Network Technical Guide (NTG)

Supplement to Austroads Guide to Traffic Management Part 10:

Transport Control – Types of Devices

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Preface

Under the Transport Integration Act 2010 (Vic) the functions of the Head, Transport for Victoria (**Head, TfV**) include the development and implementation of standards, guidelines and practices for the public transport system, the road system and related matters.

Standards and Guidelines are administered by the Department of Transport and Planning (**DTP**) on behalf of the Head, TfV.

DTP Standards and Guidelines respond to Head, TfV objectives and responsibilities, legislative requirements, Victorian Government policies and guidelines, industry best practice and emerging technologies.

Any reference in this document to another document, standard or procedure that is expressed to be a VicRoads, Roads Corporation, Department of Transport (**DoT**), or DTP document, standard or procedure shall be interpreted and applied as though it was a document, standard or procedure of Head, TfV. Any reference in any such document, standard or procedure to a legal right or obligation of VicRoads, Roads Corporation, DoT or DTP shall be deemed to be a right or obligation of Head, TfV.

Nomenclature

ⓘ This symbol intends the accompanying text to be read as INFORMATION. Common information accompanying this symbol includes RATIONALE and GUIDANCE for the associated requirement.

Disclaimer

Interpretation

In this document, except where the context otherwise requires—

- The words “shall” and “must” denotes a requirement which is mandatory.
- The word “should” denotes a requirement which is not mandatory but recommended.
- The word ‘may’ denotes a requirement which is not mandatory but is an allowance or suggestion.
- The word “includes” in any form is not a word of limitation. Mentioning anything after "includes" or similar expressions (including "for example") does not limit what else may be included.

Reference to a section, clause, schedule or appendix is a reference to a section, clause, schedule or appendix of this document.

Contents

1 Introduction 4

1.1 Purpose 4

1.2 How to Use this Supplement 4

2 Classification of Supplement Information 5

3 Details of Changes 6

Section 10.2.1 – Vehicle Signal Face Layouts 6

Section 10.3.2 – Sequences with Arrow Aspects 6

Section 10.3.8 – Special Vehicle Signals 7

Section 10.4.1 – Designation of Signal Faces 8

Section 10.4.3 – Signal Face Site Requirements 8

Section 10.4.4 – Positioning of Signal Equipment 9

Section 10.4.6 – Lantern Mounting Heights 9

Section 10.4.10 – Other Street Furniture 10

Section 10.5.1 – Advance Warning Signals 10

Section 10.5.2 – Railway Level Crossings 10

Section 10.5.3 – Emergency Vehicle Facilities 10

Section 10.5.4 – Public Transport Priority 11

Section 10.5.5 – Bicycle Facilities 12

Section 10.5.9 – Paired Intersections 12

Section 10.5.12 – Single-Lane Operation and Portable Signals 12

Section 10.5.13 – Left Turn on Red 13

Section 10.8.2 – Signs at Signal Installations 13

Appendix A.3 – Directional Pavement Markings 13

4 Additional Information 14

AI1 – Linking Traffic Signals to Railway Level 14

AI1.1 – General 14

AI1.2 – Risk Assessment and Phasing at Railway Level Crossings 14

AI1.3 – General Interfacing Requirements 15

AI1.4 – Basic Operating Procedure 16

AI1.5 – Special Procedures 22

AI1.6 – MSS Flags – Summary of Operations 24

AI1.7 – Charts and Tables 25

AI2 – Third party traffic signal & street lighting installations 32

1 Introduction

1.1 Purpose

All road agencies across Australia are working towards greater consistency between States/Territories in how road networks are managed. In order to achieve this, the Austroads Guide to Traffic Management and Australian Standards relating to traffic management have been adopted to assist in providing that level of consistency and harmonisation across all jurisdictions. This agreement means that these Austroads Guides and the Australia Standards are the primary technical references.

Austroads Guide to Traffic Management Part 10: Transport Control – Types of Devices (AGTM Part 10) is a nationally agreed guideline document outlining the use of traffic control devices on the road network and has been adopted by all jurisdictions, including DTP.

All jurisdictions will be developing their own supplement to clearly identify where its practices currently differ and to provide additional guidance to that contained within AGTM Part 10. This document is the DTP supplement and shall be read in conjunction with AGTM Part 10.

1.2 How to Use this Supplement

There are two key parts to this document:

- **Classification of Supplement Information:** this table classifies supplement information as a Departure, Additional Information or both. This information assists with identifying its hierarchy in relation to the Austroads Guide to Traffic Management.

- **Details of Supplement Information:** this section provides the details of the supplement information.

  - **Departures:** where DTP practices differ from the guidance in the Austroads Guide to Traffic Management. Where this occurs, these differences or 'Departures' will be highlighted in a box. The information inside the box **takes precedence** over the Austroads Guide to Traffic Management section. The Austroads Guide to Traffic Management section is not applicable in these instances.

  - **Additional Information:** all information not identified as a departure provides further guidance to the Austroads Guide to Traffic Management and is read and applied **in conjunction** with the Austroads Guide to Traffic Management section.

Where a section does not appear in the body of this supplement, the Austroads Guide to Traffic Management requirements are followed.

2 Classification of Supplement Information

The classification of each section as a Departure, Additional Information or both is shown in the table below.

Section	Classification
10.2.1	Departure
10.3.2	Departure and Additional Information
10.3.8	Additional Information
10.4.1	Additional Information
10.4.3	Additional Information
10.4.4	Departure
10.4.6	Additional Information
10.4.10	Additional Information
10.5.1	Additional Information
10.5.2	Additional Information
10.5.3	Departure and Additional Information
10.5.4	Departure and Additional Information
10.5.5	Additional Information
10.5.9	Additional Information
10.5.12	Additional Information
10.5.13	Departure
10.8.2	Departure and Additional Information
Appendix A.3	Departure

Austroads Guide to Traffic Management requirements are followed in their entirety for sections not shown in this table.

3 Details of Changes

Section 10.2.1 – Vehicle Signal Face Layouts

Departure

Single-aspect right turn green arrows are permitted in the special case of a dual (far-right) secondary lantern where the approach is controlled as part of a split phase arrangement – see Section 10.4.3.

Section 10.3.2 – Sequences with Arrow Aspects

Refer to Section 6.5.3 of the DTP Supplement to AGTM Part 9 for descriptions of right turn control methods.

Departure

Figure 10.22 and Figure 10.23 of AGTM Part 10 should be replaced with Figure 1 and Figure 2 below respectively.

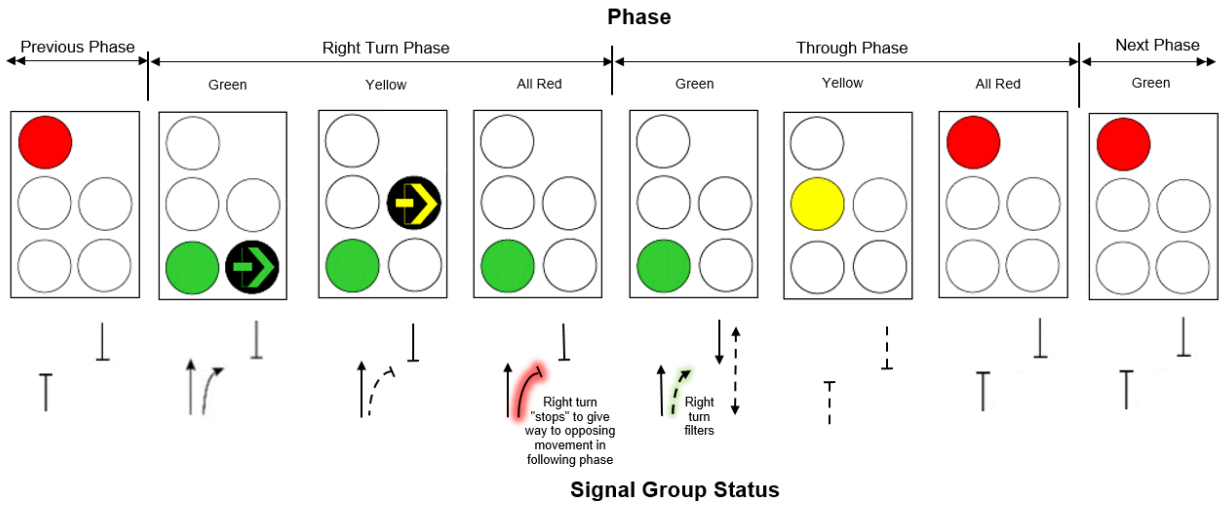


Figure 1: Partially controlled right turn

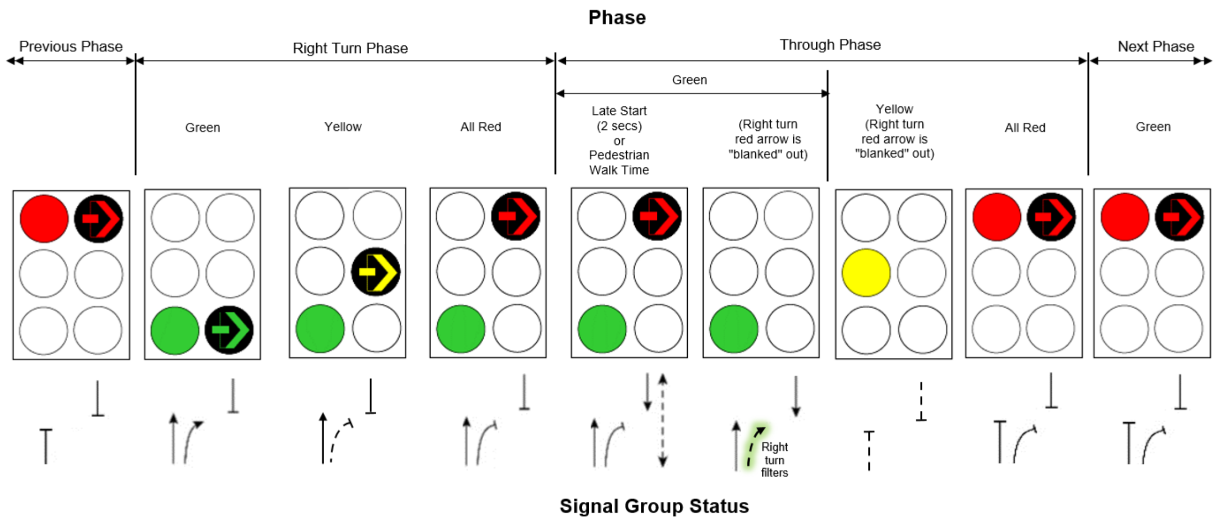


Figure 2: Partially controlled turn with red arrow drop out

Figures 3 and 4 provide further explanation to Figures 10.24 and 10.25 in AGTM Part 10 for the signal sequences for partially controlled left turns.

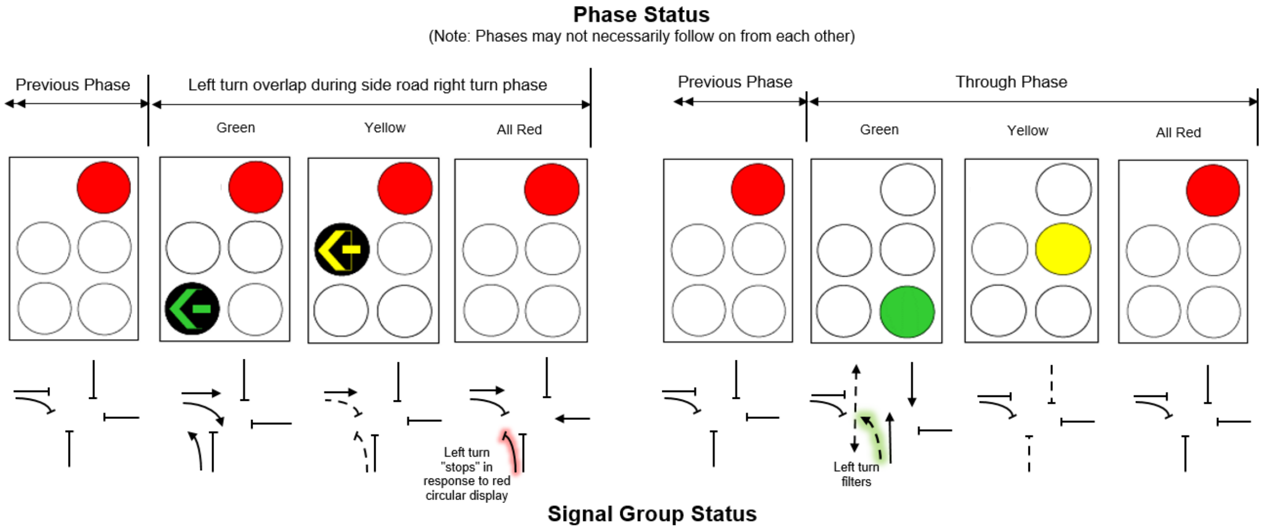


Figure 3: Partially controlled left turn – 2-aspect (Yellow/Green) left turn arrow displays

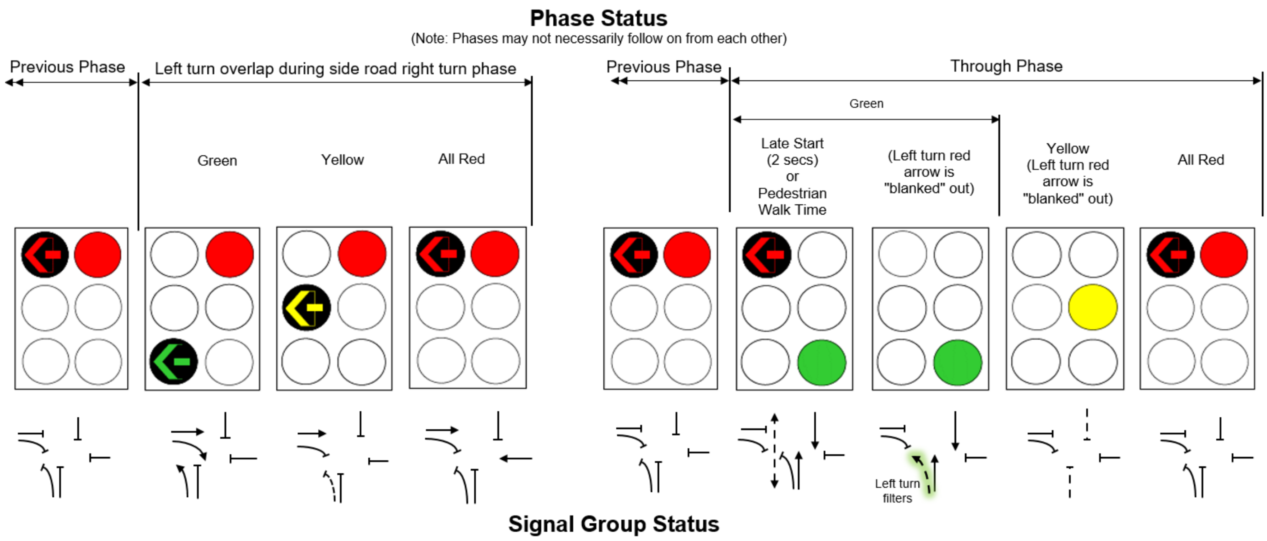


Figure 4: Partially controlled left turn with red arrow pedestrian protection

Section 10.3.8 – Special Vehicle Signals

Tram Auto Points

At tram line junctions the tram operator may install tram signal equipment and a controller to automatically switch the tram points. A connection is needed between the tram and traffic signal controllers to allow the tram phases to be called. A back-up push-button is also needed at a convenient location to allow the tram driver to call the tram phase if the tram system fails.

The procedure for installing tram automatic points is that the tram operator will send to DTP a copy of the layout of the automatic points equipment showing the locations of the controller cabinet. The tram operator arranges a signal remodel plan showing:

- the back-up push-button location
- the tram cabinet location
- the location of a 50 mm duct between the tram controller and the nearest traffic signals conduit pit
- the tram auto points lanterns.

The tram auto points lanterns should not be installed on a pedestal or pole with traffic signal lanterns.

The tram operator shall submit the traffic signal remodel plan to the relevant DTP Region to review/approve the plan. The tram operator shall organise for a DTP approved signal contractor to connect the tram auto points outputs to the traffic signal controller and install the new PROM. The Road Operations division of DTP prepares the new PROM for the tram auto points.

Section 10.4.1 – Designation of Signal Faces

Desirably a minimum of three circular displays or two turn displays should be visible when approaching an intersection and two displays should be visible when stopped.

Refer to AS 1742.14 and the DTP Supplement to AS 1742.14 for information regarding the location and number of signal displays at intersections.

Refer to AS 1742.14 and the DTP Supplement to AS 1742.14 for information regarding the use of mast arms for overhead signal faces.

The designation of the dual (far-right) secondary signal face is as shown in Figure 5 for type (b) Intersection – divided road.

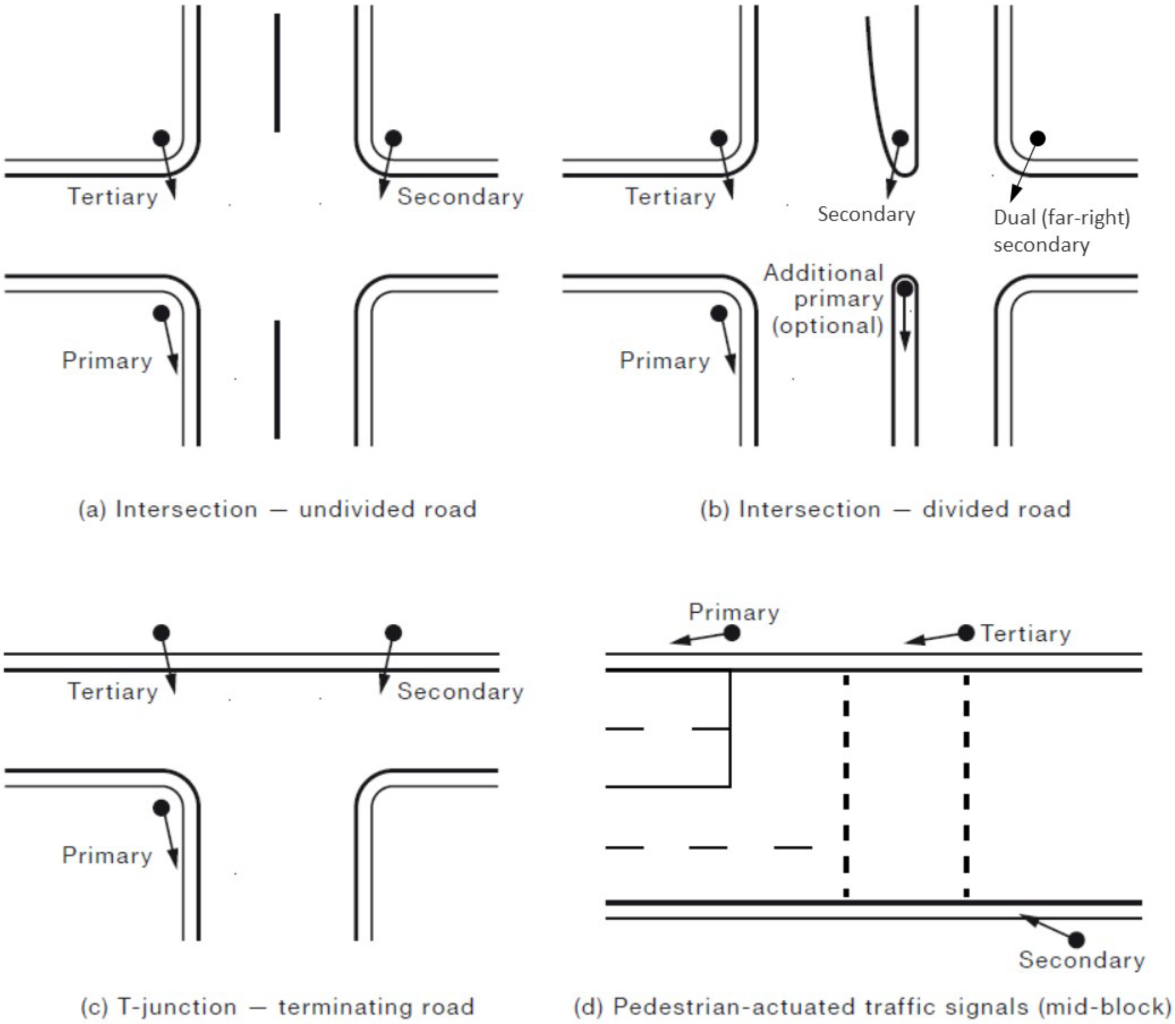


Figure 5: Revision of Designation of Signal Faces

Section 10.4.3 – Signal Face Site Requirements

Overhead secondary lanterns are generally not provided in Victoria. However, where overhead primary lanterns are provided on an undivided road, right-turn lanterns can be provided for the opposite approach (the default overhead secondary lanterns), if desired.

Dual (far-right) secondary lanterns should be provided wherever possible, especially for fully controlled right turns and/or larger intersections.

Where an approach is serviced via a split phasing arrangement, and there is a secondary 4-aspect lantern on the far side median, a dual (far-right) secondary lantern may be required where:

- there are two right turn lanes (even if one of the lanes is shared through-and-right) and a good chance of two vehicles turning right at the same time
- there are three or more stand up lanes on the opposite approach (not counting any left turn slip lane) as this means the intersection is a bit wider
- the intersection is skewed or there is unusual geometry whereby right turners could be confused about the correct carriageway to exit the intersection.

If a dual (far-right) secondary lantern is required for a split phase arrangement, it should be a 1-aspect right turn green arrow, as shown in Figure 6 below.

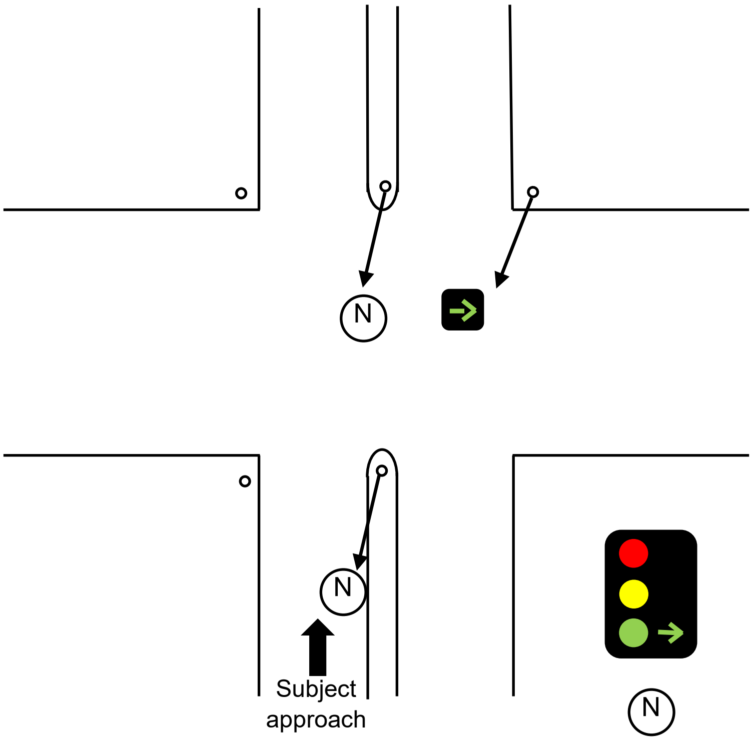


Figure 6: Dual (far-right) secondary lantern for a split phase approach

Section 10.4.4 – Positioning of Signal Equipment

Lateral post positions

Departure

Kerbside posts and mast arms should be positioned 1 m nominal from the kerb face, but may be up to 2 m nominal from the kerb face subject to compliance with other requirements (e.g. accessibility, pedestal consolidation etc.). An absolute minimum of 0.6 m from the kerb face may be considered in exceptional circumstances subject to DTP acceptance.

Section 10.4.6 – Lantern Mounting Heights

For some starting or manoeuvring lanterns, the mounting height may be reduced to 3 m for all lanterns in that display. Refer to ITS Standard Drawing TC-1116.

DTP uses signal pedestals designated 2B for 4.1 m mounting height and 2A for 3.25 m mounting height. ITS Standard Drawing TC-1100 shows the dimensions for 2B and 2A pedestals. Generally, 2B pedestals are used for all lanterns.

ITS Standard Drawing TC-1126 shows lantern mountings under verandas.

Section 10.4.10 – Other Street Furniture

Joint-use supports for side mounted signs

Multi-purpose poles are available to reduce the number of poles as follows:

- Joint use poles (JUP) - to support traffic signals and street lighting lamps available in 8.5 m, 11 m and 13.5 m heights.
- Joint use mast arms (JUMA) - to support traffic signals and street lighting lamps. Available 5.5 m clearance height, 2.5 m, 3.7 m and 5.5 m length of outreach, and 8.5 m, 11 m or 13.5 m street lighting pole heights.
- Multi-purpose poles/mast arms (JUTP) - that will support traffic signals, street lighting, tram operator overhead cables, power lines.

Often existing electricity supply authority and tramway poles can be used to support traffic signal hardware, subject to the agreement of the asset owner. Poles shall be specifically designed to mount mast arm outreaches.

Signs may be mounted onto existing utility poles to reduce the number of sign posts at the intersection.

When contemplating the use of joint-use supports for signs it is necessary to ensure that:

- The function of the sign is not adversely affected by relocating it on a joint-use support.
- All required lateral and vertical clearances are provided, refer to AS 1742.2.
- Permission is obtained for use of structures which are not DTP property.

For further information on joint use poles, refer to DTP Specification TCS 001.

Section 10.5.1 – Advance Warning Signals

In addition to the purposes for active advance warning signals detailed in AGTM Part 10, DTP also installs these signs in isolated rural locations, where traffic signals may not be expected.

Section 10.5.2 – Railway Level Crossings

If traffic or pedestrian signals are located close to a railway crossing, an interlink between the traffic signals and railway signals is often necessary. This link will ensure that the traffic signals will not cause any vehicles to store on the railway lines when a train is approaching.

Most traffic signals installed close to or across railway lines require a complex phasing system to ensure that vehicles do not queue across the railway lines. For efficient operation careful consideration should be given to achieving the maximum road capacity (number of lanes, exclusive turn lanes) and the maximum use of complementary (overlap) vehicle and pedestrian phases.

Note that roundabouts have been successfully used next to railway crossings even though the roundabout may be blocked during train movements.

See Additional Information – Linking Traffic Signals to Railway Level Crossings for a detailed description of the interlink between a railway level crossing and traffic signal controller.

Section 10.5.3 – Emergency Vehicle Facilities

To enable safe and efficient movement of emergency vehicles from their depot, traffic signals may be installed (at the cost of the emergency vehicle authority). Where the emergency vehicle facility is located at an intersection controlled by traffic signals, an all-red phase is usually incorporated and this is called from within the emergency vehicle depot.

Where the emergency vehicle facility is located near an existing intersection controlled by traffic signals, emergency vehicle signals are installed at the emergency depot and connected to the adjacent signalised intersection. An emergency clearance phase is also incorporated at the signalised intersection.

Usually, standalone emergency vehicle signals are considered when at least one of the following conditions is met:

- the depot is located on an arterial road
- there is documented evidence of crashes between exiting emergency vehicles and road traffic in the past five years
- at least 6,000 veh/d use the main road
- an average of 20 emergency departures is made each week.

Departure

In Victoria, the operation of traffic signals at emergency vehicle facilities differs from the operation described in the AGTM in that:

- DTP has moved away from the double flashing red lights as, at some sites, not all vehicles stopped when the signals operated.
- DTP does not permit the three-aspect signal face to revert to blank as it could encourage motorists to assume that the signals are faulty, and possibly cause confusion when the signals are activated.

As such, the 'non-flashing' and 'flashing' signal modes as described under 'signals for mid-block access points' are not used.

Emergency vehicle signals are treated as normal signals with standard three-aspect displays on the main road. When there is no demand from an emergency vehicle these displays remain green. When an emergency vehicle demands the emergency phase the sequence of operation is as follows:

- The main road signals are green.
- An emergency call is made from a button in the premises or by a vehicle (Note: there may be a delay time from when the call is initially made and the signals reacting to the call, depending on the specific set up of the installation).
- The main road signals change to yellow once the call is registered (yellow time is determined as per normal standards).
- The main road signals change to red (all-red time is determined as per normal standards).
- A white E display is shown to the emergency premises (as per AS 1742.14:2014 Clause 2.6).
- The white E display is terminated after the cancel button is operated in the premises (or the emergency phase terminates after a maximum time).
- An appropriate clearance time operates at the end of the E display.
- The main road signals return to green and remain green until the next emergency call.

For additional information regarding Signals for Emergency Service Vehicles, refer to AS 1742.14.

Section 10.5.4 – Public Transport Priority

Bus priority

Departure

The first paragraph in this section of AGTM 10 on bus priority should not be treated as definitive guidance, as it only covers one geometric arrangement for a bus lane at an intersection.

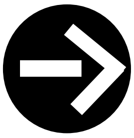
Departure

There are some situations where a single white B light can be used, (not being part of at least a four-aspect signal face).

Careful consideration should be given to the choice between a bus lane and a bus only lane. For a short queue jump lane where left turners do not need to enter the bus lane, the preferable treatment is a bus only lane, which forces cyclists and scooter riders to use the adjacent lane (or a bicycle lane if there is one).

Compared to white B lights, white arrows have the advantage of clearly conveying the permitted direction of travel to the driver. However, white arrows are more likely to be misinterpreted by other drivers as applying to them, as they are the same shape as green arrows. For this reason, the use of white B lights are the preferred practice.

B Light



White arrow

Where bus signals are needed, white B lights should be used in preference to white arrows. Exceptions are:

- Where two or more different public bus movements need to be controlled separately from the same approach
- Where the bus signals control a bus movement from a carriageway which does not carry other general traffic. In such a case, either a white B light or a white arrow is acceptable.

White arrows apply equally to trams and public buses. They should not be used on an approach with buses and trams unless any conflicts and ambiguities can be avoided.

The selection of either a single-aspect or three-aspect display is dependent on whether there is a need to control bus and general traffic independently. 3-aspect bus lanterns must be used where a red B light is necessary to prevent a conflict with the bus movement. Otherwise, a 1-aspect should be used.

The most common case is a head start for through buses in a bus lane on the left side of the road, and the buses are permitted to continue to go through while the normal green light is displayed. For this case, a 1-aspect white B light should be displayed during the head start time and should extinguish when the green traffic light comes on.

To ensure clarity of permitted movements from a bus lane or bus only lane at a signalised intersection, pavement arrows (and in some cases, signs that permit special bus movements) shall be used. Refer to DTP Supplement to AS 1742.12 for detailed guidance.

Section 10.5.5 – Bicycle Facilities

The different types of detection which may be used for cyclists are:

- rectangular lane loops
- rectangular path loops
- pedestrian push-buttons
- slanted lane loops

Section 10.5.9 – Paired Intersections

Staggered 'T' intersections

These types of intersections should be avoided because they operate very inefficiently when signalised. The reasons are that the cross streets usually require separate phases and rear end collisions often occur on the major road due to the closely spaced stop lines. There can also be "see-through" effects.

Section 10.5.12 – Single-Lane Operation and Portable Signals

A Memorandum of Authorisation from DTP is required to operate portable traffic signals on worksites.

Section 10.5.13 – Left Turn on Red

Departure

The use of left turn on red (LTOR) is not permitted in Victoria. This is due to safety concerns about the conflict between left turning vehicles and pedestrians crossing the approach that the vehicle is turning from. Although the guidelines for use of LTOR minimise the chances of such conflicts by only allowing LTOR where there are few pedestrians and simple geometry, these conflicts can occur nevertheless.

Section 10.8.2 – Signs at Signal Installations

U-turn Permitted sign

The R2-15 U-turn Permitted sign is generally not used at signalised intersections in Victoria, as U-turns are allowed at traffic signals under the Road Safety Road Rules 2017 (unless otherwise signed).

Left turn on red permitted after stopping sign

Departure

Left turn on red is not permitted in Victoria, so this sign shall not be used.

Appendix A.3 – Directional Pavement Markings

Departure

Route directional pavement markings are not used in Victoria for the purposes of navigation. This is due to pavement arrows having regulatory significance under the Road Safety Road Rules 2017 that enforce a direction of travel at the intersection that may conflict with the intended operation of the bicycle facility.

4 Additional Information

AI1 – Linking Traffic Signals to Railway Level

AI1.1 – General

Trains are considered to be “heavy rail” (rather than light rail e.g. trams) and, as such, require **“ultimate” priority** over all road users at traffic signals associated with railway level crossings. In other words, traffic signals associated with railway level crossings must be programmed such that, when a train(s) is detected, they “immediately” go into a “train sequence” which then allows the approaching train(s) to pass **safely and unrestricted** through the railway level crossing.

This section describes the general operational requirements of traffic signal controllers which are linked with gates or booms at railway level crossings in Victoria. These requirements have been in place since 1987.

As with normal traffic signal installations, there are many different traffic signal layouts and phasing arrangements that are required when traffic signals are associated with railway level crossings. Therefore, it would be impractical to document all possible scenarios required to provide **ultimate priority** to trains. This section aims to provide the following:

- The Victorian requirements for the general interfacing between the level crossing controllers and traffic signal controllers – see Section AI1.3.
- Basic operating procedure of traffic signal controller – see Section AI1.4.
- Special procedures that are required to be performed by traffic signal controllers – see Section AI1.5.
- Description of MSS flags used to monitor the basic operating procedure and the special procedures described in the previous two points – see Section AI1.6.
- Information that can be used to assist in the design of the operation of traffic signals associated with railway level crossings – see Section AI1.7.

In summary, for each traffic signal site associated with a railway level crossing, the relevant information from these sections must be included in the General Notes (OpNotes) pages of the Controller Operation Specification to then enable programming of the controller personality. The information must be tailored to suit the required operation of each site.

These requirements should be read in conjunction with the **VRIOGS (Victorian Rail Industry Operators Group Standards) Standard 012.1 – Standard for Signalling Design and Documentation**

AI1.2 – Risk Assessment and Phasing at Railway Level Crossings

AI1.2.1 – Risk Assessment

Due to the high risks at level crossings, for any new or major remodels, a Risk Assessment Workshop should be conducted by the project proponent (typically DTP/MTIA development and/or delivery teams). Among other risks, the proposed phasing sequence and its detailed operation should be discussed in detail. This would be in addition to the usual Road Safety Audits (multiples stages) and/or Safe System Assessments coordinated by the project proponent.

AI1.2.2 – Phasing at railway levels crossings

When signalised intersections (or pedestrian crossings) are associated with railway level crossings the associated phasing needs to be set up to consider two completely separate scenarios:

- When the train is NOT approaching and passing through the railway level crossing.
- When the train is approaching and passing through the railway level crossing.

Typically, completely separate phases are used to control these two separate scenarios.

While the train is NOT approaching and passing through the railway level crossing, normal vehicular (and pedestrian) phases would operate similar to phases that would be designed if there was no railway level crossing. However, where possible for new or major remodelled sites, the phasing should be designed such that vehicles are prevented from having to store (queue) on the train tracks during the normal vehicular (and pedestrian) phase sequence. If this is not possible i.e. vehicles do have to store on the train tracks during the normal vehicular (and pedestrian) phase sequence (noting this type of arrangement can result in a net safety disbenefit), then it needs to be discussed at the risk assessment workshop discussed above.

When the train is approaching and passing through the railway level crossing, typically the Train Phase Sequence (consisting of the Track Clearance Phase and Train Phase) will operate. See Section AI1.4.4 below for more information.

AI1.3 – General Interfacing Requirements

Electrical interfacing between the traffic signal controller and the level crossing controller is provided by a multi-core telephone type cable having at least 10 pairs. The wiring is detailed in the Standard Rail-Link Cable Termination Chart (see Figure 7 in Section AI1.7). This chart must be filled out for every traffic signal site associated with a railway level crossing to enable the correct connection to the rail authority level crossing controller. This chart must form part of the Controller Operation Specification for each site associated with a railway level crossing.

AI1.3.1 – Standard Rail Link Inputs

For a standard installation, the following five inputs are generated by the **rail crossing control system** (level crossing controller) and are fed into detector inputs in the traffic signal controller as external inputs:

- CABLE MONITOR via Detector No. __
- PRE RELEASE via Detector No. __
- RELEASE/FORCE (R/F) via Detector No. __
- CALL via Detector No. __
- BOOMS HORIZONTAL via Detector No. __

Each of these inputs is generated from a rail level crossing relay at particular points on the railway track. Each input can be in the *on (closed)* or *off (open)* state.

The operation of each of these inputs (except CABLE MONITOR) is described in Section AI1.4 below. The operation of the CABLE MONITOR is described below.

It must be noted that there may be some railway level crossings that do not have all standard rail link inputs due to limitations from the railway authority side, however for any new/major rail projects the railway authority must get DTP's agreement should it be proposed that the standard five inputs not be provided. The programming of the traffic signal controller needs to be modified from what is described in Section AI1.4 below to account for these changes.

Note: As well as being documented in this section of the General Notes pages of the Controller Operation Specification, these detector inputs must also be detailed on the Group Allocation & Detector Map page (Page 1) and Detector Functions page (Page 3). These detector inputs are treated as External Inputs.

(a) CABLE MONITOR

The CABLE MONITOR is an input that monitors the cable between the **rail crossing control system** (level crossing controller) and the traffic signal controller. It is normally *on.*

If a break is detected in the cable then this input will be *off*. If this occurs then this is deemed to be an abnormal condition. See Section AI1.5.1 below for details of actions to be taken when this condition occurs.

AI1.3.2 – Standard Rail Link Outputs

The traffic signal controller generates the following two outputs, which are sent to the rail crossing control system through a special signal group:

- TRAFFIC LIGHT RESPONSE (TLR)
- ACKNOWLEDGE CALL (AKN)

The ***green*** state of the signal group indicates the TLR has been sent and the ***off*** state of the signal group indicates the AKN has been sent.

Note: As well as being documented in this section of the General Notes pages of the Controller Operation Specification, the signal group must also be detailed on the Group Allocation & Detector Map page (Page 1) and Phasing Diagram page (Page 2).

AI1.4 – Basic Operating Procedure

AI1.4.1 General

The Typical Sequence Chart in Figure 8 in Section AI1.7 shows the normal sequence of events and the change in state of each input and output as a train passes through the railway level crossing. This CHART also provides information regarding the following periods as a train passes through a railway level crossing:

- Holding Section – Period between CALL and Railway Red Flashing Lights (with ringing Bells) commencing.
- Control Section – Period between Railway Red Flashing Lights (with ringing Bells) commencing and the train clearing the crossing (Booms starting to rise).

The terms “Control Section” and “Holding Section” are used in the following description of the Basic Operating Procedure.

AI1.4.2 – CALL

(a) Establishment of a train CALL

The following describes the series of events involved in a train CALL being established:

- A train on the approach to the railway level crossing activates the CALL track circuit. This CALL activation is transmitted to the railway level crossing controller which, in turn, sends the CALL to the traffic signal controller. The time between the CALL track circuit being first activated and the CALL signal being received by the traffic signal controller is typically 2 seconds (approximately). This time is sometimes referred to as COMMS delay (Communications delay) and should be considered when performing the CRITICAL RESPONSE ANALYSIS (see Section AI1.4.2).
- When the CALL signal is first received by the traffic signal controller via the CALL external detector input, the CALL presence timer is started. Once the CALL presence timer has timed for the time specified in the presence timesetting (normally 1 second) of the CALL detector, the CALL is deemed to have been **received** by the traffic signal controller.
- The CALL presence time should be considered when performing the CRITICAL RESPONSE ANALSIS.
- Note: The reason for the use of a presence timer to determine that a CALL has been received (rather than just the initial activation) is that it is important to determined that the CALL is valid rather than a momentary “glitch”.
- Once the CALL is deemed to have been received by the traffic signal controller, a CALL delay timer (sometimes called HOLD timer) is commenced. Once this CALL delay timer has timed out the CALL is **deemed to be established**. The traffic signal controller will then commence the transfer to the TRAIN PHASE SEQUENCE. The CALL delay timer is initially set to 0.5 seconds (i.e. effectively no delay).
- The reason for using a CALL delay timer is to provide flexibility to operators regarding the establishment of the CALL. For instance, if it has been determined that the CALL is consistently being established too early thereby leading to a situation where the site reaches the train phase too early (thereby creating unnecessary delays for road traffic), then the CALL delay timer can be increased to reduce delays.

Increasing the CALL delay timer should be implemented very carefully as it is important that a "Force before TLR" condition is not created by increasing the CALL delay timer.

- Alternatively, if the CRITICAL RESPONSE ANALYSIS (CRA) reveals that the traffic signal controller is unable to reach the "safe" point in the phase sequence within the agreed CRITICAL RESPONSE TIME (CRT), then the CALL delay timer could be reduced below 0.5 seconds (to say 0.1 seconds) in order to reduce the response time. See below for more information regarding the "safe" point in the phase sequence referred to above.

(b) Operation following establishment of train CALL

Following the establishment of a CALL, the controller will immediately initiate a "pre-emptive transfer" to the TRAIN PHASE SEQUENCE using methods as described in Sections (a) and (b) below. When these methods are implemented, limitations will be imposed on the normal phase sequence. For instance, certain "preferred" phases may be allowed to introduce and extend (normally unlikely), while others may be terminated immediately, dependent on satisfying minimum green and pedestrian walk and clearance times.

Analyses of the worst-case responses to train CALLs should be performed using the CRITICAL RESPONSE ANALYSIS (CRA) methodology which is explained below.

Also, there may be circumstances when it is necessary to reassess an existing train site to determine whether modifications to its "critical" timesettings (e.g. All-red times) will impact the CRITICAL RESPONSE ANALYSIS time. Methods for performing this reassessment are described below.

(c) Pre-emptive transfer from phase green

When the traffic signal controller is operating in phase green and a CALL is established, then terminate the running phase (without violating minimum green or pedestrian clearance times) and proceed via the TRACK CLEARANCE phase (if used) to the nominated TRAIN phase.

To allow the controller to react more quickly to an established CALL, if a pedestrian(s) is in walk, then substitute a reduced time (via a Special Purpose timesetting) into the Walk timesetting.

Detailed descriptions regarding how the controller proceeds to the TRACK CLEARANCE phase (if used) and to the TRAIN phase, are normally provided in the "Phase Operation" section of the Controller Operation Specification for the particular site. It is normal to refer to the "Phase Operation" section within this section.

(d) Pre-emptive transfer from phase intergreen

When the traffic signal controller is operating in phase intergreen and a CALL is established, then continue to proceed to the next phase, but do not introduce pedestrian movements (in that phase), then terminate the phase after minimum green and proceed via the TRACK CLEARANCE phase (if used) to the nominated TRAIN phase.

Other more radical conditions, such as not operating the minimum green (and therefore signal groups) of the following phase, may need to be used in order to not violate the agreed Critical Response Time (CRT) (see below).

Again, detailed descriptions regarding how the controller proceeds to the TRACK CLEARANCE phase (if used) and to the TRAIN phase, are normally provided in the "Phase Operation" section of the Controller Operation Specification for the particular site. It is normal to refer to the "Phase Operation" section within this section.

AI1.4.3 – CRITICAL RESPONSE ANALYSIS (CRA)

(a) General

The signal group output is activated by the traffic signal controller when it has reached a "safe" point in the phase sequence i.e. it indicates that the road traffic signals are ready for activation of the boom gates.

Related to this, the FORCE is indicated by the RELEASE/FORCE input going *off* and occurs when the train enters the Control Section (thereby causing the railway red lights at the crossing to flash and bells to ring). The receipt of the FORCE will not cause a flashing yellow response within the traffic signal controller during the period that the TLR output is activated (i.e. the traffic signal controller has reached the "safe" point in the phase sequence before the receipt of the FORCE)

Therefore, for the traffic signal controller, the CRITICAL RESPONSE ANALYSIS (CRA) is used to determine the worst-case response times from the receipt of the CALL to then reach the “safe” point in the phase sequence (i.e. when TLR is activated). Table 3 and Table 4 in Section AI1.7 (or similar) must be used to perform the CRA.

When performing the CRA for new or major remodelled train sites (which include major track signalling /circuitry upgrades), the Clearance times (i.e. ECO, All-red and Special All-red times) used in the analysis must be based on a speed of 40 km/h for the road with the level crossing. If the calculated CRT is under the limit of 35 seconds, then it should be recalculated based on a speed of 40 km/h for all approaches, up to the limit of 35 seconds. The reason for using this lower speed is to take account of possible future speed limit reductions as a result of site works (e.g. roadworks). It must be noted that the intergreen times (as calculated within the OpSheet) must still be based on the “normal” speed limits of the site.

To perform the CRA the Critical Response Time (CRT) must be known and agreed with the railway authority as this is the time in which the traffic signal controller must reach the “safe” point in the phase sequence. The Critical Response Time is described below.

It is important that the worst-case responses are analysed and determined – it is sometimes not the most obvious phase transition which produces the worst-case response.

RTSO staff should confirm with Signal Services prior to making any permanent or temporary changes in SCATS that would affect the CRT.

A CRITICAL RESPONSE ANALYSIS (CRA) must be carried out for every train site and must be documented in the OpNotes of the Controller Operation Specification for the site being analysed, as per Table 3 and Table 4. Also, the Critical Response Time (CRT) is to be noted within the CRA and digitised as part of the electronic Controller Operation Specification.

(b) CRITICAL RESPONSE ANALYSIS Time at Existing Sites

For existing train sites, the time calculated via the CRITICAL RESPONSE ANALYSIS (CRA) can be confirmed by examining the actual CALL to TLR time (i.e. time from the receipt of the CALL to the point when the TLR is activated). This can be examined by analysing data in the Events log within SCATS History Viewer files (.hst files).

To analyse the SCATS History Viewer data, the SCATS Events Analytics tool should be used to extract the Minimum, Maximum and Average CRA (CALL to TLR) times, based on at least one week of data. (This can be done using train detector input activations and/or MSS flags).

The crucial time from this assessment will be the **Maximum CALL to TLR time,** as this shows the worst-case time for the traffic signal controller to reach the “safe” point in the phase sequence.

To be conservative when determining the CALL to TLR time it is recommended that the CALL train input/detector activation always be used, rather than the MSS flag associated with CALL. The reason for this is that the MSS flag (MSS1) associated with the CALL input is only set from the point that the CALL is established i.e. after the CALL presence time and the CALL delay timer have operated.

(c) Critical Response Time (CRT)

(d) General

Each of the standard rail link inputs is generated from a railway level crossing relay at particular points on the railway track.

In the original discussions with the rail authority it was “agreed” that these relays should be located such that a nominal 35 seconds at least should elapse between receipt of a CALL input and receipt of the FORCE (termination of the R/F) input. This means that the traffic signal controller must reach a “safe” point in the phase sequence within that time. This time is referred to as the **Critical Response Time (CRT).**

However, there may be occasions when DTP or the rail authority requests a shorter (or longer) CRT than 35 seconds due to site constraints or due to a requirement to reduce delays to road traffic. This revised CRT must be agreed and documented between DTP and the rail authority.

The agreed CRT must be considered in the worst-case response analyses of the CRA.

The agreed Critical Response Time (CRT), whether it be the original nominal 35 seconds, or a shorter or longer time must be agreed between DTP and the rail authority. The Critical Response Time (CRT) is to be noted within the CRA and digitised as part of the electronic Controller Operation Specification for the site being analysed.

(e) Critical Response Time (CRT) at Existing Sites

As described above, a Critical Response Time (CRT) is agreed between DTP and the rail authority. For existing train sites, the actual Critical Response Time can be determined by examining data in the Events log of SCATS History Viewer files (.hst files). This would be done by analysing the CALL to FORCE time.

To analyse the SCATS History Viewer data, the SCATS Events Analytics tool should be used to extract the Minimum, Maximum and Average CRT (CALL to FORCE) time, based on at least one week of data. (This is done using train detector input activations and/or MSS flags).

The critical time from this review will be the **Minimum CALL to FORCE** time, as this shows how quickly a train can reach the Control section of track in the “worst case” scenario.

Similar to the determination of the CRITICAL RESPONSE ANALYSIS Time at existing sites, to be conservative when determining the CALL to FORCE time, it is recommended that the CALL train input/detector activations always be used rather than the MSS flag associated with CALL. As described above, the reason for this is that the MSS flag (MSS1) associated with the CALL input is only set from the point that the CALL is established i.e. after the CALL presence time and the CALL Delay timer have operated.

Reassessment of CRITICAL RESPONSE ANALYSIS time

There may be circumstances (generally roadworks) when it is necessary to reassess an existing train site to determine whether modifications to its “critical” timesettings (e.g. All-red times) will impact the CRITICAL RESPONSE ANALYSIS time and so affect its ability to reach the “safe” point in the phase sequence (i.e. the point when the TLR is activated).

This could be done using either of two methods:

- **Method 1:**
  Redoing the CRITICAL RESPONSE ANALYSIS (with the reduced speed limits for the road with the level crossing) and comparing the calculated times to the agreed Critical Response Time (CRT) that is either documented on file or provided by the railway authority. However, another method would be to compare it to the actual Critical Response Time (CALL to FORCE), as determined from data within the Events log of SCATS History Viewer.
- **Method 2:**
  By comparing the actual CRITICAL RESPONSE ANALYSIS time (CALL to TLR) to the actual Critical Response Time (CALL to FORCE), as determined from data within the Events log of SCATS History viewer.

In the event the reassessed CRA time exceeds the CRT, then the relevant DTP Branch and the proponent (for the reduced speed limit) must be advised that the project cannot proceed until an adequate solution is found. This could be done via a Risk Assessment Workshop led by the proponent, along with the relevant DTP Branches, and may include consideration of a traffic signal controller reprogram (if viable).

AI1.4.4 – TRAIN PHASE SEQUENCE

Due to the high risks at railway level crossings, for any new or major remodels, a Risk Assessment Workshop should be conducted by the project proponent (typically DTP/MTIA development and/or delivery teams). Among other risks, the proposed phasing sequence and its detailed operation should be discussed in detail. This would be in addition to the usual Road Safety Audits (multiples stages) and/or Safe System Assessments coordinated by the project proponent.

(a) Track Clearance Phase

The TRACK CLEARANCE phase (if used) runs before the booms lower in order to clear off the tracks any vehicles which may inadvertently be on them. It may run fixed-time or may be terminated (via detector extension) to suit site-specific conditions.

(b) Train Phase

The TRAIN phase operates after the TRACK CLEARANCE phase (if used). It services those traffic movements and pedestrians that do not conflict with the train tracks. It may have sub-phases to allow different vehicle movements and/or pedestrian movements to operate. When designing the train phase, consideration should be given to:

- minimum greens for groups.
- maximum times for groups; and
- how groups are extended

This operation of the train phase should be described in detail in this section of the Controller Operation Specification.

AI1.4.5 – TRAFFIC LIGHT RESPONSE (TLR)

(a) Description

The Traffic Light Response (TLR) signal group output is activated by the traffic signal controller when it has reached a “safe” point in the phase sequence i.e. it indicates that the road traffic signals are ready for activation of the boom gates.

The TLR output is sent from the traffic signal controller to the railway control equipment. Usually, the TLR is not utilised by the rail equipment. When the train enters the **Holding Section**, the CALL is sent to the traffic signal controller. When the train enters the **Control Section**, the booms are activated regardless of whether the TLR has been received or not.

The TLR output is issued to the railway track circuitry (by means of the traffic signal controller railway signal group) to indicate arrival at a nominated instant in the TRAIN PHASE SEQUENCE of the traffic signal controller. It is maintained until the PRE-RELEASE input is reinstated.

If the train does enter the Control Section **before** the TLR is sent by the traffic signal controller, then this is deemed to be an Abnormal Condition (i.e. traffic signal controller has not reached a “safe” condition). See Section AI1.5.1 below for details of actions to be taken when this condition occurs.

(b) Special (Unusual) Circumstance

A special circumstance arises if the train is held on a red signal after entering the Holding Section (or even after it has entered the Control Section). In this case, the rail equipment suppresses the normal CALL message. When the train receives a green signal, a CALL is simulated so that the road traffic signals commence their action. The rail equipment waits for the TLR message, then commences to activate the booms. If the TLR message is not received, the booms will be activated after a set period - usually the standard 35 seconds call time.

(c) When the TLR is sent

Depending on the circumstances, the TLR signal output message could be sent back to the rail crossing control system at any of the following instants in the train phase sequence:

a) start of intergreen prior to the TRACK CLEARANCE phase; or

b) start of TRACK CLEARANCE phase; or

c) end of the TRACK CLEARANCE phase late start, or

c) the end of the TRACK CLEARANCE phase minimum green period; or

d) the start of TRACK CLEARANCE phase intergreen; or

e) the start of the TRAIN phase.

Determination of the most suitable instant requires care and is determined dependent on site-specific considerations. For example, the end of a "late-start" interval during the TRACK CLEARANCE phase may be useful as it then allows some scope for fine-tuning by increasing (or decreasing) the late start period. Generally, the TLR signal output should not be commenced until traffic is expected to have cleared, as it may be used to initiate boom closure or to grant permission for train movements.

(d) TLR Signal group aspects

The TLR output is generated only during the *green* aspect of the TLR signal group, as indicated in the Typical Sequence Chart (Figure 8 in Section AI1.7).

AI1.4.6 – FORCE

The FORCE is indicated by the RELEASE/FORCE input going *off*. (This occurs when the train enters the Control Section causing the railway red lights at the crossing to flash and bells to ring).

The receipt of the FORCE (termination of the RELEASE/FORCE (R/F) input) will not cause a flashing yellow response during the period that the TLR output is activated.

On receipt of the FORCE input, an MSS flag is set. The nominated MSS remains set until the RELEASE input is reinstated. The nominated MSS is used to monitor the RELEASE/FORCE interval and/or CALL/FORCE interval.

If a FORCE input is received without a previous CALL input, then this is deemed to be an abnormal condition. See to Section AI1.5.1 below for details of actions to be taken when this condition occurs.

AI1.4.7 – BOOMS HORIZONTAL

Receipt of BOOMS HORIZONTAL input is an indication that all the booms have reached horizontal. This information may be used to terminate the TRACK CLEARANCE phase.

Previously receipt of the BOOMS HORIZONTAL input may have been used to drop red arrows so that traffic could move up and store at the horizontal booms. This practice is no longer used in order to minimise the chance of motorists storing within the intersection and/or proceeding accidentally through the horizontal booms. It must be noted that there may be some existing sites that still incorporate this practice.

On receipt of the "BOOMS HORIZONTAL" input, an MSS flag is set. The nominated MSS remains set until the "BOOMS HORIZONTAL" input is removed. The nominated MSS is used to monitor the duration of booms closure.

If BOOMS HORIZONTAL input is not received, then this is deemed to be an abnormal condition. See Section AI1.5.1 below for details of actions to be taken when this condition occurs.

AI1.4.8 – PRE-RELEASE

The PRE-RELEASE is an input that is provided by the railway authority to allow a more efficient termination of the train phase i.e. it is provided to allow the traffic signal controller to reach a state that allows road traffic to proceed earlier than if only the RELEASE input was provided. The use of the PRE-RELEASE mechanism allows the traffic signals to turn green for traffic crossing the level crossing as soon as the booms reach 60 degrees vertical (i.e. when the RELEASE (R/F) input is received).

The PRE-RELEASE input goes *off* at the same time as FORCE input (when the train enters the Control Section). At this point in the sequence, it does not have any impact on the operation of the traffic signal controller.

However, the PRE-RELEASE input does affect the operation of the traffic signal controller when it is re-activated. The operations of the controller when the PRE-RELEASE input is re-activated (i.e. train has cleared the crossing – Control Section) are described in the following sections.

(a) Normal operation for one train

As described above, the re-activation of the PRE-RELEASE input is an indication that the train has cleared the Control Section of track and that the booms are about to lift.

When it is received, the controller initiates a pre-release sequence which directs the controller to terminate all signal groups in the train phase without violating pedestrian or minimum green times. If a pedestrian is in walk when the PRE-RELEASE is received, then it is normal to select an alternate timesetting (Special Purpose Timesetting) for the pedestrian walk time, so that normal operation may resume as soon as possible. The controller will then proceed to the train phase all-red interval and remain there pending reinstatement of the RELEASE input.

(b) Second call during train phase

Following receipt of the PRE-RELEASE input, if a second CALL is received prior to the controller being in the train phase intergreen period (i.e. the booms have moved off the horizontal, but the controller is still not in the train phase intergreen) then the train phase sequence (See Section AI1.4.4 above) should be recommenced. This is to ensure that a recognisable cyclic sequence is maintained; that timers are reset; that the TLR group output is appropriate; and that the TRACK CLEARANCE phase is re-run if necessary to clear any vehicles which may have moved forwards when the booms lifted. It also allows any spare time to be usefully employed, for example where there is an unusually long interval between the CALL and the FORCE.

(c) Second call during train phase intergreen

If a second CALL is received during the train phase intergreen period then proceed to the subsequent phase (but do not service pedestrians) and then commence a new train phase sequence as described in Section AI1.4.4 above.

AI1.4.9 – RELEASE (R/F)

Once the train is clear of the crossing and the booms have raised to approximately 60 degrees, the RELEASE is indicated by the RELEASE(R/F) input going to the *on* state. This indication releases the traffic signal controller to resume normal vehicle operation with an appropriate phase, according to site-specific Compensation requirements (see Section AI1.5.3).

To monitor that the railway inputs are operating correctly, a RELEASE timer is used to monitor the time between the PRE-RELEASE being re-activated (going to on state) and the RELEASE (R/F) input going to the *on* state. This timer is described below.

(a) Release Timer

The RELEASE TIMER commences counting from receipt of the PRE-RELEASE. If the RELEASE (R/F) input is not reinstated before expiry of this timer, then this is deemed to be an abnormal condition. See Section AI1.5.1 below for details of actions to be taken when this condition occurs.

AI1.5 – Special Procedures

AI1.5.1 Abnormal Conditions

These conditions should not occur in normal operation. However, when they do, appropriate steps should be taken to register the event and to act as follows.

(a) Abnormal condition 1 - Force before TLR

Although normally 35 seconds at least should elapse between receipt of a CALL input and the FORCE (termination of the R/F input), there may be occasions when the FORCE occurs prior to the controller issuing the TLR output (i.e. train has reached the Control Section before the traffic signal controller has reached a “safe” point in the phase sequence). This will force a flashing-yellow response and generate ABNORMAL CONDITION message No. 1 via MSS3. When the full RELEASE is received (the R/F input is reinstated) the controller will go through an all-red start-up sequence and resume normal operation.

(b) Abnormal condition 2 - Late Release

As described in Section AI1.4.9, the RELEASE TIMER commences counting from receipt of the PRE-RELEASE. If the RELEASE (R/F) input is not reinstated before expiry of this timer, then the controller will generate ABNORMAL CONDITION message No. 2 via MSS4 and go to flashing-yellow. When the R/F input is reinstated, the controller will go through an all-red start-up sequence and resume normal operation.

(c) Abnormal condition 3 - Force without Call

As described in Section AI1.4.6, if the R/F input is terminated without a previous CALL input, the controller will generate ABNORMAL CONDITION message No. 3 via MSS5 and go to flashing-yellow. When the R/F input is reinstated the controller will go through an all-red start-up sequence and resume normal operation.

(d) Abnormal condition 4 - Break in Cable Monitor

As described in Section AI1.3.1, if there is a break in the CABLE MONITOR input, the controller will generate ABNORMAL CONDITION message No 4 via MSS6 and go to flashing-yellow until the CABLE MONITOR is reinstated. When this input is reinstated the controller will go through an all-red start-up sequence and resume normal operation.

(e) Abnormal condition 5 - Booms not Horizontal

In situations where the BOOMS HORIZONTAL input is required, then if the BOOMS HORIZONTAL input is not received during the train sequence, the controller will generate ABNORMAL CONDITION message No 5 via MSS7. This flag may be set at the start of the first phase following release from the train phase sequence if this condition occurs. However, this facility should be deleted if the BOOMS HORIZONTAL input is not used.

AI1.5.2 – Call Termination Timer

When a CALL input terminates prior to the FORCE (in the presence of the R/F input), a timer will begin to count down (Timer will use a nominated Special Purpose timesetting). Any further CALL inputs will reset the timer. Once the FORCE is received (R/F terminated), the timer is ignored. If the R/F input is not terminated prior to expiry of the timer, then the controller will AUTO-RELEASE from the train phase sequence and resume normal vehicle operation. The purpose of this facility is to prevent the traffic signal controller from being "locked up" indefinitely by spurious inputs (in the case of automatic track circuits) or by inadvertent or excessively early calls (in the case of manned signal-boxes). (The normal timesetting is 60 seconds)

AI1.5.3 – Operating Modes

(a) Isolation conditions

When the CALL input is received (see Section AI1.4.2), the MSS1 flag is set and will instruct the regional computer (via Variation Routine 30) to force the controller into Isolated operation. The MSS1 flag will remain on until the “termination conditions” are met as dictated by the Compensation sequence requirements, if any, for compensation to traffic delayed by the boom closure.

The compensation requirements should be described within this section. Information regarding possible compensation techniques is provided in the following paragraphs.

(b) Compensation techniques

The main requirement of the compensation techniques is to transfer to a phase which has traffic movements which have been disadvantaged by the Booms being down.

If Masterlink is resumed at the point, the compensation phase may receive a very short time through to a full cycle time, depending on the Masterlink cycle generator. To guarantee that the phase runs for a reasonable time to clear the traffic that has been waiting, it is recommended that some mechanism is employed to provide compensation.

One technique is for the traffic signals to remain in Isolated mode and hold the phase for a fixed time, after which Masterlink is then resumed.

Another technique is to set the Masterlink cycle generator to a particular value (using the MSS2 flag) – see Section AI1.5.3 below. This can be arranged so that a reasonable amount of time is allocated to the phase running immediately after the train phase. However, it must be realised that, if the Masterlink cycle generator is reset, it will directly affect all sites in that sub-system. Furthermore, it will cause cycle length rotation in any other sub-systems in the marriage chain.

A combination of both techniques will often be employed.

In order to monitor the duration of the compensation sequence, an MSS flag could be used. For example, on termination of the BOOMS HORIZONTAL, the particular MSS flag is set. It could then remain set until the end of the compensation sequence (e.g. end of the first A Phase after the train operation).

(c) Resumption of Masterlink Mode

At the start of the train phase, the MSS 2 flag is set and will stay on until the start of the intergreen of the train phase, then (if required) it will be used by Variation Parameters to determine the moment at which the cycle generator is to be set for Masterlink operation.

(d) Flexilink Operation

Flexilink mode can be operated at this site.

AI1.6 – MSS Flags – Summary of Operations

AI1.6.1 – MSS 1

This flag is used to control when the local controller is forced into Isolated operation and when it reverts back to Masterlink. It is set upon receipt of the CALL and dropped at some point after the RELEASE, depending on the requirements for compensation (see Section AI1.5.3).

AI1.6.2 – MSS 2

This flag is used to determine the exact point in the sequence when the Masterlink cycle generator is reset in preparation for picking up co-ordination. It is set at some convenient point, usually at the start of the TRAIN PHASE green, and then dropped at the start of the TRAIN PHASE intergreen or later (see Section AI1.5.3). It must be dropped before the MSS1 flag is dropped.

AI1.6.3 – MSS 3 to MSS 7

These are described under ABNORMAL CONDITIONS (see Section AI1.5.1).

AI1.6.4 – MSS to monitor duration of compensation sequence

In order to monitor the duration of the compensation sequence, a nominated MSS flag can be used.

AI1.6.5 – MSS to monitor Booms Horizontal Input

In order to monitor the Booms Horizontal input, a nominated MSS flag can be used.

AI1.6.6 – MSS to monitor RELEASE/FORCE Input

In order to monitor the RELEASE/FORCE input, a nominated MSS flag can be used.

A summary of the MSS flags is given below.

MSS Flag	Function
MSS1	Set on receipt of Call, cleared by termination conditions - used to force the site to Isolated.
MSS2	Set from start of train phase until start of intergreen of train phase.
MSS3	Abnormal condition: Force before TLR.
MSS4	Abnormal condition: Late release.

MSS5	Abnormal condition: Force without Call.
MSS6	Abnormal condition: Break in Cable Monitor.
MSS7	Abnormal condition: Booms Horizontal not seen.
MSS8	Set from start of train phase until intergreen of DØ (after train phase) or when XSF1 is set.
MSS9	Set from receipt of Call until start of CØ or BØ intergreen if Y-(Master) or Y+(Flexi) set.
MSS11*	Set from the point when the CALL is deemed to be established until the CALL is removed. *If UPS is required at a train site, MSS11 is non-critical and can be used for UPS operation.
MSS13	Set for the duration of the booms closure.
MSS14	Set on receipt of FORCE, cleared on reinstatement of RELEASE.
MSS15	Set on receipt of PRE-RELEASE, cleared on reinstatement of PRE-RELEASE.
MSS16	Set by 'Hurry Call' function used to send site to Isolated.

AI1.7 – Charts and Tables

This section contains the following information:

- Standard Rail Link Cable Termination Chart – see Figure 7
- Typical Railway Level Crossing Sequence Chart – see Figure 8
- Critical Response Analysis Table – Case 1 – see Table 1
- Critical Response Analysis Table – Case 2 – see Table 2
- Table 3 and Table 4 provide an example of Critical Response Analysis (CRA)

STANDARD RAIL LINK CABLE TERMINATION CHART
FOR CONTROLLERS WITH RELAY OR SOLID-STATE LOAD-SWITCHING

SITE: NUMBER: ______________

MUNICIPALITY: DESIGNER: DATE: ______________

** Delete the inputs and or outputs on this page which are not used.*

RAIL-LINK DESCRIPTOR or FUNCTION	NO-TRAIN CIRCUIT STATUS	PAIR REF. No.	CONDUCTOR INSULATION COLOUR	TERMINATION DETAILS
CABLE MONITOR (CONTINUITY)	CLOSED	1st	WHITE --------- BLUE -----------	DET. RETURN DETECTOR NUMBER: __________
PRE-RELEASE (FGR)	CLOSED	2nd	WHITE --------- ORANGE ------	DET. RETURN DETECTOR NUMBER: __________
RELEASE/FORCE (R/F or FCR)	CLOSED	3rd	WHITE --------- GREEN ---------	DET. RETURN DETECTOR NUMBER: __________
CALL	OPEN	4th	WHITE --------- BROWN --------	DET. RETURN DETECTOR NUMBER: __________
BOOMS HORIZONTAL	OPEN	5th	WHITE --------- GREY -----------	DET. RETURN DETECTOR NUMBER:
SPARE	OPEN	6th	RED ------------- BLUE -----------	NOT TERMINATED NOT TERMINATED
SPARE	OPEN	7th	RED ------------- ORANGE ------	NOT TERMINATED NOT TERMINATED
SIGNALS OFF (FY or BO) RLY	OPEN	8th	RED GREEN	(NC) "FLASH"
ACKNOWLEDGE CALL (AKN)	OPEN	9th	RED BROWN	(NO) "A" RLY (NC) "B" RLY
TRAFFIC LIGHT RESPONSE (TLR)	OPEN	10th	RED GREY	(NO) "A" RLY (NO) "B" RLY

For solid-state load-switching, suitable termination is as follows:

ACKNOWLEDGE CALL (AKN)	OPEN	9th	RED BROWN	(NC) "RED" RLY (NC) "YEL" RLY (NC) "GRN" RLY
TRAFFIC LIGHT RESPONSE (TLR)	OPEN	10th	RED GREY	(NO) "GRN" RLY

- "TLR" (and "AKN" outputs are driven by SIGNAL GROUP NUMBER: using the "RED", "OFF", "GRN" and "YEL" logic states as shown in the TYPICAL SEQUENCE CHART.
- The (AKN) output may be required occasionally (for manual operation at signal-box sites) thus requiring installation of the "RED" and "YEL" 240 V relays in addition to the "GRN" 240 V relay.

Figure 7: Standard Rail Link Cable Termination Chart

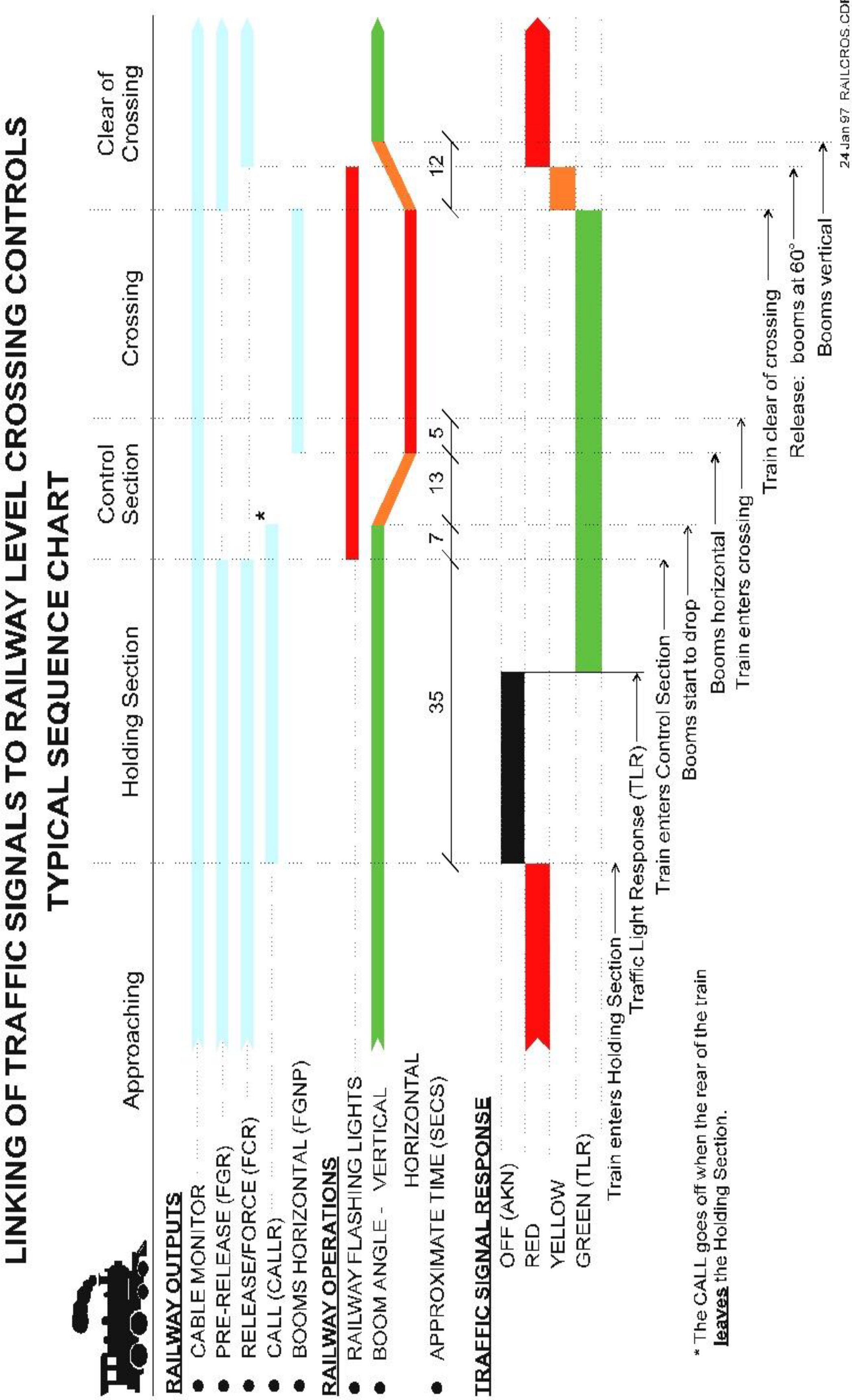


Figure 8: Typical Railway Level Crossing Sequence Chart

Table 1: Critical Response Analysis Table – Case 1

CRITICAL RESPONSE ANALYSIS (CRA) TABLE

TYPICAL TABLE FOR CALCULATION OF WORST CASE RESPONSE

TO PRE-EMPTIVE PHASE TRANSITIONS

CASE 1: CALL RECEIVED IMMEDIATELY FOLLOWING PHASE TERMINATION

Complete one column for each allowable phase transition.

Agreed Critical Response Time (CRT) for Site No:	35 seconds								
From Phase:									
COMMS DELAY	2	2	2	2	2	2	2	2	2
CALL PRESENCE	1	1	1	1	1	1	1	1	1
CALL DELAY	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
ECO									
YELLOW									
ALL RED									
To phase:									
LATE START									
MIN GREEN									
I#1 ECO									
I#2 YELLOW									
I#3 ALL RED									
To track clearance phase:									
I#4 LATE START									
I#5 MIN GREEN									
I#6 ECO									
I#7 YELLOW									
I#8 ALL RED									
I#9 **To train phase:**									
TOTALS									
Note: The TLR is usually specified in the range I#1 to I#9 above. eg I#4... TLR signal group green issued at commencement of LS interval.									
CONCLUSIONS:									

Table 2: Critical Response Analysis Table – Case 2

CRITICAL RESPONSE ANALYSIS (CRA) TABLE

TYPICAL TABLE FOR CALCULATION OF WORST CASE RESPONSE TO PRE-EMPTIVE PHASE TRANSITIONS

CASE 2: CALL RECEIVED IMMEDIATELY AFTER WALK INTRODUCTION

Complete one column for each allowable phase transition.

Agreed Critical Response Time (CRT) for Site No:	seconds								
From Phase:									
COMMS DELAY	2	2	2	2	2	2	2	2	2
CALL PRESENCE	1	1	1	1	1	1	1	1	1
CALL DELAY	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
LATE START									
WALK (Short)									
CLEARANCE									
I#1 ECO									
I#2 YELLOW									
I#3 ALL RED									
To track clearance phase:									
I#4 LATE START									
I#5 MIN GREEN									
I#6 ECO									
I#7 YELLOW									
I#8 ALL RED									
I#9 **To train phase:**									
TOTALS									
Note: The TLR is usually specified in the range I#1 to I#9 above. eg I#4... TLR signal group green issued at commencement of LS interval.									
CONCLUSIONS:									

Table 3: Example of CRICTIAL RESPONSE ANALYIS (CRA)

CRITICAL RESPONSE ANALYSIS

TABLE FOR CALCULATION OF WORST CASE RESPONSE TO PRE-EMPTIVE PHASE TRANSITIONS

CASE 1: CALL RECEIVED IMMEDIATELY FOLLOWING PHASE TERMINATION

Complete one column for each allowable phase transition.

Agreed Critical Response Time (CRT) for Site No: 1234				35 seconds				
From phase:	**A**	**A**	**A**	**B**	**B**	**B**	**C**	**C**
Comms delay	2	2	2	2	2	2	2	2
CALL PRESENCE	1	1	1	1	1	1	1	1
CALL DELAY	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
ECO	*4	*4	*4	2.5	2.5	* 5	* 5	0
YELLOW	4	4	4	3.5	3.5	3.5	3	4
ALL RED	2	2	2	1.5	1.5	1.5	1.5	2
To phase:	**B**	**C**	**D**	**A**	**C**	**D**	**A**	**D**
LATE START	0	2		***0	0		0	
MIN GREEN	8	8		10	6		10	
ECO	* 5	0		0	0		0	
YELLOW	3.5	3		4	3		4	
ALL RED	1.5	2		2	2		2	
To track clearance phase:	**D**	**D**	**D**	**D**	**D**	**D**	**D**	**D**
LATE START	2	2	2	2	2	2	2	2
MIN GREEN	** 6	** 6	** 6	** 6	** 6	** 6	** 6	** 6
ECO	** 0	** 0	** 0	** 0	** 0	** 0	** 0	** 0
YELLOW	**3.5	**3.5	**3.5	**3.5	**3.5	**3.5	**3.5	**3.5
ALL RED	** 1.5	** 1.5	** 1.5	** 1.5	** 1.5	** 1.5	** 1.5	** 1.5
To train phase:	**E**	**E**	**E**	**E**	**E**	**E**	**E**	**E**
TOTAL: (sec)	**24.5**	**26.5**	**11.5**	**29**	**24**	**10.5**	**26**	**11.5**

Notes comments

** The TLR is Issued at : **End of train clearance phase Late Start**

*** Expire AØ LS if Bus not demanded

Clearance Phase: D

Train Phase: E

Table 4: Example of CRITICAL RESPONSE ANALYIS (CRA) – Continued

CRITICAL RESPONSE ANALYSIS

TABLE FOR CALCULATION OF WORST CASE RESPONSE TO PRE-EMPTIVE PHASE TRANSITIONS

CASE 2: CALL RECEIVED IMMEDIATELY AFTER WALK INTRODUCTION

Complete one column for each allowable phase transition.

Agreed Critical Response Time (CRT) for Site No: 1234 35 seconds			
From phase: *Note*	**A**	**B**	**C**
Comms delay	2	2	2
CALL PRESENCE	1	1	1
CALL DELAY	0.5	0.5	0.5
LATE START	0	0	2
WALK (Short)	4	4	4
CLEARANCE 1 *(Longest Ped ie P1 or P2)*	10	7	8
ECO	*4	2.5	0
YELLOW	4	3.5	3
ALL RED	2	1.5	2
To track clearance phase:	**D**	**D**	**D**
LATE START	2	2	2
MIN GREEN	** 4	** 4	** 4
ECO	** 0	** 0	** 0
YELLOW	** 4	** 4	** 4
ALL RED	** 1.5	** 1.5	** 1.5
To train phase:	**E**	**E**	**E**
TOTAL: (sec)	**25.5**	**24**	**24.5**

Notes comments

* Expire ECO if going AØ→DØ

** The TLR is Issued at : **End of train clearance phase Late Start**
Substitute AØ yellow for CØ yellow if going CØ→DØ

AI2 – Third party traffic signal & street lighting installations

All traffic signal and street lighting works generated or occasioned by parties other than DTP must be fully funded by the party that generated or occasioned the works.

Examples of such works include a municipal council narrowing a road, involving the relocation of a signal pedestal or a new set of traffic signals required as mitigating works for a development on adjacent or nearby land.

The relevant DTP Region has the responsibility for ensuring that there is a clear understanding, agreement and a commitment from the third party to pay full costs incurred by DTP. Where the works come about as a result of a Planning Permit application, the planning permit condition will require works to be done *to the satisfaction of and at no cost to DTP.* Where works are not the result of a Planning Permit Application, the Region must ensure that funds have been made available prior to the issue of any formal consent for the works to commence.

When other third parties carry out works, it is preferable to inform these authorities that they must recover their own costs. Such situations should also have clear up front agreements covering matters such as responsibilities for costs involved with installation, design and maintenance.

The total maintenance cost over 10 years is calculated for:

- Intersections with SCATS
- Intersections without SCATS
- Pedestrian operated signals with SCATS
- Pedestrian operated signals without SCATS
- Pedestrian (zebra) crossings with flashing lights
- additional street lighting.

This calculation includes the electricity costs associated with the above installations.

Further details of the DTP policy, including the latest 10 year costs are available in the Statutory Planning - Operating Costs: Traffic Signals & Street Lighting policy.

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