

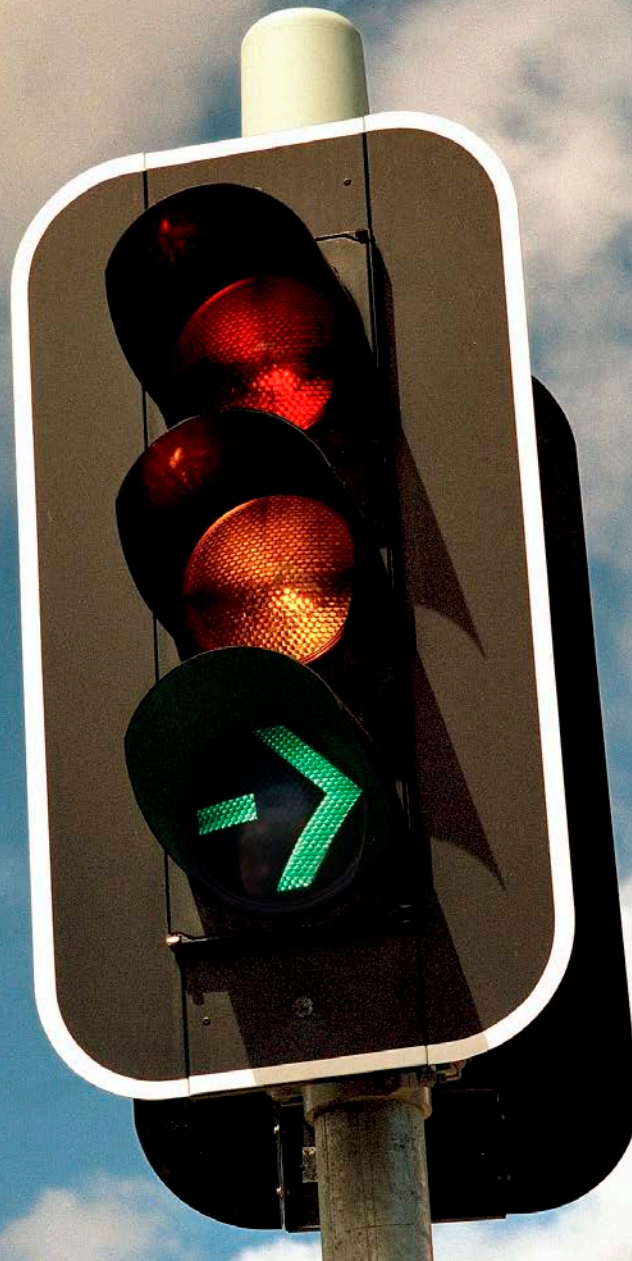


Transport  
Roads & Maritime  
Services

# Traffic Signal Design

Section 15 Special Situations

Issue No: 1.5 23 December 2016



## Preface

The traffic signal design guidelines have been developed to assist in designing traffic control signals. The information contained in the various parts is intended to be used as a guide to good practice. Discretion and judgement should be exercised, taking into account all the factors that may influence the design of traffic signals at any particular site.

The guidelines make reference, where relevant, to current Australian Standards or the Austroads Guides, and are intended to supplement and otherwise assist in their interpretation and application. If any conflict arises, the Australian Standards, the Austroads Guides and the RMS Supplements are to prevail.

The complete set of traffic signal design guidelines is as follows.

Section Title	Appendix Title
1 Investigation	A Design Plan Checklist
2 Warrants	B Traffic Signal Symbols
3 Design Process	C Location and Function of Lanterns
4 Plan Requirements	D Location and Dimensions of Components
5 Geometry	E Left Turn on Red
6 Pavement Marking	F Level Crossing Interface – Concept of Operations
7 Phasing and Signal Group Display Sequence	G Level Crossing Interface – Traffic Signal Design Guidance
8 Lanterns	
9 Posts	
10 Signs	
11 Detectors	
12 Controller	
13 Provision for Future Facilities	
14 Signalised Mid-block Marked Footcrossings	
15 Special Situations	
16 References	

## Primary references and complementary material

Roads and Maritime has adopted the Australian Standards and the Austroads Guides as its primary technical references. Roads and Maritime has developed the following complementary material which must be used in conjunction with the Standards and Guides.

- Australian Standards Traffic Supplements.
- Supplements to the Austroads Guides.
- Traffic Signal Design Guide.
- Delineation Manual.
- NSW Bicycle Guidelines.
- Standard Drawings.
- Technical Directions.
- Technical Specifications.

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## About this release

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1.2	Dec 2010	15.1 15.7.1 15.12 15.15	Contacts updated. Reference updated. Section updated. Section updated.	R O'Keefe Mgr Traffic Policies, Guidelines & Legislation
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Issue	Date	Section	Description	Approver
		15.18	Minimum width of median for stage crossings updated.	

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## 15.1 Introduction

This section describes some of the commonly encountered situations which require special treatment. If any situation not covered in this section (or the rest of the manual) arises, expert technical advice should be sought from the Principal Manager Network Operations.

## 15.2 Emergency service facilities

When traffic signals are close to a fire station, ambulance station, police station or a hospital, it may be necessary to take special precautions to ensure that emergency service vehicles are not blocked by stationary vehicles when trying to exit in an emergency. This can be achieved using traffic management treatments such as:

- Relocating the stop line further from the intersection.
- Installing warning signs and flashing lights.
- Adding a special emergency service phase.

Relocating the stop line could be appropriate where the emergency vehicle egress is at the intersection. If the resultant position of the stop line is "unnatural" from the motorist's point of view, extra facilities such as signs (eg stop here on red signal R6-6) and a wider 600 mm stop line may be necessary.

When the exit from the emergency service facility is more than 10 m from the intersection and relocation of the stop line would require a longer intergreen period, warning signs with flashing yellow lights may be located above the exit. These are operated from the depot to allow safe egress of the emergency service vehicles. It may also be appropriate to provide signs and/or pavement marking to warn motorists not to queue across the driveway.

An emergency service phase may be provided as described in specification TS-TN-022 providing the phase is warranted. The warrant should be based on the:

- Conflict between emergency service vehicles and other traffic.
- Possibility of queued vehicles blocking the exit from the emergency service facility.
- Delays to emergency service vehicles if the emergency service phase is not provided.
- Effect on traffic flow.

The emergency service phase should clear any queued vehicles within the path of the emergency service vehicle to allow it unimpeded travel in any direction through the intersection.

## 15.3 Adjacent railway crossings

If a traffic signal installation is located close to a railway crossing, special provision should be made to ensure that queues generated by the traffic signals will not extend across the railway tracks. This may be achieved by treatments such as warning signs, escape routes, additional road widening and queue detectors.

If traffic signal linking with the railway crossing is justified, track switches should be provided by the rail authority to enable a special queue-clearing sequence to be initiated at a predetermined time before the train is due at the crossing. The railway track switches should also indicate when the train has cleared the crossing. The traffic signal requirements should be determined in consultation with the rail authority during the preliminary design stage.

If the railway crossing is fitted with flashing red signals, the queue-clearing sequence should be initiated at least "X" seconds before the flashing red signals commence to operate (where "X" is dependent upon the speed of the fastest train and the worst possible phasing sequence at the site). In the case of a railway crossing provided with manually-operated gates, no special provision is generally required. The queue clearing sequence should force the traffic signals to a phase which will clear the queue across the railway crossing before the arrival of a train.

Once the queue-clearing phase has terminated, no phases or turning movements which would cross the railway line can be introduced until the train has cleared the crossing. It may be necessary to provide for additional storage of these vehicles while the railway crossing is closed.

In some situations, it may be possible to include the railway crossing within the vehicular conflict area. In this case, the train movement may be treated as a priority phase.

Special precautions will need to be taken to ensure that green traffic signal aspects are not visible across the railway crossing at the same time as the flashing red railway signals. Similarly, the positioning, screening and aiming of lanterns must be arranged to ensure that signals do not cause confusion to train drivers.

For more information on railway level crossing treatments refer to Section 15.16 and Appendices F & G.

### 15.4 Early cut-off facilities

The early cut-off period is normally used to terminate one movement before another within the same phase. A typical application of this is at staggered T-junctions as shown in Figure 15.1.

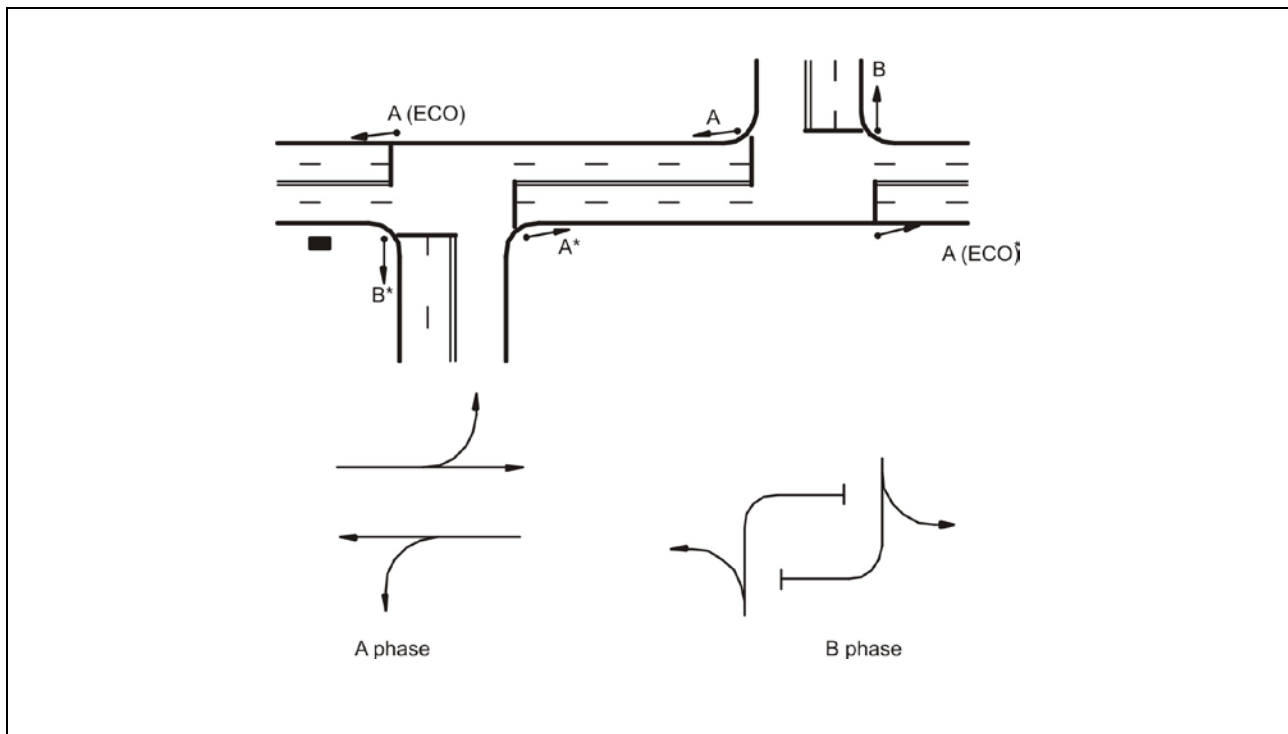
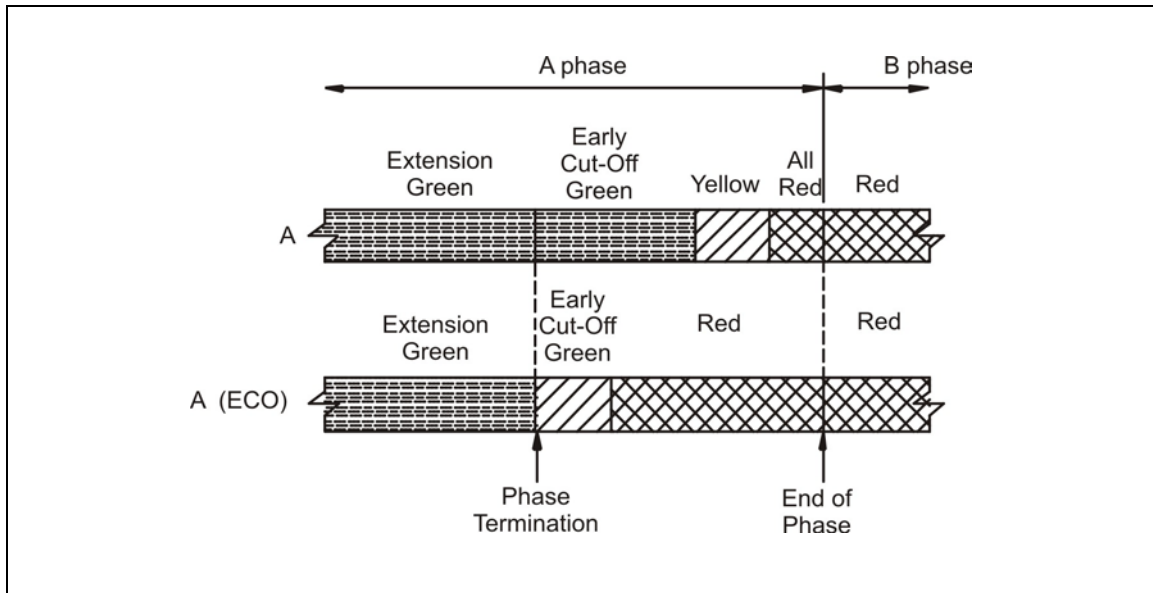


Figure 15.1 Use of early cut-off at staggered T-junction

In this example, there are two A phase stop lines in each direction. The A(ECO) signal group is the first to display a yellow aspect as shown in Figure 15.2. The A signal group remains green longer to allow the section of road between the stop lines to be cleared.

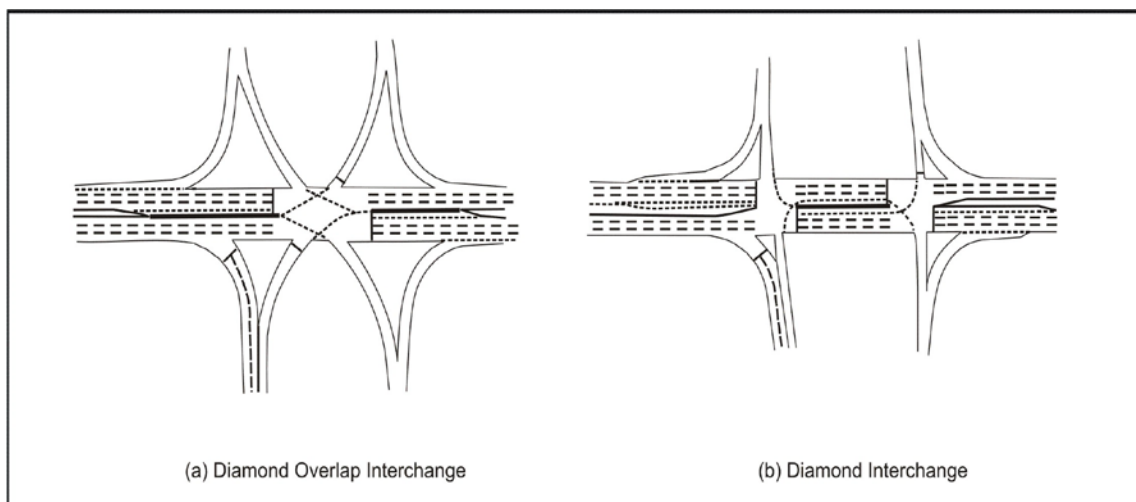
Note that this example is simplified in order to describe the principle and would only be used if the number of right-turn vehicles from the side streets is particularly low. In practice, if the zig-zag movement is dominant, the left-turn movements from the main road would be permitted during B phase. Otherwise, the side streets would more than likely have separate phases. This would result in a number of conditional early starts and conditional early cut-offs.



**Figure 15.2 Operation of early cut-off at staggered T-junction**

## 15.5 Interchange ramps

The most efficient signal design for an interchange is usually for all ramps to be concentrated at one signalised intersection as shown in Figure 15.3(a). This enables the use of a single or double diamond overlap. However, care should be taken when selecting turning radii to ensure that the opposed right turns have sufficient clearance to allow the safe operation of the diamond turns.



**Figure 15.3 Typical interchange treatments**

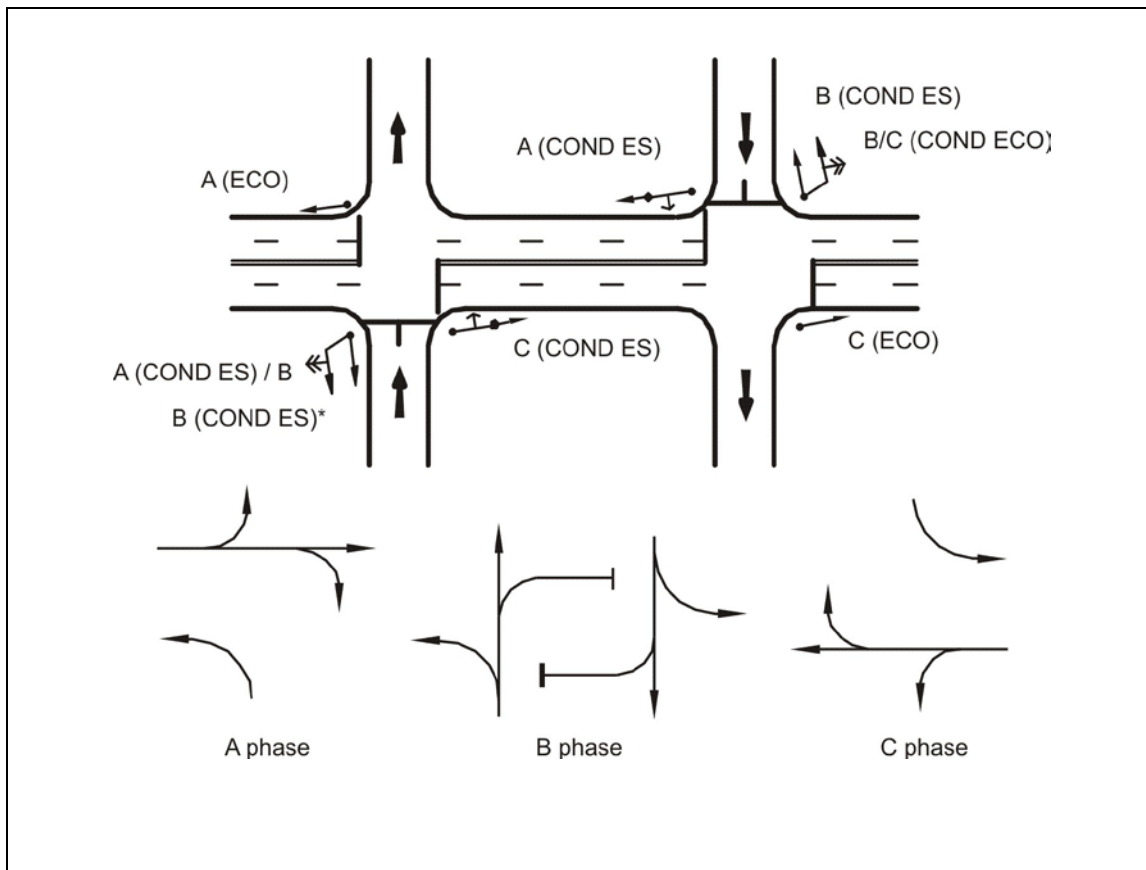
Care should be taken to ensure that the long distance between stop lines does not create unsafe conditions. This is particularly so where a marked foot crossing and/or a distant starting lantern

may cause drivers who cross the stop line at the start of the intergreen to hesitate before clearing the intersection.

Where concentration to one intersection cannot be achieved, the interchange ramps may be separated into two intersections as shown in Figure 15.3(b). The intermediate stop lines provide safe stopping for slower moving vehicles and enable a reduction in the intergreen time. The two sites may be controlled by one or two controllers. If one controller is used (usually to save costs), the site can have phase options to allow some flexibility in operation. If two controllers are used the sites can be coordinated to provide progression.

When two intersections are used, the spacing of the intersections needs to be carefully designed to ensure that adequate storage is provided for the right-turn loading vehicles. Storage requirements can be minimised by proper utilisation of the early cut-off interval.

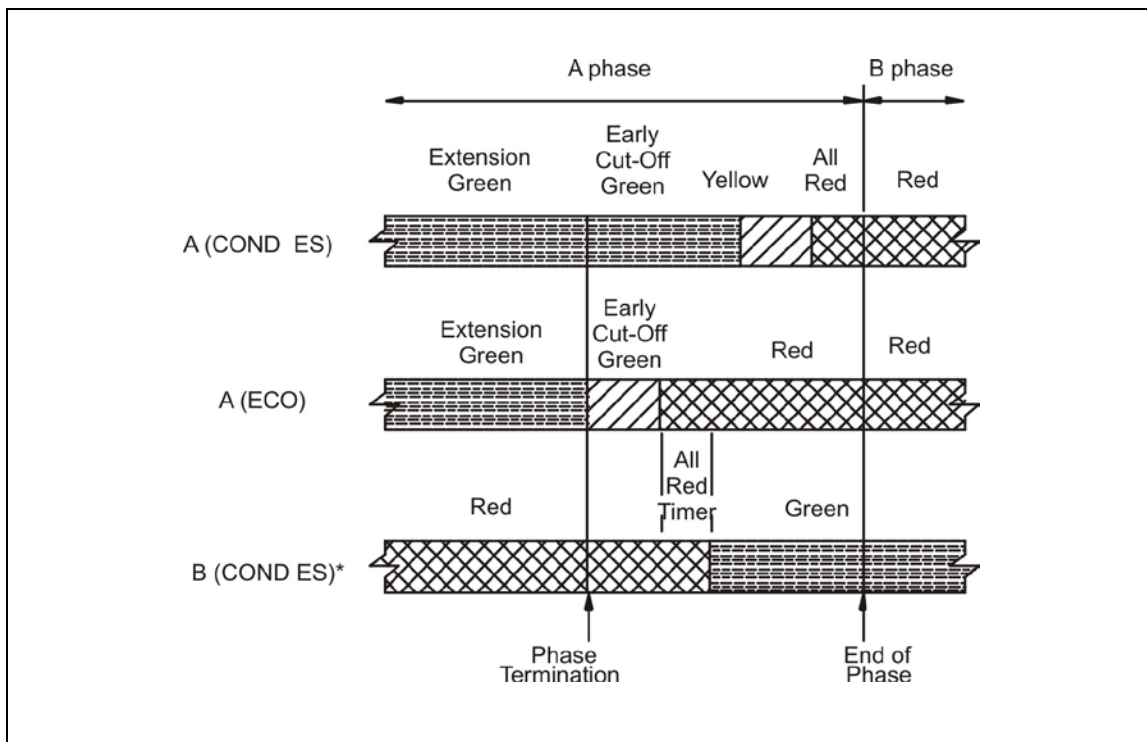
When one controller is used, the early cut-off interval may be used in a similar manner to that described above for staggered T-junctions. In this case, some of the movements may be allowed to start early in association with the early cut-off of another movement. This is known as early start (ES). An example of this is shown in Figure 15.4.



**Figure 15.4 Use of early start at interchange ramps**

In this example, when A phase is followed by B phase, the A(ECO) signal group turns yellow at the commencement of the A phase early cut-off green interval as shown in Figure 15.5. At the end of the yellow, the A(ECO) signal group turns red and the all-red timer is started. When this timer expires, the B(COND ES) signal group displays green. This is permitted because the A(ECO) signal group has cleared traffic from the conflict area. When a signal group is allowed to display green at the start of the yellow interval, this is known as green on yellow (GOY).



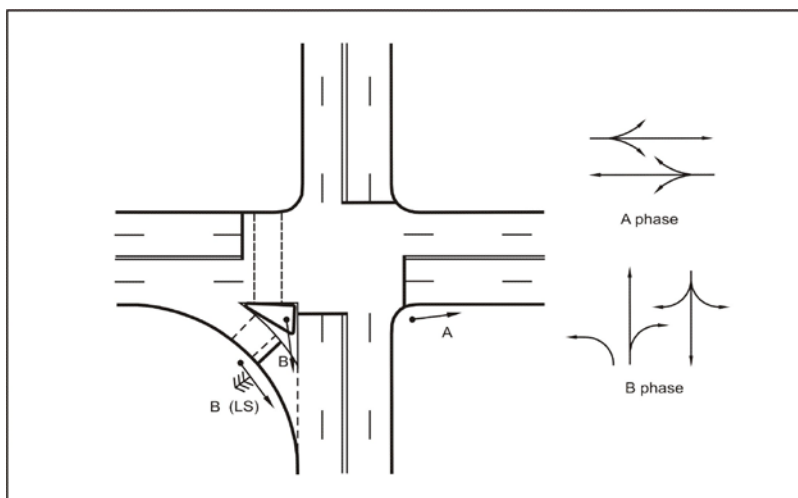


**Figure 15.5 Operation of early start at interchange ramps**

Note that this example is simplified in order to describe the principle and would only be used if the number of right-turn vehicles from the freeway ramps is sufficiently low to allow storage between the two stop lines. In practice, it would normally be more efficient to run all the through movements on the main road during A phase and provide separate phases for all other right turns. This would result in a number of conditional early starts and conditional early cut-offs.

## 15.6 Use of late start for large corner islands

In addition to the uses of the late start described in Section 7.6 of Phasing & Signal Group Display Sequence, the late start interval may be used to delay the introduction of a green signal group at a controlled left-turn slip lane where there is a large corner island, as shown in Figure 15.6.



**Figure 15.6 Use of late start for large corner islands**

In this example, the B(LS) signal group is held red for the B late start interval as shown in Figure 15.7. This allows the A phase vehicles to clear the conflict area before the left turn is introduced.

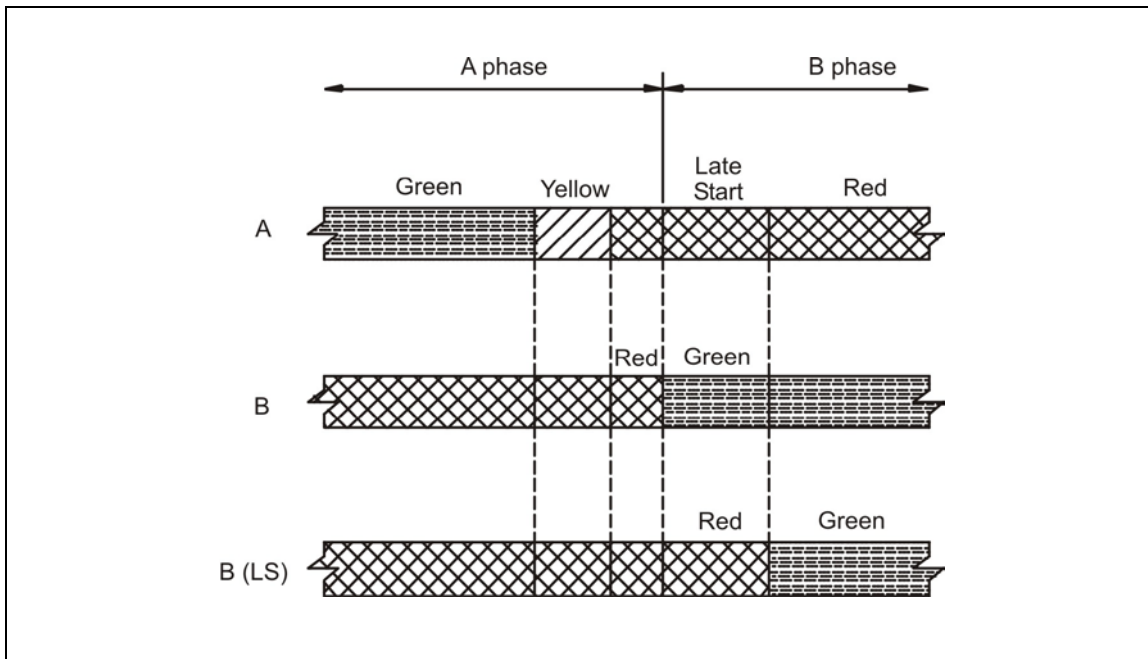


Figure 15.7 Operation of late start at a large corner island

## 15.7 Temporary installations

### 15.7.1 Portable traffic signals - shared one lane roads

Portable traffic signals are a short-term traffic control application. Their primary use is as a shuttle control where a portion of the roadway has been closed and a single lane is used alternatively by traffic approaching from opposite directions.

If a worksite is to continue unchanged for longer than two or three months, consideration should be given to the installation of temporary traffic signals rather than the use of portable signals. See RMS' Traffic Control at Work Sites.

### 15.7.2 Temporary traffic signals - shared one lane roads

When a road or bridge is under repair for longer than three months and a long stretch of one lane road is used alternatively by traffic approaching from opposite directions, temporary traffic signals can sometimes be used as a control. The general treatment in this instance is to use two phases where one phase controls each direction. Unfortunately, this requires extremely long intergreen times to allow one movement to clear the conflict area before the other movement can be started. This causes lengthy delays which could lead to driver frustration. This cannot be avoided in heavy traffic situations, but the overall delays can be minimised in low traffic situations by adding an all-red phase as shown in Figure 15.8. The controller will normally wait in the all-red phase until one of the other phases is demanded. That phase can then be introduced immediately with minimum delay to the motorist. The phase is extended and terminated as usual.

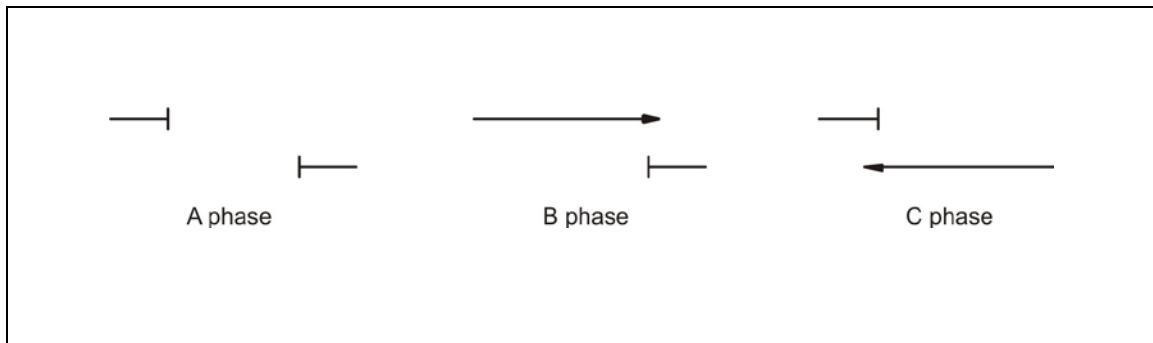


Figure 15.8 Use of an all-red phase at one-lane roads or bridges

## 15.8 Bridges

### 15.8.1 One lane bridges

Traffic signals can be used to control traffic flow at a permanent one-lane bridge site. The single lane on the bridge is used alternatively by traffic approaching from either direction and in low traffic situations an all-red phase can be added as shown in Figure 15.8.

Where guardfence is used on the bridge approaches, it should be extended, if necessary, to protect the traffic signal posts and controller as shown in Figure 15.9.

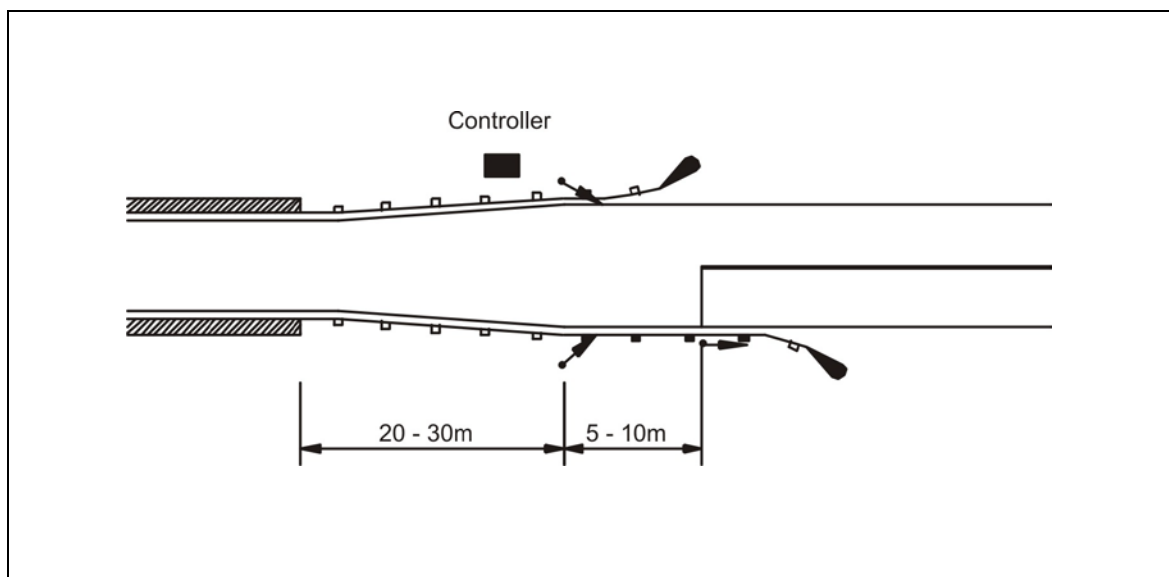


Figure 15.9 Traffic signals at a one-lane bridge

### 15.8.2 Opening bridges

Traffic signals at opening bridges are normally an integral part of the bridge operation and do not use an RMS traffic signal controller. However, if it is necessary to use an RMS traffic signal controller, the traffic signals should operate as a two-phase design where A phase is the vehicle phase and B phase is an all-red phase. B phase is only introduced when it is necessary to open the bridge. The method of demanding the phase and the timing details is site dependent.

Where guard fence is used on the bridge approaches, it should be extended, if necessary, to protect the traffic signal posts and controller as shown in Figure 15.10. See also Australian Standard AS 1742 Manual of Uniform Traffic Control Devices.

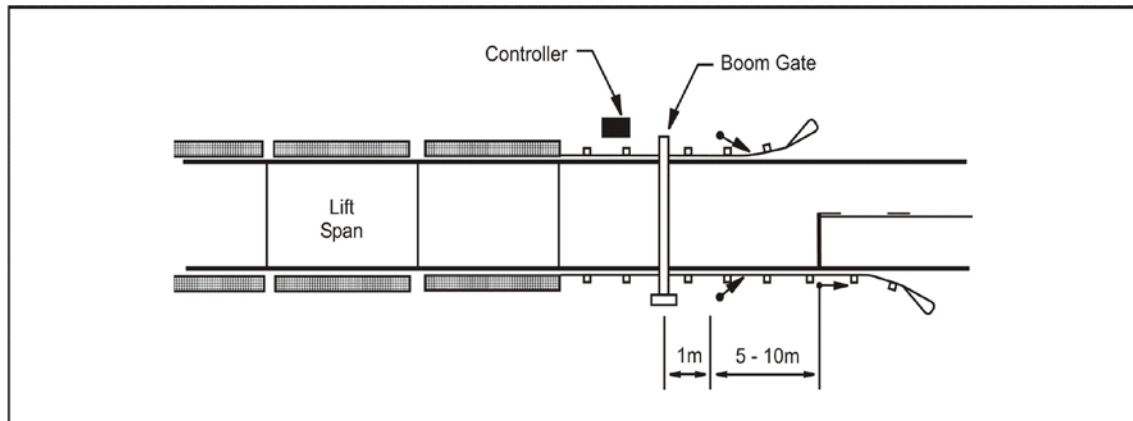


Figure 15.10 Traffic signals at an opening bridge

## 15.9 Advance warning flashing lights

In some situations it may be appropriate to install advance warning flashing lights where traffic signals are obscured by the road geometry, such as poor horizontal or vertical alignment. This may be where safe stopping sight distance is not available to either the traffic signals or to the tail lights of the last vehicle in an expected queue. There are no finite parameters to determine whether advance warning flashing lights are required or whether advance warning signs would be sufficient. Rather it requires sound judgement that additional warning is essential to prevent crashes. The proliferation of flashing lights reduces their overall effectiveness, including the effectiveness of flashing lights installed in locations of real need. Hence flashing lights should be restricted to locations where they have the highest potential for crash reduction and provoke consistent driver reaction.

If it has been determined that advance warning flashing lights are essential, they should be placed at a distance no less than the safe stopping sight distance from either the stop line at the traffic signals or the last vehicle in an expected queue, whichever results in the greater advance distance.

The installation of advance warning flashing lights should follow the following specifications:

- (a) The colour of the emitted light shall be yellow as specified in RMS' Traffic Signals Specification FWL/I 'Flashing Warning Lights for Fixed Equipment' and Traffic Signal Lanterns standard AS 2144.
- (b) Flashing lights should comprise of at least two light elements alternating 'on' and 'off' at a flash rate of between 50 and 70 times per minute, with a 50% duty cycle.

They operate as follows:

- Lights begin to flash at the start of the amber phase of the traffic signals.
- Lights continue to flash throughout the amber phase and for the duration of the red phase.
- Lights stop flashing at the beginning of the green phase. In some situations the lights may continue flashing for a short time into the green phase to allow for the delay in the movement of the queue. This 'short time' is best determined on-site to suit observed or measured conditions. If the delay in the movement of the queue is a noted safety concern then consideration should be given to installing a queue detector.

Because the advance warning flashing lights are linked to the controller, and timed as a separate signal group, they are regarded as part of the overall traffic signal installation. Consequently, the post on which the advance warning flashing lights are mounted is designated a number in sequence with the rest of the installation.

## 15.10 Provision of traffic signals on private property

The provision of traffic signals on private property requires careful consideration in regard to responsibility and possible liability. The situation can fall into two categories:

- If there is uncontrolled access to the site and it is open to any vehicle wishing to enter the site, then even if the road is privately owned, it is regarded as a road related area under the *Road Transport Act 2013* and RMS must authorise any traffic signal installation. Hence the design, installation and operation must comply with RMS policy and guidelines.
- If there is a controlled access to the site via a barrier, gate, security checkpoint or any other means, then the road within the site is deemed a private road, in which case RMS has no role in the authorisation of traffic signals and the property owner is not obliged to follow RMS policy or guidelines. In this situation the property owner carries all the risk and RMS staff must not audit or comment on the design, installation or operation of the traffic signals. To do so is to risk personal liability.

It is acceptable to alert the property owner that RMS policy and guidelines in regard to the design, installation and operation of traffic signals do exist and it would be good practice to adopt their guidance.

## 15.11 Signalised entries to private developments

A signalised entrance to a private development refers to an entrance to a private development that consists of at least one traffic movement that is controlled by traffic control signals (normally a signalised intersection) and that adjoins the public road network. The focus should be on the safe and efficient movement of people and goods and a signalised entrance to a private development must be clearly indicated and differentiated from the footpath that crosses it. There must be a **difference in level** between road and footpath through the construction of kerb and gutter and kerb ramps to eliminate any confusion over right of way between pedestrians and vehicles. The same warrants that apply to signalised mid block marked foot crossings may also be considered to apply to signalised entries to private developments (see Figure 15.11).

The Developer may be required to create an easement to allow RMS to locate traffic signal components on their (private) property, or in lieu, dedicate a section of their property as public road to allow RMS to locate and maintain traffic signal components.

Spays, clear of obstructions are required at the property line to ensure adequate visibility between vehicles on the driveway and pedestrians on the footpath.



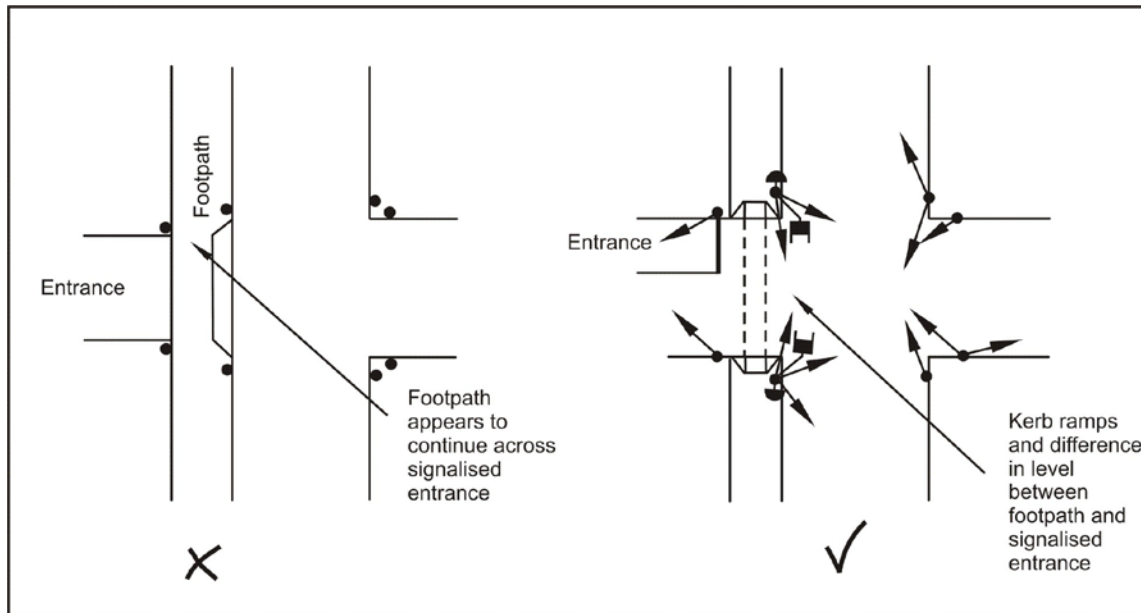


Figure 15.11 Signalled Entrance to a Private Development

## 15.12 U-Turns at signalled intersections

The *NSW Road Rules 2014* prohibit uncontrolled U-turns at all intersections controlled by traffic signals, unless there is a U-turn permitted sign installed at the intersection. Hence, a no U-turn sign is unnecessary and should **not** be used.

Notwithstanding this provision, uncontrolled U-turns are **not** permitted at any signalled intersection. If a U-turn is a necessary traffic movement this should be provided through a break in the median prior to the signalled intersection.

However, requests will be considered to allow U-turn movements controlled by a signal phase should special circumstances exist. The approval of the Principal Manager Network Operations is required.

At some intersections buses may be allowed to do a U-turn within the intersection, using their own phase, in which case the no U-turn sign with an additional plate BUSES EXCEPTED, should be used. Care must also be taken to avoid conflict with pedestrian movements.

## 15.13 Hook Turns at signalled intersections

The *NSW Road Rules 2014* require a driver, facing a hook turn only sign at a signalled intersection, to turn right by making a hook turn. Notwithstanding this requirement, hook turns are not to be permitted by motor vehicles at any signalled intersection.

Bicycle riders, however, are permitted to make a hook turn at a signalled or un-signalled intersection unless signposted otherwise. At a signalled intersection it may be necessary to locate any marked foot crossing, running parallel with the through movement, at a set back position to allow adequate storage for a rider wishing to make a hook turn to wait clear of the through traffic and not obstruct pedestrians (see Section 15.15, Page 58 of the *NSW Bicycle Guidelines* and *Technical Direction 2009/06 Bicycle Storage Areas and Advanced Bicycle Stop Lines*).

## 15.14 Ramp metering traffic signals

Ramp metering systems control the flow of traffic entering a motorway in order to maximise capacity which aims to minimise delay and travel time. Ramp metering systems do this by either preventing or delaying the breakdown of flow. Although ramp metering is generally only applicable to motorway entry ramps, it may also be applied to roads other than motorways (eg tunnels, bridges). Ramp metering systems use traffic signals; known as ramp meters, ramp signals, ramp metering signals or ramp metering traffic signals; located on the entry ramps to motorways.

Motorways that operate at or near capacity for significant periods of the day will generally require ramp metering to utilise their maximum capacity. Note that when a ramp meter is active, the motorway traffic may be flowing freely at that location. This can occur because the ramp metering system is controlling the subject ramp meter to improve traffic flow on the motorway at other locations.

Ramp metering systems may operate in conjunction with a motorway management system that comprises other motorway systems, such as lane control, variable speed limits and variable message signs. The motorway management system will often collect and process data from detectors on the motorway and provide these data to the ramp metering system for the necessary ramp metering computations. Alternatively, the ramp metering system may collect data directly from detectors.

For typical geometric layout of entry ramps with ramp metering and operational requirements guidance, refer to RMS' Smart Motorway Supplement for Ramp Signals (2016). For a description of the operation of the SCATS Ramp Metering System (SRMS) and various detector requirements, refer to RMS' SRMS Principles and Operational Strategies (2015).

The timing of ramp metering traffic signals uses a short cycle length and variable red time, providing the ability to control and vary the rate of flow of traffic entering the motorway, allowing the flow of traffic on the motorway to be maintained at a level just below its capacity.

The traffic signal lantern configuration for ramp metering traffic signals consists only of three aspect roundel displays. There are typically two lanterns provided at a ramp metering site, although additional displays may be required subject to specific site conditions (eg road geometry).

There are three basic display sequences; start up, shut down and normal operation. The start up sequence is the display of flashing yellow for a fixed period, followed by a red display and then normal operation. The display sequence during normal operation is green to yellow to red to green. The shut down sequence is switching off the signal displays after the display of green during normal operation.

Ramp metering traffic signals permit the release of only one vehicle per green per lane, which is indicated by signage. A ONE VEHICLE ONLY ON GREEN SIGNAL (G9-333) sign must be located at each traffic signal display. Where there are two or more lanes at the stop line, a supplementary plate EACH LANE (G9-334) must be located underneath each ONE VEHICLE ONLY ON GREEN SIGNAL (G9-333) sign. A STOP HERE ON RED SIGNAL (R6-6) sign should be placed on each side of the entry ramp at the stop line.

When the ramp metering traffic signals are operating, they may cycle through the normal operating sequence automatically or according to demand. There will generally be continuous demand when ramp metering is operating due to the traffic that will be queued as a result of the metering. However, it is possible that the traffic queue may be cleared at times during normal operation of the signals. If the signals are to operate according to demand, stop line detectors will be required in each lane. The signals will then not display green until a demand is received from a stop line detector.

Refer to Section 11 Detectors for ramp metering traffic signal detector requirements. The general locations of all detectors relating to ramp metering traffic signals are shown in Section 1.8 of Appendix D Location and Dimension of Components.

Traffic signals at intersections (ie not ramp metering traffic signals) are used to separate conflicting movements, improve safety, reduce crashes and provide for the efficient and safe movement of vehicles and pedestrians. Primary traffic signal lanterns are located at the stop line to warn and stop vehicles. Secondary and tertiary traffic signal lanterns are located beyond the stop line for the purpose of starting and manoeuvring vehicles. Conversely, ramp metering traffic signals are only provided with traffic signal lanterns at the secondary and tertiary positions as described below.

Ramp metering traffic signals on entry ramps permit the movement of one vehicle on each green signal per lane during the normal operating sequence. It is generally expected that there will be a queue of traffic at the traffic signals during normal operation. As such, each following vehicle is moving very slowly when required to stop for the red signal. In addition, ramp metering traffic signals do not have the conflicting movements that exist at intersections. It follows that the level of warning and stopping functions are less stringent. It is for this reason that ramp metering traffic signals are only provided with lanterns at the secondary and tertiary lantern positions, each of which satisfies the functions of warning, stopping, starting and manoeuvring.

The lane configuration at the stop line for ramp metering traffic signals ranges from a minimum of one lane to a maximum of four lanes.

Where a separate priority vehicle bypass lane is provided adjacent to the general entry ramp lane(s), a raised median must separate it laterally from the general entry ramp lane(s) for its full effective length due to the risk of collision of vehicles (likely of different types) in the two types of lanes that may be travelling at significantly different speeds. The width of the raised median must be in accordance with Section 9.3 of Posts. Separate ramp metering traffic signals may also be provided for the priority vehicle bypass lane, preferably at a location upstream of the ramp metering traffic signals for general traffic, in order to provide longitudinal separation of the separate traffic signal displays and to provide a longer acceleration length on the entry ramp for priority vehicles.

Aiming and shielding of the lanterns as described in Section 8.7 of Lanterns must be considered so their visibility from motorway traffic is minimised as far as practicable. The same consideration must be given for the visibility of all lanterns where a priority vehicle bypass lane is provided such that it is clear which traffic signals apply to general or priority vehicles.

The longitudinal distance from the stop line to the traffic signal lanterns at ramp metering traffic signals should be in accordance with the starting lantern position shown in Section 1.6 of Appendix D Location and Dimensions of Components.

For any number of lanes at a ramp meter stop line (one to four inclusive), there shall be a minimum of two traffic signal lanterns. These lanterns should be located on either side of the stop line at the starting lantern positions as shown in Appendix C Location and Function of Lanterns.

The distance from the ramp meter stop line to the entrance ramp median nose should be consistent with acceleration from stationary to an appropriate speed to enter the motorway. These distances are as shown in drawings included in RMS' Smart Motorway Supplement for Ramp Signals (2016). Adequate provision should be made for traffic to queue on the entry ramp, including consideration of the possibility of traffic queuing beyond the start of the entry ramp and onto adjoining roads.

If sight restrictions limit visibility approaching the ramp metering signals, a TRAFFIC LIGHTS (symbolic) sign (W3-3) should be provided. Where additional warning is considered necessary, a PREPARE TO STOP – TRAFFIC SIGNALS (symbol with flashing lights) sign (W3-204), may be required. The requirements for additional warning are discussed in Section 10.12 of Signs and Section 15.9 of Special Situations.

Should site conditions not allow configurations listed in this section to be implemented, advice should then be sought from both General Manager, Road Network Operations and the Principal Manager, Network Operations.

**The approval of General Manager, Road Network Operations is required for any ramp metering traffic signals.**

## 15.15 Bicycle storage areas and advanced bicycle stop lines

The *NSW Road Rules 2014* include rules for bicycle storage areas and bicycle hook turn storage areas at signalised intersections. Advanced bicycle stop lines are also covered by the road rules, although this term is not used given they are simply another type of stop line.

There are many different terminologies used when referring to bicycle storage areas and their associated components and/or variations. The terms commonly used are head start storage areas, bicycle reservoirs, bicycle storage areas, bicycle storage boxes or bike boxes. In NSW we use the terms bicycle storage area, expanded bicycle storage area, bicycle hook turn storage area and advanced bicycle stop line.

In general, bicycle storage areas are best suited for use on roads with high bicycle numbers and lower traffic volumes (eg local roads and some regional roads), while advanced bicycle stop lines are more suited to roads with both high numbers of bicycles and vehicles (eg major roads).

The guidelines for bicycle storage areas and advanced bicycle stop lines are covered in Technical Direction 2009/06 (Bicycle Storage Areas and Advanced Bicycle Stop Lines), the NSW Bicycle Guidelines (section 7.3.4) and the Austroads Guide to Road Design (Part 4A, section 10.6.4).

Where bicycle storage areas and advanced bicycle stop lines are provided:

- The primary post is to be located in the normal position ie 0.7 m beyond the outside edge of the marked foot crossing line.
- Vehicle detectors are to be located behind the vehicle stop line using the standard detector locations.
- To ensure motor vehicles stop at the first stop line in the direction of travel, and allow bicycles to proceed to the second stop line, a STOP HERE ON RED SIGNAL (R6-6) sign, with a BICYCLES EXCEPTED (R9-3) supplementary sign is to be installed. This sign is to be located behind the kerb in line with the first stop line, and also on the median, when one exists.

## 15.16 Railway level crossing shared infrastructure

The majority of situations see the traffic signals located adjacent to the level crossing (see Section 15.3). In some circumstances the room available for the provision of both traffic signal and rail infrastructure may be limited. To address the infrastructure needs of both road and rail modes within the limited space, provision of traffic and rail signals on the same infrastructure will be permitted in limited circumstances. The approval of the General Manager, Road Network Operations is required.

The general design principles that apply to shared infrastructure are:

- It may be used but is typically limited in application.
- When used, it is installed within the rail corridor and in front of the boom gate.
- It is typically used with a limited number of rail and road traffic signal lanterns, generally facing one direction only.

- It is located on both sides of the road. When a mast arm is used it is only provided on one side of the road.
- The location is typically at the same location as Assembly RX-5 in Australian Standard AS 1742.7 Manual of uniform traffic control devices Part 7 Railway crossings. Assembly RX-5 could be replaced by an overhead flashing mast arm assembly (Figure 2.1 in AS 1742.7). It is also noted that in some circumstances a supplementary assembly RX-5 may be placed on the opposite side of the road to the primary assembly.
- The desire to keep the design simple so that number of signal lanterns and sign infrastructure, and corresponding messages that a driver must recognise, are minimised and driver response time to the multiple messages is minimised.
- The design is as close as possible to the standard (non-shared) designs.
- That adequate visibility is provided for lantern displays for each system.

## 15.17 Roundabout metering traffic signals

Roundabout metering systems are designed to control the amount of traffic entering a roundabout from one or more approaches. By controlling the amount of traffic entering a roundabout the length of queues, and consequently delays, to one or a number of the other approaches to the roundabout can be reduced or managed.

The need to provide roundabout metering may occur at particular times of the day, for example during peak periods, where traffic volumes on one approach may be far greater than those on another approach resulting in significant delays to the second approach. This is especially the case when a heavy right turn movement can dominate an opposing through movement.

The operation of the traffic signals is activated by one or more sets of timed detectors located on an approach to the roundabout which detects the length of a queue on that approach. The timed detectors must be continually occupied for a predetermined set time before they trigger the operation of the traffic signals. Once the traffic signals commence operation they remain operational for a minimum set period to prevent the signals from continually switching on and off as the queue on a particular approach fluctuates. The timed detectors should be installed between 50 and 120 metres from the traffic signal stop line. The stop line associated with the primary and dual primary lanterns is to be located a minimum of 20 metres from the roundabout holding line.

Traffic signals for roundabout metering on a single lane approach must, as a minimum, comprise a primary and secondary lantern. Additional lanterns may be considered necessary depending on site conditions. On a two lane approach a minimum of three signal displays are required, preferably in the configuration, primary, dual primary and secondary. Additional lanterns may be considered necessary depending on site conditions. Two aspect Red and Yellow lanterns control the traffic on a particular approach.

The sequence of the aspect display is **Off to Yellow to Red to Off**. 'A Phase' would normally be the roundabout operating period, following the traffic signal phases that control the various roundabout approaches.

A TRAFFIC SIGNALS OPERATING WHEN LIGHTS FLASHING (W3-207 or W3-207-1) sign is to be located at a suitable location in advance of each of the signalised roundabout approaches. A G9-344 illuminated "Roundabout Operating" sign is to be attached to the traffic signal post under the tertiary and secondary lantern displays. STOP HERE ON RED SIGNAL (R6-6) signs are to be installed on both the primary and dual primary posts.

During both the Yellow and Red lantern displays the TRAFFIC SIGNALS OPERATING WHEN LIGHTS FLASHING (W3-207 or W3-207-1) sign is to operate. The G9-344 illuminated



“Roundabout Operating” signs are to be illuminated during the periods that the traffic signal system is not operating. During the operation of the traffic signals the G9-344 is to be switched off.

## **15.18 Two-stage crossings at intersections**

The normal practice is to provide a one-stage marked foot crossing on each leg of a signalised intersection. However, the installation of a two-stage marked foot crossing may be considered for medians that are greater than 3.0 metres and which provide further protection for pedestrians crossing the intersection.

The left-hand offset shown in Section 14, Figure 14.2 is preferred to the right-hand offset shown in Figure 14.3, as it provides better sighting, especially for pedestrians as they walk towards oncoming traffic. See Section 14.3 of Signalised Mid-block Marked Foot Crossings for further details including two-stage offset crossings and pedestrian fencing requirements.

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