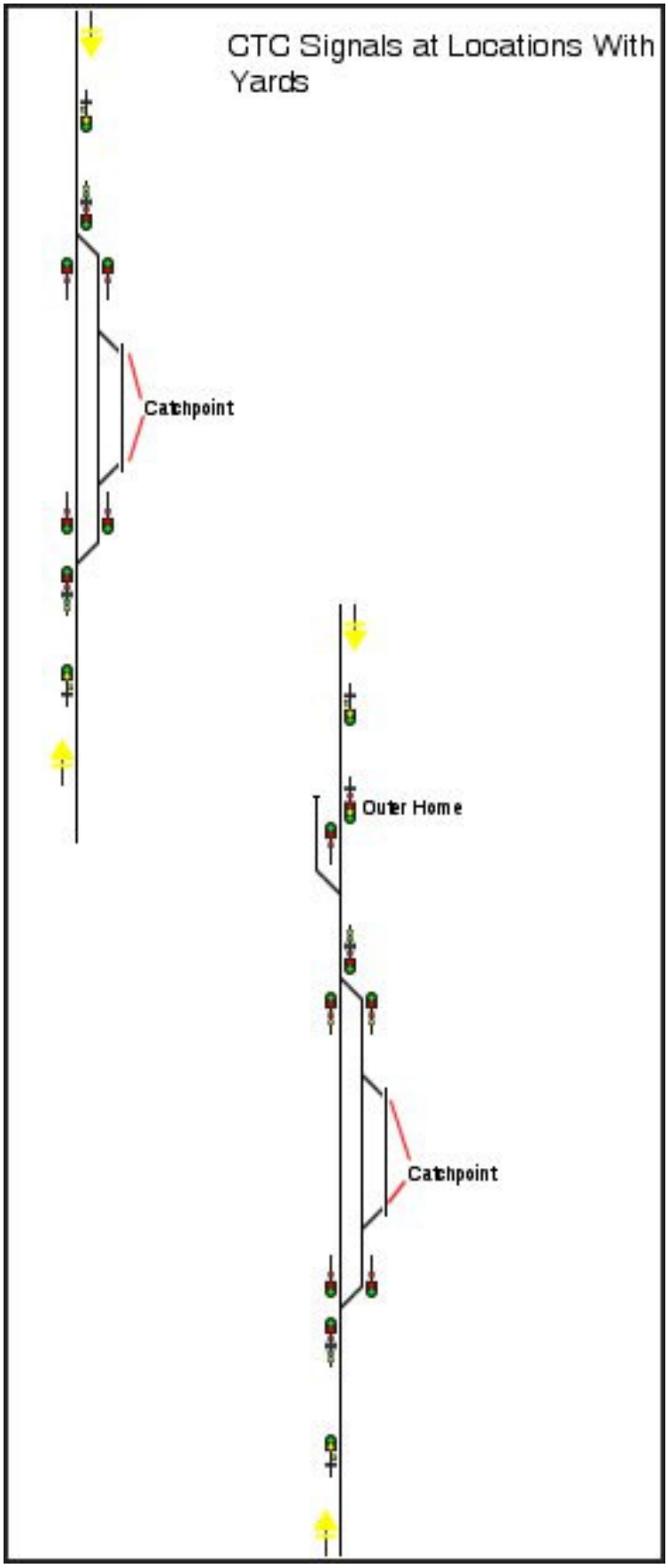


This example shows a simple CTC sector with bi-directional single track. A sector is normally between passing loops, with the starting signals at the end of the passing loops controlling entry into the sector. Once a train has passed a starting signal and has entered the sector, the starting signals at the other end of the sector are set to stop to ensure there isn't an opposing movement.

By adding the auto signals within the sector, a train can follow the first train into the sector, increasing the volume of traffic the line can carry. A sector may have from none to several auto signals.

At the loop, if either the home or the starting signals display stop or the home signal shows diverge, the distant signal shows caution.

As the starting signals also protect a junction, they are actually called home/starting signals.



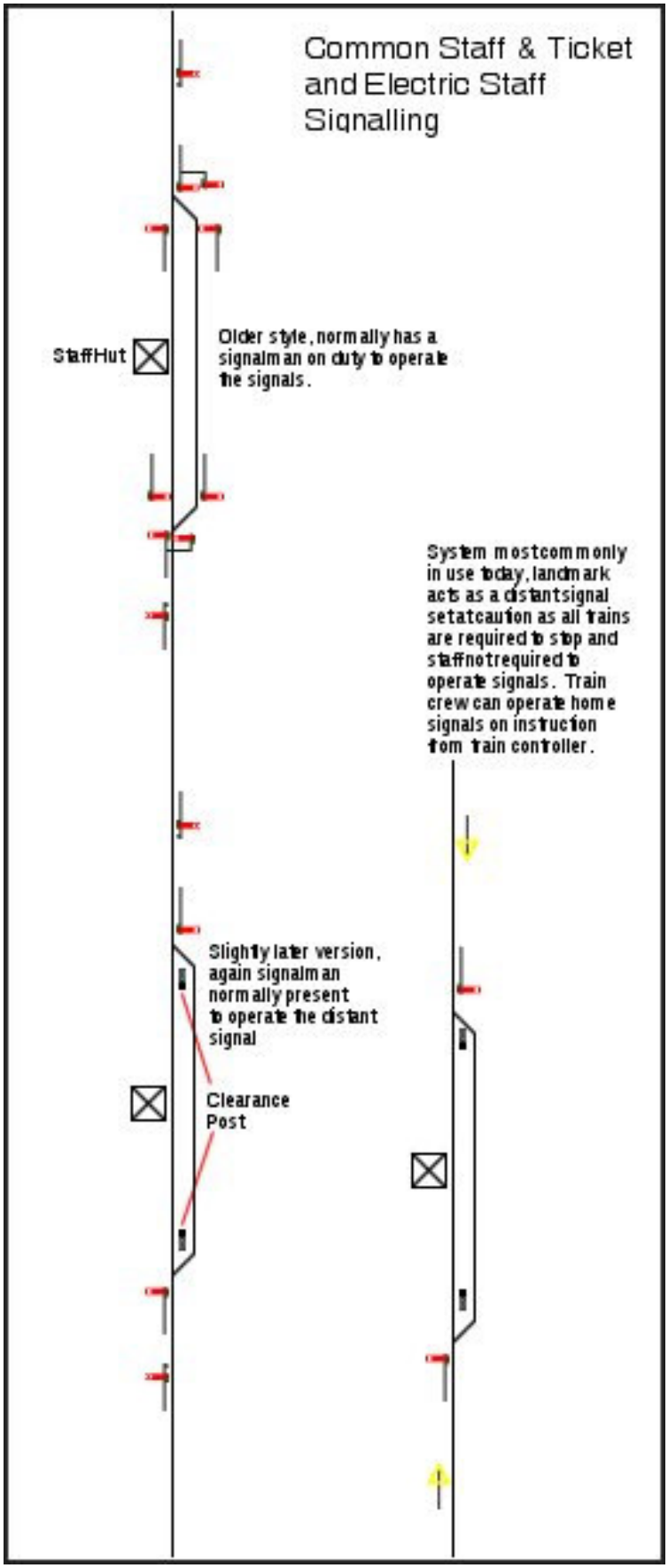
These examples show signaling at locations with yards. In both cases, the yards have catch points to stop runaway rolling-stock from accidently entering the main line.

The examples have home signals with shunting aspects to allow trains to enter the yards.

The bottom example adds a siding outside the yard. To allow for shunting to the yard, the signals at the end of the loop have shunting aspects, and a new signal has been added beyond the siding to allow movement to the siding. This new signal is the starting signal and the signals at the end of the loop are home signals.

To protect a shunting train from trains in the opposite direction, an outer home signal is located before the siding.

If any signal in the location is at stop, the distant for that direction will show caution.



Staff & Ticket and Electric Staff signaling is very basic.

The first example shows the common method used in the first half of the 1900s when most lines still used one of these safe working methods. Normally a signalman was present at the location to operate the signals and exchange the staffs.

The second example is again an early method used, and again normally required a signalman present to operate the signals.

The third example is still in use today and does not require a signalman to be present, as the distant signal is replaced with a landmark signal. Train crews can change the home signals as required and by instruction from the train crew.

Sometimes the home signal is fixed at stop and the train crew must stop and physically ensure the points in the yard are set before passing the signal.