

Traffic signal design

Appendix G - Level crossing interface

Traffic signal design guidance



The traffic signal design guidelines have been developed to assist in designing traffic control signals.

The guidelines are to comprise 16 sections and 5 appendices. These are initially being released individually and in no specific order. The sections which are to be released are as follows:

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

To determine which sections are currently available go to:

www.rta.nsw.gov.au/doingbusinesswithus/downloads/technicalmanuals/trafficsignaldesign_dll.html

The information contained in the various parts is intended to be used as a guide to good practice. Discretion and judgement should be exercised in the light of the many factors that may influence the design of traffic signals at any particular site. The guidelines make reference, where relevant, to current Australian Standards and are intended to supplement and otherwise assist in their interpretation and application.

Traffic Signal Design

APPENDIX G

LEVEL CROSSING INTERFACE Traffic signal design guidance

Special Note:

As of 17 January 2011, the RTA is adopting the Austroads Guides (Guide to Traffic Management) and Australian Standards (AS 1742, 1743 & 2890) as its primary technical references.

An RTA Supplement has been developed for each Part of the Guide to Traffic Management and relevant Australian Standard. The Supplements document any **mandatory** RTA practice and any complementary guidelines which need to be considered.

The RTA Supplements **must** be referred to prior to using any reference material.

This RTA document is a complementary guideline. Therefore if any conflict arises, the RTA Supplements, the Austroads Guides and the Australian Standards are to prevail.

The RTA Supplements are located on the RTA website at www.rta.nsw.gov.au





Roads and Traffic Authority
www.rta.nsw.gov.au

VERSION: 1.0
ISSUED: June 2010

APPROVED BY:

SIGNED

Phil Margison
General Manager
Traffic Management

AUTHORISED FOR USE BY:

SIGNED

Peter Collins
Director
Network Management

Copyright © 2009 Roads and Traffic Authority of NSW

This work is protected by copyright. Apart from any fair use as permitted under the *Copyright Act 1968*, no part may be reproduced in any way without prior written consent from the Roads and Traffic Authority of NSW.

Disclaimer and Conditions For Use

This Specification has been prepared by the Roads and Traffic Authority of New South Wales (referred to herein as RTA) for use, insofar as it is applicable, in the State of New South Wales for equipment supplied under an RTA procurement order or contract, or under a procurement order or contract from another party that is required in writing by the RTA to use this Specification.

The use of this RTA Specification other than by those parties stated above and in the manner stated above is not recommended by the RTA. Any such use is entirely the decision of the user alone. The RTA disclaims all responsibilities arising whether directly or indirectly from any such use. The RTA does not warrant that this Specification is error free, nor does RTA warrant the suitability, fitness or otherwise of this Specification for any stated or implied purposes expressed or implied in this Specification or other documents. By using this Specification, the user agrees to indemnify the RTA against the full amount of all expenses, losses, damages and costs (on a full indemnity basis and whether or not incurred by or awarded against the RTA) which may be suffered by any person or the RTA in connection with or arising out of the use of this Specification in any manner.

The RTA is not under any duty to inform you of any errors in or changes to the Specification.

ISBN 978-1-921242-95-3 (Electronic only)
RTA/Pub. 08.092

Contents

1 Introduction	G-1
1.1 Purpose	G-1
1.2 Scope	G-1
1.3 Definitions and abbreviations.....	G-1
1.4 References.....	G-2
2 General Considerations	G-3
3 Phasing	G-3
3.1 Start-up	G-4
3.2 Phase Time Settings.....	G-4
3.3 Diversion	G-5
4 Lantern Screening	G-5
5 Level Crossing Approach	G-5
6 Turning Movements	G-6
7 Advisory Signs	G-6
8 Pedestrian Movements	G-6
9 Simulation	G-6
10 Train Mode	G-7
11 Operational Monitoring	G-7
11.1 Video Monitoring.....	G-7
12 Faults	G-8
13 Fault Monitoring and Management	G-8
13.1 Alarms	G-9
14 Specific Timings	G-9
14.1 Queue Clearance Time.....	G-10
14.1.1 Method of Establishing – Empirical.....	G-10
14.1.2 Method of Establishing – Calculation.....	G-11
14.2 Gate Delay	G-11
14.3 Train Demand Response Time.....	G-12
14.3.1 Method of Establishing	G-12
15 Successive Operation	G-13
Appendix A Time to Transition – Clearance Phase	G-14
A.1 Train Demand During Late Start	G-14
A.2 Train Demand During Minimum Green	G-14

A.3 Train Demand After Minimum Green.....	G-15
A.4 Train Demand During Intergreen.....	G-15
A.5 Train Demand During Pedestrian Walk	G-17

Appendix B Queue Clearance Time – Detailed Example G-18

B.1 Scenarios.....	G-19
B.2 Scenario 1	G-20
B.3 Scenario 2.....	G-21
B.4 Scenario 3.....	G-22

Appendix C Examples G-23

C.1 Phasing.....	G-23
C.2 Minimum Green Interval Timing.....	G-23
C.3 TLR Outputs	G-23
C.4 Operational Monitoring.....	G-24
C.5 Alarms.....	G-24

Table of Figures

Figure 1 Example situation for railway – road interface.....	G-10
Figure 2 General schematic of phase intervals.....	G-14
Figure 3 General schematic of phase and pedestrian intervals	G-17
Figure 4 Example situation for railway – road interface.....	G-18
Figure 5 Scenario 1 example queue composition	G-19
Figure 6 Scenario 2 example queue composition	G-19
Figure 7 Scenario 3 example queue composition	G-19

I Introduction

I.1 Purpose

The purpose of this document is to provide guidelines for RTA staff and contractors responsible for designing intersections near railway level crossings, where the operation of the intersection needs to be coordinated with the operation of the railway level crossing.

This document also provides information on configuration issues for the traffic signal controller personality, status and monitoring of the traffic signal controller and its operation with the railway level crossing.

The intersection designer, traffic signal engineer, adaptive engineer and intersection technician will need to co-ordinate to establish all the necessary information to develop a safe and suitable solution to each individual location.

I.2 Scope

While every attempt has been made to generalise the guidelines within this document to cover the principles of the interface, it cannot hope to cover all aspects of every physical configuration between railway level crossing control and an intersection traffic signal controller. It is anticipated that through the provision of targeted examples, readers will be able to make informed decisions about the things they need to do, research or consult others about.

In addition, differences are inevitable between the interfaces to differing Railway Authority level crossings. These differences will mean that parts of this specification will not apply in certain circumstances. The designer will need to document these deviations.

This document does not give explicit rules for governing when coordination between the railway level crossing and the intersection traffic signal controller is required. It depends on the particular configuration and layout of the site, and type and extent of vehicles using the crossing and intersection. This document provides the general principles of operation and application of a coordinated interface between the railway level crossing and the road traffic signal controller.

The Level Crossing Interface – Concept of Operations [2] provides the background and general operating principles for coordination between the railway level crossing and the road traffic signal controller.

I.3 Definitions and abbreviations

Term	Meaning
ARTC	Australian Rail Track Corporation
CIS	Controller Information Sheet
clearance phase	The phase to allow vehicles that may be trapped on the crossing to clear the level crossing
clearance point	The position at which the vehicle is deemed not to be in the way. This can be characterized as: clear of the level crossing; at the intersection stop line; or having passed the intersection stop line. The clearance position may be different for different sites

Term	Meaning
gate delay	The delay from the start of the operation of the level crossing flashing lights and bells to the boom gates commencing to descend.
QCT	Queue Clearance Time – the elapsed time from the commencement of the clearance phase that it takes for a vehicle that may be queued across the level crossing to completely clear the level crossing.
RailCorp	Rail Corporation, New South Wales
RIC	Rail Infrastructure Corporation
RIU	Railway Interface Unit
RTA	Roads and Traffic Authority
TD	Train Demand – an indication from the level crossing to the traffic signal controller indicating a train is approaching. (This signal ends when the train has cleared the crossing.)
TDRT	Train Demand Response Time – the advance warning time required by the traffic signal controller of an approaching train prior to the level crossing commencing to operate.
TLR	Traffic Light Response – indication from the traffic signal controller to the level crossing indicating that the traffic signal controller is ready for the level crossing to commence operating. (This signal remains active while the Train Demand signal is present.)
TOC	Traffic Operations Controller
Traffic Signal Engineer	The person, or persons, responsible for establishing the timings for the traffic signal controller and particularly for rail level crossing coordination.
Train mode	The operating condition that a TSC is in when a train demand and/or crossing operating indication is received.
TSC	Traffic Signal Controller
XE	Crossing Operating – indication from the level crossing to the traffic signal controller indicating the level crossing flashing lights are operating.

1.4 References

- [1] RailCorp – Roads & Traffic Authority, Level Crossing – Traffic Light Design Interface Agreement, 30 May 2008
- [2] LX-CO-001, Level Crossing Interface – Concept of Operations
- [3] LX-SP-001, Level Crossing Interface – Railway Interface Unit Design
- [4] LX-IT-001, Level Crossing Interface – Railway Interface Unit Installation and Testing
- [5] RTA Publication 08/092, Traffic Signal Design, Section 8 – Lanterns
- [6] RTA Publication 08/092, Traffic Signal Design, Section 11 – Detectors
- [7] RTA Publication 08/092, Traffic Signal Design, Section 15 – Special Situations
- [8] Gipps, P. G. A Behavioural Car-Following Model for Computer Simulation. Transportation Research, Vol. 15B, No. 2, 1981, pp. 105-111.

2 General Considerations

There are many situations where traffic signals and a level crossing are in close proximity. Each situation has individual characteristics which differ from other instances, but in all cases the close proximity of the two traffic control facilities leads to an interaction of the traffic and hence there should be an interaction of the traffic control equipment.

Traffic signals near a level crossing controlled by warning lights and boom gates should have an electrical interface to the railway system. This aids in coordination between the two systems to alleviate possible queues of traffic and avoids conflicting messages being given to drivers. Where coordination is deemed to be desirable, consultation with the Railway Authority (RailCorp, ARTC, RIC) should be commenced as soon as possible but as a minimum during the preliminary design stage.

A level crossing **must be** equipped with both warning lights and boom gates where the level crossing is in close proximity to a road intersection. The approval of the General Manager Traffic Management is required prior to developing a design which does not meet this requirement.

In situations where the distance between the level crossing and the intersection is small or where the railway line passes through the intersection, 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 movement with a dedicated phase.

Where there are intersections on both sides of the level crossing, it is recommended that both intersections be equipped with traffic signals controlled by a single traffic signal controller.

Where there is an intersection on one side of the level crossing only, it is desirable to install traffic signal lanterns on the approach to the level crossing that feeds traffic to the intersection. These signals can then be sequenced with the intersection signals to prevent queues forming between the level crossing and the intersection. This is strongly recommended where any of the following conditions exist:

- the level crossing is very close to the intersection;
- it isn't possible to focus or screen traffic signals at the intersection so that they can't be seen from vehicles on the other side of the level crossing;
- the level crossing has no warning signals; or
- the railway authority is unable to provide a ***train demand*** signal sufficiently early to satisfy the ***train demand response time*** required to transition to a clearance phase.

Where there is a likelihood that a queue may develop on a departure side of the level crossing, consideration should be given to installing queue detectors in the roadway near the level crossing, see Traffic Signal Design [6] section 11.3.4.3. Detection of a queue on such a queue detector may be used to initiate a special phase sequence which inhibits movements feeding the queue or which runs phases that clear the queue.

The person, or persons, responsible for designing the intersection should document any calculations used to determine the maximum ***train demand response time***, ***queue clearance time*** and ***gate delay***.

3 Phasing

The intersection design plan, and hence the personality, should incorporate two sets of phases:

- A normal set that the controller is permitted to run when there is no train demand; and

- A train demand phase set when there is a train demand, consisting of one or more phases which allow movements other than those that give vehicles right of way to proceed towards the level crossing.

It is recommended that all movements towards the level crossing are controlled, ie no right or left turn filter movements. It is highly recommended that right turn filter movements toward the level crossing are not provided. Under a right turn filter movement a B-double may encroach into the intersection conflict zone, a train demand may be received. The B-double then has to wait until the opposing traffic has stopped before the vehicle can proceed from the intersection's conflict zone. The B-double may then be faced with level crossing warning lights while the rear of the vehicle is still within the conflict zone. A right turn movement should be given a specific phase to minimise this type of scenario.

Red signals should be displayed to movements proceeding towards the railway crossing as soon as possible after the receipt of a train demand and while the train demand signal is present.

Where a clearance phase is provided, the clearance phase shall not terminate: before the level crossing boom gates start to lower, where fitted; or a minimum of 10 seconds after the crossing warning lights begins to operate, where crossing boom gates are not fitted.

During the clearance phase, traffic signals should display green to vehicles that have already passed over the level crossing, and red traffic signals should be displayed to vehicles proceeding towards the crossing.

After the train has passed through the level crossing it may be necessary to run a specific phase before reverting to normal operation. Appendix C C.1 provides an illustration.

3.1 Start-up

When the traffic signal controller goes through a start-up sequence it is conceivable that a train demand may already be present or may arrive during start-up. The initial phase which is run may need to: be a specific phase of the train demand phase set; or be subject to change during start-up.

If the initial phase is permitted to be changed during start-up depending on whether a train demand is detected by the traffic signal controller then there are two cases: a train demand is detected and a phase of the train demand phase set is configured as the initial phase; otherwise a different phase can be the initial phase.

3.2 Phase Time Settings

The inclusion of a train demand phase set may mean that consideration needs be given to the normal phase transition timings and minimum green intervals.

If the phase following a train demand permits traffic queued at the level crossing to proceed through the intersection then a longer minimum green may be required to allow those queued vehicles time to travel to the intersection stop line before the phase terminates. Appendix C C.2 provides an illustration.

The following defines a number of time settings that need to be established and adhered to.

- Clearance phase minimum – if this is altered to a significantly shorter period than originally set then it is possible that a crossing operating early alarm will be raised regularly.
- Clearance phase maximum – if this is altered to a significantly longer period than originally set it will waste time and may promote drivers to drive around lowered boom gates. It is timed from the start of a train demand to the end of the worst case (longest) period before the level crossing boom gates to begin to lower.

3.3 Diversion

Consideration should be given to allowing diversion to another phase during the intergreen. While diversion allows the traffic signal controller to respond more quickly to a train demand received during the intergreen it places restrictions on any overlap signals that may be displayed to drivers and hence affects the efficiency of the intersection as a whole.

Where diversion during intergreen is not allowed, the intersection personality should be configured to prevent the introduction of any new signal groups when the next phase starts. This will prevent minimum timers being started and thus allow the phase to terminate quicker and transition to the clearance phase.

4 Lantern Screening

It may be necessary to install sight screens to ensure that train drivers cannot mistake the traffic signals for railway signals where traffic signals can be seen from the railway line. Lantern focusing and/or screening may be required, see Traffic Signal Design [5] section 8.7.

5 Level Crossing Approach

Where traffic signal lanterns are installed adjacent to/near a railway level crossing which face traffic that is also controlled by railway warning signals it is desirable that they only be capable of displaying off, yellow and red (this is to ensure that a green traffic signal and flashing red warning signals cannot be displayed simultaneously to vehicles arriving at the level crossing). In addition, where traffic signals are on the far side of a level crossing, special precautions may need to be taken to ensure that a green aspect is not visible across the railway level crossing at the same time as the flashing red railway signals.

Where traffic signal lanterns are installed on the approach to the crossing, it is desirable that these signals are operated in either of the following two ways:

- The signal is normally off and is only switched from off to yellow when a train demand is received, from yellow to red after 5 seconds and red to off when the train demand is cleared. This type of operation may be used when the likelihood of vehicles becoming trapped on the railway crossing is extremely low.
- The signal is normally red and is only switched off when there is no train demand and there is a demand from a detector at the stop-line near the signal and the downstream signal is green. The signal remains off for a minimum of 5 seconds and is switched to yellow if a train demand is received or if the phase in which it is running is ready to terminate. The signal switches from yellow to red after 5 seconds. Under this operation, the downstream signal must not switch to yellow until all vehicles have cleared the downstream stop-line (the stop-line detector near the downstream signal has “gapped”) in order to keep the level crossing clear of queued vehicles. This type of operation is essential when the level crossing and intersection are so close that long vehicles cannot be accommodated between the intersection stop-line and the level crossing. It may also be necessary when the railway authority is unable to provide sufficient advance warning (*train demand response time*) of the arrival of a train.

6 Turning Movements

Arrow lanterns should be provided for all turning movements proceeding from the intersection to the level crossing.

No phases or turning movements which would cross the railway line can be introduced until the train has cleared the crossing. It may be necessary to provide space for additional storage of these vehicles while the railway level crossing is closed

7 Advisory Signs

Where the level crossing is likely to remain operating for long periods (eg due to shunting of trains through the crossing), consideration should be given to providing changeable message signs which display a suitable message while the crossing is operating. This will lessen concerns that a driver may believe there is a fault in the system and perform the wrong action. This is also important if the train phase is extended via a successive train demand.

8 Pedestrian Movements

Since pedestrian movements can result in a long *train demand response time*, the design of pedestrian crossings requires careful consideration. If a pedestrian movement conflicts with a movement that runs during the *clearance phase* and the crossing is wide (due to the number and width of lanes or wide shoulders), consideration should be given to shortening the crossing (e.g. using kerb blisters) or providing a staged crossing (splitting the crossing into two sections with a central refuge area).

If a pedestrian signal that conflicts with the selected phase is already showing “WALK” when a *train demand* is received, the “WALK” should, where possible, be terminated immediately (whether the walk time has elapsed or not) and the pedestrian clearance started. The immediate termination of the “WALK” may not be advisable at certain pedestrian crossings depending on type of pedestrian use (for example: school children; aged, blind). Each site must be reviewed on its own merits.

If a train demand is received and there is a pedestrian demand, then the pedestrian demand may be suppressed until after the clearance phase has run.

Overlap of pedestrian walk and/or clearance intervals must be carefully considered as this will affect the efficiency and responsiveness to train demands.

9 Simulation

At an early stage, the proposed intersection design and level crossing operation should be modelled (e.g. using Paramics) with typical train frequencies and normal road traffic levels (to check that the operation is safe and efficient) and with frequent train arrivals and high levels of traffic demand (to ensure that queues across the railway line are handled correctly).

I 0 Train Mode

The traffic signal controller will enter train mode, ie as if a train demand has been received, under the following conditions:

- A valid, fault free, train demand is indicated.
- Only one of the train demand signals changes state.
- A valid, fault free, crossing operating indication is indicated.
- Only one of the crossing operating signals changes state.

If the traffic signal controller is in train mode for an extended period and either of the train demand or crossing operating indication is in an alarm state then the TSC will revert to flashing yellow operation. The “*extended period*” needs to be determined by the traffic signal engineer. Leaving train mode will reset the measurement of the period. Reversion from flashing yellow to normal operation may only occur if train mode is removed or until a technician intervenes on site.

It is possible for the level crossing to be operated manually by use of a switch rather than a train and the railway signalling system. The level crossing is to be considered to be under manual control if the train demand and crossing operating indication turn on within one second (in any order) of each other. The ‘one second’ period is configured by adaptation engineering personnel.

When the traffic signal controller is ready for the train (clearance phase run for the minimum period, in a train phase, etc) a traffic light response (TLR) is given to the Railway Authority to permit the crossing to operate earlier than the worst case time. The adaptive engineer should specify which controller outputs are to be used for the TLR indication with respect to any other outputs being used at the site. Appendix C C.3 provides an example.

I I Operational Monitoring

The traffic signal controller must be connected to SCATS to provide remote monitoring of site operation and alarms. The personality should be configured to provide indications to SCATS to signify the operational mode of the traffic signal controller. This allows the state of the intersection to be remotely monitored by traffic engineering staff. For example:

- The state of the train demand indication.
- The state of the crossing operating indication.
- The state of the traffic light response indication.
- If the crossing is manually operated.
- If the controller is in train mode.

Appendix C C.4 provides an example.

The use of special facility inputs in place of external detector inputs for the monitoring of the railway signalling system outputs is not recommended. Detector status is automatically provided to SCATS for monitoring purposes.

I I.1 Video Monitoring

It is recommended that a video camera be installed at the site and connected to a remote monitoring facility which is triggered when a train demand is received. The purpose of the recorder is to record driver behaviour on the crossing when a train is approaching.

Where a camera is provided, the personality should be set-up to provide an output to control the recording process. The output should be on from the time that the TD is received until after the crossing ceases to operate. When the crossing finishes operating XE is turned off. A time setting should be used to extend the recording process beyond XE being turned off. It is suggested that the time setting should be set in excess of 12 seconds.

12 Faults

If power failure at the traffic signals is likely to cause significant intersection congestion, consideration should be given to providing an uninterruptible power supply at the intersection.

In the design documentation, the traffic signal engineer responsible for the intersection should specify which of the following modes of operation should be configured if the controller detects a fault in the *train demand* and/or *crossing operating* indications:

- After any clearance phase has run, the controller remains in the *train demand phase set* until the fault is cleared.
- The controller reverts to normal signal operation, ie the normal phase set is to be used.
- The controller switches all signals to flashing yellow.

13 Fault Monitoring and Management

A traffic signal controller interfaced to level crossing signals must be connected to SCATS to ensure that the site is monitored and alarms notified.

The *train demand* and *crossing operating* indications each comprise 2 separate signals, one normally closed and one normally open. Under normal, fault free operation, each of the signals will change state when an indication is changed. If the controller detects a change in one of the two signals for each indication then a fault is detected in either the train demand or crossing operating circuits and the controller shall operate as if a train demand has been received. The following illustrate the situations. Fault free indications are capitalised.

Train Demand	normally closed - open	normally closed - closed
normally open - open	<i>Train demand</i>	NO TRAIN DEMAND
normally open - closed	TRAIN DEMAND	<i>Train demand</i>

Crossing operating	normally closed - open	normally closed - closed
normally open - open	<i>Crossing operating</i>	CROSSING NOT OPERATING
normally open - closed	CROSSING OPERATING	<i>Crossing operating</i>

In the event that the controller detects a fault with the *train demand*, *crossing operating* or *traffic light response* signals a high priority alarm (e.g. SF alarm) should be generated and communicated through SCATS.

The RTA and the Railway Authority (RailCorp, ARTC, RIC, etc) should each nominate a contact person for each intersection and establish an agreed protocol for reporting problems with the operation of either system.

13.1 Alarms

To enable traffic signal engineers and controller technicians to diagnose faults the controller should provide indications to SCATS under the following circumstances:

- Site in flashing yellow due to train mode operating excessively long, and train demand or crossing operating indication has an alarm state;
- Train demand inputs not in agreement;
- Crossing operating inputs not in agreement;
- Traffic light response feedback indication while traffic light response not indicated;
- Crossing operating indication changes state from OFF to ON while train demand not indicated;
- Crossing operating indication present for longer than a defined period after train demand is removed;
- Train demand is removed while crossing operating is applied;
- Crossing operating indication changes state from ON to OFF while rain demand is present (while the crossing is not under manual control and the train demand is a repeat demand);
- Crossing operating indication changes state from OFF to ON earlier than expected (before TLR is indicated, and the crossing is not under manual control and the controller has not started up in the clearance phase and it is more than 2 seconds before TLR is due to be indicated);
- Crossing operating indication is ON approximately 2 seconds before TLR is due to be indicated (and the crossing is not under manual control and the controller has not started up in the clearance phase);

There is a subtle difference between the last two indications. The first detects a change in state from off to on. XE should never turn on too early ie before TLR. The second detects the on state of XE relative to when TLR should turn on. As XE can be on before TLR during a train phase if there is a repeat train demand.

Restrictions in the number and types of alarm (Special Facility) that the controller can raise for special circumstances may mean that the traffic signal controller should provide secondary indications (MSS bits) to aid in remote diagnosis. All alarms should be latched alarms to ensure that the alarm does not 'disappear' when the circumstances causing the alarm are removed. A facility for the remote clearing of alarms via the SCATS interface should be given. Provision should be made for locally clearing the alarms.

Note:

ALARMS SHOULD NOT BE CLEARED UNLESS THE REASON FOR THEIR EXISTENCE IS UNDERSTOOD.

Appendix C C.5 provides an illustration of alarm definition and operation.

14 Specific Timings

The coordination between the railway level crossing and the traffic signal controller is achieved using a traffic signal controller (TSC) incorporating a railway interface unit (RIU). The RIU is fully described in Railway Interface Unit Specification [3] and the procedure for installing the RIU in the TSC is in the Installation and Testing Specification [4].

This section provides specific guidance for the traffic signal engineer in establishing the necessary information and time settings required for the TSC/Personality/RIU to work safely and efficiently with the level crossing. The following timings need to be established:

- Queue Clearance Time

- Train Demand Response Time
- Gate Delay

Figure 1 below illustrates a general situation for a railway level crossing and road intersection layout.

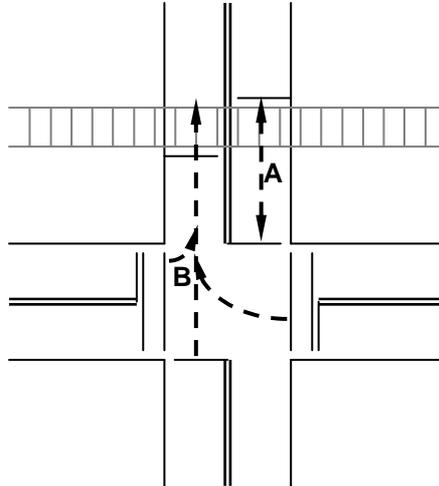


Figure 1 Example situation for railway – road interface

14.1 Queue Clearance Time

The queue clearance time (QCT) is required to clear any queue that may have formed across the level crossing. This means that the QCT must be long enough to clear the queue that may have formed along path A in Figure 1 above. The formulation of the QCT should also take into account the types of vehicle using the level crossing, eg cars, vans, trucks, B-doubles, etc.

The QCT needs to take into account the worst case scenario, where the slowest moving vehicle (eg B-double, bus) may be stopped at point c (Figure 1), ie just on the level crossing. The QCT must be sufficiently long to ensure that the slow moving/ slow accelerating vehicle is clear of the level crossing when the boom gates begin to descend.

The *queue clearance time* is defined by the RTA.

Two methods for establishing the QCT are described below. Both methods should be used to provide confirmation that the chosen value is appropriate.

In both cases the clearance position needs to be determined, ie the place at which it is determined that the queue has been cleared. This may be when the last vehicle which is obstructing the level crossing, in order of preference:

- (a) clears (has passed) the intersection stop line; or
- (b) reaches the intersection stop line; or
- (c) clears (has passed) the level crossing.

14.1.1 Method of Establishing – Empirical

The queue dynamics can be measured at site to establish the maximum length of time that it takes for all vehicles to be clear of the level crossing once the clearance phase has commenced. This measurement should look at all times of the day and week to ensure that unusual patterns are identified and timed to find the maximum time to clear the level crossing of queued vehicles.

The establishment of the queue dynamics may need to be reviewed periodically, dependant on the development and change in use of the road and area, and hence change in vehicles using the intersection – level crossing location.

14.1.2 Method of Establishing – Calculation

This methodology relies on the use of standard principles and equations.

1. A stationary vehicle takes a particular period of time to respond (initial movement) to a change in the traffic signals. The period of time is subject to:
 - (a) driver's attention;
 - (b) gradient at the vehicle's start point;
 - (c) responsiveness of the vehicle, which is dependent on:
 - (i) the drive train of the vehicle;
 - (ii) the vehicle's weight/mass;
 - (iii) vehicle's engine power; and
 - (iv) vehicle's engine innovation.

2. A vehicle takes a particular amount of time to traverse from its start position to the clearance position which is based on the following:
 - (a) the vehicle's distance from the start position to the clearance point; and
 - (b) the vehicle's average acceleration rate, which is dependent on:
 - (i) gradient from the start position to the clearance point;
 - (ii) road alignment between the vehicle's start position and the clearance point;
 - (iii) road pavement type (more significant when in combination with positive gradient);
 - (iv) the vehicle's direction of travel through the intersection, through or turning movement;
 - (v) driver behaviour (eg the driver's propensity to depress the accelerator, ambition to travel at the speed limit);
 - (vi) the actual speed of the vehicle compared with the posted speed limit; and
 - (vii) the clear distance in front of the vehicle.

3. The number and type of vehicles from the intersection stop line to and including the vehicle which is causing an obstruction on the level crossing.

The detailed example in Appendix B uses figures that are of a general nature and are for illustrative purposes only. They must not be taken as correct and equivalents must be established for each specific intersection/railway level crossing interface.

The main problem with the use of this type of calculation method is that it is very pessimistic as the values for vehicle acceleration, driver reaction, vehicle length and vehicle separation must not use optimal or optimistic values.

14.2 Gate Delay

The time from the level crossing warning lights beginning to flash to the point where the boom gates commence descending is termed the gate delay. The gate delay allows for vehicles to remove themselves from the level crossing. This is a parameter that is set in the railway signalling system and is expressed as a range because of the variation in the mechanical tolerances of the boom gates.

Generally, level crossings have a gate delay of 10 to 12 seconds. Where long or slow moving vehicles operate over the level crossing longer gate delays may be required to allow a vehicle which is 'under' the boom gate to be clear by the time the boom gate descends. The gate delay is specified by the Rail

Authority based on the type of vehicle use declared by the RTA. The following four categories have been defined, with the expected gate delay, to embrace all vehicle speeds and/or lengths.

- No long vehicles – 12 seconds
- B-doubles – 12 seconds
- Double road train – 16 seconds
- Triple road train – 21 seconds

The *gate delay* is specified by the Railway Authority.

14.3 Train Demand Response Time

The formulation of the train demand response time (TDRT) is vital to the correct operation of the interface. Its calculation is obtained from the combination of the following components:

- The time to transition to the train demand phase set or clearance phase. The time is dependent on the currently running phase and movements in the traffic signal controller and in practice lies somewhere between the best and worst cases. Examples are provided at Appendix A:
 1. The best case is where the currently running phase has already terminated and the transition to the next phase can be diverted to the clearance phase immediately, satisfying any remaining safety times during the transition (shortest delay); and
 2. The worst case is where the currently running phase has only just been initiated and can not be terminated as one or more of the safety times must be satisfied first (longest delay). Generally, the longest delay will be incurred when a pedestrian movement must be terminated and clearance intervals completed before transition to the next phase can commence.
- The queue clearance time, where appropriate. The time required to clear any vehicles that may have unwisely ventured onto the railway crossing without ensuring that they could clear the crossing completely. This time depends on the possible queue length from the intersection stop line to the level crossing and the types of vehicle that would make up the queue, eg a B-double take considerably longer to move 20 metres than an ordinary car irrespective of the type of driver. Each site needs individual inspection to determine an appropriately conservative value for the QCT.
- Level crossing boom gate delay.
- The time required for a vehicle to clear the intersection conflict zone and pass the level crossing before the warning lights start to flash (paths labelled B in Figure 1 above). In general, the worst case time for this will be for a right turn filter vehicle, as it is required to wait until there is a gap in the opposing traffic (which might not appear until the phase is terminating and the opposing traffic stops); and then exit the intersection conflict zone and proceed towards the level crossing. The time will also depend on the vehicle type.

The *train demand response time* is determined by the RTA and advised to the Rail Authority. The Rail Authority uses this time to determine how far before the level crossing it needs to position train detection devices.

14.3.1 Method of Establishing

TDRT is equal to:

- the queue clearance time (section 14.1 above) *minus*
- the gate delay (section 14.2 above) *plus*
- the time to transition.

TDRT must not be less than the time taken for a stationary right turn filter vehicle to clear the intersection conflict zone and pass the level crossing warning lights. This becomes paramount when the QCT is zero and the time to transition is short.

The time to transition from the current phase to the start of the clearance phase, is the greater of:

- The longest pedestrian clearance (which by necessity takes into account the type of pedestrians that use the crossing). This assumes that the train demand either: arrives at the start of pedestrian clearance; or during walk where walk is expired immediately. In addition, the pedestrian clearance ends at the end of all red.

OR

- The sum of minimum green time plus intergreen time.

15 Successive Operation

Where a level crossing is on a busy railway line (particularly a double track) it is reasonable to expect a second train to approach the level crossing while the first train is still passing through it. There are three general cases where successive operation is to be considered.

- The second train places a ***train demand*** while the first ***train demand*** is still in place. The traffic signal controller will not detect a second train but a continuous train demand. In this case the successive demand keeps the traffic signal controller in the ***train demand phase set*** and remains here until “both” ***train demands*** have ceased and will begin transition to the normal set of phases when ***crossing operating*** ceases.
- The second train places a ***train demand*** shortly after the level crossing has ceased operating. In this case the successive demand is treated as a new separate demand and a clearance phase is demanded, where appropriate.
- The second train places a ***train demand*** after the first ***train demand*** has been removed but while the level crossing is still operating. In this case there are two particular responses by the traffic signal controller:
 1. The second ***train demand*** arrives before the traffic signal controller has removed the ***traffic light response***. In this case the successive demand keeps the traffic signal controller in the ***train demand phase set*** and remains here until “both” ***train demands*** have ceased and will begin transition to the normal set of phases when the second ***crossing operating*** ceases.
 2. The second ***train demand*** arrives after the traffic signal controller has removed the ***traffic light response***. In this case the railway system may have started to raise the boom gates. In this instance the successive demand is treated as a new separate demand and a clearance phase is demanded, where appropriate.

Appendix A Time to Transition – Clearance Phase

This section provides a number of timing examples for establishing the time to transition to the clearance phase of the train demand phase set.

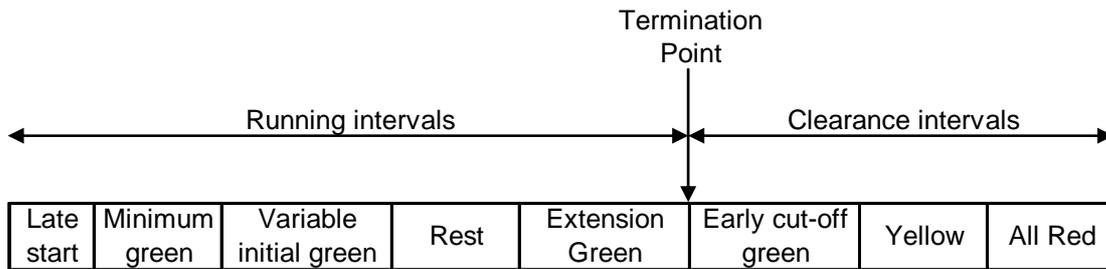


Figure 2 General schematic of phase intervals

For worst case calculation purposes it is assumed that the train demand is received at the start of the phase interval not part way through.

The early cut-off green interval is used to allow some signal groups to be terminated earlier than others and therefore extends the overall intergreen time. ECG is not used at all intersections or for all phases at an intersection. Where ECG is used it may be possible to reduce the length of the ECG to zero at intersections where it is used for particular transitions.

A.1 Train Demand During Late Start

If a train demand is received during late start of any phase the phase can not be terminated immediately. The delay before the clearance phase or a phase of the train set can be run is equal to the length of the:

- Late start¹, where used, **plus**
- Minimum green, **plus**
- Early cut-off green, where used, **plus**
- Yellow, **plus**
- All red.

The variable initial green, rest and extension green are minimised, ie 0 seconds.

A.2 Train Demand During Minimum Green

If a train demand is received during minimum green of any phase the phase can not be terminated immediately. The delay before the clearance phase or a phase of the train set can be run is equal to the length of the:

- Minimum green, **plus**

¹ Where late start is used it may be possible to expire the late start interval immediately and refrain from introducing the signal group.

- Early cut-off green, where used, **plus**
- Yellow, **plus**
- All red.

The variable initial green, rest and extension green are minimised, ie 0 seconds.

A.3 Train Demand After Minimum Green

If a train demand is received during variable initial green, rest or extension of any phase the phase can be terminated immediately. The delay before the clearance phase or a phase of the train set can be run is equal to the length of the:

- Early cut-off green, where used, **plus**
- Yellow, **plus**
- All red.

The variable initial green, rest and extension green are either already complete, terminated immediately or minimised, ie 0 seconds.

A.4 Train Demand During Intergreen

In the normal operation of a traffic signal controller, it is normal practice to “freeze” the “next phase” at the termination point.

To improve the responsiveness of the traffic signal controller, where it interfaces with the level crossing, it is possible to configure the phases and personality such that it is possible to divert from the “next phase” to the clearance phase or the train demand phase set while the running phase is in the intergreen. This relies on the personality being correctly configured to identify and respond to any overlap signal groups appropriately.

A.4.1 No Diversion

Where no diversion is allowed, the delay before the clearance phase or a phase of the train set can be run is equal to the length of the:

- Early cut-off green, where used, **plus**
- Yellow, **plus**
- All red, **plus**
- Late start², where used, **plus**
- Minimum green, **plus**
- Early cut-off green, where used, **plus**
- Yellow, **plus**
- All red.

² Where late start is used it may be possible to expire the late start interval immediately and refrain from introducing the signal group.



Note: Where diversion is not allowed, the intersection personality should be configured to prevent the introduction of any new signal groups when the next phase starts. This will prevent minimum timers being started and thus allow the phase to terminate quicker and transition to the clearance phase.

A.4.2 Diversion Permitted

Where diversion is allowed, the delay before the clearance phase or a phase of the train set can be run could be as short as 100ms, or as long as the length of the intergreen:

- Early cut-off green, where used, **plus**
- Yellow, **plus**
- All red.

Depending on when the train demand is received and the point at which the diversion takes place.

A.5 Train Demand During Pedestrian Walk

Wherever the main running phase is in its cycle the pedestrian clearance intervals must be completed before the running phase is complete.

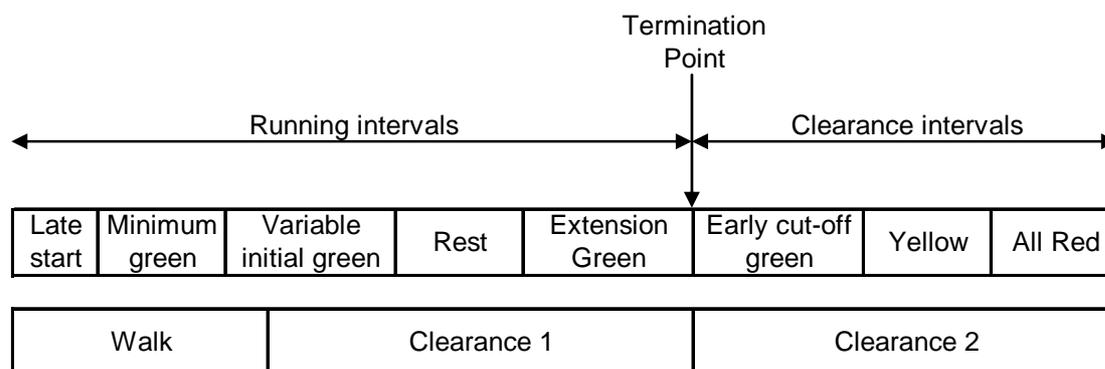


Figure 3 General schematic of phase and pedestrian intervals

Wherever the train demand is received, the WALK should be terminated immediately (not always possible depending on intersection geometry and pedestrian usage [eg school children, blind, aged]) and the clearance intervals must be correctly completed. The minimum delay before the clearance phase or a phase of the train set can be run is equal to the length of the:

- Clearance 1, **plus**
- Clearance 2.

This may be increased by the length of WALK if this cannot be terminated.

Appendix B Queue Clearance Time – Detailed Example

The values given below are only intended to illustrate the concepts being discussed; they are not necessarily representative. Traffic signal engineers, adaptive engineers and intersection designers need to assure themselves of the correct values to be used in all cases. In addition, there may be other factors which have not been addressed below which will affect the calculation of Queue Clearance Time, eg road gradients, alignments, etc.

The methodology described here is a very simplified model of queue dissipation. Notations are added to indicate where simplification could affect the overall results and why the use of conservative data compensates.

This example expands on the outline given in section 14.1.2.

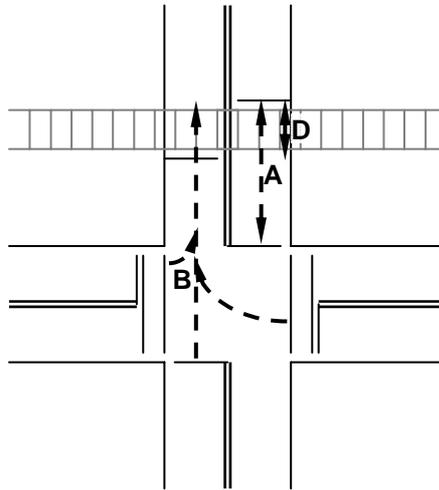


Figure 4 Example situation for railway – road interface

The distance between the intersection stop line and the level crossing stop line is 50 metres (distance A in Figure 4 above). The intersection is regularly used by cars, trucks and B-doubles.

The following assumptions are made:

- [A1] The general time to dissipate a queue of cars is taken as 2 seconds per car.
- [A2] Reaction time of the driver and car is 1 second taken from the point at which the state of the lights change to the initial movement of the car.
- [A3] For a driver and truck the reaction time is considerably greater, typically 3.25 seconds, due to such things as the drive train of the truck, weight/mass, engine innovation and power have an effect as well as the greater inertia which is required to be overcome.
- [A4] Average car length is 4.5 metres and average acceleration rate is 1.7 m/s^2 . This figure is only a guide as the engine power and driver behaviour can have a significant effect on the overall value. In addition, driver behaviour means that although the initial acceleration may be higher, the acceleration of the vehicle decreases as the absolute speed of the vehicle increases.
- [A5] B-double length is 26 metres and acceleration rate is 0.4 m/s^2 . This figure is only a guide as the engine innovation and power can have an effect on the overall value. In addition, driver behaviour means that although the initial acceleration may be higher, the acceleration of the vehicle decreases as the absolute speed of the vehicle increases.

- [A6] Stopped vehicle separation is 1.5 metres. The actual figure can range from as little as 0.5 metres to more than 2.5 metres depending on individual driver behaviour.
- [A7] Level crossing width is 10 metres, measured from crossing stop line to opposite boom gate (D in Figure 4 above). This will vary with type of railway line: single, double, triple track, etc. and requisite clearances.
- [A8] Speed limit of the road is 60kmh.

With this situation there are a number of ways in which the queue may be made up. The make up of the queue may also affect the way in which the queue adapts to the level crossing.

B.1 Scenarios

The following three figures provide different scenarios:

1. The last vehicle obstructing the level crossing is a car.
2. The last vehicle obstructing the level crossing is a B-double and its front end is the offending part.
3. The last vehicle obstructing the level crossing is a B-double and its rear end is the offending part.

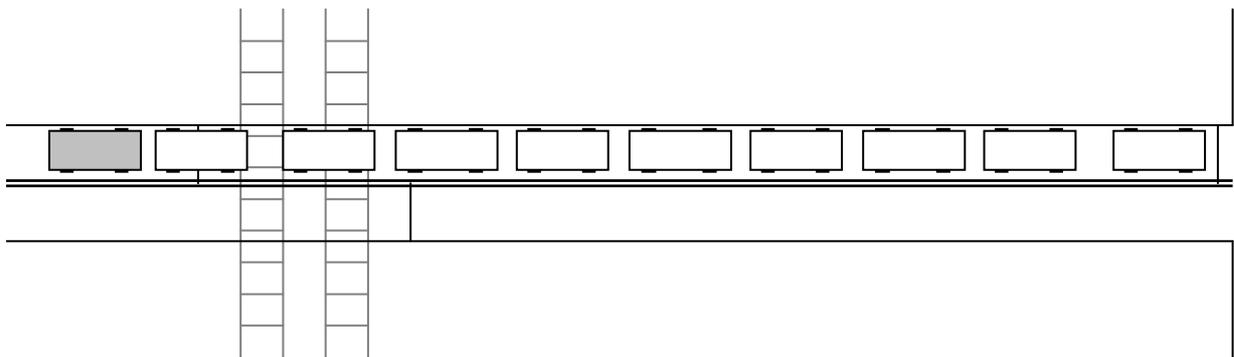


Figure 5 Scenario 1 example queue composition

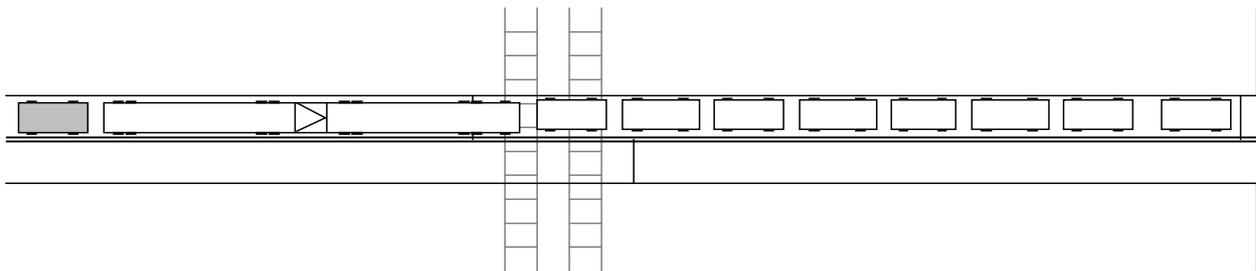


Figure 6 Scenario 2 example queue composition

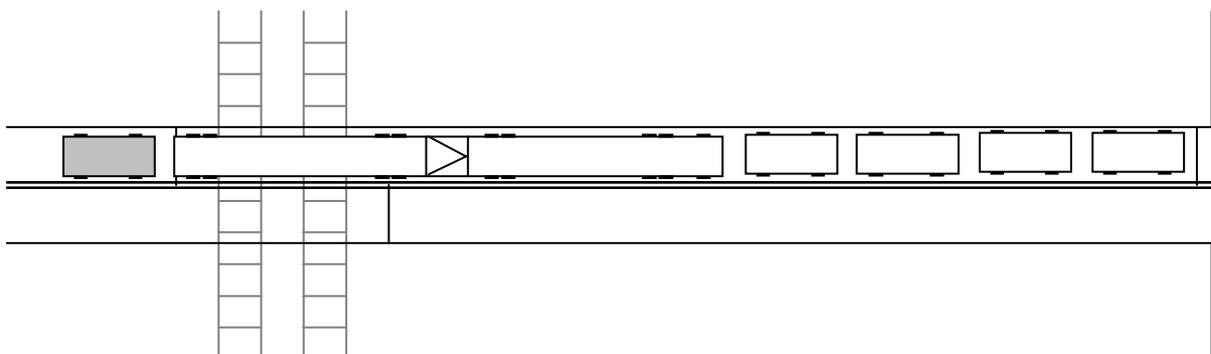


Figure 7 Scenario 3 example queue composition

The three scenarios allow for a range of queue clearance times to be established for the above. This range is not exhaustive.

In all the scenarios it has been assumed that the last vehicle's driver is distracted sufficiently to proceed onto the level crossing before ensuring that they can safely exit the level crossing's danger area. It has also been assumed that any further vehicles (shaded in the diagrams) stop at the level crossing and do not attempt to cross.

The following table summarises the scenario results calculated in the following sub-sections.

Case	Scenario		
	1	2	3
A Time for last vehicle to PASS the intersection STOP line (secs)	19s	29s	25½s
B Time for last vehicle to REACH the intersection STOP line (secs)	18½s	25s	20s
C Time for last vehicle to CLEAR the level crossing (secs)	12s	22½s	16s

Note: all calculated figures have been rounded up to the nearest half second.

Traffic signal engineers, adaptive engineers and intersection designers need to assure themselves of any values that are to be used for the intersections they are designing and responsible for.

B.2 Scenario I

B.2.1 Case A

If there are just cars in the queue and then the back of the last (8th) car will be:

46½ metres ($8 \times 4\frac{1}{2} + 7 \times 1\frac{1}{2}$) from the intersection stop line.

This puts the eighth car on the level crossing. For worst case purposes it should be assumed that the following car may have encroached past the level crossing stop line and be effectively on the level crossing as well. The back of this ninth car will be:

52½ metres from the intersection stop line.

From assumption [A1] above, the time to clear the queue of nine cars would take:

$$\begin{aligned}
 t &= \text{number of cars} \times 2 \text{ seconds} + \text{response time of first car} \\
 &= 9 \times 2 + 1 \\
 &= 19 \text{ seconds}
 \end{aligned}$$

B.2.2 Case B

For situations where it is established that the last vehicle does not have to clear the intersection stop line then the assumption [A1] above is no longer viable.

If the car on the level crossing just has to reach the intersection stop line then the time will only be marginally less, say

$$t = 18\frac{1}{2} \text{ seconds}$$

This takes account of: the vehicle is already moving; the time taken to reach the intersection stop line as opposed to clearing it is small.

B.2.3 Case C

For situations where it is established that the last vehicle does not have to clear the intersection stop line then the assumption [A1] above is no longer viable.

If the car on the level crossing only has to clear the level crossing then the time needs to be established. In this case the Gipps model [8] is used. The figure should be treated with caution.

$$t = 12 \text{ seconds}$$

B.3 Scenario 2

B.3.1 Case A

In this scenario the eighth car is followed by a B-double.

The back of the last (8th) car will be:

$$46\frac{1}{2} \text{ metres } (8 \times 4\frac{1}{2} + 7 \times 1\frac{1}{2}) \text{ from the intersection stop line.}$$

This puts the eighth car on the level crossing. For worst case purposes it should be assumed that the following B-double may have encroached past the level crossing stop line and be effectively on the level crossing as well. The back of the B-double will be:

$$74 \text{ metres from the intersection stop line.}$$

Using assumption [A1] above would provide the same 19 second queue dissipation time. Unfortunately the inclusion of a non-car invalidates the assumption. The Gipps behavioural model [8] provides a method for the establishment of an appropriate queue dissipation time.

Using the Gipps equation [8] realises the following queue clearance time:

$$t = 29 \text{ seconds}$$

B.3.2 Case B

Where the B-double only has to reach the intersection stop line then the back of the B-double will be:

$$26 \text{ metres from the intersection stop line,}$$

ie the travelled distance:

$$= 74 \text{ (back of B-double) - 26 (length of B-double)}$$

$$= 48 \text{ metres}$$

The behavioural model realises the following queue clearance time:

$$t = 25 \text{ seconds}$$

B.3.3 Case C

Where the B-double only has to clear the level crossing then the back of the B-double will be:

$$50 - 10 = 40 \text{ metres from the intersection stop line,}$$

ie the travelled distance:

$$= 74 \text{ (back of B-double) - 50 (distance between stop lines) + 10 (width of level crossing)}$$

= 34 metres

The behavioural model realises the following queue clearance time:

$t = 22\frac{1}{2}$ seconds

B.4 Scenario 3

B.4.1 Case A

B-double is last vehicle but on the level crossing not past it.

In this scenario the B-double is preceded by four cars. The back of the 4th car will be:

22½ metres ($4 \times 4\frac{1}{2} + 3 \times 1\frac{1}{2}$) from the intersection stop line.

The back of the B-double will be:

50 metres from the intersection stop line.

Using assumption [A1] above would provide the same 19 second queue dissipation time. Unfortunately the inclusion of a non-car invalidates the assumption. The Gipps behavioural model [8] provides a method for the establishment of an appropriate queue dissipation time.

Using the Gipps equation [8] realises the following queue clearance time:

$t = 25$ seconds

B.4.2 Case B

Where the B-double only has to reach the intersection stop line then the back of the B-double will be:

26 metres from the intersection stop line,

ie the travelled distance:

= 50 (back of B-double) - 26 (length of B-double)

= 24 metres

The behavioural model realises the following queue clearance time:

$t = 25$ seconds

B.4.3 Case C

Where the B-double only has to clear the level crossing then the back of the B-double will be:

50 - 10 = 40 metres from the intersection stop line,

ie the travelled distance:

= 50 (back of B-double) - 50 (distance between stop lines) + 10 (width of level crossing)

= 24 metres

The behavioural model realises the following queue clearance time:

$t = 22\frac{1}{2}$ seconds

Appendix C Examples

The following subsections provide examples of information to be considered and specified. Reference to particular detectors, phases or XSF/MSS bits is purely for example purposes and each site may be different.

C.1 Phasing

The phase following a train demand may be required to be different. For example, when the train demand is terminated the controller will move from E or F phase to one of the following phases:

- B phase if XSF2 is on (and XSF3 is off).
- C phase if XSF3 is on
- B phase if demanded and XSF2 & XSF3 are both off
- C phase if demanded and XSF2 & XSF3 are both off and B phase is not demanded.
- A phase if XSF2 & XSF3 are both off and B & C phases are both not demanded.

Or

- E phase is followed by B phase if:
 - XSF2 is off, and
 - there is no repeat Train Demand.
- E phase is followed by A phase if:
 - XSF2 is on, and
 - there is no repeat Train Demand.

C.2 Minimum Green Interval Timing

This time setting may need to be set to a longer time setting to allow vehicles queued at the railway crossing time to travel to the stop line detectors before the phase terminates.

For example, when B phase follows E phase, the B phase minimum green interval will use time setting B Spare/Special (SCATS BSP - B Special Time) which has a value larger than the normal minimum green interval.

C.3 TLR Outputs

C.3.1 TSC/4 Controller

The methods for control of the Wait outputs are different on each of the TSC/4 controllers. To avoid confusion the special facility outputs should be used instead.

Outputs to the Railway Interface Unit are:

- Special Facility Output 1 - TLRL on/off control

- Special Facility Output 2 - Shunt TLRH - force off
- Special Facility Output 3 - TLRL on/off control

C.3.2 PSC Controller

Outputs to the Railway Interface Unit are:

- Wait Indicator Output 1 - TLRL on/off control
- Wait Indicator Output 2 - Shunt TLRH - force off
- Wait Indicator Output 3 - TLRL on/off control

C.4 Operational Monitoring

The following signals allow a remote user to monitor the state of the level crossing interface operation:

- MSS 9 - ON while TD is ON
- MSS 10 - ON while TLR is ON
- MSS 11 - ON while XER is ON
- MSS 12 - ON while Crossing is Manually operated.
- MSS 16 - ON while in train mode and controller forced isolated.

Other signals which the traffic signal controller could report to SCATS: TDNO, TDNC, XENO, XENC, TLRF.

C.5 Alarms

- | | |
|---|--|
| <ul style="list-style-type: none"> ● Site reverted to FY due to Train Mode operating for too long ie exceeding time setting B10, and TD and/or XER inputs have an alarm state ie MSS 1 and/or 2 are set | <ul style="list-style-type: none"> – MSS 4 on while FY and SCATS SF2 alarm on while FY. |
| <ul style="list-style-type: none"> ● TD inputs not in agreement | <ul style="list-style-type: none"> – MSS 1 latched on and SCATS SFI alarm latched on. |
| <ul style="list-style-type: none"> ● XER inputs not in agreement | <ul style="list-style-type: none"> – MSS 2 latched on and SCATS SFI alarm latched on. |
| <ul style="list-style-type: none"> ● XER goes on while TD is off | <ul style="list-style-type: none"> – MSS 5 latched on and SCATS SFI alarm latched on. |
| <ul style="list-style-type: none"> ● XER remains on for 15 secs or more after TD is off | <ul style="list-style-type: none"> – MSS 5 latched on and SCATS SFI alarm latched on. |
| <ul style="list-style-type: none"> ● TD goes off while XER is on and the crossing is not under manual control | <ul style="list-style-type: none"> – MSS 6 latched on and SCATS SFI alarm latched on. |
| <ul style="list-style-type: none"> ● XER goes on too early (XER has turned on when TD is on but TLR is not due to be turned for at least 2 secs, and the crossing is not under manual control and the controller has not started up in D phase). | <ul style="list-style-type: none"> – MSS 7 latched on and SCATS SFI alarm latched on. |
| <ul style="list-style-type: none"> ● XER goes on too early(XER has turned on when TD is on but TLR is not due to be turned for 2 secs, and the crossing is not under manual control and the controller has not started up in | <ul style="list-style-type: none"> – MSS 8 latched on and SCATS SFI alarm latched on. |

D phase).

There is a subtle difference between alarm MSS 7 and 8. MSS 7 detects a change in state from off to on. XE should never turn on too early ie before TLR. MSS 8 detects the on state of XE relative to when TLR should turn on. Because XE can be on before TLR during D phase if there is a repeat train demand eg during E/F, XE being on too early is ignored until 2 seconds before TLR is due to turn on. XE should be off at that point.

C.5.1 Clearing

The alarms that are latched can be cleared remotely by turning the SCATS XSF 1 from off to on.

The alarms can be cleared locally by turning detector 8 from off to on, eg on the input card or HHT.

It should be noted alarms will be cleared if the controller is restarted. The alarms will be regenerated if the circumstances causing the alarm still exist.

The change in state clears the alarm not the actual state. Thus if XSF1/detector 8 are left on the alarms are not disabled.

For further enquiries

www.rta.nsw.gov.au

13 22 13

Roads and Traffic Authority

March 2008

RTA/Pub. 08.092