Mass limits for three-axle buses
Decision regulation impact statement

November 2018

National Transport Commission

Report outline

Title	Mass limits for three-axle buses
Type of report	Decision regulation impact statement
Purpose	To recommend changes to mass limits for three-axle buses to optimise the three-axle bus market, without compromising safety.
Abstract	The National Transport Commission (NTC) investigated whether there is a need to increase the mass limits that apply to three-axle buses. The NTC considered the tare mass and loaded mass these buses carry and the implications of a potential increase in three-axle bus mass limits. This paper presents our findings which consider industry impact, risks and benefits. It is based on research and stakeholder engagement with states and territories and industry.
Key words	Three-axle, bus, mass, loading, capacity, coach, tourist bus, tourism, passengers, baggage allowance, double decker
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Executive summary

Context

For some time, there has been a mismatch between regulatory provisions for determining bus occupancy numbers and the settings for maximum bus axle mass limits.

In recent years bus mass has increased to accommodate the rising tare weight of three-axle buses with dual-tyred drive axle and single-tyred tag axle (three-axle buses) associated with the introduction of mobility, safety and environmental improvements, the increasing average weight of Australians and the weight of the luggage we travel with.

The National Transport Commission's (NTC) three-axle bus limit review (NTC, 2018) examined the appropriateness of the current three-axle bus mass limit and gathered evidence to identify whether there is a need to increase the mass limits that apply to using three-axle buses on the Australian road network.

Our recommendations are designed to ensure that mass limits for three-axle buses optimise the productivity of passenger transport without negatively affecting road safety or potentially competitive freight carriers.

Issues

Three-axle buses are regularly used for long-distance regional charter and scheduled coach travel because of greater levels of comfort, driveability and their ability to traverse harsh rural conditions. In fact, 1.1 million international visitors and 1.5 million domestic overnight visitors travelled by bus or coach in 2017, with 43 per cent of those trips taking place in Australia (Austrade, 2017). However, there has been a recent shift towards three-axle buses for metropolitan timetabled services because they offer greater passenger capacity and, according to at least one state, can reduce the pavement damage caused when compared with two-axle buses.

Three-axle buses in Australia are reported to be exceeding regulated axle mass limits when fully loaded. The call from industry for higher mass limits arose from both the increased average weight of the Australian population over recent years and the increased tare weight of buses due to regulatory requirements for specific mobility, safety and environmental improvements. Additionally, our investigation found that a component of the gross mass is also likely to include passenger luggage, with buses having the lowest permissible luggage weight of any transport mode. Australia offers one of the lowest gross mass limits for three-axle buses in the world.

At least three bus operators currently advertise freight services; however, this freight is generally limited to smaller items. Our scan of the market specifies on average a weight limit of 10 kg and its carriage is subject to available space. The maximum parcel weight we found was a 20 kg limit through Greyhound Freight, which does not exceed the recommended luggage limit recommended in this regulation impact statement. It is highly unlikely this is contributing to overloading, especially as the majority of overloading reportedly falls within peak times for route services and long-distance coaches at full capacity.

There were 2,229 registered three-axle buses in Australia in 2016–17 that travelled an estimated 136 million kilometres. This is less than one per cent of the total vehicle kilometres travelled for heavy vehicles, which is around 16.8 billion kilometres. The combined estimated revenue from three-axle bus registration and road user charges was about $18.4 million.

There would be very little impact on revenue to government from three-axle buses because of our recommendation to increase the gross mass limit (GML) to 22-tonne. However, the cost per 100 km travelled for the entire fleet (based on registration numbers of 2,229 and acknowledging that some buses already operate at 22 t GML) will increase by approximately

$4.84 million per annum from the baseline of 20 t GML. On average that is less than $604,500 million per jurisdiction per annum.

While this does present an additional cost to road managers, the financial cost would be offset by the community benefits of optimising passenger services provided by three-axle bus operators, including by:

- Contributing to the efficient movement of people and reduction of urban congestion – this is one of the six 'High Priority Projects' identified by Infrastructure Australia as being the most nationally significant over the next 15 years (Infrastructure Australia, 2018). This can be achieved by using three-axle buses for commuter transport, as we're starting to see in Sydney and Brisbane.
- Proving a higher level of safety to passengers through adopting advanced safety technology that can be accommodated by manufacturers at a higher GML. This aligns with the *National Road Safety Action Plan 2018–20*, which aims to increase the market uptake of safer new and used vehicles on Australia's roads.

Pavement wear analysis provided at Section 2.3.2 highlights that at 22 t and at 23 t GML, three-axle buses cause less pavement wear per tonne GVM than two-axle buses operating at 18 t GML.

The NTC originally recommended a mass limit increase to 23 t GML which was supported by a number of jurisdictions for limited metropolitan route service buses only. In the NTC's view this may prioritise metropolitan areas over regional areas and requires further review. Bus manufacturers publish technical specifications that enable three-axle buses to operate safely up to 25 t gross vehicle mass (GVM). Australia has the lowest gross mass limits for three-axle buses in the world and may be limiting the ability to optimise the use of both vehicle and road network assets.

However, due to a current lack of detailed economic data to provide a business case to governments to support an increase beyond 22 t GML, the NTC will conduct a detailed economic analysis to investigate the role of all configurations of three-axle buses in responding to, not only tare mass increases due to state and territory regulation, but also future increased public transport demand, technological innovation, regional economic development and tourism.

Recommendations and next steps

The Transport and Infrastructure Council approve these recommendations and endorsed the RIS at its November 2018 meeting.

Our recommendations are:

Recommendation 1:

That the allowable gross mass limit for a three-axle complying bus that has a tandem rear axle group fitted with single tyres on one axle and dual tyres on the other axle should be increased to 22 t with the following requirements:

- steer axle: 6.5 t
- rear tandem axle group with single tyres on one axle and dual tyres on the other axle: 15.5 t
- tyre width at a minimum of 295mm on the single-tyred rearmost axle
- mass distribution across the rear axle group (comprised of a dual-tyred axle and a single-tyred axle) of a 60:40 distribution ratio.

Recommendation 2:

That to access additional mass under Recommendation 1:

- If manufactured before 1 January 2015:
  - To access additional mass, a complying three-axle bus must be fitted with an antilock braking system, or a vehicle stability function relevant to the bus's date of manufacture.
- If manufactured on or after 1 January 2015:
  - To access additional mass, a complying three-axle bus must be fitted with an antilock braking system and either:
    i. An eligible electronic braking system, or
    ii. A vehicle stability function relevant to the bus's date of manufacture.
  - A route service bus manufactured on or after 1 January 2015 is only required to be fitted with an anti-lock braking system.

Recommendation 3:

That the case for an increase in the passenger and/or luggage masses used in determining the occupant capacity of new buses, be considered by the Australian Government Department of Infrastructure, Regional Development and Cities as part of its current review of the Australian Design Rule 58/00.

Recommendation 4:

That the NTC provide a detailed analysis of the economic contribution of three-axle buses in Australia to TISOC in 2019.

The analysis should include an assessment of safety and the implementation cost to government and industry to adopt a three-axle bus gross vehicle mass limit up to a manufacturer's technical specifications to support increased public transport demand, technological innovation, regional economic development and tourism.

Implementation

For our recommendations to take effect, the NTC would need to amend the Heavy Vehicle (Mass, Dimension and Loading) National Regulation.

Amendments could be progressed as part of a discrete amendment package, which will be considered by TISOC in March 2019 and by the Transport and Infrastructure Council in May 2019.

The ADRs are national vehicle standards under the *Motor Vehicle Standards Act 1989,* which is administered by the Australian Government Department of Infrastructure, Regional Development and Cities.

In the case of our Recommendation 3, any increase in the passenger and/or luggage masses used in determining the occupant capacity of buses would be subject to the normal consultation arrangements for ADRs, and ministerial approval.

1 Context

Key points

The objective of our review was to:

- identify the size and nature of the problem presented by the current axle mass limit that applies to three-axle buses
- develop, assess and consult on options to address any issues identified
- recommend a course of action to be adopted nationally and an implementation plan for giving effect to that recommendation.

For some time, there has been a mismatch between regulatory provisions for determining bus occupancy numbers and the settings for maximum bus axle mass limits.

In recent years, bus mass has increased to accommodate the rising tare weight of three-axle buses associated with the introduction of regulatory requirements for specific mobility, safety and environmental improvements, and the increasing average weight of adult Australians.

While similar issues for two-axle bus mass limits are being addressed through a national notice, three-axle buses are used in operational situations such as tourism and long-distance scheduled passenger transport, which require additional analysis.

Neither the impact of mass increases for three-axle buses nor the feasibility of alternative policy responses have been investigated to a significant extent. The purpose of this project is to undertake this investigation and recommend an optimum national policy position.

1.1 Objectives

The aim of this paper is to present the findings of the National Transport Commission's (NTC) review into whether there is a need to increase the mass limits that currently apply to three-axle buses.

Our recommendations are designed to optimise the productivity of bus passenger transport without negatively impacting on road safety or infrastructure.

Our review considered safety, pavement and infrastructure risks and any competition issues, as well as the fair and reasonable ability of operators to comply with the current mass limits. No increase in passenger numbers was countenanced as a part of our assessment.

The objective of our review was to:

- identify the size and nature of the problem presented by the current axle mass limit that applies to three-axle buses
- develop, assess and consult on options to address any issues identified
- recommend a course of action to be adopted nationally and an implementation plan for giving effect to that recommendation.

Our recommendations will be presented to the Transport and Infrastructure Senior Officials Committee (TISOC) in September 2018 and, if endorsed, to the Transport and Infrastructure Council in November 2018.

1.2 Background

1.2.1 Current mass limits

The mass limit for three-axle buses in jurisdictions participating in the Heavy Vehicle National Law (HVNL) is currently 20 t.[1] Table 1 sets out the current maximum available mass limit in each jurisdiction for a three-axle bus with a rear tandem axle group fitted with single tyres on one axle and dual tyres on the other.

Table 1. Current maximum GML available for a three-axle bus with a rear tandem axle group fitted with single tyres on one axle and dual tyres on the other

State/territory	Maximum GML available currently (tonnes)
ACT	20.0
NSW	22.0
NT	20.5
Qld	20.0
SA	20.0
Tas.	20.5
Vic.	20.0
WA	20.0

In New South Wales (NSW), a notice exempts certain buses from the HVNL requirements, allowing:

- a three-axle complying bus that has a tandem rear axle group fitted with single tyres on one axle and dual tyres on the other axle to operate at up to 20.5 t, or
- a three-axle bus with a dual-tyred drive axle and a single-tyred tag axle can access a mass limit of 22 t if they hold a valid permit from the National Heavy Vehicle Regulator (NHVR).

Three-axle buses with a rear tandem axle group fitted with single tyres on one axle and dual tyres on the other can also operate at up to 20.0 t in Western Australia and at 20.5 t in Tasmania under a notice issued by the NHVR. In the Northern Territory, this configuration can operate at up to 19t generally, or at masses ranging up to a maximum of 20.5t, if they are compliant with regulations or exemptions with conditions around suspension type, or nationally consistent safety features and emission controls.

This demonstrates the inconsistency across the nation that bus operators and manufacturers are currently navigating, especially those that operate tour and charter services that cross interstate borders. The Bus Industry Confederation (BIC) stated in its submission to our *Mass limits for three-axle buses* discussion paper (June 2018) that bus mass regulations

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[1] See Schedule 1, Part 1, subsection 2(1)(a)(i)(B) of the Heavy Vehicle (Mass, Dimension and Loading) National Regulation.

need to be national, uniform and consistent across all states and territories in Australia with a new national mass regulation for three-axle buses.

Table 2 shows how Australia's (HVNL) mass limits for three-axle buses are low in comparison with other countries. It is interesting to note that Australia has one of the lowest bus mass limits in the world, despite our average adult weight being among the highest.

Table 2. How Australia compares with international jurisdictions in weight limits

Jurisdiction	Men – average weight (kg)	Women – average weight (kg)	Total GML 3-axle (t)	Passenger calculating capacity (kg)	Steer-axle limit 3-axle (t)
Australia	85.9	71.1	20.0 (HVNL)	65	6.5
Australia – airlines	85.9	71.1	n/a	76	n/a
United States	88.3	74.7	27	79.4	9
Canada	90.7	74.8	22	82	9
Europe	84.6	66.6	26	75	9.5
United Kingdom	83.6	70.2	25	65	10
New Zealand	85.1	72.6	22	68	7.2
Singapore	71.9	59.4	28	60	12
Hong Kong	72.5	59.4	24	57	8
China	70.5	59.4	25	50	10
South Africa	70.8	65	24	68	7.7
Ireland	88	73.8	24	65	10

Average	80.6 kg	67.6 kg	24.3 t	66.9	9.2
difference	+5.3 kg	+3.5 kg	–4.3 t	–1.94 kg	–2.74 t
	Result: we are heavier		Result: our mass limits are considerably lower		

Buses provide an essential link to public transport in Australia. Buses provide a variety of services, generally in one or more of the following categories:

- route services – these follow a fixed route and a published timetable and are operated by government or private companies
- school services – these transport students to and from school, often under a government-subsidised scheme
- long-distance services – these provide intrastate and interstate travel between major towns and cities
- tourist services – these operate one-day and extended tours to popular regional destinations

- charter services – these offer buses for hire to transport like-minded people to a chosen destination
- shuttle services – these provide point-to-point transport e.g. from airports to hotels
- private vehicles – these are maintained by companies, schools, churches or other organisations to transport their members.

Currently 2,229 three-axle buses are registered in Australia. Two common categories of these buses are explained in Table 3.

Table 3. Two categories of three-axle bus services this project addresses

	Long-distance coach	Double decker
	 [2]	 [3]
Service type	Charter Scheduled long distance Rail replacement	Timetabled Bus rapid transit
Area	Regional and rural	Metropolitan
Standing room	No	Yes
Luggage space	Yes	No
Safety	Electronic brake system Fire retarder Anti-rollover Lane departure warning	Electronic brake system Fire retarder Anti-rollover
Access	Wheelchair lift	Low-floor wheelchair access Hand rails Back doors (for quick departure)
Emissions control	Euro IV, V or VI engine	Euro IV, V or VI engine
Comfort	Air-conditioning Toilet Seatbelts Reclining seats	Air-conditioning
Trends	USB adapters Wi-fi Water tanks or bottles Screens on backs of seats Wheelchair accessible toilet Gully kitchen Fatigue monitoring Double-glazed windows Brake assist (with cameras)	Shift towards double deckers Rapid transit (without timetables) Brake assist (with cameras)

[2] BCI Explorer

[3] Gemilang Australia and MAN A95

1.2.2 Utilisation of three-axle buses in Australia

Three-axle buses are generally used for longer distances, including to regional tourist locations, because they provide more comfort and can carry more weight. However, some buses used for shorter trips, including for urban commuter routes in Brisbane and Sydney, also have three-axles.

The type of three-axle bus that this project is referring to is a three-axle complying bus[4] that has a tandem rear axle group fitted with single tyres on one axle and dual tyres on the other axle (see Figure 1). This can be single decked or double decked.

Figure 1. Three-axle bus with a dual-tyred drive axle and single-tyred tag axle

Source: National Heavy Vehicle Regulator

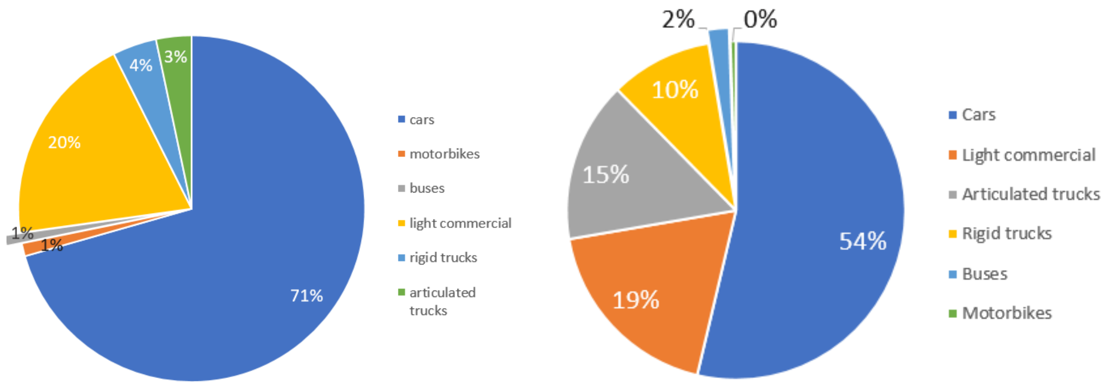
Some respondents suggested that other types of buses such as three-axle articulated buses and twinsteer double deckers should be considered as part of this project. The analysis provided for pavement wear and economic impact has been limited to a three-axle complying bus that has a tandem rear axle group fitted with single tyres on one axle and dual tyres on the other axle for this paper. However other types of three-axle buses could be considered in future, including for example through the coming review of the Heavy Vehicle National Law.

- There are currently 2,229 three-axle buses operating in Australia. A subset of these are the type of three axle buses that we are referring to in this document.
- Buses are used for only five per cent of passenger transits in Australia's cities and only make up one per cent of total road use (see Figures 2 and 3).
- In 2015–16 more than 21 billion passenger kilometres were made by bus across Australia (see also Figure 4).
- In 2015–16, 96,000 buses were registered on Australia's roads. This is an increase of 16,000 since 2008 (and an increase of 20 per cent in eight years) (BITRE, 2016).
- Buses account for 1.6 gigagrams of CO_2 equivalent emissions, which is around two per cent of all transport.
- 1.1 million international visitors and 1.5 million domestic overnight visitors travelled by bus or coach in 2017, with 43 per cent of those trips taking place in regional Australia (Austrade, 2017).
- More than 3,000 bus companies are operating across Australia, servicing towns and regions, tour and charter services and major cities, and most are small to medium sized businesses (NTC, 2016). These are often operated by local families.
- In the coach sector more than 5,000 coaches are in operation nationally, with a rolling stock value of more than $2 billion (NTC, 2016).

[4] The definition of a 'complying bus' within the HVNL is a bus with two or three axles, one of which is a steer axle, that is fitted with an approved air suspension system and meets:
(a) the emergency exit specifications in ADR 44
(b) the rollover strength specifications in ADR 59
(c) the occupant protection specifications in ADR 68.

The bus industry has been seeking higher mass limits for three-axle buses for some time. This is in response to the growing average weight of adult Australians, luggage weights and the heavy equipment required to be compliant with disability legislation and environmental controls.

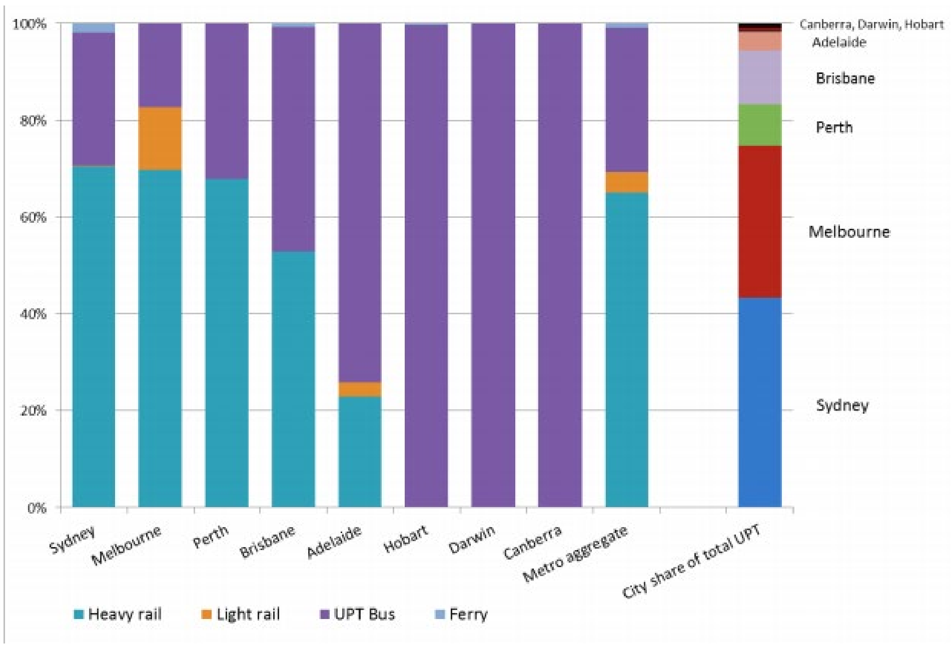
Figure 2. Bus travel only accounts for one per cent of total road use in Australia and only two per cent of carbon emissions



Source: (BITRE, 2016)

Mass limits for two-axle buses recently increased nationally to 18 t. In March 2018 NSW increased its three-axle mass limit to 22 t (to help improve bus operator efficiency) ahead of all other states and territories. However, the limits for three-axles have not changed in other states and territories falling under the HVNL.

Figure 3. Share of urban passenger transport by mode and capital city

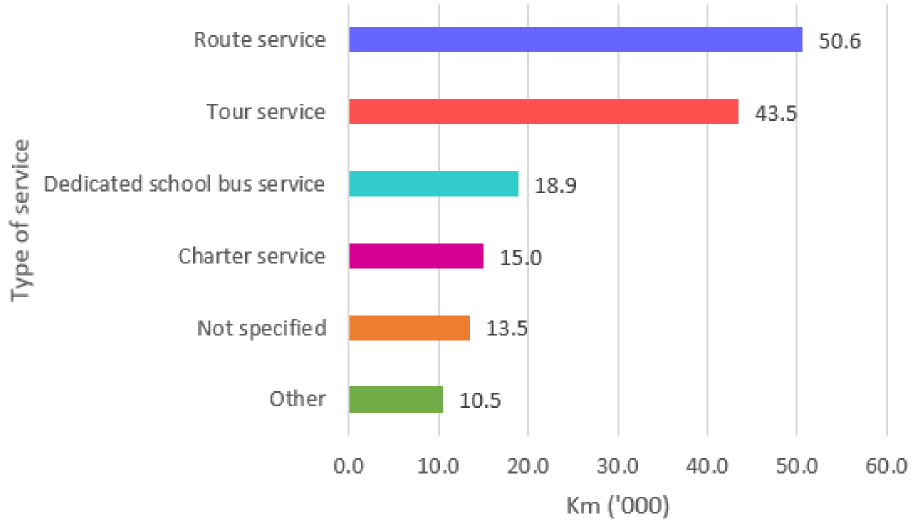


Source: (BITRE, 2013)

Maintaining operationally effective mass limits is an ongoing challenge because bus technology and government regulation continues to evolve and change.

Industry has been seeking a higher limit to reflect these changes, as well as to accommodate the growth in the average weight of adult passengers. The mass limits of three-axle buses have been in the policy spotlight since the NTC's review of two-axle bus mass limits in 2014.

Figure 4. Average kilometres travelled by buses with 20 or more seats throughout Australia, over 12 months, ending 30 June 2016



Source: (ABS, 2016)

1.2.3 The problem

There has been a mismatch between regulation for determining bus passenger numbers and maximum axle mass limits. Three-axle buses are widely used in long-haul, tourist and charter operations, where a component of their gross mass is likely to include passenger baggage.

According to research conducted by Taverner Research on our behalf, multiple sources contend that the gross loaded mass of three-axle buses is likely to often exceed the current allowable limits. The contributing causes of the increased total weight are:

- the weight of added equipment, including wheelchair lifts and related changes to doors
- the increasing average weight of the Australian population, which is now well above those assumed in setting current weight limits and passenger numbers
- increases in the weight of passenger effects included in both stowed luggage and effects carried on board.

1.2.4 Two-axle bus mass limits

In February 2014 the NTC released a discussion paper *Mass limits for two-axle buses* (NTC, 2014), which identified and discussed options to facilitate an increase in mass limits for buses fitted with two single axles.

The need for the higher mass limits arose both from the increased average weight of the Australian population over recent years and the increased tare weight of buses as a direct result of regulatory requirements for specific mobility, safety and environmental improvements.

Therefore, the NTC recommended an increase in the mass limit for two-axle buses from 16 t to 18 t. This was proposed to be implemented in the first instance by a Class 3 National Notice, which would be replaced by an amendment to the Heavy Vehicle (Mass, Dimension and Loading) National Regulation once all jurisdictions had agreed to the conditions that should apply to such a bus.

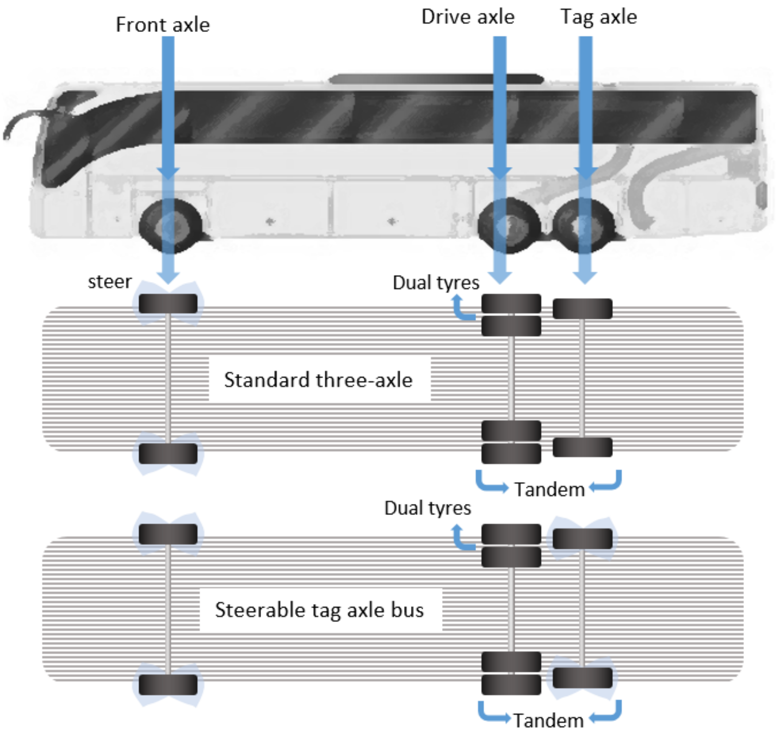
1.3 Issues

The key issues discovered during our initial review were:

1. The Australian limits are among the lowest in the world, despite having one of the heaviest populations.
2. There are different mass limits across each state and territory.
3. Added technology increases the tare mass of three-axle buses and coaches. This technology is needed to meet disability and environmental regulations.
4. Luggage allowances on buses are much lower than on all other transport modes.
5. The bus and coach transport market is shifting towards heavier vehicles such as double deckers and larger coaches for productivity gains (greater capacity at similar running costs).
6. Additional advanced safety technology is available on the market; however, due to the current mass limit, this technology is unable to be fitted without risk of overloading.

Figure 5 illustrates the design of a typical three-axle bus with a tandem axle group that has a dual-tyred drive axle and single-tyred tag axle.

Figure 5. Three-axle bus diagram from the side and underneath perspectives



1.3.1 Buses are regularly running overloaded

Multiple industry sources contend that the gross loaded mass of three-axle buses is likely to often exceed the current allowable limits, particularly for route services during peak times.

Our research explored how three-axle bus operators are currently managing their total loaded weight. Of the 23 survey respondents that run three-axle buses, 30 per cent confirmed that they take no action to limit the total loaded weight and 70 per cent take at least one step, including 35 per cent that take more than one step.

The most common step reported was to carry fewer than the approved number of passengers (44 per cent), followed by limiting the weight of stowed luggage that passengers can take with them (35 per cent). Requesting that passengers keep the weight of their stowed luggage and carry-on personal effects under a specified limit (26 per cent) was the third most common step.

Some operators ask passengers to sit in specific parts of the bus to limit the load on some axles (17 per cent) and a few (17 per cent) reported taking other steps to limit the total loaded weight.

There are no weight management policies or guidelines that the NTC is aware of that assist bus operators in this task.

The BIC has expressed concern about legal liability issues as they relate to operating over the regulated three-axle mass limits. During the NTC's review of two-axle buses, Advantia Transport Consulting's calculations confirmed that overloading was occurring on two-axle buses while operating within existing passenger capacity limits. According to the BIC, three-axle buses and coaches carry the same weight of passengers as two-axle buses and the method used to calculate the licensed passenger capacity is the same for both vehicle types. Therefore, when fully loaded, three-axle buses are likely to operate over the prescribed legal mass limit at times.

This theory is supported by action taken in NSW to increase the allowable operating mass for three-axle buses under permit in March 2018. This increase was a result of discussions and reviews by both Roads and Maritime Services and the bus industry following a high number of fines being issued to three-axle bus operators for operating over mass at both the Marulan and Mt White inspection stations. In all the instances, the buses were operating within their legal passenger carrying capacities, yet they were still over the legal operating mass limit.

Importantly, the fact that buses are operating over the regulated mass limit does not mean they are overloaded in accordance with the manufacturer's specified safe gross vehicle mass (GVM), which is 25 t or, in some cases, even higher.

1.3.2 Urban congestion management

Reducing urban congestion is the aim of five out of the six 'High Priority Projects' identified by Infrastructure Australia as the most nationally significant for Australia over the next 15 years (Infrastructure Australia, 2018).

NSW is aiming to utilise the capacity of double deckers operating on their busiest urban routes. Their analysis shows that when compared with articulated buses or two-axle buses, three-axle buses result in less pavement damage. NSW has therefore decided that any increase in road wear because of three-axle buses is outweighed by the congestion management benefits that they support.

A submission to the NTC's discussion paper from Brisbane City Council considers a potential mass limit increase for three-axle public transport buses as an opportunity to improve public transport options available to Brisbane residents and visitors.

Further to this, a mass limit increase for three-axle buses would have a positive impact on the competitiveness of the manufacturing market. Australia is not only a small market in terms of population, but we also have the lowest mass limit for three-axle buses in the world. This means that manufacturers must design and manufacture our buses differently, which results in higher prices. An increase in the allowable mass limit is likely to have a positive impact on market competition and has the potential to reduce the cost of three-axle buses in the Australian marketplace. This would also support efforts to use these buses as a tool to manage congestion.

1.3.3 Legislated technology requirements are increasing tare mass

Since 2000 we have seen a rapid uptake in technology installed on buses, which provide both safety and amenity benefits.

The rate of technological advancement is likely to continue as technological advancement in electrification, hydrogen and gas power and automated technology progresses.

However, heavier mechanical parts are increasing the tare weight and are unlikely to change as they are regulated in the *Disability Standards for Accessible Public Transport 2002* and *Vehicle Standard (Australian Design Rule 80/00 — Emission Control for Heavy Vehicles) 2005.*

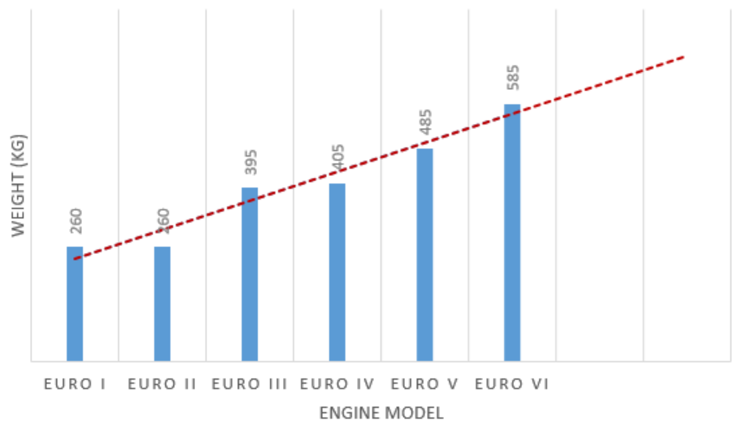
A major contributor is the wheelchair lift, which can weigh up to 600 kg. When combined with the specialised doors, glazing for those doors, removable seats and seatbelts, this equipment can easily add more than a tonne of weight.

Emission-controlled engines are the second major cause. All bus engines are manufactured in Europe where the regulation of carbon emissions, as per the European Union's Clean Air for Europe program, is much higher than in Australia.

Figure 6 lists the weights of regulation engines and how their weight has increased over time to align with European standards (European Environment Agency, 2012).

Figure 6. Emission-controlled engines and increase in weight to meet regulations

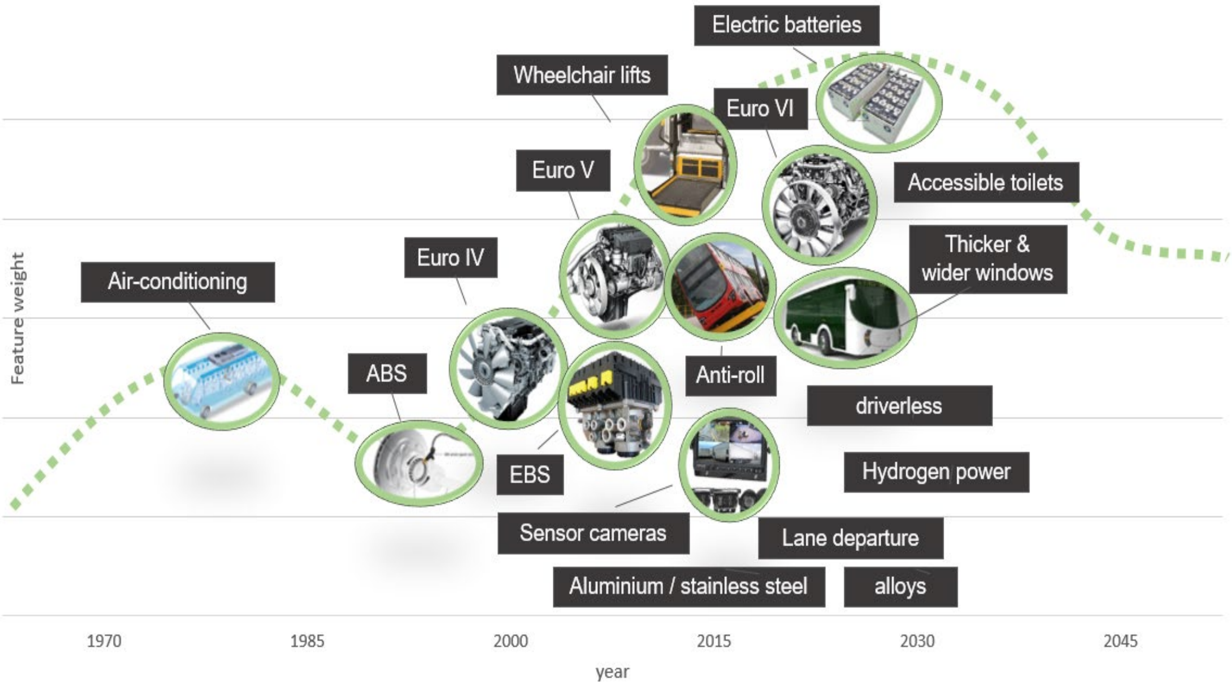
Engine model	Weight (kg)
Euro I	260
Euro II	260
Euro III	395
Euro IV	405
Euro V	485
Euro VI	585



This means imported buses are running more efficiently than our regulation requires. Despite the obvious benefits for the community, these engines are steadily growing heavier to correspond with Europe's tighter emissions controls (European Environment Agency, 2012) and currently can weigh around 600 kg.

Figure 7 shows how rapidly technology has changed over the past decade and how this has greatly increased the mass that is on a bus chassis (tare weight). It also shows how this speed of innovation is unprecedented for the bus industry.

Figure 7. Visualisation of growth in technology and resulting tare weight increases



The biggest shift in bus weight has occurred due to the technology required to be compliant with state and territory legislation, including the Bus Safety Regulations 2010 (Vic), the *Passenger Transport Act 2014* (NSW), the Passenger Transport Regulations 2009 (SA) and the Vehicle and Traffic (Vehicle Standards) Regulations 2014 (Tas). This technology is not usually subsidised by government and is installed at an operator's own cost. Table 4 shows a summary of equipment that is generally required by law across different states and territories and the weight this adds.

Table 4. Technology required to meet regulation or operational requirements

Regulation	Required equipment	Average weight (kg)
Disability Discrimination Act	Wheelchair lifts or low floor access	350–600
Fire protection	Fire retarder and liquid	50
Emissions control	Euro IV, V, VI compliant engine	350
Environmental protection	AdBlue fluid	80
Anti-rollover	Bus superstructure	1,000
Ticketing systems	Opal, Myki, etc.	20
Seatbelts for school buses	Seatbelts	150–200 (4pp)
	Total	**2,000–3,000**

As outlined in the BIC's submission to our discussion paper, the European Union recognised this issue within Council Directive 96/53/EC for two-axle buses in 2015 when they approved a mass increase of 1.5 t for two-axle buses to provide allowances for safety technology and passenger weight increases without prejudice to the load capacity of those vehicles. Australia also allowed additional mass for two-axle buses in July 2018 when the Heavy

Vehicle (Mass, Dimension and Loading) National Regulation was amended to allow certain types of eligible two-axle buses to increase their operating GML from 16 t to 18 t.

The same concepts can be applied to the increasing mass of both the tare weight of three-axle buses and the weight of the passengers and their luggage. These issues are further outlined in the following sections.

1.3.4 Australians are getting heavier

According to the Australian Bureau of Statistics (ABS 2013):

- The average Australian adult man weighs 85.9 kg.
- The average Australian adult woman weighs 71.1 kg.
- The average Australian child weighs 36 kg.

The Australian Design Rule (ADR) 58/00 says 65 kg should be used to calculate passenger weight. The average current combined weight of a man, woman and child is 64.3 kg.

Three-axle buses and coaches carry people of all ages. They often consist of ages ranging from babies to the elderly. This is more likely to occur for timetabled route services, including long-distance travel. However, for charter coaches, it's more difficult to calculate because a variable group made up of all adults, with luggage or equipment, may hire a coach.

If children are not part of the calculation, it's likely that passengers would average a higher mass of approximately 79 kg. The impact this would have on overall bus mass isn't considered significant enough to justify a change to the design rule.

1.3.5 Luggage allowances on connecting transport modes are higher

There is a disconnect between the amount of luggage people can take on board a coach in comparison with all other transport modes. For example, baggage allowances on airlines are on average 23 kg. According to the ADR 58/00, coach operators and manufacturers are expected to calculate luggage at 15 kg per person.

Three-axle coaches are regularly used for long-distance tours and to collect tourists from airports. Their customers have usually just disembarked from a plane and carry the same luggage checked in on the airline onto the coach. They also usually have carry-on bags, which can weigh up to 7 kg. We found this luggage allowance is often not enforced, and it is likely that most passengers connecting from another transport mode are carrying luggage that more realistically weighs around 23 kg.

1.3.6 Customer demand for improved features and amenity

Operators have told us that they constantly compete with increasingly cheaper airline tickets and that their customers expect the same level of features they can access on an aeroplane.

In Europe it's becoming standard on three-axle buses to offer wi-fi, USB adapters, wider and further reclining seats, water bottles, snacks, television sets, tables for laptops, reading lights, tinted windows, pillows, blankets and many other comfort features. All additional features add weight and cost money.

Research has shown that coach travel can be an efficient way of travelling and that there is space in the market to convert customers who take trains or airlines to instead take a coach, such as business travellers (Hensher & Wang, 2016).

Further, train fleets across parts of Australia are getting close to retirement age and run at similar travel times to coaches (also partly due to the congestion of the rail network). For example, the journey between Sydney and Melbourne is 12 hours either by coach or train. The cost of a new train fleet, at approximately $2 billion (Brook, 2018), is a much higher capital investment for governments than outsourcing to coach services.

1.3.7 Safety and road wear

As Brisbane City Council pointed out in its submission to our discussion paper, infrastructure protection and road safety is of the utmost importance when considering any changes to regulation mass limits of heavy vehicles such as three-axle buses.

Our research informed us that the risks from increasing current weight limits mentioned in some discussions of the weight limit are:

- increased pavement damage
- increased crash risks that could arise if greater vehicle weight results in longer stopping distances and reduced stability when cornering.

Industry stakeholders interviewed by Taverner Research have offered their view that neither risk is substantial. Industry arguments supporting the contention that there is no material increase in pavement damage that is likely to result from an increase in the allowed weight limits are:

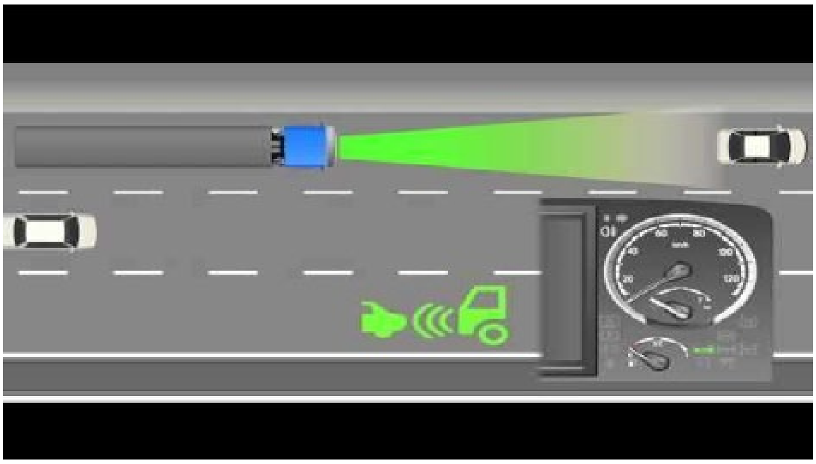
- Modern three-axle buses have two steerable axles, which reduces the damage to the pavement from the drag of a fixed axle.
- Many buses are in any case travelling over the current limit, so regularising current practice will not increase the actual risk of pavement damage.
- Most pavement damage is caused by heavy trucks, which can have a total mass very much greater than a fully-loaded three-axle bus (though this point is contested by road managers as set out below).

Furthermore, Australians are missing out on potential additional safety features due to the current allowable mass limit. One manufacturer has told us that they would like to make available the following safety features in their buses, but because they will add approximately 150–200 kg to the tare weight, they cannot do so at the current mass limit because it increases the risk of their customer being penalised for running over mass:

- **Lane departure warning** warns the driver if the coach unintentionally crosses over lane markings and creates a vibrastion in the seat on the left or right habd side, depending on which side of the vehicle a line is crossed.
- **Adaptive cruise control** assists the driver to maintain a constant time interval to the vehicles in front. It recognises the distance to and speed of vehicles ahead by using distance sensor radar. The system makes sure the coach keeps a certain time gap and speed in relation to preceding vehicles.
- **Advanced emergency braking** uses sensors from adaptive cruise control (see Figure 8) and lane departure warning systems. This works to support standstill and catching up (rear end) accidents (Scania, 2018).

These technologies also require changes and/or additions to the driver’s seat, windscreens and radar mounts, which add weight.

Figure 8. Adaptive cruise control



Source: (Scania, 2018)

Our consultation with road managers suggests that pavement damage is caused by the individual axles rather than the overall vehicle. As buses have a higher limit per axle than trucks, trucks by volume may do more damage; however, buses may technically do more damage per axle or per vehicle.

The impact of three-axle buses on road assets is calculated using several measures. These include dimensions such as height, width and length, as well as mass, axle spacing, tyre width, road overhang, turning circle and load projection. How these various factors come together sets the level of weight a three-axle bus can carry.

Manufacturers calculate a mass limit according to the structural integrity of the bus or coach. Currently, the manufacturer's limit is approximately 5 t higher than the regulated mass limit. This means most buses on our roads can safely carry more weight. Our consultation has confirmed that neither industry nor government are concerned about the potential for negative safety outcomes because of any increase in mass limits for three-axle buses. Furthermore, even if the manufacturer's specified limit was lower than the allowed GML, the loaded mass of a vehicle must not exceed the manufacturer's rating on any component such as a tyre, wheel or axle.[5]

Road asset owners manage their road maintenance investments by calculating the expected pavement wear on a road network. Generally, wear on the road increases as the axle mass of a heavy vehicle, such as a truck or bus, increases.

There are ways to minimise pavement wear. Techniques such as using wider tyres or dual-tyre axles and shifting loads between steer and rear axles can help spread the pressure impact on the point of contact with the road. However, tyre placement can affect passenger capacity volumes and must be carefully considered in bus vehicle design.

Higher mass limits need to first consider the implications for road managers who are responsible for maintaining road network assets. We discuss road wear in more detail in section 2.3.1 and explain how we have come to our recommended mass limit.

[5] See sections 8–10 of the Heavy Vehicle (Mass, Dimension and Loading) National Regulation

1.4 Consultation

1.4.1 Stakeholder feedback to *Mass limits for three-axle buses*

We released our *Mass limits for three-axle buses* discussion paper during June 2018, with consultation open until 24 July 2018. During this time, we also actively consulted with stakeholders verbally to assist in their analysis of the issues presented in section 1.3. Stakeholders provided their response to three questions:

1. Do you believe the suggested limits allows three-axle buses to run at full capacity for both route services and charter services?
2. What would the increased cost of road wear be in your jurisdiction if the mass limits for three-axle buses were increased to the suggested limits?
3. Are you aware of any other issues (not raised in this paper) that you believe would have a negative impact on industry, government or the community should the mass limits be raised as per the suggested options?

We consulted broadly with government and industry throughout the consultation period and received informal submissions from jurisdictions. Further consultation will take place with jurisdictional road managers and industry in relation to this decision RIS prior to submitting our recommendations to the Transport and Infrastructure Council in September 2018.

2 Issues and options

Key points

The main issues discovered during our research are grouped into the three themes below. These themes are discussed in this chapter:

- tare mass increase
- loaded mass increase
- infrastructure impacts.

2.1 Tare mass increase

2.1.1 Technology is increasing tare mass

The pace at which new technology is available is unprecedented for the bus industry. We believe the increase in tare mass due to regulatory requirements to carry certain technologies is a major cause of three-axle overloading.

These innovations, while adding weight, have benefits for industry, governments and communities. They provide mobility options to all members of the community and encourage safer driving practices. Generally, buses now come equipped with the items listed in Table 5.

Table 5. Approximate weight of standard bus features

Feature	Approximate weight	Cumulative weight
Three-axle tare	13.5 t	13,500
Air-conditioning	300 kg	13,800
Electronic braking system	30 kg	13,830
Anti-lock braking system	15 kg	13,845
Anti-rollover	1 t	14,845
Fire retarder	50 kg	14,895
Emissions control compliant engine	350 kg	15,245
Lane departure	20 kg (note: low weight estimate as many buses are not carrying this technology because the current allowable mass limit prevents it)	15,265
Adaptive cruise control		
Fatigue monitoring		
Collision warning		
Brake assist		
On-board television notices	10 kg/unit	15,285
Long-distance features		
Toilet	50 kg	15,315
Wheelchair lift	320 kg	15,335
Double-glazed windows	300 kg	15,635
Seatbelts	4 kg/seat	15,835
Drinking water tank	50 kg	15,885
AdBlue fluid	80 kg	15,965
Fuel tanks (300 L + 20 L)	0.85 kg/L	16,237
Audio-visual equipment	< 50 kg	16,287
Passengers (45)	65 kg/person (2,925)	19,212
Luggage	23 kg/person (1,035)	20,247
Tyres	45 kg/tyre (270)	20,517
Summary: ▪ This isn't at full capacity. ▪ This assumes some children are on board. ▪ Weights are estimates only and some allowance should be given.		**Total: 20.5 t**

Customers have also come to expect a certain level of amenity and service on buses, like any other form of public travel. For bus operators to compete, they need to consider providing items and features such as those listed in Table 6.

Table 6. Customers' expectations for future technology and comforts

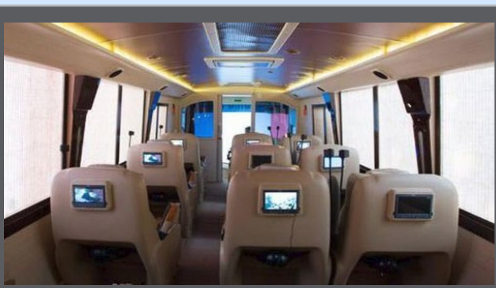
Customer features	
 [6]	 [7]
Wi-fi	< 5 kg
Screens	< 10 kg/unit
USB port	< 2 kg/unit
Bottled water	25 kg
Snacks	< 20 kg
Accessible toilets	100 kg
Fully reclining seats	< 15 kg/unit
On-demand app connectivity	n/a
Tray tables	< 2 kg/unit

Table 7 lists the weights of emission-controlled engines currently on the market.

Table 7. Emission-controlled engines and their approximate weight

Engine model	Weight (kg)
Euro I	260
Euro II	260
Euro III	395
Euro IV	405
Euro V	485
Euro VI	585

[6] PT Blue Bird

[7] Daimler AG

2.2 Loaded mass increase

2.2.1 Increased passenger weight

The weight of passengers is undoubtedly growing. However, the impact this has on bus services has not been quantified.

Between 1995 and 2011–12, the weight of men and women increased by around four per cent according to the ABS (ABS, 2013). We now are one of the most overweight countries in the world (see Figure 9).

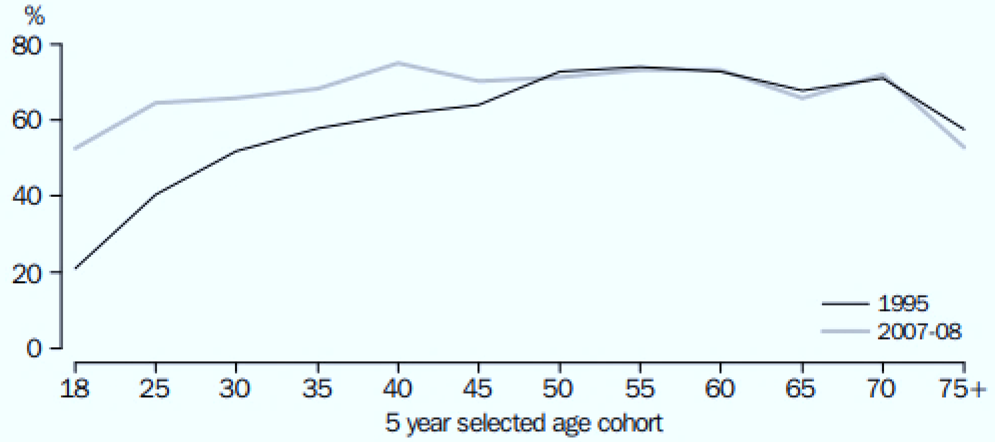
> *In 2009 the European Aviation Safety Authority (EASA) conducted a comprehensive survey of passenger weight. EASA weighed 22,901 passengers. The findings from this survey was an average male adult weight of 94 kilograms and an average female weight of 75 kilograms. Australia's adult population is very similar to those of North America and Europe.*
>
> *Given this,* ***the only reasonable conclusion is that there is a less than medium probability that the average weight of adults boarding a bus in Australia will be less than 65 kilograms and a greater than medium probability that a bus which is carrying adults in every seat will be over its GVM*** *[the NTC's emphasis].* (Hourigan, 2015)

2.2.2 Australian Design Rule 58/00

According to the *Vehicle Standard (ADR 58/00 – Requirements for Omnibuses Designed for Hire and Reward) 2006:*

- 58.3.1. In determining the occupant capacity of an omnibus, the loading condition shall be that in which a mass of 65 kg is located in each of the 'Manufacturer's' nominated seating and standing positions for driver, passengers and crew.
- 58.3.2. Where luggage space is provided, other than for personal hand luggage, and the vehicle is for carriage of passengers and luggage, a mass of 15 kg shall be added for each passenger and shall be distributed uniformly throughout the luggage space.

Figure 9. Proportion of Australian people overweight or obese by age



(a) Measured Body Mass Index.
(b) Excludes persons for whom measured height or weight was not available.

Source: National Nutrition Survey 1995 and National Health Survey 2007-08

A Dutch study from 2005 (Schoemaker, 2007) measured the combined weight of passengers and their luggage. The results found that people in Europe were generally falling between 70 and 82 kg and were carrying around 20 kg of luggage (see Table 8).

Table 8. Average passenger and luggage weights in Europe (kg)

Date	*Location*	*Trip type*	*Average passenger weight*	*Average luggage weight per person*
03.01.2005	NL	International occasional service	82.6	25.72
07.01.2005	NL	International occasional service	80.0	23.31
08.01.2005	NL	International occasional service	79.6	20.77
15.01.2005	AT	Airport feeder service	74.6	21.22
18.02.2005	UK	Domestic occasional service	81.1	17.39
19.02.2005	UK	Domestic occasional service	80.3	18.70
		International occasional service	82.5	20.64
		Unknown	-	15.17
20.02.2005	UK	International regular service	77.3	19.08
30.03.2005	AT	International regular service	71.1	14.11
01.04.2005	UK	International regular service	71.8	18.82
12.04.2005	ES	Domestic regular service	71.2	5.24
		Domestic occasional service	73.8	10.74
		International occasional service	73.5	8.82
Total	All	All	75.6	16.76

Source: Dutch Emissions Authority (NEa) (Schoemaker, 2007)

We have calculated the difference in measuring passengers at 65 kg compared with 80 kg. The difference becomes significant when buses carry around 100 people (see Table 9). Data from the B-Line double deckers running in the northern beaches in suggests this occurs during the morning peak between 7.30 am and 8.30 am.

Table 9. Difference between measuring average passenger weight at 65 kg and 80 kg at full capacity

	40 pp route bus (kg)	57 pp coach (kg)	100 pp double decker (kg)
Full capacity at 65 kg	2,600	3,705	6,500
Full capacity at 80 kg	3,200	4,560	8,000
Difference	**600**	**855**	**1,500**

2.2.3 Passenger loading calculations

Loading captures how full a bus is over the course of its journey, which can be used to calculate an average mass. On most route services, passengers alight and depart at different stops, which keeps the loading low. In comparison a charter service picks up all customers at one location and delivers them all to a single destination.

If all seats are taken on a charter bus, it is considered utilised at 100 per cent. If a route service was full when it departed its first stop and remained at capacity when it reached the end of its journey, it would still only be considered utilised at 50 per cent. This is because it returns to the depot empty. If the service started out empty and picked up passengers along the route, it would be considered utilised at 25 per cent.

Table 10 shows estimates of metropolitan bus utilisation that have been determined using outputs from the Veitch Lister Consulting transport models for Brisbane, Sydney and Melbourne. This is presented as the proportion of time that the fleet operates at a given utilisation. The transport model output gives the estimated patronage and the utilisation was found by dividing by the average fleet capacity.

Table 10. Average metropolitan bus utilisation

City	Utilisation (% average)
Sydney	12.5
Melbourne	6.7
Brisbane	10.3

Source: (Pekol Traffic and Transport, 2013)

The demand for coach travel hasn't increased in the way that route services have and, in fact, may have decreased with the introduction of cheaper air travel. Capacity rates were calculated by Pekol Traffic and Transport in 2013 (see Table 11).

Table 11. Average passenger utilisation of bus services

Passenger type	Capacity of bus (% average)
Route buses	8
School buses	13
Charter	35

Source: (Pekol Traffic and Transport, 2013)

We have taken a conservative approach and analysed capacity at 25 per cent and 40 per cent to calculate the impact passenger weight would have on a service.

Tables 12 and 13 shows that, at 40 per cent capacity, measuring passengers' weight at 80 kg would increase the overall mass by 240 kg on a route bus, 345 kg on a coach and 600 kg on a double decker.

Table 12. Difference in overall weight at 40 per cent capacity

	40 pp route bus (kg) 16 pp	57 pp coach (kg) 23 pp	100 pp double decker (kg) 40 pp
40% capacity at 65 kg	1,040	1,495	2,600
40% capacity at 80 kg	1,280	1,840	3,200
Difference	**240**	**345**	**600**

At 25 per cent capacity, measuring passengers' weight at 80 kg would increase the overall mass by 150 kg on a route bus, 210 kg on a coach and 375 kg on a double decker.

Table 13. Difference in overall weight at 25 per cent capacity

	40 pp route bus (kg) 10 pp	57 pp coach (kg) 14 pp	100 pp double decker (kg) 25 pp
25% capacity at 65 kg	650	910	1,625
25% capacity at 80 kg	800	1,120	2,000
Difference	**150**	**210**	**375**

These calculations show that increased passenger weights would have a minor impact on the overall mass of route buses (and coaches when not running at full capacity).

2.2.4 Increased luggage weight

The difference that passenger weight makes in a coach at full capacity is around 855 kg. When the increased weight of luggage is also added, the figure becomes more significant. A fully laden coach is likely to be running at 1.45 t above what the carrying capacity states in the ADRs (see Table 14).

Table 14. Increased weight of a coach due to luggage in comparison with capacity limits

	57 pp coach (kg)		57 pp coach (kg)	Total weight (kg)
Full capacity at 65 kg	3,705	15 kg luggage pp	855	4,560
Full capacity at 80 kg	4,560	25 kg luggage pp	1,450	6,010
Difference	**855**	Difference	**595**	**1,450**

Luggage is usually only taken on long-distance coach services, airport shuttles and charter services. Passengers taking luggage are often connecting with other transport modes such as flights or cruises.

As such, the luggage they are taking is likely to be the same weight as the luggage allowance for the connecting transport mode (see Table 15).

Table 15. Luggage allowances by transport mode and class of travel (kg)

	Carry-on	Economy	Business
Regional flights			
Qantas	7	23	32
Virgin Australia	7	23	32
Regional Express	7	23	23
Fly Corporate	7	15 (30*)	15 (30*)
Domestic flights			
Qantas	7	23	32
Jetstar Airways	7	23	32
Virgin Australia	7	23	32
International flights			
British Airways	23	32	60
Norwegian Air Shuttle	10	32	64
Qatar Airways	15	45	60
Air France	12	23	32
KLM	12	23	32
Air New Zealand	7	23	32
Garuda Indonesia	7	30	40
Emirates	7	23	32
Malaysian Airlines	7	30	40
United Airlines	7	23	32
Regional trains			
VLine	30	30	30
NSW TrainLink	20	20	20
Queensland Rail	20	20	20
TransWA	20	20	20
Interstate trains			
The Ghan	20	40	60
Indian Pacific	20	40	60
Overlander	20	40	60
Average	**13**	**27**	**38**
Cruise liners			
P&O	64	–	–
Carnival	64	–	–
Princess	No restriction	–	–

* 30 kg if connecting with an international flight or cruise

2.2.5 Axle configuration and the broader heavy vehicle industry

Road managers have suggested the steer axle limit would need to be increased to support an increased overall mass. This has implications for the rest of the heavy vehicle sector, which would also benefit from an increase on the front steer axle.

Most heavy vehicles have a mass limit of 6.5 t on the steer axle and this requirement remains the same to access the recommended gross mass limit increase to 22 t.

We have investigated whether the recommended mass increase requires a change to axle spacing in the Heavy Vehicle (Mass, Dimension and Loading) National Regulation and found that a bus will continue to meet the axle mass spacing requirements if it operates at 22 t. A mass limit of 22 t requires a minimum axle spacing of 2.5 m, which a bus easily surpasses.

2.2.6 Buses carrying small parcel freight

At least three bus operators currently advertise freight services; however, this freight is generally limited to smaller items. Our scan of the offerings specifies on average a weight limit of 10 kg and its carriage is subject to available space. The maximum parcel weight we found was a 20 kg limit through Greyhound Freight, which does not exceed the recommended luggage limit recommended in this paper. It is highly unlikely that this is contributing to overloading, especially because the majority of overloading reportedly falls within peak times for route services and long-distance coaches at full capacity.

In the Northern Territory for example, the wider industry is appreciative of the specialised and essential service provided by bus freight, and it is not seen as competition for the heavy freight industry.

2.3 Infrastructure impacts

2.3.1 Increased road wear

According to industry and some road managers, weight distribution between three-axles, together with improved suspensions, minimises damage to roads by modern three-axle buses when compared with two-axle and older three-axle buses. This is supported by the analysis completed by Advantia, discussed in section 2.3.2.

In general, the greater the width of a tyre, the less deterioration of pavement because the contact profile shape is more balanced and the stress more distributed.

In 2016 Austroads found that the optimum steer-axle mass was 7 t, as long as it was fitted with a wide tyre:

> *A key finding of the report was that a 6.5 t steer axle load on a narrow tyre caused more damage compared to a 7.0 t load on a wide tyre, but less when compared to a 7.2 t load on a wide tyre. Analysis scenarios were only conducted at 7.0 t and 7.2 t, but it is clear that break-even point in terms of pavement damage is between these two increments. What this means practically, is that an increase in steer axle mass limit from 6.5 t to 7.0 t would be best accompanied by a change in tyre size.* (Austroads, 2016)[8]

However, the age of the road is also a factor when considering pavement wear:

[8] This finding was relevant only to sealed unbound granular pavements.

… research conducted has determined that, with regard to the fatigue damage of asphalt and cemented materials, the standard load for an axle group type is dependent upon the thickness and modulus of the asphalt and the underlying pavement structure. (Austroads, 2015)

This is especially relevant as an asset approaches the end of its lifecycle and funding for sealing and upgrades is scarce. Industry is also protective of assets in this state, therefore when a portion of the industry is offered an increase in mass, the rest of the industry have concerns about the impact on the roads and the resultant increase in operating costs from travelling on poorer quality roads. Therefore, we need to consider not only the cost of maintaining assets but also how to preserve their life.

A study commission by the New Zealand Ministry of Transport found that road-wear costs increased by up to 50 per cent for mass increases on three-axles buses (see Table 16). This cost was for the road wear component only of the maintenance budget, which was around 20 per cent of total maintenance and operation costs. It also assumed that the vehicles were running at full capacity (Infrastructure Decisions Support, 2016).

Table 16. Summary of predicted damage cost increases for three-axle buses in New Zealand

Analysis vehicle	Load Scenario	Rear Group Limit (tonnes)	Rear Group Load Share Split	Predicted Increase in Cost ($M)		
				State Highways	Local Roads	Total
All 3-axle buses	General Mass Limits	13.6	60/40%	-	-	-
		14.5	55/45%	0.2 0.3 0.4	0.5 0.6 0.8	0.7 (25%) 0.9 (33%) 1.2 (50%)
All 3-axle urban and rural buses including double deck buses (66-seaters)	As per VDAM 2015 Schedule 2, Part C	14.6	60/40%	3.0 3.8 5.3	4.9 6.1 8.5	7.9 9.9 13.8
		16.0	60/40%	5.7 7.1 9.9	8.9 11.1 15.5	14.6 18.2 25.4
		16.0	55/45%	3.1 3.9 5.4	5.0 6.2 8.7	8.1 10.1 14.1
All 3-axle urban and rural buses - rear axle set	Increase to 16.7 tonnes	16.7	60/40%	7.9 9.9 13.9	12.2 15.3 21.4	20.1 25.2 35.3
		16.7	55/45%	4.1 5.2 7.2	6.5 8.2 11.4	10.6 13.4 18.6

Source: (Infrastructure Decisions Support, 2016)

Table 17 shows the total kilometres travelled in 2014 by buses with 20 or more seats.

Table 17. Total kilometres travelled in 2014 (buses with 20 seats or more)

Route bus	Tour bus	TOTAL
728,000,000	108,000,000	836,000,000

Source: (NTC, 2016)

A common piece of feedback to our discussion paper, predominately from road managers, was that further work was needed to quantify the cost impacts of increased mass limits, including an assessment of alternative axle mass limits.

The following section explains how we went about undertaking that assessment and provides the analysis of pavement wear at various mass limits.

2.3.2 Pavement and bridge impacts

It its submission to our discussion paper, the BIC told us that, in its view, there would be no significant negative effect on pavement wear for two reasons:

- Overloading is already happening, and the road wear impacts are already being absorbed by the network. Buses and coaches are already carrying passengers with an average mass of 80 kg per person, therefore the real world operating mass for three-axle buses is likely to be at 22–23 t.
- Three-axle buses have a lower equivalent standard axle (ESA) per tonne than the currently legal two-axle buses operating at 18 t (see Appendix 3).

Road managers told us that they need to see more evidence of the pavement impacts at various mass limits and with various configurations and tyre widths. For example, the Transport Division of Tasmania's Department of State Growth stated that road wear costs are likely to be different depending on the road construction, and the road owners affected will depend on the roads used when overloaded.

The NTC engaged Advantia to determine the pavement wear effects of increasing the maximum axle loads on three-axle buses under various loading scenarios and axle/tyre configurations. The assessment determined the effects of four parameters on pavement wear:

- gross vehicle mass
- the mass split between the steer axle and the tandem group
- the mass split between the two-axles within the tandem group
- tag axle tyre width (with single tyres).

The amount of pavement wear induced by a vehicle is a function of the load carried by each tyre and the distribution of tyres throughout the vehicle. Load is transmitted to the deep structural layers of the pavement, which lose strength over time as vehicles repeatedly pass over them.

The amount of wear that develops in a pavement due to the passing of a heavy vehicle can be estimated using the standard axle repetition (SAR) approach. This considers that a unit of pavement wear is the amount of wear caused by one pass of a standard axle (a single axle with dual tyres that is laden to 80 kN (8.16 t)). To convert this to one pass of a vehicle with various axle group types laden to various axle group loads, the following formula is used:

$$\mathrm{SAR} = \sum_{i=1}^{m} (\mathrm{L}_i / SL_i)^n$$

where:

L_i = load carried by axle group *i* in tonnes

SL_i = standard load for axle group *i* in tonnes – if the axle group happens to be at this load it produces one unit of pavement wear

n = pavement wear exponent, which may vary from 4 to 12 depending on the pavement distress type (typically 4 for overall wear of unbound granular pavements by rutting, for which the calculation is referred to as ESA)

m = number of axle groups on the vehicle (Advantia Transport Consulting, 2018).

ADR43/04 states that all axles in an axle group, other than a twinsteer axle group, must be related to each other through a load-sharing suspension. This in effect means that equal weight is distributed across all the tyres on that axle group. Therefore, the Advantia calculations include a load share of 67:33 across the tandem axle (equal weight distribution across the six tyres on the axle group). Advantia also calculated road wear based on a 60:40 weight distribution, which is required under the NSW permit to access a GML of 22 t.

The calculations also investigated the impact of tyre width on pavement damage. The full assessment is included at Appendix 3.

The BIC submission to our discussion paper stated that buses can be fitted with 375 mm minimum width tyres on the tag (these would typically be 385/65R22.5 type tyres), but consideration should be given that if the tag is a steerable tag, then the wider section tyre is not needed because the steerable tag system already reduces pavement wear when compared with a non-steerable tag. One manufacturer has also independently advised the NTC that a wide tyre on a non-steerable single-tyre tag axle can cause more damage to pavement than a standard 295 mm tyre. That's because, in this manufacturer's view, the increased surface area of the tyre creates a wider drag pattern across the pavement. BIC offered further input prior to the TISOC meeting on the 14 September 2018 to confirm that imposing a new wider tyre width restriction would be a retrospective step and would cause massive operational disruption.

The Advantia analysis shows that when using 275 or 295 mm width tyres on the tag axle, a 67:33 weight distribution (for example, equal load sharing across the tyres on the tandem axle) is optimal. If using a 375 mm tyre or wider on the tag axle, a 60:40 split is optimal. This is reflected in the current NSW permit arrangements. Generally, a wider tyre on the tag axle resulted in the lowest ESA values.

The current allowable mass under the Heavy Vehicle (Mass, Dimension and Loading) National Regulation (20.0 t GML) with 275 or 295 mm tyres has an ESA per tonne GVM of 0.19. We note that this may be a slightly conservative estimate, as some operators run with a 6.5 t steer axle and 13.5 t on the tandem rear axle and, according to road managers, more damage is usually seen because of loading on the steer axle. One road manager has suggested that with 6.5 t on the steer axle, the ESA per tonne GVM is closer to 0.20.

At 22 t GML (6.5 t + 15.5 t), the ESA per tonne GVM is set out in Table 18.

Table 18. 22 t GML loading scenarios (calculated by Advantia)

Mass distribution over tandem axle	Tag tyre width	ESA per tonne GVM
70:30	275 or 295	0.26
67:33	275 or 295	0.25
60:40	275 or 295	0.25
70:30	375+	0.25
67:33	375+	0.24

60:40	**375+**	**0.23**

Table 18 demonstrates that at 22 t GML the configuration with the lowest pavement wear has 6.5 t on the steer axle with 15.5 t and a mass split ratio of 60:40 across the rear tandem axle group, as well as wide single tyres on the tag axle.

At 22 t GML (6.5 t + 15.5), the ESA per tonne GVM with a tyre width of 295mm and a mass distribution ratio of 60:40 is 0.25. The same configuration with a tyre width of at least 375mm is 0.23.

At 22 t GML (6.5 t + 15.5 t), the difference in ESA per tonne GVM between a tyre width of 295mm and a tyre width of 375mm, both with a mass distribution ratio of 60:40, is 0.2. Engineering advice considers this difference to be insignificant.

At 23 t GML (6.5 t + 16.5 t), the ESA per tonne GVM is set out in Table 19.

Table 19. 23 t GML loading scenarios (calculated by Advantia)

Mass distribution over tandem axle	Tag tyre width	ESA per tonne GVM
70:30	275 or 295	0.30
67:33	275 or 295	0.28
60:40	275 or 295	0.28
70:30	375+	0.29
67:33	375+	0.27
60:40	**375+**	**0.25**

Table 19 demonstrates that pavement wear is reduced with wide single tyres on the tag axle. Notably, all ESA per tonne GVM values calculated at both 22 t GML and at 23 t GML are lower than for a two-axle bus at 18 t, which has an ESA per tonne GVM of 0.34.

This is supportive of the move in some urban centres (notably Brisbane and Sydney) to deploy three-axle buses for commuter transport to manage congestion during peak times. Increasing mass limits for three-axle buses will enable adoption of more three-axle buses to support this urban passenger task with less pavement wear than two-axle buses.

Related to this issue, Brisbane City Council supports an approach that provides state and local governments with sustainable infrastructure protection and road maintenance expenditure levels. The council believes that the private coach industry has work to do in ensuring bus overloading is better managed within the industry. They are concerned that without this supporting work, overloading will continue, including at higher masses.

Therefore, they believe that until this occurs, any increase regulation mass limits should be limited to public transport services, not the private coach industry. However, we believe that to unlock the safety and productivity benefits that this mass increase allows across metropolitan and regional services, we need to extend the increased mass limit to tour and charter services as well. The BIC is also developing operational guidelines which will assist operators to manage their loading.

In addition, our advice from the NHVR is that there is no reason to restrict access for three-axle buses by regulation that is associated with bridge capacity.

A ‘floating tonne’ was also considered where the total mass limit would be capped below the sum of the allowable axle mass limits. However, some road managers also suggested that pavement damage is caused by the weight of individual axles, which won’t change if a floating tonne is in place. This does not prevent industry from self-imposing a floating tonne if they believe it would assist with weight management. This would allow those operators that have weight management techniques in place to access the higher mass limit and those that have concerns about weight distributions to manage them internally by placing a smaller self-imposed ‘cap’ on their limits at the operator level. In addition, as stated in the BIC’s submission to our discussion paper, a national approach to calculating passenger capacity is a key step in achieving national consistency and improved compliance. In addition, an agreed passenger calculation methodology for all three-axle bus and coach axle group types that takes into account a full consideration of vehicle configuration and axle splits needs to be applied. The NTC suggests this guidance is best developed by industry themselves within the regulated mass limits.

Schedule 1, Part 2, Table 1 of the Heavy Vehicle (Mass, Dimension and Loading) National Regulation sets out the axle load limits for various vehicle types. For tandem axle groups, these limits assume an equal split across the tyres on each axle in the group, which equates to approximately the 67:33 split represented in the Advantia calculations.

In this scenario, there is minimal (0.1) difference between the ESA per tonne GVM for standard and wide tyres at 22 t GML with 6.5 t on the steer axle and 15.5 t on the tandem rear axle group.

The NTC acknowledge feedback received from industry that it’s easier for bus operators to carry only one type of spare tyre needed for all tyres on all axles. During TISOC, jurisdictions discussed the merits of removing the wide tyre requirement for industry. The NTC was directed to pursue these discussions out of session.

These discussions resulted in jurisdictional recognition that even though the lowest possible pavement wear at 22 t can be achieved with wide tyres of at least 375mm and an axle mass distribution ratio on the rear tandem axle group of 60:40, a minimum tyre width of 295mm will be sufficient to access a gross mass limit increase to 22 t.

Jurisdictions acknowledge that the pavement wear difference of 0.2 ESA per tonne GVM is marginal, particularly because buses are not always fully loaded when they operate on the road network and are willing to absorb this difference.

Jurisdictions expressed a desire to decrease the burden of carrying additional wide tyres on industry by electing to remove the wide tyre requirement to access a gross mass limit of 22 t.

2.3.3 Road wear costs

The *Mass limits for three-axle buses* discussion paper (NTC, 2018) provided a discussion of the Pay as You Go (PAYGO) model, a cost recovery pricing model that attributes road investment and maintenance costs to different heavy vehicle classes.

Based on this model, the estimated cost of three-axle buses on road maintenance is presented at Table 20.

Table 20. Estimated cost of three-axle buses on road maintenance

Cost directly attributable to 3-axle buses	$11.6 m
Non-directly attributable costs allocated to 3-axle buses	$5.5 m

Total road costs of 3-axle buses	$17.1 m
Number of 3-axle buses (national, 2016–17 registration data)	2,229
Registration charge (roads component, 2017–18)	$2,260
Estimated registration revenue from 3-axle buses (roads component registration charges) ($)	$5 m
Fuel used by 3-axle buses (million litres, 2016 SMVU)	51.8 L
RUC rate (cents per litre, 2017–18)	25.8 c
Estimated RUC revenue from 3-axle buses ($)	$13.4 m
Estimated total revenue from 3-axle buses ($)	**$18.4 m**
Vehicle kilometres travelled by 3-axle buses (2016 SMVU)	136.1 m

RUC = road user charges; SMVU = Survey of Motor Vehicle Use

There were 2,229 registered three-axle buses in Australia in 2016–17 that travelled an estimated 136 million kilometres. This is less than one per cent of the total vehicle kilometres travelled for heavy vehicles, which is around 16.8 billion kilometres. The combined estimated revenue from registration and road user charges was about $18.4 million.

Due to the current low volume of three-axle buses operating on the national road network, it is unlikely that a proportion of the fleet carrying weight above the current weight limit some of the time is the cause of significant extra road wear.

The cost per 100 km of travel is set out in the Table 21.

Table 21. Cost per 100 km travelled (Advantia calculations) at 6.5 t and 15.5 t axle loads

Mass distribution over tandem axle	Tag tyre width	$/100 km of travel
70:30	275 or 295	86.62
67:33	275 or 295	82.63
60:40	275 or 295	82.86
70:30	375+	84.09
67:33	375+	78.77
60:40	**375+**	**74.84**

The cost per 100 km travelled at 20 t GML is currently $57.06 with standard tyres and a 60:40 load share on tyres across the rear axle group. At 22 t with wide tyres and a mass split ratio of 60:40 weight distribution (as allowed under permit in NSW) the cost per 100km is $74.84, to reflect the least amount of pavement possible for this mass at this configuration.

The NTC performed additional calculations using Advantia's estimated road wear costs to demonstrate the cost of our recommendation. As definitive data is not available for three-axle bus patronage, we made assumptions and used the best available information to provide a model of cost implications.

Using this model, we conclude that there would be little impact on revenue to governments from three-axle buses because of our recommendations. There may be some substitution of two-axle buses to three-axle buses, which would change the registration charge revenue received. There may also be some small implications from road user charges revenue, but this is difficult to estimate.

Changing the mass limit for three-axle buses to 22 t would be likely to have two main effects:

- A number of current operators of three-axle buses would carry additional load.
- A number of operators of two-axle buses may switch to three-axle buses because these are now a more attractive option.

In the first case, this would be expected to increase the cost of road wear. However, in both cases this would also come with the benefits of additional carrying capacity (passengers and safety technology) within three-axle buses, which could decrease the number of buses required to undertake passenger services and decrease traffic congestion.

We estimate the additional road wear cost associated with the first effect would be around $4.84 million per annum nationally. This estimate is based on the conservative assumption that three-axle buses would travel at full capacity (22 t) 20 per cent of the time, empty 10 per cent of the time and at 20 t 70 per cent of the time following the policy change. This is compared with a baseline of being empty 10 per cent of the time and at 20 t 90 per cent of the time. On average that is approximately $604,500 per jurisdiction per annum.

We have also shown that buses are already running overloaded in some cases. Under this scenario, we have assumed that, irrespective of the percentage of kilometres at 22 t before the policy change, an additional 20 per cent of kilometres would be at 22 t following the change in policy.[9] Under these conditions, the increase in costs as a result of the policy would remain at $4.84 million, but the baseline and final costs would be different depending on how many kilometres are assumed to be at 22 t before the policy change.

To estimate the impact of the second effect, we can assume that two-axle buses travelling at 18 t are replaced by three-axle buses travelling at a range of different masses. Nationally, the cost of this effect would reduce road network operating costs by $1.7 million.

Under the current methodology for setting heavy vehicle charges under PAYGO, a proportion of road expenditure is recovered from heavy vehicle charges. If road expenditure were to decrease due to the proposed policy change, it would have a minimal effect on the amount of revenue recovered through heavy vehicle charges.

The reduction in operating cost to road managers is compounded by the community benefits of optimising passenger services provided by three-axle bus operators, including by:

- Contributing to the efficient movement of people and reduction of urban congestion – this is one of the six ‘High Priority Projects’ identified by Infrastructure Australia for the next 15 years (Infrastructure Australia, 2018). This can be achieved by using three-axle buses for commuter transport, as we’re starting to see in Sydney and Brisbane. This is supported by the fact that, at 22 t and 23 t GML, three-axle buses cause less pavement wear per tonne GVM than two-axle buses at 18 t GML.
- Providing a higher level of safety to passengers through adopting advanced safety technology that can be accommodated by manufacturers at a higher GML. This aligns with the *National road safety action plan 2018–20*, which aims to increase the market uptake of safer new and used vehicles on Australia’s roads.

We believe that these aspects, together with the demonstrated community benefits and additional safety benefits, are investments that align well with government priorities.

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[9] For example, if there were 20 per cent (0 per cent) of kilometres at 22 t before the policy change, the percentage of kilometres at 22 t after the policy change would be 40 per cent (20 per cent).

Tasmania acknowledged in their submission to our discussion paper that a longer-term approach is required to ensure that future vehicles (including hybrid and electrified vehicles) are appropriately configured, or loaded, to achieve mass compliance in line with other heavy vehicles.

2.3.4 Technical requirements to support safety outcomes

Both government and industry have highlighted the need to consider specific requirements to support the increase in mass limits for three-axle buses. They suggested that these could include braking and stability control requirements.

This is also supported by the National Road Safety Action Plan 2018-20, which aims to increase the market uptake of safer new and used vehicles and emerging vehicle technologies with high safety benefits. One of the areas that the plan identifies to encourage this action is to influence industry to apply, and if possible accelerate, new safety technologies, for example AEB, fatigue detection, distraction mitigation, vehicle control and aftermarket vehicle warning technologies.

As discussed in Section 1.3.7, there is already an appetite to introduce more safety technology when the GML of three-axle buses allows.

All three-axle buses manufactured on or after 1 January 2015 are required to have an anti-lock system (also known as anti-lock braking system, or ABS).

For all three-axle buses manufactured on or after 1 January 2022, this requirement will continue and a vehicle stability function (also known as electronic stability control, or ESC) including both rollover and directional control be fitted will become an additional requirement, with the exception of route service buses.

The NTC is suggesting, that to access the extra mass, operators must include safety technology to complement current and future ADR requirements.

In summary, we suggest that:

- If manufactured before 1 January 2015:
  - To access additional mass, a complying three-axle bus must be fitted with an antilock braking system, or a vehicle stability function relevant to the bus's date of manufacture.
- If manufactured on or after 1 January 2015:
  - To access additional mass, a complying three-axle bus must be fitted with an antilock braking system and either:
    - iii. An eligible electronic braking system, or
    - iv. A vehicle stability function relevant to the bus's date of manufacture.
  - A route service bus manufactured on or after 1 January 2015 is only required to be fitted with an anti-lock braking system.

ADR 35/06 saw the introduction of the requirement that all buses (having more than 9 seating positions, including that of the driver) exceeding 5.0 tonnes (excluding a route service bus) manufactured on or after 1 January 2022 be fitted with a vehicle stability function.

Although not an ADR requirement for applicable buses until 2022, the NTC's recommendation provides the option that a bus satisfies the requirements to access higher mass if it is fitted with an anti-lock braking system and either an eligible electronic braking system or a vehicle stability function.

The Vehicle Standard (Australian Design Rule 35/06 – Commercial Vehicle Brake Systems) 2018 Explanatory Statement, clarifies that route service buses are excluded from the requirement to be fitted with a vehicle stability function. The reasoning is that it was intended that the requirement only be targeted to where the biggest road safety gains could be made and so would not be applied to complex and/or niche cases at this time.

A three-axle bus which does not meet these requirements will be able to continue operating at the current mass limit within their jurisdiction. As well as being applied already by the NHVR, these specifications are also supported by the BIC.

2.4 Options considered

Options

1. No change to the axle mass limits for three-axle buses.
2. **Preferred option:** Increase the axle mass limits for three-axle buses.

Option 1: No change to the limit

If no change to the current mass limit is made and no mitigating weight management strategies are put in place, the current situation will continue to cause overloaded buses to run on our road networks. This is an unacceptable outcome.

There are no weight management policies or guidelines that the NTC is aware of that assist bus operators and drivers to manage their loaded weight.

However, if the preferred option was to retain the current mass limits for three-axle buses, then there are a range of options that could be included in such guidelines for operators to manage the loaded weight issues discussed in section 2.2. These include:

- passenger and luggage calculations that are more realistic for today's travellers
- considerations for charging for excess baggage
- guidance for weight spacing across axles
- use of trailers.

This option ignores the issue of tare mass increases and is not supportive of optimising three-axle bus services.

All stakeholders have acknowledged that there is a need to increase the mass limit for this configuration during our informal discussions – for example, stating that prescribed mass limits do not cater for the change in the construction of buses, increases in passenger weights and carried or stowed luggage.

The debate has focused more on the appropriate mass limit, with most road managers requesting further evidence of the road wear and cost impacts. One jurisdiction suggested there is strong evidence the NTC's suggested limits are not high enough to resolve the issue of noncompliance and that a minimum of 2.5 t additional mass was required to achieve this.

They believed that failure to increase limits sufficiently could result in some operators reverting to using two-axle buses or under loading, which would have undesirable impacts including increasing the number of buses required to undertake passenger services and increased traffic congestion. In that jurisdiction's view, while a reduction in passengers transported would reduce vehicle mass, there would be no overall reduction in pavement wear because there would be more vehicle movements.

Option 2: Increase the axle-mass limits

Option 2 is to increase the axle mass limits for three-axle buses to a limit that enables operators to optimise their efficiency without compromising safety or unduly damaging infrastructure.

We have outlined the likely benefits and risks of increasing the mass limit in Table 21, which together with the pavement wear analysis provided by Advantia, has helped us to determine an appropriate mass limit.

Table 22. Risk and likelihood of risk, by tonnes increases

Mass (tonne)	Increase (tonne)	Benefit	Risk	Likelihood
20.0	None	None	✗ Industry would revert to 2-axle buses because of the higher mass limit	High
21	1.0	Medium Would reflect an increase in tare weight	No change as this would protect services already running at capacity	Medium
22	2.0			
23	3.0	High ✓ Industry would reduce compliance costs ✓ Industry could increase the types of services offered ✓ Governments could take up advantages of double deckers ✓ Manufacturers could offer cheaper parts	✗ Increase in road wear	Medium Wear would likely increase; however, operators would want to keep their costs low and weight adds fuel costs
24	4.0			
25	5.0			
26	6.0	✓ Match overseas regulation ✓ Manufacturers would find it easier to import and could offer more innovative practices	✗ Open market for much larger vehicles and subsequent road wear	
No limit		✓ As above ✓ Plus, regulation would be prepared from hybrid and electric vehicles, which are significantly heavier		Very high

The *Mass limits for three-axle buses* discussion paper (NTC, 2018) contended that the mass limits for three-axle buses should be raised. This is consistent with the recent two-axle increase, and with most other countries in the world, to cater for the growing population, disability requirements, environmental protection and new technology and to better prepare for the future shift to electric, hybrid and driverless buses.

This will allow industry to minimise their compliance costs, invest in safer technology and continue or even increase their services for the community.

The same benefits apply to government-funded public transport services and will allow transport agencies to invest in more productive vehicles such as double deckers.

The benefits to the community are paramount, and we believe the increased cost to road maintenance should be addressed in the review of road pricing.

All states and territories expressed their in-principle agreement that a mass increase is appropriate; however, they all requested more evidence about the impacts of pavement damage and maintenance costs. We have provided this evidence at sections 2.3.2 and 2.3.3. Further consultation will take place with road managers before submitting our recommendations to the Transport and Infrastructure Council in September 2018.

The BIC believes that a 23 t GML, with 7 t on the steer axle and 16 t on the rear tandem axle group when using 80 kg per passenger, is a realistic assessment of in-service bus weights of single deck three-axle rigid buses.

A 23 t GML is therefore appropriate to allow three-axle rigid single buses to run at full capacity for both route services and charter services when carrying adult passengers with an average per passenger weight of 80 kg.

However, due to a current lack of detailed economic data to provide a business case to governments to support an increase beyond 22 t GML, the NTC will need to conduct a detailed economic analysis to investigate the role of three-axle buses in responding to, not only tare mass increases due to state and territory regulation, but also future increased public transport demand, technological innovation, regional economic development and tourism.

Therefore, for the recommended option of 22 t GML to take effect, the Heavy Vehicle (Mass, Dimension and Loading) National Regulation needs to be amended so that the allowable gross mass limit for a three-axle complying bus, that has a tandem rear axle group fitted with single tyres on one axle and dual tyres on the other to be increased from 20 t to 22 t with the following requirements:

- Steer axle mass limit of 6.5 t; and
- Rear tandem axle group with a single tyres on one axle and dual tyres on the other, a mass limit of 15.5 t.

The requirement initially specified for at least 375mm wide tyres and a 60:40 weight distribution across the rear tandem axle matches the lowest pavement wear configurations set out in data prepared by Advantia for the NTC, however, during post TISOC discussions jurisdictions agreed to proceed without a wide tyre requirement to minimise the associated burden on industry.

This requirement for a 60:40 mass distribution ratio remains despite advice from manufacturers' that modern three-axle buses have technical capability to automatically evenly distribute mass across tyres on different axle groups to minimise road wear impacts.

There would be no change required to the axle spacing requirements set out in Schedule 1.

In line with the current regulation mass limits, we propose not to specify which of the axles within the tandem axle group is required to have dual tyres and which is required to have single tyres. It is our understanding from manufacturers that it is more efficient to include dual tyres on the drive axle and single tyres on the tag axle, therefore regulation is not required to specify this.

2.4.1 Amending Australian Design Rule 58/00

All new road vehicles are required to meet the ADRs before they can be supplied to the market for use in transport. The ADRs are mostly performance-based standards for vehicle safety (e.g. occupant protection, lighting, braking, structural integrity etc.), emission control (including both gaseous and noise emissions) and anti-theft protection.

Development of the ADRs for safety and anti-theft is the responsibility of the Vehicle Safety Standards Branch of the Australian Government Department of Infrastructure, Regional Development and Cities. It is carried out in consultation with representatives of governments (Australian and state/territory), manufacturing and operating industries, road user groups and experts in the field of road safety.

The Technical Liaison Group (TLG) would be the principle consultative forum for advising on any proposed amendments to the Australian Design Rule 58/00. TLG consists of technical representatives of governments (Australian and state/territory), the manufacturing and operational arms of industry (including organisations such as the Federal Chamber of Automotive Industries and the Bus Industry Confederation) and of representative organisations of consumers and road users.

The NTC's discussion paper recommended that luggage allowances in the ADRs be increased from 15 to 23 kg to align with all other transport modes. However, the 15 kg passenger luggage mass currently specified for determining occupant capacity in the ADRs is only a minimum requirement and most three-axle coaches already have the capacity to carry at least 23 kg of luggage per passenger.

This is because the GVM of new three-axle coaches (as determined for certification by the ADRs) is generally around 25 to 26 tonnes, which is consistent with the maximum technically permissible mass of similar vehicles in other markets, including both Europe and the United States.

This means three-axle buses are (in the main) already technically capable of carrying a GVM greater than 23 tonnes, including a steer axle load rating of at least 7 tonnes and a rear axle group load rating of at least 16 tonnes.

In practice, the load that these coaches can legally carry in Australia is typically limited by the allowable on-road mass limits, not the passenger and/or luggage loads specified for determining occupant capacity in the Australian Design Rule 58/00.

The Bus Industry Confederation (BIC) stated in their submission to our discussion paper that increasing the luggage mass used for occupant capacity calculations from 15 to 23 kg per person could have a minor adverse effect on passenger capacity.

Passenger and luggage loads for larger buses could be managed in-service through the adoption of national operational guidelines developed by industry for calculating passenger capacity as discussed at section 2.3.2. The BIC has recently released a guide to calculate passenger capacity for the 18 tonne two-axle bus configuration with an average mass of 80 kg per passenger, and they have suggested that similar methods could be used for three-axle buses operating at 23 tonnes and above.

While no change to the ADRs is needed to allow for the implementation of our recommendations 1 and 2, the passenger and/or luggage masses used in determining the occupant capacity of new buses could still be amended to more accurately reflect actual passenger and luggage loads, including the distribution of these loads between axles.

The case for this should be considered by the Australian Government Department of Infrastructure, Regional Development and Cities as part of its current review of the Australian Design Rule 58.

Different methods for assessment of luggage loads may need to be considered for small and large buses to account for differences in operational use and the volume of the luggage compartments provided.

Any change in the passenger and/or luggage masses used in determining the occupant capacity of new buses would be subject to the normal consultation arrangements for ADRs, and ministerial approval.

Table 22 summarises the pros and cons of raising the axle-mass limit.

Table 23. Benefit matrix of raising the mass limit

	Benefits	Negatives
Operators	1. In line with 2-axle increase 2. In line with other countries 3. Reduction in compliance 4. Can run at full capacity 5. Luggage allowances in line with other transport modes	N/A
Manufacturers	1. Less investment in expensive, lighter materials 2. Can offer new models to market with Euro VI engines 3. Can offer greater capacity vehicles 4. Can offer additional safety technology	Manufacturers specialising in lighter materials may reduce their market share slightly
Passengers	1. No reduction in services 2. More (or same) amount of luggage 3. Possibility of greater comfort 4. Better connects regional passengers to other transport modes including airlines	N/A
Charter clients	1. No increase in cost 2. Operators more willing to charter for heavier groups such as sports clubs or camping groups 3. Greater capacity to accommodate tourists	N/A
Road managers	Less enforcement	Possible, yet minor increase in road wear
Regulators	National consistency	Will need to amend the HVNL and publish communications material about the changes

3 Conclusions

Key points

Based on our analysis and stakeholder feedback received to our discussion paper, the NTC is making three recommendations to optimise three-axle bus services in Australia.

3.1 Conclusions

Our review has determined that three-axle buses are likely to be running over mass on Australian roads, with the majority falling within peak times for route services and long-distance coaches at full capacity.

We concluded the reasons behind overloading were:

- a disconnect with luggage allowances on other transport modes
- heavier mechanical parts needed to meet the requirements of the federal *Disability Discrimination Act 1992*
- emissions standards for engine exhaust (Emissions Requirements for Diesel Heavy Duty Vehicles, Cwlth).

We also determined that the impact on road wear is likely to be at least partially offset by the community safety and congestion management benefits, as well as the additional safety technology that the mass increase allows. Therefore, we have made the following recommendations:

Recommendation 1:

That the allowable gross mass limit for a three-axle complying bus that has a tandem rear axle group fitted with single tyres on one axle and dual tyres on the other axle should be increased to 22 t with the following requirements:

- steer axle: 6.5 t
- rear tandem axle group with single tyres on one axle and dual tyres on the other axle: 15.5 t
- tyre width at a minimum of 295mm on the single-tyred rearmost axle
- mass distribution across the rear axle group (comprised of a dual-tyred axle and a single-tyred axle) of a 60:40 distribution ratio.

Recommendation 2:

That to access additional mass under Recommendation 1:

- If manufactured before 1 January 2015:
  - To access additional mass, a complying three-axle bus must be fitted with an antilock braking system, or a vehicle stability function relevant to the bus's date of manufacture.
- If manufactured on or after 1 January 2015:
  - To access additional mass, a complying three-axle bus must be fitted with an antilock braking system and either:
    - v. An eligible electronic braking system, or
    - vi. A vehicle stability function relevant to the bus's date of manufacture.

- ➢ A route service bus manufactured on or after 1 January 2015 is only required to be fitted with an anti-lock braking system.

Recommendation 3:

That the case for an increase in the passenger and/or luggage masses used in determining the occupant capacity of new buses, be considered by the Australian Government Department of Infrastructure, Regional Development and Cities as part of its current review of the Australian Design Rule 58/00.

Recommendation 4:

That the NTC provide a detailed analysis of the economic contribution of three-axle buses in Australia to TISOC in 2019.

The analysis should include an assessment of safety and the implementation cost to government and industry to adopt a three-axle bus gross vehicle mass limit up to a manufacturer's technical specifications to support increased public transport demand, technological innovation, regional economic development and tourism.

3.2 Implementation

For our recommended option to take effect, the NTC would need to amend the Heavy Vehicle (Mass, Dimension and Loading) National Regulation.

Amendments could be progressed as part of a discrete amendment package, which will be considered by TISOC in March 2019 and by the Transport and Infrastructure Council in May 2019.

The ADRs are national vehicle standards under the *Motor Vehicle Standards Act 1989,* which are administered by the Australian Government Department of Infrastructure, Regional Development and Cities. In the case of our Recommendation 3, any increase in the passenger and/or luggage masses used in determining the occupant capacity of buses would be subject to the normal consultation arrangements for ADRs, and ministerial approval.

3.3 Next steps

A summary of our evaluation and recommendations will be presented to TISOC in September 2018 and then to the Transport and Infrastructure Council in November 2018.

Appendix 1: Relevant clauses from the Disability Standards for Accessible Public Transport 2002

Clause	Detail
1.2	(1) The Disability Discrimination Act 1992 seeks to eliminate discrimination, 'as far as possible', against people with disabilities.
8.2	**When boarding devices must be provided** (1) A manual or power assisted boarding device must be available at any accessible entrance to a conveyance that has: (a) a vertical rise or gap exceeding 15 mm (AS3856.1 (1991) Clause 2.1.7 (f)); or (b) a horizontal gap exceeding 40 mm
8.6	**Maximum load to be supported by boarding device** (1) A boarding device must be able to support a total passenger and mobility aid weight of up to 200 kg.
9.1	**Minimum size for allocated space** The minimum allocated space for a single wheelchair or similar mobility aid is 800 mm by 1300 mm
9.4	**Number of allocated spaces to be provided — buses** (1) At least 2 allocated spaces must be provided in each bus with more than 32 fixed seats (2) At least one allocated space must be provided in each bus with less than 33 fixed seats
11.7	**Grabrails to be provided in allocated spaces** Grabrails, must be provided in all allocated spaces.
12.6	**Automatic or power-assisted doors** (1) Doors may be fully automatic (2) Power-assisted doors must not require passengers to grip or twist controls in order to operate opening devices
28.4	**Accessible seats to be available for passengers with disabilities** (1) Accessible seats must be kept for passengers with disabilities. (2) Operators must allocate unbooked accessible seats to other passengers only after all other standard seats are filled.
30.1	**Disability aids to be in addition to baggage allowance** (1) Disability aids (for example, equipment and apparatus including mobility, technical and medical aids) are to be in addition to normal baggage allowances. (2) If possible, disability aids are to be treated in the same way as cabin or accompanied baggage.
Part 4	**Target date — 31 December 2022** All public transport services are to fully comply with the relevant Standards.

Appendix 2: Australian Design Rules relevant to three-axle buses

Standard	Title	Year	Specifications
ADR 1/00	Reversing Lamps	2005	Photometric requirements for reversing lamps which will warn pedestrians and other road users that the vehicle is about to move or is moving in the reverse direction, and which during the hours of darkness will aid the driver in reversing manoeuvres.
ADR 3/04	Seats and Seat Anchorages	2017	Requirements for ‘Seats’, their attachment assemblies, their installation and any head restraint fitted to minimise the possibility of occupant injury due to forces acting on the ‘Seat’ as a result of vehicle impact.
ADR 4/05	Seatbelts	2012	Requirements for seatbelts to restrain vehicle occupants under impact conditions, facilitate fastening and correct adjustment, assist the driver to remain in his ‘Seat’ in an emergency situation and thus maintain control of the vehicle, and protect against ejection in an accident situation.
ADR 5/05	Anchorages for Seatbelts	2006	Requirements for belt anchorages so that they may be adequately secured to the vehicle structure or seat and will meet comfort requirements in use.
ADR 6/00	Direction Indicators	2005	Requirements for a device mounted on a motor vehicle or trailer which when operated by the driver signals the intention to change the direction in which the vehicle is proceeding.
ADR 8/01	Safety Glazing Material	2005	Requirements of material used for external or internal glazing in motor vehicles which will ensure adequate visibility under normal operating conditions, will minimise obscuration when shattered, and will minimise the likelihood of serious injury if a person comes in contact with the broken glazing material.
ADR 13/00	Installation of Lighting and Light-signalling Devices on other than L-Group Vehicles	2005	Requirements for the number and mode of installation of lighting and light-signalling devices on motor vehicles other than L-group vehicles.
ADR 14/02	Rear Vision Mirrors	2006	Requirements for rear vision mirrors to provide the driver with a clear and reasonably unobstructed view to the rear.
ADR 18/03	Instrumentation	2006	Requirements for the provision of speedometers.
ADR 30/01	Smoke Emission Control for Diesel Vehicles	2006	Smoke emission requirements for diesel fuelled vehicles in order to reduce air pollution.
ADR 34/03	Child Restraint Anchorages and Child Restraint Anchor fittings	2017	Requirements for ‘Child Restraint Anchorages’ and ‘Child Restraint Anchor Fittings’ which provide for the connection of standard ‘Attaching Clips’ so that ‘Child Restraints’ may be adequately secured to the vehicle. It specifies a standard package of fitting hardware and

			accessibility requirements to facilitate correct installation and interchangeability of 'Child Restraints'
ADR 35/05	Commercial Vehicle Brake Systems	2013	Requirements on commercial motor vehicles and large passenger vehicles to ensure safe braking under normal and emergency conditions.
ADR 42/04	General Safety Requirements	2005	Design and construction requirements to ensure safe operation of vehicles.
ADR 43/04	Vehicle Configuration & Dimensions	2006	Requirements for vehicle configuration and dimensions.
ADR 44/02	Specific Purpose Vehicle Requirements	2006	Specific requirements of the particular vehicles. (Emergency exits for omnibuses)
ADR 46/00	Headlamps	2006	Photometric requirements for headlamps, which will provide adequate illumination for the driver of the vehicle without producing undue, glare for other road users.
ADR 47/00	Retroreflectors	2006	Specify the dimensions, photometric and stability requirements for retro-reflecting devices which when mounted on a vehicle will ensure that they effectively warn of the presence of the vehicle.
ADR 48/00	Devices for Illumination of Rear Registration Plates	2006	Photometric requirements for devices, which illuminate the rear registration, plate by reflection.
ADR 49/00	Front and Rear Position (Side) Lamps, Stop Lamps and End-outline Marker Lamps	2006	Photometric requirements for light-signalling devices, which will indicate the presence, width and position of the vehicle when viewed from the front and from the rear.
ADR 51/00	Filament Lamps	2006	Specify the dimensional and photometric requirements for filament lamps, which ensure interchangeability and correct functioning when installed in a lamp unit.
ADR 58/00	Requirements for Omnibuses Designed for Hire and Reward	2006	Specify requirements for the construction of omnibuses designed for, and intended for licensing for, hire and reward.
ADR 59/00	Standards for Omnibus Rollover Strength	2007	Ensure that omnibus superstructures withstand forces encountered in rollover crashes to maintain a residual space during and after a rollover crash.
ADR 61/02	Vehicle Marking	2005	Specify requirements for vehicle marking.
ADR 65/00	Maximum Road Speed Limiting for Heavy Goods Vehicles and Heavy Omnibuses	2006	Specify devices or systems used to limit the maximum road speed of heavy goods vehicles and heavy omnibuses.
ADR 68/00	Occupant Protection in Buses	2006	Specify, for certain omnibuses, requirements for seatbelts, the strength of 'Seats', seat-anchorages, seatbelt 'Anchorages' and 'Child Restraint Anchorages',

			and provisions for protecting occupants from impact with 'Seat' backs and accessories on 'Seats' and armrests
ADR 74/00	Side Marker Lamps	2006	Photometric requirements of side marker lamps, which are used to increase the visibility of the sides of road vehicles.
ADR 80/03	Emission Control for Heavy Vehicles	2006	Prescribe exhaust emission requirements for heavy vehicles in order to reduce air pollution.
ADR 83/00	External Noise	2005	Defines limits on external noise generated by motor vehicles, motor cycles and mopeds in order to limit the contribution of motor traffic to community noise.

Appendix 3: Advantia Transport Calculations (see separate document)

Appendix 4: Technical requirements for eligible 2-axle buses

eligible 2-axle bus—

1. A bus is an eligible 2-axle bus if the bus—
   a. was manufactured before 1 January 2016; and
   b. has 2 axles, 1 of which is a single-drive axle fitted with dual tyres; and
   c. is 1 of the following—
      i. a complying bus;
      ii. an ultra-low floor bus;
      iii. a bus, other than an ultra-low floor bus, that is authorised to carry standing passengers;
      iv. a bus, other than an articulated bus, whose length is more than 12.5m but not more than 14.5m; and
   d. is fitted with—
      i. a *complying anti-lock braking system*; or
      ii. a vehicle stability function that complies with the version of UN ECE Regulation No. 13 that applied to the bus at the bus's date of manufacture or a later version of UN ECE Regulation No. 13.

   Note — A vehicle stability function is also known as electronic stability control or ESC.

2. A bus is also an eligible 2-axle bus if the bus—
   a. was manufactured on or after 1 January 2016; and
   b. has 2 axles, 1 of which is a single-drive axle fitted with dual tyres; and
   c. is 1 of the following—
      i. a complying bus;
      ii. an ultra-low floor bus;
      iii. a bus, other than an ultra-low floor bus, that is authorised to carry standing passengers;
      iv. a bus, other than an articulated bus, whose length is more than 12.5m but not more than 14.5m; and
   d. is fitted with—
      i. a *complying anti-lock braking system*; and
      ii. either—
         A. an *eligible electronic braking system*; or
         B. a vehicle stability function that complies with the version of UN ECE Regulation No. 13 that applied to the bus at the bus's date of manufacture or a later version of UN ECE Regulation No. 13.

complying anti-lock braking system, for an eligible 2-axle bus, means an anti-lock braking system that complies with—

(a) if a version of ADR 35 later than ADR 35/01 applied to the bus at the bus's date of manufacture—the version of ADR 35 that applied to the bus at the bus's date of manufacture or a later version of ADR 35; or

(b) otherwise—ADR 35/01 or a later version of ADR 35.

eligible electronic braking system, for an eligible 2-axle bus, means a service brake system operating on the wheels of the bus that—

(a) is primarily activated by electronic means; and

(b) has a secondary means of activation if the electronic means of activation fails.

Example of secondary means of activation— pneumatic activation

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