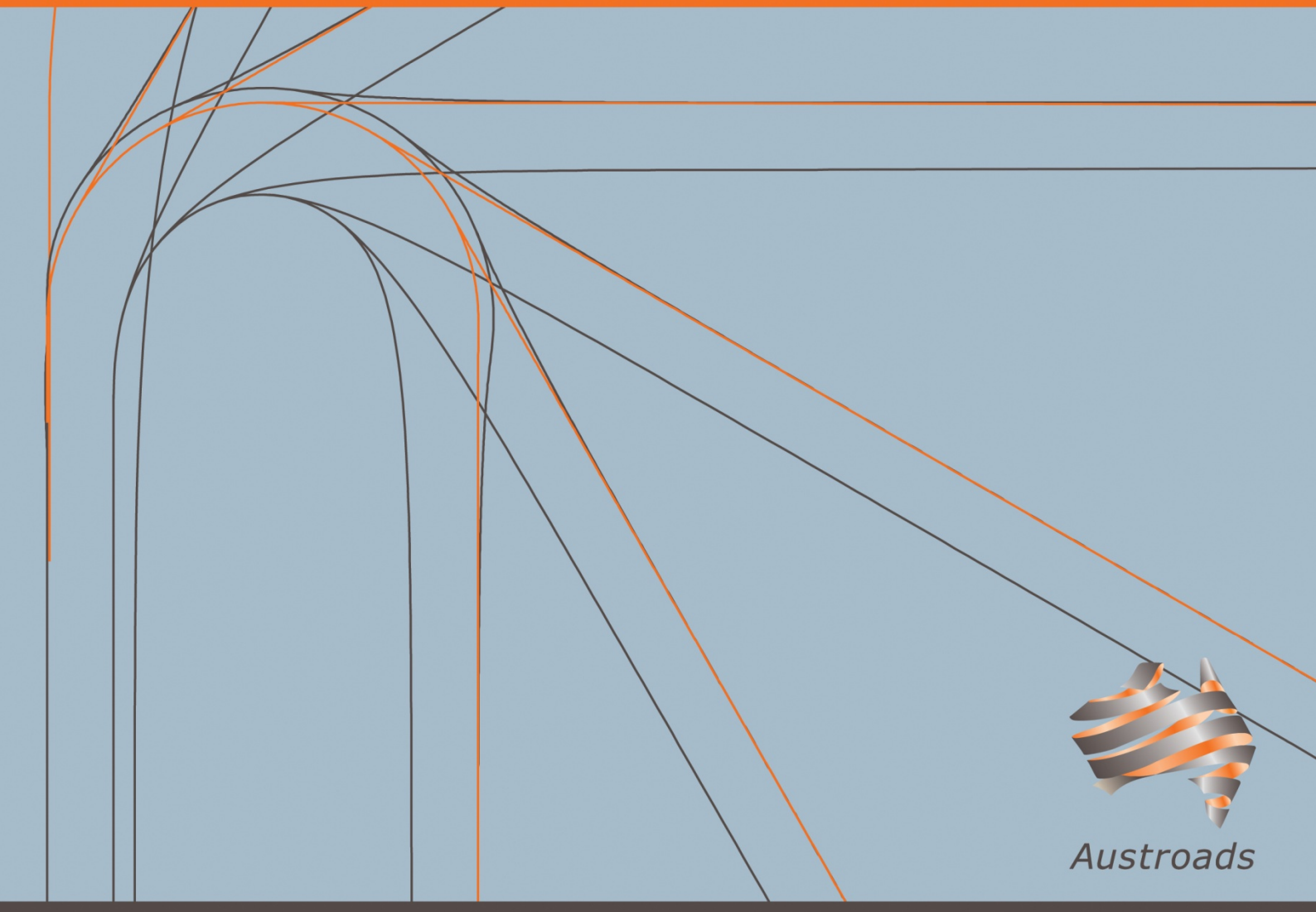
Austroads Design Vehicles and Turning Path Templates Guide



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First Published 1995
Second edition 2006
This edition April 2013

National Library of Australia
Cataloguing-in-Publication data:

ISBN 978-1-921991-84-4

Austroads Project No. TP1719

Austroads Publication No. AP-G34-13

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Austroads Design Vehicles and Turning Path Templates Guide

Sydney 2013

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- promote consistency in road and road agency operations.

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SUMMARY

When a vehicle performs a turning manoeuvre, the rear of the vehicle covers a wider path towards the inside of the turn than the path of the foremost vehicle unit. The swept path envelope is the road area covered by the outermost and innermost points of the vehicle units during the turn. It is necessary for road practitioners to have access to swept path information for a number of vehicles in order to provide appropriate and safe access at intersections. This guide has been developed to assist intersection designers and contains:

- user information and a guide covering the basis of turning templates and road hierarchy
- design vehicle dimensions
- turning templates.

The turning path templates presented are plots of the swept path envelope resulting from various angles of turn at a particular radius.

This is the third revision of the design vehicles and turning templates, which were first published by the National Association of Australian State Road Authorities (NAASRA 1985). The first revision was published in 1995 (Austroads 1995) with the second revision published in 2006 (Austroads 2006).

Changes in the third revision include:

- Two vehicles initially did not achieve the performance required to be allowed access to the road class that would be expected of the vehicle. These were the 26 metre B-double and the B-triple. These vehicles have been modified slightly so that they achieve the required performance, while still being representative of the vehicle fleet.
- Both the *Design Vehicles and Turning Path Templates Guide* and the turning templates have been updated to be more consistent with the more recently released Austroads Guides, particularly the Austroads *Guide to Road Design*.
- Formatting issues identified in the second revision, such as inconsistent scale and poor colour choice, have been rectified.

CONTENTS

TABLES

FIGURES

1 INTRODUCTION

Vehicle dimensions and performance capability of design vehicles are the key design criteria upon which road and intersection design is based. The Austroads *Design Vehicles and Turning Path Templates Guide* depicts design vehicles likely to use roads under the National Transport Commission's (NTC's) Performance Based Standards (PBS) to generate turning templates.

All vehicles using the road network must be able to safely negotiate intersections without damaging other vehicles, buildings, infrastructure and roadside furniture. It is also important that vehicles negotiating intersections do not unduly obstruct traffic.

When a long vehicle makes a low-speed turn at an intersection, the rear of the vehicle covers a wider area than the inside of the path of the front of the vehicle. This is known as low-speed offtracking. The swept path is the road area covered by the outermost and innermost points of the vehicle making the low-speed turn. As the road network consists of a hierarchy of roads with different functions, it is necessary for road practitioners to have access to swept path information for a range of design vehicles in order to provide appropriate and safe access. This guide has been developed to assist intersection designers and contains:

- user information and a guide (covering the basis of turning templates and road hierarchy)
- design vehicle dimensions
- turning templates.

The Austroads design vehicles have been produced to provide consistency when choosing an appropriate design vehicle for intersection design throughout Australia.

The design vehicles included in this document provide guidance to cover most intersection designs. Individual intersections should be designed and checked according to the vehicles expected to be negotiating these intersections.

The vehicle turning path templates presented here are plots of the vehicle wheelpath and the path traced by other relevant points on the vehicle or load. They show the swept path envelope resulting from various angles of turn at a particular radius measured to the outside front steer wheel. Thus the templates include the critical wheelpath and the swept path of the extremities of the vehicles. The various turn radii given reflect an acceptable range of turning speeds in normal traffic operation.

It should be noted that the turning speed associated with each turn radius is an indicative speed that the vehicle might travel through the turn, but clearly does not preclude vehicles travelling through the turns at speeds outside of the range specified. The swept path envelopes have been plotted using a low-speed turn at 5 km/h and while this speed may be lower than the indicative speed labelled on some of the turning path templates, the lower speed turns result in a greater swept path envelope, thus in turn resulting in a swept path envelope representing the likely worst-case.

The templates provided have been developed as a guide for designing intersections (for on-road use), or for vehicle access to and from roads and represent only the forward movement of the vehicle. For the design of off-road facilities, such as layouts of carparks and loading docks, lower absolute minimum and desirable minimum turning radii, as well as design vehicles which may not be included in this guide, may be more applicable. Australian Standards AS 2890.1-2004 (Standards Australia 2004) for passenger vehicles and AS 2890.2-2002 (Standards Australia 2002) for heavy vehicles should be used when designing off-road facilities.

Note that New Zealand has a different vehicle fleet to Australia and has its own library of turning templates as documented by RTS 18: New Zealand on-road tracking curves for heavy motor vehicles (Land Transport New Zealand 2007).

New Zealand also has performance based requirements for exceptional vehicles that are to be met before they are allowed to use restricted, strictly specified and enforced routes.

2 BACKGROUND

This is the third revision of the design vehicles and turning templates, which were first published by the National Association of Australian State Road Authorities (NAASRA 1985). The first revision was published in 1995 (Austroads 1995) and reflected changes in vehicle dimensions and introduced a number of larger vehicles. These vehicles are often used in the design process to ensure that road and intersection layouts adequately cater for the range of vehicles using them. The second revision (Austroads 2006) reflected changes in vehicle dimensions since 1995 and provided a user guide to assist with selecting the appropriate design and checking vehicles and turning radii for various intersecting road types.

The purpose of Austroads Project TP1719, *Review of the Austroads Design Vehicles and Turning Path Templates Guide*, is to revise the Austroads 2006 guide to address issues identified with the guide by its users. For example:

- The B-triple combination included in the 2006 guide did not meet the current PBS Level 3 low-speed swept path requirement, and thus required modification to meet this requirement while still being representative of the B-triple heavy vehicle fleet.
- The turning templates provided were presented in varying formats and non-standard scales, which made them difficult to use in road design tasks.
- Due to the colours used, black-and-white printing or photocopying of the templates produced poor reproductions which were difficult to use.

To address these issues, the following changes were made to the 2006 turning path templates.

Each of the design vehicles, as detailed in the 2006 templates, was assessed using the PBS standards (NTC 2008). PBS is a regulatory scheme in operation in Australia, offering an alternative to traditional prescriptive mass and dimension regulations. Under PBS, a vehicle that does not comply with prescriptive restrictions can be given access to parts of the road network if proven compliant with the PBS scheme. PBS requires vehicle performance to be determined via a number of safety and infrastructure-based tests, with access granted based on the level of performance achieved by the vehicle.

The PBS scheme has four levels of performance requirements each corresponding to a level of road access. The levels of road access range from general access (Level 1) to remote areas with low traffic volumes (Level 4).

Each of the design vehicles from the 2006 guide was assessed against the low speed swept path (LSSP) standard. The low-speed swept path is the maximum width of the swept path of a vehicle simulated driving through a 90º turn of 12.5 m outer radius at a speed of 5 km/h.

Two vehicles did not initially achieve the performance required to be allowed access to the road class that would be expected of the vehicle. These were the 26 m B-double, which achieved Level 3 performance but was expected to meet Level 2, and the B-triple, which achieved Level 4 performance but was expected to meet Level 3.

In order for these vehicles to pass the expected level, minor modifications were made to these two vehicles. All other design vehicles from the 2006 guide were retained for the updated turning template guide.

One of the issues raised by users was that the colours (light green) used in the 2006 templates when printed in black-and-white or photocopied resulted in poor reproductions and were difficult to use. In order to remedy this, the colours of the updated layout have been modified, with the colour of the outermost and innermost paths of the vehicle coloured black instead of light green, while the outside front wheelpath is now red instead of light green. When printed in black-and-white, the paths are still clear and well-defined.

Another of the issues identified was that there was an inconsistent scale associated with the templates. Each of the templates will be distributed in both portable document format (.PDF) and drawing (.DWG) format. All of the templates in .PDF format are intended to be used at the 1:250 scale when printed on A3 paper (420 x 297 mm); however, depending upon the printer settings (especially regarding the printable area of the printer) this scale may be very slightly different from 1:250. Bar scales have been used in both the horizontal and vertical directions to help identify any scaling issues when the templates are printed from the .PDF file. The .DWG version of the templates can be considered more useful provided that suitable software is available, as the template paths and/or the intersection drawings can easily be modified to have the same scale.

A small number of minor changes have also been made to the layout of the templates. A dark blue dashed line was added in order to display the beginning of the turn. Some notations and comments have also been modified in the updated layouts, with the comments now reflecting the Austroads Guides, especially the *Guide to Road Design Part 4: Intersections and Crossings – General* (Austroads 2009).

3 VEHICLES

The following vehicles, as defined in previous versions of the *Design Vehicles and Turning Path Templates Guide*, have been retained for this revision. The design of the vehicles was based on the *Australian Vehicle Standard Rules* and the *Australian Standard for Parking Facilities AS 2890.1-2004* (Standards Australia 2004), and was representative of the common vehicles of each type, as follows:

- Passenger vehicle (5.2 m)
- Service vehicle (8.8 m)
- Single unit truck/bus (12.5 m)
- Long rigid bus (14.5 m)
- Articulated bus (19 m)
- Prime mover and semi-trailer (19 m)
- Prime mover and long semi-trailer (25 m)
- B-double (25 m)
- A-double (Type I road train) (36.2 m)
- A-triple (Type II road train) (53.4 m).

As described in Section 2, two vehicles have been modified since the publication of the 2006 guide. The modified vehicles are as follows:

- B-double (26 m)
- B-triple (35.4 m, was formerly 36.5 m).

These changes have been made in such a fashion that these vehicles now achieve a low-speed swept path result that satisfies the PBS level expected, while still being representative of the vehicle fleet.

A layout drawing of each vehicle is shown in Section 3.2.

3.1 Checking Vehicles

A description of the use of the templates can be found in Section 4. While certain vehicles have been suggested for use in typical design situations (Table 4.2), in specific design situations it is appropriate to consider templates for various commonly encountered vehicles with a larger swept path. These situations include sites predominantly used by a particular vehicle type and road/intersection facilities which need to be checked to ensure that larger vehicles, operating under permit arrangements, can be accommodated where required.

The design vehicle for a particular case is not necessarily the largest of the vehicles that may operate at that location. The design vehicle is intended to represent the **majority of the vehicles** allowed to operate at that location. The design vehicles are hypothetical vehicles whose dimensions and operating characteristics are used to establish lane widths and road geometry intersection layouts. A larger vehicle may not be precluded from using the road, but may need to operate with reduced clearances or encroach into adjacent lanes. While this may inconvenience some road users, the low frequency of such occurrences makes this acceptable.

An appropriate checking vehicle must be used in order to ensure satisfactory operation of the larger vehicles. The checking vehicle will be chosen according to the potential for such vehicles to use the facility and will be at least the next larger vehicle to the design vehicle (Table 4.2).

3.2 Dimensions

The dimensions of the design vehicles are provided in Figure 3.1 to Figure 3.12. While turning path templates have been created for these vehicles, the vehicles can be used as an input for computer-based turning path prediction software, enabling more complex paths than those shown in the turning templates to be examined.

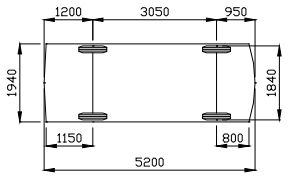

Figure 3.1: Passenger vehicle (5.2 m)

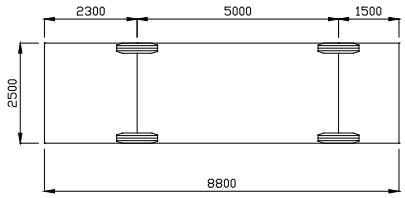

Figure 3.2: Service vehicle (8.8 m)

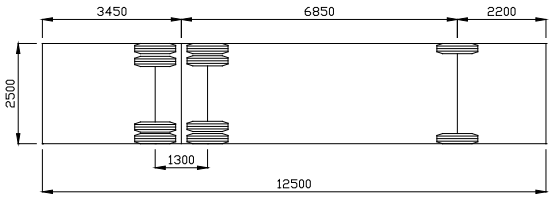

Figure 3.3: Single unit truck/bus (12.5 m)

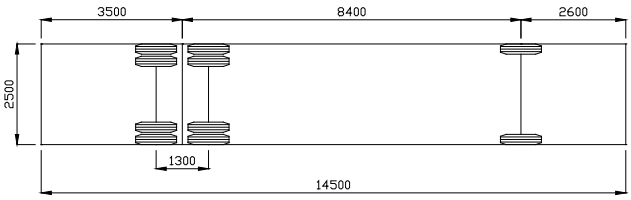

Figure 3.4: Long rigid bus (14.5 m)

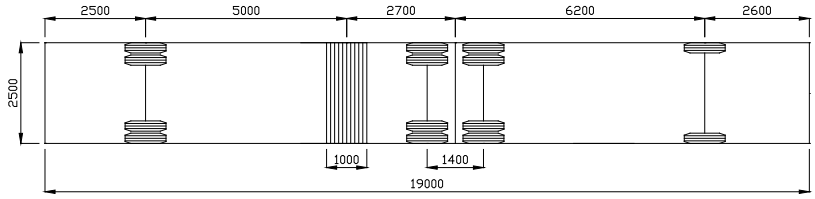

Figure 3.5: Articulated bus (19 m)

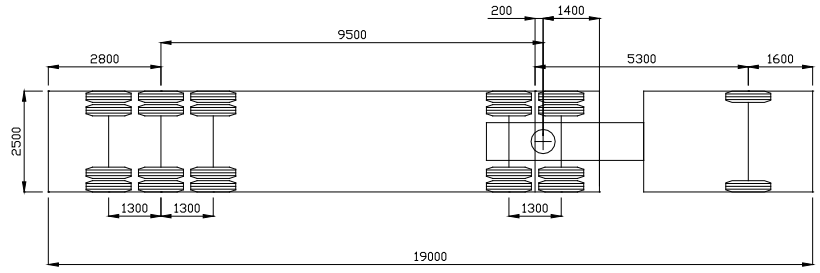

Figure 3.6: Prime mover and semi-trailer (19 m)

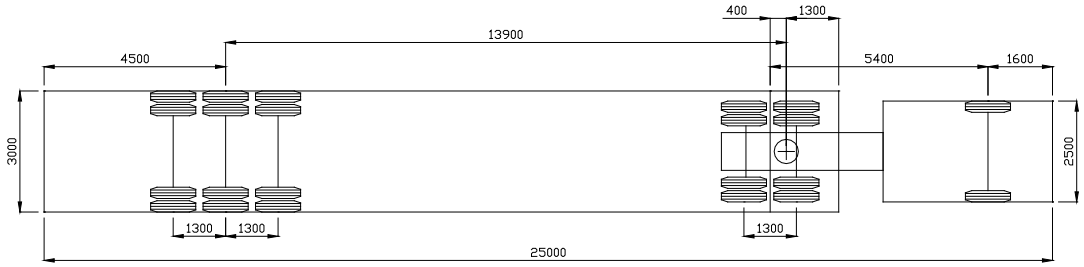

Figure 3.7: Prime mover and long semi-trailer (25 m)

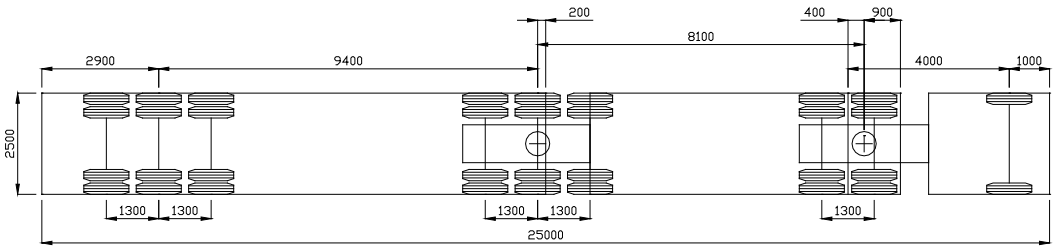

Figure 3.8: B-double (25 m)

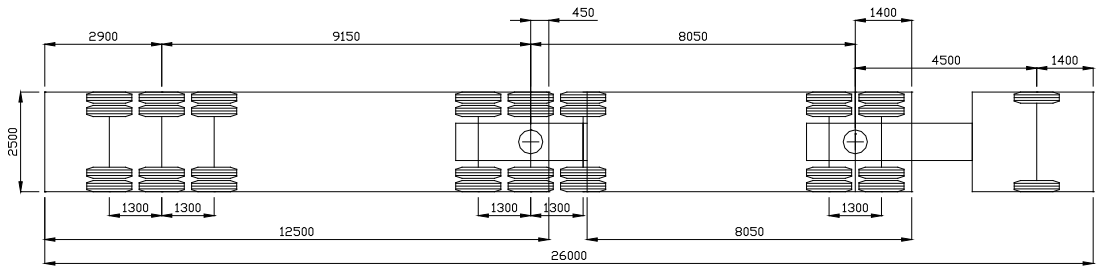

Figure 3.9: B-double (26 m)

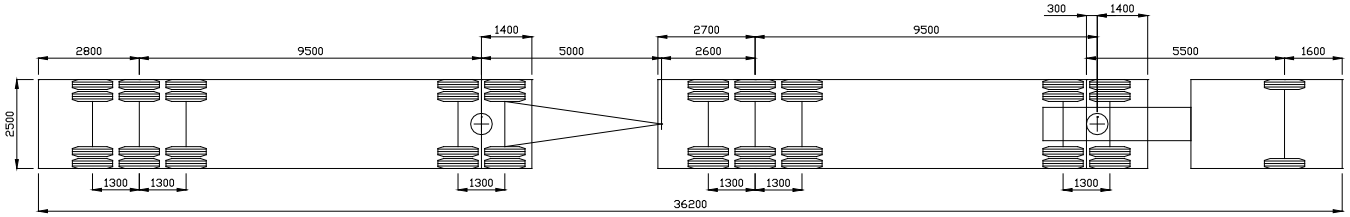

Figure 3.10: A-double (Type I) (36.2 m)

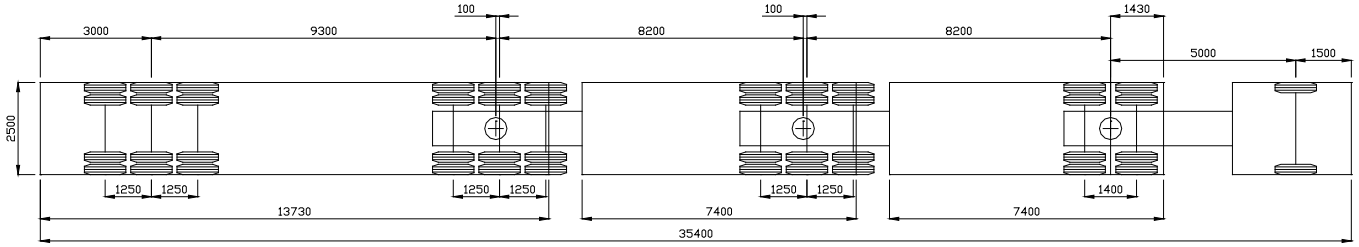

Figure 3.11: B-triple (35.4 m)

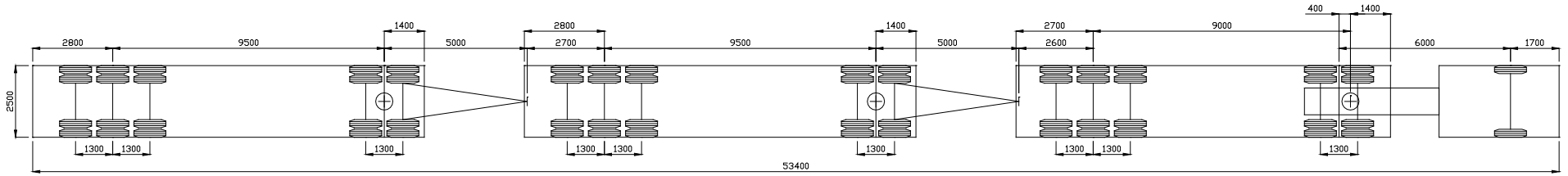

Figure 3.12: A-triple (Type II) (53.4 m)

4 USING THE TEMPLATES

4.1 Selecting a Design Vehicle

In general, the choice of vehicle for on-road facilities will depend on the functional classification of the road or roads involved (e.g. at an intersection or driveway), the composition of the traffic, and design economics.

Whilst the road network hierarchy has both functional and descriptive definitions, it is important that the land use, and hence the vehicle types that will be negotiating the intersections, be considered when determining appropriate design vehicles. For example, some local and collector roads service residential, industrial and bus routes, hence the design vehicle and turning radii need to be appropriate for such cases.

Definitions, provided in Table 4.1, describe the road terms in common use for the purpose of designing intersections.

Table 4.1: Road type definitions for intersection design

Road term	Definition
Local road/street	A road or street primarily used for access to abutting properties.
Collector road/street	A non-arterial road that collects and distributes traffic in an area, as well as serving abutting property.
Sub-arterial road	Road connecting arterial roads to areas of development, and carrying traffic directly from one part of a region to another.
Arterial road	A road that predominantly carries through traffic from one region to another, forming principal avenues of travel for traffic movements.

Source: Austroads (2010a).

4.1.1 Arterial Roads

The *prime mover and semi-trailer* vehicle should be used for intersections involving two or more arterial roads. However, for other intersections on arterial roads such as with a collector road/street, the *single unit truck/bus* will generally be more appropriate. Intersections between arterial roads and local roads should be designed using the *service vehicle.*

Where the *single unit truck/bus* has been used to set up the intersection geometry, it is necessary to check the layout using the *prime mover and semi-trailer* template to ensure that occasional use by these vehicles is viable. Similarly, with the layout of major arterial roads (e.g. designated freight routes), the design is based on the *prime mover and semi-trailer*, and in some locations may need to be checked using the appropriate template to ensure that these larger vehicles are catered for where necessary.

4.1.2 Non-arterial Roads

The *single unit truck/bus* should be used for works on collector and local roads and the *service vehicle* is appropriate for intersections involving local streets. However, in both cases, while restrictive intersection geometry may be desired to meet traffic management and environmental objectives on local roads, it is necessary to check the layout using the next larger design vehicle template to ensure that occasional use by vehicles larger than the chosen design vehicle is viable. In this case, the larger vehicle may be allowed to encroach into other traffic lanes (including the opposing traffic direction if the intersection is unsignalised), and travel over specially designed parts of traffic islands. This is usually acceptable as the frequency of this occurrence and the inconvenience and risk to other traffic at these locations is minimal. For example, articulated vehicles delivering building materials in a new estate, or furniture removal/delivery vehicles, should

be checked for their potential encroachment over kerb lines and possible interference with roadside furniture.

4.1.3 Off-road Facilities and Driveways

For off-road facilities, such as commercial and industrial sites, depots and loading docks, the design vehicle chosen should be representative of the predominant, or critical, vehicle type expected to use the facility.

For car parks and driveways into residential properties, the use of the *passenger vehicle* will be appropriate, except where it is known that larger vehicles, such as a refuse collection truck, need to be catered for.

4.1.4 Guidance for Users

Table 4.2 provides users with guidance for selecting the appropriate design and checking vehicles as well as the recommended radii.

Table 4.2: Guide to selection of the appropriate design and checking vehicle and the recommended turning radii

Intersecting road types	Design	Checking
Arterial/Arterial	Prime mover and semi-trailer (19 m) (1) Radius 15 m	Appropriate vehicle e.g. B-double (25 m) (2) or Prime mover and long semi-trailer (25 m) or Road train (3)
Arterial/Collector	Single unit truck/bus (12.5 m) Radius 12.5 m	Prime mover and semi-trailer (19 m) Radius 15 m
Arterial/Local (residential)	Service vehicle (8.8 m) Radius 12.5 m	Single unit truck/bus (12.5 m) Radius 12.5 m
Collector/Collector (industrial)	Prime mover and semi-trailer (19 m) (1) Radius 15 m	Prime mover and semi-trailer (19 m) (1) Radius 15 m
Collector/Collector (residential)	Single unit truck/bus (12.5 m) Radius 12.5 m	Prime mover and semi-trailer (19 m) (1) Radius 15 m
Collector/Local (residential)	Service vehicle (8.8 m) Radius 9 m	Single unit truck/bus (12.5 m) Radius 12.5 m
Local/Local (industrial) (4)	Prime mover and semi-trailer (19 m) (1) Radius 12.5 m (5)	Appropriate vehicle e.g. B-double (25 m) (2) or Prime mover and long semi-trailer (25 m) or Road train (3)
Local/Local (residential)	Service vehicle (8.8 m) Radius 9 m	Single unit truck/bus (12.5 m) Radius 12.5m

1 Select the appropriate vehicle for the design of sites that are frequently used by such vehicles.
2 B-double length may vary between jurisdictions.
3 Select appropriate road train from the *Guide to Road Design – Part 3: Geometric Design* (Austroads 2010b) or from relevant jurisdiction guide.
4 Also for intersections with industrial land use for collector/local intersections.
5 Simulations show that for this radius the maximum steering angle occurs at the exit of the turn and not applied at the crawl speed.

Source: Austroads (2009).

4.2 Applying Turning Path Templates

The fundamental principles in the development of turning path templates and designing for turning vehicles are that:

- The design vehicle should be able to turn (left or right) from a marked lane without crossing adjacent marked lanes. Checking vehicles may straddle the lane markings in order to be able to perform the manoeuvre as allowed by the road rules in each jurisdiction.
- The tendency for the rear of articulated vehicles to move backwards at some point through the turn should be prevented. This may occur when turning on a small radius through large angles (i.e. greater than 120°).
- All vehicles that are considered in designing the intersection can negotiate the intersection without the rear wheels of the vehicle describing a small radius such that pavement surfacing is damaged.

Turning path templates are used to:

- establish the width of pavement required at locations where vehicles execute significant turns (i.e. large angles of turn at relatively small radii)
- define the shape of the edge of the roadway, traffic islands, median ends, turning roadways and the alignment of traffic lanes etc. at intersections, median and separator openings, channelisation, entrances, etc.
- establish the areas adjacent to turning roadways, traffic lanes and in traffic islands, etc., which are likely to be encroached upon by the swept path of checking vehicles, including the area outside a vehicle's wheelpath (due to the front and rear overhang), which needs to be kept clear of road furniture and other fixed objects
- define areas within traffic islands, or on the road verge, which may need to be strengthened, or otherwise designed to carry the occasional heavy wheel loads when checking vehicles are permitted to encroach outside the normal roadway limits.

4.3 Layout Procedures

The procedures for using turning path templates in the layout design of road and other facilities are described below. These vary slightly, depending on whether a new layout is being developed, or an existing layout design is being checked, e.g. to identify the capability of a layout to cater for vehicles larger than the design vehicle.

4.3.1 Turning Radius

The minimum turning radius of a vehicle depends on a number of parameters, such as the hauling unit steering geometry, wheelbase and number of trailing axles, and the number of trailing units. However, the minimum radius that should be used for design purposes also has to cover other factors such as driver ability, driver behaviour, operational efficiency and operational safety.

For on-road situations, the absolute **minimum** radius[1] for intersection design has to cover the capabilities of all vehicles that may be expected to operate in a particular location. This means that the absolute minimum radius has to be confidently achieved by all of the vehicles using that intersection. For the *single unit truck/bus* and the 19 m *prime mover and semi-trailer* the absolute minimum radius has been set at 12.5 m which represents the required turning circle (kerb to kerb) for these vehicles under ADR 43/04 (DOTARS 2006). For each vehicle, the absolute minimum

[1] The radius which allows vehicle turning at a range of steering locks at appropriate intersection speeds without reverse movement of the vehicle.

turning radius for on-road situations requires the vehicle to slow to almost a stop before making the turn. However, the driver is not required to stop and reach full wheel lock on-the-spot before making the turn.

The desirable **minimum** radius for intersection design ensures operating efficiencies through higher turning speed, greater scope to accommodate driver variability and the ability to accommodate changes in the vehicle fleet over time.

The turn radius selected should be representative of the expected speed of turning vehicles and the type of turning vehicles. It should be noted that the turning speed associated with each turn radius is an indicative speed that the vehicle might travel through the turn, but clearly does not preclude vehicles travelling through the turns at speeds outside of the range specified. The swept path envelopes have been plotted using a low-speed turn at 5 km/h and while this speed may be lower than the indicative speed labelled on some of the turning path templates, the lower speed turns result in a greater swept path envelope, thus in turn resulting in a swept path envelope representing the likely worst-case.

Vehicle modelling and turning path simulations generally use a tangential turn. The rationale for this is set out in Queensland Department of Transport and Main Roads (2010).

> This is because the vehicle is aligned with the entrance tangent for the circular turn with the front (steered) wheels pointing straight ahead. Due to the characteristics of vehicle steering geometry, there is a transient state (or distance) where it is possible for the front wheels of a vehicle travelling at **slow speed** to follow a circular path while the steering angle is changed from straight ahead to close to the maximum angle that is needed to describe the turn.
>
> Tangential turns should always be used for the design of intersection turns and turns from the roadway into a property access. In practice, drivers may sometimes execute turns after applying some initial lock while the vehicle is stopped. This is due to factors such as driver error, constraints imposed by low-standard geometry, disabled vehicles or obstacles on the road.
>
> Initial lock turns require shorter arcs of turn but involve maximum off-tracking for more of the turn, and greater out-swing of the rear of the vehicle at the start of the turn. Initial lock turns are relevant for off-street manoeuvres (including roadside parking manoeuvres) and, in constrained situations, for entering and leaving parking spaces but not for circulating roadways within a parking facility.

4.4 Angle of Visibility

When designing intersections there is a need to ensure that drivers of heavy vehicles have appropriate visibility angles when turning at intersections. Furthermore, when providing intersection road space for large turning vehicles, it is necessary to check that car drivers are not encouraged to turn with inappropriate visibility angles.

Information on acceptable visibility required for intersections is available in the *Guide to Road Design Part 4: Intersections and Crossings – General* (Austroads 2009) and the *Guide to Road Design Part 4A: Unsignalised and Signalised Intersections* (Austroads 2010c).

4.5 Opposing Right Turns

Where opposing right turns operate simultaneously, the turns should be designed to provide sufficient clearance between the left sides of the swept paths of opposing vehicles (i.e. not wheelpaths) as follows:

- single turns: 1.0 m
- 1 single and 1 double turn: 2.0 m
- double turns: 2.0 m.

The following turning path templates should be used to design intersection geometry for opposing turns:

- single turn: 19 m articulated vehicle, minimum radius of 15 m
- double turn: articulated vehicle/car abreast, minimum radius of 15 m.

Further information on opposing right turns for intersections is available in Austroads (2009).

4.6 Preparing and Checking Designs

The following steps are recommended to prepare and check a design layout.

1 Select the appropriate design vehicle as discussed in Section 4.1.4.

2 Select the template with the radius of turn matching (as near as practicable) the turn required, bearing in mind the geometric controls of the site and the most likely vehicle turning speed. The use of the absolute minimum turn radius should be avoided on arterial roads and at other important traffic sites. Each of the templates indicates a range of appropriate speed values for the radius of turn chosen.

3 Correctly align the template within the lane from which the turn is to be made. Note that the templates are oriented for left turns.

4 Note the angle of turn required and rotate the template, about the centre of the turning radius until the nearest greater angle given on the template matches the exit direction. (This requires rotation of the template in the opposite direction to that of the vehicle movement).

5 Mark/note the vehicle's wheelpath.

6 If a reverse curve is involved (e.g. as in the layout of a roundabout), particular care needs to be taken in allowing for the transition of the wheelpath from one direction to the other. Considerable skill is required to correctly achieve this with the use of conventional single radius uni-directional turning path templates. In critical situations, designers are encouraged to use available computer-based turning path prediction software models which permit the swept path and wheelpaths to be plotted for a design vehicle following a complex turn path made up of arcs and tangents.

7 Design vehicle turning path templates should be applied to road intersection layouts to accommodate the swept path with a minimum offset of 0.5 m from the extremities of the vehicle path to a kerb, pavement edge or centreline. Note that experience and engineering judgement should be used when applying clearances.

   The 0.5 m offset need not be provided for local streets in urban areas where space is restricted or local access/minor roads in rural areas where the shoulder is partly sealed. However, it is desirable that the vehicle (i.e. swept path) should not cross the centreline of a minor rural road. A minimum clearance of 0.5 m outside the swept path should be provided to objects such as road furniture and utility poles.

In situations where space is restricted and turning speed is low, it may be necessary to allow the swept path of the design vehicle to encroach into a verge or traffic island with the wheelpaths remaining on the pavement. This may occur when designing for a large bus to use a local street, or when checking that a design layout can accommodate an occasional vehicle larger than the design vehicle. The long rigid bus may be appropriate for checking designs on arterial roads.

Where computer programs are not available, the designer may graphically check a layout design that involves a reverse turn by the following method: use the appropriate template to plot a trace, by hand, of both the outer front wheelpath and the inner path for the design vehicle, in the direction of the first turn. The reverse of the template should then be used to check the opposite direction of the turn by overlaying the template and aligning the wheelpaths previously traced. The template should be aligned so that the inner path on the template is tangential to the outer front wheelpath already plotted and, simultaneously, the outer front wheelpath is tangential to the inner path already plotted. The template will need to be rotated in order to maintain this requirement and to fit within the design controls at the site.

While this procedure may not exactly reflect the actual positioning of the vehicle as it moves through the reverse curve, experience has shown that the wheelpaths plotted using this technique match sufficiently the actual wheelpath plots produced using one of the computer-based turning path models.

4.7 Checking an Existing Layout

A common practice in layout design and traffic management is to check an existing intersection layout to verify its adequacy to cater for vehicles larger than the design vehicle on which the layout was based, e.g. a checking vehicle on freight routes (Section 3.1). This includes the identification of areas outside the normal roadway limits (as defined by the kerb and channel or the edge of the pavement), which need to be specially strengthened or otherwise treated to cater for the occasional movement of a larger vehicle.

The vehicle templates may be used, together with other relevant criteria such as environmental impacts, to check existing roads and intersections to identify routes capable of catering for the various larger vehicles. The templates are also useful in the layout design of industrial facilities used predominantly by large vehicles.

The procedure for carrying out this check is basically the same as used in initial layout design using design vehicle turning path templates except in respect to positioning of the template on the intersection layout plan. Whereas the appropriate design vehicle template would normally be positioned within the correct turn lane for the vehicle movement in question, a template representing a larger vehicle may be placed in a more favourable starting position outside the normal turn lane. Although the design vehicle wheelpath would be confined within the normal roadway, as mentioned above, the wheelpath of the larger vehicle may not be so constrained and may encroach into other traffic lanes, islands or the verge areas where this is acceptable and appropriate provision has been made.

This reflects traffic regulations which permit these large vehicles to encroach into other traffic lanes when turning, and it is generally uneconomical to design for them to turn from the normal marked turn lanes, except where they comprise a high proportion of the traffic and the consequences of their interference with other traffic cannot be tolerated. This is the case at signalised intersections where encroachment across the centreline will generally not be possible because of the presence of queuing vehicles in the street being turned into. The same may also be true where a raised median exists and designers should be aware of these constraints.

5 LIST OF TURNING TEMPLATES

The following turning templates can be obtained from the Austroads website. The templates generated for this update of the *Design Vehicles and Turning Path Template Guide* cover the same vehicles as those as listed in the 2006 guide with some amendments.

Passenger vehicle (5.2 m)

- 6.3 m radius

Service vehicle (8.8 m)

- 9 m radius, 5 km/h
- 12.5 m radius, 5 km/h
- 15 m radius, 5 to 15 km/h
- 20 m radius, 15 to 20 km/h
- 30 m radius, 20 to 30 km/h

Single unit truck/bus (12.5 m)

- 12.5 m radius, 5 km/h
- 15 m radius, 5 to 15 km/h
- 20 m radius, 15 to 20 km/h
- 30 m radius, 20 to 30 km/h

Long rigid bus (14.5 m)

- 12.5 m radius, 5 km/h
- 15 m radius, 5 to 15 km/h
- 20 m radius, 15 to 20 km/h
- 30 m radius, 20 to 30 km/h

Articulated bus (19 m)

- 12.5 m radius, 5 km/h
- 15 m radius, 5 to 15 km/h
- 20 m radius, 15 to 20 km/h
- 30 m radius, 20 to 30 km/h

Prime mover and semi-trailer (19 m)

- 12.5 m radius, 5 km/h
- 15 m radius, 5 to 15 km/h
- 20 m radius, 15 to 20 km/h
- 30 m radius, 20 to 30 km/h

Passenger vehicle (5.2 m) and a prime mover and semi-trailer (19 m)

- 15 m radius, 5 to 15 km/h
- 20 m radius, 15 to 20 km/h
- 30 m radius, 20 to 30 km/h

Prime mover and long semi-trailer (25 m)

- 12.5 m radius, 5 km/h
- 15 m radius, 5 to 15 km/h
- 20 m radius, 15 to 20 km/h
- 30 m radius, 20 to 30 km/h

B-double (25 m)

- 12.5 m radius, 5 km/h
- 15 m radius, 5 to 15 km/h
- 20 m radius, 15 to 20 km/h
- 30 m radius, 20 to 30 km/h

B-double (26 m)

- 12.5 m radius, 5 km/h
- 15 m radius, 5 to 15 km/h
- 20 m radius, 15 to 20 km/h
- 30 m radius, 20 to 30 km/h

B-triple (35.4 m)

- 15 m radius, 5 to 15 km/h
- 20 m radius, 15 to 20 km/h
- 30 m radius, 20 to 30 km/h

A-double (Type I road train) (36.2 m)

- 15 m radius, 5 to 15 km/h
- 20 m radius, 15 to 20 km/h
- 30 m radius, 20 to 30 km/h.

Note: the maximum length permitted for an A-double is 36.5 m, however the overall length of the vehicle combination is 36.2 m which reflects typical dimensions.

A-triple (Type II road train) (53.4 m)

- 15 m radius, 5 to 15 km/h
- 20 m radius, 15 to 20 km/h
- 30 m radius, 20 to 30 km/h.

Note: the maximum length permitted for an A-triple is 53.5 m, however the overall length of the vehicle combination is 53.4 m which reflects typical dimensions.

REFERENCES

Austroads 2009, *Guide to road design: part 4: intersections and crossings – general, AGRD04/09,* Austroads, Sydney, NSW.

Austroads 2010a, *Austroads glossary of terms,* AP-C87/10, Austroads, Sydney, NSW.

Austroads 2010b, *Guide to road design: part 3: geometric design,* Austroads, Sydney, NSW.

Austroads 2010c, *Guide to road design: part 4A: unsignalised and signalised intersections,* Austroads, AGRD04A/10, Sydney, NSW.

Department of Transport and Regional Services 2006, *Vehicle configuration and dimensions,* Australian design rule 43/04, DOTARS, Canberra ACT.

Land Transport New Zealand 2007, *New Zealand on-road tracking curves for heavy motor vehicles,* RTS 18, Land Transport New Zealand, Wellington, NZ.

National Transport Commission 2008, *Performance based standards scheme: the standards and vehicle assessment rules,* NTC, Melbourne, Vic.

Queensland Department of Transport and Main Roads 2010, *Interim guide to road planning and design practice,* QTMR, Brisbane, Qld.

Standards Australia

AS/NZS 2890.1–2004, *Parking facilities*. *Part 1: off-street car parking.*

AS 2890.2–2002, *Parking facilities. Part 2: off-street commercial vehicle facilities.*

Previous editions now superseded and unavailable

Austroads 1995, *Design vehicles and turning templates,* AP-34/95, Austroads, Sydney, NSW.

Austroads 2006, *Austroads design vehicle and turning path templates*, AP-G34/06, Austroads, Sydney, NSW.

NAASRA 1985, *Design vehicles and turning templates*, National Association of Australian State Road Authorities, Sydney, NSW.

INFORMATION RETRIEVAL

Austroads, 2013, **Design Vehicles and Turning Path Templates Guide**, Sydney, A4, pp.17. **AP-G34-13**

Keywords:
Design vehicles, turning templates, swept path

Abstract:

When a long vehicle makes a low-speed turn at an intersection, the rear of the vehicle covers a wider area than the inside of the path of the front of the vehicle. This is known as low-speed offtracking. The swept path is the road area covered by the outermost and innermost points of the vehicle making the low-speed turn. Since the road network consists of a hierarchy of roads with different functions, it is necessary to have a range of design vehicles in order to provide appropriate and safe access. This guide has been developed to assist intersection designers and contains:

- user information and a guide (covering the basis of turning templates and road hierarchy)
- design vehicle dimensions
- turning templates.

The design vehicles included in this document provide guidance to cover most normal intersection designs. The vehicle turning path templates are plots of the vehicle wheelpath and the path traced by other relevant points on the vehicle or load. They show the swept path envelope resulting from various angles of turn at a particular radius.

This is the third revision of the design vehicles and turning templates.