

Manual of Uniform Traffic Control Devices

Part 14

Traffic

Signals

2003 Edition



Queensland Government

Department of **Main Roads**

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DEPARTMENT OF MAIN ROADS
Queensland

Manual of Uniform Traffic Control Devices

PART 14 – TRAFFIC SIGNALS

SECTION 1. SCOPE AND GENERAL

1.1 SCOPE

This Part of the Manual specifies the type and layout of signals, aspects and displays to be used at locations controlled by traffic signals. Basic requirements for signs and pavement markings to be used in conjunction in accordance with Part 2 of this Manual are also given. This Part does not cover railway level crossing signals of the type described in Part 7.

1.2 REFERENCED DOCUMENTS

The following documents are referred to in this Part of the Manual:

AS

- 1348 Road and traffic engineering - Glossary of terms
- 2144 Traffic signal lanterns
- 4191 Portable traffic signal systems

AS/NZS

- 1906 Retroreflective materials and devices for road traffic control purposes
- 1906.1 Part 1: Retroreflective materials

AUSTROADS

- Guide to Traffic Engineering Practice
- Part 7: Traffic signals

1.3 DEFINITIONS

For the purpose of this Part of the Manual the definitions in AS 1348 and those below apply.

1.3.1 Aspect

A single optical system on a signal face capable of being illuminated at any given time.

1.3.2 Controlled area

A portion of a roadway or intersection, the entry to which is controlled by traffic signals, delineated at entry either by a marked stop line or in its absence, the primary signal position, and at exit by the point beyond which there is no further conflict with intersecting traffic.

1.3.3 Crosswalk

A portion of a road between two parallel broken lines marked on the road surface, indicating the path to be used by pedestrians at midblock pedestrian signals or intersection signals to cross the road.

1.3.4 Pelican crossing

A signal-controlled mid-block crossing at which vehicles must not enter the crossing during the pedestrian running period (green symbol) and the early part of the pedestrian clearance period (flashing red symbol), but are allowed to proceed, giving way to any pedestrians on the crossing during the rest of the clearance period, the latter being indicated to vehicular traffic by a flashing yellow signal.

This type of crossing is NO LONGER APPROVED FOR USE IN QUEENSLAND.

1.3.5 Public transport vehicle

A public passenger vehicle is prescribed in the Transport Operations (Passenger Transport) Act as a vehicle used to transport members of the public and includes a bus, taxi or limousine.

1.3.6 Roadway

That portion of the road devoted particularly to the use of vehicles, inclusive of shoulders and auxiliary lanes.

1.3.7 Signal display

An aspect which is illuminated.

1.4 TRAFFIC SIGNAL CONTROL

1.4.1 General

Traffic control signals are devices which, by means of changing coloured lights, regulate the movement of traffic.

Traffic signals are the most positive intersection control devices when correctly used. They are not suited for all intersection congestion and accident problems and their installation in some circumstances may produce adverse results, e.g. delays may increase forcing traffic to divert to unsatisfactory alternative routes which may increase problems elsewhere.

It is important that any traffic signal installation be based on a thorough knowledge of the relevant factors derived from a thorough study of traffic and road conditions. After the signals are installed their effect should be studied at intervals, firstly to ensure that they are operating as designed, and secondly to ensure that their operation remains compatible with prevailing traffic conditions.

Traffic signals at intersections may be installed in isolation or as part of a coordinated route or area system.

1.4.2 Application

The need for traffic signals at intersections may be determined from the factors set out below. The factors are a guide only; all other relevant factors should be taken into account and proper engineering judgement should be exercised.

The guides alone should not be used to justify an installation. Their sole function is to separate locations where signals are likely to be effective or ineffective. To assess priorities where all factors appear equal, cost-benefit techniques should be used.

Some examples of appropriate and inappropriate applications of traffic signals are given in Table 1.1.

Table 1.1 APPROPRIATENESS OF TRAFFIC SIGNALS

Symptom	Cause	Signal control
Congestion	Excessive delays at STOP or GIVE WAY signs	Appropriate
	Excessive delays to turning traffic	Appropriate
	Volume greater than capacity, i.e. substitute for poor road design	Inappropriate
Accidents	Angle collisions and pedestrian accidents	Appropriate
	Rear- end accidents	Inappropriate
	Right turn accidents	Inappropriate*
Access control	Flow on to freeways	Appropriate
	Inefficient flow to traffic on surface street system	Appropriate

* Unless separate turn phase is provided.

1.4.3 Guidelines for installation - intersection

In the following guidelines, the terms 'major' and 'minor' are used respectively to indicate the roads carrying the larger and smaller traffic volume:

- (a) *Traffic volume.* Where the volume of traffic is the principal reason for providing a control device, signals may be considered when traffic volumes of 600 vehicles per hour exist on the major road concurrently with 200 vehicles per hour on the higher-volume approach of the minor road for each of any 4 hours of an average day.
- (b) *Continuous traffic.* Where conditions on the major road are such that the minor road traffic suffers undue delay or hazard in entering or crossing the major highway, traffic signals may be considered if traffic volumes of 900 vehicles per hour exist on the major road concurrently with 100 vehicles per hour on the higher-volume approach of the minor road for each of any 4 hours of an average day, provided that the installation would not disrupt progressive traffic flow, and provided also that no alternative and reasonably accessible signalised intersection is present on the major road.
- (c) *Accidents.* To reduce accidents, signals may be considered if there is a 3-year average of 3 or more reported casualty accidents per year of a type which can be eliminated or reduced by traffic control and the traffic volume is at least 0.8 times the volume warrants given in (a) and (b). Signals should only be installed if simpler devices will not effectively reduce the accident rate.
- (d) *Combined factors.* In exceptional cases, signals occasionally may be justified where no single warrant specified above is satisfied but where two or more of the guidelines above are satisfied to the extent of 0.8 times or more of the stated values.

Intersection traffic signals provided on the basis of pedestrian volume are treated in Part 10 of this Manual.

1.4.4 Guidelines for installation - mid-block

Traffic signal control is provided at non-intersection locations to aid in the safe and orderly movement of traffic. Mid-block signals provided on the basis of pedestrian volume are treated in Part 10 of this Manual.

1.4.5 Traffic signal operation

Traffic signals operate in the following modes:

- (a) *Fixed-time operation.* Fixed-time signals are inflexible in their operation and can generate substantial traffic delays which may result in increasing some types of accidents.
It is desirable that fixed-time signals be confined to use within a coordinated system under time of day control of network.
- (b) *Traffic-actuated operation.* Traffic-actuated signals have the flexibility to take account of fluctuations in traffic flow thus resulting in decreased delays and increased efficiency. This also applies during periods of light traffic and the system is eminently suitable for continuous control. Pedestrian detection should be used where pedestrian symbols are provided.
Traffic-actuated signals should be employed at all intersections not incorporated in a 'master' controlled coordinated system.
Proper operation can be ensured only by the adequate maintenance of the detectors.
- (c) *Coordinated signals.* Signals on arterial routes should, desirably, be coordinated to obviate congestion and maintain flow.
The warrants for selecting either area or linear coordinated traffic signal systems depend on a number of factors such as traffic speed, traffic density, cycle length, and the degrees of platoon dispersal. Selection of the system to be used should be based on a thorough traffic study and should comply with the requirements of the transportation study (if any) for the district, town, or city.
- (d) *Flashing operation.* Flashing yellow signal operation may be used to indicate an equipment failure. Red or green signals shall never be flashed.
- (e) *Manual operation.* Signals may be equipped with a device to permit manual intervention by police or other authorised persons to switch the signals off if they are physically damaged or to switch the signals flashing yellow during emergencies.

SECTION 2. DESCRIPTION OF SIGNAL DISPLAYS

2.1 GENERAL

Signal displays shall conform to the descriptions given in this Section and shall be used for the purposes indicated. Displays shall be consistent with respect to shape, colour and purpose, regardless of the use to which they are put or the way they are controlled.

The descriptions given below to various displays indicate only their principal purposes. Meanings are given in traffic regulations which may impose additional requirements on drivers, e.g. a driver proceeding in accordance with a green circle as described in Clause 2.2.1(a) may only do so if he or she is able to clear the intersection, and may turn only if the turn is safe and not otherwise prohibited. Likewise, movements in response to certain signals are often permitted only from certain traffic lanes.

2.2 STEADY DISPLAYS FOR VEHICLES

2.2.1 Circle displays

The principal purposes of circle displays for vehicle control shall be as follows:

- (a) *Green circle.* In the absence of other displays, allows drivers to enter the controlled area, proceed straight through and turn right or turn left, filtering through opposing vehicle or pedestrian streams if necessary.
- (b) *Yellow circle.* Indicates that drivers should not enter the controlled area if they can safely stop at the relevant stop line except when an arrow display or other control device provides otherwise. This display is also used at certain mid-block access points to indicate to drivers that emergency service facility red signals are about to be displayed (see Clause 7.1.2).
- (c) *Red circle.* Indicates that drivers shall not enter the controlled area for the duration of the display, except when an arrow display or other control device provides otherwise.

2.2.2 Arrow displays

Where arrow displays are used, the following applies:

- (a) *Form and use.* Arrow displays shall take one of the following forms and shall be used as follows:
 - (i) *Horizontal arrow, left or right.* Used at intersections to control left or right turns which are approximate right angles or greater than right angles. (Arrows pointing below the horizontal may be used if needed to distinguish separate turning movements in the same general direction).
 - (ii) *Upwards arrow at 45 degrees, left or right.* Used at intersections to control left or right turns which are substantially less than a right angle. The horizontal arrow (in (i) above) may be used in lieu where it is considered this would improve driver's perception of the intersection configuration. This would be the exception rather than the rule.
 - (iii) *Vertically upwards arrow.* Used at intersections to control exclusively straight-ahead movements.
 - (iv) *Vertically downwards arrow.* Used above a traffic lane to control the use of that lane.
 - (v) *U-turn arrow.* Used at intersections to control U-turns.
- (b) *Purposes.* The principal purposes of arrow displays for vehicle control shall be as follows:
 - (i) *Green arrow at intersection signals.* Allows drivers to proceed in the direction indicated by the arrow.
 - (ii) *Green downward pointing arrow above a marked traffic lane.* Indicates that the lane is available to drivers facing the signal. Such drivers may proceed along the lane subject to the directions of any traffic signal operating along its length.
 - (iii) *Yellow arrow.* Indicates that drivers intending to proceed in the direction indicated by the arrow should not enter the controlled area if they can safely stop at the relevant stop line.
 - (iv) *Red arrow.* Indicates that drivers intending to proceed in the direction of the arrow shall not enter the controlled area for the duration of the display.

2.2.3 Red cross (X) display above a marked traffic lane

This signal display is used to indicate that the lane shall not be used by drivers facing the aspect.

2.3 FLASHING DISPLAYS FOR VEHICLES

2.3.1 Flashing yellow circle

When a flashing yellow circle aspect is displayed, it warns drivers that there is a need to exercise caution while proceeding. This aspect is sometimes referred to as a flashing beacon.

2.3.2 Flashing red circles

Flashing red circles are used at railway level crossings. They indicate that drivers shall not enter a level crossing for the duration of the display (see Part 7 of this Manual).

2.3.3 Flashing yellow arrow

The principal purpose of the flashing yellow arrow shall be to indicate that drivers may proceed in the direction of the arrow, but there is a need to exercise caution as other vehicle or pedestrian movements, or both, have precedence.

2.3.4 Flash cycle

Flashing signals shall flash at a rate 60 ± 5 flashes per minute and an on-time of 50 ± 10 percent. On-time refers to the proportion of time during which the aspect is visually illuminated.

2.4 PEDESTRIAN DISPLAYS

The principal purposes of pedestrian displays shall be as follows:

- (a) *Green symbolic walking pedestrian* - allows pedestrians to proceed to cross the roadway.
- (b) *Flashing red symbolic standing pedestrian* - is displayed during the pedestrian clearance period and indicates that pedestrians on the crossing may complete their crossing, but those who have not yet started to cross shall not leave the footpath or refuge. The flash cycle shall be as specified in Clause 2.3.4.
- (c) *Steady red symbolic standing pedestrian* - indicates that pedestrians shall not leave the footpath or refuge. If already on the crossing, they should continue quickly to the opposite footpath or refuge.

2.5 BICYCLE DISPLAYS

The principal purposes of bicycle displays shall be as follows:

- (a) *Green symbolic bicycle* - allows pedal cyclists to proceed.
- (b) *Flashing red symbolic bicycle* - is used in conjunction with pedestrian displays during the bicycle clearance period (which may be different to the pedestrian clearance period) and indicates that pedal cyclists shall not start crossing the roadway. If already on the crossing, they may complete their crossing. The flash cycle shall be as specified in Clause 2.3.4.
- (c) *Steady yellow symbolic bicycle* - is used in conjunction with vehicular signals and indicates to the pedal cyclists that they should not enter the controlled area if they can safely stop at the relevant stop line.
- (d) *Steady red symbolic bicycle* - indicates that pedal cyclists shall not enter the controlled area or crossing. If already within the controlled area or on the crossing, they should continue and clear the controlled area or crossing as quickly as possible.

2.6 PUBLIC TRANSPORT AND EMERGENCY VEHICLE DISPLAYS

2.6.1 Symbol types

The following symbols shall be used on public transport and emergency vehicle aspects:

- (a) Letter 'B' - aspects for the exclusive control of buses, taxis and limousines.
- (b) Letter 'T' - aspects for the exclusive control of cane railway trains.
- (c) Letter 'E' - aspects for the exclusive control of emergency vehicles. 'E' displays should not normally be visible to other road users.
- (d) White arrow, horizontal, angled or upward - aspects for the control of public transport vehicles.

2.6.2 Purpose of displays

The primary purposes of public transport and emergency vehicle displays shall be as follows:

- (a) *White B, T or E displays* - indicate to drivers of the corresponding vehicle type that they may proceed.
- (b) *Yellow B or T displays* - indicate to drivers of the corresponding vehicle type that they should not enter the controlled area if they can safely stop at the relevant stop line.
- (c) *Red B or T displays* - indicate to drivers of the corresponding vehicle type that they shall not enter the controlled area for the duration of the display.
- (d) *White arrow display* - indicates to drivers of public transport vehicles that they may proceed in the direction of the arrow.

SECTION 3. ARRANGEMENT OF SIGNAL ASPECTS

3.1 GENERAL PRINCIPLES

The following principles apply to the arrangement of aspects on any one signal face:

- (a) *Intersection and mid-block crossing signals.* The following shall be observed:
- (i) Except as provided in Item (viii), aspects shall be arranged in vertical columns, each column comprising up to three vehicular aspects, two pedestrian aspects or two or three bicycle aspects.
 - (ii) In each column red aspects shall be uppermost, green aspects lowest and yellow between the two.
 - (iii) The entire signal face shall comprise not more than three columns of vehicular aspects and not more than one column each of pedestrian and bicycle aspects (see also Clause 3.2(c) for preferred layouts).
 - (iv) Each horizontal row of vehicular aspects shall have aspects of the same colour, except white B aspects which shall be in the same row as green aspects.
 - (v) Except as provided in items (vii) and (viii), all aspects in any one column shall be the same shape, and if arrows, pointing in the same direction. Left turn arrows are located to the left of the circular aspects and right turn arrows are located to the right of the circular aspects.
 - (vi) The following are not permitted for vehicular control:
 - (A) A column comprising only a yellow aspect.
 - (B) A column comprising only a red and a green aspect, except for ramp metering (see Clause 7.5).
 - (vii) A column comprising a red circle, a yellow circle and a green arrow shall be permitted.
 - (viii) A single column of four vehicular aspects shall be permitted where the top two are circles; the third is either a green circle or green arrow and the bottom aspect is either a green arrow, or a white B symbol.
 - (ix) All aspects on any one signal face shall be the same size.
- (b) *Overhead lane control signals.* Except where a single aspect is designed to change symbols by electronic or optical means, a changing signal face shall comprise a green vertical arrow aspect arranged horizontally to the left of a red cross aspect (see Clause 2.2.2(b)(ii)). A non-changing signal face shall be either a single aspect, or an alternative fixed sign aspect (see Clause 3.4). A green overhead lane control arrow should not be placed in a position where it could be confused with intersection signals.

3.2 SIGNAL FACE LAYOUTS AT INTERSECTIONS

The following are requirements and recommendations for signal face layouts at intersections (excluding public transport and emergency vehicle signals):

- (a) Single aspect signal faces shall not be used except for permanent green displays.
- (b) Two-aspect vehicular signal faces shall be reserved for the special cases specified in Clause 3.7.
- (c) Signal faces should be limited to not more than two columns of aspects, in which case they shall conform to the layouts set out in Table 3.1, Cases (a) to (m).
- (d) Where it is necessary to control left turn, right turn and through movements separately, attempts should be made in the first instance to split the signals into separate two-column signal faces on different supports, to avoid three column signal faces.

NOTE: Three column signal faces are generally considered to be difficult to comprehend and may not be catered for in standard mountings or target boards.

- (e) In the event that a three-column signal face cannot be avoided, its layout shall be as follows:
 - (i) The centre column shall always be three circles.
 - (ii) Except where the third column may be needed for public transport, emergency vehicle or bicycle aspects (see Clauses 3.3 and 3.6), the left and right columns shall be left and right arrow aspects in one or other of the forms shown in Table 3.1 as part of two column signal faces.

- (f) A single column of four vehicular aspects consisting of a red circle, yellow circle and two green aspects (either green circle and arrow or two green arrows) is not permitted for overhead signals and should not be used in multicolumn signal faces.

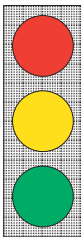
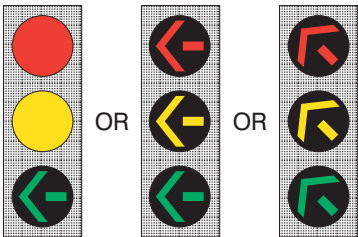
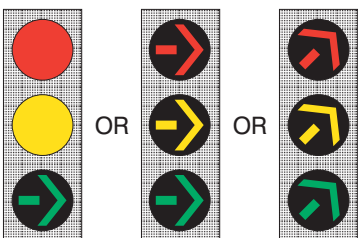
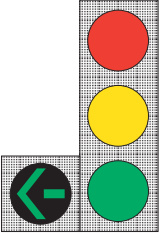
3.3 SIGNAL FACE LAYOUTS FOR PUBLIC TRANSPORT AND EMERGENCY VEHICLE CONTROL

Recommended signal face layouts are as shown in Table 3.2.

3.4 SIGNAL FACE LAYOUTS FOR OVERHEAD LANE CONTROL

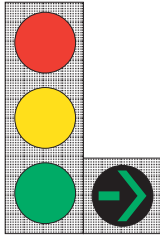
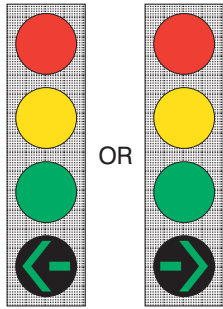
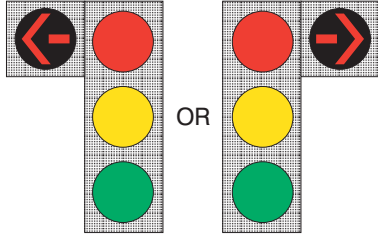
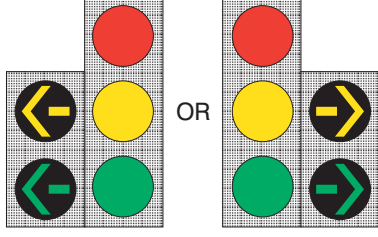
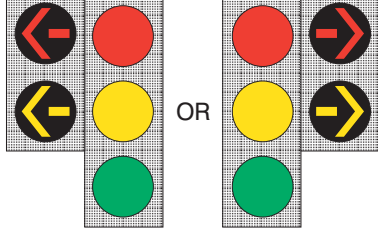
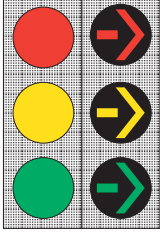
Recommended signal face layouts are as shown in Table 3.3. The symbols may be within either a circle or a square depending on the method of display, e.g. circular signal lantern, fibre-optic display on square panel.

Table 3.1 PERMITTED SIGNAL FACE LAYOUTS FOR VEHICULAR INTERSECTION AND MID-BLOCK CROSSING CONTROL

Case	Layout	Purpose	Examples of application
(a)		Single phase control of every movement on an approach	Any approach where there is no requirement for separate control of turns or of public transport vehicles
(b)		Control of an approach where all traffic turns left	A controlled left turn (LT) slip lane, e.g. with a signalized crossing. NOTE: Wherever appropriate, circle aspects are preferable to arrows on account of their better visibility (especially the red and yellow aspects)
(c)		Control of an approach where all traffic turns right	Channelized right turn (RT) from bar of a T-junction, or RT from stem of a T-junction where LT is separately channelized. NOTE: Wherever appropriate, circle aspects are preferable to arrows on account of their better visibility (especially the red and yellow aspects)
(d)		Control of LT where it always terminates concurrently with the green circle period	Where left turns can be allowed prior to the start of the corresponding through movement

(continued)

Table 3.1 (continued)

Case	Layout	Purpose	Examples of application
(e)		Control of RT where it always terminates concurrently with the green circle period	(i) Where opposing approaches run in separate phases (ii) Any situation where the opposing through (or conflicting LT) movement is terminated before the through movement
(f)		Alternatives to cases (d) and (e)	Lateral space too restricted for 2-column signal face
(g)		To delay introduction of the LT or RT filter movement until part way through the green period for through traffic	Where it is desired to enhance safety of pedestrians on a heavily used parallel crossing or to control queuing on the intersection road
(h)		Control of a LT or RT with a green arrow during one phase but may filter during a subsequent phase	Any situation where filtering can be permitted after an exclusive turn phase has terminated
(i)		Control of a LT or RT filter movement which may need to be stopped part way through the green period for through traffic	May be required for protection of turns onto an adjacent railway level crossing, bus way approach or like situation
(j)		Either continuous full control of RT, or full control during only part of a phase and allowing filtering during the remainder by using the display sequence green-yellow-red-off for the arrows	Where turns are controlled with a green arrow during a phase and filtering of the turn is unsafe during other stages in the phase or sequence

(continued)

Table 3.1 (continued)

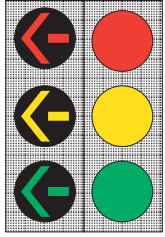
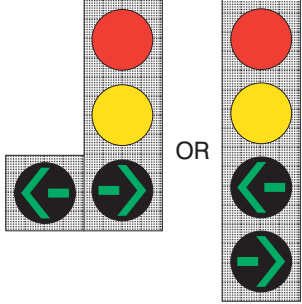
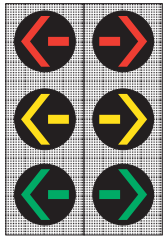
Case	Layout	Purpose	Examples of application
(k)		<p>Full control of LT when it needs to be controlled separately from the through phase</p>	<p>Where the left turn conflicts with a signal-controlled crossing and there is no left-turn slip lane</p>
(l)		<p>Control where traffic only turns left or right, and the turns may start at different times but are always terminated together, and there are no conflicting pedestrian movements</p>	<p>Approach to T-junction along stem. Single column is used where lateral space is too restricted for 2-column signal face</p>
(m)		<p>Control where traffic only turns left or right, and each turn must be controlled separately</p>	<p>Approach to T-junction along stem</p>
(n)	<p>Any 3-column signal face</p>	<p>NOT PREFERRED - See Clause 3.2(e)</p>	

Table 3.2 SIGNAL FACE LAYOUTS FOR PUBLIC TRANSPORT AND EMERGENCY VEHICLE CONTROL

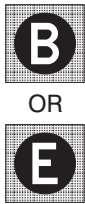
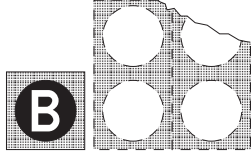




Case	Layout	Purpose	Examples of application
(a)		Control of bus or emergency vehicle movement only	<p>Bus is on a separate exclusive roadway</p> <p>Emergency vehicle leaving its station</p>
(b)		Separate control of bus movement	Priority start for public transport vehicle, especially if it must cross the path of other starting traffic
(c)		Control of bus only, where site requires yellow and red aspects to be displayed	Vehicle is approaching intersection on a separate exclusive roadway

Table 3.3 SIGNAL FACE LAYOUTS OVERHEAD LANE CONTROL

Case	Layout	Purpose
(a)		To indicate a lane which is always available for movement in this direction. See also Clause 3.5.
(b)		To indicate a lane which is never available for movement in this direction. See also Clause 3.5.
(c)	<p>Same aspect option as used in Case (b)</p>  <p>Same aspect option as used in Case (a)</p>	To indicate a reversible lane. Aspects may be coincident where aspect change is achieved by a special optical system e.g. fibre optics.

3.5 SIGN ALTERNATIVES FOR NON-CHANGING ASPECTS





Where a signal aspect is displayed above a marked lane for the purpose of lane direction control as described in Clauses 2.2.2 and 2.2.3, and that display is not required to change, i.e. the lane always flows in the same direction, it may be replaced by a fixed sign subject to the following:

- (a) The *lane arrow* shall be a downward pointing white arrow on a black background or black arrow on a white background.
- (b) The *lane cross* shall be a red cross on a white background.
- (c) The minimum signboard size shall be 600 ×600 mm.
- (d) The white portion of the sign shall comprise retroreflective material meeting the requirements of AS/NZS 1906.1, Class 1A.
- (e) On each set of signals across a roadway, signals over lanes immediately to the left or right of reversible lanes shall be signal aspects and not sign alternatives.

Steps shall be taken to ensure that sign alternatives are at least as conspicuous as the signal displays. External illumination should be considered.

3.6 SIGNAL FACE LAYOUTS FOR PEDESTRIAN AND BICYCLE CONTROL

Signal faces should conform to Table 3.4.

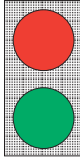
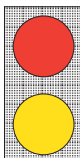

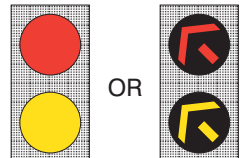
Table 3.4 SIGNAL FACE LAYOUTS PEDESTRIAN AND BICYCLE CONTROL		
Case	Layout	Purpose
(a)		<p>To control pedestrian movement at a mid-block or intersection pedestrian crosswalk.</p> <p>To control pedestrian and bicycle movements at a mid-block or intersection joint-use path crossing.</p> <p>Aspects may be coincident where aspect change is achieved by a special optical system, e.g. fibre optics.</p>
(b)		<p>To control bicycle movements at an exclusive bicycle path crossing.</p> <p>Where pedestrians are likely to use the crossing, two-aspect pedestrian lanterns shall be used (as shown in (a) above) in lieu of bicycle aspects.</p>
(c)		<p>To control pedestrian and bicycle movements at a mid-block or intersection crossing from a separated path.</p>
(d)		<p>To separately control bicycle movements where bicycles move with vehicular traffic.</p> <p>To control bicycle path approaches to at-grade exclusive bicycle path intersections with a road.</p>

NOTE: Three-aspect bicycle signals, as shown in (d) above, may be used to control movements at an exclusive bicycle path crossing in lieu of two-aspect bicycle signals in (b) above.

3.7 TWO-ASPECT SIGNAL FACES

Two-aspect vehicular signal faces should be limited to the arrangements and usage specified in Table 3.5.

Table 3.5 TWO-ASPECT VEHICULAR SIGNAL FACES

Case	Layout	Specified usage
(a)		Ramp metering (see Clause 7.5).
(b)		Roundabout metering and at mid-block access at an emergency vehicle station.
(c)		On the right hand side of the right hand roadway of a divided road (dual secondary) to reassure RT traffic in a wide intersection that they may proceed (see Figure 4.1(b)).
(d)		To stop traffic at a pedestrian crosswalk on a LT slip lane where traffic may continue to filter after the pedestrian phase has finished.

NOTE: Provision of two-aspect signals on left turn slip lanes, as indicated in (d) above, may be considered where provision of three-aspect left turn slip lane signals would result in high vehicle delays and congestion leading to high pedestrian delays. This would be the subject of detailed traffic engineering investigations. The use of this arrangement is the exception rather than the rule. Prior approval for use of this arrangement shall be obtained from the Department of Main Roads.

3.8 SEQUENCE OF SIGNAL DISPLAYS

3.8.1 Single columns

The following sets out the requirements for the sequencing of displays in a single column signal face:

- (a) *Three and four aspect columns.* The sequence shall be green–yellow–red–green. In four aspect columns, both greens shall terminate at the same time.
- (b) *Two aspect columns:*
 - (i) *At pedestrian crosswalks and bicycle crossings.* The sequence shall be green (symbol)–flashing red (symbol)–steady red (symbol)–green (symbol).
 - (ii) *At two-aspect vehicular signals.* The sequence shall be-
 - (A) *at ramp metering signals when in use* - green–red–green; *else* - off;
 - (B) *at roundabout metering signals* - off–yellow–red–off;
 - (C) *at far right secondary signals* - off–green–yellow–off;
 - (D) *at left-turn slip lanes with signal-controlled pedestrian crosswalks* - off–yellow–red–off.

3.8.2 Multi-column signal faces

The following sets out the requirements for sequencing of displays in a multi-column signal face:

- (a) The requirements of Clause 3.8.1 for single columns shall apply to each two or three aspect column.

- (b) The 'blackout' condition of a column of arrow aspects shall be used where filter movements are to take place.
- (c) Any green display shall always be followed by a yellow display on the same signal face.
- (d) A red display shall always be preceded by a yellow display on the same signal face.

3.8.3 Public transport vehicle signals

The sequencing of signal displays for buses i.e. letter 'B', shall be: white–yellow–red–white.

3.8.4 Emergency vehicle station access points, mid-block

The sequencing of signals facing approaching traffic on the frontage road shall be: off–yellow–red–off.

3.9 INTERVALS

3.9.1 Running interval

The running interval is indicated by a steady green aspect and shall always be followed by a clearing interval. Display of a green arrow aspect indicates an interval during which movement in the direction of the arrow is protected from conflict with other vehicular and pedestrian movement.

3.9.2 Clearing interval

The vehicular clearing interval is indicated by a steady yellow aspect for a period ranging from 3 to 5 seconds and shall be provided in accordance with the following –

- (i) Speed limit up to and including 60 km/h – 4 seconds
- (ii) Speed limit between 60 km/h up to and including 80 km/h – 5 seconds
- (iii) Yellow arrow aspect which operates independently of a through movement on the same approach, at all times, and which is always followed by a phase for the associated through movement – 3 seconds.

The yellow interval is followed by a short all red interval of sufficient duration to provide for the safe clearance of vehicles which have lawfully entered the intersection during the yellow interval. The minimum all-red interval shall be – 1 second.

The pedestrian and bicycle clearing intervals are indicated by the red symbolic standing pedestrian and red symbolic bicycle aspects respectively. These aspects may be shown flashing. The bicycle clearing interval may also be indicated by the yellow symbolic bicycle, where three-aspect bicycle signals are used (see Table 3.4).

3.9.3 Stopped interval

The stopped interval is indicated by a steady red aspect.

SECTION 4. LOCATION OF SIGNAL FACES

4.1 GENERAL

4.1.1 Application

As far as practicable, signal faces should be located as specified or recommended in this Section. Consistency in the location of signals is highly desirable to meet road users' expectations as to how signals are displayed and hence assist them to observe the signals correctly.

4.1.2 Designation and function

The designation and function of signal faces is as follows:

- (a) *Primary signal faces* - located adjacent to the stop line or other point where traffic is required to stop. Their principal function is to warn approaching traffic of the state of the signals, and to stop traffic at the correct position, noting that, in the absence of a stop line, traffic is legally required to stop before passing the primary signal.
- (b) *Secondary signal faces* - located to the right side of the roadway, beyond the point where traffic is required to stop, e.g. on the far side of an intersection, in a position readily visible to traffic stopped at the stop line. Their principal function is to indicate to stopped traffic the start of a running phase.
- (c) *Tertiary signal faces* - located to the left side of the roadway beyond the point where traffic is required to stop. Their principal function is to supplement the secondary signals.

The location of these signal faces at intersection and mid-block signals is shown in Figure 4.1.

4.1.3 Positioning of secondary and tertiary signal faces

Secondary and tertiary signal faces are positioned at least 6 m beyond the relevant stop line. See also Clause 5.2 regarding the mounting height of these signal faces.

4.1.4 Overhead signal faces

Overhead signal faces are required in the following situations:

- (a) Where the sight distance to the post-mounted display is inadequate, e.g. because of vertical or horizontal alignment, awnings, poles, trees or similar sight obstructions.
- (b) Where the roadway is too wide for kerb-mounted lanterns to fall within the driver's line of sight.

NOTE: Guidance on the locating of traffic signals within drivers' line of sight is given in Austroads, Guide to Traffic Engineering Practice, Part 7: Traffic Signals.

Regardless of the above requirement, overhead signals may be omitted if there is a likelihood that they could appear to apply to an adjacent upstream signalized intersection. The use of overhead displays on adjacent signal installations with a separation of less than 150 m is not recommended.

4.2 SIGNAL FACE LOCATIONS AT INTERSECTIONS

4.2.1 General

The number of signal faces to be provided at intersections given in this Clause is to be generally considered as a minimum. Additional faces may be required at multiple leg intersections or on multiple roadway approaches, or where the controlled area is exceptionally large or complex.

Where medians or separators are too narrow for signals to be placed on them, signal faces should be located as though the median or separator were non-existent.

The location of signal faces in specific situations should be adapted from the relevant examples given in Figures 4.2 to 4.5. Additional guidance on signal face locations is given in Austroads, Guide to Traffic Engineering Practice, Part 7: Traffic Signals.

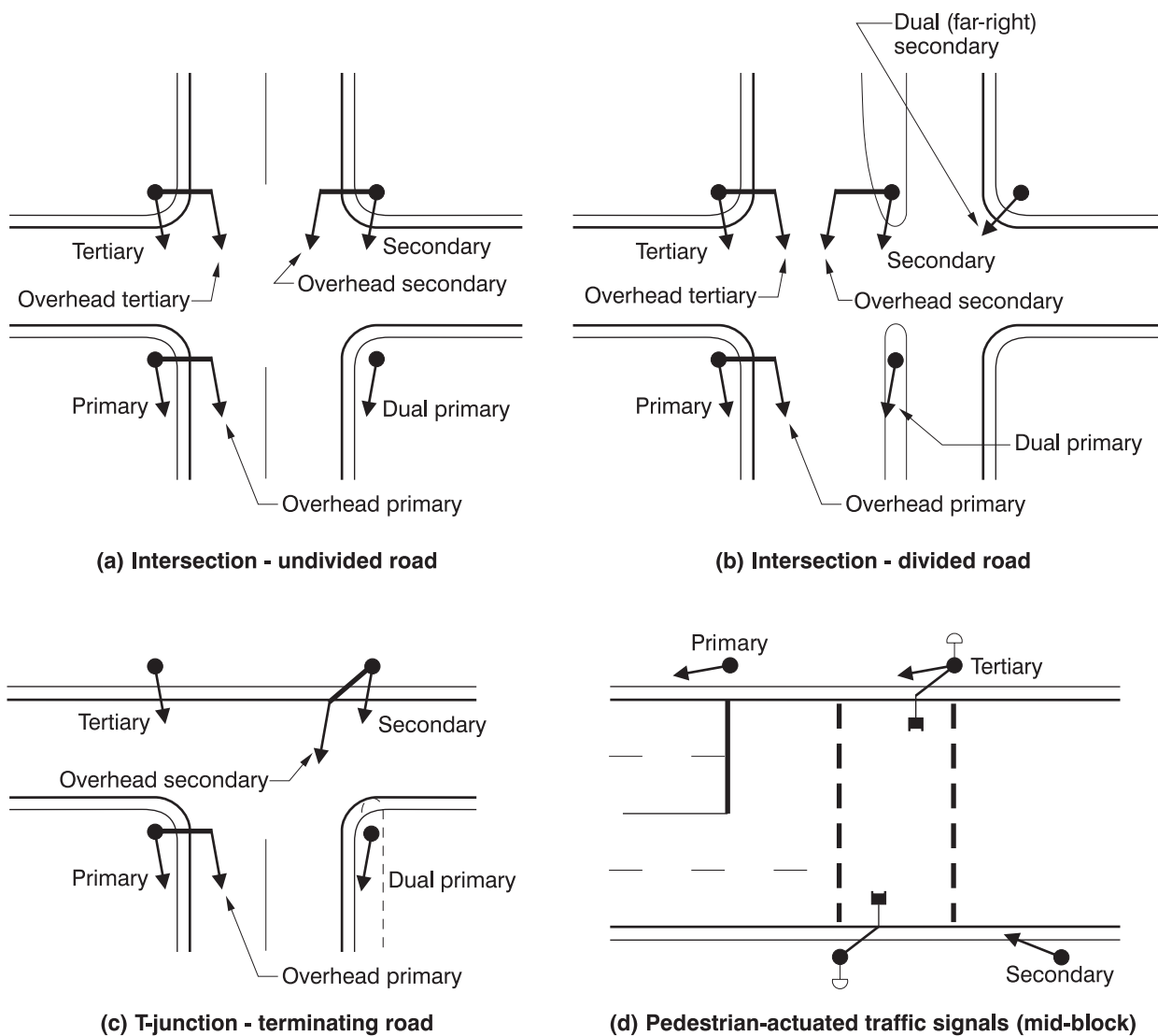


Figure 4.1 DESIGNATION OF SIGNAL FACES

4.2.2 Circle aspects

Signal faces for through movements (including concurrent filtering turning movements) are provided as follows:

- At any intersection* - a minimum of three signal faces shall be provided, e.g. as shown in Figure 4.2(a).
- On a divided road or one-way road approach* - an additional signal face should be provided at the dual primary position as shown in Figure 4.2(c). If the median is too narrow to accommodate a signal post, signal faces should be provided as in Item (c).
- At undivided road approaches with more than three lanes* - at least one overhead signal face should be provided. If an overhead secondary signal face is provided, it should be supplemented with a normal height secondary signal face if needed to assist filtering of right turning traffic (see Figure 4.2(b)).

Consideration should also be given to providing at least one overhead signal face on approaches with three lanes.

4.2.3 Left turn arrow aspects

A minimum of two signal faces for separately controlled left turn movements is provided as follows:

- Where no left turn slip lane is provided* - left turn aspects should be provided on the primary and tertiary signal faces (see Figure 4.3(a)).

- (b) *At a signal-controlled left turn slip lane* - left turn aspects should be provided at the left turn stop line in the primary and dual primary positions with respect to the stop line and in a further tertiary position just beyond the slip lane pedestrian crosswalk, if any, or otherwise not less than 6 m beyond the stop line. Left turn slip lane aspects may be circles rather than arrows if either, they are always operated concurrently with the through movement or are spatially removed from it (see Figure 4.4).

If the left turn is controlled by a red signal, consideration should be given to providing more than one red display visible to drivers stopped at the stop line.

4.2.4 Right turn arrow aspects

A minimum of two signal faces for separately controlled right turn movements is provided as follows:

- (a) *On undivided approaches* - right turn aspects should be shown on the primary signal face, or the overhead primary if there is one, and on the secondary signal face (see Figures 4.3(b) and (c)).

If both the secondary and the overhead secondary are provided, right turn aspects should be placed on both.

- (b) *On divided approaches* - right turn aspects should be provided on the dual primary and secondary signal faces. Where there are two or more lanes turning right, a far right secondary turn aspect may be required (see Figures 4.3(d) and (e)).

If the right turn is controlled by a red display, consideration should be given to providing more than one arrow signal face visible to drivers stopped at the stop line.

4.2.5 U-turn arrow aspects

Signal faces for separately controlled U-turns are provided as follows:

- (a) *U-turn to be made within the intersection* - U-turn aspects should be provided at the same locations recommended for right turn aspects.
- (b) *U-turn to be made at a median opening in advance of the intersection* - a dual primary signal face should be provided at the point where vehicles are required to stop before U-turning.

4.2.6 T-junctions

Signals at T-junctions should be located according to the principles in Clauses 4.2.1 to 4.2.5. Circle aspects should normally be used. Arrow aspects may be used where all traffic turns in one direction only, or if different movements need to be separately controlled for capacity or pedestrian protection.

Typical location of signals at T-junctions is illustrated in Figure 4.5.

4.2.7 Pedestrian aspects

When provided at intersections with vehicular traffic signals, pedestrian signal faces shall be located as follows:

- (a) At each end of the marked pedestrian crosswalk, and located within 1 m of the projection of the crosswalk edge marking and not more than 2 m from the end of the crosswalk, with the lantern aimed at the opposite end of the crosswalk.
- (b) Two at each end of a crosswalk more than 10 m wide.

At an intermediate location on a pedestrian refuge, median or median island where either the crossing distance exceeds 25 m, or the crossing is staged at the intermediate point and each stage is controlled as a separate movement, additional pedestrian lanterns should be placed on the median post.

Each pedestrian signal face should be located, and if necessary screened, to ensure that it is obvious which crossing is controlled by the signal face.

4.2.8 Bicycle aspects

When provided at intersections with vehicular traffic signals, bicycle signal faces shall take one of the following forms:

- (a) *Where bicycles cross with pedestrians* Two-aspect pedestrian signal faces as shown in Table 3.4(a) shall be provided at shared path or normal footpath crossings at the locations specified in Clause 4.2.7. Separate signal faces as shown in Table 3.4(c) are required if the bicycle crossing is separated from the pedestrian crosswalk.

- (b) *Where bicycles move with vehicular traffic* Three-aspect signal faces as shown in Table 3.4(d) shall be mounted in conjunction with vehicular signal faces at the primary and usually, the tertiary signal face positions. Bicycle signal faces should be limited to two per approach and should not be placed on overhead signal faces.
- (c) *Where bicycles use an at-grade exclusive bicycle path intersection with a road* Three-aspect bicycle signal faces as shown in Table 3.4(d) shall be used to control bicycle path approaches.

4.3 SIGNAL FACE LOCATIONS AT MID-BLOCK CROSSINGS

The minimum number of signal faces in any vehicular signal group shall be three.

Primary, secondary and tertiary vehicular signal faces should be provided. If there are more than three lanes on the approach, an overhead primary (and an overhead secondary at the back of the opposite direction overhead primary on undivided roads) should be provided.

Examples of signal faces at mid-block pedestrian signals are shown in Figure 4.6. The examples shown also apply to bicycle path crossings, or joint-use bicycle/pedestrian path crossings.

In the layout shown in Figure 4.6(b), care is needed that the signal posts do not obstruct pedestrians in the median, especially disabled pedestrians. Pedestrian fencing may be provided where the width of the median will allow.

As an alternative to the layouts shown in Figure 4.6(a) and (b), the tertiary signal posts may be located at the crosswalk line nearer to the stop line, provided that the distance from the stop line to the first crosswalk line is 6 m.

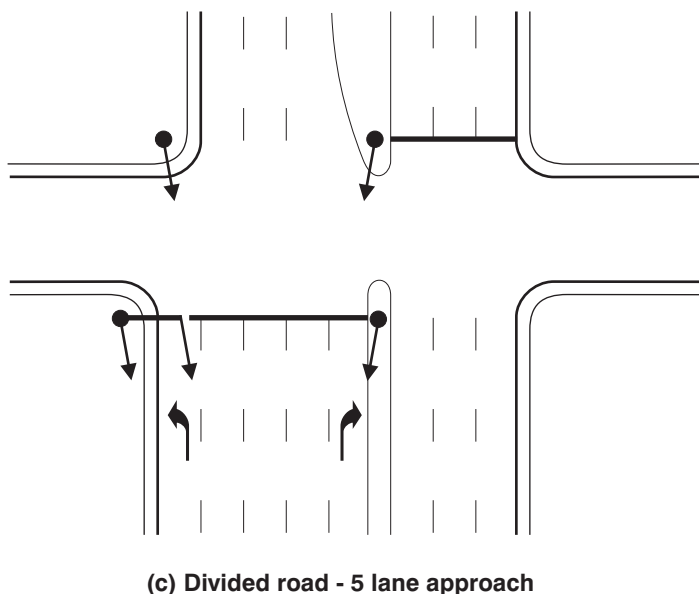
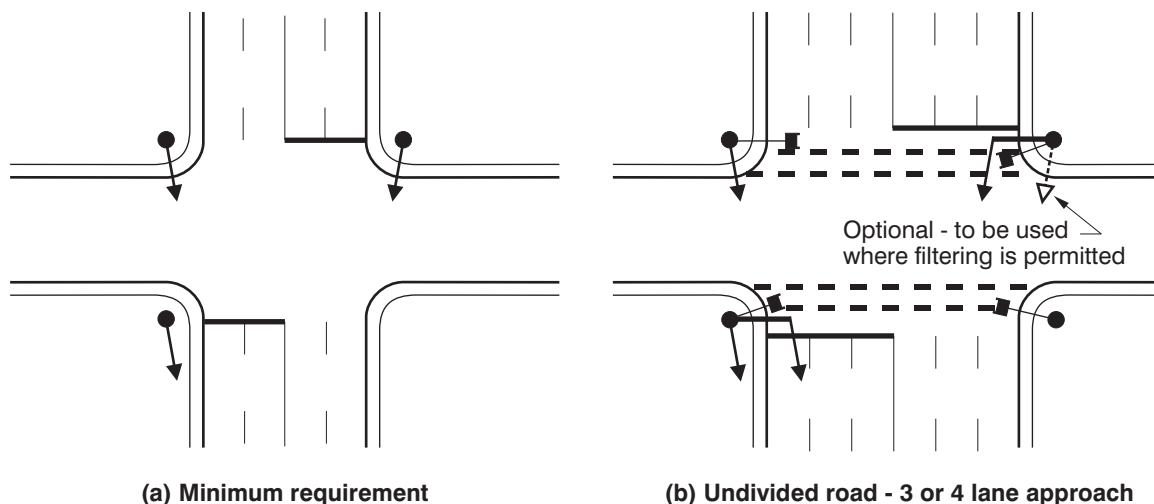
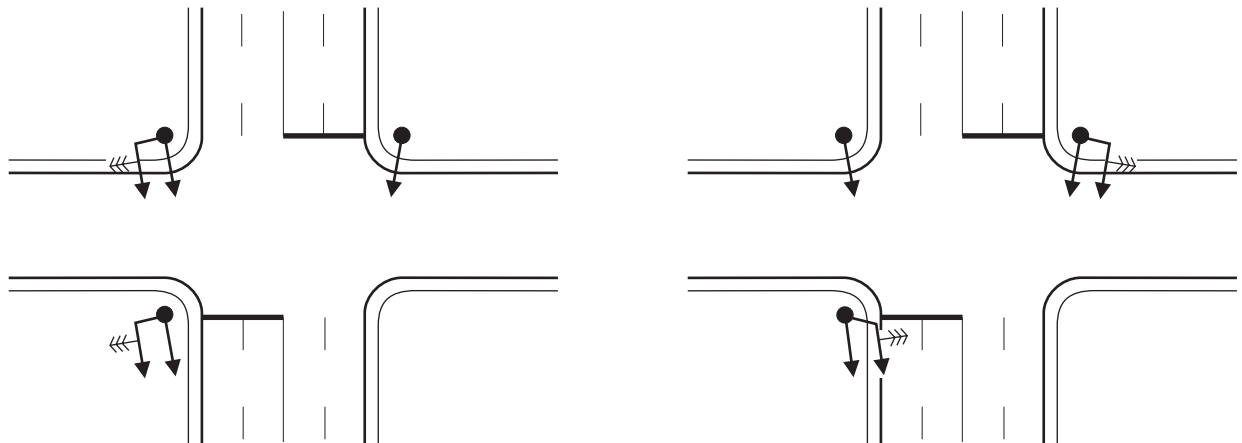
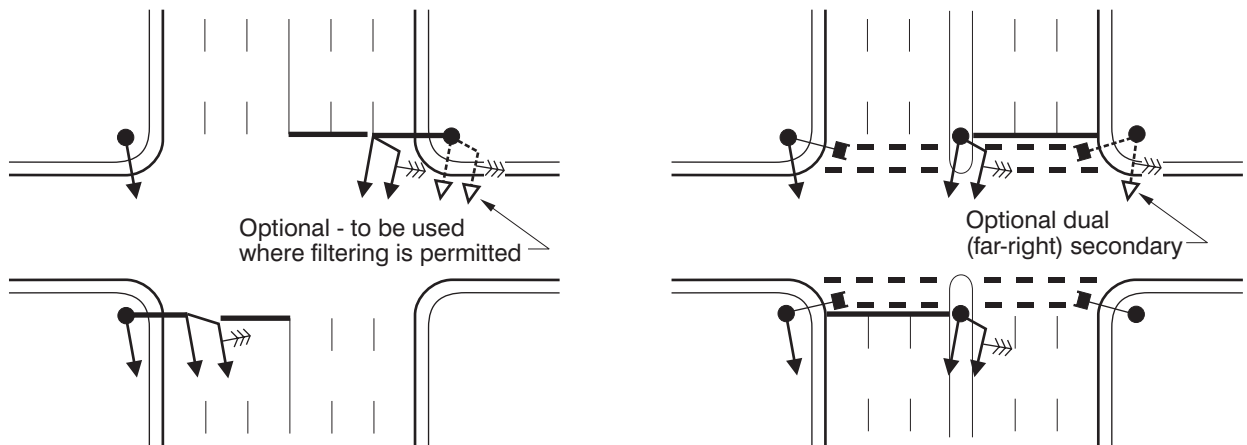


Figure 4.2 INTERSECTION SIGNALS - EXAMPLES OF SIGNAL FACE LOCATIONS FOR CIRCLE DISPLAYS



(a) Minimum requirement - left turns

(b) Minimum requirement - right turns

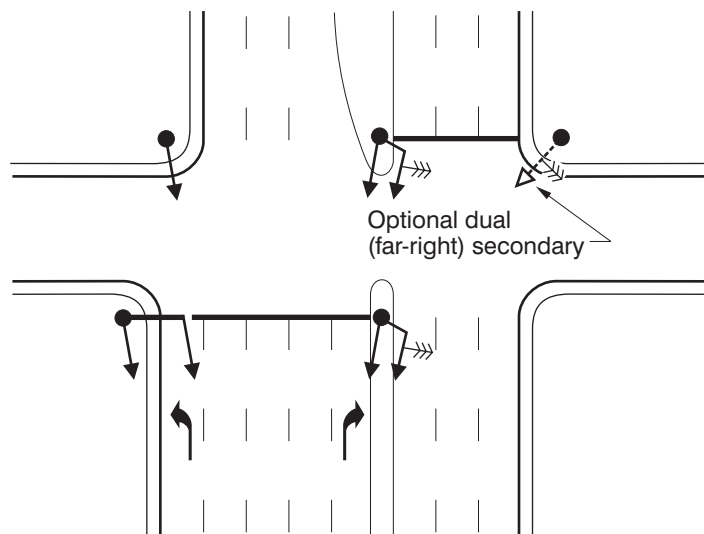


Optional - to be used where filtering is permitted

Optional dual (far-right) secondary

(c) Undivided road - 3 or 4 lanes - right turns

(d) Divided road, 3 lanes - right turns



Optional dual (far-right) secondary

(e) Divided road - 5 or 6 lanes - right turns

NOTE: Three-arrow aspects are shown for clarity.

Figure 4.3 INTERSECTION SIGNALS - EXAMPLES OF SIGNAL FACE LOCATIONS FOR CONTROLLED LEFT OR RIGHT TURNS

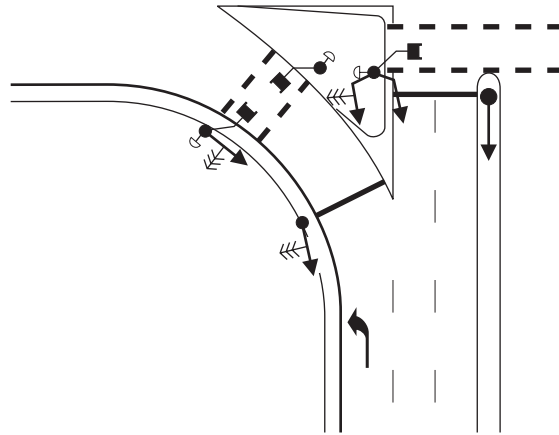


Figure 4.4 INTERSECTION SIGNALS - AN EXAMPLE OF A SIGNAL FACE LOCATION FOR A CONTROLLED SLIP LANE

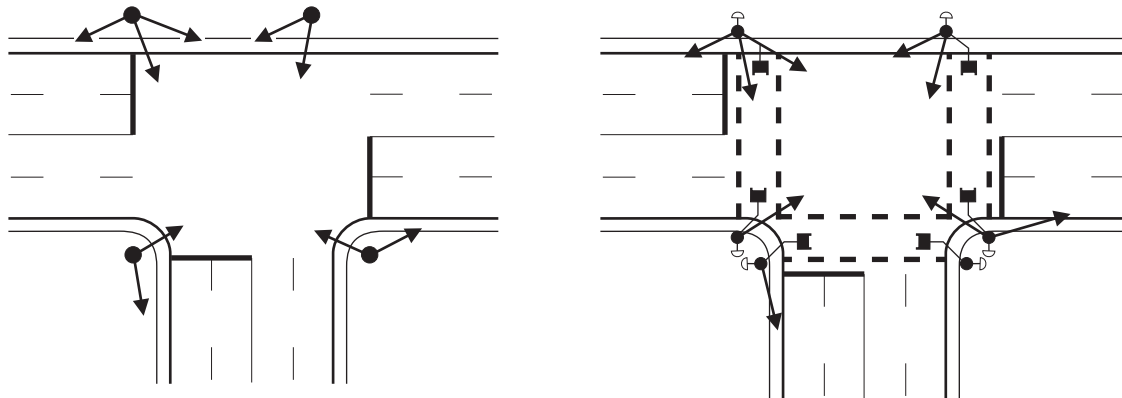


Figure 4.5 INTERSECTION SIGNALS - EXAMPLES OF SIGNAL FACE LOCATIONS FOR T-JUNCTIONS

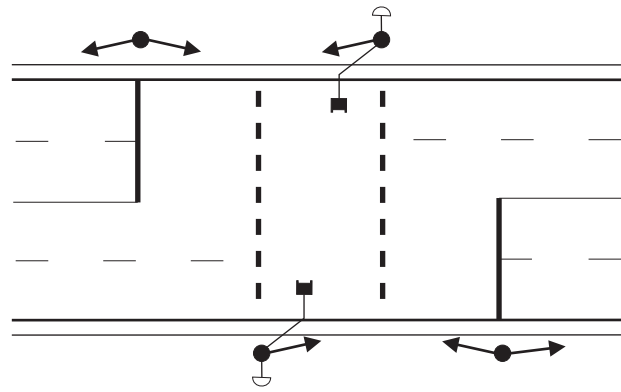
4.4 LOCATION OF OVERHEAD LANE CONTROL SIGNALS

Lane control aspects shall be erected over the centre of each lane at the beginning and end of the lane - controlled section. At intermediate points signals may be provided as required. The LANE UNDER 'X' CLOSED (G9-Q12) should be erected in conjunction with each set of signals (see Clause 6.1(j)).

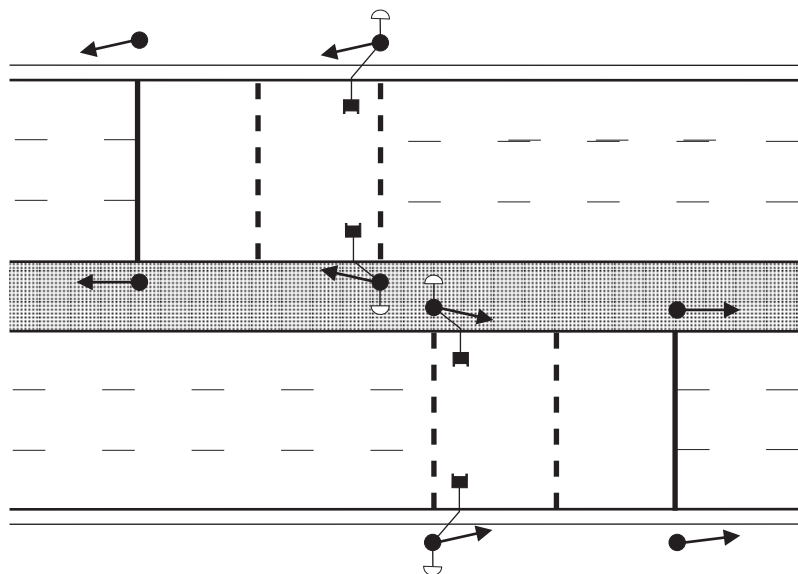
Examples of signal faces on overhead signals for the control of reversible lanes are illustrated in Figure 4.7.

Care is needed in locating lane control signals using green arrows in the vicinity of intersection signals, to ensure that they cannot be confused with intersection signals. This is normally achieved by placing the last set of overhead signals a substantial distance in advance of the intersection signals.

Non-changing aspects may be in the form of the sign alternatives specified in Clause 3.5.

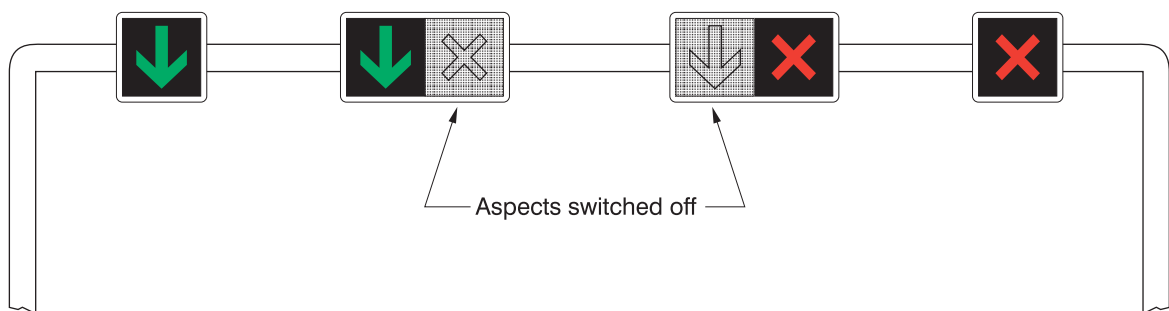


(a) Undivided road



(b) Divided road - two-stage crossing

Figure 4.6 MID-BLOCK PEDESTRIAN SIGNALS - EXAMPLES OF SIGNAL FACE LOCATIONS



NOTE: Illustration shows four lanes, two of which are reversible. The signals are shown in the notional off-peak condition, i.e. two lanes in each direction.

Figure 4.7 OVERHEAD LANE CONTROL SIGNALS - EXAMPLES OF SIGNAL FACE REQUIREMENTS

SECTION 5. DESIGN AND INSTALLATION OF SIGNAL EQUIPMENT

5.1 DESIGN AND SIZE OF ASPECT

The general purpose aspect is not less than 200 mm diameter. Extended range aspects (such as 300 mm diameter) may be justified where –

- (a) the 85th percentile approach speed exceeds 60 km/h or where an aspect is required to provide a greater advance warning than the normal 150 m from the stop line.
- (b) background interference is high;
- (c) the signals may not be expected, e.g. at the end of a freeway;
- (d) the approach is a multi-lane carriageway;
- (e) the signal is mounted overhead;
- (f) there are additional lane control devices; or
- (g) where an arrow signal is required to provide a greater advance warning than normal.

Further design details of signal aspects, including the shapes of symbols, are given in AS 2144.

5.2 LANTERN MOUNTING HEIGHT

The mounting height from pavement level to the top of the lantern assembly should generally be not more than 3 m for pedestrian lanterns or 4 m for vehicle lanterns. When secondary or tertiary signals are less than 20 m beyond the stop line, consideration may be given to lowering the mounting height to 3.2 m. The bottom of the target board on both vehicle and pedestrian lanterns should be a minimum of 2.0 m above footpath level to allow overhead clearance for pedestrians and to minimize interference with the signal.

Where a driver's view of the lantern is blocked by awnings, signs or other obstructions, its position shall be adjusted to avoid the obstruction.

The mounting height for overhead lanterns should ensure that the bottom of the target board is a minimum of 5.4 m above the road surface or an extra 0.1 m over the required road clearance where this is greater than 5.3 m to allow for the mast arm swaying in a strong wind. Greater clearances may be required on over-dimensional load routes.

5.3 TARGET BOARDS

Unless physical restrictions prevent their use, target boards designed in accordance with AS 2144 shall be provided for vehicle lanterns to improve conspicuity against distracting backgrounds. Target boards should have a minimum horizontal clearance of 300 mm to the nearest edge of the roadway.

5.4 AIMING AND SHIELDING OF LANTERNS

A traffic signal lantern is an assembly of optical components and should be properly aligned relative to its function. It is essential that lantern displays cannot be mistaken as applying to drivers on approaches other than those the displays are meant to control. Where lanes are separately controlled, it may also be desirable to minimize the visibility of lanterns to drivers in adjoining lanes.

These requirements are achieved by appropriate aiming of the lanterns or using visors and louvres, see Clause 5.5.

Visors and louvres should also be used to shield traffic signal lanterns from railway lines so that the lanterns do not confuse train drivers. If adequate shielding cannot be provided, a special screen may need to be constructed adjacent to the railway line.

The aiming of pedestrian lanterns is also important, particularly at staged crossings.

5.5 VISORS AND LOUVRES

5.5.1 Visors

Visors as specified in AS 2144 are used to shield each lantern display from incident light and to restrict, where necessary, the angular coverage of the lantern display. Visors are classified, described and used as follows:

- (a) *Type A visor* - the Type A or 'open' visor is used on all lanterns where no restriction of angular coverage is required. It shields the lantern from incident light only.

- (b) *Type B visor* - the Type B or 'closed' visor is generally restricted to use on secondary and tertiary signals. It comprises a closed tube approximately equal in length to the diameter of the signal aspect and is designed to restrict the effective angular coverage of the lantern display. Extended length versions are used, where necessary, to further restrict the angular coverage of the beam.
- (c) *Type C visor* - the Type C or 'cut-away' visor is a closed visor with either the left or right side cut away. Its normal use is on primary signals to prevent display of the signal to drivers to whom it does not apply.

NOTE: Careful consideration should be given to the need for use of the Type C visor. It is recommended that it should not be used unless steps can be taken to ensure that reflections from its inner surface do not appear to give signals to the wrong drivers.

5.5.2 Louvres

Louvres as specified in AS 2144 are used where necessary to either restrict the angular coverage of the lantern display or to control very strong incident light.

They are effective even at small angles from the direction the lantern is facing, so their use should be restricted to situations where these limitations are needed. Louvres can also produce strong reflected images of the signal under low ambient light conditions.

Horizontal louvres may be used to restrict the vertical coverage of a lantern (i.e. its vertical cut-off), to control very strong incident light or to minimize sun-phantom effects brought about by the reflection of sunlight or skylight on the optical surfaces of the lantern at certain times of the year.

Vertical louvres may be used where the required horizontal cut-off cannot be achieved by visors alone. This typically occurs at acute-angled intersections or where it is required to restrict visibility of the lantern to particular lanes.

Care should be taken to ensure that the display at one traffic signal site does not confuse drivers at another closely spaced site. If this occurs, it is generally sufficient to insert horizontal louvres in only the green aspects of the distant signal group.

The use of louvres with symbolic aspects including arrows and letters, should be avoided as far as practicable, as louvres can partially obscure the symbols and so affect their legibility.

5.6 PEDESTRIAN PUSH BUTTONS

Where provided, pedestrian push buttons should be located and oriented as follows:

- (a) At each end of the crosswalk and at each pedestrian refuge. Consideration should be given to provision of a button on any median island signal post (see Clause 4.2.7).
- (b) Not more than 1 m outside the projection of the crosswalk nor more than 2 m back from the kerbline at the crosswalk, and at a height of 1 m \pm 0.1 m from the ground.
- (c) Oriented at the kerbside so that it is parallel to the crosswalk and facing towards pedestrians about to use the crosswalk.
- (d) Oriented at an intermediate point so that its face is parallel to the direction of the crosswalk.

Push buttons should have an arrow legend on the face of the button indicating the direction or directions to which it applies. Consideration should be given to providing call-record indicator lights.

A special push-button post should be provided if no traffic signal post is located in a suitable position.

Where audio-tactile push buttons are used, adjacent buttons shall not be closer than 2 m to one another.

NOTE: Vision impaired pedestrians often need assistance in determining to which side of the push button post they should walk to cross the road. This will be provided if there are suitably located kerb ramps, as these are also a useful tactile indication to the people with sight impairment. In the absence of such ramps, other clues such as tactile pavement surface indicators may need to be considered.

Additional overhead detectors (usually infrared or microwave) may be used to detect the presence of pedestrians on the crossing and to modify the duration of the walk and pedestrian clearance intervals e.g. Puffin crossings. Other footpath or overhead detectors may be used to determine the pedestrian demand and increase the duration of the walk interval.

NOTE: A 'Puffin' signalised pedestrian crossing is a Pedestrian User Friendly Intelligent crossing.

SECTION 6. SIGNS, PAVEMENT MARKINGS AND GEOMETRIC REQUIREMENTS

6.1 SIGNS

The following signs listed in Table 6.1 are used in conjunction with traffic signals.

Table 6.1 TRAFFIC SIGNS USED AT SIGNALIZED INTERSECTIONS - SIZE TABLE

Sign	Sign Number	Size mm
No Left (Right) Turn (Note 1)	R2-6B (L or R)	600 x 600
	R2-6C (L or R)	750 x 750
	R2-6D (L or R)	900 x 900
No Turns	R2-7A	450 x 600
	R2-7B	600 x 800
GIVE WAY TO PEDESTRIANS	R2-10	600 x 600
U-TURN PERMITTED	R2-15A R2-15B	450 x 600 600 x 800
TURN LEFT AT ANY TIME WITH CARE	R2-16	750 x 600
Pedestrians may cross diagonally (Scramble crossing)	R3-5 (L or R)	90 x 110
STOP HERE ON RED SIGNAL	R6-6A	450 x 750
	R6-6B	675 x 1125
STOP HERE ON RED ARROW	R6-14A	450 x 750
	R6-14B	675 x 1125
Times of operation supplementary plates (Note 2)	R9-1-1B	600 x 400
	R9-1-1C	900 x 600
	R9-1-1D	1200 x 800
	R9-1-2B	600 x 600
	R9-1-2C	900 x 900
	R9-1-2D	1200 x 1200
Signals Ahead	W3-3A	600 x 600
	W3-3B	750 x 750
	W3-3C	900 x 900
PREPARE TO STOP (Note 3)	W8-27B	750 x 375
	W8-27C	900 x 450
	W8-27D	1200 x 600
CROSS WITH CARE	G9-Q10	90 x 300
LANE UNDER 'X' CLOSED	G9-Q12	900 x 1500

NOTES:

1. No 'A' size is shown for these signs. An 'A' size, 450 x 450 mm, may be required for special purposes such as severely limited lateral space, but is not recommended for general use.
2. Supplementary plate width to match that of R2-6 signs etc.
3. No 'A' size in W8-27 is used.

(a) *No left turn, No right turn, No turns (R2-6(L), R2-6(R) and R2-7)*

R2-6(L)



R2-6(R)



R2-7

The No Right Turn or No Left Turn signs (R2-6) shall be used at intersections where vehicles are forbidden to make a turn to the right or left, respectively.

The No Turns sign (R2-7) shall be used at intersections where vehicles are forbidden to make turns of any description.

Part time turn restrictions should be indicated either by a fixed sign as above, with a Times-of-operation supplementary plate (R9-1-1 or R9-1-2) mounted below it, or a hidden message sign, internally illuminated or illuminated by other optical or electronic means, which is displayed only during the times of operation.

A minimum of two signs shall be displayed for each direction of travel to which the restriction applies. They should be mounted along with signal faces on the same posts that would have been used if signal aspects controlling the banned turn had been installed.

(b) *U-turn permitted (R2-15)*

R2-15

U-turns are generally prohibited by legislation at signalized intersections. Therefore, the No U-turn sign (R2-5) shall not be used at signalized intersections (see Part 2 of this Manual). Where it is considered desirable and safe to relax this general rule, the U-TURN PERMITTED sign shall be used. The sign should generally be used only on intersection approaches with medians and preferably with right turn auxiliary lanes. U-turns should only be permitted where –

- (i) geometry is sufficient to allow the U-turn to be made in one manoeuvre by vehicles of the type likely to U-turn;
- (ii) there is adequate visibility of approaching vehicles; and
- (iii) there would be no danger to pedestrians.

Where a fully controlled right turn phase is provided item (ii) may not be relevant.

(c) *Give way to pedestrians (R2-10)*

R2-10

The GIVE WAY TO PEDESTRIANS sign shall be used only at signalized intersections where there is a need to remind drivers of right or left-turning vehicles that, although they are still under the control of the intersection signals, they must give way to pedestrians.

The sign may be required at or before a marked pedestrian crosswalk which is outside the intersection area where the presence of pedestrians may not be apparent to drivers of filtering vehicles. This situation occurs at staggered intersections and at pedestrian crosswalks not parallel to the road from which vehicles turn to cross them.

The sign shall not be used except in these special circumstances because indiscriminate use would reduce the effectiveness of the general regulation applying to signalized intersections.

Where the sign is internally illuminated, the legend shall be white on black background.

(d) Turn left at any time with care (R2-16)



R2-16

The sign TURN LEFT AT ANY TIME WITH CARE shall only be used at an intersection controlled by traffic signals where a slip lane is provided for the left turn movement of traffic not required to comply with the traffic signals. It shall be located in such a position that it clearly applies to the slip lane.

(e) Stop here on red signal (arrow) (R6-6 and R6-14)



R6-6



R6-14

The STOP HERE ON RED SIGNAL and STOP HERE ON RED ARROW signs may be used where vehicles are required to stop at traffic signals at a point at which drivers would normally not expect to have to stop, e.g. within a wide median. These signs are not intended for routine use at signalized intersections. The STOP HERE ON RED SIGNAL sign shall be provided on the primary signal post(s) at mid-block emergency service facilities and at roundabout metering signals (see Clause 7.6).

(f) Pedestrians may cross diagonally (R3-5)



R3-5 (R)

The Pedestrians may cross diagonally (or scramble crossing) sign R3-5 shall be used at a signalised intersection where an exclusive pedestrian phase is provided, to allow pedestrians to make diagonal crossings. It shall be placed on or near each signal pedestal on which there is a pedestrian push-button.

This type of pedestrian facility is normally applicable only at central city locations.

(g) Times of operation supplementary plates (R9-1)



R9-1-1



R9-1-2

A times of operation supplementary plate may be used in conjunction with signs R2-5, R2-6 and R2-7 where indicated in Clause 6.1(a).

The supplementary plate should be mounted below the sign and match it in width.

(h) Signals ahead (W3-3), Prepare to stop (W8-27)



W3-3

The Signals Ahead sign shall be used only in advance of a signal installation where -

- (i) visibility is restricted, i.e. where the sight distance requirements of Clause 6.4 cannot be met;
- (ii) high speeds require advance warning; or
- (iii) signal installations are unexpected.

Signs in the intersection and junction series W2 should not be used on the approach to traffic signals unless the Signals Ahead sign is also used.



W8-27

The PREPARE TO STOP supplementary plate shall be used with the Signals Ahead sign only when either the signals or the end of a stationary queue of vehicles at a stop signal may not be visible in time for an approaching driver to stop, or where the signals are located in a place where signals would not usually be expected, e.g. on a high speed rural road and the Signals Ahead sign alone has not been shown or is not likely to be shown to be adequate. The two signs may be incorporated into the advance warning signal whose design and use is given in Clause 7.4.

(i) *Cross with care (G9-Q10)*



G9-Q10

The CROSS WITH CARE (G9-Q10) adhesive label is positioned facing the standing pedestrian waiting to cross at the signals, 50 mm above the top level of the pedestrian push-button.

(j) *Lane under 'X' closed (G9-Q12)*



G9-Q12

The LANE UNDER 'X' CLOSED (G9-Q12) sign should be erected in conjunction with each set of overhead lane control signals (see Clause 4.4).

6.2 PAVEMENT MARKINGS

6.2.1 Stop lines

Stop lines at intersections and mid-block crossings should be located-

- so as to minimize inter-green times and clearance times;
- no less than 3 m from conflicting vehicle movements (or 4.4 m if a future pedestrian crosswalk is anticipated);
- adjacent to or not more than 3 m in advance of a primary signal post;
- clear of the swept path of vehicles (especially articulated vehicles) turning from other approaches;
- 1.0 m min. from parallel pedestrian crosswalks at intersections (measured from the outside edge of the crosswalk to the outside edge of the stop line);
- 3.0 m minimum (6.0 m maximum) from signalized mid-block crossings (measured from the outside edge of the crosswalk to the outside edge of the stop line);

- (g) at a minimum of 6 m (desirable 10 m) in advance of the secondary or tertiary signal face for that approach; and
- (h) at an angle of between 70 and 110 degrees to the direction of travel. The stop line may be stepped where it would be positioned at an angle of 30 degrees or greater from the right angle position to the direction of travel.

The width of a stop line shall be 300 mm.

6.2.2 Pedestrian crosswalks

Pedestrian crosswalks should be located-

- (a) as near as possible to the desire line of pedestrians; and, desirably so that drivers intending to turn are able to see the pedestrians; and
- (b) as near as possible and no greater than 20 degrees to the shortest path across the roadway to minimize clearance times, but as close as possible to parallel vehicle movements with at least 0.6 m clearance.

Where two crosswalks meet, the intersection point should be no more than 1 m from the face of the kerb. This is to minimize conflicts by pedestrians in separate phases and to deter pedestrians from waiting on the road pavement.

The minimum width of a crosswalk shall be 2 m clear distance between crosswalk lines. Where large flows of pedestrians use the crosswalk (more than two ranks per cycle in either direction during peak periods) or large numbers of pedestrians arrive in groups (e.g. near railway stations or schools), wider crossings, up to 10 m may be used.

The crosswalk lines are 150 mm wide, and broken with 1 m line segments and 300 mm gaps. Crosswalk lines are also used to define bicycle path and joint-use bicycle/pedestrian path crossings at midblock and intersection signals.

Where an exclusive pedestrian phase is provided at an intersection to allow pedestrians to make diagonal crossings (scramble crossing), the crosswalk lines closest to the centre of the intersection are omitted to allow for diagonal movement. In this case, the Pedestrians may cross diagonally sign (R3-5) shall be erected (see Clause 6.1(f)).

6.2.3 Intersection arrows

Intersection pavement arrows give a positive indication of the direction of travel permitted from the marked lanes at intersections. The choice of, and need for, intersection pavement arrow markings shall be determined as set out in Part 2 of this Manual.

6.2.4 Turn lines

Turn lines may be used within major or complex intersections to indicate the proper course to be followed by turning vehicles. They should be used within an intersection to assist separation of traffic in the case of multiple turning lanes for the one turn. They are not required when the path to be followed is obvious to drivers under all conditions (see also Clause 6.3). Turn lines should not be carried through crossings.

Turn lines comprise a broken line 80 or 100 mm wide, with 600 mm stripes and 600 mm gaps.

6.3 DIAMOND TURNS

Where a signal phasing arrangement is to permit simultaneous right turns from opposing directions, the clearance between the swept paths of the two opposing turns shall be not less than 1.0 m.

Turn lines, if provided (see Clause 6.2.4), shall start in prolongation of the separation line (undivided approach) or the left edge of the median (divided approach) and finish in a corresponding position in the road being entered. The radius of the turn line should be as large as possible and not less than 7 m.

6.4 SIGHT DISTANCE

Sight distance available along the road on approach to traffic signals and to the rear end of a stationary queue waiting at a stop signal should be stopping sight distance (SSD) as set out in Table 6.2.

Table 6.2 STOPPING SIGHT DISTANCE ON LEVEL SEALED PAVEMENTS

V₈₅, km/h	Stopping sight distance, m
31-40	35
41-50	45
51-60	65
61-70	85
71-80	115
81-90	140

NOTE: This Table has been adapted from Rural Road Design, Austroads, 1989. Values given for the speed ranges 70 km/h and below are based on a reaction time of 2.0 sec. and those above 70 km/h, 2.5 sec.

If sight distance to the rear end of a stored vehicle or stationary queue is insufficient, the probability of a rear end collision is high. Where the queued vehicle is a through vehicle, the only solution to avoiding a potential collision may be regrading. Where the queued vehicle is waiting to make a turn, possible solutions include provision of an exclusive turn lane, banning the turn, splitting the approach phasing or regrading.

Where the road alignment does not provide sufficient sight distance and the existing geometry cannot be adjusted, consideration should be given to the provision of advance warning signs (see Clause 6.1(h)) or, where necessary, advance warning signals (see Clause 7.4).

To give drivers sufficient time to sight a display and react to it, they should have at least one signal face visible for a period of 10 seconds at all points on the approach to the intersection. The required distance should be determined from the 85th percentile approach speed. Where visibility distance to primary lanterns is insufficient, consideration should be given to the provision of overhead primary, or dual primary lanterns (see Clause 4.1.4). Where sufficient visibility distance to the signals cannot be provided, advance warning signals may be considered.

SECTION 7. SPECIAL SITUATIONS

7.1 EMERGENCY SERVICE FACILITIES

7.1.1 Facilities close to a signalized intersection

When traffic signals are close to a fire or ambulance station, special precautions may need to be taken 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:

- (a) Relocating the stop line further from the intersection.
- (b) Adding a special emergency service phase to the intersection signals.

Relocating the stop line may 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 (e.g. STOP HERE ON RED SIGNAL (R6-6)) may be necessary.

It may also be appropriate to provide warning signs and pavement marking to warn drivers not to queue across the driveway.

An emergency service phase may be provided if there is likely to be -

- (i) conflict between emergency service vehicles and other traffic;
- (ii) possibility of queued vehicles blocking the exit from the emergency service facility; or
- (iii) delays to emergency service vehicles if the emergency service phase is not provided.

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.

7.1.2 Signals for mid-block access points

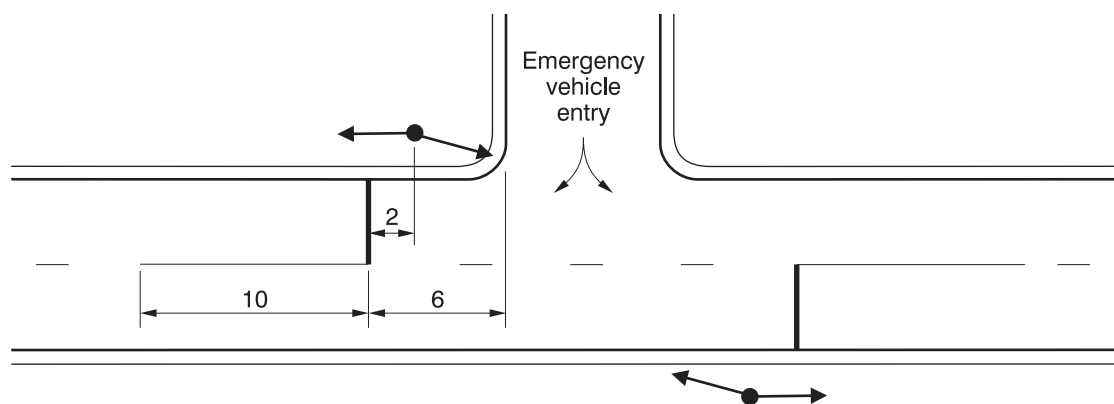
Signals for mid-block access points to or from emergency service facilities comprise signal faces provided in accordance with Figure 7.1 in the following form:

Non-flashing signals Two-aspect signal faces; the display sequence shall be off-yellow-red-off. The sign STOP HERE ON RED SIGNAL (R6-6) shall be provided on the primary signal post(s) (see Clause 6.1(e)).

NOTE: Flashing signals comprising a steady yellow signal surmounted by twin alternate flashing red signals are NOT USED IN QUEENSLAND.

Signals shall be visible to all pedestrians and other road users on the approaches.

Activation of the signals is initiated manually within the facility and automatically displays the yellow signal for 4 to 5 s followed by the red signal, which then continues to operate until switched off.



Typical signal location

DIMENSIONS IN METRES

Figure 7.1 TYPICAL MID-BLOCK SIGNALS FOR EMERGENCY SERVICE FACILITIES

7.2 SIGNALS ADJACENT TO A RAILWAY LEVEL CROSSING

If a traffic signal installation is located close to a railway level crossing, special provision shall 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.

Consideration should be given to providing a queue clearing phase or any other special phase that would avoid queue formation across the crossing before the arrival of the train. This will require traffic signal linking with the railway level crossing to enable the special phase to be initiated at a predetermined time before the train is due at the crossing. The railway signal input should also indicate when the train has cleared the crossing. Once the queue-clearing phase has terminated, no phases or turning movements which would have traffic 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 level crossing is closed.

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

Consideration should also be given to the effects that the normal operation of the railway level crossing may have on the operations of the traffic signals e.g. vehicles at the railway level crossing queuing through the signals, thus affecting the flow of traffic not using the crossing.

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

7.3 SINGLE LANE OPERATION

7.3.1 General

Single lane operation by means of traffic signals may be applied in the following cases:

- (a) As a permanent arrangement at a single lane bridge or other roadway constriction which is too narrow for two-way traffic and where the combination of length, traffic volume and inter-visibility between approaches makes it impracticable to operate on an uncontrolled or passively controlled 'give-and-take' basis.
- (b) As a temporary arrangement at roadworks or bridgeworks where the conditions in Item (a) apply. Control may be either by portable traffic signals or temporary fixed traffic signals.

Single lane operation entails arranging the signal phasing to allow alternate directional movement through the single lane, with an all-red clearance phase separating each change of direction. Signal faces each comprise a single column with three circle aspects.

7.3.2 Permanent or temporary fixed traffic signals

The minimum requirement for signal faces on each approach shall be a primary signal at the stop line or stopping position and a secondary signal on the right hand side of the roadway, 6 to 10 m beyond the primary. An optional tertiary signal should be provided on rural approaches especially where signals may be unexpected. Figure 7.2 shows the location of signals together with recommended signs and pavement marking.

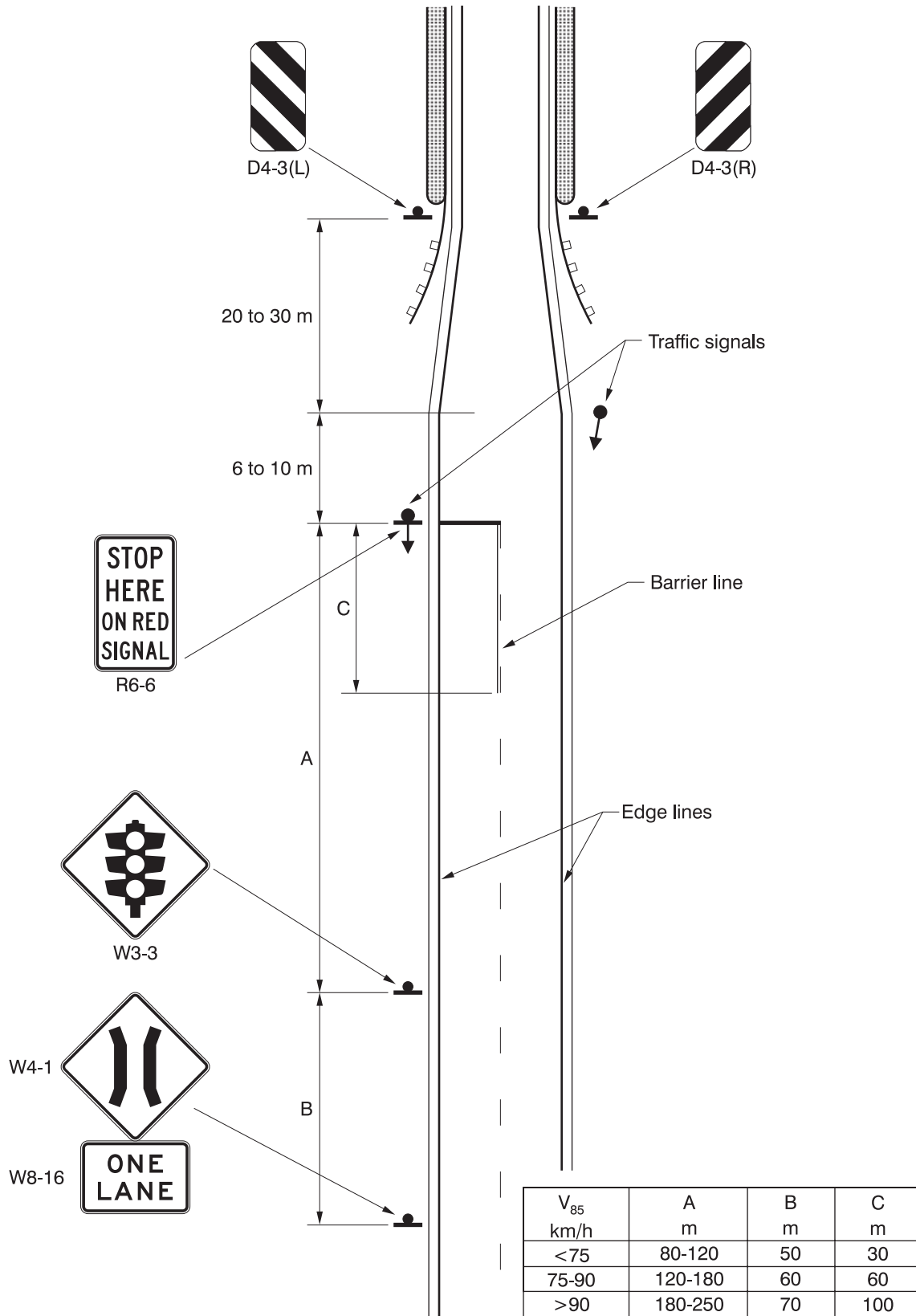
7.3.3 Portable traffic signals

A set of portable traffic signals usually comprises two trailer-mounted signal lanterns with ancillary interconnecting and operating equipment, and power supply. They are normally used with a single primary lantern located at the stop line or stopping position on each approach. Requirements for the design, construction and performance of portable traffic signal systems are specified in AS 4191.

Portable signals are intended only for traffic control applications of a relatively short duration. For sites where work will continue for a longer period without the location of the work site changing, consideration should be given to the installation of temporary fixed, rather than portable, traffic signals (see Clause 7.3.2).

Portable traffic signals are intended to be applied primarily to single lane control, i.e. where a portion of the roadway is closed so that a single lane has to be used alternately by traffic from opposite directions.

Application of portable traffic signals is described in Part 3 of this Manual.



NOTE: R6-6 is required if the position at which a vehicle must stop is not readily apparent.

Figure 7.2 PERMANENT TRAFFIC SIGNALS AT A ONE-LANE BRIDGE

7.4 ADVANCE WARNING TRAFFIC SIGNAL SIGN ASSEMBLIES

7.4.1 General

Where a requirement exists for advance warning signals as indicated in Clause 6.4, the signals should take a form similar to that described below. Examples of signal/sign assemblies are shown in Figure 7.3. The assemblies may also be used where signals are at an unexpected location on a high speed road, e.g. at a rural roadworks site.

7.4.2 Design and operation

Each assembly should be based on use of at least the 'C' size (900 × 900 mm) Signals Ahead warning sign, (W3-3), and the PREPARE TO STOP supplementary plate (W8-27) (see Clause 6.1(h)). The PREPARE TO STOP plate may be mounted below or to the side of the Signals Ahead sign, either independently or on a common yellow rectangular target board.

The lights should comprise a pair of alternately flashing yellow lights, each similar in design and performance to a yellow traffic signal aspect and may be connected to the traffic signal controller so that they flash either continuously or for an appropriate duration within the traffic signal controller sequence to provide the necessary warning for approaching drivers, having regard to the likely length of queues or the presence of a red signal.

7.4.3 Location and installation

The sign assembly is generally erected on the left hand side of the roadway, but may be erected on the right hand side if it would not be seen on the left, e.g. because of horizontal left hand curvature restricting sight distance. It may be mounted overhead, if necessary, to improve sight distance, or if a suitable structure exists at an appropriate location. In the latter case, the horizontal format of the assembly as shown in Figure 7.3(c), should be used.

A recommended method of determining the longitudinal positioning of the assembly is given in Appendix A.

7.5 RAMP METERING SIGNALS

Traffic signals provided for ramp metering purposes, e.g. on freeway entrance ramps, shall comprise two aspects, red and green (see Clause 3.7), whose purpose is to permit vehicles to proceed along the ramp to join the freeway at a predetermined rate, depending on the capacity of the freeway to absorb the entering stream. The sequence of display of aspects shall be as specified in Clause 3.8.1(b). Green periods are timed to release only one vehicle per lane, per phase.

A typical signal layout is illustrated in Figure 7.4. A minimum of two signal faces shall be provided and the distance from the associated stop line to the entrance ramp nose shall be sufficient to allow a vehicle stopped at the signals to accelerate to freeway speed before merging with the freeway stream. Adequate provision for queuing at the signals should also be made, including provision for possible queuing back beyond the ramp/approach road intersection.

Signs used in advance of, and at, ramp metering installations i.e. FREEWAY ENTRY RESTRICTED WHEN FLASHING (GE9-Q02), ONE VEHICLE ONLY ON GREEN SIGNAL (GE9-Q03), ONE VEHICLE PER LANE ON GREEN SIGNAL (GE9-Q04) and Signals Ahead (ramp metering) (W3-Q01) are prescribed in Part 8 of this Manual.

Ramp metering may also be applied to like situations on ramps leading onto roads other than freeways.

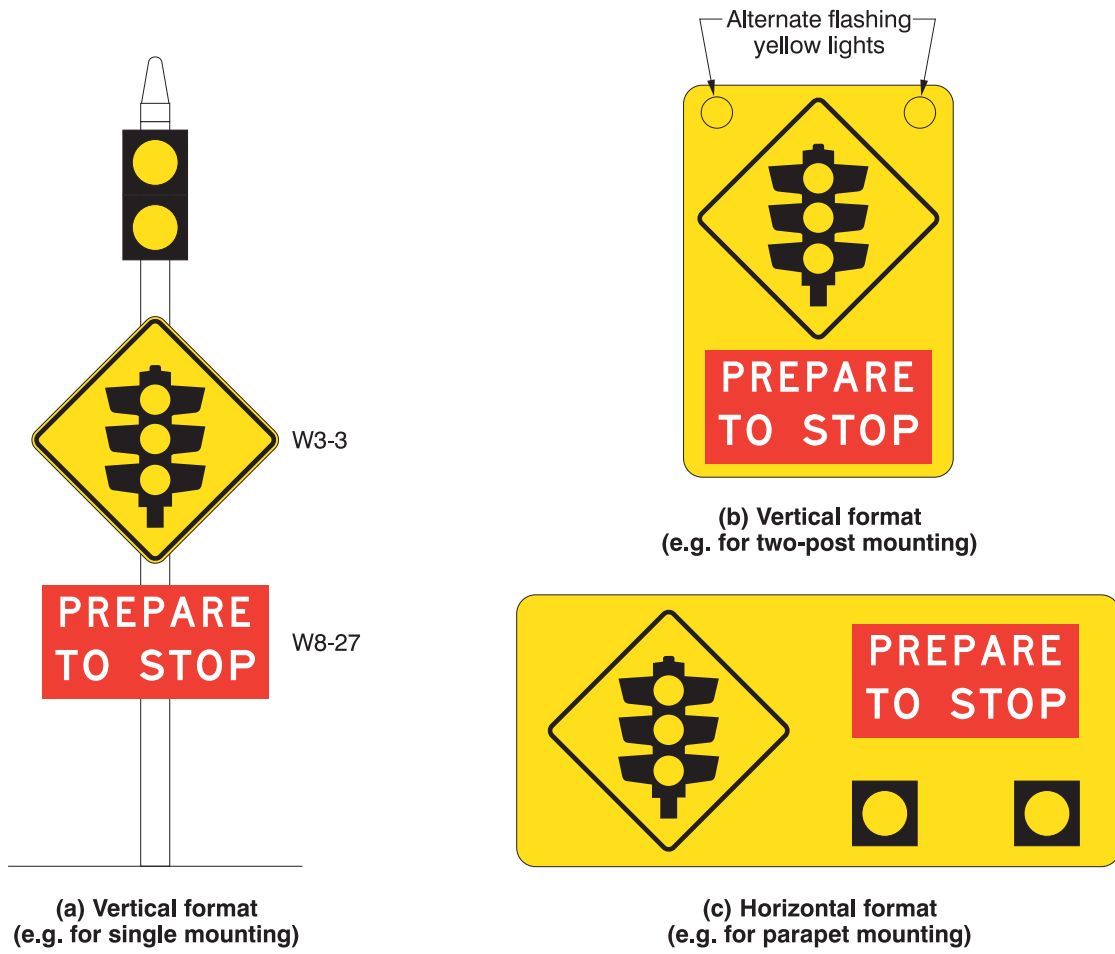


Figure 7.3 ADVANCE WARNING SIGNAL - TYPICAL LAYOUTS

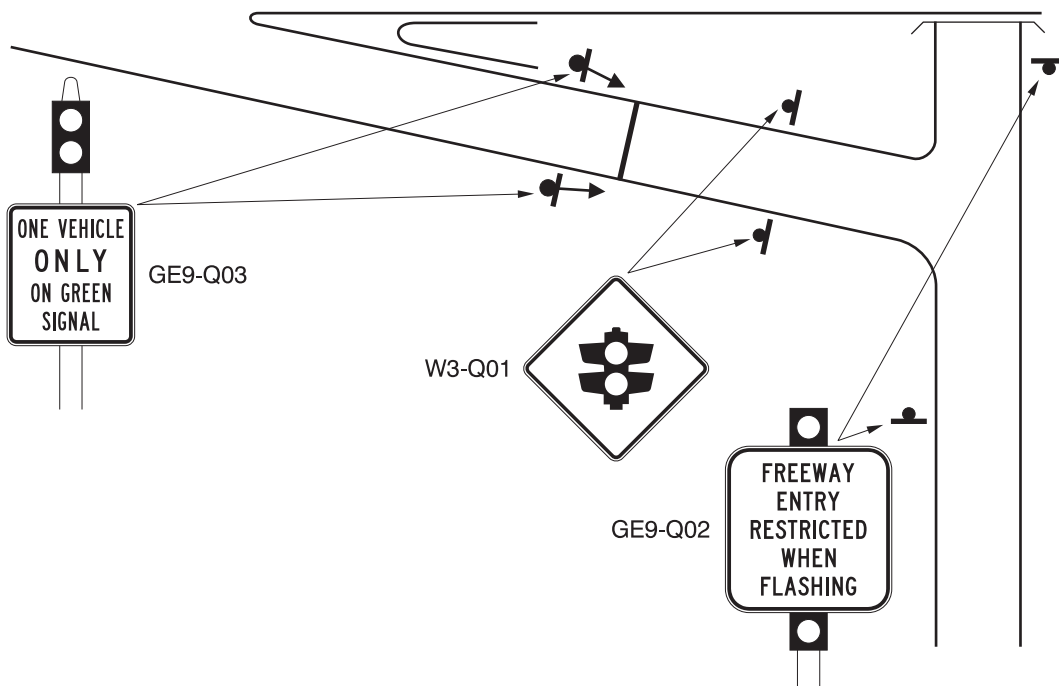


Figure 7.4 FREEWAY RAMP METERING SIGNALS

7.6 ROUNDABOUT METERING SIGNALS

Traffic signals provided for roundabout metering shall comprise two aspects, yellow and red (see Clause 3.7). Their purpose is to periodically stop vehicles on a roundabout approach when vehicle flow on the approach causes excessive delay to vehicles on another approach.

Where more than one approach is metered, signal groups shall operate independently.

The sequence of aspect display shall be as specified in Clause 3.8.1(b). Red displays should be timed to the minimum required to reduce delays for vehicles entering from another approach. When metering is not required neither aspect shall be displayed.

A minimum of one signal face shall be located adjacent to the stop line to the left of the approach. Stop lines shall be located not less than 3 m in advance of the approach holding line but preferably, should be positioned approximately 20 m from the holding line.

Regulatory signposting, e.g. STOP HERE ON RED SIGNAL (R6-6), shall be erected in accordance with Clause 6.1(e). In some cases it may be necessary to supplement the traffic signals with explanatory fixed or variable message signposting. Where sight restrictions exist, advance warning signals should be considered (see Clause 6.4).

7.7 LEFT TURN ON RED

7.7.1 General description

Left-turn-on-red (LTOR) provides for vehicles on any approach which has the LTOR sign displayed, to turn left through a red circle display after first stopping at the stop line, provided it is safe to do so. Left-turn-on-red is NOT USED IN QUEENSLAND. The LTOR sign is shown in Appendix B for information only.

APPENDIX A

LONGITUDINAL LOCATION OF ADVANCE WARNING TRAFFIC SIGNAL SIGN ASSEMBLIES

The following is a recommended method of determining the longitudinal location of advance warning signals when they are required because of insufficient sight distance on approach to the intersection signals or to a stationary queue of vehicles.

Step 1 Referring to Figure A1, determine a position P on the approach to the signals where the stopping sight distance from Table 6.2 in the direction of travel first becomes less than that required for the 85th percentile approach speed.

NOTE: The dimension 1.15 m is the eye height of the approaching driver, and the dimension 0.35 m is the lowest allowable height of a vehicle stop light.

Step 2 Fix a second position Q a distance in advance of P equal to 3 seconds of travel at the 85th percentile speed.

Step 3 Position the advance sign assembly so that both flashing yellow aspects are visible to drivers on the approach from position Q, or the distance in advance of the stop line is A, whichever is the further in advance. To ensure that stationary queues do not obscure an approaching driver's view of the advance warning signals, it may be desirable to relocate the advance warning signals further in advance of the intersection signals e.g. at not less than stopping distance in advance of the probable end of the queue. Long queue lengths might be detected by occupancy loops placed in the road pavement to detect queue length.

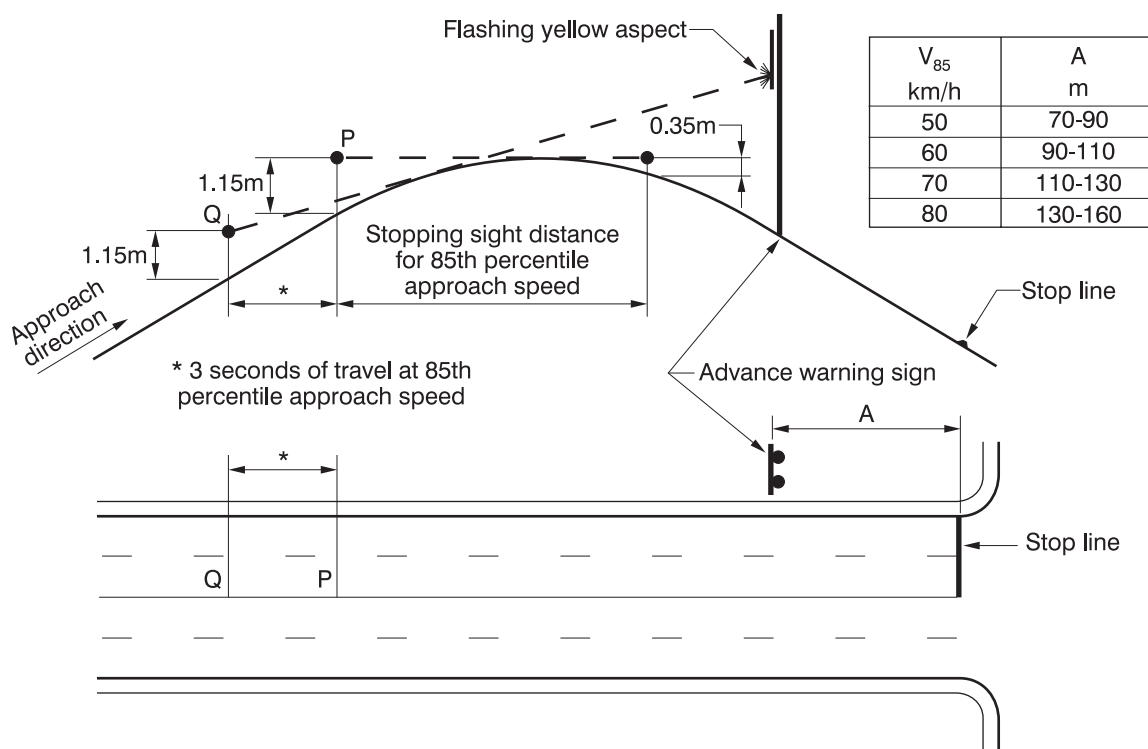


Figure A1 LOCATION OF ADVANCE WARNING ASSEMBLY

APPENDIX B

SUPPLEMENTARY LIST OF SIGNS NOT USED IN QUEENSLAND

While provisions exist in the Queensland Road Rules in relation to these signs, they are not approved for use in Queensland.

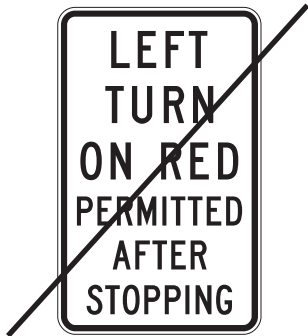
(i) *Traffic light stop sign (R1-4)*



R1-4

This sign is NOT APPROVED FOR USE IN QUEENSLAND.

(ii) *Left turn on red after stopping (R2-20)*



R2-20

This sign is NOT APPROVED FOR USE IN QUEENSLAND.

(iii) *Hook turn only (R2-21)*



R2-21

This sign is NOT APPROVED FOR USE IN QUEENSLAND pending development of application criteria by Australian Standards.