Department of Transport and Main Roads

Route Assessment Guidelines for Multi-Combination Vehicles in Queensland

October 2013

Great state. Great opportunity.

Queensland Government

Preface

If you have any comments to make about these Route Assessment Guidelines, please contact:

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The Route Assessment Guidelines were prepared to assist Transport and Main Roads' (TMR) officers in assessing the suitability of State Controlled Roads proposed for the operation of Multi-Combination Vehicles (MCVs). It has been approved and authorised for use by the Queensland Department of Transport and Main Roads.

The Guidelines should be used to assist in exercising engineering judgment, rather than strict technical benchmarks. They are intended to assist assessors in ensuring that the major relevant factors have been considered in the route assessment process. Where quantitative limits are recommended, they are intended as a guide only and are no substitute for common sense and judgment based on local knowledge and past experience.

The Guidelines will only apply to new route assessments. MCV routes, which have been approved prior to 30 June 2006 and continue to perform satisfactorily, will not be subject to these guidelines. This document may also assist in the upgrading of roads to a suitable standard for future MCV access.

This is the second version of the guidelines document and it includes minor amendments and updates to the first version.

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1.0 INTRODUCTION

1.1 General

These Route Assessment Guidelines have been prepared to assist TMR officers in assessing the suitability of State Controlled Roads proposed for the operation of Multi-Combination Vehicles (MCVs). A guideline for assessing the suitability of local government roads was published by the National Transport Commission in December 2002. The document titled “Guidelines for Assessing the Suitability of Heavy Vehicles on Local Roads” is available from the National Transport Commission website (www.ntc.gov.au).

These guidelines should be used to assess the suitability of a proposed route for B-Double and Road Train combinations. At this stage it is assumed that B-Triple and AB-Triple combinations have similar characteristics as conventional Type 1 Road Trains, and innovative combinations such as BAB-Quads, AAB-Quads and ABB-Quads have similar characteristics as conventional Type 2 Road Trains. It is envisaged that specific assessment criteria for the aforementioned MCVs will be developed and added at a later date. Guidelines for route assessments for Performance Based Standards (PBS) Level 2B, 3B and 4B vehicles are currently being developed by TMR.

This document will only apply to new route assessments. MCV routes, which have been approved prior to 30 June 2006 and continue to perform satisfactorily, will not be subject to these guidelines. This document may also assist in the upgrading of roads to a suitable standard for future MCV access.

The information has been obtained from various internal and external sources and incorporates the latest reference material available. However, these guidelines will be subject to on-going review and users can therefore expect the information to change as and when further research, and standards are developed and become available.

These Guidelines should be used to assist in exercising engineering judgment, rather than strict technical benchmarks. They are intended to assist assessors in ensuring the major relevant factors have been considered in the route assessment process. Where quantitative limits are recommended, they are intended as a guide only and are no substitute for common sense and judgment based on local knowledge and past experience. In some cases, minor deficiencies on the proposal route may still be accepted where traffic management options (signage, warning lights) and other mitigating treatments are examined.

When considering a potential route, the assessor should initially perform a desktop assessment using available records and then drive the route in both directions, bearing in mind all factors to be considered. Assessments should not be performed by desktop assessment only.

Where the heavy vehicle route intersects with an asset owned by another stakeholder, consultation should occur with the asset owner. For example, when the road intersects with a railway level crossing, the appropriate railway owner should be consulted. Consultation should also occur with local police where appropriate.

It is essential that routes for the operation of these vehicles be selected so as to minimise risk to other road users and property whilst facilitating efficient freight movement.

Appendix A contains a glossary of the technical terms used throughout these guidelines.

1.2 Acknowledgements

Special thanks to Main Roads Western Australia, New South Wales Roads & Maritime Services, and Transport South Australia for their assistance, and provision of advice and information used throughout this document.

1.3 Definitions

1.3.1 Definition of a Multi-Combination Vehicle

A MCV is defined as a large vehicle having at least two articulation points between units. Examples include B-Doubles and Road Trains, as well as many new innovative configurations such as B-Triples and AAB-Quads. Rigid vehicles and single-articulated vehicles (prime-mover and semi-trailer, or truck and pig trailer) are not considered to be MCVs, but the same principles apply in assessment of routes suitable for their operation.

1.3.2 Definition of a B-Double

A B-Double is defined as a combination consisting of a prime mover towing two semi trailers. The prime mover and the two trailers are combined by two fifth wheel (turntable) assemblies. The double articulation is the main distinguishing feature of a B-Double.

A B-Double can have an overall length of 26 metres or less. Allowable axle group spacings and additional operating conditions are provided in the Transport and Main Roads *Guideline for Multi-combination Vehicles in Queensland (Road Trains, B-doubles, B-triples, AB-triples, BAB-quads, ABB-quads) Form Number 1.* A maximum Gross Combination Mass (GCM) of 62.5 tonnes without Road Friendly Suspension (RFS), and a maximum GCM of 68 tonnes with RFS is allowed when operating under the Transport and Main Roads *Guideline for Higher Mass Limits for Vehicles with Road Friendly Suspensions in Queensland Form Number 10*.

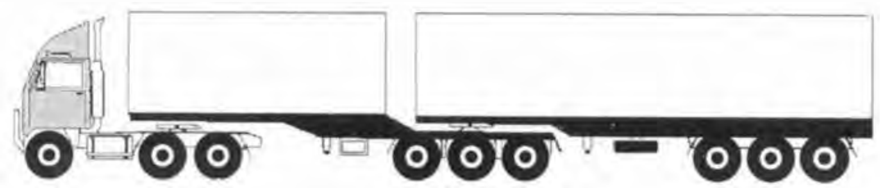


Figure 1-1: Typical B-Double

1.3.3 Definition of a Road Train

A Road Train is defined as a combination, other than a B-Double, consisting of either a rigid truck towing at least one trailer of which the combination length is greater than 19m or a prime mover towing at least two trailers. A converter dolly[†] supporting a semi-trailer is counted as one trailer. There are two groups of road trains in Queensland; Type 1 Road Trains and Type 2 Road Trains.

A Conventional Type 1 Road Train operates at an overall length of 36.5 metres or less. A maximum GCM of 79 tonnes without RFS, and a maximum GCM of 85 tonnes with RFS is allowed when

[†] Converter dolly is a unit designed to convert a semi-trailer to a trailer. It includes a fifth wheel assembly, a drawbar and an axle group, which may include tandem, or tri-axle, configurations.

operating under the Transport and Main Roads *Guideline for Higher Mass Limits for Vehicles with Road Friendly Suspensions in Queensland Form Number 10*. Conventional Type 1 Road Trains are also referred to as 'Double Road Trains' or 'A-double Road Trains'.

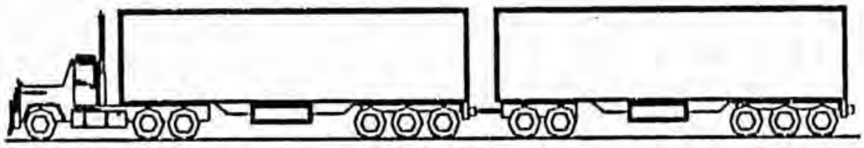


Figure 1-2: Typical Conventional Type 1 Road Train

A B-Triple is an innovative Type 1 Road Train that operates at an overall length of 36.5 metres or less. A maximum GCM of 82.5 tonnes without RFS, and a maximum GCM of 90.5 tonnes with RFS is allowed when operating under the Transport and Main Roads *Guideline for Higher Mass Limits for Vehicles with Road Friendly Suspensions in Queensland Form Number 10*. Please note, when conducting route assessments, it is assumed that B-Triple combinations have similar characteristics as conventional Type 1 Road Trains. It is envisaged that specific assessment criteria for B-Triples will be developed and added to this document at a later date.

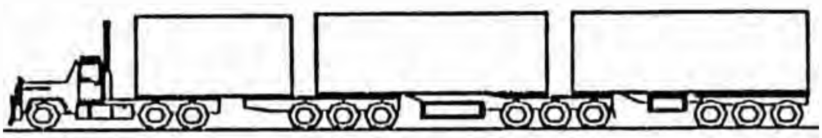


Figure 1-3: Typical B-Triple

An AB-Triple is an innovative Type 1 Road Train that operates at an overall length of 36.5 metres or less. A maximum GCM of 103 tonnes without RFS, and a maximum GCM of 113 tonnes with RFS is allowed when operating under the Transport and Main Roads *Guideline for Higher Mass Limits for Vehicles with Road Friendly Suspensions in Queensland Form Number 10*. Please note, when conducting route assessments, it is assumed that AB-Triple combinations have similar characteristics as Type 1 Road Trains. It is envisaged that specific assessment criteria for AB-Triples will be developed and added to this document at a later date.

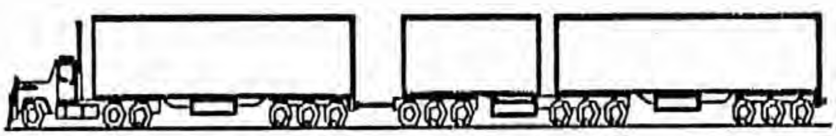


Figure 1-4: Typical AB-Triple

Allowable axle group spacings for Type 1 Road Trains are provided in Transport and Main Roads *Guideline for Higher Mass Limits for Vehicles with Road Friendly Suspensions in Queensland Form Number 10*.

A Conventional Type 2 Road Train operates at an overall length of more than 36.5 metres, but not more than 53.5 metres. A maximum GCM of 115.5 tonnes without RFS, and a maximum GCM of 124.5 tonnes with RFS is allowed when operating under the Transport and Main Roads *Guideline for Higher Mass Limits for Vehicles with Road Friendly Suspensions in Queensland Form Number 10*. Conventional Type 2 Road Trains are also referred to as 'Triple Road Trains' or 'A-Triple Road Trains'.

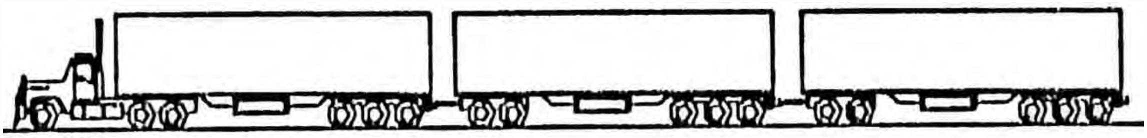


Figure 1-5: Typical Conventional Type 2 Road Train

BAB-Quads, AAB-Quads and ABB-Quads are innovative Type 2 Road Trains that operate at an overall length of more than 36.5 metres, but not more than 53.5 metres. The maximum GCM varies depending on the axle configuation. Please note, when conducting route assessments, it is assumed that innovative combinations such as BAB-Quads, AAB-Quads and ABB-Quads have similar characteristics as conventional Type 2 Road Trains. It is envisaged that specific assessment criteria for BAB-Quads, AAB-Quads and ABB-Quads will be developed and added to this document at a later date.

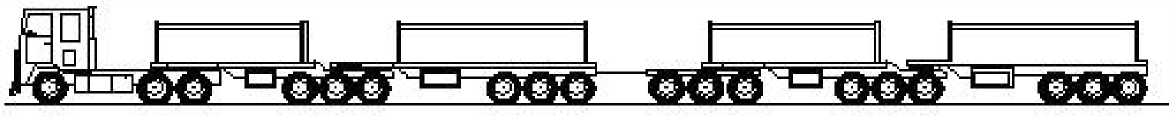


Figure 1-6: BAB-Quad Road Train

Figure 1-7: AAB-Quad Road Train

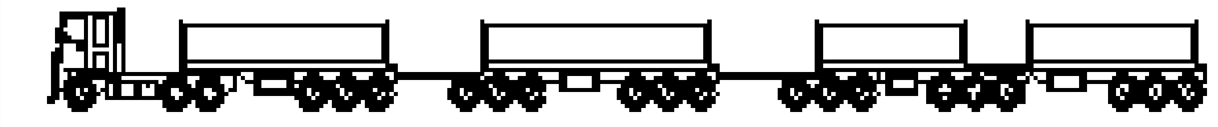
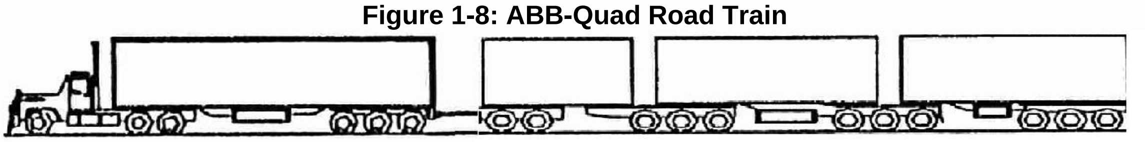


Figure 1-8: ABB-Quad Road Train



Instrumented on-road testing and computer simulations of the dynamic performance of the abovementioned innovative road trains have demonstrated that these combinations have superior dynamic characteristics to conventional Type 2 Road Trains. Despite having more trailers, a slightly greater combination mass, and more points of articulation, the utilisation of B-coupled trailers in the rear of these combinations results in improved dynamic performance. Further information on the dynamic performance of these combinations compared to conventional Type 2 Road Trains is provided in Appendix G.

1.4 B-Double Access Conditions

1.4.1 Transport and Main Roads Policy on B-Double Access

Transport and Main Roads supports initiatives that contribute to State and Regional development, improving efficiency of freight transport, improving road safety, and reducing adverse environmental impacts from road user activity. If route access conditions can be met, facilitating B-Doubles has the potential to support these objectives as:

- two B-Doubles are equivalent to three conventional semi trailer vehicles, thereby reducing total lane occupation, accident exposure and environmental impact while improving transport productivity;
- B-Doubles result in a reduction in the extent of pavement damage potential per tonne of road freight moved, when compared to conventional semi trailers;

- the use of fifth wheel couplings between each unit of a B-Double provides the combination with higher roll stability than a combination connected via a conventional drawbar, contributing to improved safety performance; and
- B-Doubles are subject to vehicle and operating conditions over and above those imposed on conventional semi trailer vehicles, resulting in an improved safety and environmental performance.

1.4.2 Conditions under which B-Doubles Operate

Length not exceeding 19 metres and GCM not exceeding 50 tonnes

B-Doubles with an overall length not exceeding 19 metres and a GCM not exceeding 50 tonnes are permitted general access to all roads in Queensland if they meet the vehicle and operating conditions specified in the current version of the Transport and Main Roads *Guideline for Multi-combination Vehicles in Queensland (Road Trains, B-doubles, B-triples, AB-triples, BAB-quads, ABB-quads) Form Number 1*. This document is available on the TMR web site.

Length not exceeding 19 metres and GCM exceeding 50 tonnes but not exceeding 55.5 tonnes

Operators of B-Doubles with an overall length not exceeding 19 metres and a GCM exceeding 50 tonnes but not exceeding 55.5 tonnes need to apply for an individual route assessment and obtain approval in accordance with these route assessment guidelines. A permit to operate will be issued by TMR if the application is approved.

Please note, when conducting route assessments, that these vehicles do not meet the 19 m B-Double general access axle spacing mass schedule (Table 4 in the *Guideline for Multi-combination Vehicles in Queensland)*. For routes that are not already B-Double gazetted (ie. general access roads), please ensure that all TMR' bridges, culverts, floodways or causeways along the proposed route have the structure capacity to transport these loads. Structural advice may be attained from TMR' Bridge Asset Management Section. For all other route assessment aspects, the vehicle is considered at 19 metres (ie. swept path and stacking distance).

In regards to previously gazetted B-Double routes, a 19 metre B-Double at 55.5 tonnes meets the axle spacing mass schedule for B-Double and Road Train routes (Table 3 of the *Guideline for Multi-combination Vehicles in Queensland)*, so structures along the route that have already been satisfactorily assess for 23 metre or 26 metre B-Doubles do not need to be re-assessed for this vehicle.

Length exceeding 19 metres

B-Doubles with an overall length exceeding 19 metres (ie. 23 m or 26 m B-doubles), may operate on routes which are gazetted for their use in Queensland if they meet the vehicle and operating conditions specified in the current version of the *Guideline for Multi-combination Vehicles in Queensland.* Permits for individual vehicles are not required provided the conditions in the Guideline are met and the proposed route is gazetted for B-Double use, either 23 m or 26 m B-doubles. Gazetted B-Double routes in Queensland are detailed on the TMR website. It should be noted that B-Doubles are also permitted to operate on all Road Train routes in Queensland.

Travel on routes that are not gazetted requires the B-Double operator to apply for an individual route assessment and obtain approval in accordance with these route assessment guidelines. A permit to operate will be issued by TMR if the application is approved. The permit, or a copy, must be carried at all times and produced when required by an authorised officer.

1.5 Road Train Access Conditions

1.5.1 Transport and Main Roads Policy on Road Train Access

Transport and Main Roads supports initiatives that contribute to State and Regional development, improving efficiency of freight transport, improving road safety, and reducing adverse environmental impacts from road user activity. Facilitating road trains has the potential to support these objectives as:

- Use of road trains on routes and in areas that are suitable for their operation reduces vehicle frequency. This results in decreased total lane occupation, accident exposure and environmental impact (fuel efficiency, dust and noise) while improving transport productivity. For example a 36.5 m Road Train is equivalent to two conventional six axle semi trailer vehicles;
- Road trains may offer some advantages in reducing road damage potential per tonne of freight moved, when compared to conventional six axle semi trailer vehicles; and
- Road trains can have logistical cost advantages over B-Doubles for some freight because they allow easy rear-end loading and unloading of the front trailer.

TMR will work with the transport industry, local government and other stakeholders to facilitate Road Trains on routes and in areas that satisfy the requirements of these guidelines, where possible. However, road network access for road trains is likely to remain restricted because:

- Road Train routes require significantly more overtaking opportunities than B-Double routes due to the fact that Road Trains are longer than B-Doubles and are not subject to minimum power requirements;
- B-Doubles are more stable than road trains as the drawbar coupling assemblies of road trains do not provide any roll stiffness between trailers and introduce another articulation point compared with the turntable couplings used on B-Doubles;
- Road trains require more road space than B-Doubles for low speed turning movements because of their extra length; and
- Road trains can require more road space than B-Doubles at high speeds because of increased transverse movement in the rear trailers (trailer fidelity).

1.5.2 Conditions under which road trains Operate

Conventional road trains, B-triples and AB-triples may operate on routes which are gazetted for their use in Queensland if they meet the vehicle and operating conditions specified in the *Guideline for Multi-combination Vehicles in Queensland.* This document and gazetted road train routes in Queensland are detailed on the TMR web site. Permits for individual vehicles are not required provided the conditions in the Guideline are met and the proposed route is gazetted for road train use. B-Triple and AB-Triple combinations operate as of right on Type 1 road train routes.

Travel on routes that are not gazetted requires the road train operator to apply for an individual route assessment and obtain approval in accordance with these route assessment guidelines. A permit to operate will be issued by TMR if the application is approved. The permit, or a copy, must be carried at all times and produced when required by an authorised officer.

Innovative road trains such as BAB-quads, AAB-quads and ABB-quads operate on sections of the type 2 road train network under a Non-Standard Vehicle Exemption Permit issued by TMR.

1.6 Who is authorised to do route assessments?

Route assessments should be undertaken by TMR employees authorised by a Regional Director. Due to the wide range of issues to be considered in the assessment, it is recommended that a team approach be adopted. TMR Roads, Rail and Ports System Management Branch engineers and advisors may also assist in route assessments in conjunction with an authorised TMR employee.

Collectively the team members should have experience with the heavy transport industry and a substantial knowledge of the following:

- the principles of heavy vehicle operation, including vehicle configurations, maximum dimensions and axle load limits;
- limitations on the ability of heavy vehicles to accelerate, brake, ascend grades, descend grades, and negotiate corners;
- heavy transport issues, legal requirements and permit systems; and
- road safety concepts and principles.

Staff undertaking route assessments are to be personally familiar with the requested MCVs operations, regulations and technical capabilities. Ideally, the assessing officers should have travelled on the requested MCV. The route should also have been driven in both directions, bearing in mind all factors to be considered. A permit will be required to operate the MCV on any non-approved route during the assessment.

When considering a potential route, the assessor is advised to initially perform a desktop assessment using all available records. In some cases this initial assessment will identify particular physical constraints such as bridge load limits and road width deficiencies that may render the route unacceptable without the need for further assessment.

Note that before making a final recommendation, TMR may deem it necessary to do any or all of the following:

- perform a further assessment of the route;
- conduct monitored field trials;
- assess the suitability of the road pavement;
- specify conditions of access such as speed limits, hours of operation or accreditation requirements;
- perform an environmental impact assessment;
- assess the stability of the vehicle and load;
- seek local council's approval for the proposed route;
- issue permits on a trial basis;
- consider a number of road network improvements as conditions of approval;
- perform a road safety audit; and
- undertake a community consultation phase.

If there is sufficient reason to doubt the suitability of the route, TMR can refuse an application, even if the route has been given a favourable assessment using these guidelines. Reasons for rejection may include issues relating to:

- impacts on predicated traffic volumes;
- current and predicted traffic mix;
- affects on integrated transport plans;
- increased conflict risks; and
- affects from the proliferation of MCVs on the proposed route.

Similarly a route that has been given a favourable assessment using these guidelines may be required to undergo a community consultation phase. TMR reserves its judgment where this is required.

1.7 Costs of road and traffic works

TMR may not be held responsible for the costs of adjustments to roads, intersections traffic devices or terminal access needed to make a route comply with these guidelines. It may be necessary for MCV operators to meet part or all of these costs. This decision may be based on whether or not the upgrade is part of the District's works program or purely for the benefit of the particular MCV operator.

Negotiations should be made with the relevant TMR Regional Director.

Any works to be funded by TMR would need to be timed in accordance with TMR's budgets and priorities for other infrastructure improvements.

2.0 AMENITY CONSIDERATIONS

2.1 Noise

MCVs have the potential to generate more traffic noise than other vehicles, especially when braking and accelerating. Noise, particularly at night, could include engines, exhaust brakes, cargo on a trailer or trailer itself jumping and banging on uneven or rough surfaces.

In assessing routes that pass through noise sensitive areas, the views of the local community are to be considered, as well as the effect that noise from the vehicle will have on adjoining land users. Schools, hospitals, libraries or residential accommodation are particularly vulnerable to the adverse impacts of noise. Heavy vehicle noise problems often occur when there are residences in close proximity to a downhill section of road that requires the use of exhaust brakes.

The assessor should consider the following factors:

- proximity of the route to dwellings, including residences, schools, hospitals;
- existing traffic, and the noise already generated;
- the time of the day that the route would be used by MCVs;
- presence of natural noise barriers such as hills and vegetation;
- the presence near dwellings of intersections and grades, which would increase local MCV noise; and
- route sections where MCV exhaust brakes would normally be used, such as downhill sections of road.

The following suggestions should be taken into account:

- Dwellings, schools and hospitals beyond 1500m from any section of the route are unlikely to be effected by noise from MCVs. However, noise may still be acceptable if dwellings are within 1500m, but further investigation is necessary;
- Noise problems are unlikely to occur within 300m of dwellings, schools and hospitals unless the road segment requires the vehicle to accelerate or decelerate (for example intersections or gradients). However, noise may still be acceptable if dwellings are within 300m of road segments with intersections or gradients, but further investigation is necessary; and
- Assessors should consider proximity of dwellings, schools and hospitals to truck parking bays especially where freight requires refrigeration.

The noise emanating from B-Doubles and Road Trains is similar to the noise from the standard six axle semi trailer vehicles that they would replace. Therefore, use of these vehicles instead of normally articulated trucks decreases total noise exposure as fewer trucks are required for a given freight task.

If there are known problems with heavy vehicle noise, or experienced judgment indicates that noise problems are likely to occur, the assessor shall consider and make recommendations on all possible solutions, including:

- signs such as "PLEASE LIMIT COMPRESSION BRAKING" or “URBAN AREA – PLEASE REDUCE NOISE”;
- a curfew for MCVs during night time hours;
- limited hours of operation;
- noise barriers along the sides of the road;
- building noise attenuation treatments;
- a requirement for noise reduction equipment to be fitted to MCVs; and
- other solutions provided by the applicant.

The applicant may be required to meet all or part of the costs associated with any noise reduction modifications.

2.2 Dust, splash and spray

The effect of dust, splash and spray of rainwater from the pavement by the MCV on other vehicles should be considered. These factors can adversely impact on other vehicles, pedestrians, cyclists and nearby property. NAASRA (1985) advised that the splash and spray emanating from a heavy vehicle is related to the number of wheels on the vehicle and becomes significant above about 80 km/h.

If there are known problems of dust, splash or spray caused by heavy vehicles or, experienced judgment indicates that these problems are likely to be significant if MCVs are introduced to the route, the assessor shall recommend whether the MCV should be required to fit spray suppression equipment or the route not be recommended for approval. Note that whilst spray suppression equipment has moderate effect, it does not stop all of the spray being thrown out the sides and rear of the vehicle.

MCVs approved to operate under permit must comply with the relevant Australian Design Rules concerning mudflaps.

2.3 Vibration

Where the MCV route passes close to abutting development the adverse impacts upon people and property due to vibration may need to be considered. If there are known problems of vibration caused by heavy vehicles or, experienced judgment indicates that vibration problems are likely to be significant if MCVs are introduced to the route, the assessor shall investigate and identify the cause of vibration (eg. manhole cover set lower than the surface) and make recommendations for rectifying the situation.

2.4 Odours and fumes

MCVs have the potential to emit more odours when carrying livestock and more fumes from exhausts than other heavy vehicles. This can be of concern to some residents and businesses and should be treated on the merits of each individual location.

The route should not be recommended for approval if there are known problems of odours and fumes caused by heavy vehicles or, experienced judgement indicates that problems associated with odours and fumes are likely to be significant if MCVs are introduced to the route.

2.5 Environmental factors

In making an assessment of a proposed route the environmental impact of the proposed operation on vegetation, wildlife and air quality must be taken into consideration. Native Title issues must also be considered. This part of the assessment may require input from an environmental officer.

2.6 Dangerous Goods

The assessor shall investigate and identify the consequences of a spill or dislodgment of large quantities of potentially hazardous materials on persons and the environment, and make recommendations on any special operating conditions that may be necessary. The assessor should also include recommendations on appropriate and acceptable emergency response procedures.

2.7 Land Use

The assessor shall take into account land use issues in relation to the route and the operator's depot location.

The proximity to residential, commercial, industrial areas, schools, hospitals, aged care, shopping centres, religious facilities and recreational areas need to be considered. If possible, routes should be selected to minimise traffic conflicts. Heavy vehicle bypasses and truck routes should be used where available to avoid residential areas, or areas with significant movements of pedestrians and cyclists.

2.8 Planning Evaluation

Assessment of a proposed route should be checked against any future planning proposals to evaluate the potential effect the requested MCV may have. The District's Transport Planning Section of Main Roads should be consulted as part of this process.

2.9 Community Consultation

Local community concerns should be taken into account and balanced against the economic, road safety, traffic management and other technical issues. The need for formal community consultation should be considered, and where deemed necessary, carried out as per Queensland Main Roads and Queensland Transport (1997).

2.10 Economic Factors

In making an assessment of a proposed route, the Regional, State and National economic benefits for the proposed operation must be taken into consideration.

2.11 Intermodal Transport Evaluation

Alternative modes of transport need to be assessed to ensure that using the requested MCV is the most effective form of transportation available taking into consideration economics, road safety, community benefit and other issues as listed in these guidelines.

3.0 TECHNICAL AND PHYSICAL CONSIDERATIONS

3.1 Pavement Widths

Haldane. M (2002) observed that MCVs that require more lane width than is available may cross the centreline, presenting safety risks to other vehicles, especially when being passed by oncoming traffic or overtaken. In the other direction, they can cause damage to the edge of the pavement seal, or if leaving the sealed surface, initiate a rollover. Clearly the ability of a MCV to travel within a specified lane width is of prime importance to its acceptability and safe operation in the traffic stream.

The lane width requirement on urban and rural roads is affected by:

- the maximum legal vehicle width (2.5 m);
- the vehicle's tracking ability; and
- the vehicle's high-speed steady state offtracking.

Tracking ability describes how well a heavy vehicle's trailing unit tracks along the same path as the hauling unit. When large combinations travel in a straight line, the trailers do not necessarily follow exactly the same path as the prime mover. In practice, each trailer will undergo oscillating small lateral deviations from the path of its lead unit as it responds to steering actions, crossfall, road surface unevenness and other external disturbances. Generally the rougher the pavement, the greater the width requirement. Tracking ability is also influenced by the following factors:

- vehicle configuration and coupling arrangements between units;
- misalignment of the axles;
- suspension (geometry, bump and roll steer effects) and tyre characteristics;
- vehicle length; and
- speed of travel.

High-speed steady state offtracking is the degree to which the rear unit of a combination tracks outside that of the haul unit on curves operating at highway speeds.

3.1.1 Urban Areas

There are a number of clearance requirements to be considered for MCVs travelling in urban areas. The carriageway widths should take into account various existing features including parking demand, angle of parking and the demand for on-road cycling provisions.

The route should be further evaluated if the minimum sealed width in the urban area is less than the applicable width shown in Table 3-1. Roadway descriptors are shown below Table 3-1.

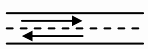
Through lanes provide travel without obstruction due to parked vehicles or stationary turning queues and therefore minimise the necessity for lane changing manoeuvres. It is preferable at least two continuous through lanes are available in the direction of travel. Short sections of single through lane may be permitted.

Table 3-1: Minimum Sealed Widths in Urban Areas (from Main Roads Western Australia (2003))

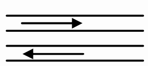
Feature	B-Double		**Type 1** Road Train		**Type 2** Road Train	
	60-70 km/h*	**80-100** km/h*	**60-70** km/h*	**80-100** km/h*	**60-70** km/h*	**80-100** km/h*
(Undivided carriageway - 2 way) Width between road edge and road centre						
Basic	3.2	3.5	3.3	3.7	3.6	4.1
with marked separation line	3.5	3.7	3.6	4.0	3.9	4.4
with on-road cyclists	4.7	5.5	4.8	5.7	5.1	6.1
with regular parallel parking	5.7	6.0	5.8	6.2	6.1	6.6
with regular angle (45°) parking	9.2	9.5	9.3	9.7	9.6	10.1
(Divided carriageway - single lane) Width between road edge and edge of median/traffic island						
Basic	3.5	3.7	3.6	4.0	3.9	4.4
with on-road cyclists	5.0	5.7	5.1	6.0	5.4	6.4
with regular parallel parking	6.0	6.2	6.1	6.5	6.4	6.9
with regular angle (45°) parking	9.5	9.7	9.6	10.0	9.9	10.4
(Undivided carriageway - 2 lanes) Width between road edge and road centre						
Basic	6.6	7.0	6.7	7.1	7.0	7.5
with on-road cyclists	8.1	9.0	8.2	9.1	8.5	9.5
with regular parallel parking	9.1	9.5	9.2	9.6	9.5	10.0
(Divided carriageway - 2 lanes) Width between road edge and edge of median/traffic island						
Basic	6.6	7.0	6.7	7.1	7.0	7.5
with on-road cyclists	8.1	9.0	8.2	9.1	8.5	9.5
with regular parallel parking	9.1	9.5	9.2	9.6	9.5	10.0
(Divided carriageway - 3 lanes) Width between road edge and edge of median/traffic island						
Basic	9.7	10.5	9.8	10.5	10.1	10.6
with on-road cyclists	11.2	12.5	11.3	12.5	11.6	12.6

* Legal speed limit for the particular section of road being assessed.

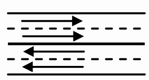
Undivided Carriageway, 2 lane



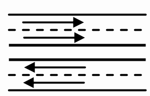
Divided Carriageway, Single Lane



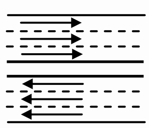
Undivided Carriageway, 2 lane



Divided Carriageway, 2 lane



Divided Carriageway, 3 lane



3.1.2 Rural Areas

Sealed Roads

Minimum carriageway and seal widths to accommodate MCVs are listed in Table 3-2. Consideration may be given to traffic composition. Refer to the Traffic Composition Section of this document.

Table 3-2: Minimum Carriageway and Seal Widths in Rural Areas for MCV Routes

AADT	Existing Alignments						New Alignments (for comparison)	
	Absolute Minimum		Desirable Minimum					
			Limited tourist traffic		Prolonged periods with > 5% caravans			
	Seal width (m)	C'way width (m)	Seal width (m)	C'way width (m)	Seal width (m)	C'way width (m)	Seal width (m)	C'way width (m)
<150	-[2]	8.0	6.0	8.0	8.0	8.0	6.0[3] 9.0	8.0 9.0
150 to 500	6.0	8.0	7.0[4]	8.0	8.0	8.0	9.0	9.0
500 to 1000	6.5	8.0	8.0	8.0	8.0	8.5	9.0	9.0
>1000	-	-	-	-	9.0	9.0	9.0	10.0

Notes:

1. The available seal and carriageway width on horizontal curves (i.e. what curve widening has been provided) will determine the suitability for a particular type or types of MCV (see Table 3-3: Curve Widening per Lane).
2. A sealed pavement is not mandatory for this traffic volume. In practice, many existing roads will have a 3.7m wide (or greater) single lane seal. Some roads may have a 6.0m seal which may function as a single lane (see Note 3) or two-lane if marked with a centre line.
3. The 6.0m seal is not marked and operates as a single 4m lane with partially sealed shoulders. An 8.0m seal provides acceptable two-lane operation.
4. Preferably 7.4 to reduce maintenance.
5. Carriageway widths < 9.0m on two-lane roads must be accompanied by embankment and table drain slopes 1 on 4 or flatter together with clear areas to prevent "shying" towards the centre of the road. However, some short local exceptions (<200m) are possible.
6. Carriageway widths < 10.0m on roads with a single-lane seal must be accompanied by embankment and table drain slopes 1 on 6 or flatter so smaller vehicles can move over to clear an oncoming MCV that stays on the seal. However, some short local sections are possible where visibility allows drivers of smaller vehicles to move over and stop prior to the restricted width section if there is an oncoming MCV.

Unsealed Roads

On unsealed roads a minimum pavement width of 8.0 metres should desirably be available for B-Doubles and a minimum pavement width of 8.4 metres should desirably be available for Road Trains.

3.2 Crossfall

The performance and lane width requirements of MCVs are influenced by crossfall. Queensland Department of Main Roads (2000) recommends that the crossfall for sealed freight routes should not exceed 3%.

However, a 4% crossfall has been used for a section of road between Hughenden and Winton. This trial on a very low traffic road with low quality paving material has attempted to provide better surface drainage and promote the use by traffic of the centre of the road in order to reduce damage to the pavement edges.

A higher crossfall (4-6%) is required for unsealed roads to ensure there is adequate drainage and minimal maintenance.

3.3 Horizontal Curves

At horizontal curves, traffic lanes may require widening prior to the route being acceptable for MCVs. In addition to the lane width required on a straight section of road, Table 3-3 details the amount of widening that should be added at curves to accommodate large vehicles. This table assumes low speed and crossfall less than 3 %. Research has shown for crossfall up to 3 % there are insignificant changes in the curve widening. Above 3% crossfall, operating clearances and reduction due to operating speed can adequately cover the increase.

Table 3-3: Curve Widening per Lane in metres (from Cox R. (1998))

Radius (m)	B-Double	Type 1 Road Train	Type 2 Road Train
30	Use Turning Templates	Use Turning Templates	Use Turning Templates
40	Use Turning Templates	Use Turning Templates	Use Turning Templates
50	Use Turning Templates	Use Turning Templates	Use Turning Templates
60	Use Turning Templates	Use Turning Templates	Use Turning Templates
70	1.31	Use Turning Templates	Use Turning Templates
80	1.16	1.62	Use Turning Templates
90	1.03	1.44	Use Turning Templates
100	0.90	1.26	1.80
120	0.80	1.13	1.61
140	0.71	1.00	1.43
160	0.62	0.87	1.25
180	0.53	0.74	1.07
200	0.45	0.62	0.89
250	0.37	0.51	0.74
300	0.30	0.41	0.59
350	0.26	0.35	0.51
400	0.22	0.30	0.44
450	No Curve Widening	0.27	0.39
500	No Curve Widening	0.25	0.35
600	No Curve Widening	0.21	0.30
700	No Curve Widening	No Curve Widening	0.25
800	No Curve Widening	No Curve Widening	0.22

Note:

- The need for sign turning templates determined by variation in widening due to angle of turn;
- The need for widening ceases when the widening is less than 0.25 m (to fit the minimum practical widening for a two-lane road of 0.5 m); and
- The curve widening for a given carriageway will be the widening per lane x number of lanes. The resultant total width of the traffic lanes may then be rounded to the nearest multiple of 0.25 m.

3.4 Curve Superelevation

There is a need to consider the amount of curve superelevation in relation to the speed of MCVs to ensure the vehicles with particularly high or unstable loads can negotiate each curve with safety. Generally, volume-loaded double deck cattle crates have a high centre of gravity and therefore are less stable on low speed curves. Appendix E contains a graph to be used to confirm the suitability of curves along the proposed route. The graph shows the relationship between speed, superelevation and minimum curve radius based on a limiting truck overturning force of 0.2 x weight. Note that it is possible for some MCVs to lose control or skid before roll-over occurs.

The route should not be recommended for approval if any of the following is true for one or more curves on a sealed route:

- The maximum speed of the curve, as determined from Appendix E, is more than 15 km/h below the posted or legal speed limit for the section of road, and there are no advisory speed signs installed on the approaches to the curve; and
- The maximum speed of the curve, as determined from Appendix E, falls below the speed shown on any advisory speed signs installed on the approaches to the curve.

Austroads (1989) states that maximum superelevation ranges from 12% in mountainous terrain to 6% in flat terrain. Additionally, the maximum adverse crossfall is 3% and only to be used on curves of radius greater than those values listed in the Road Planning and Design Manual, Chapter 11: Horizontal Alignment (Queensland Department of Main Roads, 2002).

Queensland Department of Main Roads (2000) advised that some Main Roads District practices suggest, where possible, a maximum superelevation of 4% should be used on road train routes carrying a high proportion of volume-loaded vehicles (double deck cattle crates), especially in lower speed environments. This reduction is due to their high centre of gravity and would be subject to the speed requirements and the frictional properties of the road surface.

3.5 Intersections

There is to be sufficient road length between adjacent intersections to allow the MCV to clear the first intersection before stopping at the second intersection. This situation is illustrated in Figure 3-1.

The effect of heat haze may need to be considered during the assessment of approach visibility at intersections.

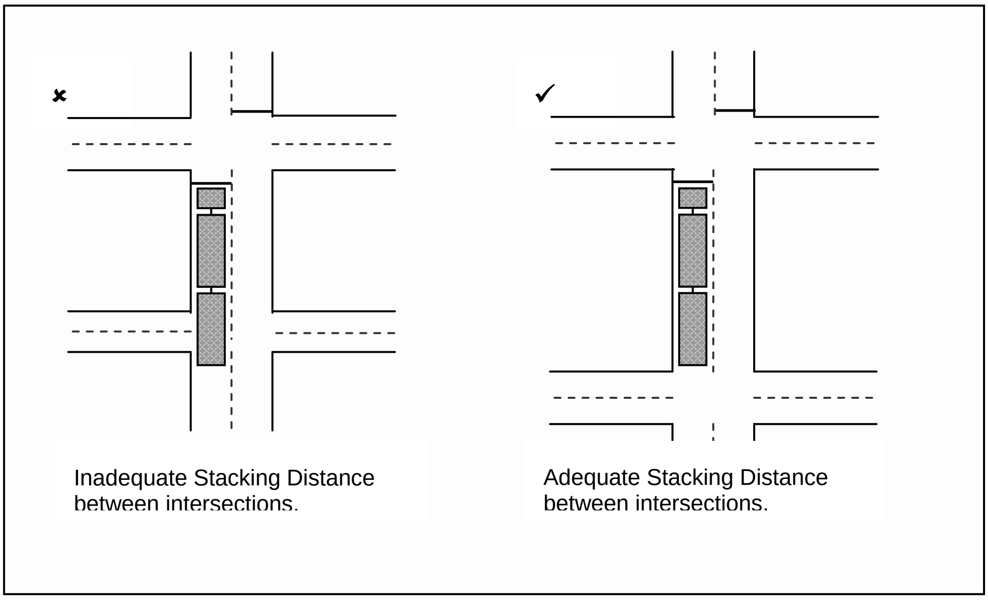


Figure 3-1: Stacking Distance between Intersections

To ensure network continuity, when assessing a new MCV route that joins onto an existing gazetted MCV route, assessors should ensure there is adequate sight distance, stacking distance and swept path geometry at the intersection of the new route and existing gazetted route.

The various operational requirements at intersections are described in the Road Planning and Design Manual 2nd Edition Queensland Practice, Volume 3 Guide to Road Design Part 4: Intersections and Crossings – General (Queensland Transport and Main Roads, 2013). The following has been adapted from the Road Planning and Design Manual and Transport and Main Roads practices, taking into account the differences in size, braking, and acceleration performance of MCVs

3.5.1 Unsignalised Intersections

The capacity and delay at unsignalised intersections and roundabouts is primarily dependent on gaps existing in traffic that are large enough for the MCV to enter or cross the traffic stream. As a result of the greater length and lower acceleration capability of MCVs, considerably larger gaps in the traffic are required to carry out manoeuvres than those required for smaller vehicles. As would be expected, the probability of finding an acceptable gap is considerably lower for these larger vehicles.

For the abovementioned reasons, selection of routes for MCVs through urban environments usually is limited to major freight routes, where MCVs have priority through unsignalised intersections.

Adequate Approach Sight Distance (ASD) and Safe Intersection Sight Distance (SISD) are two aspects to be considered for safe traffic operations at intersections. Both are illustrated in Figure 3-2.

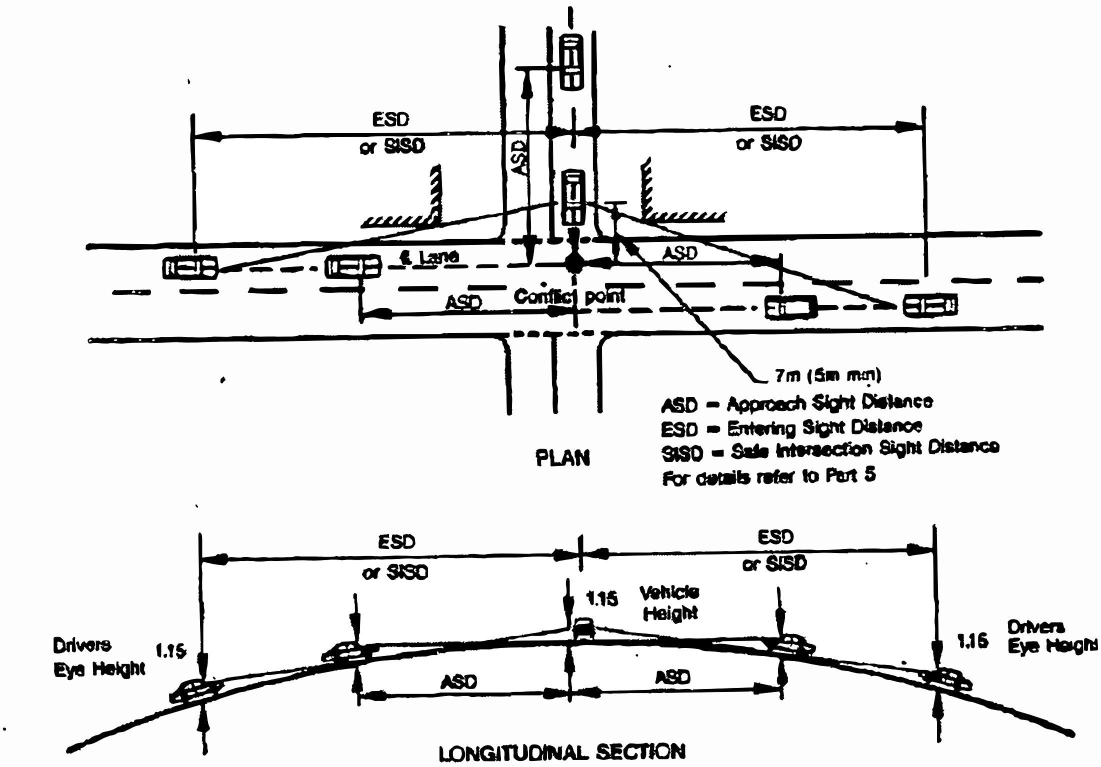


Figure 3-2: Entering Sight Distance & Safe Intersection Sight Distance (from Austroads (1991))

Approach Sight Distance (ASD)
This is the desirable minimum requirement on each leg and turning lane of an intersection to provide the driver of a vehicle adequate distance to observe the roadway layout in sufficient time to react and stop if necessary before entering the conflict area. It should be provided on all approaches to an intersection.

Approach Sight Distance is measured from driver eye height (2.4 m) to 0.00 m (the road surface). Table B1 in Appendix B shows appropriate stopping sight distances for drivers of MCVs given the vehicle type, speed and gradient of the road. The route should not be recommended for approval if the driver of a MCV, approaching any intersection on a priority road, has insufficient visibility to detect the presence of the intersection, and stop if necessary. Note that at the stopping distances involved, it is not always possible to detect the intersection by seeing to the road surface. Site inspection will show if there are sufficient features such as signs, kerbs and backdrop etc. that show the presence of the intersection, even if the road surface is not visible.

Safe Intersection Sight Distance (SISD)
This is the minimum sight distance that should be available on the major road at any intersection. It provides sufficient distance for a driver of a vehicle on the major road to observe a vehicle from a minor road approach moving into a collision situation and to decelerate to a stop before reaching the collision point. It is measured from driver eye height to driver eye height. Austroads (2002) recommends a commercial vehicle driver eye height of 2.4 m and a car driver eye height of 1.05 m. Main Roads research (Cox (2003)) does not support the 1.05 m eye height and Transport and Main Roads will continue to use 1.15 m until the issue is resolved with Austroads.

Safe Intersection Sight Distance comprises an alerted stopping sight distance plus the distance travelled in 3 seconds at the 85th percentile operating speed of the major road vehicles. Table C1 in Appendix C shows appropriate Safe Intersection Sight Distances for drivers of MCVs given the vehicle type, speed and gradient of the road.

If Safe Intersection Sight Distance cannot be provided (eg. where there are obstructions such as buildings) the intersection should be supplemented with appropriately designed control mechanisms, such as signage, pavement markings and signals.

3.5.2 Signalised Intersections

The route should not be recommended for approval if the traffic signals are not visible to the operator of the approaching MCV from the distance shown in Appendix B. Alternatively, the route can be accepted if advance yellow flashing warning signs are installed to Transport and Main Roads standards, and can be viewed by drivers at the distance from the intersection shown in Appendix B.

As well as physical obstructions such as topography and road alignment, factors that can adversely affect visibility of traffic signals include overhanging trees, sun-glare on and behind the traffic signal lenses, and poor luminance due to inadequate signal aiming.

The operational timing of any traffic signals along the proposed route (including pedestrian facilities) must be assessed to ensure the appropriateness of minimum green and inter-green phases. The minimum green time should be sufficient to allow the MCV to safely clear an intersection from a stop-start position, considering the slower acceleration rates of MCVs.

In 2001, Queensland Department of Main Roads and Queensland University of Technology conducted infield testing, in conjunction with Queensland Transport, to determine clearance time requirements of a number of MCVs on various grades.

Characteristics of the MCVs tested are provided in Table 3-4. Haldane. M (2002) provides further detail on the characteristics and application of these MCVs.

Table 3-4: Test MCV Characteristics

Characteristic	B-Double	Type 1 Road Train	Type 2 Road Train
Length	25.36 m	27.43 m	40.78 m
Width	2.5 m	2.5 m	2.5 m
Tested GCM	62.10 t	79.88 t	115.83 t
Regulation GCM	62.50 t	79 t	119 t
Payload	36.44 t	48.14 t	66.73 t
Configuration	12(S3)2	12S3-2S3	12S3(-2S3)2
Tyres	34	42	62
Engine	550 Hp (410 kW)	550 Hp (410 kW)	550 Hp (410 kW)
Power/mass (kW/t)	6.60	5.13	3.54

The following distance/time relationship, established from the infield data, can be used to determine MCV clearance time requirements on a particular grade:

$$d = \frac{C}{6}t^3 + \frac{a_0}{2}t^2 \qquad (3.1)$$

Where d is the distance travelled from rest (m) at instant t (s). C and a_o are constants provided in Table F1 of Appendix F for each test vehicle in Table 3-4, on a particular grade.

Applying the ratio of the MCVs engine power to the relevant test vehicles may approximate the values for MCVs with similar dimensions and speed, but different engine power to the vehicles tested.

In more densely populated areas, having an extendable inter-green time based on the detection of large vehicles approaching the intersection could be possible, without unduly affecting intersection performance.

It is preferable if proposed routes consist of traffic signals that are coordinated at all times or at the very least during the freight peak. This synchronisation of traffic signals is designed to permit traffic to flow through a number of signalised intersections on a so-called 'green wave', when driving at the speed of the majority of the traffic. Slower vehicles may encounter a 'red wave', being forced to stop regularly.

The additional length of MCVs needs to also be taken into account in regard to any adverse lane queue and vehicle storage impacts.

3.5.3 Roundabouts

Encroachment Areas

A vehicle may encroach on the roundabout central island if specially constructed encroachment areas are available.

Mountable aprons on splitter and central islands in roundabouts can be very useful in accommodating MCV manoeuvres while still providing control of other vehicles. However, pedestrian and cyclist needs should also be considered.

Width of Circulating Carriageway, Entries and Exits

Carriageway widths need to be developed through consideration of the number of lanes needed for overall traffic and swept path analysis for MCVs. Normal roundabout design practice allows heavy vehicles to encroach onto adjacent lanes. Otherwise, the resulting lane widths required to completely contain MCVs are excessive, therefore encouraging high speeds for other vehicles using the roundabout.

Designs should be checked to ensure that any widening to accommodate MCVs does not permit other vehicles to exceed safe design speeds through the roundabout.

Computer generated swept paths should be used to check the adequacy of roundabout island and outer kerb diameters. Refer to the Turning Paths Section of this document.

3.6 Turning

3.6.1 Turning Paths

All turns must be assessed to ensure the vehicle can safely negotiate the geometry of all corners, intersections, roundabouts, and other traffic management devices along the proposed route.

Appendix D shows the vehicle path turning radii of turning MCVs and can be used as a quick check to see whether the cornering radii are adequate. Where there is any possibility the MCV may have insufficient clearance from kerbs or other nearby objects, Transport and Main Roads VPATH computer program should be used to accurately check the swept path of the MCV.

The route assessor is required to accurately model each turn along the proposed route and ensure that the vehicle's turning path can safely negotiate the geometry of all corners, intersections, roundabouts, and other traffic management devices along the proposed route, with minimal or no interference to other traffic.

As a rule:

- The wheel paths of the rear trailer of the combination should not come any closer than 600 mm to the face of any kerb or the outer edge of any shoulder;
- The vehicle path of the vehicle should not come any closer than 1200 mm from the wheel path of an adjacent vehicle;
- The overhang path should not come any closer than 600 mm to a nearby object; and
- For a left turn, the wheel paths should not cross into the path of oncoming traffic. Although encroachment over the centre line may be acceptable where traffic volumes are very low (less than 250 vehicles per day oncoming traffic).

A field trial will also assist in assessing swept path requirements. Refer to the Road Planning and Design Manual 2nd Edition Queensland Practice, Volume 3 Guide to Road Design Part 3: Geometric Design (Queensland Transport and Main Roads, 2013). Road Planning Design Manual, Chapter 11 (Queensland Department of Main Roads, 2001) and Transport Operations (Road Use Management - Road Rules),Regulation 2009

3.6.2 Vehicle Speed while Negotiating the Turn

The vehicle turning radius is directly related to the turning speed of the vehicle. This is illustrated in Table D1 of Appendix D. It is essential that the vehicle be able to negotiate a turn at sufficient speed so as not to cause undue obstruction to traffic. Note this speed may need to be reduced to account for a high or unstable load.

For intersections where the vehicle must always stop before turning, such as at a stop sign, a turning speed of 15 km/h or less is generally sufficient.

For intersections where the vehicle rarely or never needs to stop before turning, a speed of 30 km/h should be the minimum on major roads. For minor roads, a speed of 20 km/h is acceptable. These speeds may be modified if advisory or regulatory speeds limits apply to the intersection.

3.6.3 Left Turns

Left turns onto or from arterial roads are permitted provided the turns can be executed without having a significant adverse affect on the traffic flow, taking into account the speed environment, sight distance, traffic volume and composition. When making left turns the wheel paths must not cross into the path of oncoming traffic (encroachment over the centreline may be acceptable where traffic volumes are very low, i.e. less than 250 vehicles per day oncoming traffic).

3.6.4 Right Turns

The following factors should be considered when assessing the suitability of right turns along a proposed route:

- Road width and number of traffic lanes being crossed;
- Approach vehicle speeds;
- Traffic volumes;
- Traffic composition;
- Provision of protected right turn lanes;
- The size and frequency of gaps in the opposing stream of traffic;
- Proximity of nearby traffic signals; and
- Turning path.

Urban Townsite Areas

Right turns from arterial roads should generally be limited to intersections and junctions controlled by traffic signals with exclusive right turn phases because of the additional time required to execute the turn and the larger gap required for oncoming traffic.

Right turns from arterial roads not controlled by traffic signals may be considered where traffic volumes are low or at locations provided with protected right lanes with a storage capacity appropriate to accommodate the anticipated length of the vehicle, in addition to normally expected queue lengths from other vehicles.

It is preferred that right turns onto arterial roads are performed at intersections and junctions controlled by traffic signals. Border District have advised of B-double and Road Train right turns being performed satisfactorily at unsignalised intersections, for AADT up to 5000.

Rural Areas

It is desirable that right turns onto or from arterial roads be made from appropriate turning lanes, including adequate provision for acceleration and deceleration.

3.7 Terminal/Destination Connections

The applicant is responsible for ensuring the suitability of all terminal and destination connections. Access to and from the terminal/destination must be limited to the following:

- Entry and exit must be in a forward direction;
- Entry and exit must not unduly affect the movement of other vehicles on the road system. Computer generated swept paths should be used to initially assess the suitability of the connection. Refer to the Turning Paths Section of this document;
- Sight distances at the terminal/destination connection with the road must meet the Safe Intersection Sight Distance provided in Table C1 of Appendix C. Refer to the Intersections Section of this document;

- Vehicles must be able to completely enter the terminal/destination without overhang onto the roadway or footpath. All manoeuvring, uncoupling, coupling or standing must be off public roads;
- Driveways and footpaths must have the necessary structural integrity to avoid being damaged. Local councils should be contacted regarding the structural assessment of these structures;
- The effect of the scrubbing action of MCV axle groups on the pavement in the vicinity of the driveway needs to be considered;
- When turning left into terminals/destinations vehicles must turn from a position that is wholly within the left lane. Refer to the Left Turns Section of this document;
- Right turns to and from terminal/destination connections may be considered subject to the prevailing road environment, traffic volume and traffic mix. When turning right into a terminal/destination the vehicle must turn from the lane nearest to the centre of the road. If there are any restraints on a vehicle turning right other than at a controlled intersection, approval will not be given other than in exceptional circumstances. Refer to the Right Turns Section of this document; and
- Field trials can be considered to verify the suitability of the terminal/destination connections.

The above requirements for terminals/destinations are in addition to any local government requirements regarding land use. Such local government requirements might have a bearing on the type of goods handled at the terminal/destination.

3.8 Overtaking Requirements

Provision of sufficient overtaking opportunities ensures MCVs have minimal impact on other traffic. There are two aspects of overtaking; the requirement for a MCV to overtake another vehicle and, more commonly, the requirement for another vehicle to overtake a MCV.

3.8.1 Overtaking of MCVs by Other Traffic

On undivided carriageways, opportunities for drivers to overtake slower moving MCVs are governed by factors such as vehicle speeds, overtaking sight distances, traffic volumes, traffic composition and horizontal/ vertical road alignment.

Adequate Overtaking Opportunities

The volume of traffic on a particular section of road affects the overtaking opportunities. At higher traffic volumes, providing additional overtaking opportunities to satisfy acceptance criteria is justified. Austroads (1989) details the methodology for determining whether adequate overtaking opportunities are available on a particular section of road. The acceptance criteria for rural highways and rural main roads, based on ranges of traffic volumes are shown in Table 3-5. Consideration needs to be given to seasonal variation in traffic composition when using these AADT figures. Vehicles towing caravans or trailers may find it difficult to overtake a MCV. This situation is more prevalent during the school holidays.

Table 3-5: Acceptable Criteria for Overtaking Opportunities (from Main Roads Western Australia (2003))

AADT	Maximum average distance per overtaking opportunity	Maximum distance between overtaking opportunities	Notes
500 or below	N/A	N/A	Provision of additional opportunities is usually not justified.
501–1000	15 km	30 km	
1001–1800	8 km	15 km	
1801 or above	5 km	10 km	At AADT > 2700, additional opportunities that exceed the criteria may be necessary.

If the road or highway does not meet these criteria in the above table, consideration shall be given to:

- whether the volume and composition of traffic can tolerate the lack of overtaking opportunities;
- constructing overtaking lanes;
- whether access could be granted under curfew; and
- whether access could be granted at particular times of the year when the traffic volumes are low.

In addition, a field trial may be required to assess whether vehicle queuing behind the MCV is a problem.

Sight Distance for Overtaking
For sections of road to be suitable for overtaking, there must be adequate overtaking sight distance. Overtaking sight distance is made up of two parts, being:

- Establishment distance - The length of clear visibility ahead in which a driver can establish that an overtaking opportunity exists and commence the overtaking manoeuvre.

- Continuation distance - The length of road ahead in which clear visibility remains available for a driver to complete the overtaking manoeuvre, or abandon the manoeuvre if necessary.

The percentage of road available for overtaking should include those lengths where the required minimum establishment distance is available in conjunction with the required minimum continuation distance, as shown in Table 3-6.

Table 3-6: Minimum 'Establishment' & 'Continuation' Sight Distances for Overtaking

Road section Design Speed (km/h)	Overtaken vehicle speed (km/h)		Establishment Sight Distance (m)				Continuation Sight Distance (m)			
	Semi-tr, B-dble	Road Trains	Semi-tr	B-Double	Type 1 Road Train	Type 2 Road Train	Semi-tr	B-Double	Type 1 Road train	Type 2 Road train
70	60	60	570	600	640	690	300	320	360	420
80	69	69	710	740	790	860	370	400	450	510
90	77	77	850	890	950	1,040	440	470	530	620
100	86	84	1,020	1,070	1,130	1,240	530	560	630	740
110	94	84	1,230	1,290	1,200	1,310	620	680	660	770

Given a low eye height of 1.15m, most car drivers can not adequately distinguish differences in sight distance for values greater than about 1000m. Therefore, listed sight distance values greater than 1000m can be assumed to satisfy whenever the actual sight exceeds 1000m.

The listed sight distance values have been derived from the Troutbeck (1981) overtaking model. Sight distance values have been rounded to the nearest 10m. Given the inherent level of precision in the overtaking model, it would be incorrect to determine that an overtaking zone does not exist when the actual sight distance falls below a relevant listed value by about 10m.

3.8.2 Overtaking Manoeuvres by MCVs

The overtaking sight distances required for a MCV to overtake another vehicle would be very sensitive to the speed differentials involved and is dictated primarily by the performance parameters of the MCV. The computer simulation program TRARR should be used to identify overtaking lengths required and sight distances derived from that information.

3.9 Overtaking Lanes

When overtaking opportunities along a length of road are insufficient, consideration should be given to introducing overtaking lanes.

The planning requirements for overtaking lanes include analysis of likely vehicle interactions, based on numbers and speeds of vehicles, and of overtaking sight distances. The computer simulation program, TRARR, is an extremely useful tool in identifying the requirements for overtaking lanes and should be used to carry out this analysis.

Particular attention should be given to roads with significant proportions of grade exceeding 5%.

On sections of road where a 100 km/h speed limit applies the minimum length of the overtaking lane should be 800 m including tapers.

3.10 Steep Ascending Grades

The speed of MCVs ascending long and steep grades can be reduced to the extent that the difference in speed between the MCV and other vehicles can become hazardous for vehicles approaching from behind. In some cases, the drivers of faster following vehicles may become frustrated and attempt an overtaking manoeuvre when unsafe to do so. For this reason, steep ascending grades should have overtaking lanes where possible. Refer to the Overtaking Lanes Section of this document.

A forced speed reduction to 40 km/h is considered the threshold point at which drivers will seek to overtake a slower vehicle, regardless of whether or not adequate sight distance is available.

The distances required for a MCV going up a grade to slow down to 40 km/h have been simulated using software developed for Main Roads Western Australia by the University of Western Australia in 2002. The vehicles modelled in the simulation process were:

- B-Double with a loaded mass of 67.5t and a 460 HP engine;
- Type 1 Road Train with a loaded mass of 79t and a 500 HP engine; and
- Type 2 Road Train with a loaded mass of 115.5t and a 600 HP engine.

The figures in Table 3-7 are based on the results of these simulations.

Table 3-7: Maximum distances (in metres) of uphill travel before speeds are reduced to 40 km/h (from Main Roads Western Australia (2003))

Grade %	**B-Double** (67.5 t)		**Type 1 Road Train** (79t)		**Type 2 Road Train** (115.5 t)	
	80 km/h Approach Speed	100 km/h Approach Speed	80 km/h Approach Speed	100 km/h Approach Speed	80 km/h Approach Speed	100 km/h Approach Speed
3	*	*	*	*	1,080	1,650
4	950	1,410	900	1,350	690	1,110
5	640	980	610	960	520	840
6	480	760	470	750	410	680
7	390	630	380	620	340	570
8	330	530	320	530	290	490

* MCV can maintain a higher speed than 40 km/h on these grades.

Main Roads Western Australia advised that where grades, or consecutive combinations of varying grades, are longer than the distances in Table 3-7, it is likely that the grade should have an overtaking lane for the MCVs.

The maximum desirable vertical grade for any section of a proposed route is 5%.

3.11 Safety Ramps on Steep Downhill Grades

For proposed routes where road sections have extended long down grades of 6 - 10%, safety ramps (consisting of an upward sloping escape ramp or an arrester bed of sand/gravel) should be provided about 3 km from the summit of the grade. Safety ramps should be located prior to or at the start of the smaller radius curve along the alignment. They should not require an out of control vehicle to cross oncoming traffic. When upgrading the road classification (i.e. B-Double route to a Type 1 Road Train route) consider that a heavier vehicle will obtain higher speeds on descending grades when brakes have failed. Therefore thought should be given to the length, depth, grade or material used in an arrester bed. Further information is provided in the Road Planning Design Manual, Chapter 15: Auxiliary Lanes (Queensland Department of Main Roads, 2001).

3.12 Acceleration Lanes

3.12.1 Length of Acceleration Lane

So as not to cause an undue hazard or obstruction to traffic, the length of any acceleration lanes provided on the route should be sufficient to allow MCVs, when fully loaded, to accelerate to within 70% of operating traffic speed at the point where the lane joins with the through road.

Table 3-8 shows the minimum length of an acceleration lane for different vehicles and conditions. An asterisk (*) indicates that it is not possible to accelerate from rest up to the required speed within a distance of 2000 m.

Table 3-8: Minimum Length (m) of Acceleration Lane (from Main Roads Western Australia (2002))

3.8(a) Speed limit on through road is 80 km/h (i.e.: the required entry speed for the MCV is 56 km/h)

Average gradient of acceleration lane (%)	Downhill				Uphill	
	-4	-2	-1	Level	1	2
B-Double (67.5t)	190	270	350	510	1,090	*
Type 1 Road Train (79t)	200	280	370	570	1,500	*
Type 2 Road Train (115.5t)	220	330	460	790	*	*

3.8(b) Speed limit on through road is 110 km/h (i.e.: the required entry speed for the MCV is 77 km/h)

Average gradient of acceleration lane (%)	Downhill				Uphill	
	-4	-2	-1	Level	1	’2
B-Double (67.5t)	410	630	910	1,620	*	*
Type 1 Road Train (79t)	420	670	970	1,870	*	*
Type 2 Road Train (115.5t)	470	760	1,180	*	*	*

Note that the above table refers only to situations where the through road is a main road or a highway, with moderate to high traffic volume. In other cases, traffic volumes and traffic composition should be considered when assessing the route, if the minimum acceleration lengths required to achieve 70% of the operating speed (V_{85}) are not met.

3.12.2 Signing

There shall be adequate signing, in conformity with Transport and Main Roads standards, on the through road to warn other traffic that trucks regularly cross onto the through road from the acceleration lane. Where this does not already exist, the assessor shall note the need for signing in the "comments" column of the assessment checklist.

3.12.3 Visibility of the Point of Entry

The point where the acceleration lane meets the through road shall be visible at an adequate distance along the through road to ensure that there is enough time for other traffic to slow down or stop if required.

Stopping sight distances for the MCV in the acceleration lane and visibility of the entry point in both directions of travel along the through road are shown in Appendix B.

3.13 Railway Level Crossings

Routes should only be accepted if the requirements relating to visibility, stacking distance, stopping distance, and sight distance are met. Routes should be rejected where MCVs are required to queue across railway lines due to the close proximity of road intersections. The following highlights the main considerations for MCVs at railway crossings for the various levels of protection. Further information is available in Railway Crossing (Main Roads Western Australia, 2002) and the Road Planning and Design Manual, Chapter 21: Railway and Cane Railway Level Crossings (Queensland Department of Main Roads, 2002).

3.13.1 MCVs at Crossings Controlled by Give Way Signs

A railway crossing controlled by Give Way signs requires sufficient sideways crossing visibility available for a driver to see a train is not approaching and it is safe to proceed and cross the tracks. The visibility requirements need to take into account the approach speeds of the train and MCV, grade, terrain, road and track conditions, sighting distances and the length of the MCV; however a sight distance of approximately 1000 metres is generally sufficient.

The angle between the road and the rail must be a minimum of 70° so a driver can view an approaching train within the required distance, bearing in mind any curvature of the rail and the physical limitations a truck cabin can impose on a driver’s ability to view obtuse angles, particularly to the left.

Some MCVs, such as dangerous goods vehicles, are required by law to stop at railway crossings. Therefore there must be adequate sight distance to approaching trains, before the intersection and at the stop or holding line, to allow the MCV to stop.

3.13.2 MCVs at Crossings Controlled by Stop Signs

There must be adequate visibility of the crossing and associated signs to allow sufficient time to stop the MCV before the crossing. Minimum stopping sight distances are shown in Appendix B. Assessors should consider the likely operating speed of the MCV, the decelerating capability, and any downhill and uphill grades towards the crossing. Other matters to be checked include vertical geometry, which prevents visibility of the intersection, eg. the occurrence of a crest in the road or rail line.

A railway crossing controlled by Stop signs requires that sufficient sideways crossing visibility is available for a driver, after having stopped at the crossing, to proceed clear of the crossing before the arrival of an approaching train. The visibility requirements need to take into account the approach speeds of the train, grade, terrain, road and track conditions, sighting distances, accelerating capability and the length of the MCV; however a sight distance of approximately 1000 metres is generally sufficient.

The angle between the road and the rail must be a minimum of 70° so that a driver can view an approaching train within the required distance, bearing in mind any curvature of the rail and the physical limitations a truck cabin can impose on a driver's ability to view obtuse angles, particularly to the left.

3.13.3 MCVs at Crossings Controlled by Flashing Lights

Adequate approach visibility to the primary signal displays to crossings controlled by flashing lights is required, so the driver can safely stop if necessary. Minimum sight stopping distances are shown in Appendix B.

Assessors should consider the likely operating speed of the MCV, any downhill and uphill grades towards the signals, and the phase times and size/brightness of any signal lanterns. Other matters to be checked include vertical geometry, which prevents visibility of the intersection, eg. the occurrence of a crest in the road or rail line, the possibility of the sun affecting visibility of the signals and vegetation, which may obscure the signals.

Consideration should be given to the timing delay between the commencement of the flashing lights and when the train passes, to ensure that an MCV is able to pass over the crossing or safely stop.

Alternatively, the route can be accepted if advance yellow flashing warning signs are installed in accordance with the Transport and Main Roads Traffic and Road Use Management Manual and the Transport and Main Roads Manual of Uniform Traffic Control Devices.

3.13.4 MCVs at Crossings Controlled by Flashing Lights with Boom Barriers

Checks need to be made that the timing delay between when the flashing lights commence operation and the boom gate begins to descend, is sufficient to allow the MCV to pass over the crossing without striking the boom gate.

Typical warning times for urban level crossings are 8 seconds for flashing lights followed by 10 seconds for boom gate lowering with a further wait of 10 seconds until the train arrives when travelling at maximum line speed.

Assessors should consider the likely operating speed of the MCV, any downhill and uphill grades towards the signals, and the phase times and size/brightness of any signal lanterns. Other matters to be checked include vertical geometry, which prevents visibility of the intersection, eg. the occurrence of a crest in the road or rail line, the possibility of the sun affecting visibility of the signals and vegetation, which may obscure the signals.

3.13.5 Dilemma Zone for MCVs

When a heavy vehicle is approaching a railway crossing, the operator must have enough distance/time to either decelerate to the stop or holding line, or pass completely through the railway crossing without altering the travelling speed. For example, an MCV will decelerate at a lower rate due to its increased brake response time compared to a general access vehicle, so the MCV will require more distance and advance warning time to stop. The problem is amplified, because an MCV will also use more time passing through the railway crossing, due to the additional length. The entire MCV may not be able to pass through the railway crossing before the train arrives (or the boom gates lower). Refer to Figure 3-3.

The dilemma zone begins at the point where the stopping sight distance is not satisfied and ends at the point where the MCV could safely pass through the railway crossing. The size of the zone depends on the length and the brake response time of the vehicle and therefore varies between MCV classes.

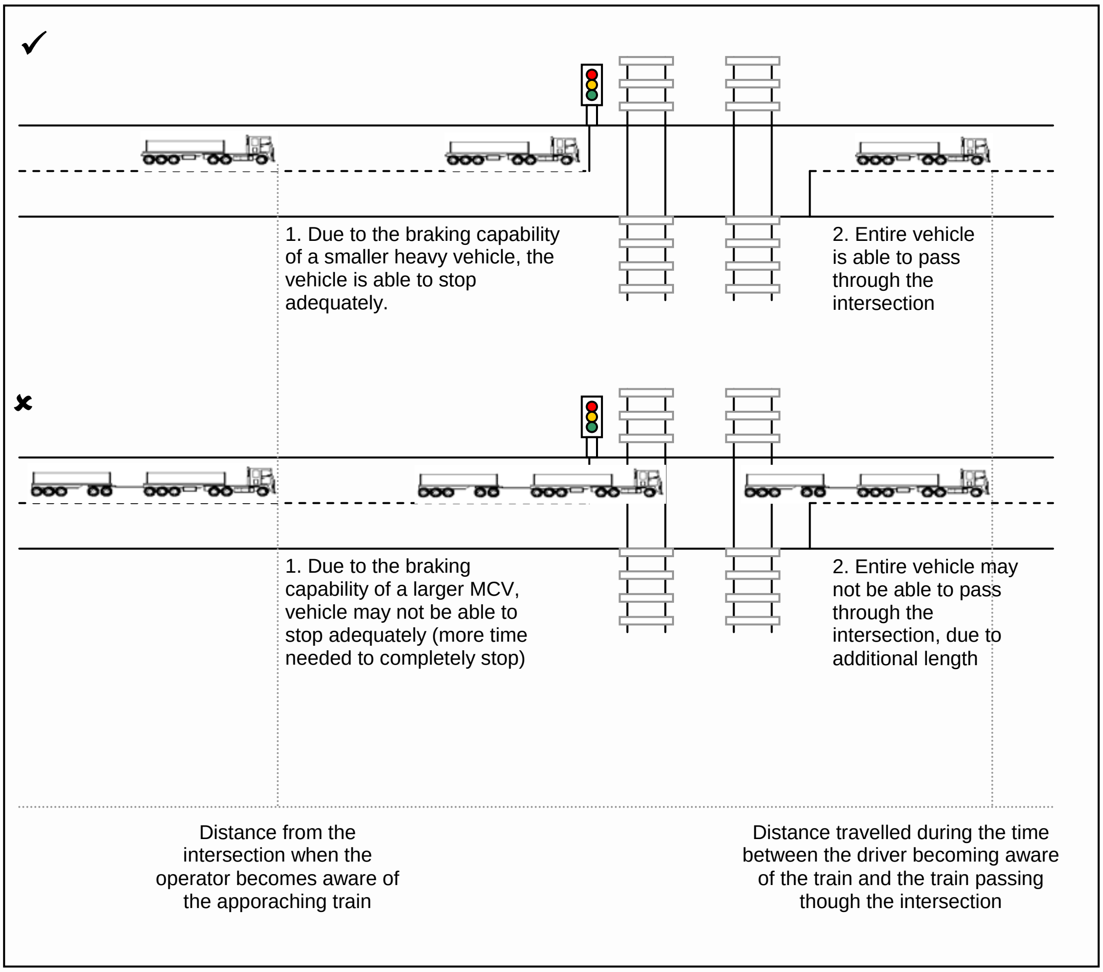


Figure 3-3: Example of the Dilemma Zone Problem

3.13.6 Proximity to an Intersection

The proximity of any railway level crossing to an intersection/junction must be reviewed to ensure there is sufficient road length either side of a level crossing to allow the MCV to:

- clear the level crossing before stopping at an intersection; and
- clear the intersection before stopping at the level crossing.

3.13.7 Stacking Distance

Routes with railway crossings having inadequate approach or departure stacking distance should not be recommended for general approval of a continual operation. The definitions of inadequate approach and departure stacking distances are described below and shown in Figure 3-4 and

Figure 3-6. Particular consideration should be given when the road classification is to be upgraded. For example, a current B-Double route, which is to be upgraded to a Type 1 Road Train route.

Exceptions can be made for stacking distance requirements for single trip permits where special arrangements to ensure safety are made.

Inadequate Approach Stacking Distance

Inadequate approach stacking distance occurs where the distance between the railway and a nearby intersection is insufficient to enable a vehicle to stop at the railway crossing without impeding the traffic flow at the intersection.

The vehicle stopping position at a railway crossing is normally indicated by a stop or holding line, or in the absence of a marked line, assumed to be 3.5 m back from the nearest rail.

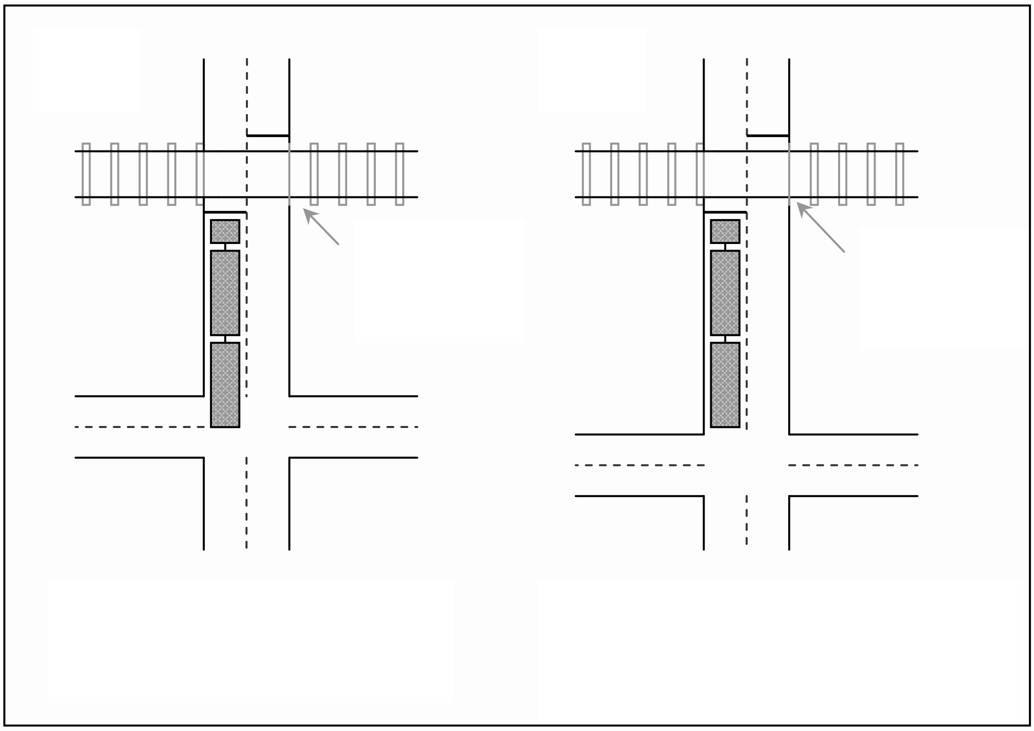


Figure 3-4: Approach Stacking Distance

At locations where inadequate approach stacking distance occurs, the assessor should consider and make recommendations on any possible road design solutions, such as those illustrated in Figure 3-5. The applicant may be required to meet all or part of the costs associated with any road modifications.

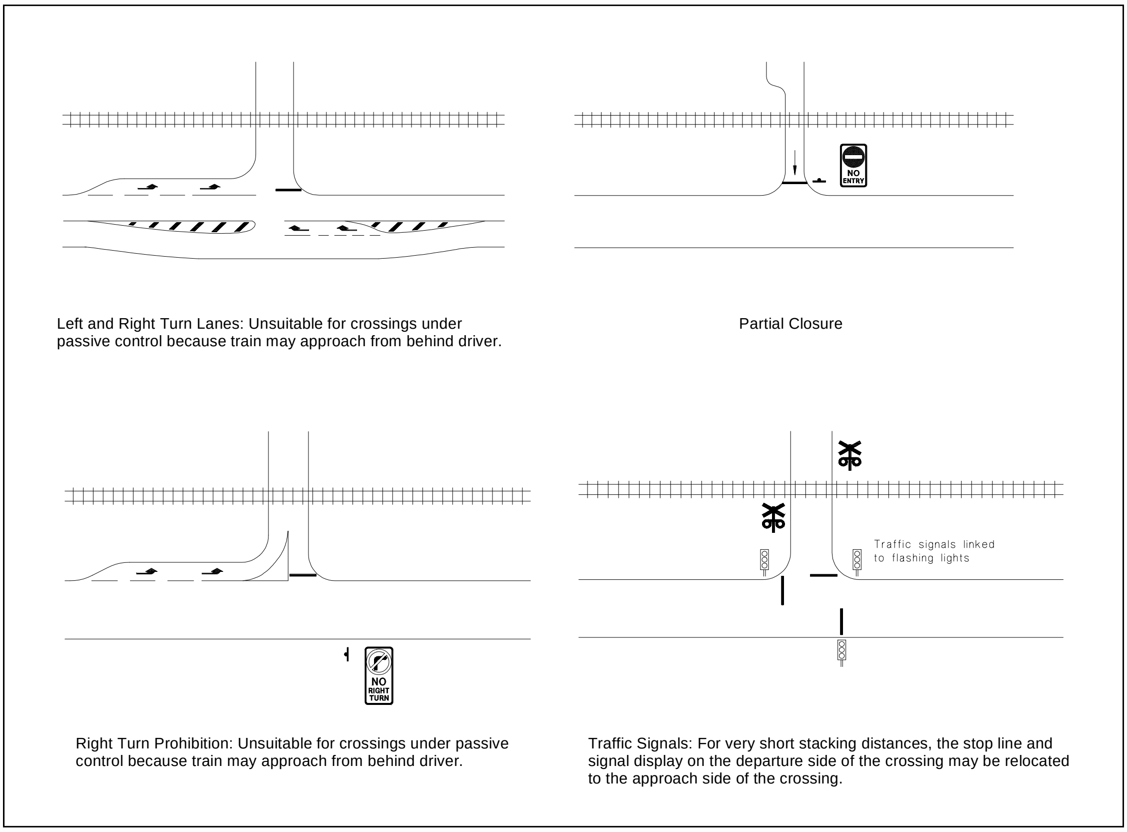


Figure 3-5: Possible Solutions for Inadequate Approach Stacking Distance (QR (2003))

Inadequate Departure Stacking Distance

Inadequate departure stacking distance occurs when part of a vehicle remains on the railway crossing while stopped to give way to traffic on the priority road of an intersection located beyond the crossing. The exception is in cases where the intersection is controlled by traffic signals that are coordinated with the operation of the railway crossing signals.

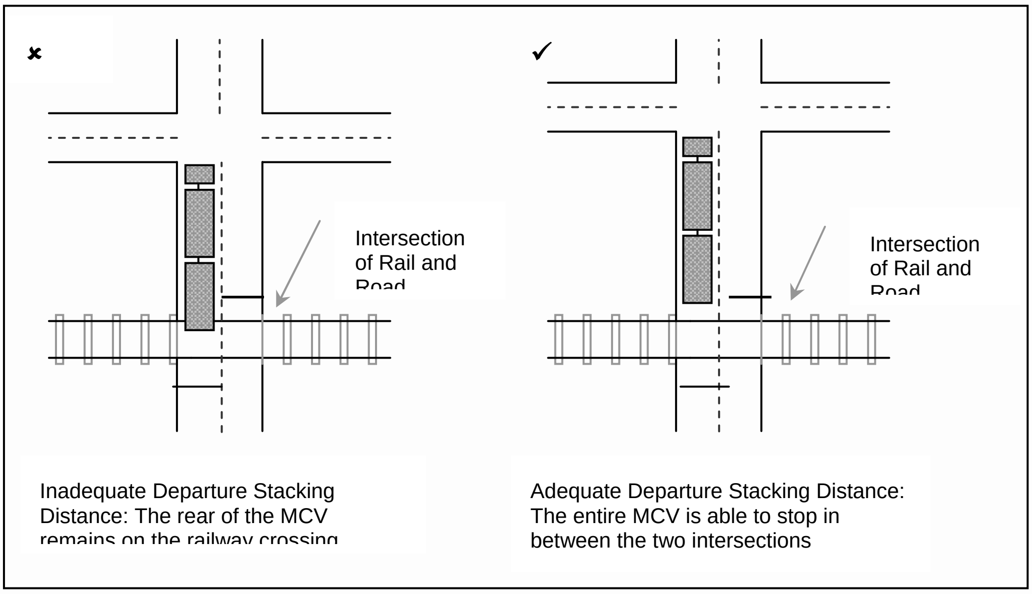


Figure 3-6: Departure Stacking Distance

The normal vehicle stopping position at a priority road intersection is generally indicated by a stop or holding line. In the absence of a marked line, the stopping position can either be assessed on site or conservatively taken as 2 m from the edge of the outer shoulder of the through road.

A 3.5 metre safety zone between the rear of the vehicle and the nearest rail is required.

At locations where inadequate departure stacking distance occurs, the assessor should consider and make recommendations on any possible road design solutions, such as those illustrated in Figure 3-7. The applicant may be required to meet all or part of the costs associated with any road modifications.

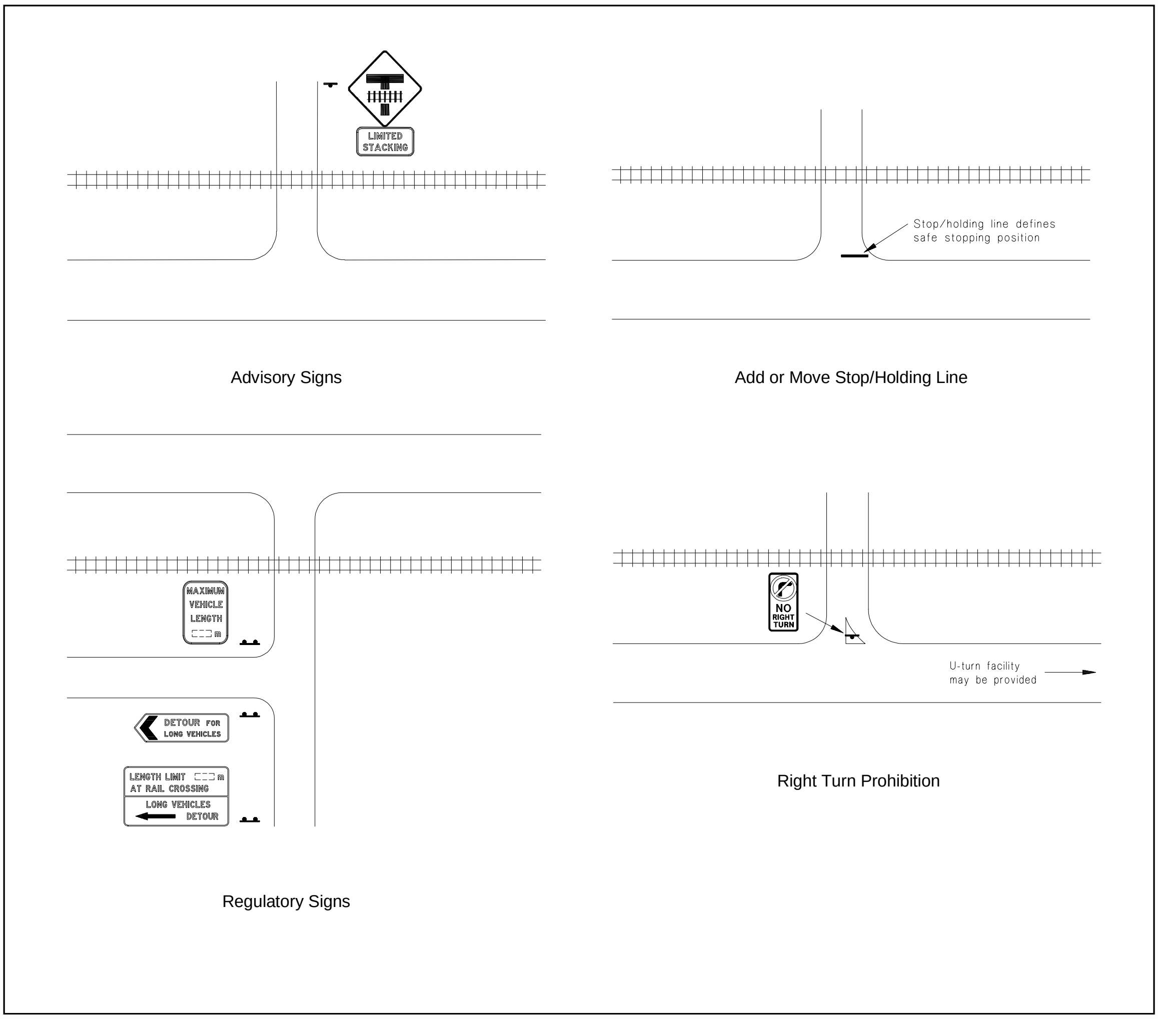


Figure 3-7: Possible Solutions for Inadequate Departure Stacking Distance (QR (2003))

3.13.8 Ridability of the Railway Level Crossing

Consideration should also be given to the ridability of the railway level crossing and the potential affect on load stability if it is rough, in terms of the additional ridability requirements of a MCV compared with semi-trailer traffic that may currently be using the crossing.

3.13.9 General

In assessing railway level crossings it shall be compulsory to liaise with the appropriate rail owner, cane railway owner and the Local Council. The assessor should also refer to the requirements of Transport and Main Roads Manual of Uniform Traffic Control Devices, Part 7 Railway Crossings.

All enquiries to Queensland Rail should be directed to:
Network Business Commercial Team
Email: aarf.freight@qr.com.au
Phone: (07) 3235 3632

3.14 Network Business Commercial Team mail aar Structures

3.14.1 Load Capacity

Recognising the gross mass of MCV configurations and implications to long-span and continuous bridges, the structural integrity of all Transport and Main Roads bridges, culverts, floodways and causeways along the proposed route must be confirmed by Transport and Main Roads Bridge Asset Management Section.

Queensland Rail may be the owner of bridges located over railway lines and in these instances the Queensland Rail Bridge Section must confirm the structural integrity.

All enquiries to Queensland Rail should be directed to:
Network Business Commercial Team
Email: aarf.freight@qr.com.au
Phone: (07) 3235 3632

Routes with bridges having legal posted load limit signs in place should only be recommended for approval where the maximum gross mass of the vehicle is 10% less than the posted load limit.

3.14.2 Width Requirements

Bridges are normally the narrowest point on any road. Table 3-9 and Table 3-10 from the Road Planning Design Manual (Department of Main Roads, 2001) shows the minimum carriageway widths for bridges on National Highways and other roads respectively. Where width requirements cannot be met, a physical inspection of the route should occur before any recommendation is submitted.

Table 3-9: Bridge Carriageway Widths – National Highways (Department of Main Roads, 2001)

Bridge		Two Way				One Way							
		Two Lane				Single Lane				Two Lane			
Length	AADT	Shldr	Lane	Shldr	Total Width	Shldr	Lane	Shldr	Total Width	Shldr	Lane	Shldr	Total Width
<20	<3000 (2)	1.5	7.0	1.5	10.0	2.0	3.5	1.0	6.5	-	-	-	-
<20	>3000 (2)	2.0	7.0	2.0	11.0	2.0	3.5	1.0	6.5	2.0	7.0	1.0	10.0
>20	<1000/ lane	0.6 (3)	7.0	0.6 (3)	8.2	2.0	3.5	1.0	6.5	-	-	-	-
>20	>1000/ lane	1.2 (3)	7.0	1.2 (3)	9.4	2.0	3.5	1.0	6.5	2.0	7.0	1.0	10.0

1. Add appropriate lane widths to the two lane configurations to determine multi-lane bridge widths.
2. AADT within 10 years, other AADTs are within 20 years.
3. Minimum allowable shoulder widths have been used.
4. If a bridge is part of a cycle route and/or is in a built-up area, extra shoulder width will be required to allow adequate cyclist access, and pedestrian facilities will be required.

Table 3-10: Bridge Carriageway Widths – Other than National Highway (Department of Main Roads, 2001)

Bridge		Two Way				One Way							
		Two Lane				Single Lane				Two Lane			
Length	AADT	Shldr	Lane	Shldr	Total Width	Shldr	Lane	Shldr	Total Width	Shldr	Lane	Shldr	Total Width
Any	<100	1.0	6.0	1.0	8.0	0.6	3.0	0.6	4.2	-	-	-	-
Any	100-500	1.0	6.0	1.0	8.0	2.0	3.0	1.0	6.0	-	-	-	-
Any	500-1000	1.0	6.5	1.0	8.5	2.0	3.25	1.0	6.25	-	-	-	-
<20	1000-2000	1.5	6.5	1.5	9.5	2.0	3.25	1.0	6.25	-	-	-	-
>20	1000-2000	1.0	6.5	1.0	8.5	2.0	3.25	1.0	6.25	-	-	-	-
<20	>2000	2.0	7.0	2.0	11.0	2.0	3.5	1.0	6.5	2.0	7.0	1.0	10.0
>20	>2000	1.0	7.0	1.0	9.0	2.0	3.5	1.0	6.5	1.0	7.0	1.0	9.0

1. Add appropriate lane widths to the two lane configurations to determine multi-lane bridge widths.
2. AADTs are within 20 years.
3. If a bridge is part of a cycle route and/or is in a built-up area, extra shoulder width will be required to allow adequate cyclist access, and pedestrian facilities will be required.

3.15 Vertical Clearances

MCVs with high loads are particularly vulnerable to striking low overhead obstructions. The assessor should confirm that adequate overhead clearances are available along the entire length of the proposed route.

The minimum overhead clearance at rigid overhead obstructions such as bridges, overpasses and signs shall be 400 mm above the height of the vehicle being investigated.

The minimum overhead clearance at non-rigid overhead obstructions such as wires and trees shall be 500 mm above the height of the vehicle being investigated.

Where high voltage power lines cross the route, the minimum overhead clearance requirements shall be checked with the local electricity authority (Energex in South East Queensland and Ergon Energy elsewhere in Queensland).

Where electric overhead wiring exists at level crossings, height clearance requirements shall be checked with the relevant rail authority.

3.16 Off-Road Parking

In rural and remote areas the route should have adequate off-road parking facilities suitable to allow the safe entry/exit and parking of the requested MCV at sufficient spacing along the route.

In any one direction of travel, the desirable maximum spacing for off-road parking facilities is:

- Rural Areas - 80 km
- Remote Areas - 120 km

An adequate off-road parking facility is defined as any:

- service station or roadhouse, (or other commercial establishment), with provision for public truck parking;
- a signed parking bay, truck bay, rest area; or
- designated road train assembly area.

Depending on the frequency of heavy vehicles using the truck parking bays, the requirement of other facilities such as rubbish bins, tables, chairs and toilets need to be considered. The assessor should also consider parking for more than one MCV.

The minimum stopping sight distances to the entry/exit points of the parking facilities for MCV traffic travelling on the through road are in accordance with Appendix B. There is also a requirement that the full length of the MCV can be parked without encroachment onto the carriageway. The recommended minimum parking bay clearance from the road is shown in Table 3-11.

Table 3-11: Recommended Minimum Clearances from the Edge of Pavement for Parked MCVs (Width of Parking Bay) (from Main Roads Western Australia (2002))

Speed Limit (km/h)	Recommended Minimum Clearance from Edge of pavement (m)*
60	5.0
70	5.7
80	6.2
90	7.6
100	8.8
110	11.0

* Note : For parking facilities located on the outside of a curve, add a further 1.6 metres to the normal minimum clearance.

The Manual of Uniform Traffic Control Devices recommends that truck parking areas be located on both sides of the road to discourage heavy vehicle drivers from performing right turns. Examples of truck parking bay signage is represented in Figure 3-8. The distances required on the signage are site specific and depend on the grade of approaches and the sight distance requirements of the vehicles intending to use the truck parking area.

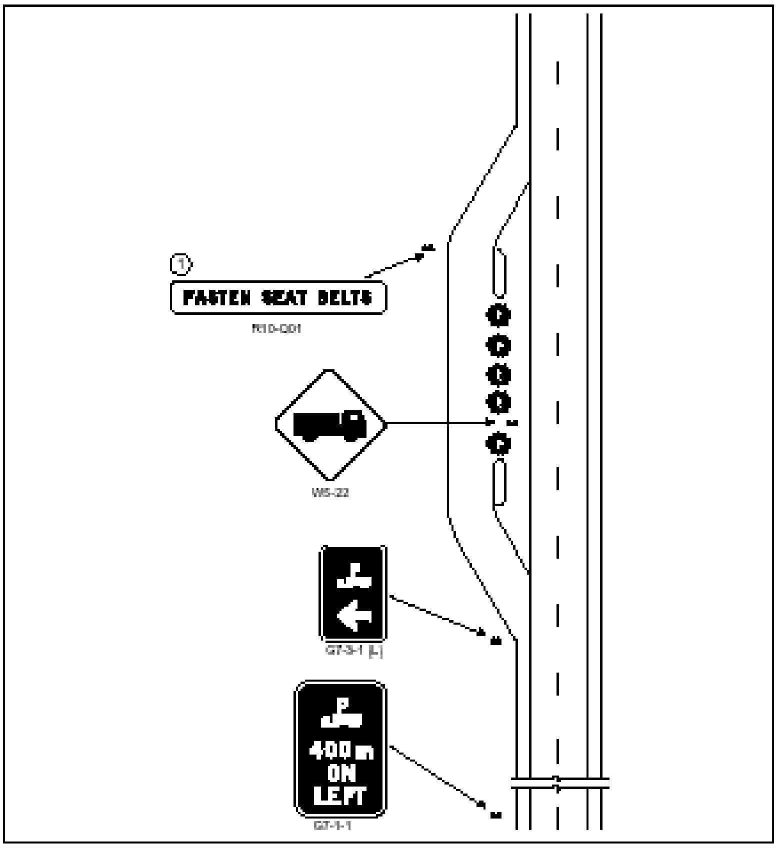


Figure 3-8: Example Signage for Truck Parking Areas (Manual of Uniform Traffic Control Devices)

3.17 Roadside Parking

To protect parked vehicles, MCVs should be excluded from undivided urban or townsite roads that have parallel parking on each side of the road and a pavement width less than 12 metres

3.18 Slowing and Stopping

The ability of the MCV to safely pull off of the carriageway, to allow following vehicles to pass or to make repairs, should be examined. Continuous sections of the route with narrow shoulders and/or deep drains should be noted and comments made on any safety implications.

4.0 TRAFFIC INTERACTION CONSIDERATIONS

4.1 Accident Reports

The accident history of any proposed route should be assessed to determine whether accident rates are worse than other roads of a comparable class. It may be useful to investigate whether certain times of the day engender particular risks, while at other times the risk is significantly lower. In these cases, it may be warranted to recommend that the MCV only use the route during the low-risk hours.

Consultation with local authorities and the police should also be conducted to ascertain whether the introduction of MCVs to the route would exacerbate existing hazards associated with typical road users integrating with heavy vehicles.

Other road users/vehicles to be considered include:

- pedestrians (especially where there are school crossings);
- cyclists;
- tourists (who would be unfamiliar with the conditions, including cars towing caravans);
- school buses (where the frequent stopping and turning by buses, and the presence of children on or adjacent to the road, can pose potential hazards);
- cattle and other stock; and
- farm machinery and implements.

To address any safety concerns, the assessor can recommend special operating conditions, such as the use of headlights when travelling through townsites, reduced speeds or curfew times. Where alternative routes exist, consideration should be given to directing the MCVs to the route with the lower accident record.

4.2 Traffic Composition

The current vehicle composition of the proposed route must be assessed. The ability of typical drivers and road users to safely integrate with the MCV may influence the acceptance of the route.

On a route where there is a high proportion of commercial vehicles, or where local drivers are already familiar with the MCVs operating in the area, there is a greater likelihood of route acceptance. However, on a route where there is a high tourist content, vehicles towing caravans, or drivers not familiar with the area and inexperienced in encountering MCVs, the possible safety risk to other road users needs to be considered. Due caution should be exercised in allowing the requested MCV operation. Appropriate signage advising motorists of MCV operation should be considered where significant amounts of tourist traffic are likely to be encountered. TC9927, TC1210-1, TC1210-2 and TC9466, are examples of such signage. Refer to the figure below.

TC9927 TC1210-1 TC1210-2 TC9466

Figure 4-1: Example MCV signage

It is in their interaction with the urban traffic stream that many of the problems of introducing MCVs into urban environments are noticed. The greater time gap required to enter or cross a traffic stream has significant effects on the capacity and delay at unsignalised intersections, and the increased time taken to clear signalised intersections and railway crossings are both major concerns that need to be considered.

4.3 Traffic Volumes

The variation in traffic volumes on the proposed route throughout the year and the day, as well as the rate of growth should be considered. It may be necessary to restrict MCV operation during peak hours in urban areas, or during certain periods of the year due to seasonal fluctuations in traffic flow. On the other hand, MCV operations may be allowed during certain periods of the year; for example to cater for grain carting season.

Overtaking opportunities for other road users is a major consideration for roads with high traffic volumes. The frequency at which opportunities occur reduces with higher traffic volumes, thereby increasing the risk taken by overtaking vehicles. In these circumstances, consideration may be given to installing overtaking lanes. Refer to the Overtaking Lanes Section of this document.

5.0 PAVEMENT CONSIDERATIONS

5.1 Pavement

Australian Road Research Board (1999) advised that generally, MCVs are permitted the same axle load limits as general access vehicles such as prime mover / semi trailers. Road damage due to vertical loading would be expected to be the same per axle - in fact, damage per tonne of payload carried is generally less for MCVs if the tractive effort at the drive axle group is shared equally between axles.

Queensland Department of Main Roads (2000) advised that MCVs may apply increased tractive forces (horizontal) as well as mass-related loadings (vertical). Dynamic or impact loadings are affected by road roughness through suspension systems (damping efficiency and frequency), bodyroll, resonance frequency and phase linkage to roughness wavelengths. These forces can influence the selection of upper pavement and surfacing materials. Research is underway to evaluate the strength of various materials under various horizontal (tractive) type loadings.

5.2 Roughness

Queensland Department of Main Roads (2000) advised that the dynamic wheel forces applied to pavements, culverts and bridges are influenced by the longitudinal profile or roughness of the road approaches and pavements over culverts, vehicle suspension type, travel speed, vehicle trailer combinations and heavy vehicle mass. Typically, an impact allowance of approximately 30% is adopted for bridge design. However, research has shown that uneven surfaces and joint discontinuities can generate dynamic effects in excess of 200% of the axle load. Consequently the road roughness can significantly influence the damage experienced by the infrastructure as well as contributing to increased heavy vehicle wear. To minimise these effects, especially on bridges and culverts, it is suggested that roughness at these locations be addressed when considering rehabilitation options or maintenance works.

5.3 High Stress Areas (Grades)

Queensland Department of Main Roads (2000) advised that MCVs are typically driven by two drive axles. For long combination vehicles with high GCMs, three drive axles may be used. The torque distribution to each axle of the group will affect the performance of the road. It is preferable that tri-axle drive prime movers be equipped with equal torque distribution to each of the three axles to prevent additional loadings. For MCVs, there is a decreasing power-to-weight ratio with increasing vehicle size. The traditional measure of pavement damage (using a fourth-power law), namely the number of Equivalent Standard Axles, considers only the vertical loading. It decreases on a per-unit-payload basis with increasing vehicle size, suggesting that pavement damage also decreases with increasing vehicle size. However, the tractive force exerted on the pavement by each drive tyre is seen to increase with vehicle size, and pavement damage due to horizontal loading at the drive group would be expected to increase with vehicle size. Heavier vehicles need extra tractive effort when accelerating to overcome the additional resistance on level ground caused by their greater number of tyres, and to maintain reasonable speed on uphill grades. The above effects place additional stresses (shear or horizontal) on the surfacing and upper 100mm of pavement layers. These, in turn, can accelerate the normal deterioration of the pavement and surfacing. It is most likely to be observed on grade sections, and on new seals or reseals. These conditions should influence the surfacing selection for new pavements or rehabilitation. For example, Queensland Department of Main Roads (2000) advised that chip seals are acceptable for short sections of grades of less than 2%, whereas for grades greater than 5%, asphalt should be selected. However, in some situations in low traffic environments, acceptable performance of the chip seal surfacing on steep grades may be achieved by the use of polymer-modified binders. Where the geometry includes climbing lanes, seal design should consider the proportion and composition of traffic for each lane.

5.4 Shoulder Treatment

Australian Road Research Board (1999) advised that road shoulder conditions also need to be considered if the vehicle is likely to need to use the shoulder. Provision of sealed shoulders, having minimal drop off from the road surface, would minimise the impact of a MCV having to cross the shoulder.

5.5 Intersection Treatment

The selection of surfacing for intersections is influenced by the vehicle types and numbers. Australian Road Research Board (1999) advised that it is at urban intersections that differences in pavement wear between MCVs and general access vehicles would be most evident. The higher engine power ratings and lower gear ratios used have the potential to cause more damage due to horizontal forces imposed on the pavement by tyres during acceleration than smaller, less powerful vehicles can cause. Distributing this higher tractive force over a greater number of axles, such as with a triaxle drive group may lessen the problem. However, in turns at intersections, the larger tyre forces generated by triaxle drive groups when combined with tractive effort (longitudinal forces) can lead to higher horizontal loading than for tandem drive groups, Australian Road Research Board (1999).

Queensland Department of Main Roads (2000) agreed that intersections are subject to both tractive forces (drive axles) and transverse forces generated by turning axle groups. For normal turning movements, where sufficient area for turning is available, the additional increase in transverse force occurs towards the rear of the vehicle. For turning vehicles, with increased trailer numbers per single vehicle, complex manoeuvres are required for intersections not designed for specific longer vehicle types. In such complex manoeuvres, the forces are generally greater towards the front of the vehicle.

Similar pavement shear forces are produced when a large vehicle turns a corner at an urban intersection. The increased offtracking of MCVs compounds this problem. Australian Road Research Board (1999) suggested that more common usage of steerable axles on trailers and dollies would lessen these cornering shear forces that are generated in multi-axle groups, and in many cases will reduce the offtracking of the vehicle.

The selection of surfacing for intersections should consider the increase in tractive and transverse forces. In many instances the effect of these forces may be beyond the limitations of a single coat sprayed seal. Where there is stone stripping at an intersection, Queensland Department of Main Roads (2000) recommended considering the following surfacing alternatives, listed in order from least to most effective:

- single coat seal with polymer modification
- two-coat seal
- two-coat seal with polymer modification
- dense graded asphalt
- dense graded asphalt with polymer modification

6.0 GENERAL ASSESSMENT CONSIDERATIONS

6.1 General Considerations

The determination of route suitability for MCV operations will usually be a judgment based upon a combination of factors. Absolute limits cannot be established to suit every situation. The conditions existing along a route under assessment may vary considerably, from open rural road, sealed or unsealed, to urban situations, and a balance has to be reached between these. Conditions on each section cannot be viewed in isolation, but must be considered in terms of the total route. The existence of a short section of poor standard road, either because of vertical or horizontal geometry, in a route of significant length and potential should not necessary preclude the whole route from being acceptable. However, the presence of an urban area, or structure that is unacceptable for the MCV and where there is no alternative route, may well preclude the whole route.

The assessor should try, in liaison with the MCV operator, to identify alternative routes if the primary route is unsuitable.

6.2 Field Trials

If the initial assessment produces inconclusive results, Main Roads may request the applicant to carry out a field trial. Field trials may also address community and council concerns by demonstrating the vehicle's performance. Field trials may require instrumentation of the vehicle to establish the dynamic behaviour and the overall performance of the combination. It may also be useful to video the vehicle to confirm safety considerations or demonstrate how the MCV interacts with other vehicles. It is the responsibility of the MCV operator to meet any costs associated with the field trial.

6.3 Restricted Hours of Operation

Implementing curfews or restricted hours of operation may be a practical solution to approving a proposed route that may otherwise be unacceptable.

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APPENDIX A: Glossary of Technical Terms

AADT: Annual Average Daily Traffic - daily number of vehicles travelling on a road, averaged over one year. Measured in vpd (vehicles per day).

Arrester Bed: Commonly found on severely descending grades, an arrester bed is a type of escape exit that decelerates out of control heavy vehicles. Often gravel and sand is used.

B-double: Articulated vehicle haulage two trailers with the rear trailer superimposed onto the front trailer of the articulated vehicle. This is achieved by the use of a fifth wheel permanently located towards the rear of the front trailer.

Carriageway Width: Carriageway width is defined as the width between the outer shoulder edges (sealed and unsealed portions) or between the kerb faces, of undivided carriageways.

Crossfall: The slope, measured at right angles to the alignment, of the surface of any part of a carriageway.

Deceleration Lane: An auxiliary lane provided to allow vehicles to decrease speed.

Gross Combination Mass (GCM): The total mass of a vehicle combination and its load.

Heavy Vehicle: A vehicle with a gross vehicle mass exceeding 4.5 tonnes.

High Speed Off Tracking: The degree to which the rear unit of a combination vehicle tracks outboard of the hauling unit during high speed turns or when travelling straight under the influence of pavement crossfall.

Highway: A road where traffic has the right to pass and owners of abutting property have access.

Intersection: A place at which two or more roads intersect at grade or with grade separation.

Lane (Traffic): A portion of the paved carriageway marked out by kerbs, painted lines or barriers, which carries a single line of vehicles in one direction.

Multi-Combination Vehicle (MCV): Multi-Combination Vehicles (MCV) consists of all combinations of vehicles exceeding 19 metres in length or 42.5 tonnes gross mass including B-Doubles, Road Trains and truck-and-trailer combinations.

One-way Road: A road or street on which all vehicular traffic travels in the same direction.

Overtaking Lane: An auxiliary lane provided to allow for slower vehicles to be overtaken. It is lined-marked so that all traffic is initially directed into the left lane, with the inner lane being used to overtake.

Pavement: That portion of a road designed for the support of, and to form the running surface for, vehicular traffic.

Pavement Width: The width between the outer shoulder edges or between the kerb faces.

Remote Area Roads: All roads in the country road network, other than Rural Area roads.

Road Friendly Suspension (RFS): Vehicle suspensions that comply with the Performance Standard described in *Vehicle Standards Bulletin No. 11 Certification of Road Friendly Suspensions April 1999* issued by the Federal Office of Road Safety.

Road Furniture: A general term covering all signs, street lights and protective devices for the control, guidance and safety of traffic, and the convenience of road users.

Roundabout: An intersection where all traffic travels in one direction around a central island.

Seal Width: Width between edges of sealed surface or between edge lines (where installed on undivided carriageways), whichever is less.

Shoulder: The portion of formed carriageway that is adjacent to the traffic lane and flush with the surface of the pavement.

Stopping Sight Distance: The distance required for a MCV driver, travelling at a given speed, to perceive an object on the road and to stop before striking it.

Superelevation: A slope on a curved pavement selected so as to enhance forces assisting a vehicle to maintain a circular path.

Swept Path: The total road area defined by the outermost and innermost points of the vehicle at each increment along the steering path of a vehicle negotiating a corner at low speed. Swept path is the sum of the vehicle width and the off tracking.

Swept Width: A measure of trailing fidelity defined as the sum of vehicle width at the rear plus the lateral deviation of the rear of the last trailer, measured during normal straight-ahead travel at highway speed.

Trailing/Tracking Fidelity: The ability of the last trailer to follow the hauling unit (prime mover) during normal straight-ahead travel at highway speed.

APPENDIX B: Stopping Sight Distance

Table B1: Stopping Sight Distance

MCV Operating Speed (km/h)	Grade								
	Downhill				Level	Uphill			
	-8%	-6%	**-4%**	-2%		2%	**4%**	6%	8%
B-Double									
40	69	66	64	62	61	59	58	57	56
50	95	91	88	85	83	80	78	77	75
60	126	120	115	111	107	104	101	99	97
70	160	152	145	140	135	130	127	123	120
80	198	187	179	171	165	159	154	150	146
90	239	226	215	206	197	190	184	179	174
100	294	276	261	249	238	228	220	213	207
110	372	345	323	305	290	277	266	256	247
Type 1 Road Train									
40	74	72	70	68	66	65	64	62	61
50	102	98	95	92	89	87	85	84	82
60	134	128	123	119	116	112	110	107	105
70	170	162	155	149	144	140	136	133	130
80	209	198	190	182	176	170	165	161	157
90	252	239	228	218	210	203	197	191	186
100	308	290	275	263	252	242	234	227	220
110	387	360	339	321	305	292	281	271	262
Type 2 Road Train									
40	80	77	75	73	72	70	69	68	67
50	109	105	102	99	96	94	92	91	89
60	142	137	132	127	124	121	118	115	113
70	179	171	165	159	154	150	146	143	140
80	220	210	201	193	187	181	176	172	168
90	264	251	240	231	222	215	209	204	199
100	322	304	289	276	266	256	248	241	234
110	402	376	354	336	321	308	296	286	278

Stopping Sight Distances should be rounded to the nearest 5 metres and are calculated using the following variables:

- reaction time of 2.5 seconds;
- brake lag (brake response time) of 1 second for B-Doubles, 1.5 seconds for Type 1 Road Trains and 2 seconds for Type 2 Road Trains; and
- longitudinal friction value of 0.29g up to 90 km/h, 0.28g at 100 km/h and 0.26g at 110 km/h

The 85th % operating speed may be different for each class of vehicle due to the road geometry on the approach.

APPENDIX C: Safe Intersection Sight Distance

Table C1: Safe Intersection Sight Distance

MCV Operating Speed (km/h)	Grade								
	Downhill				Level	Uphill			
	-8%	-6%	**-4%**	-2%		2%	**4%**	6%	8%
B-Double									
40	97	94	92	90	88	87	86	85	84

50	130	126	123	120	117	115	113	111	110
60	167	162	157	152	149	146	143	140	138
70	209	201	194	188	183	179	175	172	169
80	253	243	234	227	220	215	210	205	201
90	302	289	278	268	260	253	247	241	236
100	364	346	331	318	307	298	290	282	276
110	448	422	400	382	367	353	342	332	323

Type 1 Road Train

40	102	100	97	96	94	93	91	90	89
50	137	133	130	127	124	122	120	118	117
60	176	170	165	161	157	154	151	149	147
70	218	210	204	198	193	189	185	182	179
80	264	254	245	238	231	226	221	216	213
90	314	301	290	281	272	265	259	254	249
100	377	360	345	332	321	312	304	296	290
110	463	437	415	397	382	369	357	347	339

Type 2 Road Train

40	108	105	103	101	99	98	97	96	95
50	144	140	137	134	131	129	127	125	124
60	184	178	173	169	166	162	160	157	155
70	228	220	213	208	203	198	195	191	188
80	276	265	256	249	242	237	232	228	224
90	327	314	303	293	285	278	272	266	261
100	391	373	358	346	335	326	317	310	304
110	479	452	430	412	397	384	373	363	354

Safe Intersection Sight Distances should be rounded to the nearest 5 metres and are calculated using the following variables:

- an alert reaction time of 2 seconds;
- an observation time of 3 seconds;
- a brake lag (brake response time) of 1 second for B-Doubles, 1.5 seconds for Type 1 Road Trains and 2 seconds for Type 2 Road Trains; and
- a longitudinal friction value of 0.29g up to 90 km/h, 0.28g at 100 km/h and 0.26g at 110 km/h.

The 85^{th} % operating speed may be different for each class of vehicle due to the road geometry on the approach.

APPENDIX D: Vehicle Path Turning Radii

Table D1: Vehicle Path Turning Radii (from Main Roads Western Australia (2002))*

Vehicle Type	Maximum Speed (km/h)	r_0 (metres)	Minimum r_2 (metres)	Minimum r_3 (metres)	Maximum r_1 (metres) for angle of turn					
					30° turn	60° turn	90° turn	120° turn	150° turn	180° turn
B-Double	15	15	15.6	16.5	9.8	9.0	7.0	6.1	5.5	5.0
	20	20	20.6	21.5	14.9	13.7	12.9	12.5	12.2	12.1
	30	30	30.6	31.5	25.3	24.4	24.3	24.1	24.0	24.0
Type 1 Road Train	15	15	15.6	16.5	9.3	7.2	5.5	4.0	Not suitable for on-road situation	
	20	20	20.6	21.5	14.4	12.6	11.6	10.8	10.2	9.9
	30	30	30.6	31.5	24.8	23.7	23.1	23.0	22.9	22.9
Type 2 Road Train	15	15	15.6	16.5	8.5	5.8	3.4	1.0	Not suitable for on-road situation	
	20	20	20.6	21.5	13.8	11.4	9.5	8.1	7.0	6.1
	30	30	30.6	31.5	24.2	22.4	21.4	21.0	20.8	20.7

* Consideration should be given to speeds of other vehicles where significant pedestrian volumes exist.

r_0 = Radius of outside front wheel path

r_1 = Maximum radius of inner kerb = Radius of inside rear wheel path - 0.6 metres

r_2 = Minimum radius of outer kerb = r_0 + 0.6 metres

r_3 = Minimum clearance radius for front overhang = Path of front overhang + 0.6 metres

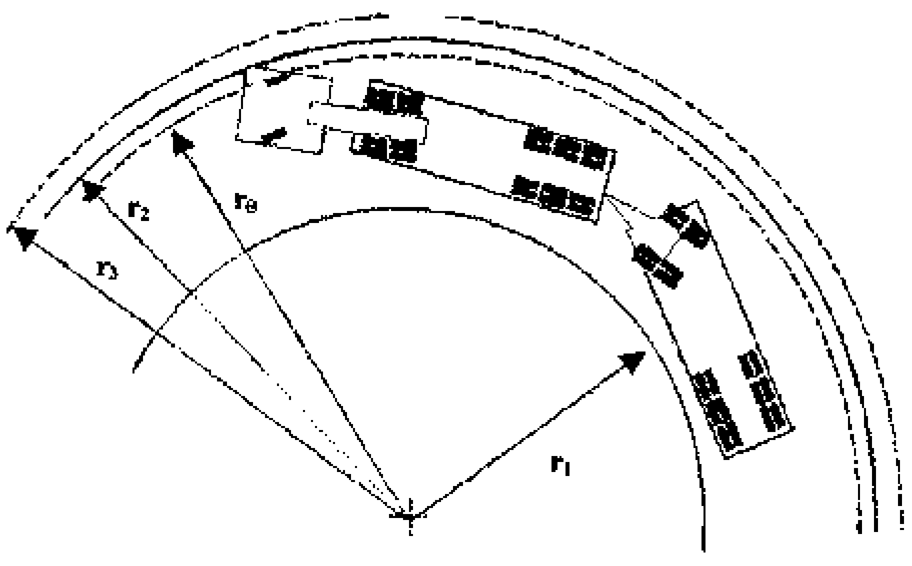

Figure D-1: Vehicle Turning Path Radii

APPENDIX E: Curves and Superelevation

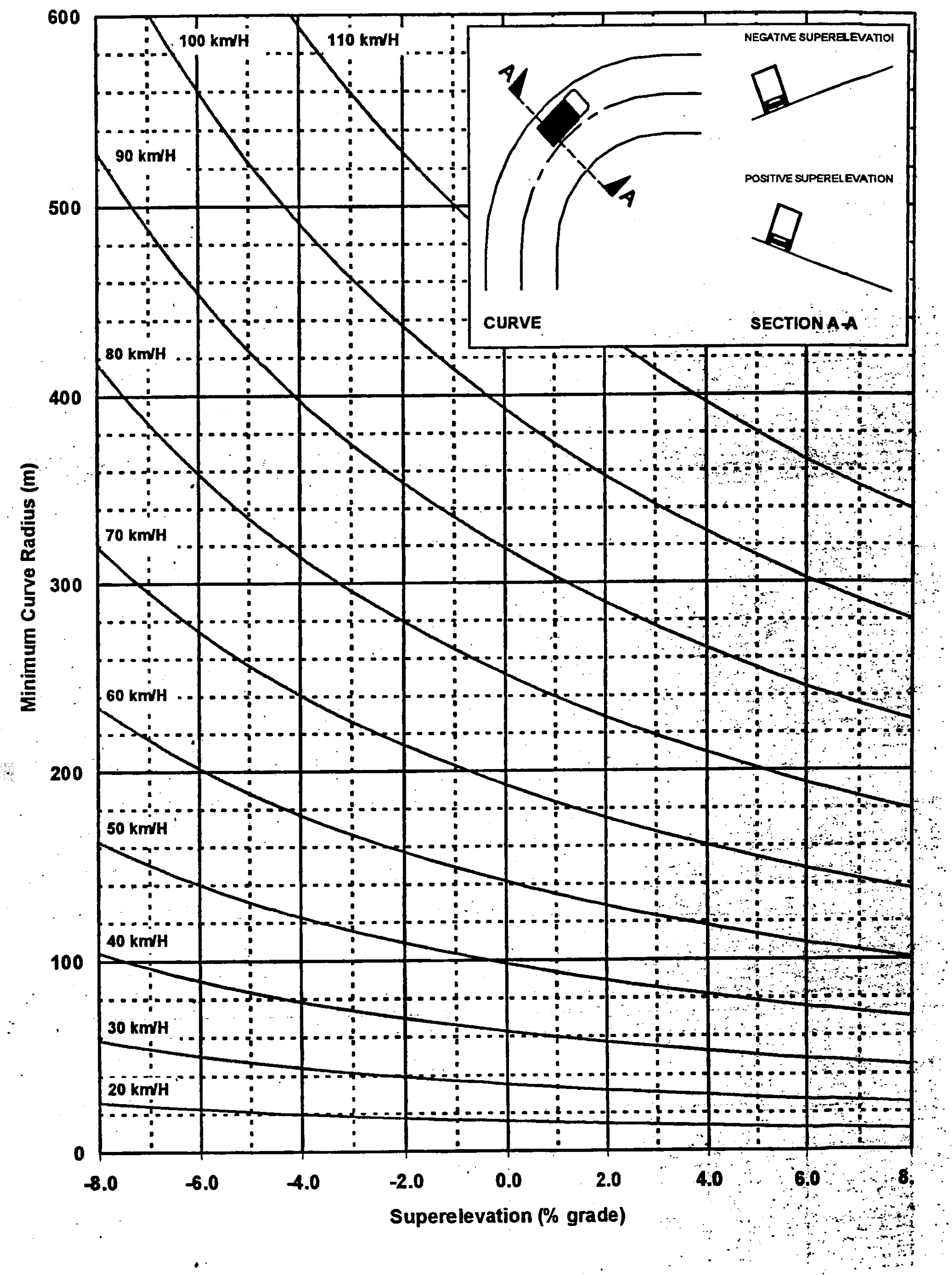

Figure E-1: Curves and Superelevation

Note that it is possible for some MCVs to lose control or skid before roll-over occurs.

APPENDIX F: Clearance Time Constants

Table F1: Clearance Time Constants, Maximum Calibrated Distance and Time for MCVs (from Bunker and Haldane (2003))

Vehicle	*C*	a_0	Maximum Calibration Distance (m)	Maximum Calibration Time (s)
-5 percent grade				
B-Double	-0.0373	1.060	263	27
Type 1 Road Train	-0.0252	0.930	371	34
Type 2 Road Train	-0.0263	0.894	345	34
AAB-Quad	-0.0228	0.7980	325	35
-4 percent grade				
B-Double	-0.0344	0.9790	*	*
Type 1 Road Train	-0.0254	0.8897	*	*
Type 2 Road Train	-0.0218	0.8030	*	*
AAB-Quad	-0.0203	0.7230	*	*
-3 percent grade				
B-Double	-0.0314	0.8980	*	*
Type 1 Road Train	-0.0255	0.8493	*	*
Type 2 Road Train	-0.0172	0.7120	*	*
AAB-Quad	-0.0177	0.6480	*	*
-2 percent grade				
B-Double	-0.0285	0.817	213	28
Type 1 Road Train	-0.0257	0.809	212	27
Type 2 Road Train	-0.0127	0.621	498	49
AAB Quad	-0.0152	0.5730	243	35
-1 percent grade				
B-Double	-0.0256	0.7790	*	*
Type 1 Road Train	-0.0248	0.7640	*	*
Type 2 Road Train	-0.0151	0.6040	*	*
AAB Quad	-0.0148	0.5115	*	*
0 percent grade				
B-Double	-0.0227	0.741	230	30
Type 1 Road Train	-0.0238	0.719	216	30
Type 2 Road Train	-0.0175	0.587	196	31
AAB Quad	-0.0144	0.4500	239	40

1 percent grade				
B-Double	-0.0221	0.7045	*	*
Double Road Train	-0.0203	0.6535	*	*
Triple Road Train	-0.0163	0.5325	*	*
AAB Quad	-0.0115	0.3910	*	*
2 percent grade				
B-Double	-0.0214	0.668	214	31
Type 1 Road Train	-0.0167	0.588	247	35
Type 2 Road Train	-0.0150	0.478	162	32
AAB Quad	-0.0086	0.3320	167	39
3 percent grade				
B-Double	-0.0194	0.6023	*	*
Double Road Train	-0.0150	0.5233	*	*
Triple Road Train	-0.0118	0.3993	*	*
AAB Quad	-0.0072	0.2853	*	*
4 percent grade				
B-Double	-0.0174	0.5367	*	*
Double Road Train	-0.0133	0.4587	*	*
Triple Road Train	-0.0085	0.3207	*	*
AAB Quad	-0.0058	0.2387	*	*
5 percent grade				
B-Double	-0.0154	0.471	145	30
Type 1 Road Train	-0.0116	0.394	151	34
Type 2 Road Train	-0.0053	0.242	166	45
AAB Quad	-0.0044	0.1920	124	44

Values for –5%, -2%, 0%, 2% 5% grades have been evaluated by infield testing. The other values have been linearly interpolated; however the trends show a reasonable correlation.

Beyond the maximum calibrated distances and maximum calibrated time values provided in the above table, the vehicle data was affected by inconsistencies in driver behaviour and are not considered valid. '*' indicates that maximum calibrated distances and maximum calibrated time values have not been determined.

APPENDIX G: Dynamic Performance of Innovative Road Trains

BAB-Quad Combinations

Instrumented on-road testing and computer simulations of the dynamic performance of BAB-Quad combinations have demonstrated that these combinations have superior dynamic characteristics to conventional Type 2 Road Trains. Despite having more trailers, a slightly greater combination mass, and more points of articulation, the utilisation of B-coupled trailers in these combinations results in improved dynamic performance.

The combinations have the same number of axle groups and similar GCM to conventional Type 2 Road Trains, but the adoption of B-type connection (fifth wheel and kingpin) increases significantly the dynamic performance of the combination. The rearward amplification, load transfer ratio, and high-speed dynamic offtracking of the BAB-Quads are superior and would offer considerable safety related improvements over the conventional Type 2 Road Trains.

BAB-Quad combinations are within the maximum length limit of 53.5 metres for Type 2 Road Trains and meet all of the standards for Road Trains provided in the Transport and Main Roads *Guideline for Multi-combination Vehicles in Queensland (Road Trains, B-doubles, B-triples, AB-triples, BAB-quads, ABB-quads) Form Number 1.* The trailers and dollies used in the combination are designed to meet the 3L+12.5 bridge formulae currently used for assessing the minimum extreme axle spacing in Road Train configurations.

Department of Transport and Main Roads reports that the drivers of the BAB-Quads are extremely positive about the performance of these new combinations. Many operators prefer these vehicles to equivalent–length conventional Type 2 Road Trains due to the increased dynamic stability and equivalent low-speed manoeuvrability. A further advantage of BAB-Quad combinations is that they can easily be split up into two standard B-double combinations. This process significantly improves the productivity of road train operations that require access to regions outside of the approved road train areas.

Since the introduction of the BAB-Quads, Department of Transport and Main Roads has also seen benefits in the following areas: stability, versatility, driver stress and fatigue and effects on other road users. The stability and superior on-road performance of the BAB-Quads allow the drivers to carry out their task without the continuous stress of the third trailer sway.

AAB-Quad Combinations

Computer simulations of the dynamic performance of various Type 2 Road Trains have demonstrated that the four-trailer AAB-Quad combinations have generally comparable or better dynamic performance characteristics to existing, equivalent-length three-trailer conventional Type 2 Road Trains.

In general, the AAB-Quad combinations offer increased productivity with greater dynamic stability and equivalent low-speed manoeuvrability. The high-speed dynamic performance is not unduly compromised by the provision of roll coupling between the rearmost trailers, and a greater number of tyres with which to resist lateral forces.

The AAB-Quad has a lower load transfer ratio than conventional Type 2 Road Trains; this is the evidence of the benefit of roll-coupling in connecting the rear two trailers of the AAB-Quad. Despite the rearmost trailer of the AAB-Quad being subjected to higher lateral accelerations than the rearmost trailer of a conventional Type 2 Road Train, there is less load transfer during a lane change manoeuvre, and the vehicle is less likely to roll over during such manoeuvres.

The AAB-Quad has comparable high-speed offtracking to the conventional Type 2 Road Train, having a comparable length, greater mass but more tyres with which to resist the lateral forces generated during the turn. The most important dynamic stability performance measures (load transfer ratio, dynamic offtracking and rearward amplification) for the AAB-Quad configuration exhibit increased stability performance that will contribute to the safe operation of these vehicles. The yaw damping ratio of AAB-Quad configurations also represents a significant improvement over the Type 2 Road Train resulting in shorter time required for the swaying motion of the rearmost trailer to die out.

AAB-Quad combinations are within the maximum length limit of 53.5 metres for Type 2 Road Trains and meet all of the standards for Road Trains provided in the Transport and Main Roads *Guideline for Multi-combination Vehicles in Queensland (Road Trains, B-doubles, B-triples, AB-triples, BAB-quads, ABB-quads) Form Number 1.*. The trailers and dollies used in the combination are designed to meet the 3L+12.5 bridge formulae currently used for assessing the minimum extreme axle spacing in Road Train configurations.

Recent computer assessment has demonstrated that the AAB-Quad combination can satisfy 8 of 9 Performance Based Standards' performance measures evaluated. The failed measure was the high-speed transient offtracking, but it must be noted that conventional Type 2 Road Trains also fail this measure.

In terms of roll stability, rearward amplification, and tracking ability on the straight path, the AAB-Quad configuration was found to be an improvement to existing Type 2 Road Trains. The AAB-Quad combination is considered to offer significant improvements in both productivity and safety when compared to conventional Type 2 Road Trains currently in operation.

APPENDIX H: Route Assessment Form and Checklist

This appendix contains the assessment form and checklist for use in assessing MCV routes in accordance with the requirements set out in these Guidelines.

MULTI-COMBINATION VEHICLE (MCV) ROUTE ASSESSMENT FORM

Vehicle Details: **Reference No. ___________ (Office use only)**

Vehicle Make : _________________________ Vehicle Type: ____________________

Gross Vehicle Mass (tonnes) __________ Engine Capacity: _____ Power: ______ HP/kW

Maximum Overall Combination Length (Including load): ______________ (metres)

Maximum Height of Vehicle and Load : _________ (metres)

Maximum Width of Vehicle and Load: __________ (metres)

Vehicle Owner Details:

Name: ____

Address: ____

Phone: _________________________________ Fax: _____________________________

Email address: ____

Route Details:

Segment Number *	Road Name	From	To	**Vehicles Per** Day (AADT)
1				
2				
3				
4				
5				
6				

Results of Route Assessment:

For each of the route segments, mark a "✓ " against the segment number if it meets all applicable requirements. Mark a "✗ " against the segment number if it does not meet one or more of the requirements.

Segment Number	**✓ = Pass** **✗ = Fail**	**Comments** (If required, additional comments can be written on the back of this form)
1		
2		
3		
4		
5		
6		

Declaration: (Assessor to complete)

I hereby declare that

1. I have assessed this route in accordance with all the requirements and procedures in the attached *Multi-Combination Vehicle Route Assessment Checklist* and the Main Roads *Route Assessment Guidelines for Multi-Combination Vehicles in Queensland*; and

2. The information provided on this form and the attached checklist is true and correct to the best of my knowledge.

Signed: ________________________________ Date: ____________________

Print Name: ____________________________ Phone: ______________________

PLEASE ATTACH THE COMPLETED CHECKLIST TO THIS FORM

* A segment is a section of the proposed route. i.e. break the route up into 6 segments. These segments are each assessed individually by the assessor.

MULTI-COMBINATION VEHICLE (MCV) ROUTE ASSESSMENT CHECKLIST

To assist with assessment a checklist has been provided for use in assessing MCV routes in accordance with the requirements set out in these Guidelines.

Please remember that these guidelines should be used to assist in exercising judgment and not as a substitute for it. They are intended to assist assessors in ensuring that the major relevant factors have been considered in the route assessment process. Where quantitative limits are recommended, they are intended as a guide only and are no substitute for common sense and judgment based on local knowledge and past experience.

The checklist should be used by the route assessor and attached to the MCV Route Assessment Form when complete.

For each of the following items, mark a tick "✓" for the route segments that meet the requirement, a cross "×" for the segments that do not meet the requirement or for requirements that do not apply, mark as not applicable "N/A". The item number in the first column refers to the relevant section of the document *Route Assessment Guidelines for Multi-Combination Vehicles in Queensland.* For more information on the requirements listed below, refer to the relevant section of the Guidelines.

Item No. in the Guideline	Description	Requirement	Segment Number from MCV Route Assessment Form						**Comments** (If extra space for comments is required, write them on the back of this checklist or attach them as additional sheets)
			1	**2**	**3**	**4**	**5**	**6**	
AMENITY ISSUES									
2.1	**Noise**								
		The views of the local community have been considered.							Community consultation recommended? Yes No
		Experienced judgment indicates that additional noise is likely to be insignificant if MCVs are introduced to the route.							Nature and location of potential noise problem(s): If a segment does not meet this requirement, Recommended solution(s): Noise level measurements recommended? Yes No Curfew recommended? Yes No
2.2	**Dust, Splash and Spray**								

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		There are no potential hazards to other vehicles from dust, splash or spray on any part of the segment.							
		Will spray suppression equipment be required? (Tick Yes or No)	Yes			No			
2.3	**Vibration**								
		There are no known problems of vibration caused by heavy vehicles, and experienced judgement indicates these problems are likely to be insignificant if MCVs are introduced to the route.							Nature and location of potential vibration problem(s): Recommended solution(s):
2.4	**Odours and Fumes**								
		There are no known problems of odours or fumes caused by heavy vehicles, or experienced judgement indicates these problems are likely to be insignificant if MCVs are introduced to the route.							
2.5	**Environmental Factors**								
		The environmental impact of the proposed operation on vegetation, wildlife and air quality have been taken into consideration for the proposed route.							
		Native Title issues have been taken into consideration for the proposed route.							
2.6	**Dangerous Goods**								
		There are no particular factors that need to be further investigated to address the consequences of spill or dislodgment of dangerous goods carried by MCVs.							Does the operation require approval from the Department of Minerals and Energy? Yes No If so, has this approval been obtained? Yes No Other Comments:
2.7	**Land Use**								
		All land use issues in relation to the proposed route and the operator's depot location have been considered.							
2.8	**Planning Evaluation**								

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		All planning evaluation factors have been taken into consideration for the proposed route.							
2.9	**Community Consultation**								
		All community consultation factors have been taken into consideration for the proposed route.							
2.10	**Economic Factors**								
		All economic factors have been taken into consideration for the proposed operation.							
2.11	**Intermodal Transport Evaluation**								
		All intermodal factors have been taken into consideration for the proposed route.							
TECHNICAL AND PHYSICAL CONSIDERATIONS									
3.1	**Pavement Widths**								
3.1.1	Urban Areas	Carriageway widths in urban areas are in accordance with the minimum requirements shown in Table 3-1 of the Guidelines.							
3.1.2	Rural Areas	Sealed Roads - Widths are in accordance with the minimum requirements shown in Table 3-2 of the Guidelines Unsealed Roads - Pavement width for B-Doubles $\geq$ 8.0 metres and Road Trains $\geq$ 8.4 metres.							
3.2	**Crossfall**								
		Sealed roads -crossfall does not exceed 3% Unsealed roads – crossfall of 4% to 6%							
3.3	**Horizontal Curves**								
	Widening	Curves have been widened to the requirements shown in Table 3-3 of the Guidelines.							

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3.4	**Curve Superelevation**								
		The maximum speed of all curves, as shown in Appendix E, satisfies the following: ▪ The maximum speed of the curve is not more than 15 km/h below the posted or legal speed limit for the section of road, and there are no advisory speed signs installed on the approaches to the curve; and ▪ The maximum speed of the curve does not fall below the speed shown on any advisory speed signs installed on the approaches to the curve.							
3.5	**Intersections**								
		There is sufficient road length between adjacent intersections to allow the MCV to clear the first intersection before stopping at the second intersection.							
		For roads joining onto existing gazetted route, there is adequate sight distance, stacking distance and swept path geometry at the intersection of the new route and the existing gazetted route.							
3.5.1	Unsignalised Intersections	Adequate Approach Sight Distance, as shown in Appendix B, is provided at all intersections.							If a segment does not meet this requirement, Recommended solution(s):
		Adequate Safe Intersection Sight Distance, as shown in Appendix C, is provided at all intersections, else appropriately designed control mechanisms are in place.							
3.5.2	Signalised Intersections	Visibility to the traffic signals are available at the stopping sight distance shown in Appendix B of the Guidelines or, alternatively advance warning is provided at the distances shown in Appendix B.							
		Signal phase timings are appropriate for the longer braking distance and acceleration time of the MCV.							
		The length of the MCVs will not cause lane queuing or vehicle storage problems.							

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3.5.3	Roundabouts	Widening of the circulating carriageway to accommodate the MCV does not permit other vehicles to exceed safe design speeds through the roundabout.							
		The carriageway widths and outer kerb diameters have been assessed in accordance with Section 3.5.3 in the Guidelines.							
3.6	**Turning**								
3.6.1	Turning Paths	Main Roads VPATH computer program has been used to accurately check that all turns along the proposed route can be safely negotiated by the MCV.							
		At all turns, clearances to kerbs and adjacent objects conform to Section 3.6.1 of the Guideline.							
		At left turns, the turning MCV will not cross over the centreline into the path of on-coming traffic unless the AADT is less than 250.							
3.6.2	Vehicle Speed while Negotiating a turn	The MCV can negotiate each turn at sufficient speed so as not to cause undue obstruction to other traffic.							
3.6.3	Left Turns	All left turns can be made without adversely affecting other road users as per Section 3.6.3 of the Guidelines.							
3.6.4	Right Turns	All factors as per Section 3.6.4 in the Guidelines have been considered.							
		Appropriate right turns are provided at all rural and urban intersections.							
3.7	**Terminal/Destination Connections**								
		Applicant has satisfactorily ensured suitability of terminal/destination connections.							
		Entry and exit does not unduly affect the movement of other vehicles on the road system.							
		Adequate sight distance is available at all terminal/destination connections.							

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		The MCV can completely enter the terminal/destination without overhang onto the footpath or roadway.							
		Driveway and footpaths have the necessary structural integrity to avoid being damaged.							
		Left and right turns to and from terminal/destination connections are in accordance with Sections 3.6.3 and 3.6.4 of the Guidelines.							
3.8	**Overtaking Requirements**								
3.8.1	Overtaking of MCVs	Adequate overtaking opportunities, as per Table 3-5 of the Guidelines, are available.							If requirement is not met, refer to Section 3.9 for alternative solutions. Recommendation(s):
		Is vehicle queuing behind the MCV a problem?	Yes			No			
		Overtaking lanes are required.	Yes			No			Location:
		Overtaking sight distance conforms to the requirements in Table 3-6 of the Guidelines.							
3.8.2	Overtaking by MCVs	The length of overtaking opportunities and sight distances are sufficient.							
3.9	**Overtaking Lanes**								
		The requirements for overtaking lanes have been identified by TRARR.							
		Particular attention has been given to roads with significant proportions of grade exceeding 5%.							
		Where 100km/h speed limit applies, the minimum length of the overtaking lane is 800 metres, including tapers.							
3.10	**Steep Ascending Grades**								
		Each steep grade either:							

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		▪ has an overtaking lane; or ▪ is shorter than the maximum length shown in Table 3-7 of the Guidelines.							
3.11	**Safety Ramps on Steep Downhill Grades**								
		On segments with extended long down grades of 6 - 10%, safety ramps are provided about 3 km from the summit of the grade.							
3.12	**Acceleration Lanes**								
3.12.1	Length of Acceleration Lane	Freeways, highways and other major roads – The minimum length of all acceleration lanes conform to Table 3-8 of the Guidelines. Other roads - Length of lane must by sufficient to allow MCV to accelerate to within 70% of traffic speed.							
3.12.2	Signing	Has the appropriate signage been provided on all entry lanes?	Yes			No			Where is signage needed:
3.12.3	Visibility of the Point of Entry	The visibility of all points of entry conforms to the requirements in Section 3.12.3 of the Guidelines.							
3.13	**Railway Level Crossings**								
		The requirements relating to visibility, stacking distance, stopping and sight distance are met for all crossings.							
3.13.1	Crossings Controlled Give Way Signs	There is sufficient visibility for a driver to see that a train in not approaching and that it is safe to proceed and cross the track.							
		There is sight distance of at least 1000 metres on each side of the crossing.							
		The angle between the road and the rail is a minimum of 70°.							
3.13.2	Crossings Controlled by Stop Signs	There is adequate visibility of the crossing and associated signs to allow sufficient time to stop the MCV.							

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		There is adequate visibility for a driver, after having stopped at the crossing, to proceed clear of the crossing before the arrival of an approaching train.							
		There is sight distance of at least 1000 metres on each side of the crossing.							
		The angle between the road and the rail is a minimum of 70°.							
3.13.3	Crossings Controlled by Flashing Lights	There is adequate visibility to the primary signal displays on the approach to the crossings.							
		The minimum sight stopping distance is in accordance with those prescribed in Appendix B of the Guidelines OR Advance flashing warning signs are installed in accordance with Main Roads Traffic and Road Use Management Manual.							
3.13.4	Crossings Controlled by Flashing Lights and Boom Barriers	There is sufficient timing delay between lights flashing and boom descending to allow the MCV to clear the crossing without striking the boom gate.							
3.13.6	Proximity to an Intersection	The MCV can clear the level crossing before stopping at an intersection.							
		The MCV can clear the intersection before stopping at the level crossing.							
3.13.7	Stacking Distance	All railway crossings have adequate approach stacking distance.							
		All railway crossings have adequate departure stacking distance.							
3.13.9	General	The appropriate rail owner, cane railway owner and local council have been consulted.							
3.14	**Structures**								
3.14.1	Load Capacity	Each structure on the segment has been assessed and approved by Main Roads Bridge Asset Management Section for the MCV in question.							
		For each structure on the segment the gross mass of the vehicle is at least 10% less than the posted limit of the structure.							

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3.14.2	Width Requirements	Bridge carriageway widths are in accordance with the widths shown in Table 3-9 or Table 3-10 of the Guidelines.							
3.15	**Vertical Clearances**								
		The following overhead clearances are available (above the height of the MCV) over the entire segment: ▪ Rigid Obstructions - 400 mm ▪ Non-Rigid Obstructions - 500 mm ▪ High voltage power lines - as approved by the local electricity authority (Energex or Ergon Energy). ▪ Electric overhead wiring at level crossings – as approved by the relevant rail authority.							
3.16	**Off-Road Parking**								
		In non-urban areas, adequate off-road parking facilities are provided at the following maximum spacings, for any one direction of travel: ▪ Rural Areas - 80 km ▪ Remote Areas - 120 km							
		Minimum stopping sight distances to the entry/exit points of adequate off-road parking facilities are in accordance with Appendix B of the Guidelines.							
		The full length of MCVs can be accommodated within the off-road parking facilities without encroachment into the carriageway.							
		The minimum parking bay width is in accordance with Table 3-11 of the Guideline.							
3.17	**Roadside Parking**								
		Undivided urban or townsite roads that have parallel parking on each side of the road have a pavement width of at least 12 metres.							
3.18	**Slowing and Stopping**								
		There are no continuous sections of the route with narrow shoulders or deep drains that would prevent a vehicle from pulling off the carriageway to allow overtaking, or for repairs or emergencies.							

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TRAFFIC INTERACTION CONSIDERATIONS									
4.1	**Accident Reports**								
		Examination of accident history for the route has been undertaken in consultation with local authorities and police and shows that the introduction of MCVs is unlikely to exacerbate existing hazards.							If requirement is not met refer to Section 4.1 for alternative solution(s). Recommendation(s):
4.2	**Traffic Composition**								
		The current vehicle composition of the proposed route has been assessed. There are no safety concerns about the effect of MCV access to other road users							Do school buses use any part of the route? Yes No Other Comments:
4.3	**Traffic Volumes**								
		The variation in traffic volumes on the proposed route throughout the year and the day has been considered.							
GENERAL ASSESSMENT CONSIDERATIONS									
6.2	**Field Trials**								
		A field trial is required to demonstrate the overall performance of the MCV along the entire route.	Yes			No			