Intersections
Guide to Traffic Management Part 6
Guide to Road Design Part 4 and 4A
6 November 2017
Today’s moderator

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About Austroads

The peak organisation of Australasian road transport and traffic agencies

- Roads and Maritime Services New South Wales
- Roads Corporation Victoria
- Department of Transport and Main Roads Queensland
- Main Roads Western Australia
- Department of Planning, Transport and Infrastructure South Australia
- Department of State Growth Tasmania
- Department of Transport Northern Territory
- Transport Canberra and City Services Directorate, Australian Capital Territory
- Commonwealth Department of Infrastructure and Regional Development
- Australian Local Government Association
- New Zealand Transport Agency
Housekeeping

Webinar = 55 mins
Question time = 15 mins
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Austroads Guides

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Today’s presenters

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## Agenda

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<td>Q&amp;A</td>
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Introduction
Peter Aumann
Guide Relationships

• Guide to Road Design Parts 4, 4A, 4B and 4C provide guidance relating to design parameters for intersections and crossings together with typical layouts of various intersections, interchanges and crossings and other relevant facilities.

• Part 6 of the Guide to Traffic Management provides guidance on traffic management aspects, including the selection of intersection type, including considerations for various road user types.

Lisa Steinmetz
Process

Project Team

Austroads Project Manager
Dave Landmark

Senior Research Engineer, ARRB
Lisa Steinmetz

Principal Research Engineer, ARRB
Peter Aumann

Review Team

Austroads Project Working Group
Austroads Traffic Management Working Group
Stakeholders-Road and Traffic Authorities
Austroads Network Taskforce
Austroads Board
Purpose

- Focuses on traffic management and treatments
- Describes the use and design of:
  - various intersection types
  - techniques to be applied for efficient and safe intersections
Structure

1. Introduction
2. Selection of Intersection Types
3. Roundabouts
4. Signalised Intersections
5. Unsignalised Intersections
6. Road Interchanges
7. Rail Crossings
8. Pedestrian and Cyclist Crossings
Key Updates

Safety Systems principles

Network Operations objectives

See General
# AGTM Part 6: Intersections, Interchanges and Crossings

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</thead>
</table>
Types of Intersections

Rural channelised turn treatments

• Increased separation

See Section 2.2.4
Types of Intersections

Left in/left out (LILO)

- Channelised left turn treatment added

See Section 2.2.4
Types of Intersections

Staggered T-intersections

• Additional content on left-right (preferred configuration), although direction of stagger may also be influenced by existing site conditions, traffic volumes, and road alignment.

(a) Left-right (L-R)  
(b) Right-left (R-L)  
(c) Left-right (L-R)
Intersection Selection

Selection process

• Safe System and network performance objectives

See Section 2.3.2
Intersection Selection

- Intersection safety performance predominantly influenced by approach speed, impact angle and opportunity for conflict

# Intersection Selection

- **Safe System Assessment Framework**

<table>
<thead>
<tr>
<th>Stages</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Assess objectives</td>
<td>The first step is to identify and document the objective of the assessment in terms of purpose, scale and depth.</td>
</tr>
</tbody>
</table>
| 2. Project context          | Consider:  
  - What is the reason for the project?  
  - What is the function of the road?  
  - What is the speed environment?  
  - What road users are present?  
  - What is the vehicle composition? |
| 3. Safe System Matrix       | In order to ensure that Safe System elements are considered, or to measure how well a given project (e.g. an intersection, road length, area, treatment type etc.) aligns with Safe System principles, the Framework provides a Safe System matrix. The matrix helps the assessment of different major crash types against the exposure to that crash risk, the likelihood of it occurring and the severity of the crash should it occur. |
| 4. Treatment hierarchy      | Finally the Framework outlines a Safe System-based hierarchy of solutions for common high severity crash types:  
  - run-off-road  
  - head-on  
  - intersection  
  - pedestrian  
  - bicyclist  
  - motorcyclist  
  - other  
  The guidance on Safe System treatment hierarchy can inform decisions regarding the appropriate treatments that might be used to address crash risks identified by the assessment matrix. |

See Section 2.3.2
Intersection Selection

• Network operation
  - Consider road user needs
  - Priority for certain road user groups or balancing priorities for multiple groups

See Section 2.3.2
Intersection Selection

Assessment of Intersection Control Options

• Traffic control selection to optimise safety and operational performance

• Safe System intersection hierarchy of control:
  1. roundabouts
  2. signalised intersections
  3. unsignalised (stop or give way preferred to road rules only).

See Section 2.3.3
## Intersection Selection

### Suitability of types of traffic control to different intersection layouts

<table>
<thead>
<tr>
<th>Intersection layout</th>
<th>Roundabout</th>
<th>Signals</th>
<th>Stop or give way</th>
<th>Road rules only</th>
</tr>
</thead>
<tbody>
<tr>
<td>T-intersections</td>
<td>All forms of control generally work well.</td>
<td>Generally work well.</td>
<td>A staggered T-intersection is preferred(1).</td>
<td></td>
</tr>
<tr>
<td>Four-way intersection</td>
<td>Generally work well.</td>
<td>Generally work well.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Y-junction</td>
<td>Generally work well.</td>
<td>Generally work well.</td>
<td>Not recommended due to poor observation angle on the minor road.</td>
<td>Not recommended due to poor observation angle on the minor road. Also confusion regarding who has right-of-way.</td>
</tr>
<tr>
<td>Multileg intersection (more than four legs)</td>
<td>Single lane roundabouts generally work well. Multileg, multilane roundabouts cause significant driver confusion in terms of the appropriate lane choice for the intended movement.</td>
<td>Can experience high crash rates. Can result in inadequate sighting of lanterns. Can produce a high proportion of inter-green time.</td>
<td></td>
<td>Can cause confusion as to who has right-of-way.</td>
</tr>
</tbody>
</table>
Intersection Selection

Warrants for BA, AU and CH Turn Treatments

• New curves for 70-100 km/h and <70 km/h
• Calculation of the major road traffic volume now includes road types:
  - Two-lane two-way
  - Four-lane two-way
  - Six-lane two-way

See Section 2.3.6
Road User Considerations

Pedestrians
Age, ability
Safe System

Cyclists
Types, ability, level of service, type of facility

Motorcyclists
Unique needs, susceptible to crashes at intersections

Trucks
Negotiate intersections with adequate clearance

Public transport
Vehicles and needs of users

See Section 2.4
Intersection Performance

Safety performance:

• ensuring adequate visibility
• minimising potential for conflict
• managing priority movements
• managing speeds
• clear and easy to understand design and layout

See Section 2.5
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<tr>
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</thead>
</table>
Roundabouts

• Safe System considerations
• Expected crash reductions
• Concerns and considerations for motorcyclists, cyclists and pedestrians
• Potential speed reduction treatments for approaches
• Signalised roundabouts

See Section 3

Section 3.3.1
Section 3.4
Section 3.5.4
Section 3.6
AGTM Part 6: Intersections, Interchanges and Crossings

1. Introduction
2. Selection of Intersection Types
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6. Road Interchanges
7. Rail Crossings
8. Pedestrian and Cyclist Crossings
## Contribution of signal management to meeting road user needs

<table>
<thead>
<tr>
<th>Road user need</th>
<th>Contribution of signal management</th>
</tr>
</thead>
</table>
| Mobility       | • Adjust signal timings and phasing to reduce delay at individual intersections, for priority road users/movements at certain times of the day.  
                  • Improve coordination of signals along a corridor to maximise throughput and progress priority uses/movements at certain times of the day.  
                  • Implement network-wide congestion management strategies (e.g. pre-emption/gating of general traffic to address recurrent congestion problems in an area.  
                  • Support control of access to the network and dissipation of traffic to assist incident management in reducing non-recurrent congestion.  
                  • Actively discourage vehicle movements in locations with good level of service for other modes, to encourage modal shift and reduce traffic on the network.  
                  • Support public transport and freight movements where intended. |
| Safety         | • Prevent unsafe conflict of movements.  
                  • Provide protection to vulnerable road users such as pedestrians and cyclists. |
| Access         | • Improve level of service for all road users.  
                  • Assist in improving equity for side/local road access to key arterials during off-peak periods.  
                  • Provide priority for emergency vehicles where possible. |
Signalised Intersections

- Table 4.2 Factors affecting signalised intersection capacity and safety
- Table 4.3 Road user requirements for arterial road signalised approaches
- Table 4.4 Road user requirements for local road signalised approaches
- Table 4.5 Lane management at signalised intersections

See Section 4
Signalised Intersections

Elements of traffic signal operation

• Provides a summary and directs readers to GTM Part 9 for more information.

<table>
<thead>
<tr>
<th>Traffic signal operation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signal phasing</td>
<td>A signal phase is a state of the signals during which one or more movements (streams of vehicles) receive right-of-way subject to resolution of any vehicle or pedestrian conflicts by priority rules. A phase is identified by at least one movement gaining right-of-way at the start of it and at least one movement losing right-of-way at the end of it. Needs of different road user groups, for example motorcyclists, should be taken into consideration when design of the signal phasing is undertaken.</td>
</tr>
</tbody>
</table>
| Signal timings           | Signal timing at a signalised intersection, including the allocation of appropriate green times to competing traffic movements, requires consideration of:  
• safety  
• adequate capacity  
• efficient traffic operation  
• equity in levels of service for different movements  
• priority for different road users. |
| Coordination of traffic signals | Coordination of traffic signals is implemented to improve the level of service of a road or a network of roads. |
| Traffic detection        | The effectiveness of traffic signal systems and hence signalised intersections depends on the ability to detect traffic on intersection approaches and respond with appropriate changes of phase and timing requirements. Pedestrian demands are usually recorded when a pedestrian presses a push button mounted on the side of the signal post, although other (often automated) sensors may be used. 
Detection of bicycles and light motorcycles is more difficult, but may be achieved by attention to the design of detection loops. |
# AGTM Part 6: Intersections, Interchanges and Crossings

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Unsignalised Intersections

**Amended Traffic controls** Section 5.2.2

- Sight distance requirements for Stop signs, drivers eye height changed to 1.10 m
- Acknowledge New Zealand stipulation that Stop signs to be erected at a blind intersection
## AGTM Part 6: Intersections, Interchanges and Crossings

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8. Pedestrian and Cyclist Crossings
Interchanges

• Spacing of interchanges  
  Section 6.3.1

• Ramp metering  
  Section 6.9

See Section 6
Rail crossings

• Safety at Rural Rail Crossings

• Level crossing treatments
  − Rumble strips
  − Speed limit signs
  − Yellow box marking in addition to the queue relocation and passive signs
  − Provision of additional storage or an escape lane
  − ‘Upgrade protection’ amended to include ‘passive to active protection’ and ‘improve active protection elements

• Selection of treatment (ALCAM)
AGTM Part 6: Intersections, Interchanges and Crossings

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Pedestrian and cyclist crossings

• Bicycle path terminal treatments at road crossings  
  See Section 8.2.2
• Crossings at signalised facilities  
  − Pedestrian countdown timers  
  See Section 8.2.3
• Bicycle treatments at intersections  
  See Section 8.3
Unconventional & Innovative Designs

Vertical deflections at/on approaches

Flower roundabout

See Commentary 6
Process

Project Team

Austroads Project Manager
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Review Team

Austroads Project Working Group

Austroads Road Design Task Force

Stakeholders-Road and Traffic Authorities

Austroads Board
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- VicRoads

- Mike Whitehead
- TMR

- Austroads
- Project Working Team

- Peter Ellis
- RMS

- John Matta
- VicRoads

- Tony Arnold
- ABC

- Matthew Pascos
- VicRoads

- Fergus Tate
- NZTA

- Richard Fanning
- VicRoads

- Matthew Pascos
- VicRoads
Part 4 Purpose

Part 4 Intersections and Crossings- General provides:

• information for the geometric design of at-grade intersections.

• some information on the types of intersections,

• design considerations for intersections and the

• design process for the development of an intersection layout.
Part 4A Purpose

Part 4A: Signalised and Unsignalised Intersections provides:

• guidance for the geometric design of at-grade intersections (excluding roundabouts).
• intersection sight distances
• turn treatments
• auxiliary lanes at intersections
• size of traffic islands.
## Key moves from Part 4A to Part 4

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<td>Section 7.1-7.5</td>
<td>Types of treatment and selection, rural channelised left turn, cyclists at rural free flow left turn lanes on bicycle routes, left turn treatments</td>
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<td>Section 9</td>
<td>U-turn treatments</td>
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<td>Section 10</td>
<td>Signalised intersections, urban roads, rural roads</td>
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Introduction

Section 1.3.1: Providing for a Safe System

- Emphasis to understand the interaction between road elements and the likely crashes
- More information is referenced to Guide to Road Design Part 1: Introduction to Road Design

Section 1.3.3: Progressive Safety Updates

- Innovative and emerging treatments – need for assessment and translation to local conditions, assessing risk, safety, operation, whole of life costs

Section 1.5: Other Considerations moved to Section 3.7
# AGRD Part 4: Intersections and Crossings - General

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<td>9. Cyclist Crossings</td>
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<tr>
<td>10. Rail Crossings</td>
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</tbody>
</table>
Types of Intersections

- Key reference made to GTM Part 6: Intersections, Interchanges and Crossings

- Emphasis design principles for an intersection:
  - are the same irrespective of the type of control
  - in urban areas, need to consider parking on approaches, cyclists and pedestrians

- Basic Forms of intersection moved to Appendix A
## AGRD Part 4: Intersections and Crossings - General

|-----------------|---------------------------|-----------------------------------------------|-------------------|------------------|
Design Considerations

- Emphasis to consider all road users, particularly pedestrian and cyclists
- Road users are not:
  - surprised by the location of the intersection or the layout
  - not severely disadvantaged for making.

Source: Australian Road Research Board
# AGRD Part 4: Intersections and Crossings - General

|------------------------|---------------------------|-------------------------------------------------|-------------------|-------------------|
Design Process

Table 4.1: Factors regarding function

• Emphasis on identifying:
  1. All possible conflict points
  2. Movement priority based on function and classification.

Section 4.3: Locations of Intersections

• Emphasising that design is an iterative process and layouts may need to change through the course of the design development.
Design Vehicles

Table 5.1: Selection of design and checking vehicles

- Updated to align with Design Vehicles and Turning Path Templates Guide (AP-G34-13)

Source: Austroads Design Vehicles and Turning Path Templates (2013)
# AGRD Part 4: Intersections and Crossings - General

|-----------------|---------------------------|-----------------------------------------------|------------------|------------------|
Public Transport

Providing for Buses and Bicycles

- Emphasising the need to consider cyclists, in particular commuter cyclists, even if there is an off-road bicycle path

Source: Australian Road Research Board
|-----------------|--------------------------|-----------------------------------------------|------------------|------------------|
Property Access

Access Spacing and Proximity of Driveways to Intersections

• Section transferred from Appendix A5 and including Table (7.1):
Examples of upstream functional intersection distances

Figure 7.1: Upstream functional intersection area (based on right-turning vehicles)

Table 7.1: Examples of upstream functional intersection distances

<table>
<thead>
<tr>
<th>Location</th>
<th>Speed (km/h)</th>
<th>$d_1 + d_2$ (m)</th>
<th>Storage: $d_2$ (m)</th>
<th>Upstream functional distance (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural</td>
<td>80</td>
<td>185</td>
<td>25(1)</td>
<td>210</td>
</tr>
<tr>
<td>Rural</td>
<td>100</td>
<td>250</td>
<td>25(1)</td>
<td>275</td>
</tr>
<tr>
<td>Rural</td>
<td>110</td>
<td>310</td>
<td>25(1)</td>
<td>335</td>
</tr>
</tbody>
</table>
Median Openings

Additional guidance for high-speed divided roads

• The U-turn facility should be based on a network wide strategy (i.e. U-turn facility spacing)

• If a facility cannot be provided within 3 km, consideration providing a channelised right-turn treatment (CHR) of adequate truck storage length (Appendix A.7.1)
Introduction

Safe System approach

Additional information relating to the considerations for motorcyclists:

• Visibility between vehicles
• Layout recognition, particularly for motorcyclists
• Travel paths and clear of areas where debris may build up
• Skid resistant pavement markings
Sight Distance

Setbacks for sightlines

See Section 3.2.2
Pedestrian Sight Distance

Variable $t_c$ in Equation 3 corrected to read:

\[
\text{critical safe gap} = \frac{\text{crossing length}}{\text{walking speed}}
\]
AGRD Part 4A: Unsignalised & Signalised Intersections

1. Introduction
2. Layout Design Process
3. Sight Distance
4. Types of Intersection and their Selection
5. Auxiliary Lanes
6. Traffic Islands and Medians
7. Right-turn Treatments
8. Left-turn Treatments
9. Signalised Intersections
Auxiliary Lanes

Acceleration distance (lane lengths): New Table 5.5 (previously Table 5.4)

- distance for 4 secs of travel time
- merge taper length

<table>
<thead>
<tr>
<th>Design speed of road entered[^]</th>
<th>Length of acceleration lane A (m) (including length of merge taper)</th>
<th>4 sec travel (m)</th>
<th>Merge $T_m$ (m)</th>
<th>Min. desirable length 4 sec + $T_m$[^]</th>
</tr>
</thead>
<tbody>
<tr>
<td>(km/h)</td>
<td>0(2)</td>
<td>20</td>
<td>30</td>
<td>40</td>
</tr>
<tr>
<td>50</td>
<td>70</td>
<td>55</td>
<td>45</td>
<td>30</td>
</tr>
<tr>
<td>60</td>
<td>110</td>
<td>95</td>
<td>85</td>
<td>70</td>
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<tr>
<td>70</td>
<td>165</td>
<td>130</td>
<td>140</td>
<td>125</td>
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<td>80</td>
<td>235</td>
<td>220</td>
<td>210</td>
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<td>90</td>
<td>330</td>
<td>315</td>
<td>305</td>
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<td>100</td>
<td>450</td>
<td>435</td>
<td>425</td>
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<tr>
<td>110</td>
<td>610</td>
<td>595</td>
<td>585</td>
<td>570</td>
</tr>
</tbody>
</table>

[^]: Design speed of entry curve (km/h)

See Section 5.3.2
Questions?

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# Upcoming Austroads webinars

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<td>16 November</td>
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<tr>
<td>Current Practice and Developments in Concept of Operations</td>
<td>21 November</td>
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Thank you for participating