

ATTACHMENT A

A national framework for modular B-triple operations

April 2012

Policy paper



National Transport Commission

National Transport Commission

A national framework for modular B-triple operations

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Report outline

Title:	A national framework for modular B-triple operations
Type of report:	Policy paper
Purpose:	SCOTI approval
Abstract:	<p>In accordance with the 2006 Council Of Australian Governments (COAG) National Transport Reform Agenda, the framework proposed here is for a single national approach to B-triple operations that includes a B-triple road network and prescriptive modular B-triple vehicle specifications and operating conditions. The Commission anticipates that the framework will replace the inconsistent state-by-state approaches currently adopted for B-triples, which largely discourage the use of B-triples for interstate operation. The approach is based on B-triple operation under a Class 2 notice, which is reflective of current B-double and road train operation. This report presents a productivity analysis, a safety analysis and an infrastructure impact analysis (pavements and bridges). It also presents a cost-benefit analysis that includes the monetised safety and environmental benefits of national B-triple operation.</p>
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Foreword

Australia's freight task is forecast to increase significantly in the coming decades, with the Bureau of Infrastructure, Transport and Regional Economics (BITRE) predicting almost a doubling of the 2010 task by 2030. The enormity of the increase will place immense pressure on infrastructure, the environment, safety, congestion, and amenity.

Facilitating the transition of freight movement from road trains to B-triples is consistent with the NTC's objective of improving transport productivity, safety and environmental outcomes. Communities will benefit from a reduction of freight vehicles on our road network by minimising the trips required to service a freight task. Fewer freight vehicles, reduced total kilometres travelled, and transitioning to modern, safer vehicles all have a direct positive impact on road safety, leading to reduced deaths and injuries.

Road freight productivity affects all Australians. The costs of goods and services, from the price of bread and milk at the local supermarket to the minerals and agricultural products exported through our ports, are directly impacted by the cost and efficiency of transport. Improved efficiency and productivity of freight operations reduces costs thus benefiting the nation.

Importantly, fewer freight vehicles on the road combined with fewer kilometres travelled reduces exhaust emissions and fuel usage. Protecting our environment has become a national objective. Minimising freight vehicles on our roads and encouraging new generation, more environmentally friendly vehicles assists in meeting the national objective.

An objective of this reform is to ensure the best possible take-up and use of B-triples. Implementation of this reform will drive better outcomes for the transport industry and the broader community; it will save lives, deliver environmental improvements, generate productivity improvements, reduce urban congestion and improve urban liveability.

Public consultation through an August 2011 discussion paper enabled the preparation of this final policy paper. The NTC now submits this policy paper to the Standing Council On Transport and Infrastructure (SCOTI) for endorsement.



Greg Martin PSM
Chairman

Executive summary

A reform for improved long-distance road freight transport

A B-triple is a modular road freight vehicle that is effectively an extension of the common B-double configuration, having an additional lead trailer. In terms of mass and dimensions, B-triples are comparable with Type I road trains (i.e. double road trains, or A-doubles) but they have improved safety and productivity characteristics. While B-triples presently operate in many parts of Australia, they are disadvantaged by inconsistent treatment between each state and territory, and their access to the road network is often not commensurate with their safety and productivity offering. An introduction to vehicle modularity and related technical terms is provided in Section 2.

B-triples are set to improve highway safety, cut greenhouse gas emissions and provide a much-needed productivity boost to Australia's long-distance road transport industry. If B-triples operate nationally on the existing Type I road train network, where they will replace some current road train operations, by 2030 Australia stands to prevent 25 fatalities, 1.1 million tonnes of CO₂ emissions, and \$1.1 billion in costs that would otherwise flow on to all Australians. More than 90% of the total cost saving comes from the productivity boost alone, which allows reduced vehicle running costs as a result of reduced vehicle numbers and reduced vehicle-kilometres travelled.

Much of the appeal of the B-triple is its ability to be assembled from standard B-double trailer equipment and then easily converted back into a B-double when leaving the approved road network. This provides a substantial productivity improvement over the equivalent conversion of a conventional A-double road train into a single semi-trailer when leaving the approved road network. The longer-term objective, however, is to expand B-triple operations beyond the Type I road train network to incorporate appropriately upgraded strategic routes, commencing with some of the missing eastern seaboard inter-capital connections as the highest priority. This is where the true potential for B-triples lies—in enabling a quantum leap in productivity and safety of the kind that B-doubles brought when introduced over the past 20 years.

Contained within this discussion paper is quantitative evidence of the benefits that the B-triple offers in comparison with the conventional A-double. Benefits derive from:

- improved productivity that results in fewer trips and therefore fewer vehicles required to service a given freight task
- improved safety due to (a) the B-triple's vastly superior on-road dynamic performance and (b) reduced vehicle numbers
- reduced wear and tear on road pavements on both a per-vehicle and a per-tonne-of-payload basis
- reduced loading on most bridges.

This reform has been five years in the making, beginning with a COAG mandate in 2006. An appetite for B-triples is now evident across a range of stakeholder groups, industry and government alike. Not since the broad introduction of B-doubles has Australia had a similar opportunity to impact so positively on the road transport industry's triple bottom line.

The problem and the regulatory proposal

B-triples already operate in all states and territories except the Australian Capital Territory and Tasmania, but road network access and operating conditions differ vastly across the nation. This effectively constrains B-triples to intrastate, rather than interstate, operations. For example, limited road network access and unpopular operating conditions in New South Wales not only limit the numbers of B-triples operating in that state, but also discourage B-triples wishing to enter from the surrounding jurisdictions. This stifles many opportunities for better national freight movement.

B-triples will not be able to flourish as a national road freight productivity solution until such inconsistencies are overcome. This will require the development of a single, nationally agreed B-triple network and a single, nationally agreed B-triple vehicle specification and associated operating conditions. Over time, access should be extended beyond road train areas to a strategic inter-capital network. The initial national B-triple network to be agreed as part of this regulatory proposal builds on a network already agreed by transport ministers in 2007. It is the same as the Type I road train network.

The regulatory proposal is for B-triples to be granted access under a Class 2 notice using an approach that encourages modular co-operation of B-doubles and semi-trailers within existing transport fleets. As the proposal may be implemented using existing legislative arrangements and will not have major impacts on stakeholders, it is not required to undergo a regulatory impact assessment. The modular approach sets five key prescriptive requirements for B-triples:

1. **Configuration:** Must be constructed from a prime mover having a single steer axle and a tandem drive axle group towing three triaxle semi-trailers all connected by fifth-wheel couplings.
2. **B-double compatibility:** Must form a compliant 26-metre B-double when one lead trailer is removed, regardless of which one is removed. The purpose of this requirement is to mitigate the risk of non-compliance with B-double requirements when one trailer is removed.
3. **Overall length:** Maximum 35 metres, including any bull bar and other after-market fittings.
4. **Kingpin-to-rear dimension:** Maximum 29.6 metres.
5. **Mass limits:** General Mass Limits and Concessional Mass Limits.

Some supplementary requirements are necessary, including catch-all requirements. These are detailed in Section 4.3. Having met all of the prescriptive requirements, a modular B-triple will be deemed to have on-road performance that is consistent with PBS safety standards, as demonstrated by a detailed analysis in this report.

This policy proposes that any existing state-based arrangements for non-modular B-triple operation will be allowed to continue unaffected in the relevant states once this policy is implemented.

Productivity analysis

Measured in terms of the reduction in the number of trips required to service a given freight task, calculated from relative payload mass and volume, B-triples will provide similar improvements in productivity for both mass-constrained and volume-constrained freight. When operating on the Type I road train network, B-triples offer a modest improvement over current A-double operation—up to 10% fewer trips to service a given freight task. When operating off the Type I road train network, where A-doubles are currently broken down into single semi-trailers, B-triples broken down into B-doubles will require up to 38% fewer trips to service a given freight task. When operating on a future expanded B-triple network, on inter-capital routes where B-doubles are currently used in large numbers, B-triples will require up to 26% fewer trips to service a given freight task.

Safety analysis

Modular B-triples will generally be 31.0 to 35.0 metres long, with a typical range being 32.5 to 33.5 metres. This is less than the maximum overall length of an A-double, which is 36.5 metres. B-triples will generally perform at least in accordance with Level 3 of the PBS scheme simply by meeting the prescriptive modular requirements. (Hence formal PBS approval is not a necessary requirement of this policy.) Modular B-triples offer similar or much improved performance in comparison with conventional A-doubles in all key performance measures except swept path width. However, their performance in that measure meets PBS Level 3 and is also considerably better than that of the non-modular 36.5-metre B-triple that operates widely on the Type I road train network.

It follows that, from a safety perspective, modular B-triples should be able to access at least the entire national Type I road train network and should be encouraged to gain access to a much broader network as routes are appropriately upgraded. There is no safety-based reason presented in this analysis that supports withholding access for modular B-triples to any part of the Type I road train network if that network is presently open to A-doubles (since A-doubles have less favourable safety performance than modular B-triples).

Infrastructure impact analysis

The impact of B-triples on the infrastructure was examined in terms of both pavement loading and bridge loading. A pavement loading analysis using the Standard Axle Repetition (SAR) approach shows that B-triples induce less wear and tear on road pavements than conventional A-doubles because of their more efficient carriage of mass over more tyres; they also satisfy current and proposed future PBS Pavement Vertical Loading Standards.

As detailed in the relevant 'axle spacing/mass schedules' enforced by jurisdictions where applicable, B-triples satisfy the same bridge loading formula that applies to A-doubles. Although they can be slightly heavier than A-doubles, B-triples will not necessarily induce greater structural effects in all bridges. This is because bridge loading depends on the distribution of load to the vehicle's axles and the spacing of the vehicle's axles relative to the dimensions of the bridge spans. A bridge loading analysis demonstrates that in the vast majority of cases, the impact of B-triples on bridges is less than that of the Austroads Bridge Assessment Group (ABAG) double road train. In a very limited number of cases (particularly hogging moments in continuous spans between 20 and 35 metres), the impact of B-triples is higher than that of the ABAG double road train. In these cases the magnitude of the additional effect is limited to a maximum of 16%. This does not necessarily mean that bridge capacities will be exceeded. Unless a specific bridge is considered inadequate by a bridge owner for particular reasons (e.g. on the basis of a bridge inspection and a special assessment of capacity), the calculation of structural effects detailed in this analysis confirms that bridges belonging to the Type I road train network are suitable for modular B-triple operations.

Community acceptance

With any reform centred on the introduction of higher-productivity vehicles there is the potential for adverse reactions from some members of the community based on the misconception that higher-productivity vehicles are less safe. This was the case when B-doubles were first introduced 20 years ago, and B-doubles have since made an unquestionable contribution to road safety.

In 2010 the NTC commissioned a survey of community attitudes to freight vehicles (Synovate 2010). Of the top twelve identified major concerns while driving, listed in order of frequency within the sample, the survey found that large vehicles did not feature until the last three items on the list, and only 5% of respondents listed one of those three concerns as their number one concern.

Despite having three trailers, modular B-triples are shorter than A-doubles (hence easier to pass) and will have the same number of axle groups and articulation points. Although marginally heavier, their mass is carried by more tyres in contact with the road and they are controlled by more brakes. Their trailers are connected in a way that increases stability, so they offer a substantial and quantifiable improvement in road safety from a number of perspectives, particularly rear trailer rollover, as demonstrated by PBS assessment.

Registration charges

The registration charges that are applied to prime movers, trailers and converter dollies play an important role in the long-term investment decisions that operators make with regard to their vehicle fleet. With the registration charges currently applied to lead trailers, the total registration charge for a B-triple is significantly higher than that of an A-double or an A-triple. As a consequence, those operating a B-double or a B-triple are placed at a competitive disadvantage when competing for freight on a road train network. The NTC is cognisant of this and other pricing

issues relating to lead trailers and is currently progressing the matter through a separate project in consultation with government and industry stakeholders. A report will be delivered to the Standing Council on Transport and Infrastructure (SCOTI) in March 2012.

Key recommendations

As modular B-triples are generally safer, more efficient and do not cause more damage to pavements and bridges than the equivalent A-double road trains which currently operate on Australia's Type I road train network, the NTC recommends that SCOTI:

- APPROVE the adoption of a single national modular B-triple vehicle specification¹ with access to the existing Type I road train network².
- ENDORSE the National Framework for Modular B-triple Operations to enable modular B-triples to have access to the current Type I road train network on the same basis as double (Type I) road trains with any future additional conditions to be developed by way of Ministerial Guidelines.
- ENDORSE, in order to facilitate enhanced access and associated productivity gains across Australia for modular B-triples, that access conditions for modular B-triples may be reviewed by States and Territories on expansions of the network in accordance with the Intergovernmental Agreement on Heavy Vehicle Regulatory Reform.

Drafting the Policy Paper

These recommendations and their corresponding supporting material were initially developed following a consultation workshop and direct consultation with key stakeholders. They were published in an August 2011 discussion paper, which was subjected to a period of national public consultation that included a second workshop. The discussion paper obtained significant coverage in the industry media during the consultation period, and comments were received from a wide range of stakeholders. Formal submissions published on the NTC's website were addressed during the revision of the discussion paper to form this policy paper. The main changes to the paper were to clarify or confirm the following items, which received attention in several of the submissions:

- That existing state-based arrangements for B-triples up to 36.5 m long may continue, and that under the future Heavy Vehicle National Law it is possible that 36.5 m B-triple notices that apply across more than one State could be made
- That the adoption of a 35 m overall length limit for modular B-triples (in lieu of a 36.5 m limit) maintains swept path to within the PBS Level 3 envelope, further enables a future expanded national B-triple network, allows almost all existing standard B-double trailer equipment to be used in a modular fashion, and strongly mitigates the risk of B-double non-compliance as a direct result of the modular B-triple policy
- That the respective costs and benefits of the Intelligent Access Program (IAP) and "non-IAP" alternatives are positively correlated, particularly because of the link between the higher cost of the IAP option and the greater administrative certainty that it provides to transport operators and road managers. The decision to not recommend IAP for modular B-triples was retained as it would financially restrict the number of prime movers that could be used. Furthermore road enforcement is considered to be an effective way to enforce the policy proposal introduced in this paper since modular B-triples are easily identifiable.

Summaries of the public submissions and the NTC's response to each are presented in Section 11. For the assistance of jurisdictions, section 12 contains an example of a Class 2 modular B-triple notice.

¹ As detailed in Section 4.

² See maps provided in Section 5

Acknowledgments

The NTC acknowledges Matthieu Bereni for managing this project and Rob Di Cristoforo from Advantia Transport Consulting in preparing this report, with contributions from Matthieu Bereni (bridge loading analysis), Anthony Germanchev and team from ARRB Group (safety analysis) and Associate Professor Kim Hassall from Melbourne University and the Industrial Logistics Institute (cost-benefit analysis).

The NTC also acknowledges significant technical input from the Australian Trucking Association, the Australian Road Transport Suppliers Association, the Truck Industry Council and each state and territory road authority.

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Introduction

1.1 Context

Since the national adoption of B-doubles in the early 1990s, B-double numbers have grown at a remarkable rate; the B-double now carries more Australian road freight than any other vehicle configuration, taking its share almost exclusively from single-articulated vehicles (Pearson 2009). Projections indicate that the B-double's share of the freight task will plateau at around half of all road freight by 2030 (BITRE 2011). With its significant productivity advantage over the single-articulated vehicle, which was the common workhorse vehicle configuration at the time B-double were introduced, the B-double has since enabled Australia to almost unwittingly accommodate a doubling of the road freight task, and it will continue to provide benefits as road freight demand grows.

1.2 Context

Since the national adoption of B-doubles in the early 1990s, B-double numbers have grown at a remarkable rate; the B-double now carries more Australian road freight than any other vehicle configuration, taking its share almost exclusively from single-articulated vehicles (Pearson 2009). Projections indicate that the B-double's share of the freight task will plateau at around half of all road freight by 2030 (BITRE 2011). With its significant productivity advantage over the single-articulated vehicle, which was the common workhorse vehicle configuration at the time B-double were introduced, the B-double has since enabled Australia to almost unwittingly accommodate a doubling of the road freight task, and it will continue to provide benefits as road freight demand grows.

As well as providing a significant productivity advantage, B-doubles have demonstrated a remarkable road safety record in comparison with the single-articulated vehicles that they have replaced. According to truck crash statistics published by National Transport Insurance's National Truck Accident Research Centre (2011), B-doubles are currently responsible for 46% of articulated vehicle freight tonne-kilometres and yet are involved in only 29% of major articulated vehicle crashes. This under-representation in crashes may be attributed to the fact that B-doubles are a more dynamically stable configuration, and generally use newer equipment that is better maintained and driven by more experienced and more qualified drivers on higher quality roads.

As a result of the B-double's productivity and safety success story there has been growing support throughout Australia, from industry and governments alike, for higher productivity vehicles that use B-double component vehicles (i.e. trailers coupled by fifth wheels). Examples include B-triples, AB-triples, ABB-quads and BAB-quads, as well as longer and heavier variants of the B-double. All of these innovative vehicle configurations offer improved productivity and safety performance in comparison with conventional multi-combination vehicle configurations (e.g. A-doubles and A-triples).

In accordance with the 2006 Council Of Australian Governments (COAG) National Transport Reform Agenda, the National Transport Commission (NTC) has been working towards a national framework for modular B-triple operations to provide wider and more consistent B-triple access across the country. Differences between each state and territory effectively discourage B-triple use for interstate operation. The ultimate goal of this reform is to enable B-triples to operate nationally wherever Type I road trains currently operate and also on suitable non-road-train routes of strategic importance. These include routes linking major inland freight generators to the eastern seaboard capitals, and routes linking the eastern seaboard capitals to each other.

The mass and dimensions of the B-triple are similar to those of the A-double, with productivity being slightly better for B-triples. B-triples are therefore expected to replace some A-double operations on road train routes, but the rate of substitution could be significantly augmented because B-triples offer a distinct advantage when they are disassembled for travel on non-road-train routes. While an A-double can be broken down into two semi-trailers, a B-triple can be broken down into a semi-trailer and a B-double. There are other options, many of which will be discussed herein. The most important road safety benefit of B-triple substitution in favour of the A-double is trailer roll-coupling, which prevents dynamic rear trailer rollover of the type that occurs with A-doubles.

With B-doubles presently accepted as the standard vehicle configuration for long-distance and inter-capital road freight transport on the eastern seaboard, and with projections that the Australian road freight task will almost double by 2030 (BITRE op. cit.), there is an opportunity for B-triples to be more widely and consistently introduced on routes of strategic importance to provide a quantum leap in productivity over the B-double. BITRE (op. cit.) projects that B-triple road freight share could reach one-fifth of total if B-triples are allowed access to the right set of inter-capital routes outside of built-up areas.

1.3 COAG National Transport Reform Agenda

The B-triple initiative of the COAG National Transport Reform Agenda involved the identification of a suitable road network for B-triples to improve the safety and efficiency of freight transport.

In consultation with governments and industry the NTC developed a potential national B-triple network that was a combination of the Type I road train network—which is currently suited to B-triple vehicles—and parts of the AusLink network that would provide the key additional inter-capital links along the eastern seaboard, subject to any necessary upgrades for B-triple vehicles. This potential network, reproduced in Figure 1, was presented to the Australian Transport Council (ATC) for endorsement at its meeting of 13 October 2006.

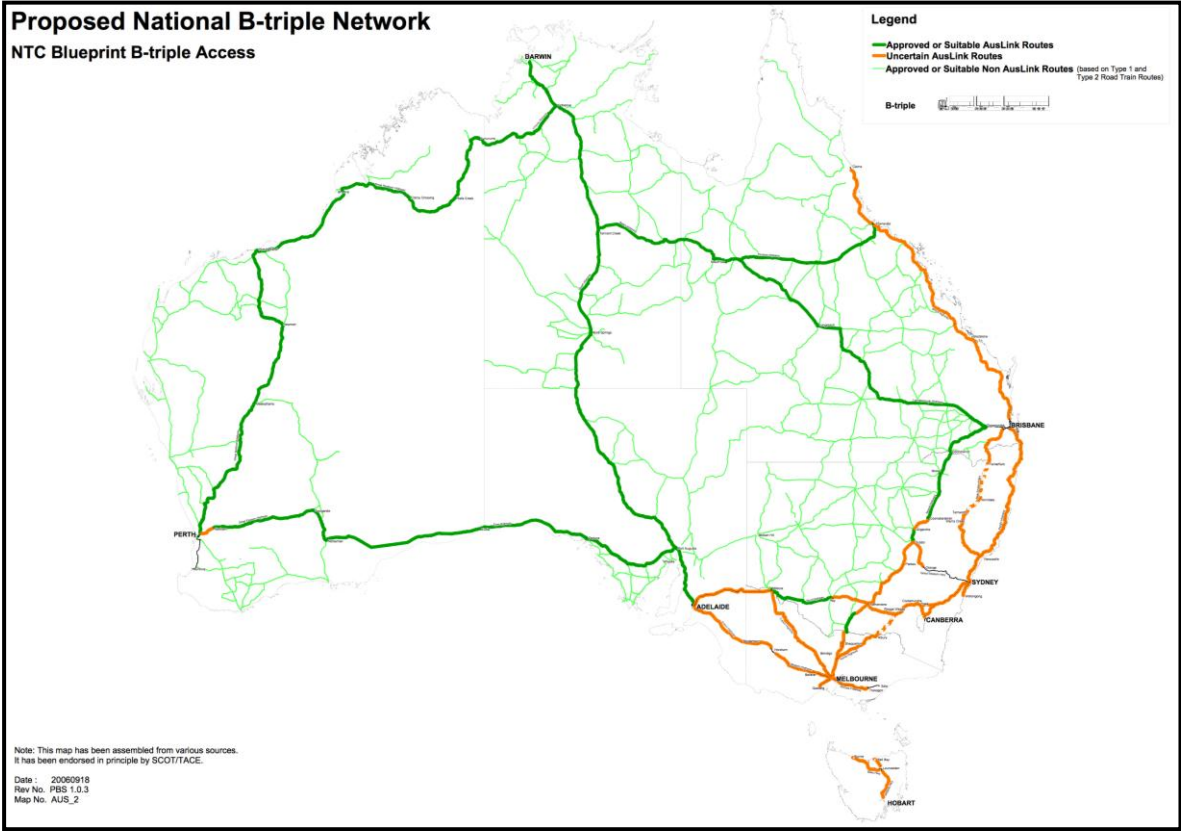


Figure 1. Potential national B-triple network presented to ATC on 13 October 2006

ATC ministers endorsed the Type I road train network portion of the proposed network (shown in green colour), but requested that further refinement of the network be undertaken by jurisdictions, co-ordinated by the NTC, to confirm the routes that would be approved for B-triples by July 2007. The refined network, reproduced in Figure 2, was presented to and agreed by ATC at its meeting of 4 May 2007 as the initial national B-triple network. The agreed network is largely consistent with the road train network except in NSW, where it is a very restricted network by comparison. Ministers also requested that the NTC work with industry to identify the next routes for expansion of the B-triple network.

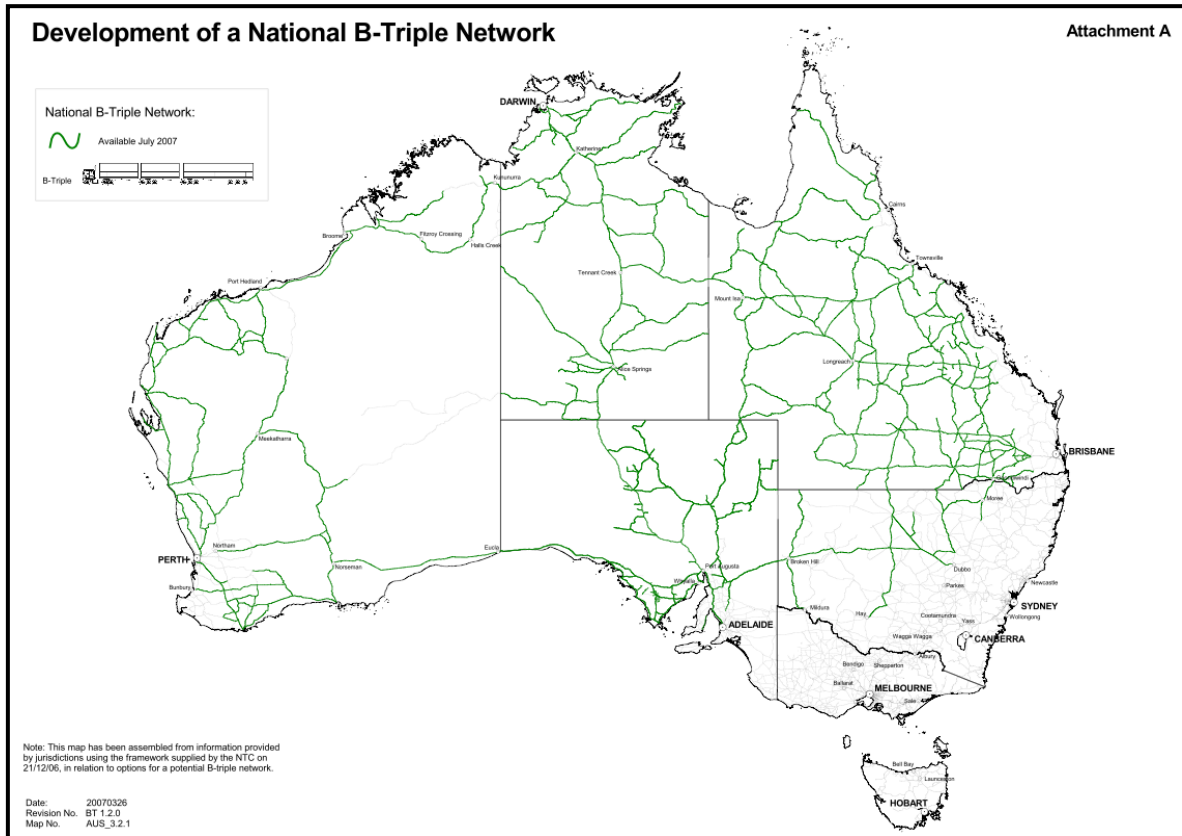


Figure 2. Initial national B-triple network agreed by ATC on 4 May 2007

In consultation with state and territory road authorities, the NTC then developed a map that augmented the approved initial B-triple network with the potential short- and medium-term additions of a future expanded network (Figure 3). This map indicates that the orange-coloured routes could be available by 2012 (i.e. 0 to 5 years from 2007).

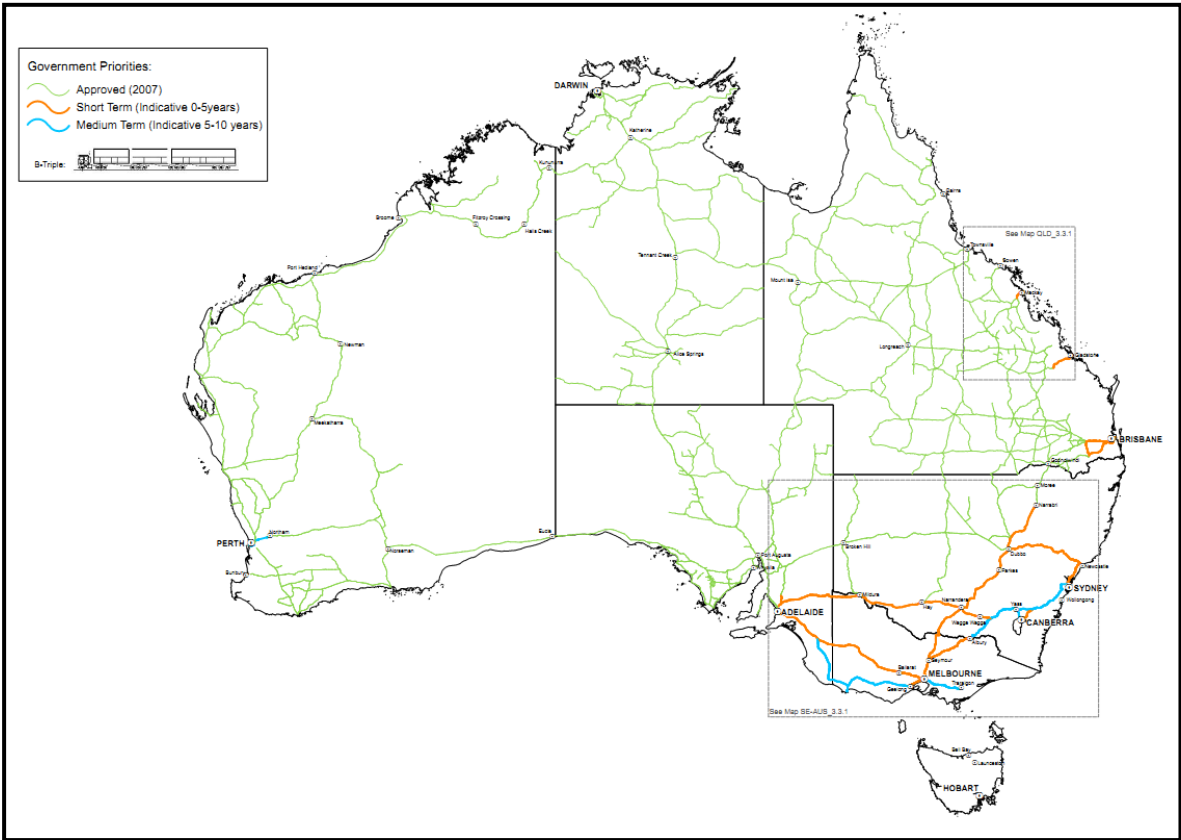


Figure 3. Projected expansion to an inter-capital network (proposed in 2007)

Certain timeframes and infrastructure investment costs are associated with realising the proposed expansion to the network, and such expansion will necessarily occur in stages. In 2011 the NTC consulted with industry to determine which of the proposed expansion routes (i.e. the orange and blue routes in Figure 3) are of most importance to meet current and future freight demands, and therefore warrant the most urgent attention. The routes identified were all currently approved road train routes plus:

- Melbourne-Sydney via the Hume Highway (soon to be fully duplicated)
- Melbourne-Toowoomba via the Hume, Goulburn Valley, Murray Valley, Newell and Gore Highways (much of which is currently approved for B-doubles or road trains at Higher Mass Limits)
- Adelaide-Melbourne via the Dukes and Western Highways
- Adelaide-Sydney via the Sturt and Hume Highways.

These routes necessarily require consideration of staging areas and last-mile access.

Despite ATC agreement on the initial national B-triple network in 2007 there are at present no nationally agreed vehicle specifications and operating conditions for B-triples. To satisfy COAG’s original intention there is a need to agree on these, and that is the primary focus of this regulatory proposal.

1.4 Problem statement

B-triples currently operate under vastly different local policies in Western Australia, Northern Territory, South Australia, Queensland, New South Wales and Victoria. The vehicle specifications and operating conditions and the extent of available networks are different in each state and territory. To give some examples:

- In Queensland B-triples have access to the entire Queensland Type I road train network under a local multi-combination vehicle guideline.
- In South Australia standard B-triple access is limited to a basic inter-capital network, but there is a proposal under consideration that will allow wider network access to B-triples that meet Performance Based Standards.
- In New South Wales B-triples may operate on a limited network under the local Road Train Modernisation Program, which places a number of additional requirements on vehicles and operators (such as accreditation under the National Heavy Vehicle Accreditation Scheme mass and maintenance management modules, and Intelligent Access Program participation).
- In Victoria there is only one long-standing point-to-point B-triple operation between the Ford Motor Company's Geelong and Broadmeadows plants, which uses a fully-duplicated B-double route. While there are some Type I road train routes near Mildura in the north west, no B-triples are allowed to operate on those routes.

B-triples will not be able to flourish as a national road freight productivity solution until such inconsistencies are overcome. This will require the development of a single, nationally agreed B triple network and a single, nationally agreed B triple vehicle specification and associated operating conditions. Over time, access should be extended beyond road train areas to a strategic inter-capital network.

1.5 Consultation

In addition to public consultation as part of the release of this discussion paper, the NTC has engaged directly with certain representative organisations through face-to-face meetings, telephone calls and written communications. The main bodies included:

- Australian Trucking Association (ATA)
- Australian Road Transport Suppliers Association (ARTSA)
- Australian Logistics Council (ALC)
- Australian Livestock Transporters Association (ALTA)
- Truck Industry Council (TIC)
- NatRoad
- Austroads (Bridge Technology Program and Freight Program)
- Australian Local Government Association
- Road and transport departments and agencies from each state and territory and the Commonwealth.

The industry supports wider and more general adoption of B-triples because the productivity and safety benefits will improve business in numerous ways, as evidenced by a quotation from one representative transport operator:

B-triples would allow me to haul more freight while using less fuel, less labour, less emissions; they're a more productive vehicle, and they're a safer vehicle too, meaning less damage to the freight, and it gives me peace of mind for my drivers.

– *Craig Day, Days Transport, Narrandera*

The industry projects a unified and consistent message in relation to this reform. On the other hand, the views of state and territory governments vary considerably because of differences in existing local policies and implementations.

2. Vehicle modularity and related technical terms

2.1 B-triple vehicle configuration and coupling

A B-triple is a vehicle combination comprising a prime mover towing three semi-trailers (Figure 4). The articulation points between the three trailer units each feature a fifth-wheel coupling (or 'B' coupling, hence the name 'B-triple'). Such a coupling supports the front of the following trailer and allows free relative rotation between adjacent vehicle units about the vertical axis (when turning) and the transverse axis (when travelling over crests and through dips), but strongly resists relative rotation about the longitudinal axis. The resistance to relative rotation about the longitudinal axis is commonly referred to as 'roll-coupling'. When cornering or experiencing dynamic motion from driver steering or road surface irregularity, forces acting on the trailers try to roll the individual units of a combination over to one side or the other. With roll-coupling, each vehicle unit is forced to maintain approximately the same angle of tilt as the adjacent units. For a B-triple this has the effect of stabilising each trailer against rollover. It is widely accepted that vehicle combinations featuring 'B' couplings exhibit far greater dynamic rollover stability than those with non-roll-coupled 'A' couplings (i.e. standard converter dollies).



Figure 4. B-triple vehicle configuration

The B-triple is a straightforward extension of the ubiquitous B-double (Figure 5), obtained by the addition of another lead trailer similar to the first.



Figure 5. B-double vehicle configuration

2.2 Comparison with A-double

The conventional equivalent to the B-triple configuration in mass and dimensions is the A-double (Figure 6). As the name suggests, an A-double is a vehicle combination comprising a prime mover towing two semi-trailers joined by a converter dolly ('A' coupling). Most A-doubles have a tandem axle converter dolly (as shown) but it is becoming increasingly common for triaxle converter dollies to be used, particularly for high-density payloads in the resources sector, producing the same axle footprint and gross mass as the standard B-triple. Triaxle converter dollies introduce a potential mass compliance issue when connecting the rear trailer directly to a tandem drive prime mover, as the kingpin load from the trailer may be too high to be supported by a tandem axle group.



Figure 6. A-double vehicle configuration

2.3 Breaking down into smaller combinations

It is common for multi-combination vehicles to be broken down into smaller combinations for travel on routes that are not approved for carrying the entire multi-combination. The B-triple offers some benefits over the conventional A-double for this type of travel.

2.3.1 A-double

When an A-double arrives at the boundary of a more restricted area, beyond which it is not allowed to operate, it can be broken down into separate semi-trailer combinations if another prime mover is available. Alternatively, it can make separate trips with the same prime mover. If travelling into the more restricted area and returning to the same point, the converter dolly may be stored in an appropriate location for later re-coupling (Figure 7a). If travelling right through the more restricted area and re-configuring as an A-double on the other side, the converter dolly may remain coupled behind one of the semi-trailers (Figure 7b).

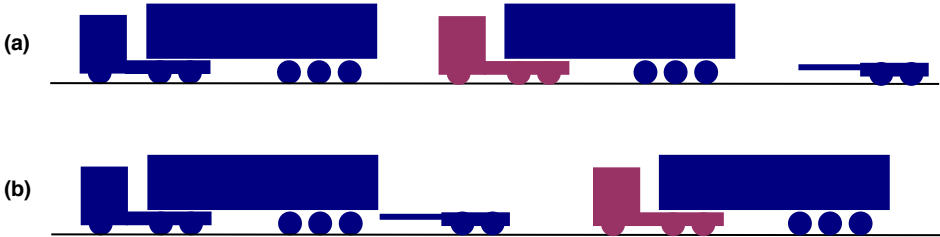


Figure 7. Breaking down an A-double into two smaller combinations

2.3.2 B-triple

When a B-triple arrives at the boundary of a more restricted area, beyond which it is not allowed to operate, it can be broken down into separate semi-trailer or B-double combinations if another prime mover (or prime movers) is available. Alternatively, it can make separate trips with the same prime mover. The B-triple can be broken down into one semi-trailer combination and one B-double combination by either breaking off the last trailer (Figure 8a) or breaking off the last two trailers (Figure 8b).

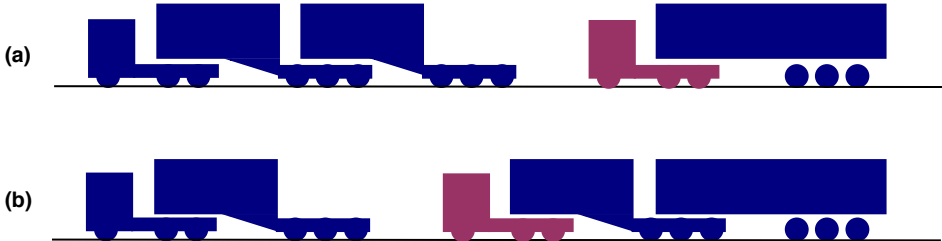


Figure 8. Breaking down a B-triple into a B-double and a semi-trailer

The B-triple can also be broken down into three semi-trailer combinations (Figure 9).



Figure 9. Breaking down a B-triple into three semi-trailers

If an additional semi-trailer combination is available, the B-triple can be broken down into two B-double combinations (Figure 10).



Figure 10. Breaking down a B-triple into two B-doubles

Further, two B-triples can be broken down into three B-doubles if an additional prime mover is available.

The choice of which way to break down the B-triple depends on numerous factors. If the freight is destined for locations that require access to non-B-double routes, then it is necessary to break down the B-triple into three semi-trailers. If the freight is destined for locations on the B-double network, then either of the B-double options is available.

2.4 Extending to Type II road train operation

Type II road trains operate on a much less extensive network than Type I road trains. They can be up to 53.5 metres long and, depending on axle configuration, can weigh in excess of 115 tonnes. The A-double and B-triple offer different opportunities for Type II road train operation, with the B-triple offering more modern configurations.

2.4.1 A-double

With an extra converter dolly and semi-trailer, an A-double can be converted into an A-triple (Figure 11). This is the standard road train configuration that has operated for many years.



Figure 11. A-triple vehicle configuration (Type II road train)

2.4.2 B-triple

With the same additional equipment, a B-triple can be converted into either an ABB-quad (Figure 12a) or a BAB-quad (Figure 12b). These four-trailer road train configurations simultaneously offer improved productivity and safety over the conventional A-triple road train. Their additional degree of roll-coupling makes them particularly stable on the road at high speed, and they are the preferred road train configuration for many transport operators.



Figure 12. (a) ABB-quad and (b) BAB-quad vehicle configurations (Type II road trains)

2.5 Summary of A-double and B-triple modularity

The A-double and B-triple modular combinations discussed above are summarised in Table 1. Other configurations may be possible.

Table 1. Summary of A-double and B-triple modularity

When you add...		to the components of an A-double you can build...	
1 prime mover		2 prime mover semi-trailer combinations (1 converter dolly left over)	
1 converter dolly 1 semi-trailer		1 A-triple	
When you add...		to the components of a B-triple you can build...	
1 prime mover		1 prime mover semi-trailer combination 1 B-double combination	
2 prime movers		3 prime mover semi-trailer combinations	
1 prime mover semi-trailer combination		2 B-double combinations	
1 B-triple		3 B-double combinations	
1 converter dolly 1 semi-trailer		1 ABB-quad or BAB-quad road train	

3. The regulatory proposal and its alternatives

3.1 An agreed national B-triple network and an associated vehicle specification and operating conditions

3.1.1 Network

Aspects of a heavy vehicle's design that affect its potential operating network include its safety performance (particularly related to its overall length and its swept path width when turning, but also its dynamic performance) and its infrastructure impact (pavement loading and bridge loading).

Compared with A-doubles, B-triples offer improved safety in all key aspects of safety performance except swept path width, which, for a given overall length, is generally greater for B-triples than for A-doubles. If the regulatory proposal imposes a suitable control on B-triple overall length, then it is possible for a B-triple's swept path width to be within the accepted road design envelope of 10.6 metres (Performance Based Standards Level 3), if not comparable with that of an A-double (which is typically less than 10.6 metres). Section 7 demonstrates that this is in fact the case. Thus under such a regulatory proposal B-triples will exhibit acceptable safety performance across the board, and so, from a safety perspective, should be allowed access to at least the entire existing Type I road train network. A detailed assessment of the safety performance of B-triples in comparison with that of A-doubles, including swept path width, is presented in Section 7.

Although slightly heavier than an A-double, the infrastructure impacts of a B-triple are not necessarily worse than those of an A-double:

- When considering pavement loading, B-triples are more efficient from the perspective of load carried per unit of pavement wear, because their mass is spread over more tyres. This benefit can be quantified using simple calculations, and an analysis is presented in Section 8.1.
- When considering bridge loading, B-triples firstly satisfy the bridge formula and secondly induce less effects on most bridge structures. Shorter bridges (e.g. those with spans less than 20 metres) see little difference between the loads imposed by a B-triple and those imposed by a B-double, let alone an A-double, because only part of the vehicle combination is on the span at any given time. Longer bridges are subject to greater loads if the entire B-triple can fit on the span at one time. This, however, does not necessarily mean that the bridge capacity will be exceeded. A detailed analysis is undertaken in Section 8.2.

Road authorities are able to conduct network-level analyses to determine whether particular vehicle configurations can be accommodated by bridge structures on a given network, and they are able to identify those structures that can support certain traffic if they are suitably upgraded.

This discussion paper is concerned only with a first step of introducing B-triple access to a national B-triple network that consists of the Type I road train network. The national B-triple network agreed to in 2007 already contains routes that are in addition to existing road train routes. The NTC has since received notice of further additional routes from some road authorities. These additional routes, plus the existing Type I road train network could form the basis of a future extended modular B-triple network.

Objective #1: To approve a 2012 national B-triple network that consists of the Type I road train network.

3.1.2 Vehicle specification and operating conditions

The NTC has considered two approaches to developing a nationally consistent vehicle specification for B-triples. The approach initially desired by state and territory transport agencies in 2006, although not consistent with the COAG direction, was to require B-triples to be approved under the Performance Based Standards (PBS) scheme. To assist industry the NTC prepared a blueprint PBS vehicle design and funded its PBS assessment and approval. The goal was to

enable any industry member wishing to operate a vehicle falling within the blueprint design envelope to avoid going through the PBS assessment process.³ Industry did not support the blueprint design, as it was inflexible and required most operators to purchase new specialised trailer equipment. No transport operators adopted the blueprint design and none advanced their own proprietary designs based on new or existing standard B-double trailer equipment.

In theory, the development of prescriptive regulations offers a more simple and practical alternative to the current PBS scheme. In practice, however, gaining national agreement on prescriptive regulations for higher productivity vehicles has been a particularly difficult objective to achieve. An approach that has been previously documented by the NTC (National Transport Commission 2009) is based on using PBS to 'codify' accepted performance. In the spectrum of heavy vehicle on-road performance, at one end is as-of-right access for standard (prescriptive) heavy vehicles, and at the other are highly innovative vehicles, for which there is uncertainty about on-road performance and therefore more comprehensive assessment is required (Figure 13).

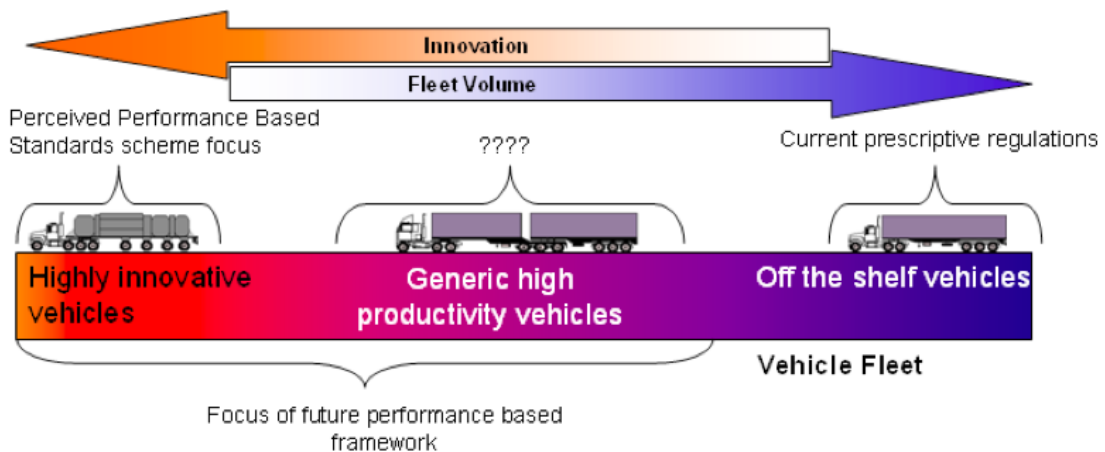


Figure 13. Performance-based assessment – fleet coverage objectives

B-triples currently fall in the centre of the spectrum, where they can be treated under the PBS scheme but could just as easily be defined as off-the-shelf vehicles once tested against PBS standards. Given their proven performance against PBS standards, modular B-triples can be considered for treatment as prescriptive vehicles where the prescriptive requirements placed on them are a means of ensuring that performance is consistent with the PBS standards.

This approach, referred to as 'the prescriptive modular approach', uses new or existing standard B-double trailer equipment to form B-triples subject to some basic prescriptive requirements. Having used PBS methods to test for B-triple performance under these requirements, sufficient controls are in place to ensure safe vehicle operation. This approach is examined in detail herein and a proposed specification is advanced. Some basic operating conditions, such as vehicle signs and speed limits, are contained within the requirements.

Objective #2: To approve a single national B-triple vehicle specification and operating conditions based on the modular use of new or existing standard B-double trailer equipment.

3.2 Status quo

Maintaining the status quo means persisting with local policies in each state and territory. As local policies differ widely, interstate operation is discouraged.

This approach is undesirable because:

³ The resultant blueprint B-triple specification sheet is available for download at: <http://www.ntc.gov.au/DocView.aspx?DocumentId=1551>

- It fails to achieve the COAG objective of 2006, which was a *national* network and operating conditions specific to B-triples.
- Even if the PBS scheme is used to obtain national approval, this does not provide any guarantee of access to a national network, which has been one of the major hurdles for the PBS scheme across all vehicle classes. PBS access approvals are treated on a case-by-case basis in most jurisdictions, and for larger and heavier vehicles they often result in specific operational routes rather than broad networks, with inconsistent operating conditions. At best, this approach will offer access to the PBS Level 3 network, which may never be expanded to the extent that a dedicated B-triple network could be expanded.
- B-triple performance is close to PBS Level 2 network standards. Generally overall length, swept path width, driveline performance and infrastructure impact are the only aspects that relegate them to PBS Level 3 approval. Over time, however, a dedicated B-triple network as envisaged by COAG can comprise the road train network (currently consistent with PBS Level 3) plus parts of the B-double network that (a) can accommodate increased length and swept path width at the few included junctions, (b) have gentle grades and few stopping points and (c) have bridges of suitable strength. Such a network would suit the specific nature of the B-triple, which is characterised by its exceptional safety performance in comparison with the conventional A-double, despite both having similar size and mass.

4. Modular B-triple specification

4.1 Principle

The prescriptive modular approach exploits the fact that B-double trailers are a logical building block for B-triple combinations. Under this approach B-triples should be able to be constructed from standard B-double trailer equipment provided that they satisfy any necessary controls applicable to operating as a B-triple. B-double trailer equipment is ubiquitous and largely consistent within each commodity or body type, so the outcome of constructing B-triples from such equipment is expected to be fairly predictable.

The proposed prescriptive modular B-triple specification is constructed on the principle that the B-triple combination must be able to be broken down into a complying 26-metre B-double, and that this must be the case regardless of which of the two lead trailers is removed from the combination.⁴ This approach effectively imposes by extension the existing 26-metre B-double requirements, including additional prime mover safety features, on the vehicle components used in a prescriptive modular B-triple. A-doubles are not required to have some of these features, such as anti-lock braking systems (ABS) on prime movers, so this presents an increase in safety for modular B-triples in comparison with conventional A-doubles.

It is unnecessary to list, in this B-triple vehicle specification, all of the requirements that apply to a 26-metre B-double. In effect, the requirement to form a complying 26-metre B-double implies that all of the 26-metre B-double requirements are applicable when operating as a B-double. It is up to the operator and each state and territory's enforcement system to ensure compliance. Likewise, it is unnecessary to list in this B-triple vehicle specification all of the requirements that apply to a B-triple or other multi-combination vehicle operating on the Type I road train network.

This specification is concerned primarily with ensuring that combinations operated under the proposed prescriptive modular B-triple policy have acceptable safety and infrastructure impacts and that the risk of non-compliance with B-double requirements when one trailer is removed is mitigated to the extent that is practical. Certain 36.5 m B-triples operating under existing state-based policies do not form legal B-doubles when one trailer is removed, so in respect of that issue, this policy includes a 'B-double compatibility' requirement.

4.2 Key requirements

The five key requirements are:

- Configuration
- B-double compatibility
- Overall length
- Kingpin-to-rear dimension
- Mass limits.

4.2.1 Configuration

Must be constructed from a prime mover having a single steer axle and a tandem drive axle group towing three triaxle semi-trailers all connected by fifth-wheel couplings.⁵

⁴ The resultant B-double may be less than 25 metres long but it must meet 26-metre B-double requirements. Specifically, the prime mover must have the front under-run and cab strength safety features that are required for 26-metre B-doubles.

⁵ This is the industry-standard B-triple configuration, which is equivalent to the industry-standard B-double configuration with an additional lead trailer.

4.2.2 B-double compatibility

Must form a compliant 26-metre B-double when one lead trailer is removed, regardless of which one is removed. In Figure 14 an incompatibility example is given for the case where the overall length of one of the resultant B-doubles is greater than 26 metres.

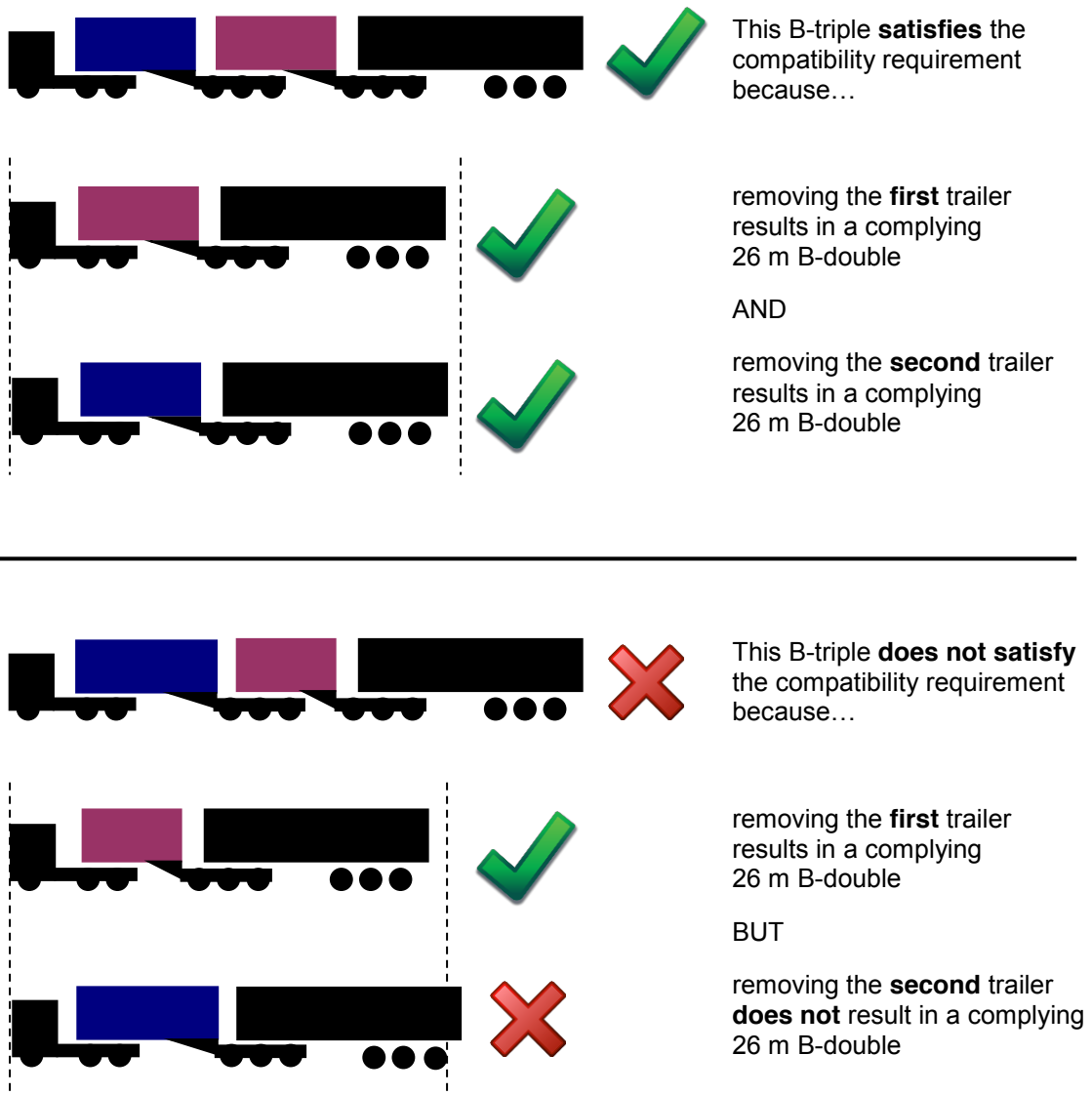


Figure 14. Demonstration of the B-double compatibility requirement

4.2.3 Overall length

Maximum 35 metres, including any bull bar and other after-market fittings.⁶

⁶ This is 9.0 metres longer than a 26-metre B-double, and allows the addition of most existing standard lead trailers to form a B-triple from a 26-metre B-double. The choice of 35 metres, and not 36.5 metres, is a necessary control to aid compliance and enforcement of the B-double compatibility requirement, and makes virtually no difference to the number of modular combinations possible from existing stock. It also ensures that low-speed swept path width is within acceptable limits. Based on the dimensions of existing vehicles in the fleet, most modular B-triples will have an overall length in the range of 32 to 34 metres.

4.2.4 Kingpin-to-rear dimension

Maximum 29.6 metres.⁷

4.2.5 Mass limits

General Mass Limits and Concessional Mass Limits (not Higher Mass Limits).

4.3 Supplementary requirements

4.3.1 Vehicle marking

In accordance with the provision contained in the proposed Heavy Vehicle National Law⁸, a 'LONG VEHICLE' warning sign must be displayed at the rear of modular B-triples.

4.3.2 Operation as a B-double or less

When operating as a B-double, single semi-trailer or bobtail prime mover, the vehicle is subject to all of the rules and regulations that normally apply to the respective configuration in the relevant state or territory.

4.3.3 Operation as a B-triple or more

When operating as a B-triple or as part of another multi-combination vehicle (e.g. an ABB-quad or BAB-quad road train), the following requirements apply:

- The vehicle is subject to all of the rules and regulations that normally apply to the respective configuration in the relevant state or territory, including a speed limit of 90 km/h or 100 km/h depending on the state or territory.
- Notwithstanding the road train prime mover speed-limiting requirements in the relevant state or territory, the prime mover must be speed-limited according to ADR 65 with a maximum road speed capability of either 90 km/h or 100 km/h.

4.3.4 Additional requirements applicable only to B-triple operation

When operating as a B-triple the following additional requirements apply:

- The prime mover must have an engine with a maximum power output of not less than 500 HP (373 kW).
- The prime mover must be rated by the manufacturer for a startability of 10% and a gradeability of 12%.⁹
- The prime mover must be capable of maintaining a minimum speed of 70 km/h on a 1% gradient at the B-triple maximum GCM rating of 84.5 tonnes (CML). This can be demonstrated by truck manufacturer calculation or by physical test.

⁷ This is 9.0 metres longer than the equivalent dimension for a 26-metre B-double, and ensures that prime mover wheelbases remain within acceptable limits from a driver health perspective (as per the 26 m B-double) when operating at maximum length. It also ensures that prime movers are dimensionally interchangeable between B-triples and B-doubles used under this policy.

⁸ Schedule 3 of the proposed Heavy Vehicle (Vehicle Standards) National Regulation/Part 3 Vehicle marking/Section 5 Warning signs for combinations longer than 22m stipulates: "(3) A combination, other than a road train, longer than 22m, but not longer than 36.5m, must display a long vehicle warning sign at its rear."

⁹ This requirement corresponds with PBS Level 3 and is therefore appropriate for B-triple operations on the Type I road train network. It is also appropriate for future B-triple operations on an expanded B-triple network that incorporates major B-double routes, where grades are typically less than 10%. The PBS Level 2 requirement is too onerous for B-triples because it allows for B-double routes that B-triples will not be able to access.

4.4 Note on braking systems

The Australian Road Transport Suppliers Association (ARTSA) has recently developed a Brake Code of Practice for the mixing of prime mover and trailer brake technologies in combination vehicles. This is an important development given Australia's reliance on a variety of mostly North American, European and Japanese trucks coupled with mostly Australian trailers. Differences in regulations in overseas markets sometimes result in sub-optimal distribution of braking effort to each axle group.

While it is not proposed as a requirement under this policy, it is recommended that the operators of prescriptive modular B-triples adopt the prime mover and trailer technology mixtures endorsed by the ARTSA Brake Code of Practice. Until such time as the national B-triple network incorporates a significant network of inter-capital routes (i.e. while it largely reflects the Type I road train network), it is considered inappropriate to impose any brake system requirements in excess of the requirements currently applying to A-doubles.

5. Network access and implementation

5.1 The national B-triple network

The only formally approved national B-triple network is that approved by ATC in 2007 (Figure 2, p3). The 2007 network did not include all Type I road train routes.

Road authorities have advised the NTC of routes proposed for inclusion in a 2011 revision of the national B-triple network (Figure 15). The revised network (shown in green) features additional routes in comparison with the 2007 network, including some non-road-train routes, but it does not contain all currently approved road train routes—the New South Wales road train routes shown in orange are not included. Shown in blue are the routes prioritised by industry for future expansion of the network beyond road train routes. Figure 16 shows a more detailed view of the proposed network in south-eastern Australia.

5.2 Implementation

Under existing national model law and the forthcoming (2013) Heavy Vehicle National Law, heavy vehicles are categorised in the following four classifications:

- **General access** vehicles are those complying with the vehicle standards and mass and loading regulations (e.g. rigid trucks, semitrailers, standard type truck-trailers).
- **Class 1** vehicles are engaged in 'special purpose' transport operations, which include oversize and overmass, agricultural and mobile plant vehicles (e.g. low loaders, concrete pump trucks).
- **Class 2** vehicles are specific types and combinations that are compliant with applicable model regulations but as a result of their size and/or mass they are subject to restricted access (e.g. B-doubles, road trains and long buses).
- **Class 3** vehicles are non-standard heavy vehicles¹⁰ that do not fall within the Class 1 or 2 categories. These are typically higher productivity vehicles that operate under concessional access/permit schemes or under the PBS scheme (e.g. super B-doubles and, under existing legislation, all PBS vehicles). Their access to the road network is either restricted or in accordance with the PBS access levels.

One type of Class 2 vehicle is the road train, of which the B-triple is one example. Both the existing model law and the proposed Heavy Vehicle National Law provide that Class 2 vehicles may be authorised to use a specified road network. Authorisation may be granted by a notice published in the Government Gazette or by a permit. Three states (Victoria, New South Wales and Western Australia) currently use the concept of Class 2 vehicles, while the other jurisdictions currently have laws that achieve a similar outcome.

Under the Heavy Vehicle National Law existing state access arrangements for non-modular B-triples will be preserved and in the future it is possible that 36.5 m B-triple notices that apply across more than one State could be made. This policy proposes that any existing state-based arrangements for B-triple operation will be allowed to continue unaffected in the relevant states once this policy is implemented.

The current treatment of B-doubles, B-triples and A-doubles in each of the 'road train' jurisdictions is shown in Table 2.

¹⁰ Non-standard heavy vehicles refers to those vehicles that do not comply with applicable vehicle standards and/or mass and loading regulations, and therefore, do not qualify for 'as of right' access to the road network.

Development of a modular B-triple network

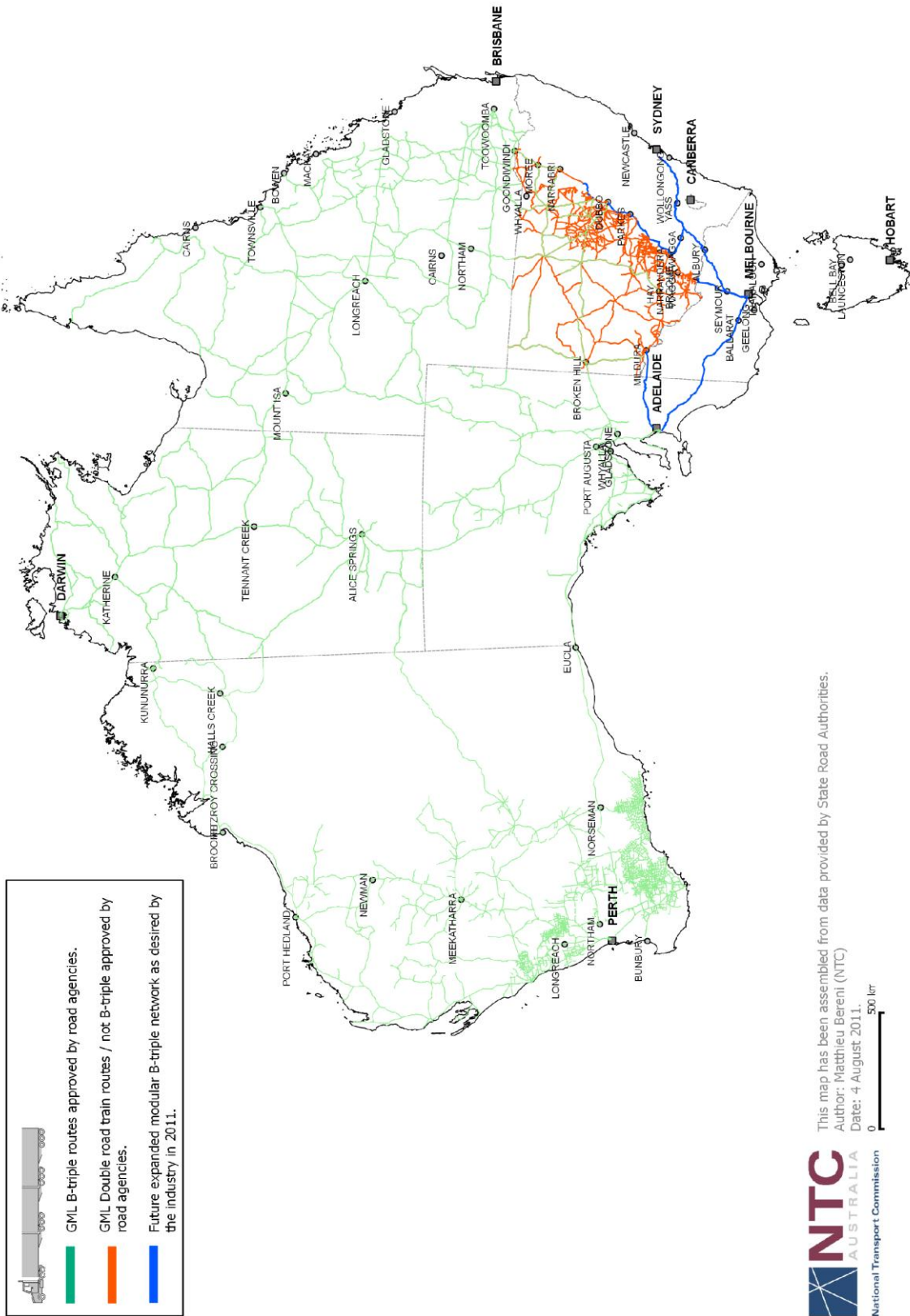


Figure 15. Potential B-triple network (2011 and beyond)

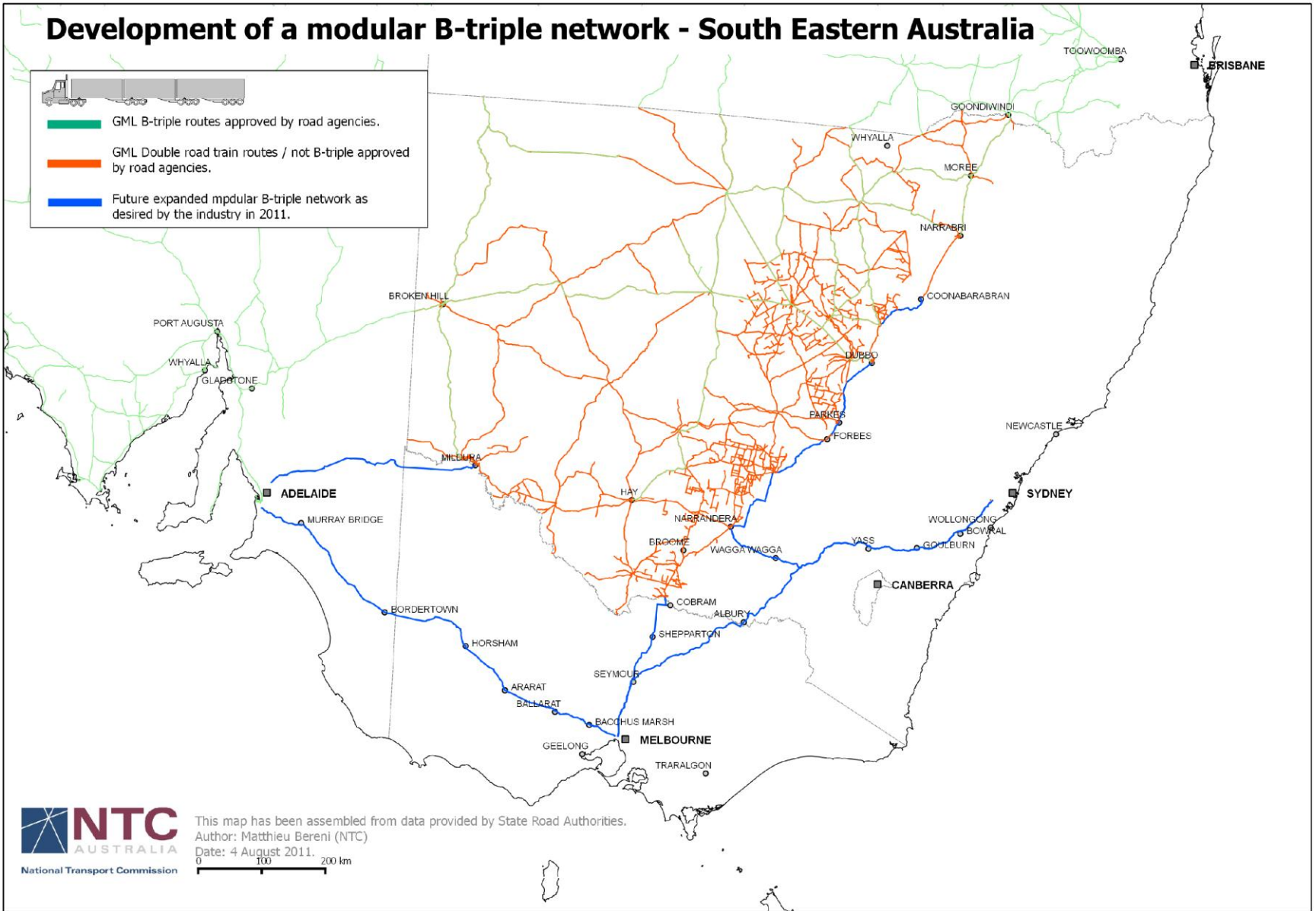


Figure 16. Potential B-triple network (2011 and beyond) – SE Australia

Table 2. Treatment of B-doubles, B-triples and A-doubles in WA, NT, SA, QLD & NSW

	B-doubles	B-triples	A-doubles
WA ⁽¹⁾	RAV Category 2 routes under Class 2/3 period permits.	RAV Category 6 routes under Class 2/3 period permits.	RAV Category 5/6 routes under Class 2/3 period permits.
NT	As-of-right access per the Motor Vehicle Registry Information Bulletin ('notice').		
SA	B-double routes under the B-double notice.	Selected routes under individual permit.	Road train routes under the road train notice.
QLD	B-double routes under the Guideline for Multi-Combination Vehicles	Road train routes under the Guideline for Multi-Combination Vehicles	
NSW	B-double routes under a Class 2 notice.	Selected routes under individual permit (Road Train Modernisation Program).	Road train routes under a Class 2 notice.
VIC	B-double routes under a Class 2 notice.	Trial evaluation under a restricted permit.	Road trains operating under permit on the A20 between Mildura and the South Australian border

NOTES: 1. WA has implemented ten Restricted Access Vehicle (RAV) networks, named Category 1 to 10 in order of increasing vehicle mass and dimension capacity.

While NT and QLD treat B-triples in the same way as A-doubles (i.e. granting the same network access under the same type of access approval), WA, SA and NSW provide less network access for B-triples, and in SA and NSW individual permits are used for B-triples while A-doubles operate under notice. As part of a B-triple trial evaluation in Victoria, a number of B-triples have been operating safely between Ford's Broadmeadows and Geelong facilities under a restricted permit for around 14 years whereas A-doubles are only allowed under PBS.

The regulatory proposal is to treat modular B-triples as Class 2 vehicles under notice. It is proposed that existing laws, and the Heavy Vehicle National Law from commencement, will be used consistently to allow modular B-triples to use a national B-triple network subject to the same conditions in all states and territories. This does not require any changes to regulation, though a definition of 'Modular B-triple' may eventually be included in the law to clarify what type of road train is a modular B-triple.

This approach will allow safer, more productive and more infrastructure-friendly modular B-triples to operate with no greater regulatory burden than B-doubles and road trains do at present.

5.3 Intelligent Access Program (IAP)

5.3.1 The IAP domain

The IAP is a voluntary program which provides heavy vehicles with improved access to Australia's road network in return for monitoring of compliance with specific access conditions by vehicle telematics solutions.¹¹

IAP was conceived as a tool to enable governments to remotely manage the risk of sensitive infrastructure being exposed to the passage of heavy vehicles, plant and equipment. For example, mobile cranes can pose a major risk to infrastructure because they can be much heavier than the mass limits for other vehicles of similar length, and their mass is concentrated over relatively few axles. The consequence is that some infrastructure could be severely or catastrophically damaged from one pass of such a vehicle if it happens to stray from an approved route. Road authorities are able to allow such vehicles broader access to their road networks if they can be assured of better route compliance through the IAP. Some parts of the infrastructure may have administrative controls in place to minimise risk. For example, time-of-day restrictions may be placed on a vehicle so that it cannot travel during heavy traffic periods.

¹¹ Source: <http://www.iap.gov.au> (accessed 30 June 2011). The word 'voluntary' should not be understood to mean that participation in the IAP is voluntary; rather, it is voluntary to participate in the particular transport operations that require IAP participation in some jurisdictions. In other words, it is the operator's choice whether to conduct each type of operation, but if the operator chooses to conduct a particular operation that requires IAP participation then IAP participation is mandatory for that operator.

Some PBS vehicles are good candidates for IAP monitoring. For example, a high mass PBS vehicle that does not satisfy the axle spacing mass schedule may have been approved by special assessment to travel on a specific point-to-point route featuring no sensitive infrastructure. IAP is not widely used as a tool for monitoring route compliance of the more common restricted-access vehicles such as B-doubles and road trains, although some jurisdictions do apply it as such (e.g. HML access in New South Wales).

5.3.2 National In-Vehicle Telematics Strategy

The NTC developed a National In-Vehicle Telematics Strategy (National Transport Commission 2010a) that was approved by ATC in May 2011. It included the following policy principles to improve the safety, productivity, efficiency and environmental performance of the transport and logistics industry:

- The role of business is to develop innovative solutions – only the private sector has the drive, capacity, incentives and resources to innovate.
- The role of governments is to provide policy certainty – creating an environment for business to invest with confidence.
- Technology is a tool to enable policy – policy should not be designed to fit a technology.
- Interoperability standards and platforms must be public, transparent and performance based – governments should provide standards and policy directions to help facilitate supply chain interoperability and in-vehicle telematics uptake.
- Telematics-based compliance monitoring should be voluntary wherever practical.
- Uptake by industry should be encouraged (e.g. reward ‘good behaviour’).
- Mandating in-vehicle telematics applications requires careful evaluation – a framework is needed to evaluate options, risks and cost-benefits in a transparent and consistent manner.
- National approaches for telematics use – national consistency delivers economies of scale and drives greater uptake within industry.

The strategy then recommended that governments engage with industry to develop a framework for assessing administrative costs before requiring in-vehicle telematics, with the objective of demonstrating clear, transparent and consistent benefits to avoid unnecessary cost or cross-border technology barriers.

5.3.3 IAP costs

Some form of non-IAP remote vehicle tracking is undertaken voluntarily by around 90% of transport operators to improve their business efficiency.¹² This can be done with any GPS-enabled equipment that provides the desired outcomes. Non-IAP equipment generally does not offer tamper-evidence or a guaranteed level of service, so although it may be used as evidence, it is exposed to legal challenge. IAP participation, on the other hand, requires equipment to be installed and maintained by a certified and audited IAP Service Provider, who collects data and issues reports of any non-compliant activity to the appropriate road authority. There is necessarily a higher cost associated with IAP-certified vehicle tracking in return for the greater certainty and reliability that it provides.

¹² Source: National In-Vehicle Telematics Strategy. Operators who use non-IAP equipment record network location data and, despite the equipment not being IAP-approved, that data can still be used as evidence. This was the intent of the NTC’s Compliance & Enforcement package. IAP data and operator chain party data are all evidence, and available to enforcement staff as per the Model Compliance & Enforcement Bill.

Whether undertaking non-IAP or IAP-certified vehicle tracking there are certain upfront and ongoing costs, as set out in Table 3. Note that these costs are indicative only, and market values may vary considerably in either direction from those indicated.

Table 3. Indicative vehicle tracking cost comparison (IAP versus non-IAP)

	Upfront costs	Monthly costs	Annual costs
Non-IAP equipment used only for commercial business purposes (e.g. freight tracking)	\$600–\$700 typical unit installation ⁽¹⁾	\$30 tracking services \$11 SIM card	NIL
IAP-certified equipment used for IAP applications and possibly also for commercial business purposes	\$1,500–\$1,700 typical unit installation ⁽²⁾ Optional \$500 self-declaration input device	\$30 tracking services \$11 SIM card \$133 IAP fee	\$250 hardware inspection ⁽³⁾

NOTES: 1. Cost of some unit installations can be higher if the operator elects to include a high-level of commercial services (up to \$2,000). 2. Cost of some unit installations can be higher if the operator elects to include commercial services in addition to the basic IAP function (typically up to \$3,000 - \$3,500 for a high-level system). 3. Hardware inspection costs can be higher, e.g. if the IAP Service Provider is required to travel. One transport operator quoted an annual hardware inspection cost of \$900. (All other costs provided by a certified IAP Service Provider.)

From the typical costs shown in Table 3 it can be determined that the difference between the typical non-IAP use of vehicle tracking and typical tracking under the IAP could compare as follows:

- Upfront costs: From \$800 to \$1,600 more per prime mover (i.e. two to three times more) under the IAP
- Ongoing costs: \$1,846 more per prime mover per year (i.e. almost four times more) under the IAP.

Despite many road train operators already conducting voluntary vehicle tracking using non-IAP services, switching to IAP monitoring for B-triple operation on a B-triple network will add considerable cost that must be weighed up against the benefits of the operation. In the early stages of implementation of this policy, where modular B-triple access is likely to include at best the existing Type I road train network, operators tend not to see the value of IAP participation. If a significant national inter-capital network was published and approved by all jurisdictions, with access open to any modular B-triple meeting the requirements of this policy, this view may change.

5.3.4 Incompatibility with the modular approach

Under this proposal it is intended that a transport operator will be able to form compliant modular B-triple combinations from a wide range of existing compliant 26-metre B-double vehicle units. An operator could easily have dozens of prime movers that are suitable for the task, and each would need to be fitted with an IAP unit if they might be used to form a modular B-triple. The costs outlined in the previous section would then apply to each prime mover to which an IAP unit is installed, regardless of whether it is ultimately used to form a modular B-triple. Requiring IAP participation for modular B-triples would therefore either impose exorbitant costs on operators with many prime movers, or financially restrict the number of prime movers that could be used, thereby eroding the gains that could potentially be achieved from a high level of modularity.

5.3.5 Self-declaration of vehicle configuration

The IAP is not yet sufficiently mature to allow automatic detection of which trailers have been connected to a prime mover. This means that to apply IAP to the modular B-triple application, the vehicle operator must self-declare the times during which a particular prime mover is set up as a B-triple. When operation is declared as (say) a B-double, the vehicle would not be monitored. When operation is declared as a B-triple, the IAP Service Provider would issue non-compliance reports if the vehicle left the approved B-triple network.

Self-declaration may be done by the truck driver using an on-board Self-Declaration Input Device (SDID), which comes at additional cost, or by the company's office administration staff using an online facility. Either way, this reduces the application to an honesty system; it is reliant on drivers (or office administration staff) to honestly declare when a vehicle is operating as a B-triple. Audits of transport operators' weighbridge and delivery dockets may be cross-referenced with times when

vehicles were declared as 'non-B-triple' to detect instances of false declaration. Since modular B-triples are easily identifiable, road enforcement is considered to be an effective way to enforce the policy proposal introduced in this paper.

5.3.6 Risk of route non-compliance

There is no evidence to suggest that modular B-triple operations pose a risk of route non-compliance that exceeds the risk now associated with B-double operation (which involves a vastly greater network and presumably many more opportunities and incentives for non-compliance) or road train operation (which currently involves a network that exceeds the network made available to B-triples in New South Wales and poses greater safety risk because of the poorer on-road performance of road trains).

Table 4 lists the ways in which IAP is applied to some common modular vehicles (semi-trailers, B-doubles and road trains). Note that IAP is not applied to most semi-trailers, B-doubles and road trains, while it is applied to certain HML vehicles in New South Wales and Queensland only, and certain innovative road trains in New South Wales only. With no evidence to suggest that the risk of route non-compliance of the IAP-applied vehicles is greater than that of the remainder of the fleet, it is inappropriate to impose the type of monitoring currently active in only two jurisdictions on a national policy.

Table 4. Existing IAP application to common modular vehicles

IAP is not applied to...	IAP is applied to...
Triaxle semi-trailers at GML and CML Triaxle semi-trailers at HML in most states	Triaxle semi-trailers at HML in New South Wales and Queensland
B-doubles at GML and CML B-doubles at HML in most states	B-doubles at HML in New South Wales and Queensland
Road trains, including B-triples, AB-triples, ABB-quads and BAB-quads in most states where these combinations are applicable	B-triples and AB-triples in New South Wales

5.3.7 Community acceptance

Community acceptance is often quoted by governments as a reason for suggesting IAP participation for a particular transport operation. It is argued that the public will be more accepting of larger, higher-productivity vehicles on the road network if they can be assured that the vehicles will be route-compliant. To the contrary, certain members of the public tend to oppose any large truck introduction regardless of route compliance (i.e. they would object to B-triples even on B-triple approved routes), but over time their acceptance increases to a very high level, such as the case of B-doubles over the past 20 years.

5.3.8 Proposal

The industry opposes IAP participation for B-triples, and only a minority of jurisdictions support it, albeit without sufficient supporting evidence. It is recommended that IAP participation is not made a requirement under this proposed national policy.

6. Productivity analysis

6.1 Overview

This section is primarily about productivity analysis but also includes discussion about safety. The discussion about safety is based on crash statistics and the reduced risk brought about by reduced trip numbers if a more productive vehicle is used for a given freight task. Section 7 presents a more detailed analysis of safety based on an assessment of vehicle dynamics for the proposed vehicle specification and comparison vehicles.

National adoption of modular B-triples under the policy presented in this paper has the following benefits:

- **For operation on road train routes**, B-triples offer a modest productivity increase and a significant safety increase in comparison with conventional A-doubles. Not only are B-triples inherently safer, particularly in terms of dynamic rollover prevention, but their higher productivity means that fewer trips are required to achieve the same freight task, thereby resulting in reduced exposure.
- **For operation on B-double routes**, B-triples can be broken down into B-double combinations, providing a significant increase in productivity and safety in comparison with the single semi-trailers that would be formed from breaking down conventional A-doubles. The crash statistics published by National Transport Insurance's National Truck Accident Research Centre (2011) demonstrated the safety benefits convincingly; while B-doubles are responsible for 46% of articulated vehicle freight tonne-kilometres they are involved in only 29% of major articulated vehicle crashes.
- **For operation on a future extended national B-triple network** servicing the eastern seaboard capital cities on B-triple-ready B-double routes,¹³ B-triples would be able to improve on the productivity and safety of the B-doubles currently used on those routes.

A quantitative analysis of these points is presented below. It shows that for mass-constrained freight and volume-constrained freight, the productivity benefits of B-triples for all freight densities are compelling.

6.2 Mass-constrained freight

Mass-constrained freight is freight of such high density that it can bring a vehicle up to its maximum permitted mass without completely filling the volume available for freight. Examples of mass-constrained freight include bulk liquids and mined resources. When analysing vehicle productivity for mass-constrained freight the important parameters are the maximum permitted mass of the vehicle and the tare mass of the vehicle, where the maximum payload mass is the difference between the two.

Table 5 presents the results of a mass-constrained productivity analysis for the four vehicle configurations discussed. The analysis shows that:

- **For operation on road train routes**, B-triples offer a 10% payload mass increase over A-doubles, resulting in 9% fewer trips for the same freight task.
- **For operation on B-double routes**, B-doubles formed from B-triples offer a 61% payload mass increase over semi-trailers formed from A-doubles, resulting in 38% fewer trips for the same freight task.
- **For operation on a future extended national B-triple network**, B-triples offer a 35% payload mass increase over B-doubles, resulting in 26% fewer trips for the same freight task.

¹³ "B-triple ready" B-double routes are B-double routes that are classed as suitable for B-triple operation, which may be subject to infrastructure upgrades as deemed necessary by the road authority.

Table 5. Mass-constrained productivity analysis

	B-triple	A-double	B-double	Semi-trailer
Gross Combination Mass at General Mass Limits (tonnes)	82.5	79.0	62.5	42.5
Payload mass (tonnes)*	52.44	47.77	38.93	24.13
Number of trips required to transport 1,000 tonnes	19.1	20.9	25.7	41.4

* Payload mass values are industry averages (Australian Trucking Association 2010)

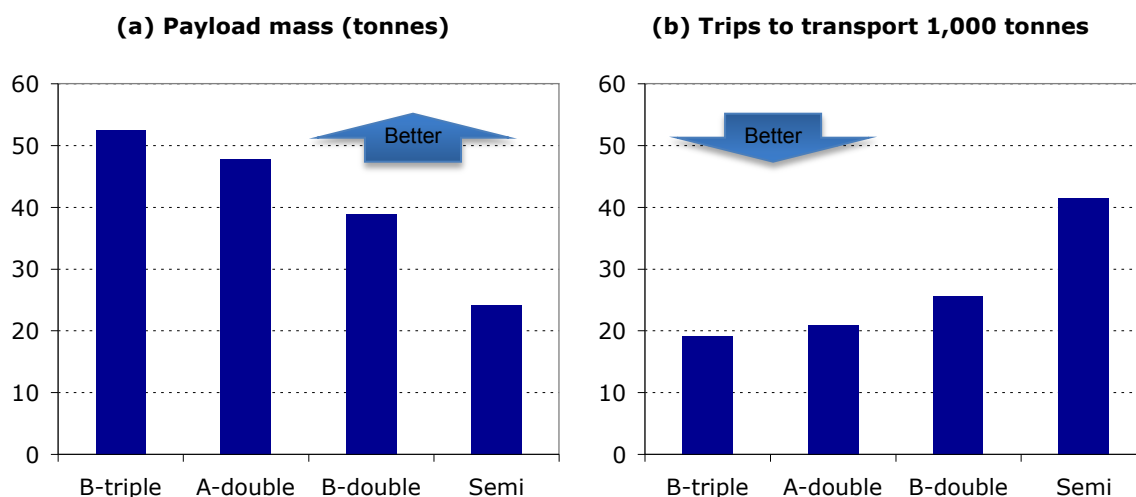


Figure 17. Mass-constrained productivity analysis

6.3 Volume-constrained freight

Volume-constrained freight is freight of such low density that it can completely fill the volume available for freight without the vehicle reaching its maximum permitted mass. Examples of volume-constrained freight include consumer products such as whitegoods and electronics. When analysing vehicle productivity for volume-constrained freight the important parameter is the available volume of the vehicle.

Table 5 presents the results of a volume-constrained productivity analysis for the four vehicle configurations discussed. The analysis shows that:

- **For operation on road train routes**, B-triples offer a 5% payload volume increase over A-doubles, resulting in 4% fewer trips for the same freight task.
- **For operation on B-double routes**, B-doubles formed from B-triples offer a 55% payload volume increase over semi-trailers formed from A-doubles, resulting in 35% fewer trips for the same freight task.
- **For operation on a future extended national B-triple network**, B-triples offer a 35% payload volume increase over B-doubles, resulting in 26% fewer trips for the same freight task.

Table 6. Volume-constrained productivity analysis

	B-triple	A-double	B-double	Semi-trailer
Payload volume (pallets)*	46	44	34	22
Number of trips required to transport 1,000 pallets	21.7	22.7	29.4	45.5

* The analysis is based on palletised freight for ease of calculation. It assumes standard 12-pallet lead trailers and standard 22-pallet tag trailers. Modular B-triples may in fact be able to use at least one 14-pallet lead trailer for further increased productivity.

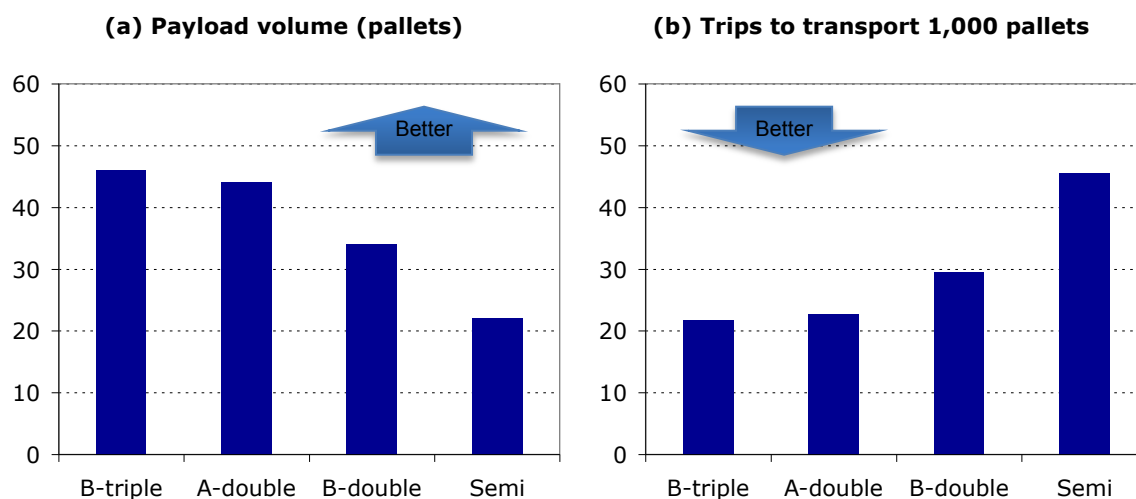


Figure 18. Volume-constrained productivity analysis

7. Safety analysis

B-triples are generally safer than conventional A-doubles because of their improved on-road dynamics, which is largely a product of their fully roll-coupled trailer configuration. This section presents the key findings of an analysis undertaken to quantify the level of safety of B-triples. The safety analysis used well-established PBS assessment techniques based on computer simulation of on-road vehicle dynamics. The objective was to examine the safety performance of a wide range of modular B-triple configurations that could be assembled from B-double equipment by comparing their performance in a range of PBS tests with two independent benchmarks:

- the performance levels defined in each of the PBS standards, where Level 3 corresponds with the Type I road train network and Level 2 corresponds with the B-double network
- the performance of a conventional A-double subjected to the same PBS tests.

The approach to interpreting the results of the tests was two-fold:

- Where B-triple performance was found to be consistent with a PBS standard at Level 3 (or indeed Level 2 or better), this was considered to be an indicator of acceptable performance by the B-triple
- Where performance was not consistent with a PBS standard at Level 3 or better, performance was considered to be acceptable if it was equal to or better than that of the corresponding conventional A-double benchmark.

Accordingly, if potential B-triple configurations under the proposed modular approach were found to meet at least one of the performance benchmarks in each test, it could be considered that prescriptive modular B-triples offer a sufficient level of on-road safety without the need to impose a more burdensome PBS approval framework.

Also included in the safety analysis was a representative 'non-modular' 36.5-metre B-triple for each commodity or body type. These B-triples do not meet the requirements of a modular B-triple but are presently operating on many parts of the Type I road train network.

The safety analysis was conducted by ARRB Group Ltd and was documented in a detailed report (Bucko, Germanchev & Eady 2011). This section presents the key findings of that report.

The safety analysis demonstrated that, in general, modular B-triples significantly exceed the safety benchmarks set by the PBS levels and the conventional A-double's performance. The PBS Level 3 benchmark corresponds with the Type I road train network; modular B-triple performance is in some aspects up to the benchmarks for Level 2 (corresponding with B-double routes) and Level 1 (corresponding with General Access). Modular B-triples demonstrate a quantum improvement in performance over the A-double, particularly during highway travel.

7.1 Parameters of the analysis

7.1.1 Commodities and body types

The analysis considered B-triples designed for the following commodity or trailer body types, considered to be representative of the vast majority of potential B-triple operations:

- general freight
- refrigerated freight
- bulk commodities (including both high-sided and low-sided tipper bodies for carrying low-density and high-density bulk freight respectively)
- liquid commodities (road tankers)
- livestock.

7.1.2 Representative prime movers, lead trailers and tag trailers

In consultation with the Australian Trucking Association, the Truck Industry Council and major prime mover and trailer manufacturers, the NTC compiled dimension specifications of representative prime movers, lead trailers and tag trailers that are currently in use and being sold in Australia for B-double operation, and that would also be potentially suitable for B-triple operation according to the modular approach. The key dimensions of each vehicle unit define the locations of axles, coupling points and body extremities. Table 7 sets out the number of prime movers, lead trailers and tag trailers for which details were obtained for each commodity or trailer body type, and the total number of possible B-triple combinations that can be assembled from those vehicle units. Dimension details of the individual vehicle units are available in the ARRB report.

Table 7. Vehicle units considered in the safety analysis

	Number of prime movers (PM)	Number of lead trailers (LT)	Number of tag trailers (TT)	Number of possible B-triple combinations (PM*LT*LT*TT)
General freight	30	12	15	64,800
Refrigerated freight		7	8	11,760
Bulk commodities (including both high-sided and low-sided tipper bodies for carrying low-density and high-density bulk freight respectively)	7	4	4	448
Liquid commodities (road tankers)	19	4	8	2,432
Livestock	8	3	3	216
Total units	64	30	38	79,656

7.1.3 Resultant B-triple combinations

Not every combination of prime mover, lead trailer and tag trailer will form a complying modular B-triple, as there are requirements for overall length, B-double compatibility, kingpin-to-rear dimension and the bridge formula. The many vehicle units considered by this study were hypothetically assembled into an exhaustive list of 79,656 potential B-triple combinations and checked against the modular B-triple dimensional requirements to determine which combinations were in fact complying modular B-triples. This eliminated many of the potential combinations from further examination.

Of those combinations that did satisfy all of the requirements, a worst-case subset was then selected for analysis in the PBS tests, as it was neither feasible nor particularly informative to test every remaining combination.

7.1.4 B-triple combinations selected for safety analysis

The B-triple combinations selected for the safety analysis are:

- **Generic:** Those combinations having typical dimensions and considered to be most suitable within the pool of potential combinations. The overall length range is approximately 32.5 to 33.5 metres depending on the commodity or body type.
- **Short prime mover:** Same as the generic but with a short prime mover (i.e. those with the smallest sum of front overhang, wheelbase and fifth wheel position). The overall length range is approximately 31.8 to 33.3 metres depending on the commodity or body type.
- **Long prime mover:** Same as the generic but with a long prime mover (i.e. those with the largest sum of front overhang, wheelbase and fifth wheel position). The overall length range is approximately 33.0 to 34.0 metres depending on the commodity or body type.
- **Trailer axle groups forward and aft:** Same as the generic but with varied longitudinal placement of axle groups relative to coupling points.

- **Shortest combination:** Shortest combination that could be constructed from the range of individual vehicle units for each commodity or body type. The overall length range is approximately 31.1 to 32.6 metres depending on the commodity or body type.
- **Longest combination:** Longest combination that could be constructed from the range of individual vehicle units for each commodity or body type. The overall length range is approximately 33.0 to 35.0 metres depending on the commodity or body type.

The selected subset of combinations captures the extremes of both high-speed and low-speed dynamic performance within the scope of the safety analysis.

7.1.5 Benchmark A-double

A benchmark A-double was constructed for each commodity or body type from a prime mover and two semi-trailers (those used for the corresponding generic B-triple), and a tandem axle converter dolly with 5-metre drawbar length connecting the two trailers. In the next pages, Benchmark A-doubles are referred to as “Reference road trains”.

7.2 Analysis method

The B-triple vehicles and the benchmark A-double vehicles were all submitted to PBS tests to determine their performance against the following measures:

- **Driveline-related performance**
 - Startability
 - Gradeability
 - Acceleration Capability
- **Low-speed dynamic performance**
 - Low-Speed Swept Path
 - Frontal Swing
 - Tail Swing
 - Steer Tyre Friction Demand
- **High-speed dynamic performance**
 - Tracking Ability on a Straight Path
 - Static Rollover Threshold
 - Rearward Amplification
 - High-Speed Transient Offtracking
 - Yaw Damping Coefficient.

These tests are defined by the National Transport Commission (2007) and were approved by ATC as part of the Performance Based Standards Regulatory Package in October 2007. They are recognised internationally as a vehicle safety analysis method best suited to the introduction of higher productivity vehicles on specific road networks.

7.3 Analysis results

7.3.1 Interpreting the results

The results of some of the low-speed and high-speed dynamic performance tests are presented in Figure 19 to Figure 24. Note that:

- There is one graph for each performance measure, with the vertical axis quantifying that measure.
- A green arrow in the top left corner indicates whether it is better to achieve a higher value or a lower value for that measure.
- The background shading indicates the performance required to meet the PBS standard. Some standards have various performance levels.
- Colour-coded vertical bars representing vehicle performance results for each B-triple variant are grouped by commodity or body type. The black bar in each group represents the non-modular 36.5-metre B-triple and should not be considered when examining modular B-triple performance.
- The horizontal lines indicate the reference A-double benchmark for each commodity or body type.

7.3.2 Driveline-related performance

Modular B-triples were found to demonstrate good performance in the driveline-related PBS tests, achieving PBS Level 2 performance in Startability and Gradeability (Part A) and PBS Level 3 performance in Gradeability (Part B) and Acceleration Capability.

The critical test in the assessment of driveline performance was Gradeability (Part B): Speed on a 1% grade. It was determined that an engine power output of at least 500 HP is required to ensure that a modular B-triple can maintain a speed of at least 70 km/h on a 1% grade, which is the speed required to meet both PBS Level 2 and PBS Level 3. This power output includes a conservative 5% safety margin to account for the fact that the analysis did not consider every possible combination of available gearboxes and final drive ratios.

7.3.3 Low-speed dynamic performance

Of the four low-speed dynamic performance tests, Low-Speed Swept Path is the most important in the context of this study. Low-Speed Swept Path determines whether a vehicle will be able to make a turn at an intersection without the rear trailer cutting in too much. Performance is influenced by the action of fifth wheel couplings (or 'B' couplings). These increase the swept path width in comparison with drawbar couplings (or 'A' couplings) of the type used in A-doubles.

The results of the analysis are presented in Figure 19. In general the swept path width of the modular B-triples was approximately 0.5 to 1.2 metres greater than that of the reference A-doubles, but still within the PBS Level 3 envelope of 10.6 metres. There was only one modular B-triple variant that fell outside of the PBS envelope, albeit by a small amount—the 'longest combination' tanker. The non-modular 36.5-metre B-triples (black bars) exhibited swept path width close to, and sometimes slightly outside, the PBS envelope. In summary, the swept path width of modular B-triples is regarded as acceptable by PBS standards, and considerably better than that of the non-modular 36.5-metre B-triples that currently operate on Type I road train routes.

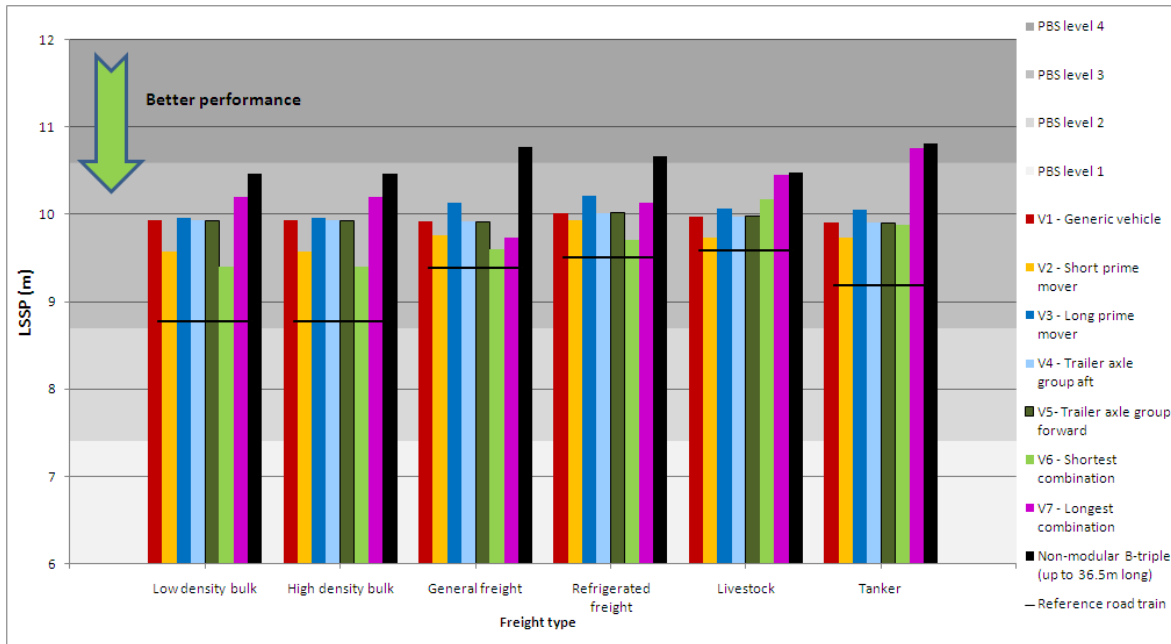


Figure 19. Results for Low-Speed Swept Path

For the remaining measures related to low-speed dynamic performance (Frontal Swing, Tail Swing and Steer Tyre Friction Demand), the B-triple demonstrated performance well within the limits set by the PBS standards.

7.3.4 High-speed dynamic performance

High-speed dynamic performance of the modular B-triples was found to be excellent on all measures except Static Rollover Threshold in the case of livestock transport. However, the performance of the modular B-triples of all freight types was considerably better than that of the corresponding reference A-double, no doubt because of trailer roll-coupling. In fact, the modular B-triples had a Static Rollover Threshold around 0.01 to 0.02 g better (up to 5% better) than the A-doubles across the board (Figure 20). Modular B-triples therefore offer a significant improvement in Static Rollover Threshold and a corresponding reduction in the risk of rollovers.

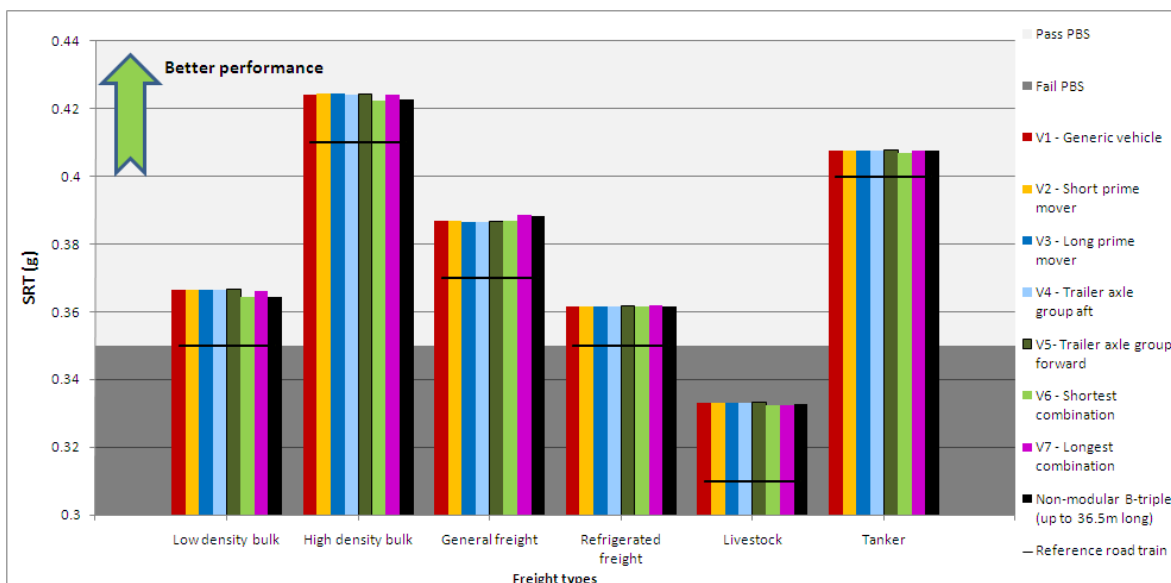


Figure 20. Results for Static Rollover Threshold

Tracking Ability on a Straight Path of the modular B-triples was typically around 50 mm narrower (better) than that of the reference A-doubles, and was within the PBS Level 2 envelope for all freight types (Figure 21). This means that modular B-triples will require less lane width than conventional A-doubles, and will, on this measure alone, be suitable for operation on B-double routes.

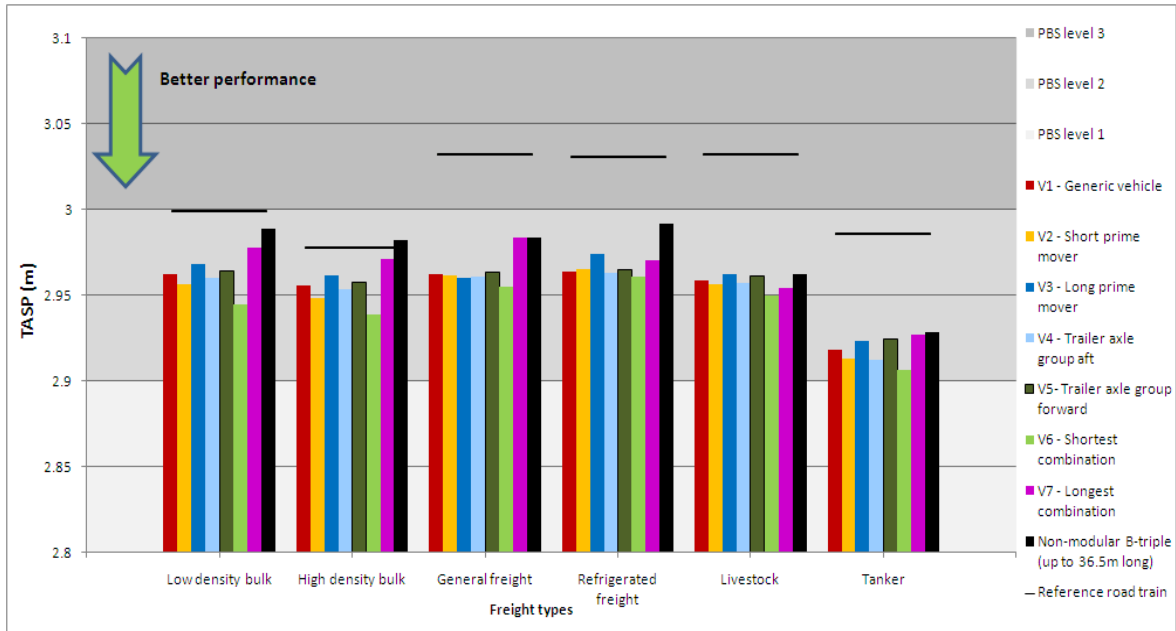


Figure 21. Results for Tracking Ability on a Straight Path

Rearward Amplification of the modular B-triples was less than half that of the reference A-doubles, primarily because of trailer roll-coupling (Figure 22). This means that even a severe steering motion, such as an emergency avoidance manoeuvre, is much less likely to cause a B-triple to roll over than to cause the rear trailer of an A-double to roll over.

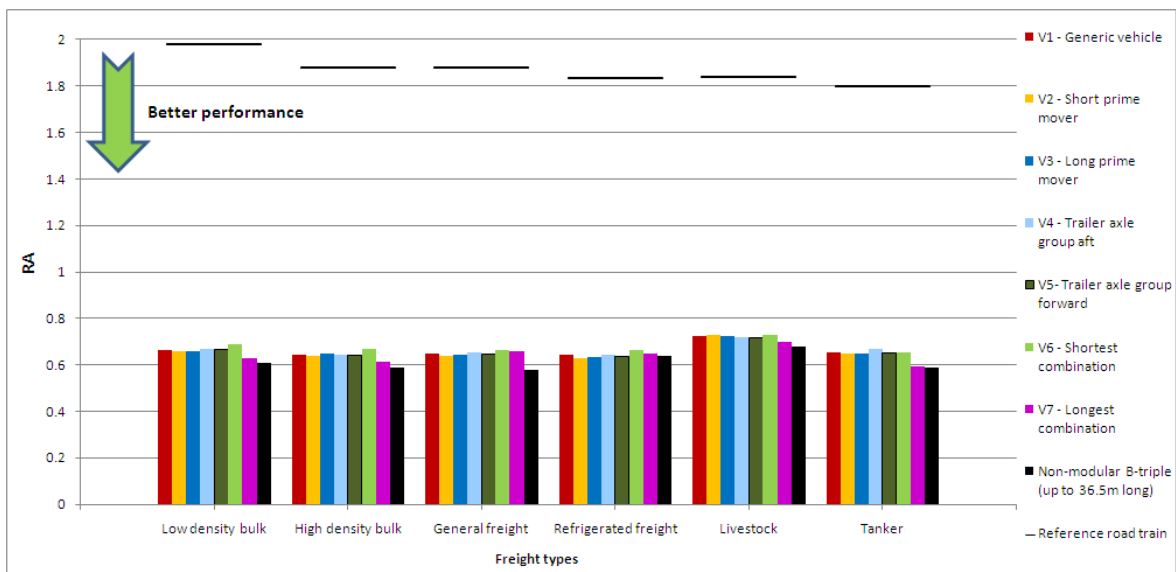


Figure 22. Results for Rearward Amplification

High-Speed Transient Offtracking was 0.2 to 0.3 metres less (better) than that of the reference A-doubles, and was within the PBS Level 1 envelope, the level of performance that even some common General Access vehicles cannot achieve (Figure 23). This means that during a severe steering motion, such as an emergency avoidance manoeuvre, a modular B-triple will experience much less rear trailer swing-out than an A-double (and even some General Access vehicles).

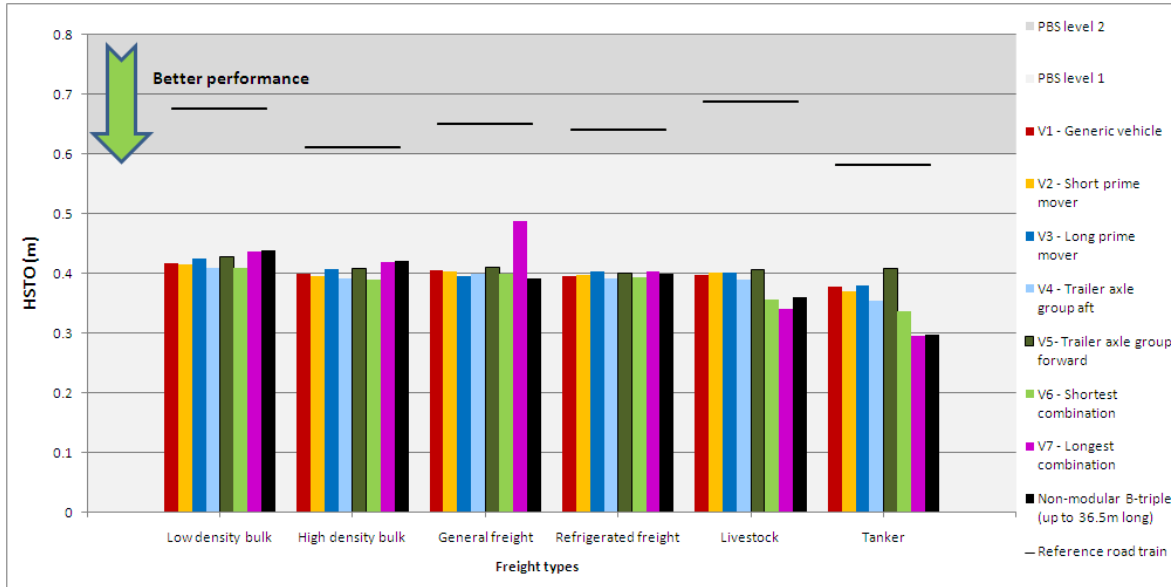


Figure 23. Results for High-Speed Transient Offtracking

Yaw Damping Coefficient of the modular B-triples was much better than that of the reference A-doubles, and well within the PBS envelope (Figure 24). This means that a modular B-triple is better than an A-double at settling down after a disturbance has caused the rear trailer to swing from side-to-side.

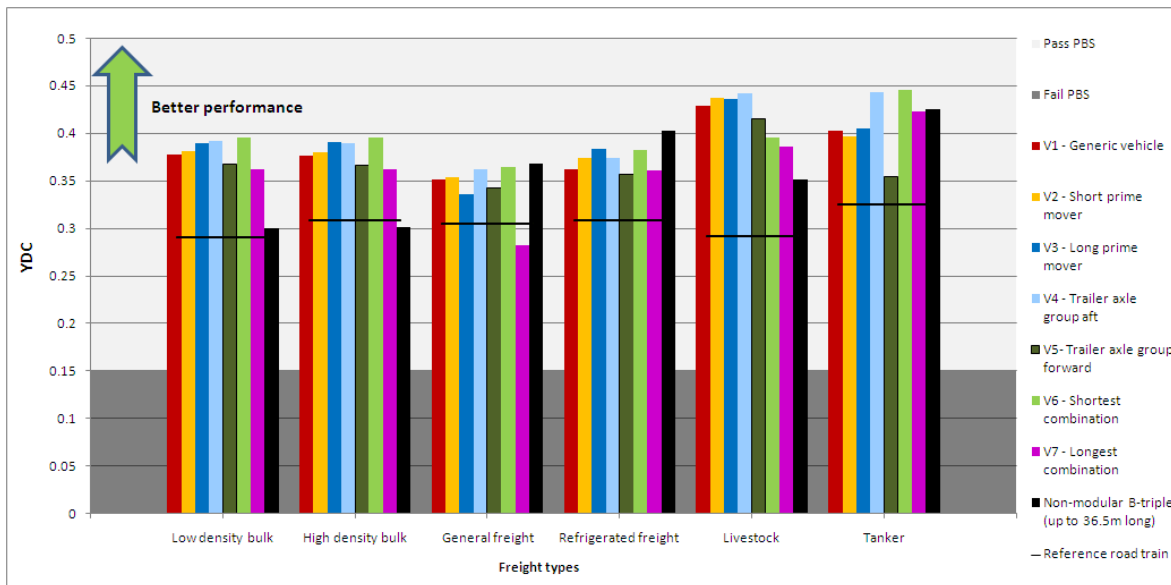


Figure 24. Results for Yaw Damping Coefficient

7.4 Summary of key points

The following key points were drawn out by the safety analysis:

- Modular B-triples will generally be between 31.0 and 35.0 metres long, with a typical range being 32.5 to 33.5 metres.
- Modular B-triples will have driveline performance that meets PBS Level 3, where PBS Level 3 is applicable to the Type I road train network. This means that modular B-triples will not be at risk of slowing traffic down any more than is acceptable on the Type I road train network.
- Modular B-triples will have swept path performance that meets PBS Level 3 and is less than that of non-modular 36.5-metre B-triples that presently operate on all Type I road train routes in most road train jurisdictions.
- Modular B-triples will have improved rollover stability in comparison with conventional A-doubles, which presently have access to the entire Type I road train network.
- Modular B-triples will have vastly better performance than A-doubles in other aspects of high-speed dynamic performance, as well as meeting PBS standards in excess of the level required for operation on the Type I road train network.

It follows that, from a safety perspective, modular B-triples should be able to access at least the entire national Type I road train network and should be encouraged to gain access to a much broader network as routes are appropriately upgraded. There is no safety-based reason presented in this analysis that supports withholding access for modular B-triples to any part of the Type I road train network if that network is presently open to A-doubles (as A-doubles have less favourable safety performance than modular B-triples).

8. Infrastructure impact analysis

The effects of modular B-triples on the infrastructure are examined by separate analyses of pavement loading and bridge loading.

8.1 Pavement loading analysis

8.1.1 Standard Axle Repetition (SAR) approach

Pavements have been empirically proven to progressively wear out over time due to the repeated passing of laden heavy vehicles. The amount of wear that develops can be estimated using the Standard Axle Repetition (SAR) approach. The SAR approach considers that one unit of pavement wear is the amount of wear caused by one pass of a standard axle, being a single axle with dual tyres that is laden to 80 kN (8.16 tonnes). According to Austroads (2001) the amount of wear caused by one pass of a vehicle with various axle group types laden to various axle group loads is equal to the wear caused by an equivalent number of passes of a standard axle (i.e. standard axle repetitions, or SAR) using the formula:

$$SAR = \sum_{i=1}^m (L_i / SL_i)^n \quad (\text{Eqn. 7a})$$

where:

L_i = load carried by axle group type i in tonnes

SL_i = standard load for axle group type i in tonnes (see Table 8)

n = pavement wear exponent, which may vary from 4 to 12 depending on the pavement distress type (see Table 9)

m = number of axle groups on the vehicle.

Table 8. Standard load by axle group type

Axle group type	Standard Load (tonnes)
Single axle with single tyres (SAST)	5.40
Tandem axle with dual tyres (TADT)	13.77
Triaxle with dual tyres (TRDT)	18.46

Source: Austroads (2011) – relevant axle groups only

Table 9. Pavement wear exponent by pavement distress type

Pavement distress type	Pavement wear exponent
Overall wear of sprayed seal surfaced unbound granular pavements	4
Asphalt fatigue wear to asphalt surfaced pavements	5
Rutting and loss of shape of flexible pavements with bound layers	7
Cemented materials fatigue wear of flexible pavements that include bound cemented materials	12

Source: Austroads (2011)

Jameson (2002) reported that around 84% of Australia's sealed roads are constructed from unbound granular pavements with thin bituminous surfacings or overlays. When considering only roads outside built-up areas (i.e. roads that would be used by B-triples), the proportion of roads constructed in this way will be much higher. This road construction is therefore considered to be

representative of the sealed roads on which B-triples will operate, and a pavement wear exponent of 4 is therefore appropriate. There is comparatively little research into pavement wear exponents for unsealed roads, partly because of the different array of materials and distress types for unsealed roads, although a pavement wear exponent of 4 is often used for unsealed road thickness design.¹⁴ For the purpose of this analysis it is therefore appropriate to use a pavement wear exponent of 4 as being representative of both the sealed and unsealed roads on which B-triples will operate. Note that calculating Standard Axle Repetitions using a pavement wear exponent of 4 is often referred to as calculating Equivalent Standard Axles (or ESAs).

Table 10 presents the results of a pavement wear analysis using the SAR approach. It can be determined from the analysis results that:

- **For operation on road train routes**, B-triples produce 16% less pavement wear than A-doubles for the same freight task.
- **For operation on B-double routes**, B-doubles formed from B-triples produce 21% less pavement wear than semi-trailers formed from A-doubles for the same freight task.
- **For operation on a future extended national B-triple network**, B-triples produce 10% less pavement wear than B-doubles for the same freight task.

Table 10. Pavement wear analysis based on the SAR approach

Loading	B-triple	A-double	B-double	Semi-trailer
	ESAs per vehicle pass			
Laden	7.72	8.40	6.34	4.96
Unladen	1.15	1.19	1.13	1.14
	ESAs per 1,000 tonnes by proportion of distance travelled fully laden			
Full one way, empty the other (50%)	169	201	192	253
Always full (100%)	147	176	163	206

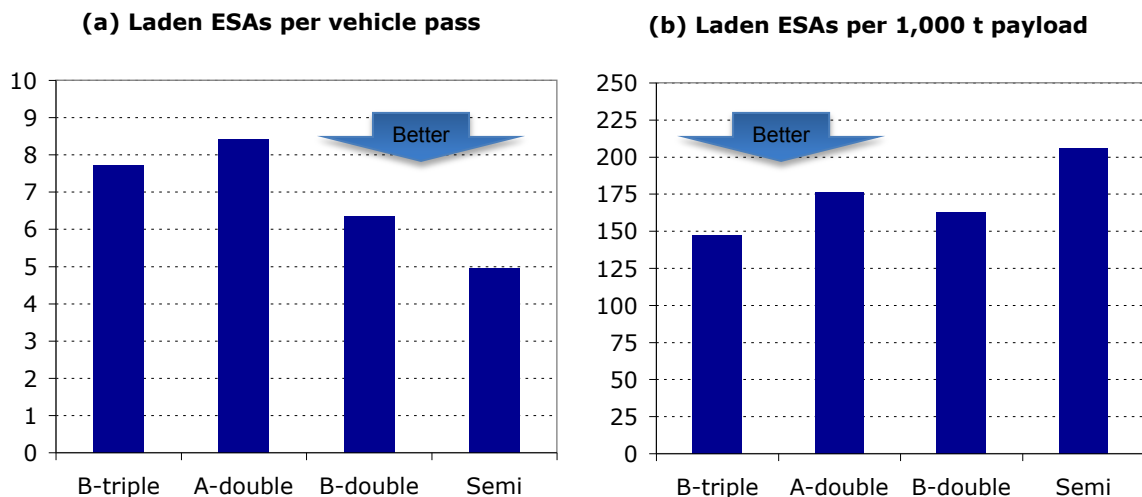


Figure 25. Pavement wear analysis based on the SAR approach

¹⁴ Richard Yeo, General Manager Research and Development, ARRB Group Ltd, email communication 3 June 2011.

8.1.2 Performance Based Standards (PBS) approach

The proposed prescriptive modular B-triple mass limits are in agreement with the current interim PBS Pavement Vertical Loading Standard, which constrains axle group loads to within current prescriptive limits and places no independent constraints on Gross Combination Mass.

8.1.3 Austroads ‘ESA Green Line’ approach

Austrroads (2011) has proposed an alternative to the PBS Pavement Vertical Loading Standard, known as the ‘ESA Green Line’ approach. This approach has not been endorsed by the NTC as it has not been subjected to a public impact assessment. Further, the industry has voiced concerns about how the approach limits some new vehicles to less mass than existing vehicles.

Despite its lack of national endorsement and formal status in the regulations, one road authority (SA) relies on the ESA Green Line approach to assist them with road access decisions for some vehicle types, hence its inclusion in this pavement wear analysis.

The ESA Green Line approach finds that a vehicle demonstrates acceptable pavement wear if its total ESA value is less than that calculated by the following equation:

$$ESA = 1.88 + 0.0877GM \tag{Eqn. 7b}$$

where:

ESA = number of Equivalent Standard Axles

GM = gross mass of the vehicle.

With a gross mass of 82.5 tonnes at General Mass Limits for B-triples, equation 7b yields 9.12. Since the actual ESA (7.72, see Table 10) is less than 9.12, the B-triple satisfies the ESA Green Line requirement (Figure 26).

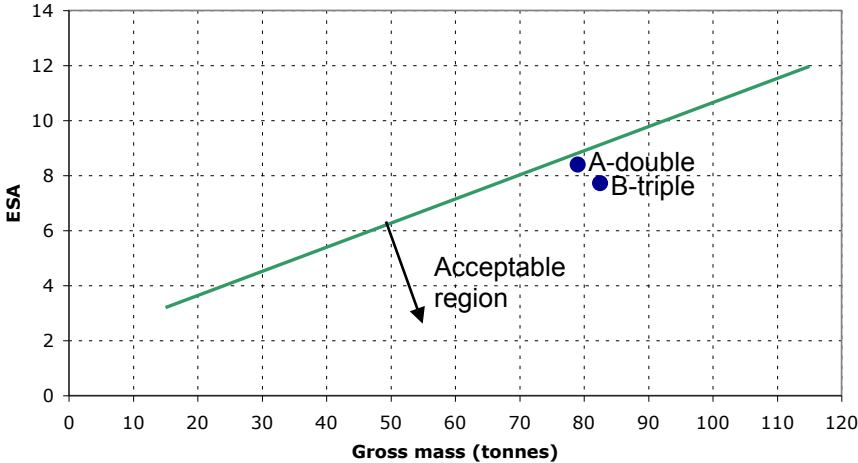


Figure 26. B-triple on the ESA Green Line chart

8.2 Bridge loading analysis

This regulatory proposal includes an initial step of granting modular B-triple access to a national B-triple network that includes the entire Type I road train network. The Type I road train network is commonly associated with A-double road trains at 79.0 tonnes General Mass Limits, but it is now open to B-triples at 82.5 tonnes General Mass Limits on almost all routes.¹⁵ Road authorities have suggested that some Type I road train routes may not be suitable for modular B-triples because of insufficient bridge capacity, but this hypothesis has yet to be fully tested.

Firstly, although B-triples are slightly heavier than A-doubles, they will not necessarily induce greater structural effects in all bridges. This is because bridge loading depends on the distribution of load to the vehicle's axles and the spacing of the vehicle's axles relative to the dimensions of the bridge spans. Secondly, if B-triples do induce greater effects under certain circumstances, this does not necessarily mean that bridge capacity will be exceeded.

This section presents a bridge loading analysis that characterises the effects of B-triples operating at General Mass Limits and Concessional Mass Limits on a wide range of bridges. The assessment draws from the methodology proposed by Woodrooffe et al. (2010).

8.2.1 Capacity approach versus reference vehicle approach

The assessment of bridge loading due to heavy vehicle use is a complex matter that can be addressed using various approaches. One approach, known as the capacity approach, compares the calculated effects due to the passing of a given vehicle over a given bridge with the known capacities of that bridge. The capacity approach is very data-intensive and is normally conducted only for very heavy load movements over a small number of bridges, where a very detailed assessment is required and all of the required engineering data is available.

When conducting network-level analyses for common freight vehicles to access hundreds or thousands of bridges it is not feasible to use such a data-intensive method. In such cases the preferred approach, known as the reference vehicle approach, compares the calculated effects due to the passing of a given vehicle over a given bridge with the calculated effects due to the passing of another vehicle for which the bridge has previously been approved as suitable. One shortcoming of the reference vehicle approach is, of course, that it does not consider bridge capacity, so if the given vehicle imposes greater effects than the reference vehicle on a certain type of bridge, this does not necessarily mean that the bridge capacity has been exceeded. If the reference vehicle approach finds cases where the given vehicle's effects exceed those of the reference vehicle, a capacity analysis may indicate that the affected bridges are in fact able to support the load.

Due to the nature of this regulatory proposal, which is not required to address a specific bridge or a particular kind of bridge, it is appropriate to adopt a reference vehicle approach in analysing bridge loading. If certain effects are shown to be greater for the B-triple on certain types of bridges, it is up to bridge owners to determine whether individual bridge capacity is exceeded, and not to simply refuse access to those bridges.

8.2.2 Reference vehicle

A bridge is designed for the passage of a loaded vehicle as designated in a bridge design code. The design code specifies maximum stresses that can be resisted by key bridge elements, including the main girders or beams and the supports or piers. The maximum stresses depend on the materials used to construct the bridge.

In response to a request from the National Road Transport Commission (NRTC) for a consistent set of rules to be used for assessing the load capacity of bridges throughout Australia, in 1997 the Austroads Bridge Assessment Group (ABAG) issued *Guidelines for Bridge Load Capacity Assessment*. Issue 3 of the guidelines proposed typical live loads (truck configurations) to be used as reference vehicles. These included a six-axle articulated vehicle, a nine-axle B-double and a double road train. The double road train configuration, of interest to this study, is represented in 0.

¹⁵ New South Wales is the exception, with many of its Type I road train routes not currently open to B-triples.

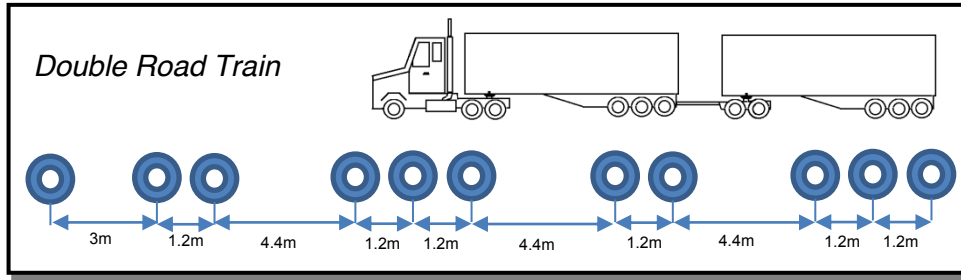


Figure 27. ABAG double road train loaded at GML (Austroads 1997)

The ABAG double road train loaded to General Mass Limits (Gross Combination Mass of 79.0 tonnes) will serve as the reference vehicle for this analysis.¹⁶ It should be noted that the axle spacing of the ABAG double road train can vary depending on the situation, but for this assessment performed at General Mass Limits, the 4.4 metre spacing is appropriate.

8.2.3 Structural effects examined

Following a consultation workshop held at the NTC on 12 May 2011, it was agreed to assess the impact of B-triples on bridges using beam analysis. The structural effects to be included in this assessment were (Figure 28):

- **reaction forces** acting upwards on beams from piers and abutments
- **shear forces** at various points along a beam
- **bending moments** at various points along a beam. Bending moments will be positive ('sagging') if the bridge has simply-supported spans, but may be either positive ('sagging') or negative ('hogging') if the bridge has spans that run continuously over a pier.

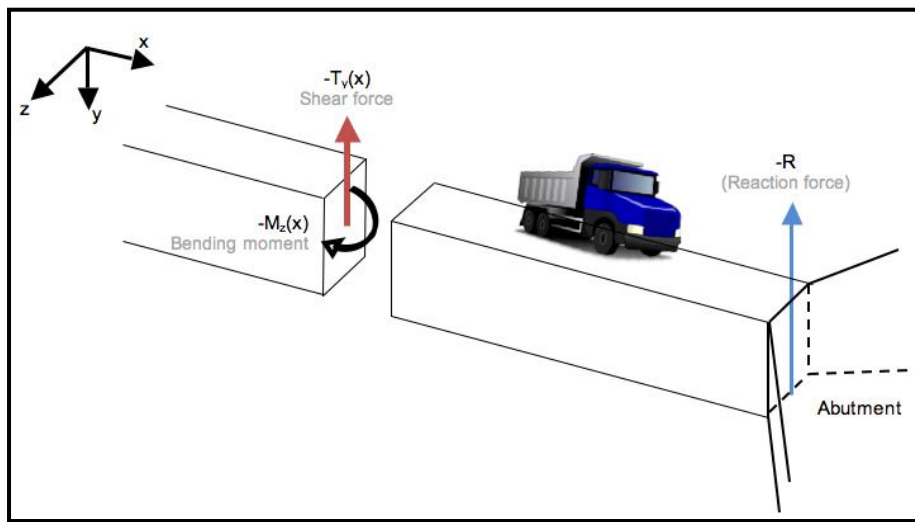


Figure 28. Reaction force, shear force and bending moment

Reaction forces, shear forces and bending moments under rolling loads (i.e. moving heavy vehicles) vary considerably as the vehicle rolls along, and each one typically reaches a peak at

¹⁶ ABAG Issue 3 was not used in Queensland, so 'Shortest Type I road train' is an alternative term that is more appropriate in the Queensland context.

some point during the vehicle's travel across the bridge. In this analysis, effects are calculated for a multitude of vehicle positions (every 5 centimetres) as it rolls from one end of the bridge to the other. The value of each effect is obtained by adding the value calculated for each individual axle load using the principle of superposition.

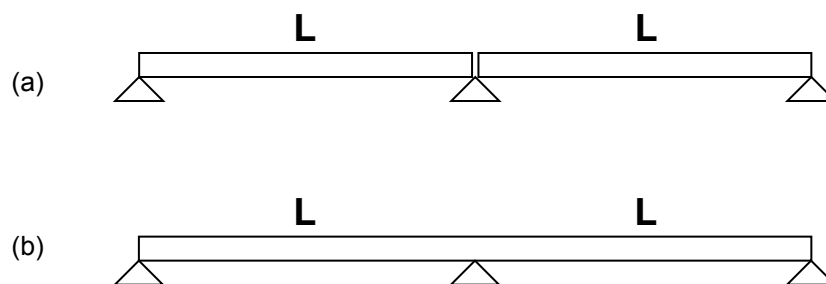
8.2.4 Span types

In consultation with road authority bridge engineers, it was agreed that the analysis would consider both:

- 2-span simply-supported bridges with equal span lengths
- 2-span continuous bridges with equal span lengths.

The span lengths to be examined were 5 metres to 50 metres in increments of 0.05 metres.

Single-span bridges were not examined separately because they are effectively examined as part of the analysis of the 2-span simply-supported bridges. It may have been desirable to also examine 3-span continuous bridges with unequal span lengths. This is a much more complex task (which would have required agreement between jurisdictions on the span length ratios used to model 3-span continuous bridges) and in any case was considered unnecessary for the purpose of this regulatory proposal. Figure 29 illustrates the two bridge types examined.



**Figure 29. Two-span bridges with equal span lengths:
(a) simply-supported, and (b) continuous**

8.2.5 Vehicles

The vehicles used for the analysis were all loaded to General Mass Limits and included:

- ABAG double road train (the reference vehicle)
- generic general freight modular B-triple
- shortest general freight modular B-triple
- longest general freight modular B-triple.

The general freight modular B-triples (generic, shortest and longest) are each defined in Section 7—they are based on actual vehicle data obtained from the industry.

8.2.6 Results of the analysis

For each of the examined effects (reactions, shear forces and bending moments), magnitudes are presented in plots as percentage differences relative to those of the ABAG double road train. The ABAG double road train effects are therefore zero in all cases and do not need to be plotted. Positive percentages indicate that the modular B-triple induces effects that are greater by that percentage, and *vice versa*.

2-span simply-supported bridges with equal span lengths

The analysis found that the effects of modular B-triples are in all cases less than or equal to those of the ABAG double road train, as indicated by Figure 30 to Figure 32. In some cases the B-triple effect is significantly less.

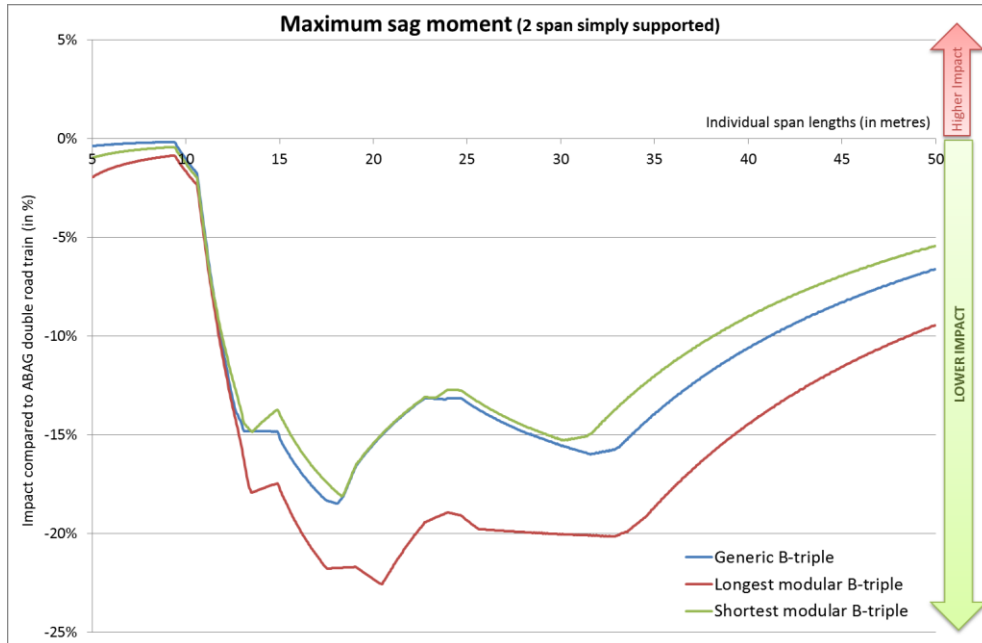


Figure 30. Maximum sagging moment

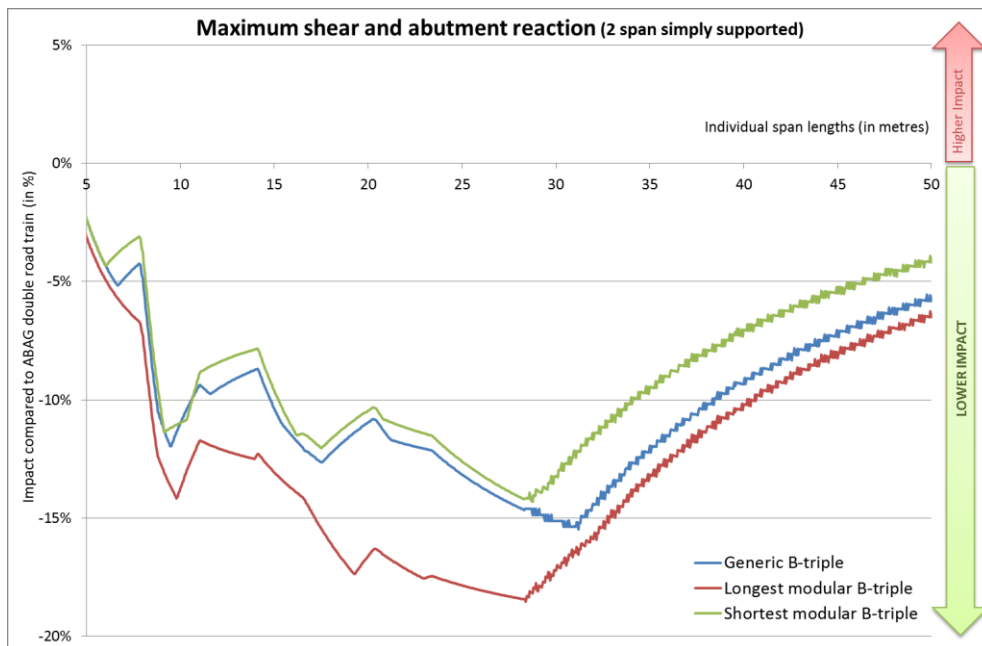


Figure 31. Maximum shear force (and abutment reaction)

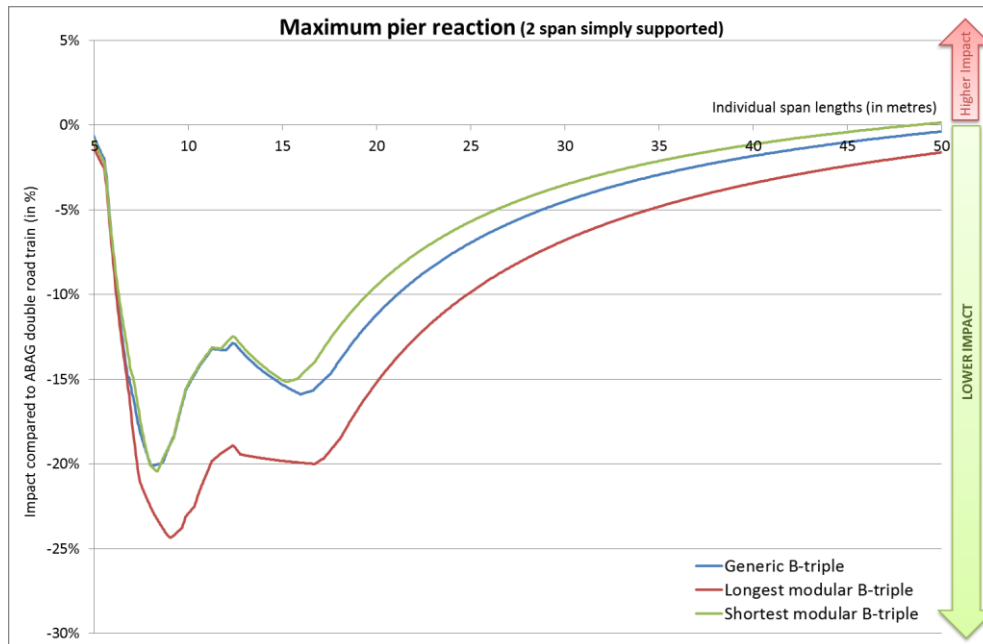


Figure 32. Maximum central pier reaction

Table 11 lists the numerical differences between the generic modular B-triple, the longest modular B-triple, the shortest modular B-triple and the ABAG double road train. With the exception of one small positive value (0.1%), all values are negative, indicating that the B-triple has a lower impact on the bridges examined.

Table 11. Summary of relative structural effects: 2-span simply-supported, modular B-triples vs. ABAG double road train

	Generic B-triple			Longest modular B-triple			Shortest modular B-triple		
	Maximum sagging moment	Maximum shear force and abutment reaction	Maximum central pier reaction	Maximum sagging moment	Maximum shear force and abutment reaction	Maximum central pier reaction	Maximum sagging moment	Maximum shear force and abutment reaction	Maximum central pier reaction
Minimum	-18.5%	-15.5%	-20.1%	-22.6%	-18.5%	-24.4%	-18.1%	-14.3%	-20.4%
Maximum	-0.2%	-2.3%	-0.4%	-0.90%	-3.1%	-1.5%	-0.4%	-2.3%	0.1%

The impact of modular B-triples on 2-span simply-supported bridges is less than that of the ABAG double road train.

2-span continuous bridges with equal span lengths

The analysis found that the effects of modular B-triples are in most cases much less than those of the ABAG double road train, but in some cases slightly more:

- Maximum sagging moment induced by the modular B-triples is less than that induced by the ABAG double road train for all spans (Figure 33).
- Maximum hogging moment induced by the modular B-triples is greater than that induced by the ABAG double road train for spans of 20 to 35 metres (Figure 34). The difference increases with vehicle length, with the longest modular B-triple inducing effects up to 16% greater (worst case). High hogging moments must be treated carefully as they can lead to the cracking of decking slabs.

- Maximum shear force induced by the modular B-triples is less than that induced by the ABAG double road train for all spans (Figure 35).
- Maximum abutment reaction induced by the modular B-triples is less than that induced by the ABAG double road train for all spans (Figure 36).
- Maximum central pier reaction induced by the modular B-triples is greater than that induced by the ABAG double road train for spans exceeding 33 metres (Figure 37). The worst B-triple reaction exceeds the ABAG double road train reaction by up to 2.2%.

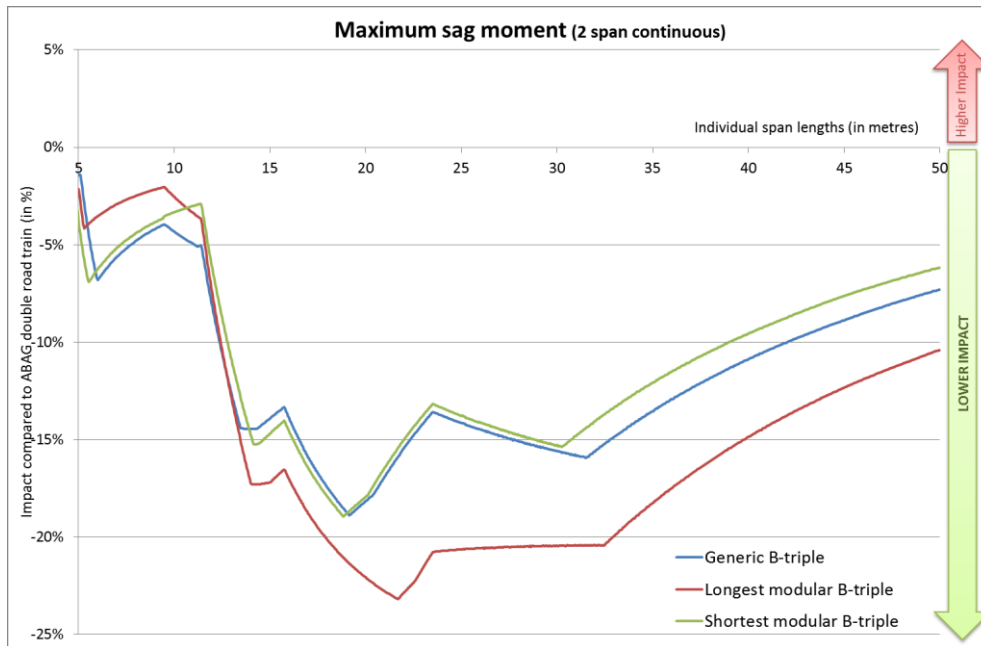


Figure 33. Maximum sagging moment

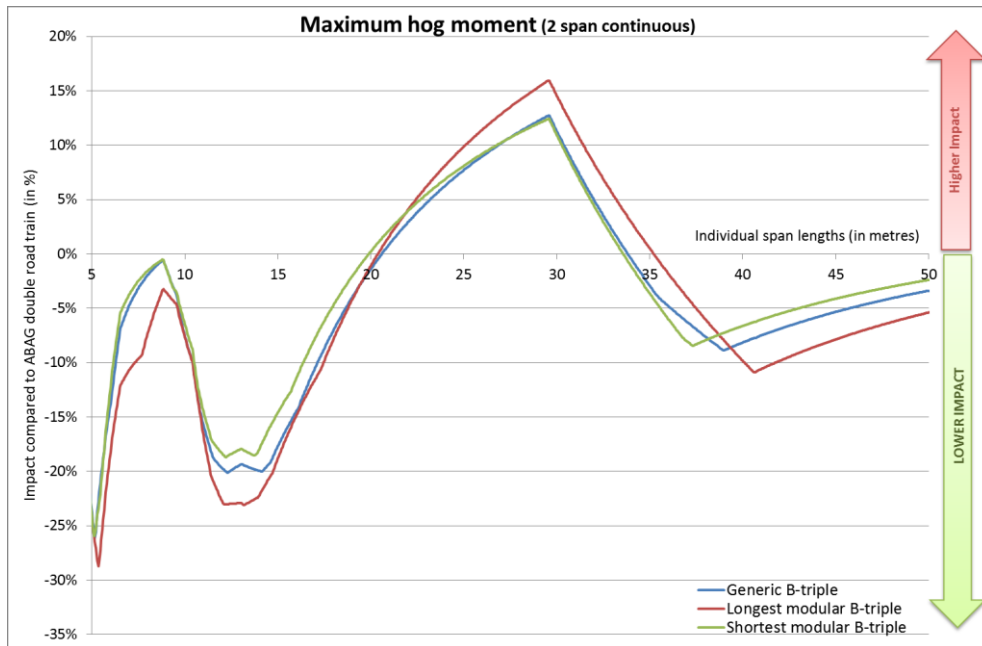


Figure 34. Maximum hogging moment

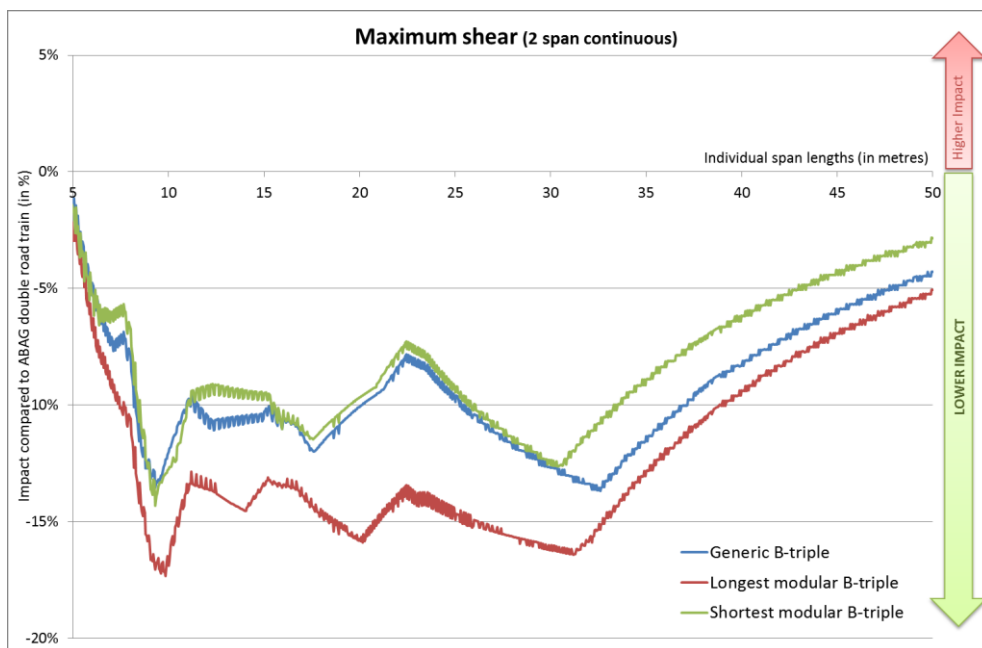


Figure 35. Maximum shear force

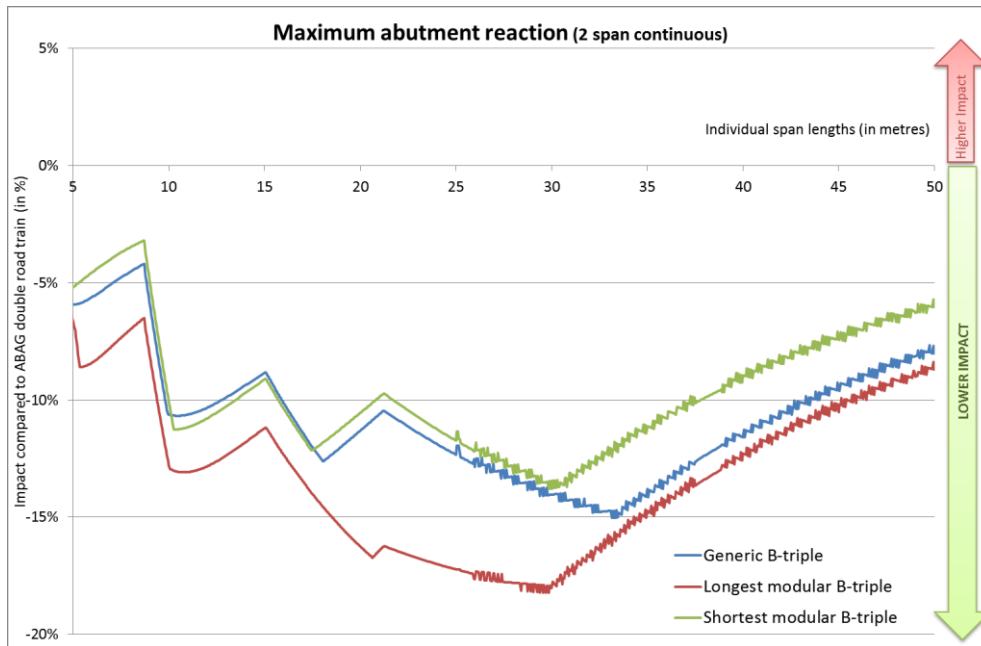


Figure 36. Maximum abutment reaction

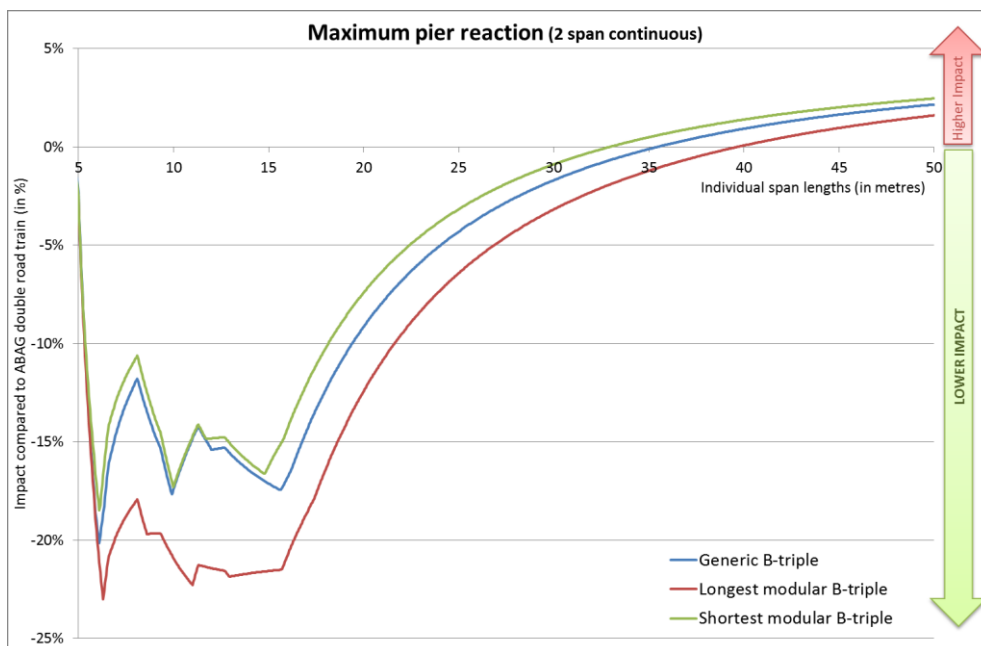


Figure 37. Maximum central pier reaction

Table 12 lists the numerical differences between the *generic* modular B-triple and the ABAG double road train. The shaded cells indicate the positive values, where effects are greater for the generic modular B-triple.

The impact of modular B-triples on 2-span continuous bridges is generally lower than that of the ABAG double road train. In a limited number of cases, the impact is higher. In the worst case, the longest modular B-triple induces 16% higher hogging moments in 2-span continuous bridges of about 30 metres span length.

Table 12. Summary of relative structural effects: 2-span continuous, modular B-triples vs. ABAG double road train

Generic modular B-triple	Maximum sagging moment	Maximum hogging moment	Maximum shear force	Maximum abutment reaction	Maximum central pier reaction
Minimum	-18.9%	-26.1%	-13.7%	-15.0%	-20.1%
Maximum	-1.4%	+12.7%	-1.1%	-4.2%	+2.2%

Longest modular B-triple	Maximum sagging moment	Maximum hogging moment	Maximum shear force	Maximum abutment reaction	Maximum central pier reaction
Minimum	-23.2%	-28.7%	-17.3%	-18.2%	-23.0%
Maximum	-2.1%	+15.9%	-2.2%	-6.5%	+1.6%

Shortest modular B-triple	Maximum sagging moment	Maximum hogging moment	Maximum shear force	Maximum abutment reaction	Maximum central pier reaction
Minimum	-19.0%	-25.9%	-14.3%	-13.8%	-18.5%
Maximum	-2.9%	+12.4%	-1.5%	-3.2%	+2.5%

In the vast majority of cases, the impact of B-triples on bridges is less than that of the ABAG double road train. In a very limited number of cases (particularly hogging moments in continuous spans between 20 and 35 metres), the impact of B-triples is higher than that of the ABAG double road train. In these cases the magnitude of the additional effect is limited to a maximum of 16% more. This does not necessarily mean that bridge capacities will be exceeded. Unless a specific bridge is considered inadequate by a bridge owner for particular reasons (e.g. on the basis of a bridge inspection and a special assessment of capacity), the calculation of structural effects detailed in this analysis confirms that bridges belonging to the Type I road train network are suitable for modular B-triple operations.

8.2.7 Concessional Mass Limits

Modular B-triples operating at Concessional Mass Limits (CML) have been considered and assessed as part of the bridge analysis. For CML loading, the mass of each axle group with the exception of the front axle of the prime mover is increased by 0.5 tonne. This applies to B-triples and double road trains, and increases the Gross Vehicle Mass of both vehicle configurations by 2.0 tonnes.

The minor increase in individual axle masses when operating at CML has minimal impact on the scale of structural effects in simply supported and 2-span continuous bridges. The bridge analysis found that for both bridge categories, CML loading increases the maximum structural effects by no more than 2.7% compared to the GML generic B-triple¹⁷.

Therefore, modular B-triples can operate at CML provided all CML requirements are satisfied.

¹⁷ In other words, the figures listed in the 'Maximum' row of Table 11 and 12 would increase by no more than 2.7 for CML loading. For instance, the maximum hogging moment for the generic B-triple at CML is 15.4% higher than the same moment due to the ABAG double road train while it is 12.7% higher for the generic B-triple at GML

9. Community acceptance

With any reform centred on the introduction of higher-productivity vehicles there is the potential for adverse reactions from some members of the community based on the misconception that higher-productivity vehicles are less safe. This was the case when B-doubles were first introduced 20 years ago, and B-doubles have since made an unquestionable contribution to road safety.

Although it is understandable that the public may express negative views about some aspects of B-triple operation, examining those aspects in detail shows that they are not necessarily cause for concern.

9.1 Public perceptions of road freight

In 2010 the NTC commissioned a survey of community attitudes to freight vehicles (Synovate 2010). The survey involved 1,500 people from five states, and included a mix of urban and regional participants. Of the top twelve identified major concerns while driving, listed in order of frequency within the sample, the survey found that large vehicles did not feature until the last three items on the list, and only 5% of respondents listed one of those three concerns as their number one concern (Figure 38).

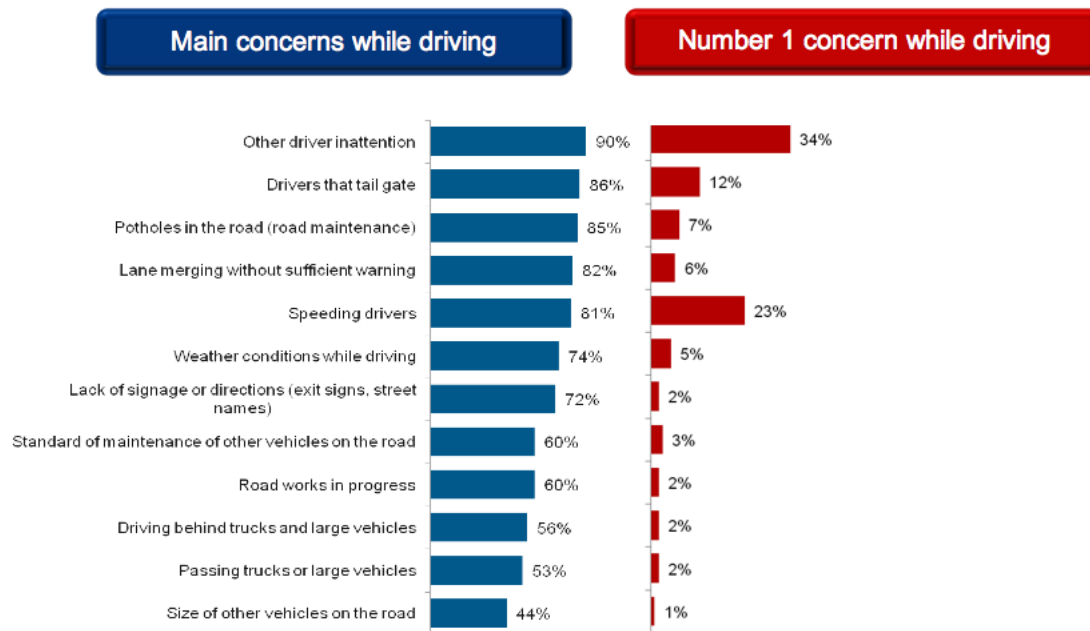


Figure 38. Hierarchy of public concerns while driving (Synovate 2010)

The survey found that:

In most cases, trucks are not a 'top of mind' concern to everyday drivers and less so for weekend drivers. Freight movement and its importance to the daily lives of Australians and the Australian economy is also not 'a top of mind' connection. While concern is raised over the number of vehicles (congestion/traffic flow) on the road, this is not solely related to the number of freight vehicles. Larger vehicles, a more common reference when discussing size of vehicle than the term 'truck', includes SUV/4WD vehicles, commercial/delivery vans, people carriers, cars towing caravans or trailers.

The survey found that the size of freight vehicles was not a key concern when driving compared with the way in which vehicles are driven. The size of other vehicles on the road rates very low and is only a top concern for 1% of respondents.

Given that people are generally more concerned with driver behaviour on the road than with the size of the vehicle, it is worth noting that modular B-triples will be driven by drivers who have been

qualified with a Multi-Combination (MC) license, which is the type of license required to drive anything from a B-double up to the largest road train. This is a higher level of qualification than the Heavy Combination (HC) license that is a minimum requirement for the drivers of semi-trailers and truck-trailers, or the lower categories of license required for various sizes of rigid truck.

The excellent trailer behaviour of modular B-triples will improve the experience of other road users when sharing the roads with them, especially when overtaking.

Key findings from a 2010 study commissioned by the NTC on the public perceptions of road freight show that the size of freight vehicles is not a key concern when driving compared with the way in which vehicles are driven.

9.2 Involvement of heavy vehicles in crashes

Aggressivity of heavy vehicles in crashes (i.e. the tendency for heavy vehicles to cause more damage to lighter vehicles and more severe injuries to light vehicle occupants) is another concern that is sometimes raised by car drivers when discussing increases in the size and mass of heavy vehicles. Knight et al. (2008) reported that beyond a certain heavy vehicle mass, a light vehicle becomes insensitive to further increases in mass:

As the ratio of the masses of the vehicles increases, the change in velocity sustained by the lighter vehicle as a fraction of the closing velocity quickly rises. In [heavy goods vehicle] to car impacts where the mass ratio is sufficiently large, physics dictate that the energy dissipated in a collision becomes insensitive to the mass of the truck – at mass ratios around 10:1 the smaller of the two vehicles sustains virtually all the change of velocity resulting from the collision. Current mass ratios in car-truck collisions are sufficiently large – mass ratios of up to 50:1 are possible – that there would be no perceptible increase in impact severity for the car were heavier goods vehicles allowed. However, this only holds true where there are no obstacles in the path of the car post-collision. If the car were to suffer a secondary collision with another heavy vehicle then the severity could be increased.

Despite having three trailers, modular B-triples are shorter than A-doubles (hence easier to pass) and will have the same number of axle groups and articulation points. Although marginally heavier, their mass is carried by more tyres in contact with the road and they are controlled by more brakes. Their trailers are connected in a way that increases stability, so they offer a substantial and quantifiable improvement in road safety from a number of perspectives, particularly rear trailer rollover, as demonstrated by PBS assessment.

Despite their potentially higher mass, the severity on car occupants of crashes in which B-triples may be involved will not be higher than that of crashes involving double road trains. Further, thanks to the productivity gains offered by B-triples, a reduction in the number of kilometres travelled by B-triples is expected to reduce the frequency of crashes involving heavy vehicles.

9.3 Overtaking time and intersection or level crossing clearance time

The length of a combination vehicle has effects on:

- the time required for other vehicles to overtake the combination vehicle on the open road
- the time required for the combination vehicle to pass through an intersection or railway level crossing.

This policy proposal is for 35 metre modular B-triples, having an overall length that is shorter than that of conventional 36.5 metre A-doubles and 36.5 metre B-triples. The consequence of this shorter overall length is improved safety in both of these areas.

Furthermore, the superior trailer performance of B-triples¹⁸ provides other road users with greater safety, especially when attempting to pass the combination.

¹⁸ As demonstrated in Section 7 (Safety analysis).

10. Cost-benefit analysis

A cost-benefit analysis was undertaken to estimate the savings that could be gained from national B-triple operation on the Type I road train network over the period from 2011 to 2030. As well as estimates of the reduction in vehicle numbers and vehicle-kilometres travelled, which result in direct financial savings to operators, estimates were made of the reduction in road fatalities and CO₂ emissions. These were then monetised and added to the direct financial savings.

The analysis was based on the assumption that B-triples will be used for some road train network operations that are currently undertaken using A-doubles and B-doubles, and that savings would come from not only the improvement in productivity when operating a B-triple on approved B-triple routes, but also the advantages of operating modular B-triple sub-configurations when travelling off approved B-triple routes (see examples in Section 2.3). The latter is believed to be potentially responsible for the majority of benefits over A-double operation until such time as the approved network is significantly more extensive than existing road train routes (e.g. includes key inter-capital corridors).

Once the B-triple network has been sufficiently expanded to incorporate the key inter-capital corridors—where there are currently no A-doubles operating—the benefits of B-triple operation on those approved B-triple routes in comparison with B-doubles and semi-trailers will be much greater.

The analysis was conducted by the Industrial Logistics Institute (ILI) and was documented in a detailed report (Hassall 2011). The key findings of the report are presented below.

10.1 Summary of findings

Assuming a scenario of median B-triple take-up, over the period from 2011 to 2030 the regulatory proposal based on Type I road train network access stands to offer:

- at least **1,000 fewer** heavy vehicles on the road
- at least **1 billion fewer** vehicle-kilometres travelled
- at least **25 fewer** road fatalities
- at least **1.1 million fewer** tonnes of CO₂ emissions
- total monetised savings of almost **\$1.1 billion** Net Present Value (NPV), of which **\$1 billion** derives from direct financial savings brought about by reduced vehicle numbers and reduced vehicle-kilometres travelled.

The modelling assumes that (a) access will be limited to road train routes and thus there will be no need for major infrastructure upgrades and (b) there will be no additional costs to operators (such as those associated with the PBS and IAP schemes).

The modelling is based on an initial approved B-triple network that does not extend to major inter-capital corridors. As the approved B-triple network is expanded, the benefits are expected to become greater than those reported here.

Table 13 sets out the results of the analysis, including figures for low and high take-up scenarios.

Table 13. Summary of findings: B-triple operation between 2011 and 2030

	Take-up scenario		
	Low	Median	High
Number of B-triples	1994	3665	7009
Reduction in total truck numbers	546	1,028	1,964
Reduction in vehicle-kilometres travelled (million km)	572	1,017	1,785
Reduction in road fatalities	14	25	45
Savings from reduction in road fatalities (NPV)	\$36.4M	\$64.8M	\$114M
Reduction in CO ₂ emissions (million tonnes)	0.635	1.131	1.929
Savings from reduction in CO ₂ emissions (NPV)	\$14.6M	\$26.0M	\$45.6M
Direct financial savings (NPV)	\$561M	\$999M	\$1,750M
TOTAL SAVINGS (NPV)	\$612M	\$1,090M	\$1,909M

10.2 Exclusions

The analysis did not account for the effect of the future expanded B-triple network. The immediate objective of this discussion paper is to provide access to a network that initially will exclude those expanded routes. The ultimate outcome once those expanded routes are included will be better than that reported here.

The analysis did not account for the savings that road authorities will realise from reduced wear and tear on pavements and the consequent reduction in pavement maintenance spending. These effects would only have added to the benefits of B-triple operation.

10.3 Take-up scenarios

The three B-triple take-up scenarios used as the basis for economic modelling—low, median and high—are based on an estimated annual growth rate and an estimated number of B-triples as a proportion of the road train fleet as at 2030 (Table 14). The annual growth rates are the growth rates reported by NTC (2010) for semi-trailers (low) and B-doubles (median), with the high growth rate assumed to be 150% of the median growth rate. The assumed 2030 fleet proportions are based on industry consultation.

Table 14. B-triple take-up rates for operation on road train routes 2011-2030

	Take-up scenario		
	Low	Median	High
Growth rate (per annum)	2.2%	3.2%	4.8%
Long-term proportion of the road train fleet	20%	30%	40%

10.4 Commodity types

The analysis considered B-triple substitution into fleets comprising four major commodity types—grain, livestock, bulk liquids and general freight. These commodity types are those considered in the safety analysis summarised in Section 7, and reportedly account for almost 89% of current A-double operations.

10.5 Substitution assessment

10.5.1 Case A: B-triples replacing A-doubles on road train routes

B-triples will replace some A-doubles in operations that are highly corridor-based and that have local connections to origins and destinations off the road train network. By removing one lead trailer a B-triple can be converted into a B-double for transport to the off-network sites. This offers higher

productivity for off-network travel than an A-double, which can only be reduced to a semi-trailer combination when departing from the road train network.

The reduction in vehicle-kilometres travelled was calculated by simulation for the various commodity types and commodity-based networks that are relevant to the operation of B-triples on road train routes. The method used was the same as that used by NTC (2010).

A weighted average of kilometres saved was then calculated based on the number of kilometres travelled by vehicles of each commodity type (Table 15).

Table 15. Weighted average of reduction in vehicle-kilometres travelled

Commodity type	Kilometres saved	Weighting
Grain	10.8%	15.2%
Livestock	10.0%	16.6%
Tanker	12.5%	19.7%
General freight	17.0%	37.3%
Other	12.5%	11.2%
AVERAGE (weighted)	13.5%	

NOTE: The percentage reduction in vehicle-kilometres travelled may also be presented as a reduction factor of 0.865 (i.e. 1 – 0.135).

A given percentage reduction in vehicle-kilometres travelled does not necessarily result in the same percentage reduction in the number of vehicles; the reduction in the number of vehicles is usually greater. NTC (2010) used an equation derived from statistical analysis to estimate the reduction in vehicle numbers for a given productivity increase if the reduction in vehicle-kilometres travelled is known:

$$VEH = (KM + (0.10 \times CAP) - 0.25)/0.75 \quad \text{Eqn. 10.1}$$

where:

VEH = the reduction factor for vehicle numbers

KM = the reduction factor for vehicle-kilometres travelled

CAP = a factor representing the increase in productivity from existing vehicles to new vehicles.

The ILI report shows that vehicle numbers are likely to fall by 17%.

10.5.2 Case B: B-triples replacing B-doubles on road train routes

B-triples will replace some B-doubles that use the road train network. At present, B-doubles cannot be converted into A-doubles for higher-productivity operation on road train routes, but B-doubles can be converted into B-triples under the proposed modular approach. Three B-triples can carry the same payload as four B-doubles, so upgrading to B-triples can reduce the number of B-double prime movers by 25%.

Using Eqn. 10.1 the ILI report shows that vehicle-kilometres travelled are likely to fall by 22%.

10.6 Calculation of direct financial savings

Direct financial savings were calculated from the saved vehicle-kilometres travelled and the representative transport cost per kilometre as published by NTC (2010), taking into account any difference in the operating cost of the old and new vehicles (such as registration charges). The NPV analysis used a discount rate of 7% as per NTC (2010).

10.7 Calculation and monetisation of reduction in road fatalities

Trucking statistics typically segregate rigid trucks from articulated trucks, but articulated trucks are often lumped together. Insurance company data can often provide helpful indications of the relative risk of different configurations of articulated vehicles, and can shed light on the safety benefits of modern multi-combination vehicles such as B-triples.

Table 16 provides fatality data for rigid and articulated vehicles. The articulated vehicles category includes all combination vehicles, but is dominated by general access vehicles (such as semi-trailers and truck-trailers).

Table 16. Truck-involved fatal crashes and fatalities

Truck type	Fatal crashes per 100M km	Fatalities per 100M km
Rigid	0.90	0.96
Articulated	2.09	2.55

Source: National Transport Commission

Table 17 provides insurance claim data obtained from insurance companies. It shows that multi-combination vehicles exhibit much less crash risk than single-articulated vehicles (the 'bigger is safer' outcome). Based on consultation with insurance companies it is considered that B-triple crash risk will be less than that of B-doubles, and should be assumed to be 10% less.

Table 17. Truck insurance claims

Truck type	Claimable incidents per 100M km (interstate operations)
Single semi-trailer	59.87
B-double	20.48
Type I road train	20.51
Type II road train	20.07

Source: National Truck Accident Research Centre

Upon quantifying the number of fatalities saved by the introduction of B-triples, the saving can be monetised on a value-of-life basis, where one life is valued at \$3.5 million. This comes from the statistical value-of-life approach adopted by the Department of Finance and Deregulation (DFD) as opposed to the cost-of-accident approach adopted by the Bureau of Infrastructure, Transport and Regional Economics (BITRE). The value of life is increased by 3% per annum, and discounted at the DFD-recommended level of 7% per annum. This assumption was used by the NTC (2010).

10.8 Calculation and monetisation of reduction in CO₂ emissions

This analysis considers only the reduction in CO₂ emissions and not Particulate Matter (PM-10) or Nitrogen Oxides (NO_x). It can be assumed that reductions in PM-10 and NO_x will be of the same order as that of CO₂ on the basis that the reductions come about simply from reduced vehicle travel and not from changes in engine technology. However, it is probable that B-triple prime movers will on average have more modern engines than the average existing road train and will therefore contribute to greater percentage reductions in PM-10 and NO_x than for CO₂.

The modelling was based on a carbon price of \$23 per tonne rising to \$30 per tonne by a risk-free long-term bond yield of 7% per annum, which is the average long-term bond yield since July 1990.¹⁹

10.9 Impact on rail freight

Freight customers will trade off freight cost and transit time. In many cases, if freight cost is sensitive it is transit time that drives the choice of freight mode between air, road, rail and coastal shipping. If rail freight is cheaper than road freight on a particular corridor, it is unlikely that freight movements will favour the rail mode if customer expectations of transit times are not met. Freight modes are generally not contestable with regard to the transit times that customers expect.

In general, where transit times are similar but freight costs are reduced, the introduction of B-triples will take road freight from other, less efficient road freight services. The impact on rail freight market share will be minimal.

10.10 Cost of implementation

B-triple operations under the proposed policy will be confined to an approved national B-triple network. At present it is proposed that the initial B-triple network will mirror the Type I road train network and other routes that are currently suitable for B-triple operation.

Type I road train routes are designed for A-double operation at an overall length of up to 36.5 metres and a gross combination mass of up to 81 tonnes Concessional Mass Limits. Modular B-triples, at an overall length of up to 35 metres (less than A-doubles) and a gross combination mass of up to 82.5 tonnes General Mass Limits (4.4% more than A-doubles) will be less damaging to pavements and will not require major bridge upgrades.

This proposal does not require PBS approval or IAP participation, both of which would add regulatory costs to operators.

The cost of initial implementation of the proposed policy is therefore negligible.

¹⁹ Note the similarity between these figures and those in the 10 July 2011 Gillard government announcement, which has a carbon tax starting at \$23 per tonne and rising to \$29 per tonne over three years.

11. Summary of comments received on the August 2011 discussion paper

Respondent	Summary of comments	NTC response
Fellows Bulk Transport	Supportive of the proposal. Opposed to PBS, IAP and high A-trailer registration charges. Would like to see the B-triple network expanded to include the Northern Highway in Victoria for grain transport.	The objections to PBS and IAP are noted. The NTC has proposed neither PBS nor IAP for application to modular B-triples under the proposed policy. The NTC is currently progressing the A-trailer registration charges matter, in consultation with government and industry stakeholders, and will deliver a report to SCOTI in March 2012. Expansion of the B-triple network is expected to occur gradually in response to industry demand, balanced by government funding priorities given that some routes may require costly upgrades in order to accommodate B-triples.
Northern Territory Government, Department of Lands and Planning	Supportive of the proposal. Expressed some concern about the B-double compatibility requirement potentially limiting flexibility, fleet utilisation and further take-up of B-triples. Suggested that the requirement is redundant, as B-double compliance is the driver's responsibility when operating as a B-double.	The NTC accepts the concerns raised regarding the B-double compatibility requirement. This issue was considered during the design of the requirement. It was designed to ensure that there was no increase in the risk of B-double non-compliance as a direct result of the policy, which could occur if greater demand is placed on drivers when breaking down combinations on a journey. The separate 35 m overall length requirement is believed to place a similar level of limitation on the sorts of trailers that can be used in modular B-triples, so the B-double compatibility requirement is not exclusively responsible for any limitation within the policy. The 35 m length limit does not restrict the use of standard B-double equipment, and was selected (as opposed to a 36.5 m length limit) specifically to control the swept path width (which is generally greater for a B-triple than for an A-double). The greater swept path width of B-triples on certain road train routes was a top-of-mind concern for some jurisdictions based on the design limits of existing infrastructure. Modular B-triples at 35 m long meet the PBS Level 3 performance requirement.

<p>Commercial Vehicle Industry Association of Queensland</p>	<p>Supportive of the proposal. Expressed some concern about the status of existing B-triple operations that do not meet the requirements of the proposed policy, and about the 35 m length limit potentially limiting productivity. Suggested a dual approach whereby modular B-triples may operate at up to 36.5 m when on the road train network and up to 35 m when on the expanded B-triple routes.</p>	<p>Under the Heavy Vehicle National Law existing state access arrangements will be preserved and in the future it is possible that 36.5 m B-triple notices that apply across more than one state could be made. This policy proposes that any existing state-based arrangements for B-triple operation will be allowed to continue unaffected in the relevant states once this policy is implemented. This means that existing or new B-triple combinations not meeting the requirements of the national policy but meeting the requirements of existing state-based policies may still be allowed to operate as B-triples do at present under those policies. See earlier response regarding the 35 m length limit. The suggested dual approach does not solve the problem of controlling B-triple swept path width on road train routes.</p>
<p>Australian Trucking Association</p>	<p>Supportive of the proposal.</p>	<p>Comments noted.</p>
<p>Darebin City Council</p>	<p>Supportive of the proposal for B-triple travel on suitable and approved regional freight corridors. Expressed some concern about residential amenity. Unlikely to permit B-triple access within Darebin City Council without a comprehensive assessment that demonstrates a positive outcome.</p>	<p>Comments noted.</p>
<p>Independent Transport Safety Regulator</p>	<p>Detailed submission expressed concerns about rail level crossing safety.</p>	<p>The NTC understands that rail level crossings will be a major factor in the assessment of potential routes for expansion of the national B-triple network beyond road train routes. An assessment will need to be conducted if an extended network includes a level crossing. Such roads will most likely need to have crossings grade-separated or otherwise modified before B-triple access is granted. In the Heavy Vehicle National Law, the road managers would be expected to consider the impact of B-triple use on roads interacting with level crossings before granting consent to such access.</p>

<p>Australian Regulatory Telematics Industry</p>	<p>Supportive of the proposal, but recommends that IAP be made a mandatory requirement under the policy. Suggests that non-IAP systems provide doubtful evidence because they are not tamper-evident like IAP-certified systems, which also have a service level guarantee and therefore necessarily higher operational costs. Suggests that IAP is not a deterrent to operators when there is a benefit to be gained, citing high take-up for HML access. Suggests that the self-declaration 'honesty system' can be bolstered by audits of transport operator weighbridge and delivery dockets. Suggests that B-triples will routinely travel off-route just as B-doubles currently do, and that IAP will be a deterrent to this non-compliant activity. Suggests that IAP will allay community concerns about off-route travel.</p>	<p>Comments noted. A number of clarifications have been made in the paper. While there may be subtleties to the various arguments for and against IAP for modular B-triples, the overwhelming evidence from the consultation process, both written and oral, is that the industry and indeed most jurisdictions have expressed no appetite for its application in this policy. There is no evidence that the risk of a B-triple going off route is higher than that of a road train. Application of IAP will impact policy and use of existing B-double equipment (which do not need IAP). Also, this policy does not include HML.</p>
<p>Dr Philip Laird, University of Wollongong</p>	<p>Expresses concerns about potential resultant modal shift from rail to road due to the NTC's focus on improving road productivity more than rail productivity. Suggests current pricing mechanisms favour road transport, and recommends Mass Distance Location pricing for B-triples. Suggests that any shift from sea and rail transport to road transport will result in a reduction in safety, and that there needs to be more assessment of the safety of B-triples before their access is expanded.</p>	<p>The NTC's work program is developed each year in consultation with its reform partners, and ultimately approved by Transport Ministers. The modular B-triple reform was requested under the COAG National Transport Reform Agenda. The NTC is actively engaged in a number of reforms focusing on all modes of transport. Please refer to www.ntc.gov.au</p>

<p>Truck Industry Council</p>	<p>Supportive of the proposal. Noted that a particular benefit of the B-double compatibility rule is the resultant front under-run protection, emissions, cabin strength and braking capabilities of prime movers used in modular B-triples. Opposed to IAP as a condition on modular B-triples because of the lack of mass and trailer monitoring across a whole combination vehicle, and because it compromises the modularity concept when B-double prime movers in a fleet may not have IAP installed. Recommended that the minimum engine horsepower requirement be augmented with a requirement that the vehicle must be able to maintain a minimum speed of 70 km/h on a 1% gradient at the B-triple maximum GCM rating of 84.5 tonnes (CML) as is currently the case for B-double prime movers. Suggested the use of a plate affixed to the prime mover to identify it as being suitable for modular B-triple operation. Noted that truck manufacturers will take modular B-triple operation into account when determining warranties, service intervals and life expectancies for new vehicles.</p>	<p>Horsepower requirement has been augmented after further consultation with the Truck Industry Council. The vehicle plating suggestion requires further development and may be considered in future refinements.</p>
<p>Tasmanian Department of Infrastructure, Energy and Resources</p>	<p>Supportive of the proposal, noting that Tasmania currently does not allow the operation of any vehicle combination larger than a B-double, and is unlikely to introduce B-triple operations in the near future.</p>	<p>Comments noted.</p>
<p>Dutch Ministry of Infrastructure and the Environment</p>	<p>Supportive of the proposal. Several research projects in the Netherlands over the past ten years have reached similar conclusions regarding the link between higher vehicle productivity and greater safety on the road. Experience with the European Modular System (25.25 m, 60 t) has identified different levels of support and different treatment in different countries, which is making it difficult to expand the concept throughout Europe.</p>	<p>Comments noted.</p>

Western Australian Department of Transport	Supportive of the proposal, in particular the concept that routes currently open to 36.5 m A-doubles should be considered suitable for the operation of 35 m B-triples, and that IAP should not be imposed on modular B-triples.	Comments noted.
Queensland Department of Transport and Main Roads	Supportive of the proposal. Expressed some concern about the potential for conflict between existing state-based B-triples and national modular B-triples after implementation, such that there will be separate access regimes for modular versus non-modular B-triples. This may restrict Queensland non-modular B-triples from accessing routes in other jurisdictions if those jurisdictions require all B-triples to meet the national policy.	There will likely be separate access regimes for 'existing' non-modular B-triples and 'new' modular B-triples after implementation of the national B-triple policy, the main one being the greater extent of national access ultimately available to modular B-triples. This policy proposal recommends that any existing state-based arrangements continue after implementation, which will allay any concerns held by existing B-triple operators about a loss of current arrangements.
Kelvin Baxter Transport	Supportive of the proposal. Has been operating B-triples for three years. Seeks expansion of the network beyond road train routes, and is opposed to IAP.	Comments noted.
Australian Road Transport Suppliers Association	Supportive of the proposal. Particularly supportive of the comments in Section 4.4 relating to braking compatibility.	Comments noted.

<p>New South Wales Department of Transport, Roads & Maritime Services</p>	<p>Supportive of the modular approach to B-triples, but expressed some concerns about a lack of fit with existing B-triple policy in NSW. Noted that trailers used in B-triples must be ADR 63 compliant. Noted that in NSW B-triples must have a gradeability of 12% and must maintain 70 km/h on a 1% grade. Noted that NSW is developing a streamlined vehicle certification process for B-triples to ensure that B-triples are constructed in accordance with engineering requirements. Noted that in NSW operators must be accredited under NHVAS mass management and maintenance management modules. Noted that IAP would be a requirement for NSW operation. Noted that additional work will be undertaken by RMS to confirm the extent of the existing Type I road train network that can be approved for B-triple operations, and work is being done to examine the potential for a future expanded network east of the Newell Highway. Unsupportive of the Class 2 notice as a mechanism for granting access on the basis that it does not provide adequate assurances for broader operation of such vehicles.</p>	<p>The policy proposal implicitly requires that trailers used in modular B-triples are ADR 63 compliant (refer to Section 4.3.3). With regard to gradeability performance, the proposal had already been updated on a recommendation from the Truck Industry Council and is now consistent with the NSW approach. Despite being in place since 2008 in NSW, only a limited number of vehicles with permits operate at GML under the Road Train Modernisation Program. Contrastingly, the policy proposal introduced in this paper encourages greater uptake without additional burden.</p>
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12. Implementation of a national modular B-triple policy

Consistent with the approach currently used for B-double and road train operations, the regulatory proposal recommends implementing the modular B-triple policy by way of a "Class 2 Modular B-triple Authorisation Notice 2013" shown in section 13 under the following arrangements:

- By each jurisdiction using its equivalent of a Class 2 notice until January 2013; each State being able to grant an exemption or issue an authorisation under their current law
- By the National Heavy Vehicle Regulator from January 2013 under a Commonwealth Gazette Notice

It is considered that the implementation of the present policy shall not present any major difficulty as it is understood that no legislative amendments are required in the jurisdictions to implement this policy.

Furthermore, in order to assist with the assembly of compliant modular B-triples, the NTC will also be producing an online Vehicle Assessment Tool that will allow anyone to verify that modular B-triples formed from a given prime mover and a set of trailers are compliant with the present regulatory proposal. The Vehicle Assessment Tool is expected to be hosted online on the NTC's website and accessible to anyone with an internet connection.

13. Example of a Class 2 modular B-triple notice

Heavy Vehicle National Law

Class 2 Modular B-triple Authorisation Notice 2013

I, [xxx], Chief Executive of the National Heavy Vehicle Regulator, in accordance with section 119 of the Heavy Vehicle National Law, by this Authorisation Notice authorise the use of the category of Class 2 heavy vehicles as described in Part 2 - **Applications**, on the areas and routes described in Part 3 - **Stated Areas or Stated Routes** and subject to any conditions described in Part 4 - **Conditions**.

Chief Executive
National Heavy Vehicle Regulator

Part 1 – Preliminary

1.1 Citation

This Notice may be cited as the **Class 2 Modular B-triple Authorisation Notice 2013**.

1.2 Commencement

This Notice takes effect on 1 January 2013.

1.3 Effect

This Notice remains in force up to and including 31 December 2017, unless it is amended or cancelled earlier.

1.4 Interpretation

1.4.1 **Modular B-triple** means a road train with the following characteristics:

- constructed from a prime mover having a single steer axle and a tandem drive axle group towing three triaxle semi-trailers all connected by fifth-wheel couplings;
- no longer than 35 metres;
- no longer than 29.6 metres from centreline of the kingpin on the first trailer to the rear of the combination; and
- if one leading semi-trailer was removed the combination would be a B-double complying with the dimension requirements of the Heavy Vehicle (Mass, Dimension and Loading) National Regulation.

1.4.2 **Travel restriction** means a restriction on the use of a vehicle during stated hours of stated days or a restriction on the use of a vehicle travelling in a specific direction on a stated area or stated route.

1.4.3 Unless stated otherwise, the words and expressions used in this Authorisation Notice have the same meaning as those defined in the Heavy Vehicle National Law.

Part 2 – Application

- 2.1 This Notice applies to a vehicle operating as a **modular B-triple** that complies with the mass and dimension limits prescribed in the Heavy Vehicle (Mass, Dimension and Loading) National Regulation.

Part 3 - Stated Areas or Stated Routes

3.1 Approved areas and routes

- 3.1 Modular B-triples operating under this Notice may operate on each approved area or route listed in Column A of the Schedule, subject to compliance with any **travel restrictions** which applies to an approved area or route listed in Column B of the Schedule.

Part 4 - Conditions

4.1 Operating requirements

- 4.1 A copy of this Authorisation Notice must be kept in the driver's possession whenever the vehicle is operating as a **modular B-triple** under this Authorisation Notice, and must be produced when requested to do so by a police officer or an authorised officer.

SCHEDULE

Column A – Area or Route	Column B - Travel Restrictions
Example Road	Turning left onto Example Road from Another Example Road is prohibited at all times.
Another Example Road	The road may not be used between 7:30 am and 10:00 am or between 2:30 pm and 7:00 pm on weekdays.

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