NHVR
National Heavy Vehicle Regulator

Performance Based Standards

An introduction for road managers

May 2019

Foreword

The National Heavy Vehicle Regulator (NHVR) recognises the important role road managers have in assessing and providing consent for heavy vehicle access to local road networks to transport more than two billion tonnes of freight around Australia every year. They play an important role in determining whether the use of certain heavy vehicles is safe, will cause damage to road infrastructure or have adverse impacts on the communities involved.

The Performance Based Standards (PBS) scheme allows heavy vehicle operators to use innovative and optimised vehicle designs to achieve greater productivity and improved safety, while making the least possible impacts on the environment and road infrastructure.

This booklet is designed to provide road managers with a greater understanding of the PBS scheme, its principles, benefits and approval processes, to make it as easy as possible to assess, and grant network access to, innovative, newer and safer vehicles.

During the past decade, Australia's heavy vehicle industry has embraced new technologies and designs, as well as the substantial benefits associated with more PBS vehicles on our roads. According to a joint report by the NHVR and the Australian Road Transport Suppliers Association (ARTSA), the proportion of PBS vehicles in the general heavy vehicle population continues to grow. In 2018, almost one in five eligible heavy vehicles manufactured was PBS approved and as at March 2019, there were 8,726 PBS-approved combinations on our roads comprised of more than 18,000 individual vehicle units.

Growth in the number of PBS vehicles on our roads is resulting in significant safety, productivity and sustainability benefits for industry and the community. A PBS marketplace review released in 2018 by the National Transport Commission (NTC) highlighted that PBS vehicles are involved in 46% fewer major crashes per kilometre travelled than conventional vehicles and improve productivity by an average of 15 to 30%. They also deliver substantial environmental and community benefits, including savings of an estimated 173 million litres of fuel and approximately $107 million in road maintenance expenses in 2018.

When considering access requests, I hope that road managers will find this booklet a valuable resource to build their understanding of the capabilities of PBS vehicles and how they can contribute to local and National economies.

I would like to thank Australia's heavy vehicle industry, road managers and operators for their support of the PBS scheme during its first decade and look forward to working together so we can continue to realise the benefits of these productive, better, and safer vehicles into the future.

Sal Petroccitto
CEO

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Thurwood Transport 28-pallet quad-axle reefer

PBS scheme

The PBS scheme is a world-leading program that allows Australia's heavy vehicle industry to match the right vehicles to the right tasks. It gives industry the opportunity to innovate with vehicle design to improve productivity and achieve safer performance while minimising impacts on the environment and road infrastructure and improving overall safety.

PBS vehicles are designed and built to perform their tasks as productively, safely and sustainably as possible, and to operate on networks that are appropriate for their level of performance. They are assessed against stringent safety and infrastructure standards to ensure they are safe and fit for use on existing road networks.

The PBS scheme is voluntary and sits alongside the long-standing prescriptive regulatory system for heavy vehicles. It was first introduced in 2007 and from 2014, the PBS scheme was incorporated into the Heavy Vehicle National Law (HVNL) and its administration and development is being progressed by the NHVR.

PBS benefits

In Australia, over 75% of non-bulk domestic freight is transported by road. With population growth expected to reach 30 million by 2030, the national freight task will continue to grow, placing increased pressure on the freight network. Introducing more productive and efficient vehicles, such as PBS combinations, will help ease this pressure by reducing the number of heavy vehicle movements required to complete the freight task.

The challenge for the heavy vehicle supply chain is to ensure goods are transported in the most cost-effective manner, thereby staying competitive. Minimising the cost of the road freight movement per unit, and the cost of the impact on infrastructure resulting from these movements, is an effective way to achieve this.

More productive trucks on our roads brings significant safety, productivity, environmental and infrastructure benefits for the Australian community, as well as direct economic benefits, including increased investment in local communities and employment opportunities.

Safety benefits

PBS vehicles are involved in 46% fewer major crashes per kilometre travelled than conventional heavy vehicles[1], and they continue to meet higher safety standards through the use of innovative design and the latest safety technologies.

According to Australia's PBS fleet report (NHVR and ARTSA, 2018), PBS vehicles have a median age of just under four years, compared with over 12 years for the entire heavy vehicle fleet. This younger PBS fleet has considerable advantages, including better safety equipment and fewer maintenance demands compared with older vehicles.

1 Reforming the Performance-Based Standards scheme Policy paper (NTC , May 2018).

Additionally, these more productive PBS combinations have the capacity to transport more freight per trip, therefore reducing the total number of heavy vehicles on our roads. Fewer trucks on our roads means road users have less exposure to heavy vehicles, reducing the risk of crashes, lowering potential road trauma incidents and creating safer roads for everyone.

Productivity benefits

PBS vehicles are designed for the task they need to undertake rather than their conventional counterparts, meaning more freight can be moved in the same number of trips more safely.

PBS combinations offer significant productivity benefits, including:
- productivity improvements of 15–30%
- up to 260 million fewer kilometres travelled annually, compared to conventional vehicles.

Environmental benefits

Travelling fewer kilometres and using generally newer vehicles means less fuel is required for a PBS vehicle to complete the same freight task compared to its prescriptive equivalent.

The NHVR estimates that, as of March 2019, the PBS fleet will provide annual savings of:
- 200 million litres of fuel
- 486,000 tonnes of carbon dioxide emissions.

These savings will continue to increase as the PBS fleet size grows.

Infrastructure benefits

The impact a heavy vehicle has on road infrastructure can be influenced by many different factors including pavement and vehicle type, axle configuration, vehicle length and total combination mass.

There is a common concern that the increased mass of PBS vehicles will accelerate pavement wear and result in increased damage to infrastructure. However, PBS vehicles are designed in a way that can minimise these potential impacts. For example:
- The increase in vehicle mass of a PBS vehicle is achieved by increasing vehicle length and including additional axle groups. This means the load on a PBS vehicle is distributed among a longer combination and a greater number of axle groups, meaning the pavement effect of each individual axle group is often less or comparable with existing prescriptive combinations.
- PBS vehicles are designed to have increased payload capacity, meaning the same freight task can be completed in fewer trip numbers. This results in less pavement and infrastructure exposure to heavy vehicle movements and may reduce overall infrastructure maintenance cost.

CASE STUDY

28-pallet quad-axle refrigerated trailer

On behalf of Victoria's Thurwood Transport, MaxiTRANS' brand Maxi-CUBE designed and manufactured a 20m prime mover and 28-pallet quad-axle refrigerated trailer (reefer) combination, featuring a steer axle at the rear of the quad-axle group. According to MaxiTRANS, the 28-pallet reefer is one of the most productive single trailers of its kind on Australian roads. With space for an extra six pallets over a standard refrigerated trailer's 22-pallet capacity, it provides Thurwood with a 27% productivity increase, saving six trips a month. Based in Derrimut in the western suburbs of Melbourne, Thurwood Transport is using the reefer to transport fresh produce up and down the eastern seaboard.

CASE STUDY

PBS 30m A-double – Port of Brisbane

TEU[1] (container) numbers through the Port of Brisbane from November 2017 to January 2018 increased by 27% compared to the same period in 2012–2013. The increase was partly due to the Port allowing access to 30m A-double combinations, which can carry four TEUs compared to the prescriptive prime mover and semitrailer combination which can only carry two TEUs. Despite the 27% increase in freight movement, truck numbers have only increased by 16%, resulting in an overall decrease in truck trips per TEU movement.

1 TEU – Twenty-foot equivalent unit

2 Understanding PBS vehicles

PBS Design and Vehicle Approval process

The PBS Approval process is a strict procedure to ensure PBS vehicles are designed and built to operate as productively, safely and sustainably as possible on networks appropriate for their level of performance.

The approval process includes the following steps:

1. Authorised PBS Assessor simulates proposed vehicle design against PBS standards.
2. The PBS Assessor submits application for PBS Design Approval to NHVR on behalf of applicant.
3. NHVR reviews and refers application to PBS Review Panel[1].
4. NHVR issues PBS Design Approval considering PBS Review Panel advice.
5. Authorised PBS Certifier inspects as-built vehicle against PBS Design Approval and provides certification report to NHVR.
6. NHVR issues PBS Vehicle Approval, provided 'as-built' combination complies with design parameters.
7. If there is no Notice under which the PBS vehicle can operate, operator submits access permit application via NHVR Customer Portal.

PBS Assessor – Authorised by the NHVR to perform computer simulations of vehicles against the PBS standards. Only PBS Assessors can submit an application for a PBS Design Approval on an applicant's behalf.

PBS Certifier – Authorised by the NHVR to certify and inspect as-built combinations against the PBS Design Approval specifications. Only PBS Certifiers can submit an application for a PBS Vehicle Approval on an applicant's behalf.

1 The PBS Review Panel consists of representatives from each jurisdiction. Some vehicle designs have been pre-advised by the PBS Review Panel and are therefore exempted from submission to the Panel.

Pre-advised design approval process

The HVNL requires all Design Approval applications to be submitted to the PBS Review Panel (the Panel) for review and advice. To simplify this approval process, the NHVR has worked in partnership with the Panel to agree on efficiency improvements, that allow some commonly approved vehicle designs to be exempted from submission. This process is known as 'pre-advised'.

Since the commencement of the pre-advised design approval process in March 2017, application processing times for qualifying vehicle types have reduced on average from four weeks to three business days. Pre-advised designs benefit from faster turnaround times without compromising the integrity of the PBS standards or the safety of the broader community.

The following types of PBS combinations are currently eligible to access the pre-advised approval process:

- truck and dog trailer
- prime mover and semitrailer
- B-double
- A-double.

Mass and length restrictions apply depending on the level of access required.

In addition, pre-advised designs exclude:

- designs that include innovative design features like semi-trailers with two axle groups
- designs that require an exemption from one or more PBS standards.

These excluded designs all require the PBS Review Panel's review and advice before the NHVR can consider approving them.

For more information, please refer to PBS Design Approval Application Form – Part A www.nhvr.gov.au/road-access/performance-based-standards/application-process-and-forms.

PBS Design and Vehicle Approval processes

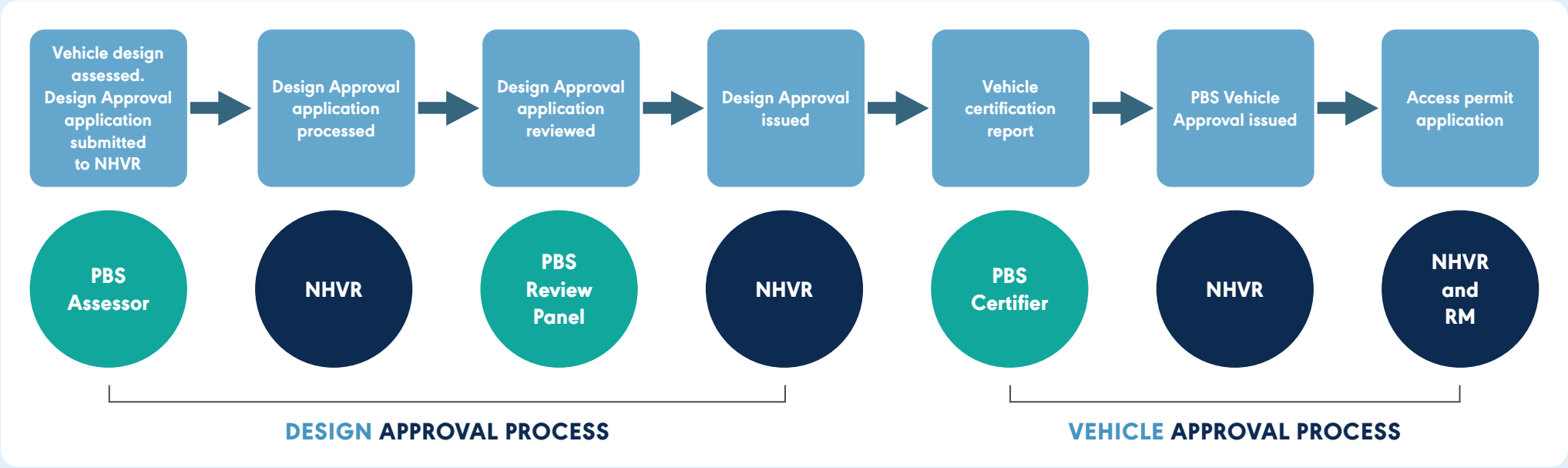

Figure 1. PBS Design and Vehicle Approval processes

PBS Vehicle Approval

The PBS Vehicle Approval serves as evidence that the vehicle has been accepted into the PBS scheme and is used to apply for an access permit.

A PBS Vehicle Approval contains the following information:

- mass limits
- operating conditions
- exemptions from Australian Design Rules and National Regulations
- combination layout drawing
- VINs and relevant technical specifications
- tyres fitted to the vehicle at inspection and those that may replace them in the future.

Exemptions from stated vehicle standards

The innovative nature of the PBS approach means vehicles do not always have to comply with the prescriptive standards and regulations applied to conventional vehicles. To allow for improved vehicle design, PBS vehicles may be granted exemptions from certain vehicle standards and regulations, such as those contained in the Australian Design Rules, the *Heavy Vehicle (Vehicle Standards) National Regulation* and the *Heavy Vehicle (Mass, Dimension and Loading) National Regulation (MDL)*.

The HVNL allows PBS vehicles to receive exemptions from the following prescriptive regulations:

- combination length
- trailer length, including swing radius, wheelbase and rear overhang
- vehicle height
- vehicle width
- drawbar[1] length
- tow coupling overhang[2] and location.

The PBS Vehicle Approval will detail the vehicle standards and regulations from which a particular PBS vehicle has been granted exemptions.

1 That part of a trailer (other than a semitrailer) that connects the trailer body to a coupling for towing purposes.
2 The horizontal distance from the centre of the rearmost axle group, to the pivot point of the coupling near the rear of the vehicle.

PBS axle limits

Typically, PBS vehicles have individual axle group masses that are the same as prescriptive vehicles and are in line with the MDL Regulation limits. For example, a PBS vehicle with a tri-axle group would normally be permitted 20t, which is the same as the prescriptive General Mass Limits (GML).

As the on-road performance of PBS vehicles is assessed against PBS standards, these combinations are allowed increased Total Combination Mass (TCM) compared to the prescriptive fleet. The additional TCM would often come from the increased vehicle dimensions and additional axle groups. Unlike PBS vehicles, the prescriptive fleet is not subject to safety performance assessment.

Further, PBS combinations that are subject to Tier 1 bridge formulae would often have the maximum axle group masses limited to below the maximum prescriptive limit contained in the MDL Regulation.

For bridge assessment requirements, refer to the Infrastructure standards section (page 26).

Vehicles fitted with quad-axle groups

The MDL Regulation allows quad-axle groups to operate at masses greater than 20t and up to 27t, provided a combination is PBS approved.

To ensure continued infrastructure protection, vehicles with masses above 21t on the quad-axle group will require a Tier 3 bridge assessment to be carried out, making these vehicles route-specific and subject to road manager consent.

Pavement wear comparison using Equivalent Standard Axles

When considering pavement impact using Equivalent Standard Axles (ESA) calculations, pavement wear can be assessed using a 'ESA/Payload' ratio.

Increased PBS vehicle mass combined with additional axle groups will inevitably result in greater ESA. However, because a PBS combination carries more freight and requires fewer trips to complete the same freight task, it consequently imposes less road wear per unit of freight carried.

The table below compares a 30m PBS Level 2 A-double with a benchmark semitrailer combination.

	Semitrailer	PBS A-double	% difference
GML mass (t)	43	79.5	+85
Trips per 1,000t of payload	42	21	-50
ESA per 1,000t of payload	304	225	-26

Source: Truck impact chart (ATA, 2018).

PBS quad-axle semitrailer vs prescriptive tri-axle semitrailer

By loading quad-axles to 27t (7t above the prescriptive limit of 20t), PBS offers a 11% productivity increase compared with a prescriptive tri-axle semitrailer.

	Prescriptive tri-axle semitrailer HML	PBS quad-axle semitrailer QML[1]
TCM (t)	46	50.5
Trips per 1,000t of payload	37	33

A PBS quad-axle semitrailer requires four fewer trips than a prescriptive combination to complete the same freight task. The reduction in trip numbers means fewer vehicles on the road, reducing pavement wear, congestion, emission levels and other road users' exposure to heavy vehicle traffic.

1 QML – quad-axle mass exception limit.

General access for Specified PBS vehicles

On 1 October 2018, amendments were made to the HVNL to allow Specified PBS vehicles (also known as Level 1 PBS vehicles) general access on all roads when operating at General Mass Limits (GML), as stated in the *Heavy Vehicle (Mass Dimension and Loading) National Regulation (MDL).*

A Specified PBS vehicle:
- has a current PBS Level 1 Vehicle Approval
- is no longer than 20 metres
- is not a bus, road train, A-double or B-double
- is loaded to GML masses as per Schedule 1 of the MDL Regulation.

The following mass exception limits do not apply to Specified PBS vehicles:
- concessional mass limits (CML)
- higher mass limits (HML)
- quad axle mass exception limits (QML)
- one tonne tri-axle mass transfer allowance.

The following GML apply to the corresponding vehicles, as per Schedule 1 of the MDL:
- 43t for a complying steer axle vehicle that is neither a B-double nor a road train
- 46.5t for a prime mover with a twinsteer axle group towing a tri-axle semitrailer
- 42.5t for a vehicle that is not mentioned above and that is neither a B-double nor a road train.

Specified PBS vehicles must comply with the axle and axle group mass limits in Table 1 of Schedule 1 of the MDL Regulation (axle spacing tables). Combinations towing a dog or pig trailer must ensure the trailer mass is not more than the mass of the towing vehicle (1:1 towing ratio).


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3 PBS classifications

PBS classifications

Based on on-road performance, PBS vehicles are classified into one of four levels in accordance with the *Standards and Vehicle Assessment Rules* (NTC, 2008).

In accordance with the *PBS Network Classification Guidelines* (NTC, 2007), a vehicle that is approved at a particular level is eligible to operate on the road network of the same classification level or higher, subject to road manager approval.

	Equivalent prescriptive vehicle configuration	Network access
PBS Level 1	19m prime mover and semitrailer	General access
PBS Level 2	26m B-double	26m B-double network
PBS Level 3	36.5m Type I road train	36.5m Type I road train network
PBS Level 4	53.5m Type II road train	53.5m Type II road train network

Table 1. PBS network descriptions

Network levels are based on geometric requirements – that is, how much road space is required for safe vehicle operation. Structural limitations due to vehicle mass and axle loads are not part of the geometric assessment. Heavier vehicles may have geometric performance suitable for a particular level of road network; however, the impact on the infrastructure due to increased vehicle mass needs to be considered separately.

The PBS standards have been aligned so that a worst case PBS vehicle for a given level will perform no worse than its equivalent prescriptive vehicle configuration. For example, a worst case PBS Level 1 vehicle will geometrically perform no worse than a prescriptive 19m prime mover and semitrailer, and a worst case PBS Level 2 vehicle will perform no worse than a prescriptive 26m B-double.

Table 2 shows a comparison of vehicle geometric performance. The standards relating to geometric performance are Frontal Swing, Low Speed Swept Path, Tail Swing, Tracking Ability on a Straight Path and High-Speed Transient Offtracking. The standards relating to geometric performance are the main focus when considering access suitability.

	PBS Level 2 Limit	Prescriptive 26m B-double (3-3)	PBS Level 2 30m B-double (4-4)	PBS Level 2 30m A-double (3-2-3)
Tracking Ability on a Straight Path	≤ 3m	3m	2.88m	2.9m
Low Speed Swept Path	≤ 8.7m	8.4 – 9.1m	8.7m	8.4m
Frontal Swing				
a) Maximum frontal swing	≤ 0.85m	0.7m	0.53m	0.6m
b) Maximum of Difference	≤ 0.4m	0.4m	0.3m	0.3m
c) Difference of Maxima	≤ 0.2m	0.2m	-0.08m	-0.09m
Tail Swing	≤ 0.35m	0.35m	0.28m	0.05m
High-Speed Transient Offtracking	≤ 0.8m	0.4 – 0.8m	0.76m	0.8m

Table 2. Prescriptive 26m B-double vs 30m PBS Level 2 30m combinations

The LSSP performance of a longer 30m PBS Level 2 Quad-Quad B-double is the same as a prescriptive 26m 9-axle B-double. The optimised turning capability of a longer PBS B-double combination is achieved through improved vehicle design and the use of steerable axles on its quad-axle groups. When the steer axle is fitted at the back it shifts the axle group's turning centre to the second axle, effectively shortening the S-dimension of the semitrailers, resulting in better turning capability.

The LSSP performance of a longer 30m PBS Level 2 A-double is better than that of a prescriptive 9-axle 26m B-double (8.4m vs 8.7m). The improved turning capability of a longer 30m PBS A-double is achieved via the inclusion of an extra articulation point between the dolly and rear semitrailer.

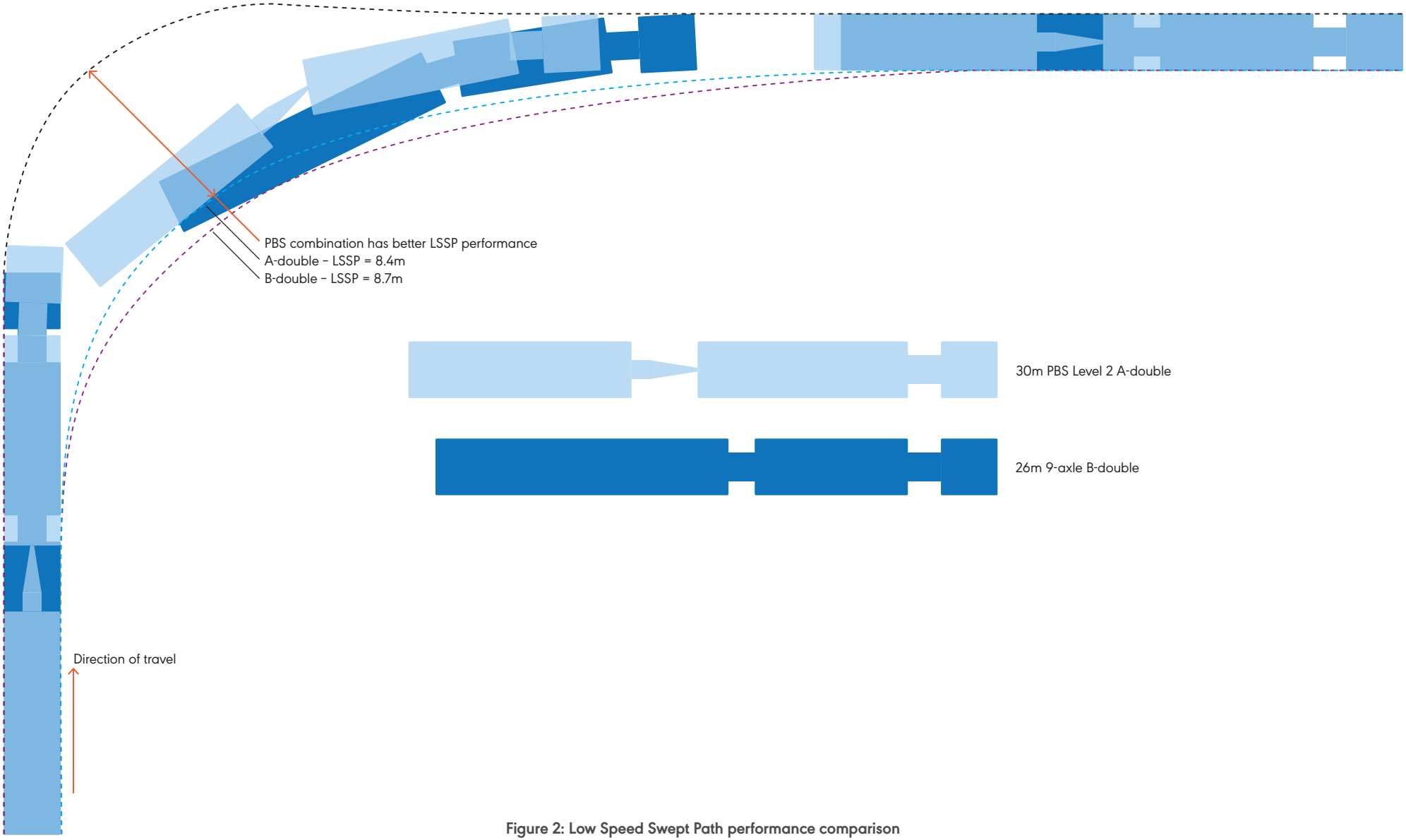


Figure 2: Low Speed Swept Path performance comparison

PBS length limits and Class A and B networks

Vehicle length is an important factor when considering access; however, the length of the vehicle does not determine the level of vehicle performance.

The *PBS Network Classification Guidelines* (NTC, 2007) identifies the following length limits for PBS combinations. Levels 2 to 4 are split into two classes: Class A and Class B.

	Overall vehicle length (m)[1]	
	Class 'A'	**Class 'B'**
PBS Level 1	L ≤ 20.0	L ≤ 20.0
PBS Level 2	L ≤ 26.0	26.0 < L ≤ 30.0
PBS Level 3	L ≤ 36.5	36.5 < L ≤ 42.0
PBS Level 4	L ≤ 53.5	53.5 < L ≤ 60.0

Table 3. PBS network access by vehicle length

Class A vehicles conform to the existing prescriptive networks e.g. a Level 2 PBS vehicle that is no longer than 26m (Class A) is suitable for operation on the existing 26m B-double network.

Class B vehicles exceed prescriptive lengths, yet achieve equal or better geometrical performance than an equivalent prescriptive combination vehicle, with the exception of overall combination length. Despite increased length, geometrically Class B vehicles perform no worse than the requirements for that access level.

Vehicles that exceed the upper length bracket for their level will require an individual route assessment. For example, a 31m long vehicle can be approved on PBS Level 2 Class B road; however, an individual route assessment will be required to determine suitability. In this case the following should be taken into consideration:

- length of parking bays, rest and decoupling areas
- signal timing and stacking distances between adjacent intersections and at railway level crossings
- entry length onto main roads and highways
- overtaking provisions.

For detailed route assessment requirements, refer to the *PBS Network Classification Guidelines* (NTC, 2007).

Vehicle length vs on-road performance

Overall vehicle length is one of the primary drivers of freight vehicle productivity, particularly for those vehicles with loads that are volumetrically constrained.

Vehicle length is also an important factor when considering access. Despite Class B vehicles being longer than Class A vehicles, the on-road performance of a Class B vehicle is no worse than its prescriptive equivalent.

On-road performance of a Class B vehicle

- A Class B vehicle will not require any more road space to complete a prescribed 90° low-speed turn than equivalent prescriptive combinations.
- Low Speed Swept Path, Frontal Swing, Tail Swing and Tracking Ability on a Straight Path performance of longer Level 2 Class B vehicles will be no worse than the equivalent 26m prescriptive B-double combination.
- Access of a PBS Level 2 Class B vehicle to an existing prescriptive 26m B-double road should not be refused on the grounds of swept path width or lane width because the Class B vehicle will not require any more road space than an equivalent 26m long prescriptive combination.

1 Length limits are part of the road classification system and are not designed to control the length of PBS combinations.

4 Assessing PBS vehicles for road access

Responding to an access request

The NHVR receives access permit applications through the NHVR Portal, reviews them for accuracy and completeness, and then forwards them to the relevant road manager for consent.

The HVNL requires a road manager to respond to an access request within 28 days of receiving the application. The road manager can request an extension of time for complex applications.

If a route or network assessment has been undertaken and is determined to be unsuitable for the requested combination and/or mass limits, road managers should consider the following before refusing access:

- suggest an alternative route (only if the route does not affect another road manager's road infrastructure)
- consider reduced masses, if no alternative route is available
- request a business case from the operator, so the benefits to the economy and local community can be weighed against risks. The business case may include:
  - the commodity being transported
  - the number of trips required per week
  - how the PBS vehicle will improve the efficiency of the freight task compared to the use of prescriptive vehicles (e.g. anticipated reduction in trip numbers)
  - the local business involved and benefits to the community
- request a route/bridge assessment (in some cases at the operator's expense).

When considering an application for access, it is important to understand that PBS vehicles are designed to meet a specific freight task. Generally, the freight task already exists and will remain constant after the approval of PBS vehicles. If access for a PBS combination is not granted, the task may be completed by prescriptive combinations instead, requiring a greater number of trips, resulting in increased traffic, reduced area amenity and more emissions. For example, granting an access approval to a PBS vehicle for a construction project will not necessarily invite more applications to use that road. Once the construction project has been completed, the heavy vehicles will no longer need access to the area.

Handling large volumes of consent requests

Permit pre-approvals

The NHVR encourages road managers to provide pre-approvals for frequently used vehicle types and routes.

A permit pre-approval is a method used to resolve a large number of consent requests for similar vehicle combinations. It is an administrative arrangement between the NHVR and road managers that allows a road manager to advise the NHVR that any permit application falling within nominated specifications may be approved without the need to consult the road manager.

Pre-approvals are set up to help reduce the administrative burden on road managers and allow them more time to focus on complex consent requests.

A permit pre-approval can be issued for a specified time period along with operating conditions specific to the vehicle and area of access. A permit issued under a pre-approval is subject to the same legislative requirements as other access permits and can be revoked in accordance with the law.

A copy of every permit issued under the permit pre-approval is available on the NHVR Road Manager Portal.

5 PBS standards

PBS standards

PBS vehicles are assessed against 16 stringent safety standards and four infrastructure standards to ensure they are safe and fit the existing road networks. Every vehicle combination is assessed against these standards by an authorised PBS Assessor via a computer simulation, or physical testing.

This section provides an overview and detailed explanation of the PBS standards against which every vehicle is assessed.

Note: Ride quality, handling quality and overtaking are not included in the table below or descriptions on the following pages.

For detailed assessment methods, refer to *The Standards and Vehicle Assessment Rules* (NTC, 2008).

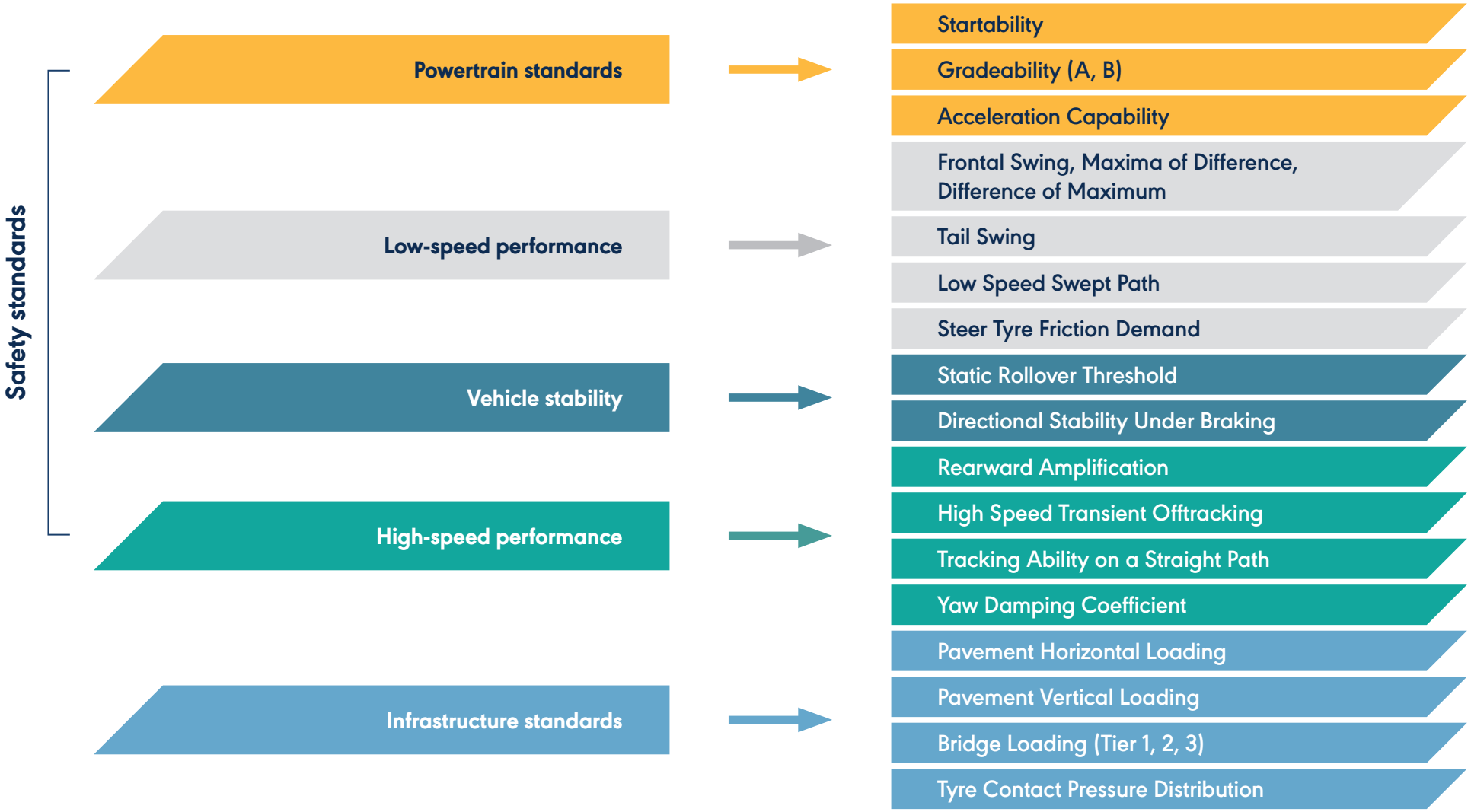


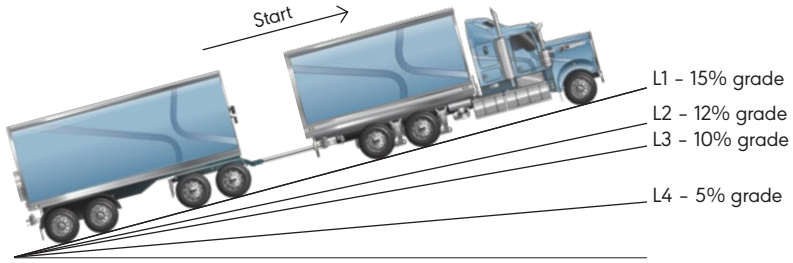
Figure 3. PBS safety and infrastructure standards

Safety standards

Startability

The primary purpose of this standard is to manage safety risks associated with starting on grades by ensuring a PBS vehicle has adequate starting capability on grades.

This means that a PBS vehicle has been assessed as capable of starting on the steepest grade it has to negotiate on the nominated route when operating at its maximum allowed gross mass. This is to ensure it does not become a safety risk or inconvenience to other road users.



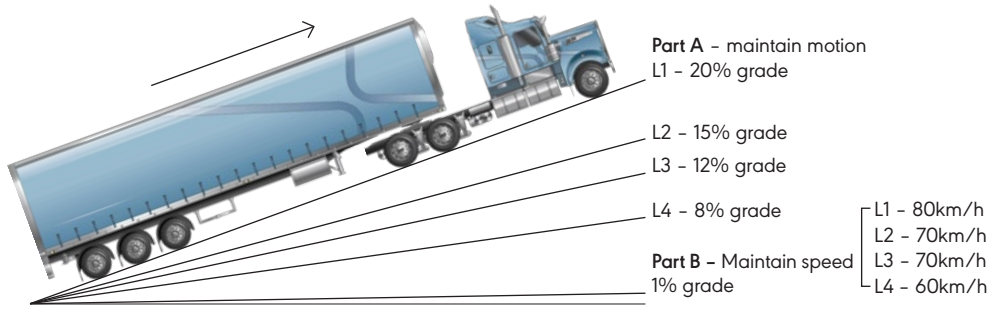
Gradeability (A, B)

Gradeability is the ability of the vehicle to maintain forward motion on a specified upgrade.

The primary purpose of this standard is to manage safety risks associated with travel on grades by ensuring a PBS vehicle has the capability to maintain acceptable speeds on upgrades.

Part A is the ability of a vehicle to maintain forward motion on a specified upgrade.

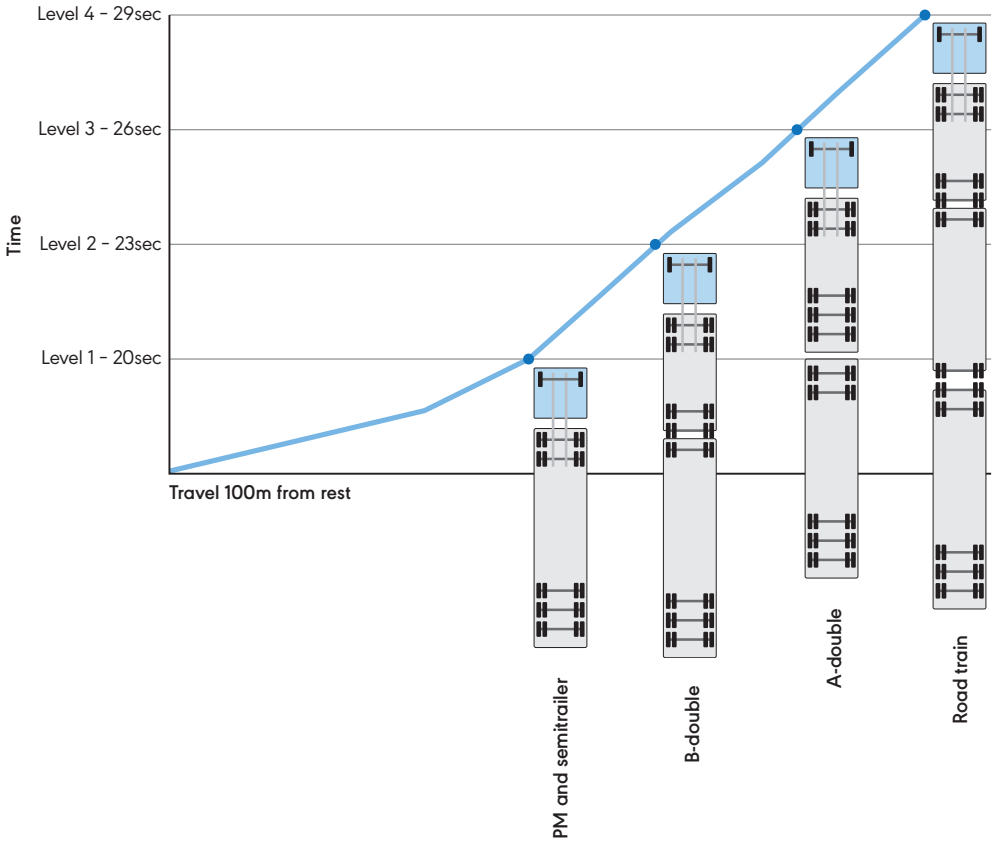
Part B is the ability of a vehicle to maintain minimum speed on a 1% upgrade.



Acceleration Capability

Acceleration Capability is the ability of the vehicle to either accelerate from rest on a road with no grade.

The primary purpose of this standard is to manage safety risks associated with travel through intersections and rail crossings by specifying minimum times for a PBS vehicle to accelerate from rest, increase speed and travel specified distances. The PBS vehicle must be able to accelerate from rest and travel 100m on a road with no grade within a specified time.

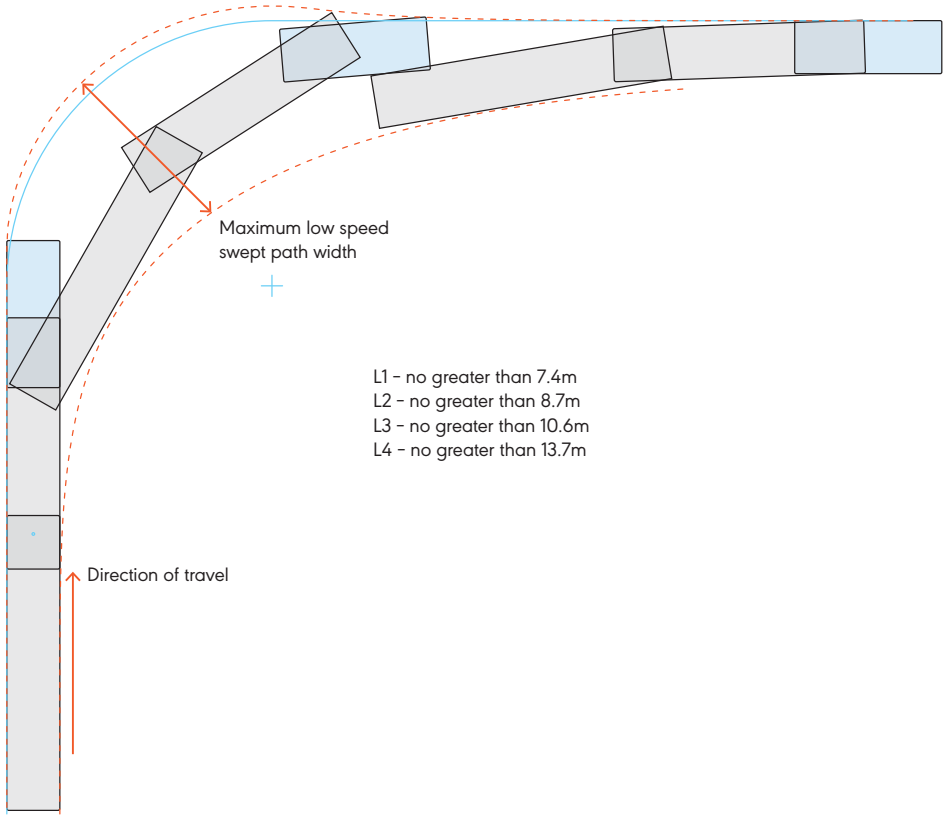


Low Speed Swept Path (LSSP)

LSSP is the maximum width of road space required for a vehicle to complete a 90° low-speed (< 5km/h) turn on a 12.5m radius.

When a long vehicle makes a low-speed turn at an intersection, the rear of the vehicle will follow a path that is inside the path taken by the front of the vehicle. Poor LSSP performance may cause the vehicle to encroach into adjacent or opposing lanes, collide with parked or stopped vehicles, damage roadside furniture or endanger pedestrians, or its rear wheels may climb the kerb or fall off the edge of the pavement.

The primary purpose of this standard is to manage safety risks associated with turns at intersections by limiting the road space required by PBS vehicles making low-speed turns.



Frontal Swing (FS)

FS is the maximum projection of the front overhang of the hauling unit outside the path of the front steering wheel in a prescribed 90° low-speed turn.

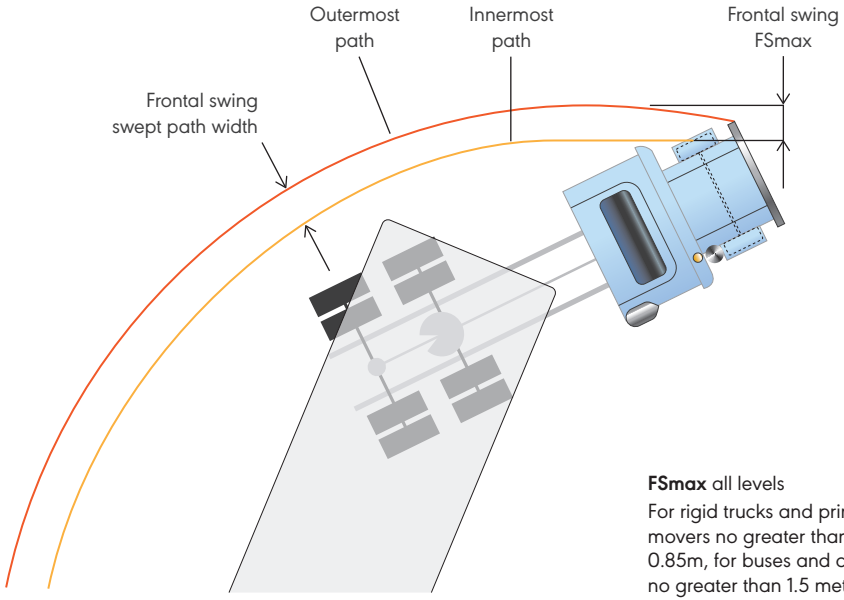
The primary purpose of this standard is to manage safety risk by limiting the road space required by a PBS vehicle when making a tight turn at low-speed. A large amount of FS is undesirable, as the vehicle might encroach on other lanes, endanger pedestrians or collide with roadside furniture.

Maxima of Difference (MoD) and Difference of Maximum (DoM)

MoD and DoM relate to the amount by which the front outside corner of a semitrailer swings out beyond that of the path of the hauling unit or preceding semitrailer.

MoD is the maximum difference between the swing-out of adjacent vehicle units when performing a low-speed turn.

DoM is the difference between the maximum frontal swing-out distances between adjacent vehicle units when performing a low-speed turn.



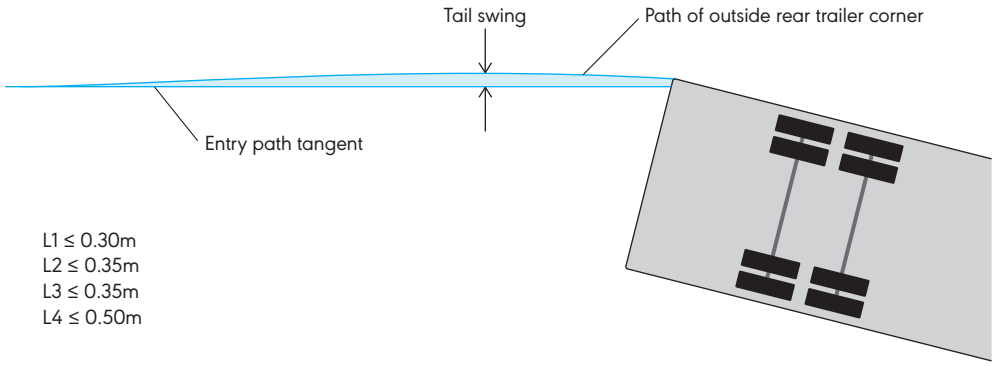
FSmax all levels
For rigid trucks and prime movers no greater than 0.85m, for buses and coaches no greater than 1.5 metres.

Tail Swing (TS)

TS is the maximum outward lateral displacement of the outer rearmost point on a vehicle unit during the initial and final stages of a prescribed 90° low-speed turn.

TS is typically of more concern in urban areas. Vehicles with significant rear overhang (e.g. route buses or semitrailers) and/or coupling rear overhangs will exhibit significant amounts of tail swing when negotiating tight manoeuvres, such as when exiting kerbside pickup areas.

The primary purpose of this standard is to manage safety risks by limiting the road space requirement of a PBS vehicle when making a tight turn at low-speed.

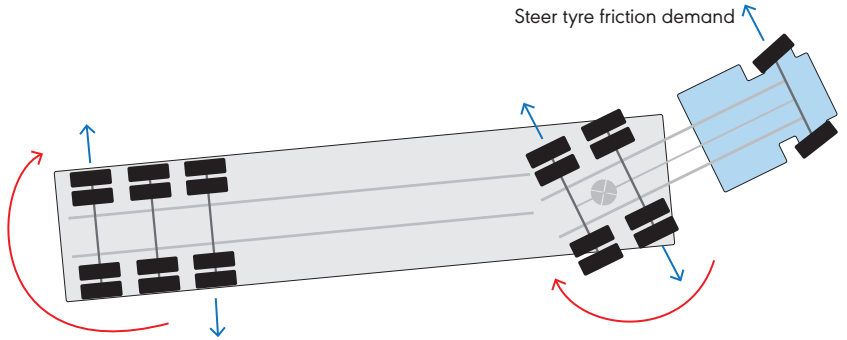


Steer Tyre Friction Demand

Steer Tyre Friction Demand is the proportion of the available friction that is used by the vehicle's steer tyres when performing a low-speed 90° turn.

During a small radius turn at low-speed, loss of steering will occur when the available tyre/road friction limit at the steer tyres is exceeded. In this situation, the vehicle will tend to 'plough straight ahead', exhibiting significant heavy understeer and risking low-speed collisions with other vehicles or roadside objects.

The primary purpose of this standard is to manage safety risks by limiting the likelihood of a vehicle losing steering control when making a tight turn at low-speed.

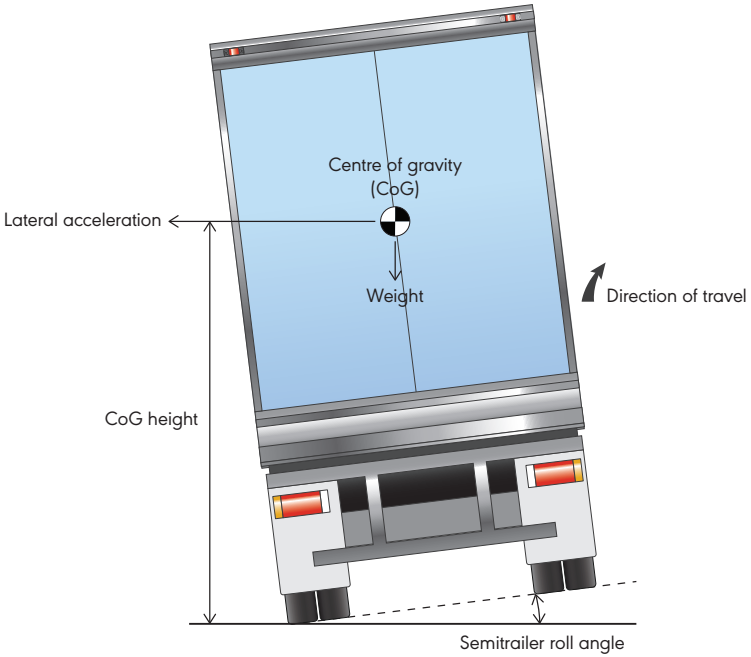


Static Rollover Threshold (SRT)

SRT is the amount of lateral force a vehicle can sustain without rolling over while travelling along a curved path.

High values of SRT imply better resistance to rollover. Rollover occurs when the lateral (or sideway) acceleration is sufficient to exceed the vehicle's rollover stability threshold.

The primary purpose of this standard is to manage safety risk by limiting the rollover tendency of a PBS vehicle during turns. A PBS vehicle will have an SRT of no less than 0.35g. Where the vehicle is a road tanker hauling dangerous goods in bulk, or a bus or coach, the rollover stability threshold must not be less than 0.40g.

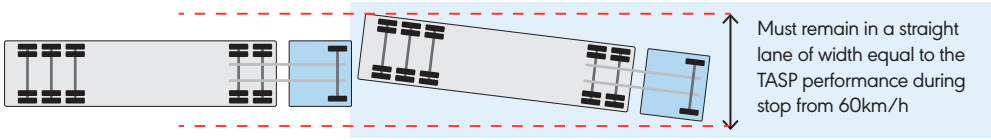


Directional Stability Under Braking

The purpose of the directional stability standard is to manage the safety risk of vehicle instability when braking in a turn or on pavement cross slopes.

A vehicle must not exhibit gross wheel lock-up behaviour in any loading condition and must remain in a straight lane of width equal to that specified in the standard 'Tracking Ability on a Straight Path' for the corresponding level of operation when it is braked from 60 km/h.

Compliance with this standard is achieved through 'deemed-to-comply provisions' (e.g. a vehicle that has a functioning anti-lock or a load proportioning brake system that effectively prevents gross wheel lock-up on each axle group is deemed to comply with the standard).



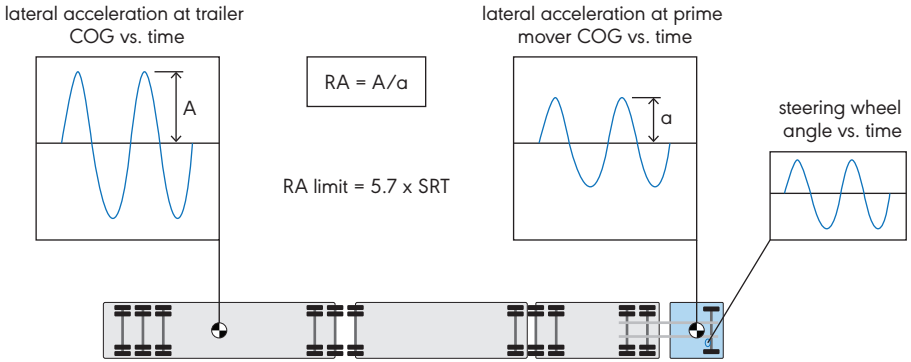
Braking performance to ensure straight-line stability

Rearward Amplification (RA)

RA is the degree to which the lateral acceleration of the hauling unit is amplified compared to the rear unit of the combination.

RA generally relates to heavy vehicles with more than one articulation point, such as truck-trailers and road train combinations. These vehicles exhibit a tendency for the trailing unit/s to experience higher levels of lateral acceleration (sway) than the hauling unit. The amount of sway exhibited by the trailing units is a serious safety concern in rapid path-change manoeuvres and can lead to rear-trailer rollover.

The primary purpose of this standard is to manage safety risks by limiting the lateral directional response of multi-articulated PBS vehicles in avoidance manoeuvres performed at highway speeds without braking.

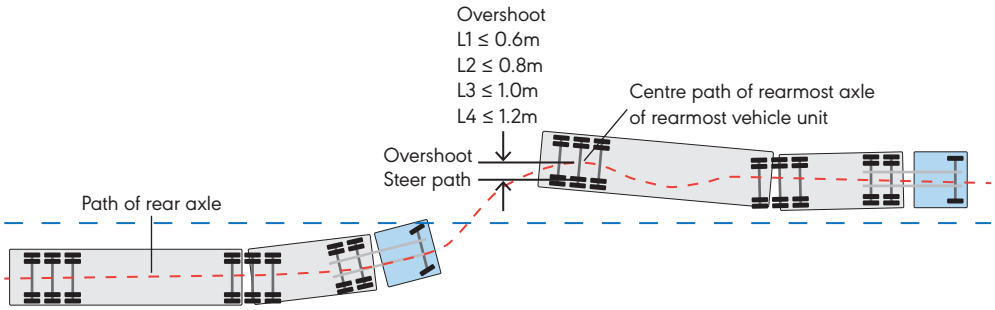


High Speed Transient Offtracking (HSTO)

HSTO is the distance that the last axle on the rearmost trailer tracks outside the path of the steer axle in a sudden evasive manoeuvre.

In a sudden evasive manoeuvre, the sideways movement of the rear end of a vehicle may extend beyond or 'overshoot' that of the hauling unit. The amount of HSTO overshoot can be viewed as an indication of the severity of intrusion into an adjacent or opposing lane, striking a kerb or dropping off the road seal (thus precipitating rollover), or collision with a roadside object.

The primary purpose of this standard is to manage safety risks by limiting the sway of the rearmost trailers of multi-articulated PBS vehicles in avoidance manoeuvres performed at highway speeds without braking.

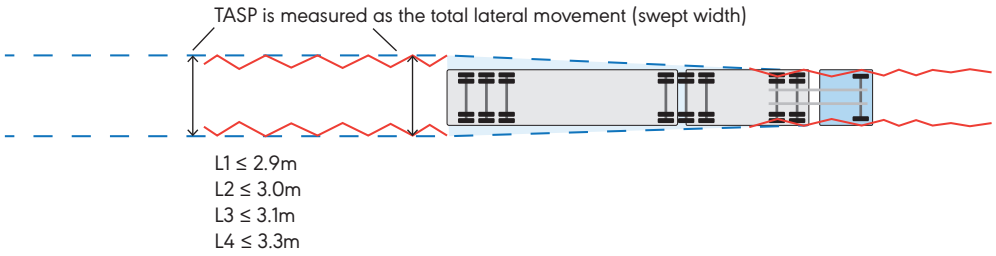


Tracking Ability on a Straight Path (TASP)

TASP is the ability of the trailing units to follow along the same path as the hauling unit.

TASP is measured as the total swept width while travelling on a straight path, including any variations due to cross fall, road surface unevenness and driver steering activity. Each trailer in a combination will undergo small lateral deviations from the path of its lead unit as it responds to the driver's steering actions, road surface unevenness and other external disturbances. TASP is a practical requirement and necessary for safe operation.

The primary purpose of measuring and controlling tracking ability is to manage safety risks associated with the vehicle's ability to remain within its traffic lane when travelling at high speed on straight roads with uneven surfaces.

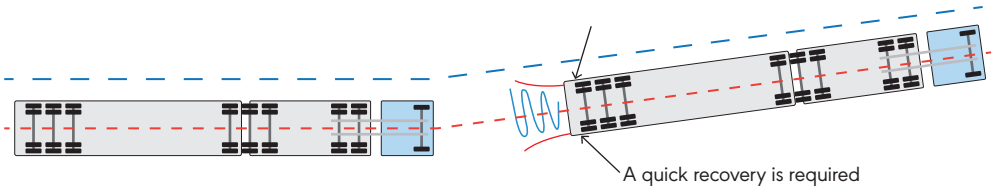


Yaw Damping Coefficient

The Yaw Damping Coefficient quantifies how quickly 'sway', or yaw oscillations settle after application of a short duration steer input at the hauling unit.

An important consideration in the stability and handling of heavy vehicles is how quickly swing or sway oscillations take to 'settle down' or decay after a severe manoeuvre has been performed. Vehicles that take a long time to settle represent a higher safety risk to other road users and to the driver.

The primary purpose of this standard is to manage safety risks by requiring acceptable attenuation of any sway oscillations of articulated PBS vehicles.

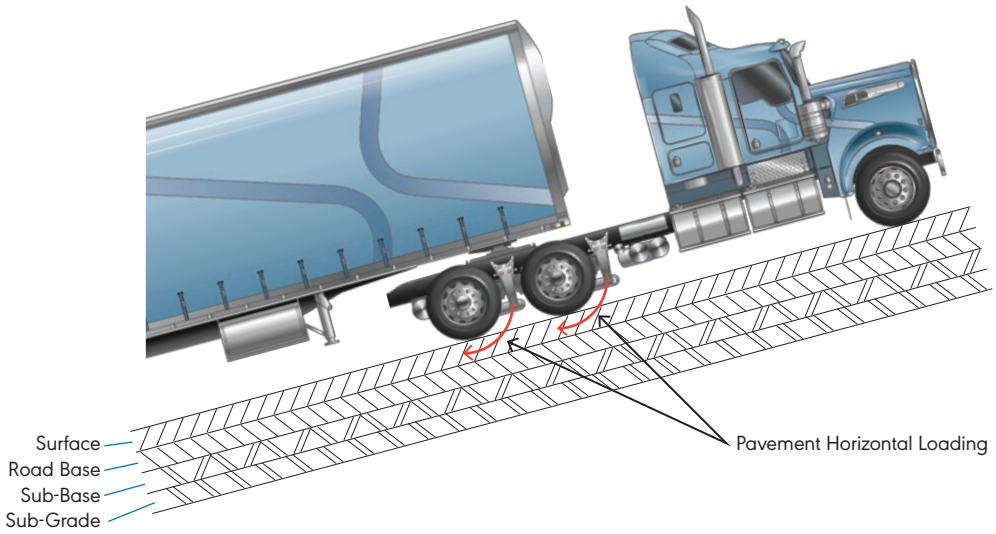


Pavement Horizontal Loading

Pavement Horizontal Loading is the degree to which horizontal forces are applied to the pavement surface in a low-speed turn during acceleration and on uphill grades.

The horizontal forces imposed on a pavement are forces caused by braking by the drive axle/s when a vehicle starts, accelerates or climbs an uphill grade, and the forces generated during a turning manoeuvre.

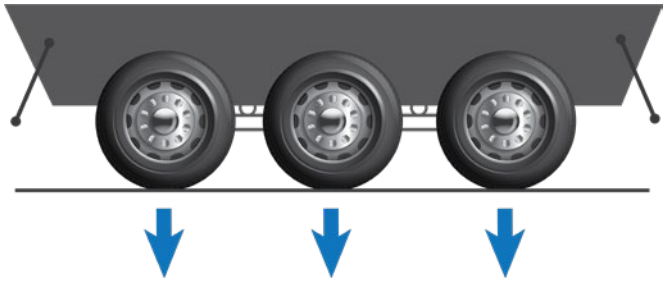
The purpose of this standard is to regulate road wear by limiting the impact on the surface of road pavements.



Pavement Vertical Loading

The purpose of the Pavement Vertical Loading standard is to limit the stress on the pavement layers below the surface of the road.

While the total gross mass is not limited by this standard, the individual axle group loads for a PBS vehicle should not exceed the maximum permitted for that type of axle group.



Bridge Loading

Three tiers of bridge assessment are used to protect bridges and to limit the maximum effect on bridges caused by heavy vehicles. Each successive tier may allow greater gross mass but reduce the extent of network access.

Tier 1 bridge assessment is the general requirement for bridge loading and is based on the vehicle complying with the bridge formulae.

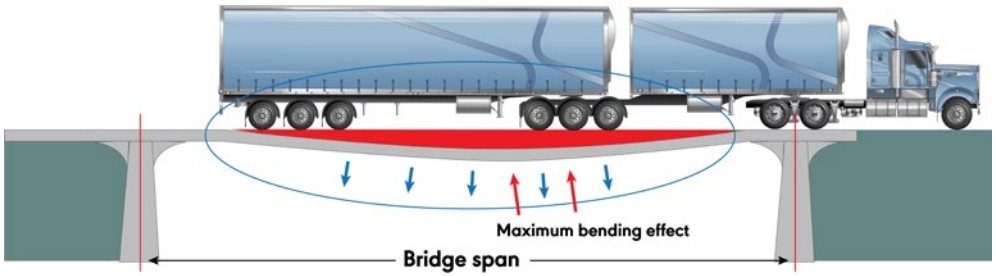
The Tier 1 bridge formulae use the same principle as Axle Tables in Schedule 1 of the MDL, which limits the mass between any extreme axles of any two axle groups.

Combinations failing to comply with the Tier 1 bridge formulae will require a Tier 2 or 3 bridge assessment.

Tier 2 assessment is also known as Maximum Effect Relative to Reference Vehicle (MERRV).

The assessment is used to demonstrate that the maximum bridge effects are no worse than those caused by existing commercial vehicles. The assessment must be undertaken by a qualified engineer.

Tier 3 assessment requires approval by the owners of the specific bridges, based on detailed individual bridge analysis. The bridge assessment may be outsourced to an engineer using the authorities' bridge data. The assessment may be done at the operator's expense.



Tyre Contact Pressure Distribution

The purpose of this standard is to restrict road wear by setting minimum tyre widths and by limiting the local contact pressure between the tyre and the road within the tyre contact patch. Existing prescriptive requirements relating to minimum tyre width and maximum pressure have been retained and applied to PBS vehicles.

Increased vehicle mass on bridges

The following should be taken into account when assessing the effect of increased vehicle mass on a bridge to determine whether additional loading can be safely accommodated within the bridge's capacity.

- The type of bridge structure and its span length.
- PBS axle group masses are the same as prescriptive vehicles; therefore, load effects on short-span bridges will be no worse because they do not need to support all axles of the combination at once.
- A tandem-axle dolly A-double will be no worse than a B-double with consecutive tri-axle groups on short-span bridges because the bridge span will only support one axle group at a time.

Common PBS vehicles: On-road performance and benefits

Below are examples of how three common PBS combinations typically perform and the benefits they offer. The performance values described in the following examples are based on the average of the fleet (performance of individual combinations may vary).

Example 1: 3-axle truck and 4-axle dog trailer

More than 87%[1] of 4-axle dog trailers manufactured in 2017 were PBS approved, making the 3-axle truck and 4-axle dog combination the largest group of PBS vehicles currently on the roads.

The 3-axle truck and 4-axle dog combinations are typically approved at the levels in Table 4.

	Steer[2] (t)	Drive (t)	Trailer (t)	Total (t)	Length (m)
PBS Level 1 GML	6.5	16.5	13.75	50.5	≤ 20.0
PBS Level 2 HML	6.5	17.0	17.0	57.5	≤ 20.0
Prescriptive GML	6.5	16.5	16.5	43.0	≤ 19.0

Table 4. 3-axle truck and 4-axle dog combinations mass and length limits

All PBS 3-axle truck and 4-axle dog combinations comply with Tier 1 bridge formulae[3], which determine the maximum allowable mass across consecutive axle groups depending on the distance between any two axle groups. See the infrastructure standards section for more info.

Productivity gains

A PBS Level 2 3-axle truck and 4-axle dog combination at 57.5t has the following advantages when compared to a prescriptive truck and dog combination:

- Up to 22% increase in payload capacity
- Up to 18% fewer truck trips required to complete a given freight task.

On-road performance

When considering the on-road performance of PBS 3-axle truck and 4-axle dog combinations, it is important to recognise that the same vehicle will perform differently at different masses. As shown in Table 4, combinations are typically approved at Level 1 when operating at GML (50.5t) and Level 2 when operating at HML (57.5t).

The difference in on-road performance for this vehicle at the higher mass is summarised in Table 5.

PBS standard	PBS Level 1 limit	Performance at 50.5t	PBS level 2 limit	Performance at 57.5t
LSSP	≤ 7.4m	6.2m	≤ 8.7m	6.2m
Typical SRT	≥ 0.35g	0.43g	≥ 0.35g	0.42g
HSTO	≤ 0.6m	0.6m	≤ 0.8m	0.8m
Acceleration capability	≤ 20 sec	19 sec	≤ 23 sec	21 sec
At 57.5t, most 3-axle truck and 4-axle dog combinations would meet all other PBS Level 1 standards.				

Table 5. Select 3-axle truck and 4-axle dog performance values

LSSP performance

The combination mass is a non-critical parameter when it comes to a vehicle's ability to complete a low-speed 90° turn. Irrespective of mass (50.5t or 57.5t), the LSSP of a typical PBS 3-axle truck and 4-axle dog combination is 6.2m. A prescriptive 19m prime mover and tri-axle semitrailer would have a LSSP of around 7m and a typical 26m prescriptive 9-axle B-double would have a LSSP of between 8.4m and 9.1m.

Summary

Considering productivity gains, coupled with the combination length not exceeding 20m, compliance with Tier 1 bridge formulae and performance being no worse than its prescriptive counterparts; PBS 3-axle truck and 4-axle dog combinations should be considered for general access at 50.5t and for access to existing B-double networks at 57.5t.

1 *Australia's PBS fleet report* (ARTSA and NHVR, 2018).
2. Complying steer axle.
3 Axle group masses may be reduced to ensure compliance with the Tier 1 bridge formulae.

Example 2: 30m A-double

The 30m A-double consists of a 3-axle prime mover, two tri-axle semitrailers and a tandem- or tri-axle dolly. A 30m A-double combination is typically approved at the masses in Table 6.

Vehicle	Steer[1] (t)	Drive (t)	Trailer (t)	2-axle dolly (t)	Trailer (t)	Total (t)	Length (m)
PBS Level 2 HML	6.5	17.0	22.5	17.0	22.5	85.0	≤ 30.0
Prescriptive 9-axle B-double HML	6.5	17.0	22.5	NA	22.5	68.5	≤ 26.0

Table 6. Level 2 and B-double HML masses

Individual axle group masses are the same as the prescriptive MDL limits for the corresponding axle group. The extra TCM is gained by incorporating an additional axle group (dolly) compared to a B-double.

On-road performance

The increased number of articulation points means a longer vehicle can complete a tighter turn. For example, the LSSP of a typical PBS 30m A-double combination is 8.4m and the LSSP of a prescriptive a 26m B-double is around 8.7m. Therefore, where 26m B-doubles are already approved, 30m A-doubles that meet PBS Level 2 standards should also be considered for access, as they do not have a greater LSSP. Other performance standards will also be no worse than the equivalent 26m 9-axle B-double prescriptive combination.

Example 3: 20m prime mover and tri-axle semitrailer

A PBS 20m prime mover and tri-axle semitrailer is approved at Level 1, with the masses in Table 7:

	Steer[1] (t)	Drive (t)	Trailer (t)	Total (t)	Length (m)
PBS Level 1 GML	6.5	16.5	20.0	43.0	≤ 20.0
PBS Level 1 CML	6.5	17.0	21.0	44.0	≤ 20.0
PBS Level 1 HML	6.5	17.0	22.5	46.0	≤ 20.0
Prescriptive tri-axle semitrailer GML	6.5	16.5	20.0	43.0	≤ 19.0
Prescriptive tri-axle semitrailer HML	6.5	17.0	22.5	46.0	≤19.0

Table 7. Prime mover and tri-axle semitrailer mass and length limits

On-road performance

The increase in combination length provides an extra metre of load space and a 7% increase in volumetric payload capacity, meaning the same volume of payload can be transported in fewer trips.

A PBS Level 1 approval means that a vehicle's performance is no worse than that of a prescriptive 19m prime mover and tri-axle semitrailer. With axle group masses in line with prescriptive regulations and an overall combination length of 20m, these vehicles are suitable for general access.

1 Complying steer axle.

National Heavy Vehicle Regulator
PBS Vehicle Configurations

Disclaimer: This chart shows some of the NHVR-approved PBS heavy vehicle combinations used in Australia. Other heavy vehicle configurations may not be represented. The mass and length limits shown are from the Heavy Vehicle (Mass, Dimension and Loading) National Regulation (the MDL Regulation) and are provided for general guidance only. These limits are available only to vehicles that comply with all other regulatory requirements (e.g. width and height limits, tyre width, vehicle standards, load restraint, suspension type etc.). In some circumstances, other mass concessions and length limits may also be available. The NHVR website provides links to the MDL Regulation and to national and state Notices that may apply, depending on individual circumstances. For further information, contact the NHVR on 1300 MYNHVR (1300 696 487) at info@nhvr.gov.au or www.nhvr.gov.au/contact-us

Common PBS vehicle configurations		Description	PBS level	Maximum length† (m)	Maximum permitted mass		
					GML (t)	CML (t)	HML (t)
PBS TRUCK AND DOG TRAILERS							
1		3-axle truck and 3-axle dog trailer	1 2	20.0 20.0	48.5 48.5	– 49.5	– 49.5
2		3-axle truck and 4-axle dog trailer	1 2	20.0 20.0	50.5 56.0	– 57.5	– 57.5
3		3-axle truck and 5-axle dog trailer	2	26.0	59.5	61.5	63.0
4		3-axle truck and 6-axle dog trailer	2	26.0	63.0	65.0	68.5
5		4-axle truck and 3-axle dog trailer	1 2	20.0 20.0	50.0 53.0	– 54.0	– 54.0
6		4-axle truck and 4-axle dog trailer	1 2	20.0 20.0	50.0 60.5	– 62.0	– 62.0
7		4-axle truck and 5-axle dog trailer	2	26.0	64.0	66.0	67.5
8		4-axle truck and 6-axle dog trailer	2	26.0	67.5	69.5	73.0
PBS PRIME MOVER AND SEMITRAILERS							
9		2-axle prime mover and 2-axle semitrailer	1	20.0	32.0	32.5	32.5
10		3-axle prime mover and 2-axle semitrailer	1	20.0	39.5	40.5	40.5
11		3-axle prime mover and 3-axle semitrailer	1	20.0	43.0	44.0	46.0
12		4-axle prime mover and 3-axle semitrailer	1	20.0	47.5	48.5	50.5
13		3-axle prime mover and quad-axle semitrailer	1	20.0	43.0	44.0*	50.5*
14		4-axle prime mover and quad-axle semitrailer	1	20.0	47.5	48.5*	55.0*◇
15		Prime mover and semitrailer with 2 axle groups (2-1)△	1	20.0	48.0	49.0	49.0
16		Prime mover and semitrailer with 2 axle groups (1-3)△	1	20.0	49.7	50.7	53.5◇

Common PBS vehicle configurations		Description	PBS level	Maximum length† (m)	Maximum permitted mass		
					GML (t)	CML (t)	HML (t)
PBS B-DOUBLES							
17		3-axle prime mover B-double (2-2)	1	20.0	50.5	–	–
			2	26.0	56.0	57.5	57.5
			3	30.0	56.0	57.5	57.5
18		3-axle prime mover B-double (3-2)	1	20.0	50.5	–	–
			2	26.0	59.5	61.5	63.0
19		3-axle prime mover B-double (3-3)	2	26.0	63.0	65.0	68.5
			3	30.0	63.0	65.0	68.5
20		3-axle prime mover B-double (4-3)	2	26.0	63.0	65.0*	73.0*
			3	30.0	63.0	65.0*	73.0*
21		3-axle prime mover B-double (4-4)	2	26.0	63.0	65.0*	77.5*
			3	30.0	63.0	65.0*	77.5*
PBS A-DOUBLES							
22		3-axle prime mover A-double (2-2-2)	2	30.0	72.5	74.5	74.5
23		3-axle prime mover A-double (3-2-3)	2	30.0	79.5	81.5	85.0
			3	36.5	79.5	81.5	85.5
24		3-axle prime mover A-double (3-3-3)	2	30.0	83.0	85.0	85.0
			3	36.5	83.0	85.0	91.0
PBS ROAD TRAINS							
25		A-triple (3-3-3-3-3)	4	42.5	126.5	128.5	141.5
26		B-triple (3-3-3)	3	36.5	83.0	85.0	91.0
27		AB-triple (3-3-3-3)	3	36.5	103.0	105.0	110.0
28		BA-triple (3-3-3-3)	3	36.5	103.0	105.0	110.0
29		AB-double (1-2-1)	1	20.0	50.5	–	–
			2	20.0	59.0	59.5	59.5
PBS BUS							
30		Bus	1	14.5	20.5	–	–
PBS TRUCK AND PIG TRAILERS							
31		3-axle truck and 2-axle pig trailer	1	20.0	38.0	38.5	38.5
32		4-axle truck and 2-axle pig trailer	1	20.0	42.5	43.0	43.0

† Vehicles may exceed the upper length in their level. Road manager approval and/or an individual route assessment will be required. * Quad-axle mass limit (QML). The MDL Regulation allows quad-axle groups up to 27 tonnes provided a combination is PBS approved. ◊ Operation of PBS vehicles on the PBS road network will require Road manager consent. Δ Vehicle Standards exemptions are required before a PBS vehicle approval is issued.

Resources

- *The Standards and Vehicle Assessment Rules*, NTC, 2008
- *Approved Guidelines for Granting Access*, NHVR, 2014
- Heavy Vehicle (Mass, Dimension and Loading) National Regulation
- Vehicle (Vehicle Standards) National Regulation
- PBS combinations fitted with quad-axle groups, NHVR, 2017
- *Quantifying the Benefits of High Productivity Vehicles*, Austroads, 2014
- *Reforming the Performance-Based Standards scheme Policy paper, NTC,* 2018
- *Australia's PBS fleet*, ARTSA and NHVR, 2018
- *Truck impact chart*, ATA, 2016
- Restricted Access Vehicle Route Assessment Tool (RAVRAT)
- PBS Assessor and Certifier contacts
  www.nhvr.gov.au/road-access/performance-based-standards/useful-contacts
- www.nhvr.gov.au/pbs

NHVR

This guide can be accessed on our website at www.nhvr.gov.au/publications

For more information please contact the NHVR via:
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