PRODUCTIVITY GAINS THROUGH EXPANSION OF PERFORMANCE BASED STANDARDS NETWORK IN QUEENSLAND

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Abstract

This paper presents a discussion on the productivity gains that have been achieved in Queensland through the expansion of the Performance Based Standards (PBS) road network relevant to PBS Level 2B vehicles. Typical vehicle designs which are allowed under Level 2B are presented and their benefits discussed, alongside the background and a description of the route assessment process that has facilitated their introduction. Some practical experiences with the operation of these vehicles are also provided.

Keywords: heavy vehicle, freight transport, route assessment, B-double, A-double, productivity, PBS, Performance Based Standards.

1. Introduction

The Performance Based Standards (PBS) scheme provides industry with opportunities to design and operate innovative heavy vehicles, resulting in increased productivity, safer performance and managing effects on roads and bridges. The scheme focuses on how well the vehicle performs, rather than its physical characteristics (e.g. length and mass).

The basic concept of PBS is matching the right vehicles to the right roads. There are four levels in the PBS scheme for both vehicles and roads. Levels are also divided further into subclasses A and B, based on vehicle overall length. Whilst the more restrictive Class A networks have mostly been classified throughout Australia, Class B networks, which can provide significant productivity benefits, are still largely unmapped.

ARRB has developed an innovative assessment methodology in collaboration with the Queensland Department of Transport and Main Roads (TMR) to assess Class B routes. The approach has been applied to open up the Level 2B network in Queensland allowing vehicles up to 30 m to operate on areas that had previously been restricted to vehicles up to 26 m in length. This paper discusses typical 2B vehicle designs and their benefits, a description of the route assessment process that has facilitated their introduction, and presents some notes on practical experiences.

2. The Performance Based Standards assessment scheme

The notion of a performance-based approach for heavy vehicle regulation was first introduced in 1986 as part of the Canadian Heavy Vehicle Weights and Dimensions Study (Ervin and Guy, 1986). In 2006, a review of Australia's freight transport task (SKM, 2006) highlighted that the industry faced an immense challenge – a predicted doubling in size by 2020. This estimate was revised (IBISWorld, 2008), and it has been predicted that Australia's freight task in 2008 (503 billion tonne kilometres) will triple in size to 2050 (1,540 tonne kilometres).

In response, Australian regulators and asset owners refined the original performance-based concept, and developed the regulatory package now known as the Performance Based Standards (PBS) scheme, in an effort to introduce a wide range of innovative vehicles, delivering much-needed productivity benefits to the transport industry and providing it with a framework to meet future requirements.

The regulatory controls under the PBS scheme focus on investigating how well the vehicle performs, rather than specifying maximum dimensions or characteristics (e.g. length, width and height), through a set of sixteen safety-related and four infrastructure protection standards, which focus on quantifying vehicle performance in many key areas (NTC, 2008). PBS vehicles must meet stricter safety standards, and demonstrate better performance than existing equivalent vehicles.

The basic concept of the PBS scheme is that vehicle performance matches the capacity of the road, and all PBS vehicles must demonstrate equal (or higher) levels of safety performance or infrastructure protection than the conventional vehicles that they replace. State-based operating permits and road network access arrangements are provided based on the level of performance achieved in the PBS standards. The corresponding levels of performance ensure the vehicle is matched to the right road network, with more stringent performance standards for greater access.

This regulatory package is representative of worldwide best-practice, using defined performance requirements in critical safety areas such as high-speed dynamic behaviour and roll stability. The use of this approach generally permits longer and heavier vehicle combinations to be operated than those allowed under prescriptive regulations, which has the end result of increasing safety and efficiency.

3. Performance Based Standards in practice

The PBS scheme has been in operation since October 2007. By January 2010, over 80 buses and heavy vehicle combinations had gained approval (NTC, 2010). Recent figures published by the PBS Review Panel (PRP) (Anderson, 2012) have indicated that from 2010 to 2011, there have been between 15 and 35 individual approvals granted at each PRP meeting. These meetings are held between four and five times per year. Anderson notes that in some cases, up to 15 vehicles may operate on a single PBS approval, meaning that a PBS 'design' can result in any number of vehicles of that design in operation under the approval granted by the relevant roads authority.

However, these figures need to be assessed within the context of the total number of registered freight vehicles in order to judge whether PBS, as a regulatory mechanism to improve productivity, is achieving its aims. Figures published by the Australian Bureau of Statistics (ABS, 2011), show that there were 318,223 heavy rigid trucks, and 85,965 articulated trucks registered in Australia in 2011.

This simple comparison, while lacking sufficient depth to capture the full contribution of PBS to the freight industry thus far, illustrates that more PBS heavy vehicles are required in order for the full extent of the intended gains to be achieved. Several industry commentators have noted the 'roadblocks' that are perceived to exist within the scheme, which include the time and expense for PBS applicants, the complexity of the system, but most prominently focus on the lack of network access available for PBS vehicles.

4. Determining network access arrangements

In order to address concerns regarding network access, the NTC also provided a framework (NTC, 2007) intended to allow asset owners and managers to classify their road networks, and directly match them to vehicles within the PBS scheme. The framework linked eight vehicle characteristics directly to four levels of network access, and provided advice on ten specific road parameters that should be considered in order to geometrically classify routes.

Each of the vehicle characteristics and road parameters is listed in Table 1. Full detail on the road parameters is shown in the network classification guidelines (NTC, 2007).

Table 1 – Vehicle performance characteristics and relevant road parameters

Vehicle performance characteristic	Road parameters
Startability Gradeability Acceleration capability Tracking ability on a straight path Low-speed swept path Tail swing Frontal swing High-speed transient offtracking	Road width Bridge widths Intersection and rail level crossing clearance times Overtaking provision Entry length onto main roads and highways Approach visibility (stopping sight distance) Vertical (overhead) clearance Off-road truck parking Roadside infrastructure Amenity and environmental factors

It is important here to recognise that the assessment proposed under the guidelines is geometric in nature, in that it focuses solely on assessing the geometric characteristics of the road, and does not include any consideration of effects on bridges and pavements. Generally, structural assessments are completed on a case-by-case basis by the bridge owners, and the nature of the assessment depends on the vehicle design and compliance with the bridge loading standard.

There are four levels of access within the PBS scheme, which translate to the four vehicle classes outlined in Table 2. The four levels range from greatest access to Australia's road network (Level 1) to least (most-restricted) access (Level 4). Example vehicles for each class are also provided for context. Recognising that vehicle performance (and subsequently, network access) could vary substantially within individual classes of vehicles, the guidelines make provision for two subclasses of network access, designated Class A and Class B, based on overall vehicle length.

Table 2 - Four levels of access under the PBS scheme

Level	Typical vehicle	Network access by vehicle length (m)	
		Class 'A'	Class 'B'
Level 1	Single articulated	$L \leq 20$ (general access)	
Level 2	B-double	$L \leq 26$	$26 < L \leq 30$
Level 3	A-double	$L \leq 36.5$	$36.5 < L \leq 42$
Level 4	A-triple	$L \leq 53.5$	$53.5 < L \leq 60$

The application of the NTC's route assessment guidelines to Australia's national road network began in 2007, and was largely completed in 2008, although new routes are constantly being classified and added. This was an important step towards national consistency of route classification and has achieved much in terms of addressing one of the barriers to uptake of the PBS system, being the lack of network access for PBS vehicles, and also that there was little certainty regarding the level of access that would eventually be granted for a particular vehicle.

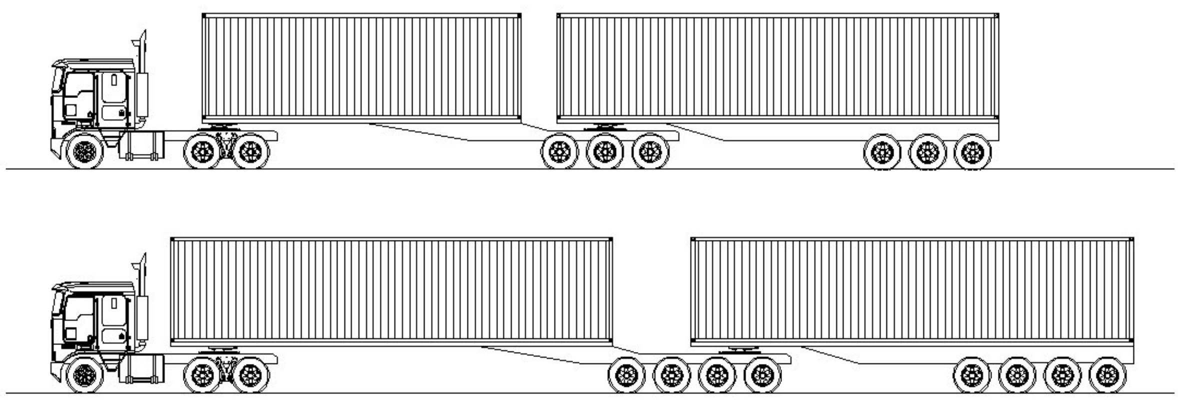
Despite these advances, there are still issues. While the route assessment process classified many national routes, the majority of Australia's road network remained unclassified, and many state and local roads were not captured, which meant that in effect for some applicants questions remained regarding certainty in the potential for their vehicle to be granted access.

In consultation with Queensland's Department of Transport and Main Roads (TMR) Regions and local government authorities, Queensland's PBS Class A road network was classified in mid-2008. Queensland was the first jurisdiction in Australia to classify and publish its Class A network for PBS vehicles. This was achieved by translating its existing access arrangements for the B-double and road train networks to fit the PBS classifications. Although TMR actively encouraged and supported industry take-up and adoption of Class A vehicles by providing a published Class A network, the overall level of adoption within the industry was low, and generally attributed to the disparity between the low profit margins for operators, when compared with the increased cost of manufacturing a PBS vehicle, and further concerns regarding eventual approval of access.

It was identified that further significant productivity benefits could be realised through the classification of a Class B network, which would allow longer and heavier vehicles to be operated. In particular, large increases to productivity could be realised by longer PBS Level 2 vehicles, for instance those that could potentially carry two 40-foot shipping containers.

5. Benefits of Class B vehicles

To understand the productivity benefits available under Class B vehicles, it is useful to compare them to existing regulation vehicle designs, or Class A vehicles that they replace. Figure 1 depicts a typical regulation vehicle available for operation on Level 2A routes; a 26 m B-double, while 30 m A-double designs are available under Level 2B, and comply with length limits. A 'super' B-double fitted with quad-axle groups is also shown for comparison.



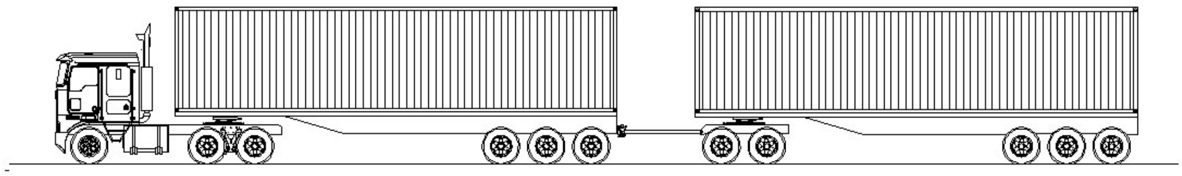


Figure 1 – The regulation design B-double, overall length < 26 m (top), a super B-double, overall length < 30 m (middle), and a PBS Level 2B A-double, overall length < 30 m (bottom)

It is evident from the example shown in Figure 1 that although both the super B-double and the A-double combinations are longer than the conventional Level 2 B-double, they can carry a disproportionately higher payload volume and mass. Table 3 shows gross combination masses (GCMs) for each of these vehicles under the General Mass Limits (GML) and Higher Mass Limits (HML) loading schemes as per heavy vehicle policy in Queensland. Operation at HML axle masses is permitted for vehicles fitted with road friendly suspension (RFS), and operating under the Intelligent Access Program (IAP) implemented by Transport Certification Australia (TCA).

Table 3 – Gross combination masses for the three vehicle combinations

Vehicle	**Access level**	**Gross combination mass (t)**	
		General Mass Limits	**Higher Mass Limits**
Regulation B-double	Level 2	62.5	68.0
Super B-double	Level 3*	67.0	73.0
A-double	Level 2B	79.5	85.0

*Super B-doubles are generally restricted to Level 3 operation due to swept path performance. If this is deemed unimportant at the route assessment stage, Level 2B access may be granted.

As these figures show, both the super B-double and the A–double are only 4 m (15%) longer than the B-double, but the super B-double can theoretically carry 4.5 tonnes (7%) more freight, and the A-double can theoretically carry 17 tonnes (27%) more freight than the B-double, when compared at GML axle load limits. On this basis alone, both vehicles (but particularly the Level 2B A-double) present a substantial productivity increase over the Level 2A vehicle.

Super B-doubles and A-doubles also have the potential benefits of reducing the impact on infrastructure for a given freight task, which can be simply demonstrated using the widely-accepted equivalent standard axle (ESA) calculation method. The ESA method compares mass carried by axle groups to a reference load, and calculates the increased effect on pavements of adding mass by raising the ratio of the two loads to the fourth power. Further information on the method, and how it may be used in the future to provide a pavement wear assessment method for heavy vehicles, can be found in Donald et al (2011). Total ESA results and ESA per tonne of payload for each of the three vehicles is shown in Table 4.

Table 4 – Total ESA, and ESA per tonne of payload

Vehicle	Total ESA	ESA/tonne payload
Regulation B-double	6.30	0.14
Super B-double	5.76	0.10
A-double	8.34	0.14

As is evident, both the super B-double and the A-double, despite carrying substantially more mass, can reduce or equal the impacts on pavements when considered from a transport task (i.e. impacts on infrastructure per tonne of payload) perspective. This finding illustrates that fewer PBS vehicles are required to perform the same freight task, while still ensuring infrastructure protection; however the question remains regarding how their introduction to the road network can be effectively managed.

6. Class B network classification in Queensland

In 2008, TMR produced guidelines for classifying Class B networks, which were based on the NTC's original classification guidelines (NTC, 2007), and included updates and modifications addressing the increased length of the Class B vehicles.

Due to growing industry interest in PBS Class B vehicles and TMR's support of the PBS scheme, in January 2011 TMR's Heavy Vehicle Access Policy Unit established the Route Assessment Team (RAT) to assess strategic and industry requested routes for the longer PBS Class B vehicles. In recognition of the complex nature of the process, ARRB Group was engaged to conduct the geometric assessments, with the RAT providing leadership and direction in the coordination of these assessments and regularly consulting with asset owners to promote the approach, whilst balancing community, environmental and safety concerns.

Substantial time savings were made in the undertaking of the geometric assessments as the majority of the data required already existed in various forms, which meant that ARRB's task focussed on collation of the data, analysis, and subsequent review and route mapping. Video and geometric data of the network, previously collected by an ARRB Hawkeye 2000 Network Survey Vehicle (NSV), was processed using ARRB's Hawkeye Processing Toolkit, (which incorporated both the NTC and TMR PBS classification guidelines), and analysed to provide Class B classifications for the following elements of the network:

- stacking distances at intersections and railway level crossings
- warning times at railway level crossings
- intersection signal timing
- storage lane length at intersections
- overtaking provision and opportunity
- swept paths
- grades

It is useful here to contemplate why these network elements were chosen for consideration. As the prime difference between Class A and Class B vehicles is increased length, and the roads under consideration are already classified as the appropriate A-Level classification, the only geometric considerations in the route assessment are aspects that increased vehicle length will potentially affect, such as those aspects outlined in the list above, and others which cannot be assessed using video data, such as enforcement bays and rest area sizes.

It is important to highlight that under this approach, Class B vehicles are still required to meet the same pavement, bridge effects and on-road vehicle performance envelope as Class A vehicles. Separate intersection safety assessments can also be conducted when interaction with local traffic is identified as a potential issue. Community and amenity issues were also considered through consultation with asset and road owners and managers as part of the overall decision on the final route classification. In some instances, small-scale road improvements such as the installation of in-pavement loop detectors to increase minimum intersection green-phase time are made. For one particular intersection, the turn manoeuvre was required to be signalised, and the roadway widened to permit level 2B classification. In all instances, road improvements were funded by TMR.

In terms of dealing with new requests from industry for access, the overall process is quite streamlined. In the first instance, TMR receives the request from an operator, and will determine the priority of the required route assessment. Then, TMR seeks and obtains in-principle support from all asset owners to assess their roads on their behalf, and obtain a quote from ARRB for the assessment. Following an internal review of budget and priorities, TMR may engage ARRB to conduct the assessment. ARRB will gather the data and conduct the assessment, analyse the results and provide TMR with a finalised report.

TMR then reviews the report and again engages all relevant asset owners, which include TMR Regions, local councils, private road owners, and infrastructure facilities including ports, to receive their final approval of the route classification. Once obtained, TMR will then map the route, publish the route on its website, notify the NTC so it the national PBS maps can be updated, and issue the operator with an approval permit. Once a route is mapped it is available to all previously-approved vehicles operating at that level of access, not just the operator that submitted the original request. To date, each of the route assessments have been fully funded by TMR, with nil cost passed on to the operator for the route assessment and subsequent permit.

The main issues which have been experienced by TMR are the long lead-time of the overall process, which can be exacerbated by the time required to gain in-principle support from all the asset owners, a problem which is often endemic to a process which necessitates consultation on a wide level. The availability of the required road data has also caused some issues.

The outcome of this process is that, as of the end of May 2012, a total of 468 kilometres of roads have been assessed and approved in South-East Queensland and Townsville (linking the Level 3A network west of Townsville to the Townsville Port, and Townsville Port to Yubulu north of Townsville) for the operation of PBS Level 2B vehicles, at a maximum length of 30 metres (Figure 2). Additionally, a total of 323 kilometres of roads have been assessed and are close to finalisation in freight precincts at Acacia Ridge and the Hemmant area, and the Cunningham Highway from Warwick to the Ipswich Motorway.

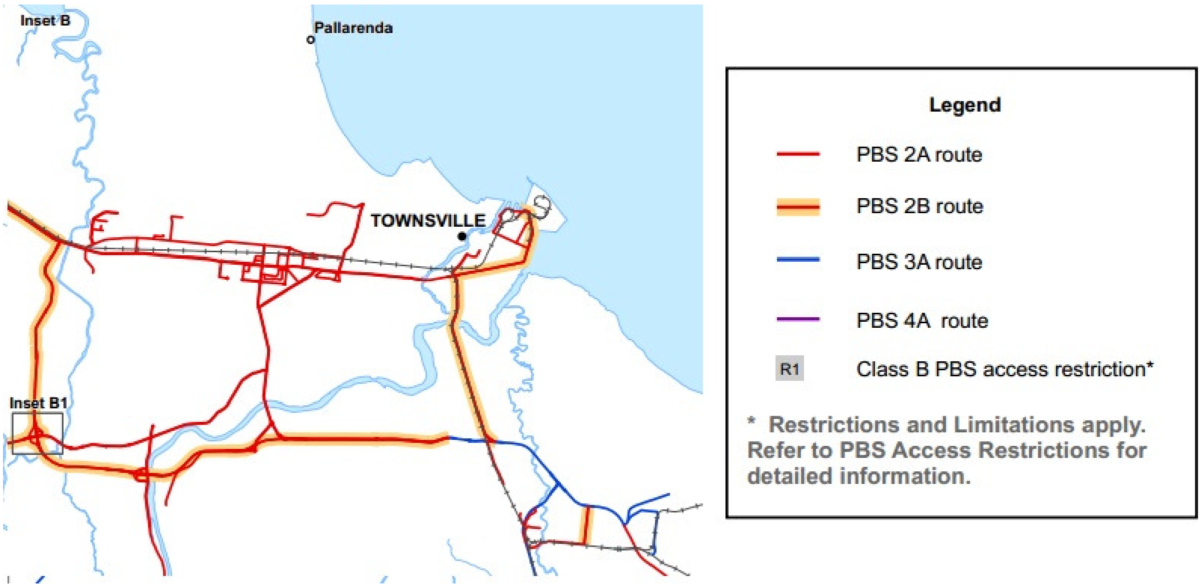


Figure 2 – Route classification map of the Townsville area, North Queensland (Source: TMR, 2012)

Approximately 2,162 kilometres of state controlled and local authority roads are currently being assessed by ARRB in freight precincts at Eagle Farm and Gladstone, and the Bruce Highway from the NSW border to the Mackay/Fitzroy Region boundary. In the immediate future, it is expected that 130 kilometres of state controlled and local authority roads will be assessed for PBS Class B vehicles. These roads include key access roads in Mackay, Goondiwindi, Amberley and Lytton.

Approximately 376 kilometres of the Bruce Highway from the Mackay/Fitzroy Region boundary to Mackay is expected to be assessed in early 2013. In the immediate future, it is expected that 3,318 kilometres of state controlled and local authority roads will be assessed for PBS Class B vehicles.

On completion of this body of assessment work, it is expected that Queenslad will have an established Level 2B network allowing access from the Level 3B network to the ports in Townsville, Mackay, Gladstone and Brisbane, and the entire length of the Bruce Highway from the NSW's border to St Lawrence (north of Rockhampton).

7. Practical experiences with Level 2B vehicles – achievements and lessons

While it is evident that both super B-doubles and A-doubles present productivity advantages when compared with the Level 2A B-double, it is interesting to consider the practical experiences of their operation. Bruzsa (2012) highlighted that for containerised grain transports in Queensland, one regulation design B-double is restricted by its dimensions and maximum axle masses to carrying two 20-foot containers, while an A-double can manage two 40-foot containers (Figure 3).

While super B-doubles carrying two 40-foot containers have been achieved under the PBS scheme, such vehicles typically struggle to meet the PBS Level 2 swept path requirements without steerable axles, and must also be fitted with quad-axle groups, in order to manage the mass of the two containers (Figure 1, middle). As a result, their practicality is limited and they are not in wide operation throughout Queensland.

Figure 3 – A Level 2A B-double (top), compared with a Level 2B A-double (bottom)

Anecdotal evidence from operators has indicated that A-doubles have a distinct advantage in terms of their flexibility, in that they can be split up, and the individual trailers used in other tasks. One company transporting containerised grain from Toowoomba to the Port of Brisbane has said it is experiencing a 30% productivity gain through the use of A-doubles, and these vehicles have quickly become the preferred option for container movements from Toowoomba to the Port. The same company said that all grain container movement jobs are now being priced/quoted based on using a PBS Level 2B A-double.

The operation of Level 2B vehicles between Toowoomba and the Port of Brisbane since October 2010 has achieved significant freight efficiency gains through the reduction of heavy vehicle trips by up to 50% for freight tasks associated with the export of containerised grain. The reduction of truck trips translates to reduced heavy vehicle congestion, about 230,000 litres of reduced fuel usage, and 490 tonnes of reduced greenhouse gas emissions every year, achieved with negligible financial outlay in terms of road upgrades.

However, while clearly offering productivity advantages, there are some situations where the A-double vehicles are not suited. The combinations are much more difficult to manoeuvre when reversing than a B-double, and this has caused problems at some container unloading facilities which require the combination to reverse into position in order to be unloaded. As a result, that particular facility operator has prohibited A-double access, which has required transport operators to split A-double combinations at a nearby container park, and deliver the two trailers separately, adding considerable delay to the operation.

8. Conclusions

The expansion of the PBS network has enormous potential to assist with Australia's challenge of a significantly increasing freight task over the coming decades. While the current focus has been for industry requested and strategic Level 2B networks, the future will likely also include assessments and expansion of Level 3B and Level 4B networks, allowing vehicles up to 42 m and 60 m respectively.

The ability to recognise and realise an increased network capacity will enable Australia to meet the future demands of the freight transport task, and simultaneously ensure that appropriate levels of safety performance are achieved, and infrastructure is protected. Demand from industry is ever increasing, and Queensland's consistent and efficient route assessment approach will continue to be applied leading to a safer, more efficient and targeted network.

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