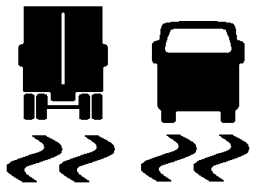
Australian Government

Department of Infrastructure, Regional Development and Cities

Regulation Impact Statement

National Heavy Vehicle Braking Strategy Phase II – Improving the Stability and Control of Heavy Vehicles



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Regulation Impact Statement Improving the Stability and Control of Heavy Vehicles

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EXECUTIVE SUMMARY

The impact of road crashes on society is significant, costing the Australian economy over $27 billion per annum (BITRE, 2014). Heavy vehicle crashes constitute around $1.5 billion of this, including approximately $375 million from crashes involving a rollover and/or loss of directional control (rollover and/or loss of control crashes).

Crashes involving heavy vehicles have drawn increasing attention from policy makers, road safety advocates and the general-public, as well as from the heavy vehicle industry itself. While in fatal multi-vehicle crashes a lighter vehicle is most likely to have been at fault (NTARC, 2017), heavy vehicles nonetheless have characteristics that can increase both the risk and severity of crashes, including for example a high gross mass, elevated centre of gravity, long vehicle length and relatively long stopping distances.

Heavy vehicles represent 3 per cent of all registered vehicles in Australia (Australian Bureau of Statistics, 2017a) and account for just over 8 per cent of total vehicle kilometres travelled on public roads (Australian Bureau of Statistics, 2017b). However, on average they are involved in around 17 per cent of fatal crashes and 5 per cent of serious injury (hospital admission) crashes. Over the last three years (2014-2016), an average of 220 people have been killed from 190 fatal crashes involving heavy trucks or buses each year. The two most recent years of available data (2012-13 and 2013-14) also show that close to 1,750 people are hospitalised each year from road crashes involving heavy vehicles.

Heavy vehicle rollover and loss of control crashes together make up the specific road safety problem that has been considered in this Regulation Impact Statement (RIS). For this RIS, heavy vehicles are defined as passenger or goods vehicles greater than 4.5 tonnes Gross Vehicle Mass (GVM) and trailers greater than 4.5 tonnes Gross Trailer Mass (GTM).

Industry and governments have been active in encouraging or mandating advanced technologies such as Autonomous Emergency Braking (AEB), Antilock Brake Systems (ABS), Electronic Braking Systems (EBS), Electronic Stability Control (ESC) and Roll Stability Control (RSC). These technologies are increasingly being mandated in some overseas and international regulations and so as part of Phase II of the National Heavy Vehicle Braking Strategy under the National Road Safety Strategy 2011-2020 (and associated 2015-2017 action plan), the Australian Government is considering the case for requiring advanced ESC based systems for new heavy vehicles. If adopted, this would be implemented through the national standards for new vehicles known as the Australian Design Rules (ADRs). This would then build on requirements set in 2013 for ABS to be fitted to some heavy vehicles, as well as industry's recently published guidance on optimising braking performance when operating with equipment having different levels of these types of technologies.

The RIS explored six options to improve heavy vehicle control and stability by increasing the fitment of ESC systems to new heavy trucks/buses and RSC systems to new heavy trailers. These were Option 1: no intervention (business as usual); Option 2: user information campaigns; Option 3: fleet purchasing policies; Option 4: codes of practice; Option 5: mandatory standards under the *Competition and Consumer Act 2010* (C'th) (CCA); and

Option 6: mandatory standards under the *Motor Vehicle Standards Act 1989* (C'th) (MVSA). Of these options, Option 1, Option 2 and Option 6 were considered viable and so were examined in detail. Option 2 was separated into two sub-options: 2a (targeted awareness) and 2b (advertising). Option 6 was initially separated into three sub-options: 6a (broad scope), 6b (medium scope) and 6c (narrow scope). Following consultation, a fourth sub option, 6c Plus was introduced as an extension to Option 6c. The results of the benefit-costs analysis over a 35 year period for each of these options (assuming an intervention period of 15 years) are summarised in Table 1 to Table 3 below.

Table 1: Summary of gross benefits and net benefits for each option

	Gross benefits ($m)			Net benefits ($m)		
	Best case	Likely case	Worst case	Best case	Likely case	Worst case
Option 1: no intervention	-	-	-	-	-	-
Option 2a: targeted awareness	-	115	-	-	69	-
Option 2b: advertising	-	17	-	-	-52	-
Option 6a: regulation (broad scope)	337	337	337	266	167	-24
Option 6b: regulation (medium scope)	303	303	303	273	204	75
Option 6c: regulation (narrow scope)	269	269	269	264	216	140
Option 6c Plus: regulation (narrow scope, post consultation extension)	-	273	-	-	217	-

Table 2: Summary of costs and benefit-cost ratios for each option

	Costs ($m)			Benefit-cost ratios		
	Best case	Likely case	Worst case	Best case	Likely case	Worst case
Option 1: no intervention	-	-	-	-	-	-
Option 2a: targeted awareness	-	46	-	-	2.51	-
Option 2b: advertising	-	69	-	-	0.24	-
Option 6a: regulation (broad scope)	71	169	361	4.75	1.99	0.93
Option 6b: regulation (medium scope)	30	99	228	9.96	3.07	1.33
Option 6c: regulation (narrow scope)	5	53	129	51.8	5.10	2.08
Option 6c Plus: regulation (narrow scope, post consultation extension)	-	57	-	-	4.83	-

Table 3: Summary of number of lives saved and serious injuries (hospital admissions) avoided

	Lives saved	Serious injuries avoided
Option 1: no intervention	-	-
Option 2a: targeted awareness	41	432
Option 2b: advertising	9	92
Option 6a: regulation (broad scope)	148	1496
Option 6b: regulation (medium scope)	136	1292
Option 6c: regulation (narrow scope)	124	1084
Option 6c Plus: regulation (narrow scope, post consultation extension)	126	1101

Option 6a: regulation (broad scope) generated the highest number of lives saved (148) and serious injuries avoided (1496), of the options examined. However, Option 6c: regulation (narrow scope) generated the greatest net benefits ($216 m) and the highest benefit-cost ratio (5.10). In considering these options, industry was also surveyed regarding the practicalities of fitting ESC/RSC systems, including their use in regional and remote areas.

According to the Australian Government Guide to Regulation (2014) ten principles for Australian Government policy makers, the policy option offering the greatest net benefit should always be the recommended option.

Prior to consultation, Option 6c: regulation (narrow scope) was the recommended option. Under this option, fitment of ESC would be mandated for new prime movers greater than 12 tonnes GVM and new buses greater than 5 tonnes GVM, fitment of ABS would be mandated for new trailers greater than 4.5 tonnes GTM, and fitment of RSC would be mandated for new trailers greater than 10 tonnes GTM.

The full requirements would be targeted to where the biggest road safety gains could be made and so would not be applied to more complex and/or niche cases at this time and as part of this proposal. In this respect ESC would not be required for articulated or route service buses, or off-road vehicles. Feedback was also sought on a possible exemption from ESC for prime movers with four or more axles. In addition, converter dollies as well as trailers fitted with an axle group consisting of more than four tyres in a row of axles or more than four axles in an axle group (certain low-loaders) would not be required to be equipped with either ABS or RSC.

A sensitivity analysis was undertaken for Option 6c. This considered three variables: the discount rate, the effectiveness of stability control systems, and the expected business as usual fitment rate of stability control systems. The net benefits from this option remained positive under all scenarios.

The consultation version of this RIS was circulated for a six-week public comment period, together with consultation draft ADRs 35/06 and 38/05. A summary of the feedback and Departmental responses is included in Appendix 18.

During the consultation period, feedback was received from state and territory government agencies and industry. Most feedback supported the implementation of Option 6a. Many responses particularly noted support for application of the standard to rigid vehicles.

A majority of respondents supported the broadest level of regulation, Option 6a, over the narrower regulatory case, Option 6c. The Truck Industry Council (TIC), representing the manufacturers and suppliers of new heavy vehicles in Australia preferred Option 6c but proposed that Option 6a be revisited at a later date.

A compromise proposal was developed that would extend Option 6c partially towards Option 6a. Option 6c was extended to Option 6c "Plus". This Option 6c Plus would increase the scope of regulation to some types of heavier (NC category) rigid vehicles — those with a short wheelbase[1] — that often share chassis and running gear of a prime mover model. This extension of Option 6c would include an additional ten per cent of new heavy rigid trucks (over 12 tonnes GVM) and a $4m increase in costs, with a corresponding reduction in road trauma of 2 lives and 17 serious injuries and so an increase in net benefits of $1m. Beyond Option 6c Plus, further analysis of the case to fit ESC to the rest of the rigid vehicle fleet will be conducted in the future as part of work to consider Advanced Emergency Braking Systems (AEBS) for heavy vehicles. This option also included minor adjustments to implementation timing.

Option 6c Plus: regulation is therefore the recommended option. Under this option, fitment of ESC would be mandated for new prime movers and short wheel base rigid vehicles greater than 12 tonnes GVM and new buses greater than 5 tonnes GVM, fitment of ABS would be mandated for new trailers greater than 4.5 tonnes GTM, and fitment of RSC would be mandated for new trailers greater than 10 tonnes GTM. The proposed implementation timetable is:

- For heavy trucks and buses (ADR category NC and ME vehicles)
  – 1 November 2020 for new models and 1 January 2022 for all new vehicles.
- For medium and heavy trailers (ADR category TC and TD vehicles)
  – 1 July 2019 for new models and 1 November 2019 for all new vehicles

This RIS has been written in accordance with Australian Government RIS requirements, addressing seven questions as set out in the Australian Government Guide to Regulation (2014):

1. What is the problem you are trying to solve?
2. Why is government action needed?
3. What policy options are you considering?
4. What is the likely net benefit of each option?

[1] Short wheelbase for this RIS refers to vehicles where 'Cab-over engine vehicles' have a wheelbase not exceeding 4.5 metres and conventional (bonneted) vehicles have a wheelbase not exceeding 5.0 metres.

5. Who will you consult about these options and how will you consult them?
6. What is the best option from those you have considered?
7. How will you implement and evaluate your chosen option?

In line with the principles for Australian Government policy makers, the regulatory costs imposed on business, the community and individuals associated with each viable option were quantified and measures that offset these costs have been identified.

1. WHAT IS THE PROBLEM?

1.1. Road Trauma from Crashes Involving Heavy Vehicles

The impact of road crashes on society is significant. Individuals injured in crashes must deal with pain and suffering, medical costs, lost income, higher insurance premium rates and vehicle repair costs. For society as a whole, road crashes result in enormous costs in terms of lost productivity and property damage. The cost to the Australian economy has been estimated to be at least $27 billion per annum (BITRE, 2014). This translates to an average of over $1,100 per annum for every person in Australia. This cost is broadly borne by the general public, businesses and government. There is also a personal cost for those affected that is not possible to measure.

In 2015-16, the Australian domestic road freight task reached 219 billion tonne-kilometres, increasing by more than 23 per cent since 2006-07. At the same time, crashes involving heavy vehicles have drawn increasing attention from policy makers, road safety advocates and the general-public, as well as from the heavy vehicle industry itself. While in fatal multi-vehicle crashes a lighter vehicle is most likely to have been at fault (NTARC, 2017), heavy vehicles nonetheless have characteristics that can increase both the risk and severity of crashes, including for example a high gross mass, elevated centre of gravity, long vehicle length and relatively long stopping distances.

Heavy vehicles represent 3 per cent of all registered vehicles in Australia (Australian Bureau of Statistics, 2017a) and account for just over 8 per cent of total vehicle kilometres travelled on public roads (Australian Bureau of Statistics, 2017b). However, on average they are involved in around 17 per cent of fatal crashes and 5 per cent of serious injury (hospital admission) crashes. These crashes are estimated to cost the Australian economy around $1.5 billion each year (in 2017 dollar terms), including approximately $375 million from crashes involving a rollover and/or loss of directional control (rollover and/or loss of control crashes).

Heavy vehicle rollover and loss of control crashes are the specific road safety problem that has been considered in this RIS. According to data from Budd and Newstead (2014), these accounted for 22 per cent of all heavy vehicle injury crashes in Australia, over the period 2008 to 2010 (including 16 per cent involving rigid trucks, 34 per cent involving prime movers and 52 per cent involving road trains). Common causes of these crashes include entering corners at too high a speed, sudden steering manoeuvres to avoid other vehicles or obstacles, shifting of loads such as liquids in tanks, and cornering and/or braking on road surfaces exhibiting uneven levels of grip (e.g. dry bitumen and loose gravel).

Industry and governments have been active in encouraging or mandating advanced technologies such as AEB, ABS, EBS, ESC and RSC. These technologies are increasingly being mandated in some overseas and international regulations and so as part of Phase II of the National Heavy Vehicle Braking Strategy under the National Road Safety Strategy 2011-2020 (and associated 2015-2017 action plan), the Australian Government is considering the case for requiring advanced ESC based systems for new heavy vehicles. These systems are specifically designed to reduce the risk of rollover and loss of control crashes. If adopted, this would be implemented through the national standards for new vehicles known as the Australian Design Rules (ADRs). In parallel, Australian heavy vehicle industry bodies have worked together to develop a 'Guide to Braking and Stability Performance for Heavy Vehicle Combinations', which would complement any regulated requirements for ESC based systems, together with already regulated requirements for compatibility. Further detail on compatibility and this guide are included in Appendix 10.

For the purposes of this RIS, heavy vehicles are passenger or goods vehicles greater than 4.5 tonnes GVM and trailers greater than 4.5 tonnes GTM. Under the ADRs, these are represented by the vehicle categories MD4, ME, NB2, NC, TC (> 4.5 tonnes GTM) and TD. Appendices 1 and 2 describe these vehicles in more detail.

1.2. Extent of the Problem in Australia

Fatal crashes

The Australian Road Deaths Database, maintained by the Bureau of Infrastructure, Transport and Regional Economics, provides basic details of road crash fatalities in Australia as reported by the police each month to the State and Territory road authorities. This includes details on the number of fatal crashes and fatalities in crashes involving heavy articulated trucks (prime movers), rigid trucks and buses. During the 12 months to the end of December 2016, 213 people died from 191 fatal crashes involving heavy trucks or buses. Over the last three years (2014-2016), an average of 220 people have died from 190 fatal crashes involving heavy trucks or buses each year.

Figure 1 shows the annual number of fatal crashes involving heavy trucks and buses in Australia for each calendar year in the period 2007 to 2016, while Figure 2 shows the corresponding number of fatalities.

Figure 1: Fatal crashes involving heavy trucks and buses in Australia, annual totals 2007-2016 (source: Australian Road Deaths Database)

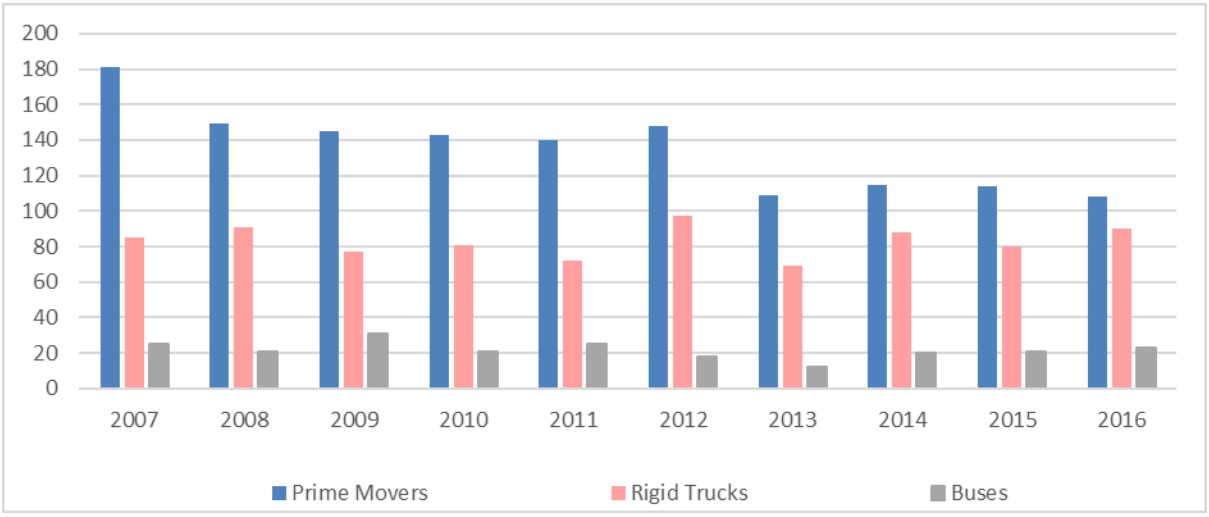

Figure 2: Fatalities in crashes involving heavy trucks and buses in Australia, annual totals 2007-2016 (source: Australian Road Deaths Database)

It can be seen that fatalities in crashes involving prime movers decreased by nearly 40 per cent between 2007 and 2013, but have been relatively constant over the last four years. Fatalities in crashes involving rigid trucks and buses have been relatively constant over the last 10 years.

The involvement of trucks in fatal crashes is much greater than buses. Over the last three years (2014-2016), the proportions of fatal heavy vehicle crashes involving a prime mover, rigid truck or bus were 52 per cent, 40 per cent and 10 per cent respectively (these add up to more than 100 per cent because some crashes involved more than one heavy vehicle type).

Based on detailed injury crash data from Budd and Newstead (2014), it is estimated that there are currently around 45 deaths each year in approximately 40 fatal crashes that involve a rollover or loss of control of a heavy vehicle. Further, around three quarters of these fatalities (approximately 35 each year) are from crashes involving a prime mover.

Fatal road crashes involving heavy trucks and buses in Australia cost approximately $1 billion each year (in 2017 dollar terms). Using the above fatality figures, those involving a rollover or loss of control of a heavy vehicle are estimated to cost $200 million each year (in 2017 dollar terms).

Appendix 12 and Appendix 13 set out the detailed methodology and calculations used to estimate the above fatalities in heavy vehicle rollover and loss of control crashes, as well as the cost of these crashes.

Serious injury crashes

Data compiled by the National Injury Surveillance Unit at Flinders University, using the Australian Institute of Health and Welfare National Hospital Morbidity Database provides details on hospitalisation due to road crashes, including those involving heavy vehicles. The two most recent years of available data (2012-13 and 2013-14) show that close to 1,750 people are hospitalised each year from road crashes involving heavy vehicles. While not a perfect measure, hospital admission provides the best available indication of serious injury crashes in Australia.

Based on the injury crash data from Budd and Newstead (2014), it is estimated there are currently (as of 2016-17) around 500-525 people admitted to hospital each year from road crashes involving a rollover or loss of control of a heavy vehicle. It is estimated that between half and two thirds of these cases (around 290 hospital admissions each year) were from crashes involving a prime mover.

Serious injury crashes involving heavy trucks and buses in Australia cost approximately $550 million each year (in 2017 dollar terms). Those involving a rollover or loss of control of a heavy vehicle are estimated to cost $160 million each year (in 2017 dollar terms).

Appendix 12 and Appendix 13 set out the detailed methodology and calculations used to estimate the above hospitalisations in heavy vehicle rollover and loss of control crashes, as well as the cost of these crashes.

1.3. Government Actions to Address the Problem

Existing government actions to address the problem of road trauma in crashes involving heavy vehicles include: the setting of national vehicle standards by the Australian Government through the ADRs; the setting of requirements for the configuration and operation of heavy vehicles through Heavy Vehicle National Law (HVNL) or by States and Territories; the application of Performance Based Standards (PBS), and other special access arrangements and conditions.

National Vehicle Standards

The Australian Government administers the *Motor Vehicle Standards Act 1989* (C'th) (MVSA), which requires that all new road vehicles, whether they are manufactured in Australia or are imported, comply with national vehicle standards known as the ADRs, before they can be offered to the market for use in transport in Australia. The ADRs set minimum standards for safety, emissions and anti-theft performance.

The brake system is one of the most critical systems for vehicle control and stability. ADR 35/05 – Commercial Vehicle Brake Systems (Australian Government, 2014b) sets the minimum requirements for brake systems on heavy vehicles and ADR 38/04 – Trailer Brake Systems (Australian Government, 2014c) sets the minimum requirements for brake systems on heavy trailers. The current versions of ADRs 35 and 38 were introduced in 2013 and implemented changes agreed for Phase I of the NHVBS. The focus of these changes was the mandating of ABS for heavy trucks/buses and ABS or Load Proportioning (LP) for heavy trailers.

ABS is a safety technology that monitors the wheel slip on sensed wheels and manages (modulates) the brake pressure applied to the controlled wheels to prevent the wheels from locking during braking (ARTSA, 2011). Appendix 5 outlines the operation of the various types of ABS available for heavy vehicles. LP modifies the braking signal of a vehicle, relative to the load carried, to provide a more consistent deceleration response across the full range of vehicle load conditions. This prevents over-braking of wheels, particularly on high grip surfaces (e.g. dry bitumen roads), which also limits wheel lock. Prevention of wheel lock helps to maintain directional stability and control during braking. This reduces loss of control crashes involving jack-knifing of articulated vehicles and road or lane departure, due to skidding of wheels under heavy braking.

ABS is also an integral part of more advanced EBS (or in the case of trailers, TEBS), including ESC for heavy trucks/buses and RSC for heavy trailers. ESC and RSC systems provide for added braking control and stability and are the focus of Phase II of the NHVBS and so the subject of this RIS. Appendix 7 outlines the operation of the ESC and RSC systems available for heavy vehicles.

Heavy Vehicle National Law

The Heavy Vehicle National Law (HVNL) was established in 2014 to provide nationally consistent arrangements for regulating the use of heavy vehicles to improve safety, and better manage the impact of heavy vehicles on the environment, road infrastructure and public amenity. The HVNL also aims to promote the safe transport of goods and passengers, and improve the heavy vehicle industry's productivity, efficiency, innovation and safe business practices. It is administered by the National Heavy Vehicle Regulator (NHVR) in all States and Territories except for Western Australia (WA) and the Northern Territory (NT). WA and the NT instead continue with their own local arrangements.

The Australian Government has:

- Driven the establishment of the NHVR and continues to provide support to it with respect to heavy vehicle road safety reforms. It has committed $15.9m funding to the NHVR for heavy vehicle safety initiatives, including the installation of new monitoring systems, as part of a national compliance and enforcement network. Other initiatives include industry education on chain of responsibility obligations that have been strengthened under the HVNL, and assisting with the development of Industry Codes of Practice to strengthen safe business practices.
- Committed over $800,000 over two years to fund a joint heavy vehicle driver fatigue research project between the Cooperative Research Centre for Alertness, Safety and Productivity and the National Transport Commission (NTC). These organisations will work together to undertake research to evaluate the impact of HVNL fatigue provisions on road safety risks.

Performance Based Standards

The Performance Based Standards scheme offers the heavy vehicle industry the potential to achieve higher productivity and safety through innovative and optimised vehicle design. To obtain PBS approval, heavy vehicles must meet 16 additional safety standards and four additional infrastructure standards. Vehicles meeting these requirements can then be exempted from requirements relating to their dimensions and configuration (including length, width, height, rear overhang, retractable axles and tow coupling overhang/location etc.) and/or be permitted for operation at higher mass limits on approved routes. PBS has been in operation since October 2007.

Heavy Vehicle Safety and Productivity

The Australian Government has also extended the Heavy Vehicle Safety and Productivity Programme (HVSPP) and will provide $40 million per year from 2021-22 onwards, building on the current $328 million investment from 2013-14 to 2020-21. The HVSPP is an initiative to fund infrastructure projects that improve productivity and safety outcomes of heavy vehicle operations across Australia. The Government contributes up to 50 per cent of the total project cost, through national partnership agreements with State and Territory governments. Examples of current safety projects include road freight route upgrades/improvements and the construction of more roadside rest areas for heavy vehicle drivers.

Other Government Actions

The NSW Environment Protection Authority (EPA), which regulates the on-road transport of dangerous goods in NSW, has prohibited the transport of dangerous goods in heavy tanker trailers built after 1 July 2014 that do not have RSC fitted (NSW EPA, 2014a) and has made a determination which will prohibit from 1 January 2019 (NSW EPA, 2014b), the transport of dangerous goods in all heavy tanker trailers that do not have RSC fitted.

VicRoads implemented a requirement for EBS with RSC to be fitted to all B-Double trailers used in key logging areas. It reports (VicRoads, 2013) that rollovers were subsequently reduced from around 40 per year in the areas covered (average for 2006 to 2009) to eight semitrailer rollovers and no B-double rollovers in the year following introduction. VicForests followed on from this by requiring all semitrailers used in heavy vehicle combinations (not just B-Doubles) contracted by it to be equipped with EBS with RSC (VicRoads 2013).

Additional safety requirements and access arrangements also exist for heavy vehicles, including most buses subject to state/territory government contracts for fleet services as well as many heavy trucks used in major infrastructure projects in NSW and Victoria. For example, the NSW Government has implemented the Safety, Productivity & Environment Construction Transport Scheme (SPECTS) which allows greater road access and higher mass limits for enrolled trucks/trailers throughout a defined network of roads within the Newcastle-Sydney-Wollongong region. To qualify for SPECTS, all trucks and trailers manufactured after 1 January 2017 must be equipped with ESC and RSC respectively.

1.4. The National Road Safety Strategy 2011-2020

Under the National Road Safety Strategy (NRSS) 2011-2020, the Australian Government and state and territory governments have agreed on a set of national road safety goals, objectives and action priorities through the decade 2011-2020 and beyond (Transport and Infrastructure Council, 2011). The NRSS aims to reduce the number of deaths and serious injuries on the nation's roads by at least 30 per cent by 2020 (relative to the baseline period 2008-2010 levels), as endorsed by the Transport and Infrastructure Council (the Council), in 2011.

An updated National Road Safety Action Plan 2015-17 (the Action Plan) developed cooperatively by federal, state and territory transport agencies, was endorsed by the Council in November 2014 (Transport and Infrastructure Council, 2014). The Action Plan is intended to support the implementation of the NRSS, addressing key road safety challenges identified in a 2014 review of the strategy. It details a range of national actions to be taken over the period.

Considering the case for mandating ESC for new heavy vehicles, is one of three priority actions identified in the Action Plan, to improve the safety of the vehicle fleet.

2. WHY IS GOVERNMENT ACTION NEEDED?

Government action may be needed where the market fails to provide the most efficient and effective solution to a problem. In this case the problem is that heavy vehicle crashes involving a loss of vehicle control and/or stability, are estimated to cost the Australian community around $375 million every year. These crashes are not reducing as much as they could, given the availability of effective safety technologies and the mandating of them in major markets such as Europe and the US.

In Australia, the introduction of safety technologies through market action alone is significantly slower for heavy vehicles than it is for light vehicles. A major reason for this is the nature of construction of heavy vehicles. In comparison to light vehicles (for example cars and Sports Utility Vehicles), heavy vehicles are more likely to be built to order, with engines, drivetrains, suspensions, brakes, axles and safety systems such as ESC and RSC individually specified by the purchaser. Purchasers will mostly focus on maximising productivity for the money they spend. Further, a significant number of heavy vehicles are built in Australia and/or specifically for the Australian market. For example, nearly half of heavy duty trucks (see Figure 3 below) and around 95 per cent of heavy trailers are built in Australia. This means that the designs and regulations of other countries will have a lesser influence on the makeup of the Australian heavy vehicle fleet. In the case of heavy trailers, which are almost exclusively designed and built in Australia, there is even less influence on the vehicles that end up in the fleet. Because of this, the relatively low level of fitment of safety systems in Australia will continue without some sort of market intervention.

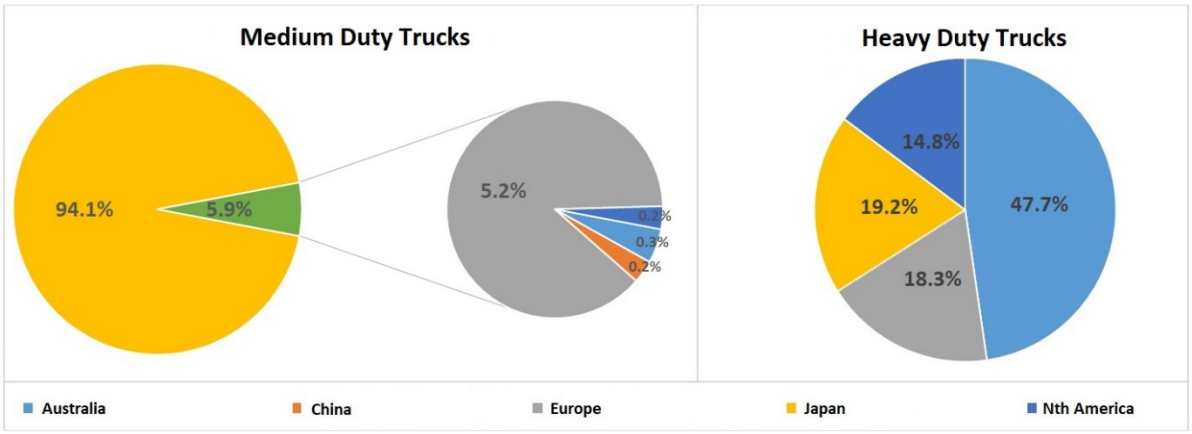

Figure 3: Truck Sales in Australia (2014) by Country/Region of Manufacture (source: TIC, 2015)[2]

[2] Medium duty trucks have a GVM >8 tonnes and a GCM ≤ 39 tonnes. Heavy duty trucks have a) 3 or more axles; or b) 2 axles, a GVM >8 tonnes, and a GCM > 39 tonnes.

The purpose of this RIS is to examine the case for Australian Government action to reduce rollover and loss of control crashes of new heavy vehicles supplied to the Australian market. In this respect, there are stability control systems available for heavy vehicles that are effective in reducing these types of crashes. There are also a number of viable actions (policy options), as detailed in section 3 of this RIS, that the Australian Government could take to increase the rate of fitment of such systems to new heavy vehicles in Australia. There are also technical standards currently mandated in other markets which would provide a sound basis for regulation of these systems through the ADRs.

Stability control systems are also being considered as a priority technology for heavy vehicles under the NRSS as increasing fitment of RSC and/or ABS to new trailers will facilitate the future fitment of other advanced technologies such as AEB. This is because ABS on trailers (including as part of RSC systems) helps prevent trailer swing out during heavy (i.e. emergency) braking, including during automatically commanded braking actions as occur with an AEB system.

Consideration of requiring AEB on heavy vehicles may follow as a subsequent proposal to this one. In this respect it is important to highlight that it would be addressing a different subset of crashes to ESC and so does not impact on the analysis in this RIS.

2.1. Stability Control Systems for Heavy Vehicles

Two different types of stability control systems are available for heavy vehicles. These are RSC and ESC. Both are driver assistance technologies, designed to improve heavy vehicle control and stability.

RSC is designed to reduce the chance of a vehicle rolling over. RSC automatically decelerates a vehicle when it detects, based on the measurement of vertical tyre loads or at least lateral acceleration and wheel speeds, that the vehicle is at risk of a rollover. This is achieved through automatically applying the brakes on at least one axle of the vehicle. Automatic reductions in engine power and engine braking may also be used to slow power driven vehicles. RSC systems are currently available for heavy trucks, buses and trailers. NHTSA estimated that RSC for heavy vehicles is 37-53 per cent effective in reducing rollover crashes and 2 per cent effective in reducing loss of control crashes (NHTSA, 2015).

ESC is designed to reduce the chance of a vehicle understeering (ploughing out), oversteering (spinning out) or rolling over. ESC systems for heavy vehicles incorporate all of the functionality of an RSC system. In addition, ESC also acts to bring a vehicle back on course when it detects based on the measurements of steering wheel angle and the vehicle yaw (angular acceleration) rate that the vehicle is not following the course intended by the driver. This is achieved by the system automatically and selectively braking individual wheels to generate the forces needed to bring the vehicle back on track. ESC systems are currently available for heavy trucks and buses, but not trailers. NHTSA estimated that ESC for heavy vehicles is 40-56 per cent effective in reducing rollover crashes and 14 per cent effective in reducing loss of control crashes (NHTSA, 2015).

Appendix 7 includes further detail on the types of stability control systems available for heavy vehicles, while Appendix 8 includes further detail on the effectiveness of these systems.

2.2. Current Market Fitment Rates

In Australia, around 25 per cent of new heavy trucks are fitted with ESC and around 40 per cent of new heavy trailers are fitted with RSC (various industry sources 2016). Notably, this is much lower than in Europe where fitment of these systems is now mandatory (subject to some limited exemptions) for all new heavy vehicles (there was a phased implementation between 2011and 2016). The mandate in Europe has therefore not strongly influenced the Australian market.

2.3. Available Standards

The recognised international heavy vehicle braking standard is the United Nations (UN) Regulation No. 13 (R13) – Uniform provisions concerning the approval of vehicles of categories M, N and O with regard to braking (UN, 2014). This regulation covers general braking including compatibility between towing vehicles and trailers, as well as ABS and ESC/RSC systems, and the fitment of standard connectors to provide power to electronic brake systems on trailers. To meet the latest version of this regulation (UN R13/11), medium and heavy trucks and buses (with limited exceptions) must be equipped with ESC, and medium and heavy trailers with air suspension and no more than three axles must be equipped with at least RSC.

The United States has also recently introduced a national standard for ESC on heavy vehicles. This standard is the US Federal Motor Vehicle Safety Standard (FMVSS) No. 136 – Electronic Stability Control Systems for Heavy Vehicles (NHTSA, 2016b). It requires ESC to be fitted (with limited exemptions) to truck tractors (prime movers) and buses with a GVM over 11,793 kg (26,000 pounds). It commenced as a mandatory standard for certain three-axle prime movers manufactured on or after 1 August 2017 and will apply to all prime movers and buses (with a GVM > 11,793 kg) manufactured on or after 1 August 2019.

Further detail of these standards is provided in Appendix 9 — Available Standards for Stability Control Systems for Heavy Vehicles.

2.4. Objective of Government Action

Australia has a strong history of government actions aimed at increasing the availability and uptake of safer vehicles and Australians have come to expect high levels of safety. The general objective of the Australian Government is to ensure that the most appropriate measures for delivering safer vehicles to the Australian community are in place. The most appropriate measures will be those which provide the greatest net benefit to society and are in accordance with Australia's international obligations.

The specific objective of this RIS is to examine the case for government intervention to improve the stability and control of the new heavy vehicle fleet in Australia. This is in order to reduce the cost of road trauma to the community from heavy vehicle rollover and loss of control crashes.

Where intervention involves the use of regulation, the Agreement on Technical Barriers to Trade requires Australia to adopt international standards where they are available or imminent. Where the decision maker is the Australian Government's Cabinet, the Prime Minister, minister, statutory authority, board or other regulator, Australian Government RIS requirements apply. This is the case for this RIS. The requirements are set out in the Australian Government Guide to Regulation (Australian Government, 2014a).

3. WHAT POLICY OPTIONS ARE BEING CONSIDERED?

A number of options were considered below to improve heavy vehicle stability and control through increasing the fitment of ESC systems to new heavy trucks/buses and RSC systems to new heavy trailers supplied in Australia. These included both non-regulatory and/or regulatory means such as the use of market forces, public education campaigns, codes of practice, fleet purchasing policies, as well as regulation through the ADRs under the MVSA.

3.1. Available Options

Non-Regulatory Options

Option 1: no intervention
Allow market forces to provide a solution (no intervention).

Option 2: user information campaigns
Information campaigns (suasion) to inform the heavy vehicle industry about the benefits of ESC and RSC.

Option 3: fleet purchasing policies
Permit only heavy trucks/buses fitted with ESC and heavy trailers fitted with RSC for government fleet purchases (economic approach).

Regulatory Options

Option 4: codes of practice
Allow heavy vehicle supplier associations, with government assistance, to initiate and monitor a voluntary code of practice for the fitment of ESC to new heavy trucks/buses and RSC to new heavy trailers (regulatory—voluntary). Alternatively, mandate a code of practice (regulatory—mandatory).

Option 5: mandatory standards under the Competition and Consumer Act
Mandate standards for fitment of ESC to new heavy trucks/buses and RSC to new heavy trailers under the *Competition and Consumer Act 2010* (CCA) (regulatory—mandatory).

Option 6: mandatory standards under the MVSA (regulation)
Mandate standards for fitment of ESC to new heavy trucks/buses and RSC to new heavy trailers under the MVSA (regulatory—mandatory).

3.2. Discussion of the Options

Option 1: No Intervention (Business as Usual)

The Business as Usual (BAU) case relies on the market fixing the problem, the community accepting the problem, or some combination of the two.

The current voluntary fitment of ESC to new heavy trucks is around 25 per cent (various industry sources 2016) while the current voluntary fitment of RSC to new heavy trailers is around 40 per cent (various industry sources 2016). These fitment rates have arisen without regulation in Australia, including due to many heavy vehicle manufacturers and operators recognising the benefits of these technologies and responding accordingly. However, it is also important to note that fitment of these technologies is significantly higher in some other markets, most notably Europe were fitment is now mandatory (subject to some limited exemptions) for all new vehicles.

Under Option 1, voluntary fitment by industry of ESC to new heavy trucks/buses and RSC to new heavy trailers is projected (based on recent trends and regulation in other markets) to gradually increase over the next 15-20 years. This BAU option was analysed further to establish the baseline for comparison of the options.

Option 2: User Information Campaigns

User information campaigns can be effective in promoting the benefits of a new technology to increase demand for it. Campaigns may be carried out by the private sector and/or the public sector. They work best when the information being provided is simple to understand and unambiguous.

Appendix 3 — *Awareness Campaigns* details two real examples of awareness campaigns; a broad high cost approach and a targeted low cost approach. The broad high cost approach cost $6 million and provided a benefit-cost ratio of 5. The targeted low cost approach cost $1 million and was run over a period of four months. It provided an effectiveness of 77 per cent. However, these figures are indicative only as the campaigns do not relate to ESC/RSC or automotive topics generally. It is likely that a campaign would have to be run on a regular basis to maintain effectiveness.

Appendix 4 — *Information Campaigns* details three notable automotive sector advertising campaigns for Hyundai, Mitsubishi and Volkswagen. The cost of such campaigns is not made public. However, a typical cost would be $5 million for television, newspaper and magazine advertisements for a three-month campaign (*Average Advertising Costs* n.d.). Research has shown that for general goods, advertising campaigns can lead to an around 8 per cent increase in sales (Radio Ad Lab, 2005). This increase is similar to the result achieved by the Mitsubishi campaign promoting the benefits of its ESC. While some costs were available, the effectiveness of the campaigns was not able to be determined. It is likely that a campaign would have to be run on a continuous basis to maintain its effectiveness. Campaigns around vehicle safety technologies do not need to consider manufacturer system development costs, because consumers are educated to choose from existing (developed) models that already include the technology.

Table 4 provides a summary of the costs and known effectiveness of the various information campaigns.

Table 4: Estimation of campaign costs and effectiveness

Campaigns	*Estimated cost ($m)*	*Expected effectiveness*
Awareness - broad	6	$5 benefit/$1 spent
Awareness – targeted *	1 per four month campaign, or 3 per year	Total of 77 per cent awareness and so sales (but no greater than existing sales if already more than 77 per cent)
Advertising*	1.5 per month campaign, or 18 per year	8 per cent increase in existing sales.
Fleet	0.15	-
Other	0.2-0.3	-

* used in benefit-cost analysis (Section 4).

Targeted awareness campaigns (Option 2a) could include the promotion of ESC/RSC for heavy vehicles as well as market incentives, including at point of sale. Such campaigns can be tailored to a specific user group. With the existing BAU fitment rates expected for ESC for heavy trucks and buses, it was determined that targeted awareness campaigns would remain relevant for the first 14 of the 15 years of implementation. This would be an unusually long period for a targeted awareness campaign. This means advertising fatigue would need to be considered together with cost in implementing this type of campaign. This has been taken into account in the benefit-cost analysis for this sub-option, by adopting an initial campaign period of 2 years followed by every second year.

Advertising campaigns (Option 2b) typically capitalise on media and event promotion of a technology, and may be less specific in effect than targeted awareness campaigns. They usually have a minor to moderate effect on technology uptake in comparison to targeted awareness campaigns, and may be more costly.

With the existing BAU fitment rates expected for ESC for heavy trucks and buses, it has been determined that targeted awareness campaigns would have the strongest effect over the later years of a policy lifespan for heavy trucks, and would have minimal effect over the entire period for buses. This is because buses have a higher BAU fitment rate, which means only a small increase in overall fitment is possible relative to BAU. Options 2a and 2b therefore only considered heavy trucks. This has been taken into account in the benefit-cost analysis.

This option (including its sub-options 2a and 2b) was analysed further in terms of expected benefits to the community.

Option 3: Fleet Purchasing Policies

The Australian Government could intervene by permitting only heavy trucks/buses fitted with ESC and heavy trailers fitted with RSC to be purchased for its fleet. This would create an incentive for manufacturers to fit these systems to models that are otherwise compatible with government requirements.

However, as the Australian Government fleet was made up of only 1066 heavy commercial vehicles as at 30 June 2013 (less than 0.2 per cent of all registered heavy vehicles), Australian Government fleet purchasing policies are not considered an effective means to increase the penetration of ESC/RSC systems more generally in the Australian heavy vehicle fleet.

This option was therefore not considered any further.

Option 4: Codes of Practice

A code of practice can be either voluntary or mandatory. If mandatory, there can be remedies for those who suffer loss or damage due to a supplier contravening the code, including injunctions, damages, orders for corrective advertising and refusing enforcement of contractual terms.

Voluntary Code of Practice

Compared with legislated requirements, voluntary codes of practice usually involve a high degree of industry participation, as well as a greater responsiveness to change when needed. For them to succeed, the relationship between business, government and consumer representatives should be collaborative so that all parties have ownership of, and commitment to, the arrangements (Commonwealth Interdepartmental Committee on Quasi Regulation, 1997).

A voluntary code of practice could be an agreement through industry bodies to fit ESC to heavy trucks/buses and RSC to heavy trailers at nominated fitment rates. However, this would not cover all heavy vehicle industry participants and any breaches would be difficult for the various industry bodies or the Australian Government to control. Further, given the sophistication of ESC systems for heavy trucks/buses, detecting a breach would be particularly difficult in a case of reduced performance. Such breaches would usually only be revealed through failures in the field or by expert third party reporting. Any reduction in implementation costs relative to other options would therefore need to be balanced against the consequences of these failures. In the case of ESC/RSC for heavy vehicles, a breach could have serious consequences, including additional road deaths and injuries.

For safety critical matters such as ESC/RSC for heavy vehicles, voluntary codes of practice are a high risk and cost proposition in terms of both monitoring and detecting breaches and being able to take timely action to intervene.

This sub-option was therefore not considered any further.

Mandatory Code of Practice

Mandatory codes of practice can be an effective means of regulation in areas where government agencies do not have the expertise or resources to monitor compliance. However, in considering the options for regulating the performance of heavy vehicles, the responsible government agency (Department of Infrastructure, Regional Development and Cities) has existing legislation, expertise, resources and well-established systems to administer a compliance regime that would be more effective than a mandatory code of practice.

This sub-option was therefore not considered any further.

Option 5: Mandatory Standards under the CCA—Regulation

As with codes of practice, standards can be either voluntary or mandatory as provided for under the CCA.

However, in the same way as a mandatory code of practice was considered in the more general case of regulating the performance of heavy vehicles, the responsible government agency (Department of Infrastructure, Regional Development and Cities) has existing legislation, expertise and resources to administer a compliance regime that would be more effective than a mandatory standard administered through the CCA.

This option was therefore not considered any further.

Option 6: Mandatory Standards under the MVSA—Regulation

Background

Australia mandates approximately sixty ADRs under the MVSA. Vehicles are approved on a model (or vehicle type) basis known as type approval, whereby the Australian Government approves a vehicle type based on test and other information supplied by the manufacturer. Compliance of vehicles built under that approval is ensured by the regular audit of the manufacturer's production processes.

The ADRs apply equally to new imported vehicles and new vehicles manufactured in Australia. No distinction is made on the basis of country of origin/manufacture and this has been the case since the introduction of the MVSA.

Under Option 6, the Australian Government would determine new versions of ADRs 35 and 38 under the MVSA, including requirements for ESC on heavy trucks/buses, ABS on medium trailers and RSC on heavy trailers, to improve heavy vehicle control and stability. As ADRs only apply under the MVSA to new vehicles, implementation of this option would not affect vehicles already in service.

If this option were chosen to be implemented, the requirements for ESC/RSC would be aligned as much as possible and appropriate with corresponding requirements of the international standard UN R13 and in the case of ESC for trucks/buses, the United States Federal Motor Vehicle Safety Standard (FMVSS) No. 136 – Electronic Stability Control Systems for Heavy Vehicles.

As discussed earlier, consideration of the case for mandating of ESC for heavy vehicles (limited to RSC for trailers) is one of three priority actions identified in the National Road Safety Action Plan 2015-17, to improve the safety of the vehicle fleet. This proposed action also constitutes Phase II of the National Heavy Vehicle Braking Strategy (NHVBS) as set out at item 16 (c) in the Safe Vehicles section of the NRSS 2011-2020.

Mandatory standards for ESC for heavy vehicles have been adopted in other markets (including Europe, the USA and Japan – each to varying extents) and are considered a viable option for Australia. This option was therefore analysed further in terms of expected costs to business and benefits to the community.

Scope/Applicability

There is considerable variation in the characteristics of heavy vehicles across ADR categories and in some cases also within categories. This includes variations in GVM/GTM, wheelbase, brake system type (hydraulic or air), number of axles, suspension type (steel springs or air), and centre of gravity height. There is also considerable variation in the nature of applications for which various categories of heavy vehicles are used, which in-turn alters the risk of a heavy vehicle being involved in a type of crash (e.g. a rollover) that might be prevented by ESC/RSC. For example, prime movers (predominantly ADR category NC) are the most likely to be used for longer distance (including interstate) freight transport at highway speeds and cover a large number of kilometres in a year, while medium rigid trucks (mostly ADR category NB2 vehicles) are more suitable for local deliveries in urban areas with lower speed limits.

Further, there is also some variation in the categories of heavy vehicles for which ESC/RSC has been mandated for new vehicles in other markets, including the major markets of Europe, the United States and Japan.

Given this variation in heavy vehicle characteristics by category and the extent/scope of mandatory requirements in other markets, there is also likely to be some variation in the relative benefits and costs of ESC/RSC across the different ADR categories for heavy vehicles. Taking all of this into account, there were three sub-options considered relevant in relation to the scope of vehicles for which mandatory requirements for ESC/RSC could be applied under the ADRs. These are:

- Option 6a: regulation (broad scope) — a new version of ADR 35 would be implemented to require ESC for new trucks/buses greater than 4.5 tonnes GVM and a new version of ADR 38 would be implemented to require ABS for new trailers greater than 4.5 tonnes GTM, with the addition of RSC for new trailers greater than 10 tonnes GTM. These vehicles are represented by ADR vehicle categories NB2, NC, MD4, ME, TC and TD.
- Option 6b: regulation (medium scope) — a new version of ADR 35 would be implemented to require ESC for new trucks greater than 12 tonnes GVM and new buses greater than 5 tonnes GVM, and a new version of ADR 38 would be implemented to require ABS for new trailers greater than 4.5 tonnes GTM, with the addition of RSC for new trailers greater than 10 tonnes GTM. These vehicles are represented by ADR vehicle categories NC, ME, TC and TD.
- Option 6c: regulation (narrow scope) — a new version of ADR 35 would be implemented to require ESC for new prime movers greater than 12 tonnes GVM and new buses greater than 5 tonnes GVM, and a new version of ADR 38 would be implemented to require ABS for new trailers greater than 4.5 tonnes GTM, with the addition of RSC for new trailers greater than 10 tonnes GTM. These vehicles are represented by ADR vehicle categories NC (of which prime movers are a subset), ME, TC and TD.
- Option 6c Plus: regulation (narrow scope, post consultation extension) — a new version of ADR 35 would be implemented to require ESC for new prime movers and short wheel base rigid vehicles greater than 12 tonnes GVM and new buses greater than 5 tonnes GVM, and a new version of ADR 38 would be implemented to require ABS for new trailers greater than 4.5 tonnes GTM, with the addition of RSC for new trailers greater than 10 tonnes GTM. These vehicles are represented by ADR vehicle categories NC (of which prime movers are a subset), ME, TC and TD.

ESC was considered rather than RSC for heavy trucks and buses because the ratio of overall effectiveness in rollover and loss of control crashes relative to incremental cost for each of these systems is such that ESC will produce the greater net benefit. Further, this aligns with the approach taken in the major markets of Europe, Japan and the US. RSC was considered for heavy trailers, as this is the only stability control system available for trailers.

Each sub-option (6a, 6b , 6c and 6c Plus) was analysed further in terms of expected benefits to the community as well as costs to business and consumers.

Technical Requirements

ADRs 35 and 38 currently set Australian developed requirements for commercial vehicle brake systems and trailer brake systems respectively, but also allow the international standard UN R13 as an alternative.

Following completion of Phase I of the NHVBS in 2013, an Industry Reference Group (IRG) was established to help with implementation and any necessary follow-on amendments to ADRs 35 and 38. The IRG comprised representatives of heavy truck, trailer and bus manufacturers and operators as well as brake system suppliers (refer Appendix 17). Since 2014, the IRG has again provided its expertise towards Phase II, which is being considered as part of this RIS. As a result of this work, the technical requirements around Option 6 are close to finalised, pending feedback as part of this RIS process.

In terms of the requirements set out with the IRG, Option 6 as a whole would continue to allow for certification of vehicles to UN R13 as an alternative, as the current series of UN R13 already includes requirements for ESC for heavy trucks/buses and RSC for medium and heavy trailers. Some limited supplementary requirements would continue to be applied for vehicles certified to UN R13 (refer to Appendix 11 and to the draft ADRs provided as part of the consultation for full details). These are necessary for certification of specific types of vehicles, including vehicles designed for use in road train combinations (which is not provided for in UN R13), some heavy trucks/buses designed for off-road use, as well as for ongoing compatibility of new truck brake systems with heavy trailers in the Australian fleet. Technical requirements for ESC on heavy trucks/buses and RSC on heavy trailers, would also be included in the text of the new versions of ADRs 35/38.

In the case of ADR 35, ESC performance based requirements have been developed and would be applied for heavy buses (category ME vehicles) greater than 12 tonnes GVM and prime movers (category NC prime movers). These are closely aligned with the performance requirements of FMVSS 136. The proposed test was not developed for and would not be applied under any sub-option to buses between 4.5 and 12 tonnes GVM or rigid trucks. The performance requirements would be supplemented by functional requirements for the ESC system, as it is not possible to cover all loss of vehicle stability and control scenarios through a single test type. These functional requirements would be closely aligned with those in both UN R13 and FMVSS 136 (which are similar in practical terms).

ESC would not be required under any option for articulated buses, route service buses, trucks or buses ‘designed for off-road use’ (note: ‘designed for off-road use’ would be defined for relevant vehicle categories in an appendix to the ADR) or rigid trucks with four or more axles. These exemptions are proposed because the benefits of ESC relative to costs are expected to be relatively low for these vehicles.

An exemption for ESC on prime movers with four or more axles has also been included in the consultation draft ADR 35/06. This is because there are only around 100 of these sold

each year by up to seven different manufacturers, which would make testing of ESC for these models or variants very expensive on a per vehicle basis. An alternative option could be to require prime movers with four axles to be equipped with ESC, but not require manufacturers to conduct the J-turn test for these. The Department sought feedback on this proposal, including the alternative option for prime movers with four axles.

In the case of ADR 38, LP would no longer be an alternative to ABS, and functional requirements are proposed to be included for RSC on heavy trailers (greater than 10 tonnes GTM). These requirements would be closely aligned in practical terms with UN R13, which already includes requirements for both ABS and RSC on medium and heavy trailers.

Exemptions from mandatory fitment of both ABS and RSC are proposed for converter dollies as well as trailers fitted with an axle group consisting of more than four tyres in a row of axles or more than four axles in an axle group (in-practice: certain non-standard low-loaders). This is because RSC is expected to provide much more benefit on a semi-trailer than a converter dolly, and non-standard low-loaders are more niche vehicles that typically travel at relatively low speeds, often behind a pilot/escort vehicle.

In contrast to UN R13 which currently only requires RSC on trailers with air suspension, the Department also proposed to require RSC on trailers with other types of suspension (e.g. steel springs), and sought feedback on this proposal. Feedback is summarised in Appendix 18. This is because there may no longer be any technical barrier to fitment of effective RSC systems on trailers with other types of suspension, steel spring suspension is much more common in Australia than Europe, and UN R13 may be amended in the near future to also require this.

Automatic slack adjusters would be required for the service brakes of all vehicles under ADR 35/06, and at least all category TC (>4.5 tonnes GTM) and TD trailers equipped with ABS (including as part of an RSC system) under ADR 38/05. These automatically adjust the initial clearance between brake friction elements (pads/shoes and rotors/drums) to compensate for changes arising from wear. Poorly adjusted brakes can increase the vehicle stopping distance, as well as reduce the effectiveness of stability control systems, which automatically and in the case of ESC selectively apply these brakes whenever the vehicle is at risk of a rollover and/or loss of control. Automatic slack adjusters are most important for vehicles equipped with ABS (including as part of ESC/RSC), as the combination of poorly adjusted brakes and the modulation of braking by the ABS, is expected to result in the greatest increase in overall air consumption. However, given poorly adjusted brakes continue to be one of the most common safety defects found by heavy vehicle inspectors, the Department proposed to extend the requirement for automatic slack adjusters in ADR 38/05 to apply to all category TC (>4.5 tonnes GTM) and TD trailers, sought feedback on this proposal. Feedback is summarised in Appendix 18.

Trucks designed for use in road train combinations would be required (by ADR 35) to be equipped with a 24-volt electrical connector (ISO 7638-1 connector). Likewise, each trailer designed to tow another trailer in a road train combination would be required (by ADR 38) to be equipped with a 24-volt electrical connector at the front and rear. This is because a 12-volt truck supply can often be inadequate to power TEBS (including RSC systems and ABS) on third and subsequent trailers in road train combinations, due to voltage drops along trailer electrical wiring and across connectors.

There are also a number of deregulatory changes, in response to suggestions by industry, which the Department is proposing to include as part of Option 6. These include the inclusion of alternative service and secondary brake effectiveness test procedures for compressed air brake vehicles in ADR 35 and allowing a rated brake chamber volume to be used to determine the minimum required air reservoir (storage) volume for vehicles with certain brake chamber types in both ADRs 35 and 38. Further rationale for these changes is included in section 4.1 of this RIS below (under the heading 'savings').

As discussed above, the detailed form of changes proposed to the current ADRs 35 and 38 to implement this option, have been established in consultation (including circulation of a number of draft ADRs) with the IRG. Further detail of the proposed changes for the sub-option with the largest net benefits (Option 6c Plus) is provided in Appendix 11. Draft ADRs 35/38 were also provided as part of the public consultation for this particular sub-option.

As ESC for heavy trucks/buses, ABS for medium trailers and RSC for heavy trailers are the most significant changes being proposed, this RIS primarily focuses on these technologies.

Implementation Timing

The ADRs only apply to new vehicles and typically use a phase-in period to give models that are already established in the market, time to change their design. The implementation lead-time of an ADR is generally no less than 18 months for models that are new to the market (new model vehicles) and 24 months for models that are already established in the market (all new vehicles), but this varies depending on the complexity of the change and the requirements of the ADR.

In this case, the Department considers that relative to new trailers complying with the proposed requirements for ABS and RSC, more time would need to be allowed for new heavy trucks/buses to comply with the proposed ESC requirements. This is because manufacturers of prime movers and heavy buses would need to undertake detailed development and testing of ESC systems as well as other braking changes to ensure they satisfy the minimum performance requirements proposed for ADR 35, while there are trailer brake sub-assemblies already available for trailer manufacturers to use which would meet the ABS and RSC requirements proposed for ADR 38.

The proposed applicability dates for heavy trucks and buses under this option (including each sub-option) are:

- 1 November 2020 for new model vehicles; and
- 1 January 2022 for all new vehicles.

These dates are approximately 31 months for models that are new to the market (new model vehicles) and 45 months for models that are already established in the market (all new vehicles). This lead-time is considered suitable to allow for the scope of design change and testing needed to incorporate an ESC system.

The proposed applicability dates for medium and heavy trailers under this option (including each sub-option) are:

- 1 July 2019 for all new model vehicles; and
- 1 November 2019 for all new vehicles.

These dates are approximately 15 months for models that are new to the market (new model vehicles) and 19 months for models that are already established in the market (all new vehicles). This lead-time is considered suitable for manufacturers to implement any design and production changes needed, source trailer brake sub-assemblies already available in the market and update certification information.

4. WHAT ARE THE LIKELY NET BENEFITS OF EACH OPTION?

4.1. Benefit-Cost Analysis

The Benefit-cost methodology used in this analysis is a Net Present Value (NPV) model. Using this model, the flow of benefits and costs are reduced to one specific moment in time. The time period for which benefits are assumed to be generated is over the life of the vehicle(s). Net benefits indicate whether the returns (benefits) on a project outweigh the resources outlaid (costs) and indicate what, if any, this difference is. Benefit-cost ratios (BCRs) are a measure of efficiency of the project. For net benefits to be positive, this ratio must be greater than one. A higher BCR in turn means that for a given cost, the benefits are paid back many times over (the cost is multiplied by the BCR). For example, if a project costs $1m but results in benefits of $3m, the net benefit would be 3-1 = $2m while the BCR would be 3/1 = 3.

In the case of adding particular safety features to vehicles, there will be an upfront cost (by the vehicle manufacturers) at the start, followed by a series of benefits spread throughout the life of the vehicles. This is then repeated in subsequent years as additional new vehicles are registered. There may also be other ongoing business and government costs through the years, depending on the option being considered.

Three of the policy options outlined in Section 3.2 of this RIS (Option 1: no intervention; Option 2: user information campaigns; and Option 6: mandatory standards under the MVSA (regulation)), were considered viable to analyse further. Option 6 has three sub options that have varying levels of regulation, dependent on vehicle category and type. The results of each option were compared with what would happen if there was no government intervention, that is, Option 1: no intervention (BAU).

The overall period of analysis would be for the expected life of the option (around 15 years for regulation) plus the time it takes for benefits to work their way through the fleet (around 35 years, the maximum lifespan of a heavy vehicle).

Given ADRs 35 and 38 are primarily intended to make vehicles safer to use, the benefit side of the analysis focuses on safety benefits from expected reductions in fatal and serious injury crashes. However, it should be noted that many operators would be likely to obtain other benefits (for example, lower tyre running costs due to fewer flat spots on trailer tyres) that have not been counted towards the overall benefits in this RIS. The net benefit and the benefit-cost ratio for each option are therefore likely to be conservative estimates.

Benefits

For Option 1, there are no benefits (or costs) as this is the BAU case.

For Options 2 and 6 the benefits were estimated based on the difference between the expected BAU level of fitment of stability control systems (i.e. ESC or RSC as applicable) to new heavy vehicles and the level of fitment expected under the implementation of each proposed option. Figure 4 to Figure 9 show the anticipated level of fitment for each of the analysed options (1, 2a, 2b, 6a, 6b and 6c) across the intervention period (2020-2034).

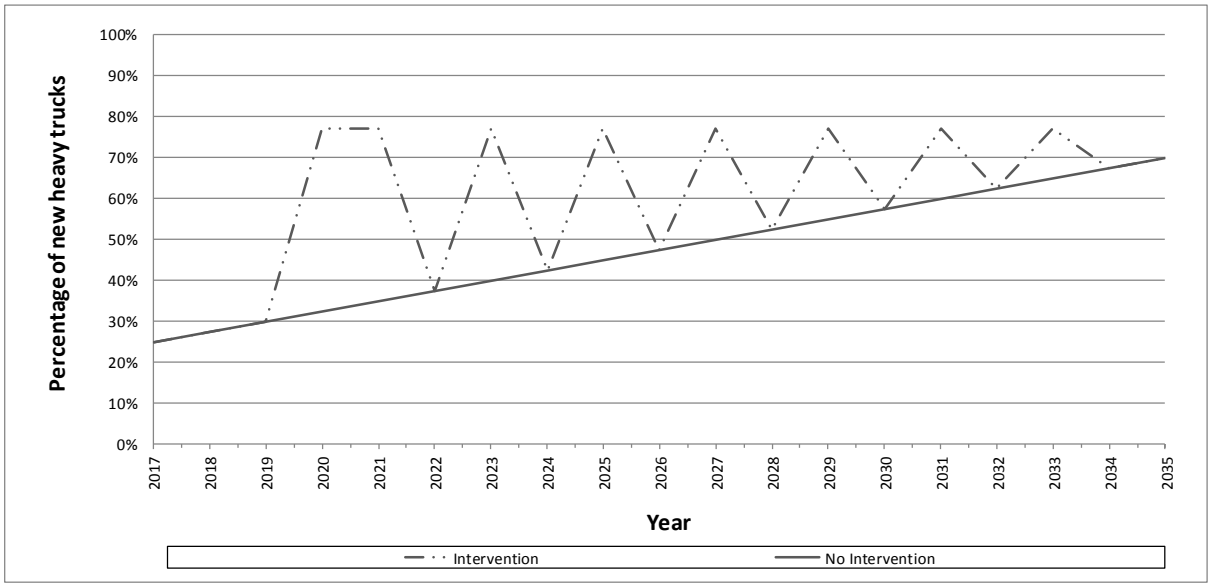

Figure 4: Percentage of new heavy trucks (over 4.5 tonnes GVM) fitted with ESC under BAU (no intervention) and Options 2a (intervention) scenarios in Australia

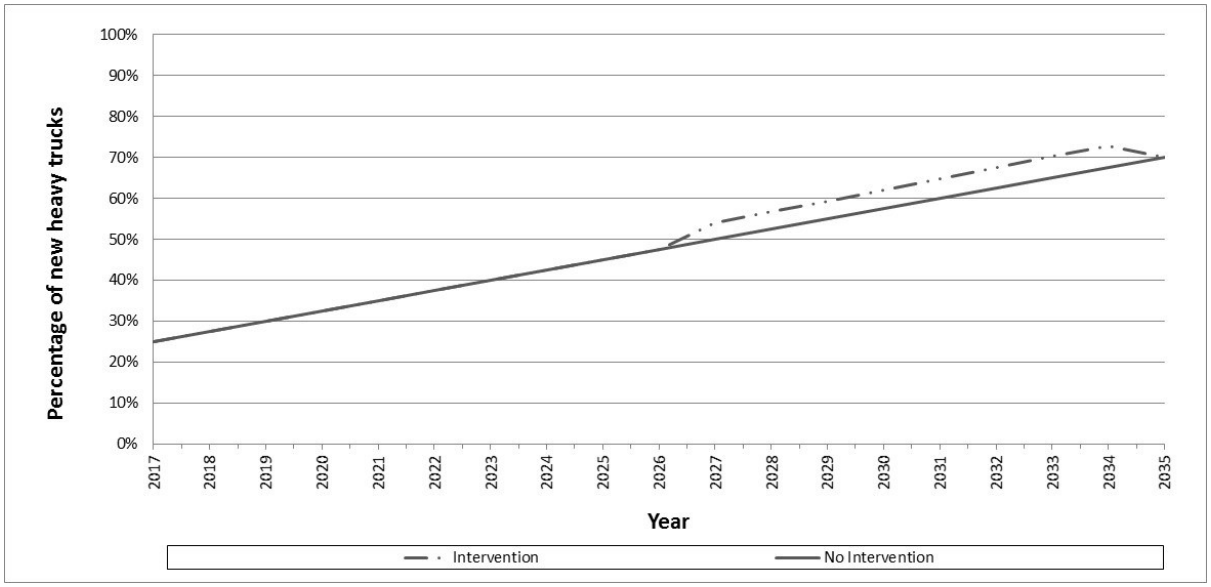

Figure 5: Percentage of new heavy trucks (over 4.5 tonnes GTM) fitted with ESC under BAU (no intervention) and Option 2b (intervention) scenarios in Australia

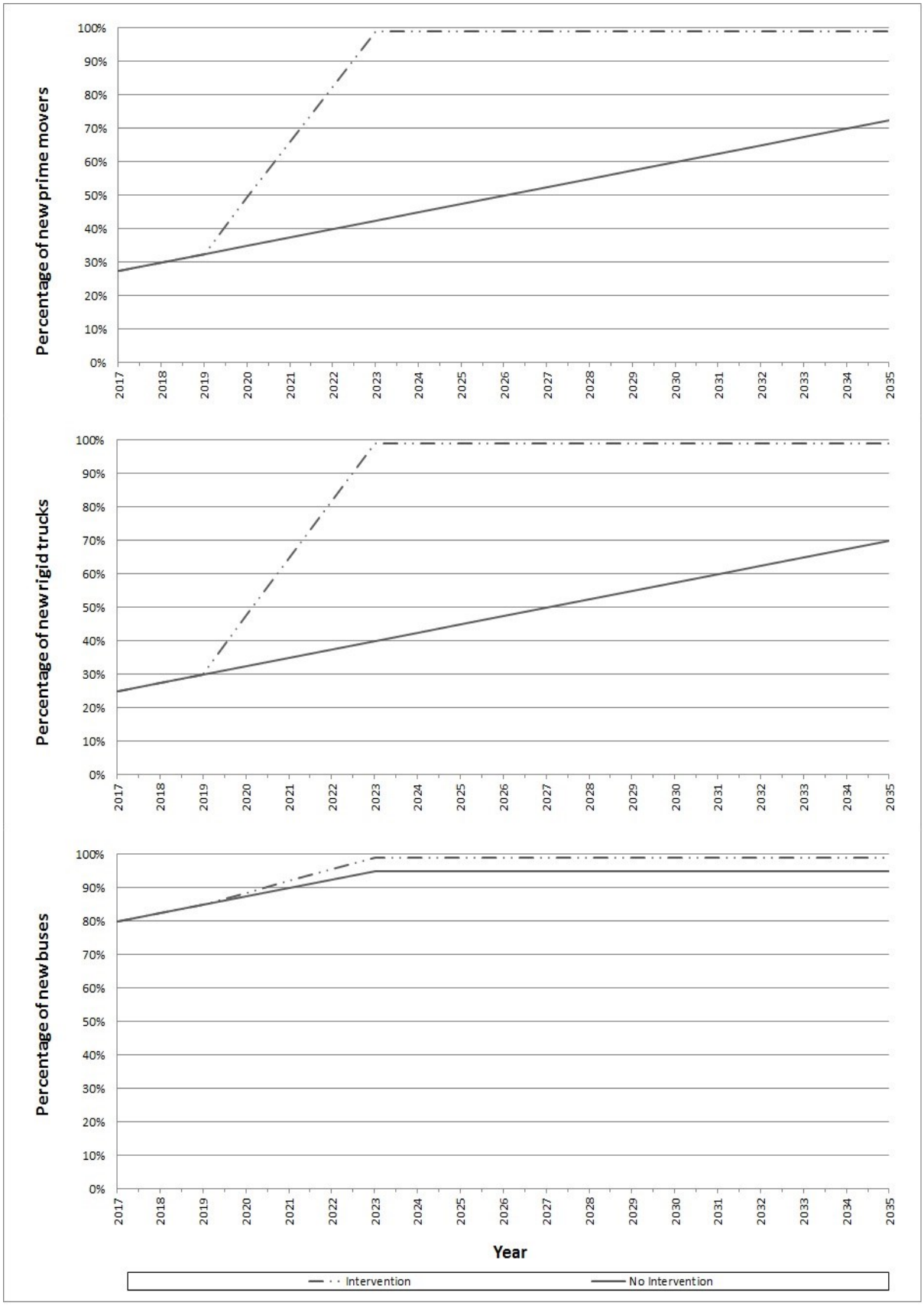

Figure 6: Percentage of new heavy trucks and buses (over 4.5 tonnes GVM) fitted with ESC under BAU (no intervention) and Option 6a (intervention) scenarios in Australia (excludes route service and articulated buses)

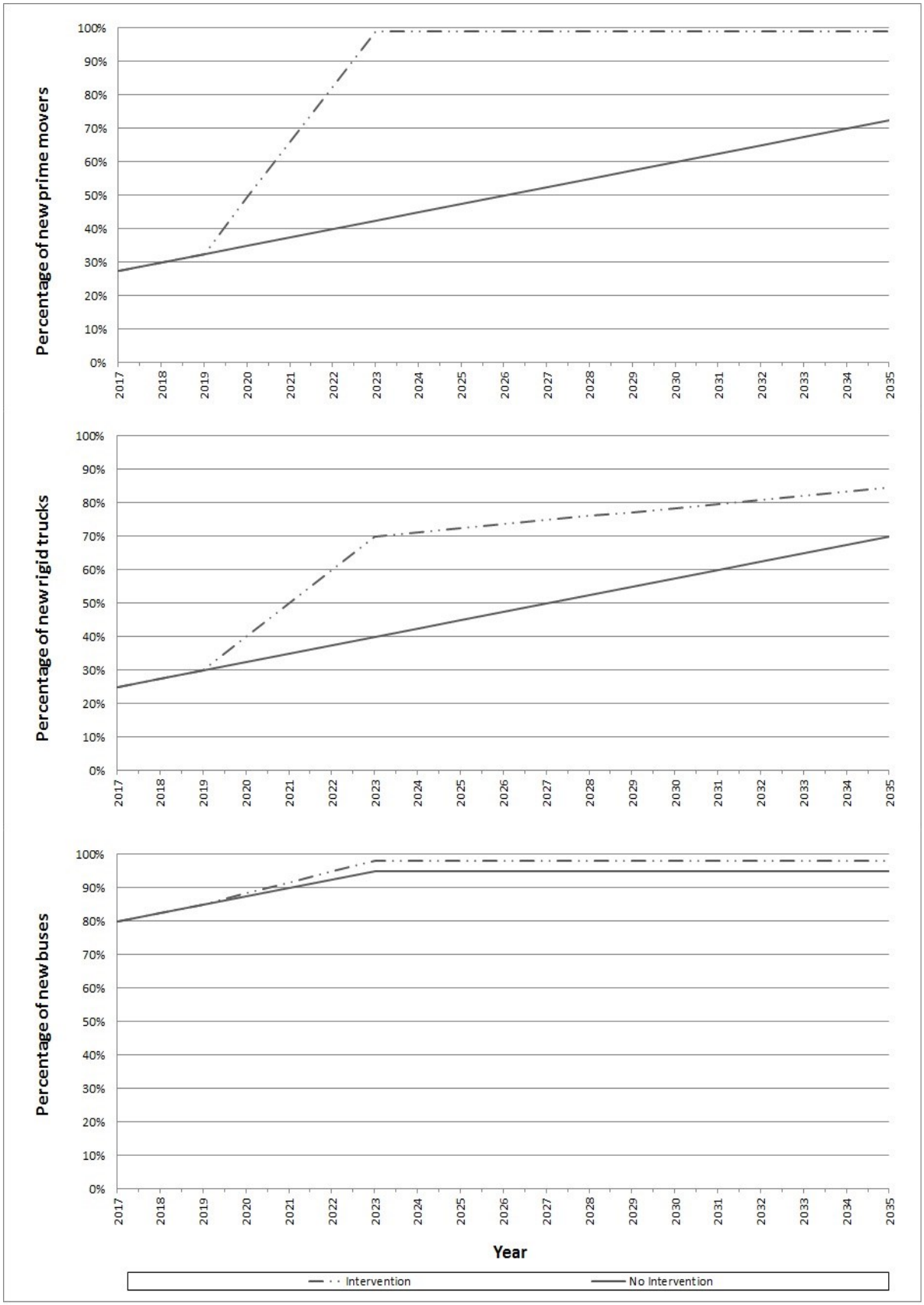

Figure 7: Percentage of new heavy trucks and buses (over 4.5 tonnes GVM) fitted with ESC under BAU (no intervention) and Option 6b (intervention) scenarios in Australia (excludes route service and articulated buses)

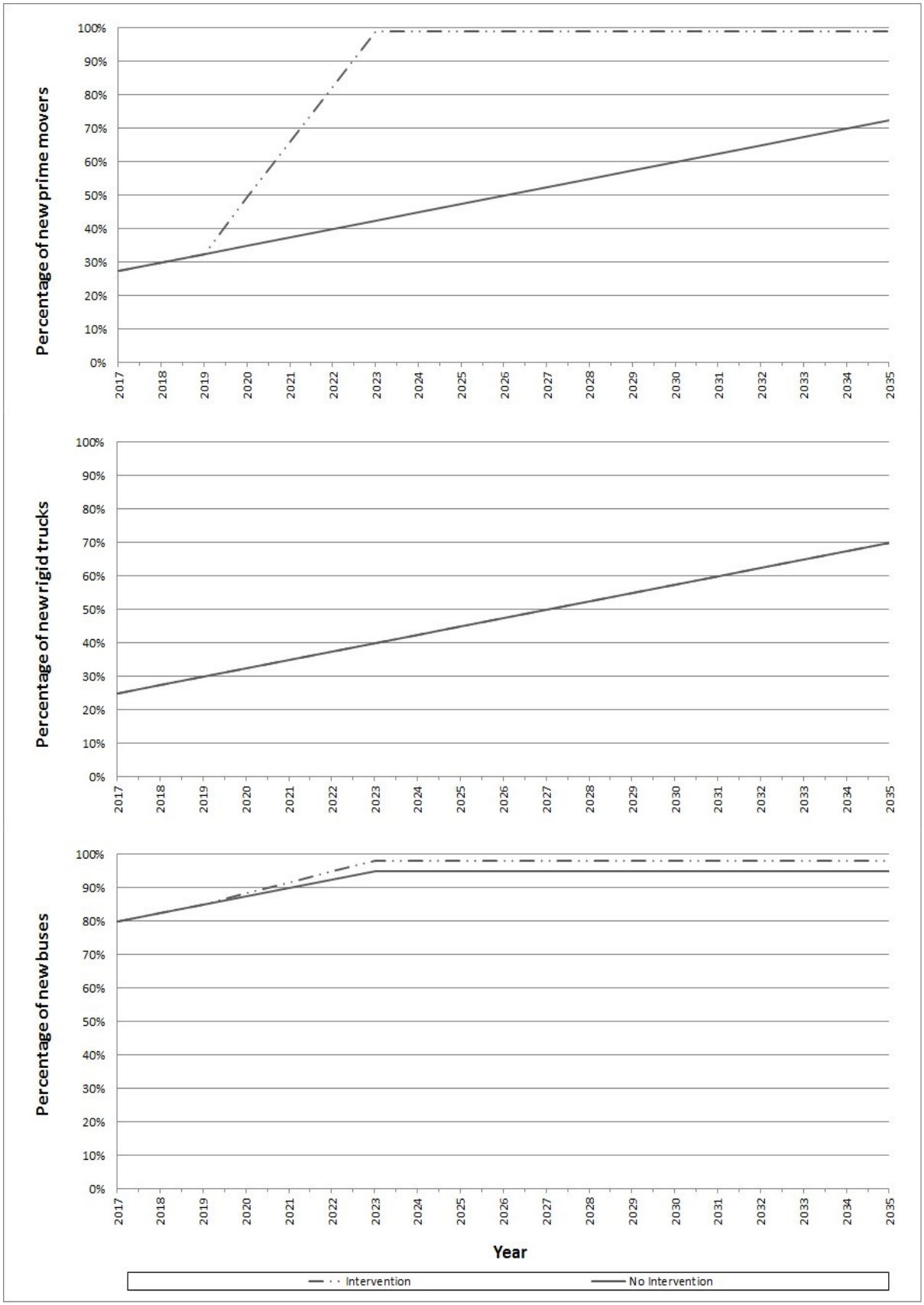

Figure 8: Percentage of new heavy trucks and buses (over 4.5 tonnes GVM) fitted with ESC under BAU (no intervention) and Option 6c (intervention) scenarios in Australia (excludes route service and articulated buses)

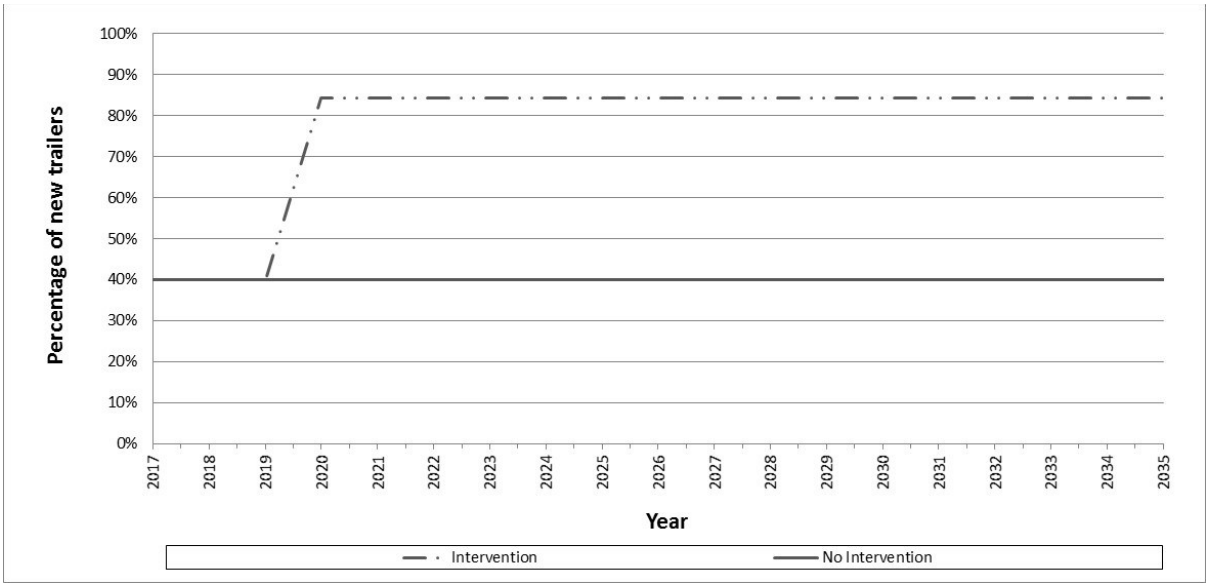

Figure 9: Percentage of new trailers (over 4.5 tonnes GTM) fitted with RSC under BAU (no intervention) and Options 6a, 6b and 6c (intervention) scenarios in Australia

The BAU fitment rate of ESC to heavy buses (excluding route service and articulated buses) was set much higher than that of trucks and trailers. For the purposes of the analysis an 80 per cent BAU fitment rate was assumed for new heavy buses in 2017, rising to 95 per cent by 2023. The relatively high BAU fitment rate for buses is considered to be due to a combination of state/local government contract arrangements, higher in-service mass limits available for buses with ESC, and a general desire among the operators/purchasers of new buses to minimise (including by adopting new safety technologies) the risk of their vehicles (which can carry significantly more occupants than other categories of vehicles), being involved in road crashes. Much of the benefit of national regulation of ESC on buses would therefore likely come through the transfer of state/local contract arrangements and standards into national standards. This would allow for the requirements for each bus model to be handled only once and on a national basis.

Effectiveness of stability control systems for heavy vehicles

The effectiveness of ESC/RSC for heavy trucks and buses and RSC for heavy trailers in reducing rollover and loss of control crashes were estimated by weighting effectiveness values used by NHTSA for each crash type (NHTSA, 2015), according to the relative incidence of these crashes by heavy vehicle category/body style in Australia (from Budd and Newstead, 2014). Table 5 shows the effectiveness values established using this method.

Table 5: Estimated effectiveness of ESC/RSC for heavy trucks and buses, and RSC for heavy trailers (bold values used in analysis)

	ESC Effectiveness (per cent)			RSC Effectiveness (per cent)		
	Rollover (R)	*Loss of Control (LoC)*	*Overall (R & LoC)*	*Rollover (R)*	*Loss of Control (LoC)*	*Overall (R & LoC)*
Prime Movers	48 (40-56)	14	**27**	45 (37-53)	3	18.4
Rigid Trucks			**22.5**			12.8
Buses			**20.8**			10.6
Trailers	n/a	n/a	n/a			**18.4**

Appendix 8 includes further detail on the effectiveness of ESC and RSC systems for heavy vehicles.

Costs

System development costs

No additional system development cost was added for options 2a and 2b, as it was assumed that the heavy vehicle owners/operators persuaded by information campaigns to purchase heavy trucks and trailers equipped with stability control systems, would simply choose from existing models available with these systems.

A development cost of $400,000 was added for each additional vehicle model for which ESC would be developed due to government intervention under options 6a, 6b and 6c. The truck development cost was determined by averaging cost estimates from a number of manufacturers for prime movers. These ranged between $250,000 and $565,000 to design, produce and test a model equipped with ESC to the proposed requirements. The average development cost for rigid trucks would likely be higher than this, particularly if an ESC performance test (e.g. J-turn test) were to be required for these vehicles. This is because rigid trucks are typically available in a much larger range of wheelbase and axle configurations than prime movers, and ESC system design and testing is highly dependent on these design variables. However, as there is no ESC performance test proposed under any option for rigid trucks, the average development cost for prime movers was taken to be reasonably representative of the average for all types of trucks under options 6a and 6b, as well as for prime movers under option 6c.

No additional system design and development cost were allocated for the vehicle models that would be fitted with ESC under BAU. For these models, it is assumed manufacturers are already undertaking (and will continue to undertake) extensive vehicle tests, computer simulation and/or component tests to validate the performance of their ESC systems prior to supply to market. In many cases, this would include tests for certification to UN R13 and/or FMVSS 136, which the manufacturer could then use to demonstrate compliance to the ADR. For the remaining cases, the manufacturer would likely use any further regulatory tests as part of a much broader internal validation process, and there would be no more than a minor impact on the overall system design and development cost.

Beyond purchase and installation costs, no additional system design or development cost were allocated for trailers under options 6a, 6b, 6c and 6c Plus. This is because, the major brake suppliers in Australia have already designed and developed brake sub-assemblies/kits that trailer manufacturers could directly install. These comply with the proposed requirements and so would not require additional testing to be carried out for each model of trailer. It is expected that this would continue to be the case for the duration of this option.

System costs

A system fitment cost of $1,500 was allocated for each additional truck and $3,000 for each additional bus equipped with ESC as a consequence of government intervention under options 2a, 2b, 6a, 6b, 6c and 6c Plus. This was determined by averaging cost data from heavy vehicle manufacturers and represents the incremental cost of an ESC system relative to the ABS that would otherwise be fitted to these vehicles under BAU. This is because ABS, which is mandatory (under ADR 35/05) for all heavy trucks and buses with no more than four axles, includes many components in common with ESC. The additional components required for ESC typically include a yaw sensor, a steering angle sensor, and additional cables/wiring as well as an electronic control unit upgrade. Further modification of the general brake circuits and/or steering column (to allow for the steering angle sensor) may also be required for some vehicles.

An additional system fitment cost of $525 was included for each additional trailer equipped with RSC as a consequence of government intervention under options 2a, 2b, 6a, 6b, 6c and 6c Plus. This was determined by averaging cost data provided by trailer brake suppliers and represents the incremental cost of an RSC system (which includes ABS) relative to the mix of brake systems (i.e. mainly ABS or LP) that would otherwise be fitted to these trailers under BAU.

Additional system fitment costs of $175 were also included for each additional trailer equipped with ABS instead of LP, as a consequence of government intervention under options 6a, 6b, 6c and 6c Plus (note: this was increased to $1,150 for trailers not equipped with LP under BAU). This was determined by averaging cost data provided by trailer brake suppliers and represents the incremental cost of an ABS system relative to the mix of brake systems (i.e. mainly LP plus some conventional air brake systems) that would otherwise be fitted to these trailers under BAU.

Other business costs

In time and with the increased fitment of advanced braking systems (including RSC and/or ABS) on heavy vehicles, system manufacturers have continually improved the ruggedness and reliability of the underlying electronics and sensors. Modern systems are much more capable than ever of operating in hostile environments, where the systems are exposed to extreme heat, cold, dust or mud.

Nonetheless, through the ongoing NHVBS process and in particular the IRG, there have been some concerns raised about the suitability of advanced braking systems in remote areas, particularly with regard to maintenance and repair costs. As a result, the Department of Infrastructure, Regional Development and Cities (the Department) undertook a wide survey of operators and maintainers to gather information on any issues. This survey was followed up with face-to-face visits at a number of operators' premises, to gather further information and insights.

Operator concerns raised in regard to reliability and maintenance were centred on trailers rather than trucks, with ABS sensors, electrical wiring and connectors (RSC/ABS plugs and sockets) identified as the components which need the most maintenance. Overall, operators reported that while there are some added costs in running and maintaining advanced braking systems, these are generally outweighed by the benefits, including prevention of rollovers and other crashes. The NHVBS Operator/Maintenance Survey summary is included as Appendix 15 to this RIS.

In terms of the Benefit-Cost analysis for this RIS, the Department applied an annual maintenance premium for each additional trailer that would be operated with ABS (including as part of an RSC system) in remote areas due to implementation of options 6a, 6b, 6c or 6c Plus. This equated to around $220 of possible extra maintenance per annum (over an average of 11 years in operation) for 5 per cent (percentage of outer regional/remote area operators based on industry estimates) of new trailers entering the fleet each year. No other business cost was allocated for the balance of trailers primarily operated in major cities and inner regional areas, because any increased running cost (e.g. maintenance) for advanced systems, would likely be more than offset by other savings not counted as benefits in this RIS (e.g. fewer tyre flat spots, less property damage in non-injury crashes, insurance savings etc.). Similarly, no other business cost was allocated for trucks or buses as new trucks/buses are already required to be equipped with ABS under BAU and the additional components required for ESC (i.e. steering wheel angle sensor, yaw rate/lateral acceleration sensor and an upgraded control unit) would be unlikely to greatly add to the overall cost of running these vehicles.

Government costs

It was assumed there would be a cost of $600,000 per year for the Australian Government to create and run a targeted awareness campaign under option 2a, and a cost of $18m per year for the Australian Government to create and run an advertising campaign under option 2b.

It was assumed there would be an estimated annual cost of $50,000 for the Department to create, implement and maintain a regulation under Option 6, as well as for the National Heavy Vehicle Regulator (NHVR), WA and NT to develop processes for its in-service use, such as vehicle modification requirements. This includes the initial development cost, as well as ongoing maintenance and interpretation advice. The value of this cost was based on Department experience.

Summary of costs

Table 6 provides a summary of the various costs associated with the implementation of Options 2a, 2b, 6a, 6b, 6c and 6c Plus.

Table 6: Summary of costs associated with the implementation of each option

Costs related to:		Cost relative to BAU			Option(s)	Applicability	Impact
Development of systems		Best Case	Likely Case	Worst Case			
Trucks		$250,000	$400,000	$565,000	6a, 6b, 6c, 6c Plus	Per model[1]	Business
Buses		$250,000	$400,000	$565,000			
Trailers		-	-	-			
Fitment of systems		Best Case	Likely Case	Worst Case			
Trucks		$800	$1,500	$3,480	2a, 2b, 6a, 6b, 6c, 6c Plus	Per vehicle[2]	Business
Buses		$2,500	$3,000	$3,500			
Trailers	RSC	$400	$525	$800			
	ABS	$50 ($1000)[4]	$175 ($1150)[4]	$300 ($1300)[4]			
Maintenance of systems		Best Case	Likely Case	Worst Case			
Trucks		-	-	-	6a, 6b, 6c, 6c Plus	Per vehicle each year[3]	Business
Buses		-	-	-			
Trailers		$185	$220	$275			
Implement and maintain policy			$600,000		2a	Per year	Government
Implement and maintain policy			$18,000,000		2b	Per year	Government
Implement and maintain regulation			$50,000		6a, 6b, 6c, 6c plus	Per year	Government

Notes:

1 Limited to 70 per cent of heavy truck models, 90 per cent of medium truck models, and 50 per cent of bus models, for which ESC would not be developed under BAU

2 Limited to vehicles that would not be fitted with ESC/RSC (or ABS in the case of certain trailers) under BAU

3 Limited to 5 per cent of all new medium and heavy trailers estimated to be primarily used in outer regional/remote operations (various industry sources)

4 Value used for small percentage of trailers not equipped with LP under BAU

Savings

System development savings

It is proposed that an alternative set of service and secondary brake test procedures with maximum stopping distance limits be included under options 6a, 6b, 6c and 6c Plus, to allow results from service and emergency brake tests conducted according to the US FMVSS No. 121 – Air Brake Systems, to be used in demonstrating compliance to ADR 35. The full details of these alternative tests and the stopping distance limits for each test were included in the draft ADR 35 provided as part of the public consultation. It is estimated that this would likely save around $12,500 in test costs (ranging between $10,000 and $15,000) for an

average of six new truck models introduced to the Australian market by North American (or North American parent) based truck manufacturers each year.

System savings

Under the current ADRs 35/05 and 38/04, the minimum air reservoir (i.e. storage) capacity required for compressed air brake systems is a defined multiple (12 times for trucks/buses and 8 times for trailers) of the combined volume of the brake chambers/actuators at the maximum travel (stroke) of their pistons or diaphragms. The intention is to ensure the brake reservoir volume is sufficient to maintain an adequate air pressure supply to each brake chamber after several brake applications in quick succession.

The current ADR requirements for the air reservoir capacity were adopted from an earlier version of the US FMVSS No. 121 – Air Brake Systems. However, the US NHTSA has since amended FMVSS 121 to allow a rated volume to be used as an alternative, for certain standard types of brake chambers. This allows manufacturers to use certain standard longer stroke brake chambers, without needing to increase the reservoir volume above that typically required for short stroke brake chambers of the same nominal piston or diaphragm area. Before making this change, NHTSA considered results of research tests conducted by its own Vehicle Research and Test Center and the Society of Automotive Engineers (SAE), both of which indicated long stroke brake chambers use similar volumes of air to standard length chambers, when properly adjusted. NHTSA concluded that long stroke brake chambers would "help improve the braking efficiency of vehicles, increase the reserve stroke, reduce the number of brakes found to be out of adjustment during inspections, and reduce the incidence of dragging brakes" (NHTSA, 1995). The current Canadian Motor Vehicle Safety Standard (CMVSS) No. 121 also allows the same rated brake chamber volumes (Transport Canada, 2013).

Although the current ADR requirements do not prohibit longer stroke brake chambers, they do require a larger reservoir volume to be installed, which is a disincentive for manufacturers to fit them. Given these long stroke chambers can offer safety benefits while generally not using any more air, there is no longer a safety case to require a larger reservoir volume when they are fitted. Therefore, it is proposed under options 6a, 6b, 6c and 6c Plus to amend the ADR requirements for the air reservoir capacity to allow the same rated volumes as the current FMVSS 121 (NHTSA, 2016a) and CMVSS 121. Automatic slack adjusters would also be required on all service brakes (as is also the case in FMVSS 121 and CMVSS 121) to reduce the likelihood of any elevated air consumption due to brakes being out of adjustment. Based on advice from the TIC in Australia, it is estimated that manufacturers would choose to fit an additional 20 per cent of all new trucks sold in Australia with long stroke brake chambers, and this would save an average of $1000 per vehicle, ranging between $500 and $1,500 per vehicle.

Overall these proposed changes would allow manufacturers, particularly North American (and North American parent) based truck manufacturers not otherwise already certifying vehicles to UN R13, to fit the same combination of brake chambers and slack adjusters as for other larger markets (including the US and Canadian markets). The estimated savings would be realised through economies of scale and standardisation of production. Further, this will also help to minimise ESC development costs, as the installation of different brake system components (including different size brake chambers), would otherwise be likely to necessitate further development and testing of the ESC.

Summary of savings

Table 7 shows the savings estimated as a result of the proposed deregulatory changes under options 6a, 6b, 6c and 6c Plus.

Table 7: Savings associated with the implementation of each option

Savings related to:	**Saving relative to BAU**			**Option(s)**	**Applicability**	**Impact**
Development of systems	Best Case	Likely Case	Worst Case			
Trucks	$15,000	$12,500	$10,000	6a, 6b, 6c, 6c Plus	Per model[1]	Business
Buses	-	-	-			
Trailers	-	-	-			
Fitment of systems	Best Case	Likely Case	Worst Case			
Trucks	$1,500	$1,000	$500	6a, 6b, 6c, 6c Plus	Per vehicle[2]	Business
Buses	-	-	-			
Trailers	-	-	-			

Notes:

1 Limited to an estimated 6 new truck models certified each year by North American or North American parent based truck manufacturers

2 Limited to an estimated 20 per cent of all new trucks that would be sold each year in Australia with long stroke brake chambers because of the proposed change to the ADR

These savings were subtracted from the costs for the 15 years of regulation considered in the benefit-cost analysis for options 6a, 6b, 6c and 6c Plus.

Benefit-Cost Analysis Results

Appendix 13 details the calculations for the benefit-cost analysis. A summary of the results is provided below in Table 8. A seven per cent discount rate was used for all options.

Table 8: Summary of benefits, costs, lives saved and serious injuries avoided under each option

	Net Benefits ($m)	Cost to Business ($m)	Cost to Government ($m)	Benefit-Cost Ratio	Number of Lives Saved	Serious Injuries Avoided
Option 1						
Best case	-	-	-	-		
Likely case	-	-	-	-	-	-
Worst case	-	-	-	-		
Option 2a						
Best case	-	-	-	-		
Likely case	69	43	2.4	2.51	41	432
Worst case	-	-	-	-		
Option 2b						
Best case	-	-	-	-		
Likely case	-52	5.0	64	0.24	9	92
Worst case	-	-	-	-		
Option 6a						
Best case	266	70	0.7	4.75		
Likely case	167	169	0.7	1.99	148	1496
Worst case	-24	360	0.7	0.93		
Option 6b						
Best case	273	30	0.7	9.96		
Likely case	204	98	0.7	3.07	136	1292
Worst case	75	228	0.7	1.33		
Option 6c						
Best case	264	4.5	0.7	51.8		
Likely case	216	52	0.7	5.10	124	1084
Worst case	140	129	0.7	2.08		
Option 6c Plus						
Likely case	217	56	0.7	4.83	126	1101

Sensitivity Analysis

A sensitivity analysis was carried out for Option 6c, to determine the effect of some of the less certain variables on the outcome of the benefit-cost analysis. Prior to consultation, this was the option showing the highest net benefit. As Option 6c Plus has minimal changes to the Option 6c case, and would fall between Option 6c and Option 6b in terms of costs and benefits (closer to Option 6c), the sensitivity analysis is still indicative of the sensitivities of the recommended Option 6c Plus, post consultation.

Firstly, while a 7 per cent (per annum) real discount rate was used for all options, the benefit-cost analysis for Option 6c was also run with a rate of 3 per cent and 10 per cent. Table 9 shows that the net benefits are positive under all three discount rates.

Table 9: Impacts of changes to the real discount rate (Option 6c)

	Net benefits ($m)	BCR
Low discount rate (3%)	452	7.19
Base case (likely case) discount rate (7%)	216	5.10
High discount rate (10%)	130	4.06

Secondly, the effectiveness of ESC/RSC systems on heavy vehicles was also subjected to a sensitivity analysis, including both a high and a low effectiveness scenario. As discussed earlier, the overall effectiveness values assumed for the base case analysis in this RIS range between 18 per cent (for RSC on trailers) and 27 per cent (for ESC on prime movers). In this respect, NHTSA in its final notice for FMVSS 136 estimated that ESC for truck tractors (i.e. prime movers) reduces rollover and loss of control crashes by 25-32 per cent overall, while Bendix (a major stability system manufacturer) claimed from its own analysis of the same crashes that ESC would be 78 per cent effective overall (NHTSA, 2015). To account for uncertainty, both a low (10 per cent) and a high (40 per cent) effectiveness value were used for ESC/RSC either side of the likely effectiveness (18.4 per cent for RSC on trailers, 20.8 per cent for ESC on buses and 27 per cent for ESC on prime movers). As shown in Table 10, even with a relatively low effectiveness of 10 per cent, the net benefits remain positive.

Table 10: Impacts of changes to effectiveness of stability control systems for heavy vehicles (Option 6c)

	Net benefits ($m)	BCR
Low effectiveness (10%)	69	2.31
Base case (likely case) effectiveness (18% for RSC on trailers; 27% for ESC on prime movers)	216	5.10
High effectiveness (40%)	341	7.45

Finally, the BAU fitment rate was also subjected to a sensitivity analysis, including both a high and a low fitment rate scenario, to account for variations in the market uptake of stability control systems. For the base case analysis, the following BAU fitment rates were estimated:

- for category NC prime movers — 32.5 per cent of new vehicles fitted with ESC in 2019, increasing by 2.5 per cent per annum to 70 per cent by 2034;
- for category ME omnibuses — 85 per cent of new vehicles fitted with ESC in 2019, increasing by 2.5 per cent per annum to 95 per cent by 2023; and
- for category TC (>4.5 tonnes GTM) and TD trailers — 40 per cent of new vehicles fitted with RSC in 2019, remaining constant over the analysis period.

As a sensitivity test, the annual increase in the voluntary fitment of ESC to prime movers and buses was set at 1.5 per cent per annum for the low case and 5 per cent per annum for the high case, while the voluntary fitment of RSC to trailers was kept constant. As shown in Table 11, the net benefits remain positive even with a higher voluntary fitment rate.

Table 11: Impacts of changes to the BAU fitment rate of stability control systems for heavy vehicles (Option 6c)

	Net benefits ($m)	BCR
Low fitment rate (1.5% per annum increase)	258	5.36
Base case (likely case) fitment rate (2.5% per annum increase)	216	5.10
High fitment rate (5% per annum increase)	141	4.38

More detailed results of the sensitivity analyses are available at Appendix 14.

4.2. Economic Aspects—Impact Analysis

Impact analysis considers the magnitude and distribution of the benefits and costs among the affected parties.

Identification of Affected Parties

In the case of stability control systems for heavy vehicles, the parties affected by the options are:

Business

- vehicle manufacturers or importers;
- component suppliers;
- vehicle owners; and
- vehicle operators.

There is an overlap between businesses and consumers when considering heavy vehicles. Unlike light vehicles, heavy vehicle owners and operators, in general, are purchasing and operating these vehicles as part of a business. This is distinct to businesses that manufacture the vehicles or supply the components.

The affected businesses are represented by a number of peak bodies, including:

- The Australian Livestock and Rural Transporters Association (ALRTA), that represents road transport companies based in rural and regional Australia;
- The Australian Road Transport Suppliers Association (ARTSA), that represents suppliers of hardware and services to the Australian road transport industry;
- The Australian Trucking Association (ATA), that represents trucking operators, including major logistics companies and transport industry associations;
- The Bus Industry Confederation (BIC), that represents the bus and coach industry;
- Commercial Vehicle Industry Association Australia (CVIAA); that represents members in the commercial vehicle industry;

- Heavy Vehicle Industry Australia (HVIA), that represents manufacturers and suppliers of heavy vehicles and their components, equipment and technology; and
- The Truck Industry Council (TIC), that represents truck manufacturers and importers, diesel engine companies and major truck component suppliers.

Governments

- Australian/state and territory governments and their represented communities.

Impact of Viable Options

There were three options that were considered viable for further examination: Option 1: no intervention; Option 2: user information campaigns; and Option 6: regulation. This section looks at the impact of these options in terms of quantifying expected benefits and costs, and identifies how these would be distributed among affected parties. This is discussed below and then summarised in Table 12.

Option 1: no intervention

Under this option, the government would not intervene, with market forces instead providing a solution to the problem.

As this option is the BAU case, there are no new benefits or costs allocated. Any remaining option(s) are calculated relative to this BAU option, so that what would have happened anyway in the marketplace is not attributed to any proposed intervention.

Option 2: user information campaigns

Under this option, heavy vehicle owners and operators would be informed of the benefits of ESC for trucks and RSC for trailers through information campaigns.

As this option involves intervention only to influence demand for stability control systems in the market place, the benefits and costs are those that are expected to occur on a voluntary basis, over and above those in the BAU case. The fitment of stability control systems would remain a commercial decision within this changed environment.

Benefits

Business — heavy vehicle owners/operators

There would be a direct benefit through a reduction in road crashes (over and above that of Option 1) for the heavy vehicle owners/operators who are persuaded by information campaigns to purchase and/or operate heavy trucks and trailers equipped with stability control systems. This would save an estimated 41 lives and 432 serious injuries under Option 2a, and 9 lives and 92 serious injuries under Option 2b (over and above Option 1). A significant proportion of these would be occupants of a heavy vehicle. There would also be direct benefits to business (including owners/operators and/or insurance companies) through reductions in compensation, legal costs, driver hiring and training, vehicle repair and

replacement costs, loss of goods, and in some cases, fines relating to spills that lead to environmental contamination.

There could also be other minor benefits such as reduced tyre wear and fuel savings, as well as better on road handling of heavy vehicle combinations. These minor benefits were not costed in the benefit-cost analysis.

Business — manufacturers/component suppliers

There would be no direct benefit to heavy vehicle manufacturers (as a collective). Heavy vehicle owners/operators persuaded by the campaign would simply choose from existing truck and trailer models already equipped with stability control systems. This could lead to some shift in market share between the respective heavy vehicle brands (depending on the availability/cost of the technology by manufacturer), but would be unlikely to have much effect on the overall number of new heavy vehicles sold. Brake suppliers would benefit directly in terms of increased income/revenue from supplying more brake sub-assemblies equipped with stability control systems, to truck and trailer manufacturers.

Governments/community

There would be an indirect benefit to governments (over and above that of Option 1) from the reduction in road crashes that would follow the increase in the uptake of new heavy trucks and trailers equipped with stability control systems, achieved as a result of the information campaigns.

This would have benefits of $115 m under Option 2a and $17 m under Option 2b over and above Option 1. These benefits would be shared among governments and so the community.

Costs

Business

There would be a direct cost (over and above that of Option 1) to the heavy vehicle owners/operators who are persuaded by information campaigns to purchase and/or operate heavy trucks and trailers equipped with stability control systems. This is due to the additional cost of purchasing a vehicle equipped with these technologies. This would cost $43 m for Option 2a and $5.0 m for Option 2b over and above Option 1. The heavy vehicle owners/operators would be likely to absorb most of this cost (but, as noted above, would also receive much of the benefits).

Governments

There would be a cost to governments for funding and/or running user information campaigns to inform heavy vehicle owners and operators of the benefits of stability control systems. This is estimated at $2.4 m for Option 2a and $64 m for Option 2b.

Option 6: regulation

As this option, including each of the sub options, involves direct intervention to compel a change in the safety performance of heavy vehicles supplied to the marketplace, the benefits and costs are those that would occur over and above those of Option 1. The fitment of stability control systems would no longer be a commercial decision within this changed environment.

Benefits

Business — heavy vehicle owners/operators

There would be a direct benefit through a reduction in road crashes (over and above that of Option 1) for the heavy vehicle owners/operators who purchase and/or operate new heavy trucks and trailers equipped with stability control systems, due to the Australian Government mandating standards. This would save an estimated 148 lives and 1496 serious injuries under Option 6a, 136 lives and 1292 serious injuries under Option 6b, 124 lives and 1084 serious injuries under Option 6c and 126 lives and 1101 serious injuries under Option 6c Plus (over and above Option 1). A significant proportion of these would be occupants of heavy vehicles. There would also be direct benefits to business (including owners/operators and/or insurance companies) through reductions in compensation, legal costs, driver hiring and training, vehicle repair and replacement costs, loss of goods, and in some cases, fines relating to spills that lead to environmental contamination.

There could also be other minor benefits such as reduced tyre wear and fuel savings, as well as better on road handling of heavy vehicle combinations. These minor benefits were not costed in the benefit-cost analysis.

Business — manufacturers/component suppliers

There would be no direct benefit to heavy vehicle manufacturers (over and above that of Option 1). Brake suppliers would benefit directly in terms of increased income/revenue from supplying more brake sub-assemblies equipped with stability control systems to truck and trailer manufacturers.

Governments/community

There would be an indirect benefit to governments (over and above that of Option 1) from the reduction in road crashes that would follow the increase in the number and percentage of new heavy trucks and trailers equipped with stability control systems, due to the Australian Government mandating standards.

This would have benefits of $337 m under Option 6a, $303 m under Option 6b, $269 m under Option 6c and $273 m under Option 6c Plus (over and above Option 1). These benefits would be shared among governments and so the community.

Costs

Business

There would be a direct cost to heavy vehicle manufacturers (over and above that of Option 1) as a result of design/development, fitment and testing costs for the additional heavy vehicles sold fitted with stability control systems due to the Australian Government mandating standards. This would cost $188 m under Option 6a, $118 m under Option 6b, $72 m under Option 6c and $76 m under Option 6c Plus (over and above Option 1). However, there is also an estimated $34 m in savings for manufacturers from other proposed changes to the mandatory standards (see Table 7 above). The net direct cost to heavy vehicle manufacturers would therefore be $154 m under Option 6a, $84 m under Option 6b, $38 m under Option 6c and $42 m under Option 6c Plus (over and above Option 1). It is likely that the manufacturers would pass this net increase in costs on at the point of sale to heavy vehicle owners/operators who would then absorb most of it (but, as noted above, would also receive much of the benefits).

There also may be some extra cost for owners/operators, particularly those based in rural and regional areas, to maintain and repair electronic components (e.g. sensors) and wiring for stability control systems on heavy vehicles (see Table 6 above). This is estimated to be $14 m under Options 6a, 6b and 6c.

Governments

There would be a cost to governments for developing, implementing and administering regulations (standards) that require the fitment of stability control systems. This is estimated to be $0.7 m for each sub-option.

Table 12: Summary of the benefits and costs of each option (for 15 year life of policy/intervention)

	Option 1: no intervention		Option 2a:		Option 2b:	
	Gross benefits	**Costs**	**Gross benefits**	**Costs**	**Gross benefits**	**Costs**
Business — manufacturers/ component suppliers	n/a	n/a	None	Cost of vehicle countermeasures — $43 m	None	Cost of vehicle countermeasures — $5.0 m
Business — owners/operators	n/a	n/a	Reduced road trauma — $115 m		Reduced road trauma — $17 m	
Government	n/a	n/a		Cost of information campaigns — $2.4 m		Cost of information campaigns — $64 m
Lives saved	n/a	n/a	41 lives		9 lives	
Serious Injuries prevented	n/a	n/a	432 cases		92 cases	
BCR	n/a	n/a	2.51		0.24	

	Option 6a: regulation (broad scope)			Option 6b: regulation (medium scope)		
	Gross benefits	**Costs**	**Savings**	**Gross benefits**	**Costs**	**Savings**
Business — manufacturers/ component suppliers	None	Cost of vehicle countermeasures (incl. remote operator maintenance) — $203 m	Savings for tests/components — $34 m	None	Cost of vehicle countermeasures (incl. remote operator maintenance) — $132 m	Savings for tests/components — $34 m
Business — owners/operators	Reduced road trauma — $337 m		None	Reduced road trauma — $303 m		None
Government		Cost of implementing and administering regulations — $0.7 m			Cost of implementing and administering regulations — $0.7 m	
Lives saved	148 lives			136 lives		
Serious Injuries prevented	1496 cases			1292 cases		
BCR	1.99			3.07		

<table>
<tr><th></th><th colspan="3">Option 6c: regulation (narrow scope)</th><th colspan="3">Option 6c Plus: regulation (narrow scope, post consultation extension)</th></tr>
<tr><th></th><th>Gross benefits</th><th>Costs</th><th>Savings</th><th>Gross benefits</th><th>Costs</th><th>Savings</th></tr>
<tr><td>Business — manufacturers/ component suppliers</td><td>None</td><td rowspan="2">Cost of vehicle countermeasures (incl. remote operator maintenance) — $86 m</td><td>Savings for tests/components — $34 m</td><td>None</td><td rowspan="2">Cost of vehicle countermeasures (incl. remote operator maintenance) — $90 m</td><td>Savings for tests/components — $34 m</td></tr>
<tr><td>Business — owners/operators</td><td rowspan="2">Reduced road trauma — $269 m</td><td rowspan="2">None</td><td rowspan="2">Reduced road trauma — $273 m</td><td rowspan="2">None</td></tr>
<tr><td>Government</td><td>Cost of implementing and administering regulations — $0.7 m</td><td>Cost of implementing and administering regulations — $0.7 m</td></tr>
<tr><td>Lives saved</td><td colspan="3">124 lives</td><td colspan="3">126 lives</td></tr>
<tr><td>Serious Injuries prevented</td><td colspan="3">1084 cases</td><td colspan="3">1101 cases</td></tr>
<tr><td>BCR</td><td colspan="3">5.10</td><td colspan="3">4.83</td></tr>
</table>

5. REGULATORY BURDEN AND COST OFFSETS

The Australian Government Guide to Regulation (2014) requires that all new regulatory options are costed using the Regulatory Burden Measurement (RBM) Framework. Under the RBM Framework, the regulatory burden is the cost of a proposal to business and the community (not including the cost to government). It is calculated in a prescribed manner that usually results in it being different to the overall costs of a proposal in the benefit-cost analysis. In line with the RBM Framework, the average annual regulatory costs were calculated for this proposal by totalling the undiscounted (nominal) cost (including development and fitment cost) for each option over the 10 year period 2020-2029 inclusive. This total was then divided by 10.

The average annual regulatory costs under the RBM of the six viable options, Options 1, 2a, 2b, 6a, 6b and 6c, are set out in the following four tables. There are no costs associated with Option 1 as it is the BAU case. The average annual regulatory costs associated with Options 2a, 2b, 6a, 6b,6c, 6c Plus are estimated to be $6.5 million, $0.5 million, $23.9 million, $15.5 million, $10.6 million and $11.1 million respectively.

Table 13: Regulatory burden and cost offset estimate table — Option 1

Average annual regulatory costs (relative to BAU)				
Change in costs ($ million)	Business	Community organisations	Individuals	Total change in costs
Total, by sector	-	-	-	-

Table 14: Regulatory burden and cost offset estimate table — Option 2a

Average annual regulatory costs (relative to BAU)				
Change in costs ($ million)	Business	Community organisations	Individuals	Total change in costs
Total, by sector	$6.5 m			$6.5 m

Table 15: Regulatory burden and cost offset estimate table — Option 2b

Average annual regulatory costs (relative to BAU)				
Change in costs ($ million)	Business	Community organisations	Individuals	Total change in costs
Total, by sector	$0.5 m			$0.5 m

Table 16: Regulatory burden and cost offset estimate table — Option 6a

Average annual regulatory costs (relative to BAU)				
Change in costs ($ million)	Business	Community organisations	Individuals	Total change in costs
Total, by sector	$23.9 m			$23.9 m

Table 17: Regulatory burden and cost offset estimate table — Option 6b

Average annual regulatory costs (relative to BAU)				
Change in costs ($ million)	Business	Community organisations	Individuals	Total change in costs
Total, by sector	$15.5 m			$15.5 m

Table 18: Regulatory burden and cost offset estimate table — Option 6c

Average annual regulatory costs (relative to BAU)				
Change in costs ($ million)	Business	Community organisations	Individuals	Total change in costs
Total, by sector	$10.6 m			$10.6 m

Table 19: Regulatory burden and cost offset estimate table — Option 6c Plus

Average annual regulatory costs (relative to BAU)				
Change in costs ($ million)	Business	Community organisations	Individuals	Total change in costs
Total, by sector	$11.1 m			$11.1 m

The Australian Government Guide to Regulation sets out ten principles for Australian Government policy makers. One of these principles is that all new regulations (or changes to regulations) are required to be quantified under the RBM Framework and where possible offset by the relevant portfolio.

It is anticipated that regulatory savings from further alignment of the ADRs with international standards will offset the additional RBM costs of this measure.

6. WHAT IS THE BEST OPTION?

The following options were identified earlier in this RIS as being viable for analysis:

- Option 1: no intervention;
- Option 2: user information campaigns; and
- Option 6: mandatory standards under the MVSA (regulation).

6.1. Net Benefits

Net benefit (total benefits minus total costs in present value terms) provides the best measure of the economic effectiveness of the options. Accordingly, the Australian Government Guide to Regulation (2014) states that the policy option offering the greatest net benefit should always be the recommended option.

Option 6c Plus: regulation (narrow scope, post consultation extension – ESC for new prime movers and short wheel base rigid vehicles greater than 12 tonnes GVM and new buses greater than 5 tonnes GVM, and ABS for new trailers greater than 4.5 tonnes GTM, with the addition of RSC for new trailers greater than 10 tonnes GTM) had the highest net benefit of the options examined, at $217 m for the likely case. This benefit would be spread over a period of around 45 years, including the assumed 15 year period of regulation followed by a period of around 30 years over which the overall percentage of heavy vehicles fitted with these technologies in the fleet continues to rise as older vehicles without ESC are deregistered at the end of their service life.

Options 2a: targeted awareness, 6a: regulation (broad scope), 6b: regulation (medium scope) and 6c: regulation (narrow scope) also had positive net benefits of $69 m, $167 m, $204 m and $216 m respectively for the likely case. However, Option 2b (advertising) had negative net benefits, indicating the costs of implementing this option would exceed the benefits.

6.2. Benefit-Cost Ratios

Option 6c had the highest BCR of 5.10 (likely case). Option 6c Plus had the next highest BCR of 4.83 (likely case), followed by Option 6b with a BCR of 3.07 (likely case), Option 2a with a BCR of 2.51 (likely case) and Option 6a with a BCR of 1.99 (likely case).

6.3. Casualty Reductions

Option 6a would provide the greatest reduction in road crash casualties, including 148 lives saved and 1496 serious injuries (hospital admissions) avoided. The next best reduction in casualties would be for option 6b, with 136 lives saved and 1292 serious injuries avoided, followed by Option 6c Plus with 126 lives saved and 1101 serious injuries avoided, and then Option 6c, with 124 lives saved and 1084 serious injuries avoided.

The road casualty reductions for user information campaigns would be much lower than regulation, with 41 lives saved and 432 serious injuries avoided under option 2a, and only nine lives saved and 92 serious injuries avoided under option 2b.

6.4. Recommendation

This RIS identified the road safety problem in Australia of crashes involving rollover and/or loss of control of heavy vehicles, particularly articulated combinations. The primary countermeasure used to reduce the occurrence of these crashes is a stability control system. Although market uptake is increasing, the current overall fitment across the fleet is still relatively low with around 25 per cent of new heavy trucks fitted with ESC and 40 per cent of new heavy trailers fitted with RSC.

There is a strong case for government intervention to increase the fitment of stability control systems to heavy vehicles. The current low fitment rate, number and severity of crash outcomes indicates a need for intervention. The analysis has shown that a narrow scope regulation aimed primarily at articulated combinations (headed by prime movers) will provide significant reductions in road trauma while achieving the maximum net benefit for the community.

In this case, Option 6c Plus (regulation) would offer positive net benefits of $217 m resulting from savings of 126 lives and 1101 serious injuries from a 15-year period of regulation. In terms of efficiency of regulation, the BCR for Option 6c Plus is 4.83. The higher net benefits and BCR for Options 6c and Option 6c Plus relative to Options 6a or 6b is mainly because prime movers are much more likely (on a per vehicle basis) than rigid trucks to be involved in a fatal or serious injury crash involving a rollover or loss of control. For example, the probability of a prime mover being involved in a fatal rollover or loss of control crash is estimated to be nearly 13 times greater than the average for a rigid truck. For comparison, the probability of a prime mover being involved in an injury crash of any severity or type is estimated to be just under 3 times greater than the average for a rigid truck. These differences in crash risk are thought to be more because of differences in exposure due to the way these vehicles are used (e.g. long distance vs. more localised transport), rather than the design characteristics of these vehicles.

The BCR for Option 6c Plus is higher than the typical value of around two for a vehicle safety regulatory proposal. Overall, the positive net benefits and higher than average BCR are because:

- There are still relatively low fitment rates of stability control systems on heavy vehicles;
- Heavy vehicles are much more likely on a per vehicle basis to be involved in rollover crashes than light vehicles. This is particularly the case for prime movers. This means that targeted fitment of stability control systems can provide a relatively cost effective technical countermeasure for these crash types;
- Significant regulatory savings have been identified and proposed as part of the overall package, without reducing safety; and
- Heavy vehicle crashes are relatively expensive on average, due to the size and mass of these vehicles, and play an important role in contributing to Australia's productivity.

The costs associated with stability control systems would be minimised through closely aligning the requirements with those in UN R13 and FMVSS 136. This provides manufacturers flexibility to use systems that have already been developed and tested in the regions that the vehicle was originally designed. In the case of trailers, the stability control systems are already available as kits and are being used on many trailers in Australia.

Option 6 offers the important advantage of being able to guarantee 100 per cent provision of stability control systems to applicable vehicles. There would be no guarantee that non-regulatory options, such as Option 2, would deliver an enduring result, or that the predicted take-up of stability control systems would be reached and then maintained. Given there is currently a relatively low uptake of this technology, there is good reason to conclude that, under BAU, sections of the market will continue to offer stability control only as an extra — often as part of a more expensive package of options. If regulation had to be considered again in the future, there would also be a long lead time (likely to be greater than two years to redevelop the proposal, as well as the normal implementation, programming, development, testing and certification time necessary for implementing stability control in line with a performance based standard).

According to the Australian Government Guide to Regulation (Australian Government, 2014a) ten principles for Australian Government policy makers, the policy option offering the greatest net benefit should always be the recommended option. Option 6c Plus: regulation (narrow scope stability control - ESC for new prime movers and short wheel base rigid vehicles greater than 12 tonnes GVM and new buses greater than 5 tonnes GVM, ABS for new trailers greater than 4.5 tonnes GTM, with the addition of RSC for new trailers greater than 10 tonnes GTM), is therefore the recommended option. It represents an effective option that would guarantee on-going provision of improved stability control in the new heavy vehicle fleet in Australia.

Although the recommended option does not require mandating ESC for the majority of rigid trucks (except for the small proportion of NC rigid trucks with a short wheel base), this could be revisited at a later stage, should it be warranted (particularly for category NC vehicles). In this respect, it is likely that the costs of testing, developing and fitting ESC to rigid trucks will come down over time. In the meantime, voluntary measures such as policies by certain companies or sections of industry will continue to encourage increasing fitment of ESC to rigid trucks, especially those considered more susceptible to rollovers (for example trucks with concrete agitators and waste disposal units). It is also expected that mandating of ESC for new prime movers will result in more operators demanding ESC on new rigid trucks, as they become increasingly aware of the benefits of these systems.

6.5. Impacts

Business/consumers

The three options considered would have varying degrees of impact on consumers, business and the government. The costs to manufacturers would be passed on to operators (purchasers of new heavy vehicles) who would mostly absorb them. Much of the benefit would be directly received by heavy vehicle operators through reductions in road trauma (at least half the lives saved are expected to be from heavy vehicles) and other road crash related costs, with the remainder shared between governments and the wider community.

Option 6 would normally be considered the most difficult option for the vehicle manufacturing industry, because it would involve regulation-based development and testing with forced compliance of all applicable models. However, in the case of heavy vehicle stability control, the three major markets of Europe, the US and Japan have each mandated standards for electronic stability control on heavy vehicles. This would give manufacturers flexibility to adapt stability control systems from their home markets to the vehicles they supply in Australia. This should enable some leveraging of testing and certification already conducted in other markets, which will help to minimise design and development costs as much as possible.

Governments

The Australian Government maintains and operates a vehicle certification system, which is used to ensure that vehicles first supplied to the market comply with the ADRs. A cost recovery model is used and so ultimately, the cost of the certification system as a whole is recovered from business.

6.6. Scope of the Recommended Option

As discussed in section 2.3 above, the relevant international standard is the UN Regulation No. 13, and the heavy vehicle categories for which stability control requirements apply under this regulation are the UN vehicle categories of M2 and M3 (omnibuses), N2 and N3 (goods vehicles — GVM exceeding 3.5 tonnes), as well as O3 and O4 (trailers — GTM exceeding 3.5 tonnes). The US FMVSS 136 standard for ESC on heavy vehicles applies to a smaller range of vehicles: truck tractors (i.e. prime movers) and buses with a GVM exceeding 11,793 kg (11.793 tonnes). There are various other exemptions under both of these standards.

Under the recommended Option 6c Plus, a new ADR 35/06 would be implemented to require ESC for new prime movers and short wheel base rigid vehicles greater than 12 tonnes GVM and new buses greater than 5 tonnes GVM; and a new ADR 38/05 would be implemented to require ABS for new trailers greater than 4.5 tonnes GTM, with the addition of RSC for new trailers greater than 10 tonnes GTM. These vehicles are represented by ADR vehicle categories NC (of which prime movers are a subset), ME, TC (> 4.5 tonnes GTM) and TD. Exemptions from fitment of ESC would apply under ADR 35/06 for articulated and route service buses, and trucks and buses 'designed for off-road use' (note: 'designed for off-road use' would be defined for relevant vehicle categories in an appendix to the ADR). Feedback was sought on a possible exemption for ESC on prime movers with four or more axles, with feedback that this was acceptable due to the small number of vehicles this would apply to. Exemptions from fitment of both ABS and RSC would apply under ADR 38/05 for converter dollies as well as trailers fitted with an axle group consisting of more than four tyres in a row of axles or more than four axles in an axle group (certain non-standard low-loaders).

6.7. Timing of the Recommended Option

As discussed in section 3.2 above, the indicative implementation timetable of the proposed ADRs 35/06 and 38/05 is:

- For heavy trucks and buses (ADR category NC and ME vehicles)
  – 1 November 2020 for new model vehicles and 1 January 2022 for all new vehicles.
- For medium and heavy trailers (ADR category TC and TD vehicles)
  – 1 July 2019 for new model vehicles and 1 November 2019 for all new vehicles.

As noted earlier, the implementation lead-time for an ADR change that results in an increase in stringency is generally no less than 18 months for new models and 24 months for all other models. The proposed timetable would meet these typical minimum lead-times. A longer implementation lead-time is recommended for heavy trucks and buses relative to trailers, because truck/bus manufacturers would need to undertake detailed development and testing to ensure each vehicle model satisfies the proposed ADR 35/06, while there are brake sub-assemblies already available for trailer manufacturers to use, which would meet the proposed ADR 38/05.

7. CONSULTATION

7.1. General

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

The Department undertakes public consultation on significant proposals. Depending on the nature of the proposed changes, consultation could involve the Technical Liaison Group (TLG) and the Australian Motor Vehicle Certification Board (AMVCB), the Strategic Vehicle Safety and Environment Group (SVSEG) and the Austroads Safe Vehicles Theme Group (SVTG), the Transport and Infrastructure Senior Officials' Committee (TISOC) and the Transport and Infrastructure Council (the Council).

- TLG consists of technical representatives of government (Australian and state/territory), the manufacturing and operational arms of the industry (including organisations such as the Truck Industry Council and the Australian Trucking Association) and of representative organisations of consumers and road users (particularly through the Australian Automobile Association). AMVCB consists of the government members of TLG.
- SVSEG consists of senior representatives of government (Australian and state/territory), the manufacturing and operational arms of the industry and of representative organisations of consumers and road users (at a higher level within each organisation as represented in TLG). SVTG consists of the government members of SVSEG.
- TISOC consists of state and territory transport and/or infrastructure Chief Executive Officers (CEOs) (or equivalents), the CEO of the National Transport Commission, New Zealand and the Australian Local Government Association.
- The Council consists of the Australian, state/territory and New Zealand Ministers with responsibility for transport and infrastructure issues.

While the TLG sits under the higher level SVSEG forum, it is still the principal consultative forum for advising on the more detailed aspects of ADR proposals. Membership of the TLG is shown at Appendix 16 — Technical Liaison Group (TLG).

7.2. The National Heavy Vehicle Braking Strategy

The NHVBS began as a request by the then Standing Committee on Transport for the NTC to review the case for mandating ABS on heavy vehicles. This ran in parallel with a general Departmental review of the heavy vehicle braking ADRs 35 and 38 in 2006, and the publication of ADRs 35/02 and 38/03 in 2007. These came into force in 2009. As the issues that needed to be considered became broader than just ABS, the NTC, in conjunction with the Department, initiated a project to develop a more comprehensive NHVBS.

This began with an extensive consultation process. Public meetings were held in Melbourne in 2005 involving discussions with representatives of transport industry groups, to discuss the general situation with heavy vehicle braking regulation and on-road performance. A discussion paper (Hart, 2006) was released in 2006 that identified seven strategic objectives. Three workshops were held in Melbourne, Brisbane and Perth to describe the proposals and to receive feedback. These were then followed by a further meeting of around twenty industry and road agency representatives. Overall, the consultation process involved detailed discussions with about 200 representatives and written comments were received from about 40 correspondents.

Following this process, the final NHVBS (Hart, 2008) was published in November 2008 and after further consideration was adopted into the NRSS in two parts: Phase I and Phase II. Phase I focused on the adoption of ABS (with an allowance for LP systems for trailers) and was finalised in 2013. The adoption of stability control systems is the focus of Phase II, considered in this RIS.

Following the completion of Phase I, the Department undertook to survey industry regarding the advantages and disadvantages, including reliability, of other advanced braking systems (e.g. ESC, RSC etc.), to support the development of this RIS under Phase II of the NHVBS. This survey was followed-up with face-to-face visits at a number of operators' premises, to gather further information and insights. The NHVBS Operator/Maintenance Survey summary is included as Appendix 15 to this RIS.

The proposal to mandate stability control systems for heavy vehicles has also already been discussed at a number of SVSEG and TLG meetings and has been developed in close consultation with the NHVBS Phase II IRG, comprised mainly of industry technical experts on heavy vehicle braking. The member organisations of the IRG are shown at Appendix 17. There has been significant progress made on ADR content through the group and the draft ADRs now have broad support within the IRG. However, it is also recognised that heavy vehicle braking is a complex topic and as such there is likely to be further feedback received as a result of this RIS and the public comment period.

7.3. Public Comment

The publication of an exposure draft of the proposal for public comment is an integral part of the consultation process. This provides an opportunity for businesses and road user groups, as well as all other interested parties, to respond to the proposal by submitting their comments to the Department. Analysing proposals through the RIS process assists stakeholders in identifying the likely impacts of the proposals and enables more informed discussion on any issues.

In line with the Australian Government Guide to Regulation (2014) the proposal was circulated for a six-week public comment period. A summary of public comment and Departmental responses is included in Appendix 18.

Australia is a party to the World Trade Organisation (WTO) Agreement, and a policy of harmonisation of vehicle requirements with international regulations is a means of compliance with its obligations under that agreement. A notification was lodged with the WTO for the required period, to allow for comment by other members to the WTO. No responses were received.

Option 6a, which involved the broadest level of regulation, received the majority of support during the consultation period, including from some of the peak industry groups. However, it was reconfirmed that Australian government policy, as set by the Australian Government Guide to Regulation, is that the option with the highest net benefit (in this case Option 6c) should always be the recommended option.

Based on both the responses to consultation and in order to stay within Australian government policy, a compromise proposal was developed that could extend Option 6c partially towards Option 6a. This option would increase the scope of regulation to some types of heavier (NC category) rigid vehicles — those with a short wheelbase — that often share chassis and running gear of a prime mover model. In most cases these would be considered to be close variants for the purposes of reducing the cost of testing. Extending Option 6c in this way provides three main benefits, while still meeting the policy requirements that underpin the RIS.

Firstly, it moves somewhat towards the option preferred by the majority of respondents from the consultation, providing the best available compromise within the policy constraints.

Secondly, it provides further road trauma reductions while minimising increases in costs, thereby increasing the estimated net benefits.

Thirdly, it alleviates some concerns industry and/or state road agencies may have about the in-service conversion of rigid vehicles without ESC. This would be the case where a short wheelbase rigid without ESC is converted into a prime mover, without an ESC system being fitted, after being supplied in-service. Such a scenario is possible and would undermine the targeted regulation of ESC for prime movers through the ADRs.

The extended option, nominally Option 6c "Plus", additionally covers *cab-over* rigid trucks up to 4.5 metres in wheelbase and *conventional* (bonneted) rigid trucks up to 5 metres in wheelbase, which align well with the wheelbase of most prime movers. The ESC requirements would set a fitment and functional requirement only, to reduce testing and certification costs. In most cases (although not necessarily) these types of vehicles will also be variants of prime mover designs, which will require both the technical and performance requirements for ESC. It is considered that the ESC on these additional vehicles will perform sufficiently to contribute to similar trauma reductions, but with a reduced cost per vehicle associated with testing and certification. This extension of Option 6c would include an additional ten per cent of new heavy rigid trucks and a $4m increase in costs, with a corresponding reduction in road trauma of 2 lives and 17 serious injuries and so an increase in net benefits of $1m.

Beyond Option 6c Plus, further analysis of the case to fit ESC to the rest of the rigid vehicle fleet will be conducted in the future as part of work to consider Advanced Emergency Braking Systems (AEBS) for heavy vehicles.

Following the consultation period, the merits of Option 6c Plus were worked through in conjunction with the relevant part of industry, as well as other minor adjustments around technical requirements. Draft ADR 35/06 was updated to reflect Option 6c Plus.

Concerns had also been raised during the consultation on suitable test facilities in Australia for the performance test. The Department subsequently made changes to the test requirements in the draft ADR 35/06 based on this feedback. These changes would maintain the integrity of the performance test while reducing restrictions on the infrastructure required. An allowance for computer simulation, based on similar allowances in UN R13, was also included. This would allow for simulation based on physical tests to be undertaken, further reducing test costs. Industry welcomed these additions and the flexibility and reduction in test costs they would provide.

The benefit-cost analysis of Option 6c Plus is included in the second part of Appendix 19 (pg.196).

A concern was raised from one stakeholder about the cost used for the serious injury value in the benefit-cost analysis. It was suggested that a higher value would be more appropriate, based on a willingness to pay methodology. The Department conducted further sensitivity analysis on using this or other values. It also sought advice on the suggested value with one of the authors of a paper cited by the stakeholder as supporting its view. The sensitivity analysis showed that changing the serious injury value to the suggested value results in no change in the relative order of options in terms of net benefits. It was concluded that the original values used in the benefit-cost analysis were the most appropriate.

The additional sensitivity analysis of injury values is included in the first part of Appendix 19 (pg. 195).

8. IMPLEMENTATION AND EVALUATION

New ADRs or amendments to the ADRs are determined by the Minister for Urban Infrastructure and Cities under section 7 of the MVSA.

As Australian Government regulations, ADRs are subject to review every ten years as resources permit. This ensures that they remain relevant, cost effective and do not become a barrier to the importation of safer vehicles and vehicle components. The new versions of ADRs 35 and 38 would be scheduled for a full review on an ongoing basis and in line with this practice.

9. CONCLUSION AND RECOMMENDED OPTION

Heavy vehicle rollover and loss of control crashes are the specific road safety problem that has been considered in this RIS. These accounted for 22 per cent of all heavy vehicle injury crashes in Australia, over the period 2008 to 2010 (including 16 per cent involving rigid trucks, 34 per cent involving prime movers and 52 per cent involving road trains). ESC for heavy vehicles and RSC for trailers are proven technologies to prevent or mitigate these crash types.

The specific objective of this RIS was to examine the case for government intervention to improve the stability and control of the new heavy vehicle fleet in Australia. Fitting ESC and RSC to heavy vehicles and their trailers is a proven way to address this objective which has already been mandated in other world markets including Europe and the US. The overall estimated effectiveness for these technologies for the Australian case is 21 to 27 per cent for ESC depending on the category of vehicle and 18 per cent for RSC on trailers.

In Australia, around 25 per cent of new heavy trucks are fitted with ESC and around 40 per cent of new heavy trailers are fitted with RSC. Notably, this is much lower than in Europe where fitment of these systems is now mandatory (subject to some limited exemptions) for all new heavy vehicles. The mandate in Europe has therefore not strongly influenced the Australian market. The US mandate for prime movers began in August 2017and will begin for heavy buses in August 2018. Overall, there is a low level of fitment across the Australian heavy vehicle fleet despite ESC and RSC being available to the Australian market. This shows that there is a need for intervention.

This RIS examined five options in addition to the business as usual case to increase fitment of ESC and RSC to the heavy vehicle fleet. It found there were significant benefits to be gained in the reduction of rollover and loss of control crashes by mandating ESC/RSC fitment. This could not otherwise be realised either through the business as usual approach or various other non-regulatory options such as user information campaigns.

The benefit cost analysis found that there was a case for the provision of ESC and RSC systems for heavy vehicles and heavy trailers through government intervention, in the form of ADRs based on UN R13/11 that incorporate a performance standard adapted from FMVSS 136.

The consultation during both the RIS process through the IRG and the public consultation process yielded a number of improvements to the recommended option. These related to both technical content and scope of application.

A majority of respondents supported the broadest level of regulation, Option 6a, over the narrower regulatory case, Option 6c. Option 6a included ESC being fitted to all heavy rigid vehicles. However, the benefit-cost analysis did not support moving this far beyond Option 6c as the net benefits of Option 6a were lower. A compromise proposal was instead developed that would extend Option 6c partially towards Option 6a. This Option 6c "Plus" would increase the scope of regulation to some types of heavier rigid vehicles — those with a short wheelbase — that often share chassis and running gear of a prime mover model. This extension of Option 6c would include an additional ten per cent of new trucks and a $4m increase in costs, with a corresponding reduction in road trauma of 2 lives and 17 serious injuries and so an increase in net benefits of $1m. Beyond Option 6c Plus, further analysis of the case to fit ESC to the rest of the rigid vehicle fleet will be conducted in the future as part of work to consider Advanced Emergency Braking Systems (AEBS) for heavy vehicles.

According to the Australian Government Guide to Regulation (2014) ten principles for Australian Government policy makers, the policy option offering the greatest net benefit should always be the recommended option.

Therefore, Option 6c Plus: regulation is the recommended option. Under this option, fitment of ESC would be mandated for new prime movers and short wheel base rigid vehicles greater than 12 tonnes GVM and new buses greater than 5 tonnes GVM, fitment of ABS would be mandated for new trailers greater than 4.5 tonnes GTM, and fitment of RSC would be mandated for new trailers greater than 10 tonnes GTM. The proposed implementation timetable is:

- For heavy trucks and buses (ADR category NC and ME vehicles)
  – 1 November 2020 for new models and 1 January 2022 for all new vehicles.
- For medium and heavy trailers (ADR category TC and TD vehicles)
  – 1 July 2019 for new models and 1 November 2019 for all new vehicles

The positive net benefits of this intervention over the business as usual case are estimated at $217 m with potential to save 126 lives and see a reduction of 1101 serious injuries over a 15 year period of regulation.

In terms of impacts, the costs to business for the necessary changes to vehicles would normally be passed on to consumers, while the benefits would flow to the community and the consumers or their families that are directly involved in crashes. However, in this case offsets will be identified to reduce or eliminate this cost through other deregulation initiatives.

10. REFERENCES

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APPENDIX 1 — HEAVY VEHICLE CATEGORIES

A two-character vehicle category code is shown for each vehicle category. This code is used to designate the relevant vehicles in the national standards, as represented by the ADRs, and in related documentation.

The categories listed below are those relevant to vehicles greater than 4.5 tonnes *Gross Vehicle Mass* and trailers greater than 4.5 tonnes *Gross Trailer Mass* (Heavy Vehicles).

OMNIBUSES

A passenger vehicle having more than 9 seating positions, including that of the driver.

An omnibus comprising 2 or more non-separable but articulated units shall be considered as a single vehicle.

LIGHT OMNIBUS (MD)

An omnibus with a '*Gross Vehicle Mass*' not exceeding 5.0 tonnes.

Sub-category

MD4 – over 4.5 tonnes, up to 5 tonnes '*Gross Vehicle Mass*'

HEAVY OMNIBUS (ME)

An omnibus with a '*Gross Vehicle Mass*' exceeding 5.0 tonnes.

GOODS VEHICLES

A motor vehicle constructed primarily for the carriage of goods and having at least 4 wheels; or 3 wheels and a '*Gross Vehicle Mass*' exceeding 1.0 tonne.

A vehicle constructed for both the carriage of persons and the carriage of good shall be considered to be primarily for the carriage of goods if the number of seating positions times 68 kg is less than 50 per cent of the difference between the '*Gross Vehicle Mass*' and the '*Unladen Mass*'.

The equipment and installations carried on certain special-purpose vehicles not designed for the carriage of passengers (crane vehicles, workshop vehicles, publicity vehicles, etc.) are regarded as being equivalent to goods for the purposes of this definition.

A goods vehicle comprising two or more non-separable but articulated units shall be considered as a single vehicle.

MEDIUM GOODS VEHICLE (NB)

A goods vehicle with a '*Gross Vehicle Mass*' exceeding 3.5 tonnes but not exceeding 12.0 tonnes.

Sub-category

NB2 – over 4.5 tonnes, up to 12 tonnes '*Gross Vehicle Mass*'

HEAVY GOODS VEHICLE (NC)

A goods vehicle with a '*Gross Vehicle Mass*' exceeding 12.0 tonnes.

TRAILERS

A vehicle without motive power constructed to be drawn behind a motor vehicle.

MEDIUM TRAILER (TC)

A trailer with a '*Gross Trailer Mass*' exceeding 3.5 tonnes but not exceeding 10 tonnes

HEAVY TRAILER (TD)

A trailer with a '*Gross Trailer Mass*' exceeding 10 tonnes

APPENDIX 2 — COMMON TYPES OF HEAVY TRUCKS AND VEHICLE COMBINATIONS

Rigid heavy commercial vehicles offer a load carrying area and may be equipped with a tow bar or other coupling on the rear of the vehicle. Articulated heavy commercial vehicles consist of a prime mover (towing vehicle) which has no significant load carrying area but is linked with a turntable device to a semi-trailer.

The various types of heavy commercial vehicles operating in Australia are detailed below. In summary, there are five main operating classes of heavy commercial vehicles. These are:

- Rigid commercial vehicles
- Rigid commercial vehicles with trailers
- Semi-trailers
- B-Doubles
- Road trains (including B-Triples)

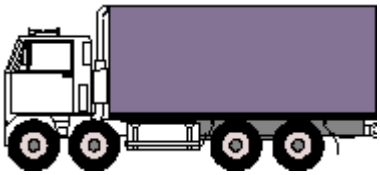
A B-Double combination consists of a prime mover towing two semi-trailers. The first trailer includes a turntable, which links to the second trailer, rather than using a dolly to link the trailers as in many road train configurations. A road train comprises of a prime mover hauling three or more trailers (including any converter dolly) or a rigid heavy commercial vehicle hauling two or more trailers.

RIGID HEAVY COMMERCIAL VEHICLES

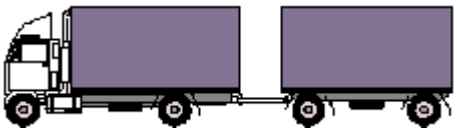
1. TWO AXLE

2. THREE AXLE

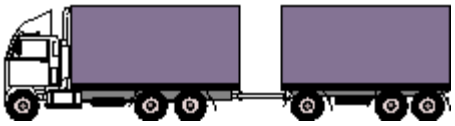
3. FOUR AXLE TWIN-STEER



4. TWO AXLE WITH TWO AXLE DOG TRAILER



5. THREE AXLE WITH THREE AXLE DOG TRAILER



ARTICULATED HEAVY COMMERCIAL VEHICLES

6. THREE AXLE SEMI-TRAILER

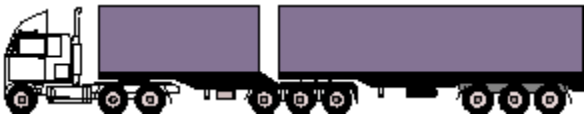
7. FIVE AXLE SEMI-TRAILER

8. SIX AXLE SEMI-TRAILER

9. SEVEN AXLE B-DOUBLE

10. EIGHT AXLE B-DOUBLE

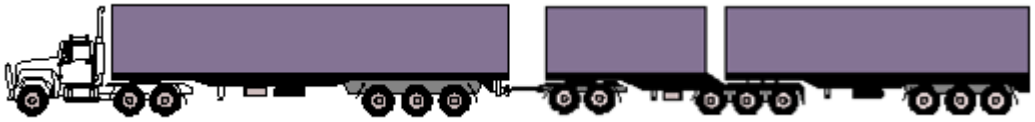
11. NINE AXLE B-DOUBLE



12. B-TRIPLE ROAD TRAIN

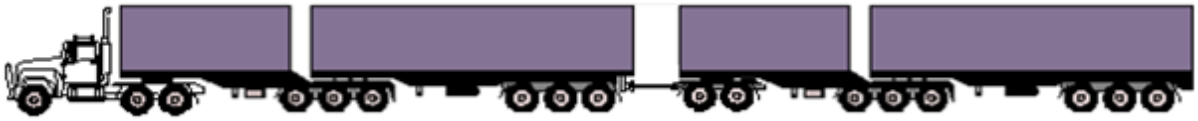
13. DOUBLE ROAD TRAIN (or A-DOUBLE)

14. AB-TRIPLE ROAD TRAIN



15. TRIPLE ROAD TRAIN (or A-TRIPLE)

16. BAB QUAD ROAD TRAIN



17. ABB QUAD ROAD TRAIN

Images sourced/adapted from National Transport Commission (2010)

APPENDIX 3 — AWARENESS CAMPAIGNS

There are numerous examples of awareness advertising campaigns that have been successful. One particularly successful campaign was the Grim Reaper advertisements of 1987. In an attempt to educate the public about risk factors for HIV Aids; television and newspaper advertisements were run showing the Grim Reaper playing ten pin bowling with human pins. This campaign led to significant increases in HIV testing requests meaning that the campaign effectively reached the target market. Other awareness campaigns can be as successful if well designed, planned and positioned. Two examples are the more recent Skin Cancer Awareness Campaign and the Liquids, Aerosols and Gels Awareness Campaign.

Providing accurate costings is a difficult task. Each public awareness campaign will consist of different target markets, different objectives and different reaches to name a few common differences. In providing a minimum and maximum response two cases have been used; the maximum cost is developed from the Department of Health & Ageing's Skin Cancer Awareness Campaign. The minimum cost is developed from the Office of Transport Security's Liquids, Aerosols and Gels (LAGs) Awareness Campaign.

Broad High Cost Campaign

The "Protect yourself from skin cancer in five ways" campaign was developed in an effort to raise awareness of skin cancer amongst young people who often underestimate the dangers of skin cancer.

Research prior to the campaign found that young people were the most desirable target market as they had the highest incidence of burning and had an orientation toward tanning. This group is also highly influential in setting societal norms for outdoor behaviour. A mass marketed approach was deemed appropriate.

The Cancer Council support investment in raising awareness of skin cancer prevention as research shows that government investment in skin cancer prevention leads to a $5 benefit for every $1 spent.

Whilst it is not a direct measure of effectiveness, the National Sun Protection Survey would provide an indication as to the changed behaviours that may have arisen as a result of the advertising campaign. The research showed that there had been a 31 per cent fall in the number of adults reporting that they were sunburnt since the previous survey in 2004 suggesting that the campaign was to some extent effective.

The actual effectiveness of the campaign was not publicly released.

The costs of this campaign were from three sources:

Creative Advertising Services (e.g. advertisement development)	$378,671
Media Buy (e.g. placement of advertisements)	$5,508,437
Evaluation Research (measuring the effectiveness of the campaign)	$211,424
Total	**$6,098,532**

Applicability to Stability Control Systems for Heavy Vehicles

Using a mass marketing approach can be regarded as an effective approach because it has the ability to reach a large number of people. However, this may not be the most efficient approach as most people exposed to such advertisements would not be members of the target market. Further, political sensitivities can arise from large scale marketing campaigns and that there would likely be a thorough analysis of any such spending. As a result, it would be essential to demonstrate that such a campaign is likely to be effective prior to launch.

The scale of the above example would be too large for a campaign targeting an Australian heavy vehicle fleet. Unlike the examples given in Appendix 4, heavy vehicles are traditionally not advertised as commodities through television media, as the target market is too small proportion of the public. In lieu of advertising the equipment through manufacturers commercials, a safety advertisement would instead reach a larger proportion of the public that have the means to act on the campaign. Comparing to reported expenditure of government agencies for 2015-2016 (Department of Finance, 2016), the estimate of $1.5 million per month, or $18 million per year to run a mass market approach was comparable.

Targeted Low Cost Campaign

In August 2006, United Kingdom security services interrupted a terrorist operation that involved a plan to take concealed matter on board an international flight to subsequently build an explosive device. The operation led to the identification of a vulnerability with respect to the detection of liquid explosives.

As a result, the International Civil Aviation Organisation released security guidelines for screening Liquids, Aerosols & Gels (LAGS). As a result new measures were launched in Australia. To raise awareness of the changes, the following awareness campaign was run over a period of four months:

1) 14 million brochures were published in English, Japanese, Chinese, Korean & Malay and were distributed to airports, airlines, duty free outlets and travel agents
2) 1200 Posters, 1700 counter top signs, 57000 pocket cards, 36 banners and 5000 information kits were prepared.
3) Radio and television Interviews
4) Items in news bulletins
5) Advertising in major metropolitan and regional newspapers
6) A website, hotline number and email address were established to provide travellers with a ready source of information.
7) 5 million resealable plastic bags were distributed to international airports

8) Training for 1900 airport security screeners and customer service staff was funded and facilitated by the department.

The campaign won the Public Relations Institute of Australia (ACT) 2007 Award for Excellence for a Government Sponsored Campaign having demonstrated a rapid rise in awareness. 77 per cent of travellers surveyed said they had heard of the new measures in general terms and 74 per cent of respondents claimed to be aware of the measures when prompted.

The costs of this campaign were from three sources:

Developmental Research (e.g. Understanding Public Awareness prior to the campaign)	$50,000
Media Buy (e.g. Placement of advertisements)	$1,002,619
Evaluation Research (Measuring the effectiveness of the campaign)	$40,000
Total	**$1,092,619**

Applicability to Stability Control Systems for Heavy Vehicles

This campaign had a very narrow target market; international travellers. As a result, the placement of the message for the most part was able to be specifically targeted to that market with minimum wastage through targeting airports and travel agents.

Should a heavy vehicle campaign be run, there would be a similar narrow target market; new heavy truck/bus and/or trailer buyers. As a result, placement of similar marketing tools could be positioned in places where these buyers search for information. Particular focus may be on heavy vehicle sales locations and in print media (e.g. magazines) specifically covering heavy vehicles.

The scale of the above example would be too large for a campaign targeting an Australian heavy vehicle campaign. Targeting specific media publications, both online and print media, would provide the best outcomes. Using reported expenditure of government agencies for 2015-2016 (Department of Finance, 2016), an estimate of $200,000 for a three month period was used. The cost modelling of this option started with a two year campaign followed by campaigns every second year (to prevent advertising fatigue) while the BAU fitment rate remained under 70 per cent.

APPENDIX 4 — INFORMATION CAMPAIGNS

The following are real-world advertising campaigns that featured automotive technologies as a selling point, with a measured outcome:

A Mitsubishi Outlander advertising campaign was launched in February 2008. It focused solely on the fact that the car had "Active Stability Control as standard". Changes in sales were attributable directly to the campaign. There was an immediate effect with sales of the Mitsubishi Outlander increasing by 9.1 per cent for the month of February alone.

A Hyundai advertising campaign was launched in April 2008, offering free ESC on the Elantra 2.0 SX until the end of June. This was supplemented by television commercials launched in early May. The impact of this campaign was significant, with a 52.8 per cent increase in sales for this model over the period.

A 2008 Volkswagen Golf advertising campaign aimed to inform the market that the Golf had "extra features at no extra cost". The result was a 69.1 per cent increase in sales for those models over the April – June period.

APPENDIX 5 — TYPES OF ANTILOCK BRAKE SYSTEMS FOR HEAVY VEHICLES

Antilock Brake Systems (ABS) may be grouped according to how wheel braking is controlled. The basic types are:

Individual control (IR)

This controls braking individually for each wheel. Giving the shortest stopping distances, it can also produce higher yaw moments when road adhesion is different between right and left wheels (known as split-μ conditions). It is normally only used on non-steer axles.

Select-low control (SL)

This controls braking at the same level across an axle, giving no yaw moments in split-μ conditions. The braking level is set to that of the axle in the multi-axle group with the least grip. In split-μ conditions the stopping distances are longer than IR but under normal conditions they are the same.

Select-high control (SH)

This controls braking at the same level across an axle, giving no yaw moments in split-μ conditions. The braking level is set to that of the axle in the axle group with the most grip. In split-μ conditions the stopping distances are shorter than IR but under normal conditions they are the same.

Wheel lock-up can occur on the un-sensed wheels. The performance differences between the Select-low and Select-high set-ups is mainly relevant to multi-axle rear groups. The brake design rules require that wheels on at least axle be independently sensed and this can result in two of three axles in a tri-axle group not being sensed. All wheels are however, controlled based upon the performance of the sensed axle.

Select-smart control (SSM)

This controls braking at the same level across an axle and so is similar to SL. However in this case the wheel with the least grip is allowed to lock to a limited extent and so stopping distances are shortened when compared to SL, with only a minor reduction in steer ability in split-μ conditions.

Individual control modified (IRM)

This controls braking individually for each wheel but modifies it slightly to reduce yaw moments.

Generally, the control strategies for Anti-Lock Brakes have become more sophisticated as these systems have been paired with vehicle stability controls. Controlled levels of wheel lock can be allowed or implemented by most current controllers to improve stability performance.

ARTSA (2017) outlines the systems in terms of the numbers of wheel speed Sensors (S) and Modulators (M) used and their fitment to Australian vehicles.

Trucks

2S/2M—A single-axle system. Two sensed wheel ends on one axle and two modulators controlling that axle. This system is not used on trucks in Australia as it does not meet the ADR requirement that all wheels on the vehicle be controlled.

4S/3M— Sensors on four wheels on two axles (a front and a rear axle). The steer axle wheels are modulated together (one modulator) and the rear axle has two modulators. The rear axle(s) have independent side modulation. The rationale for it is that ABS modulation on one side of a steer axle might cause a steering effect under heavy braking. Hence the steer axle has a single modulator that controls both sides.

This configuration is often used on air-over-hydraulic (AOH) brake systems that are common on light-medium commercial vehicles. Only one AOH booster is required for the steer axle ABS. This scheme is rarely if ever used on full airbrake trucks in Australia.

4S/4M—Four sensed wheel ends and four modulators. This is the usual scheme on Australian motive trucks whether they have singe-axle or multi-axle groups. Each rear modulator controls one, two or three wheels on each side of both rear axles. It is relatively common on all configurations including 8x4 trucks.

6S/4M—Six sensed wheel ends and four modulators. The rear wheels are controlled in pairs so that the ABS responds to pending lock-up on any of the rear wheels. A 4S/4M system will have comparable ABS performance to a 6S/4M system if its sensors are installed on the rear axle that is most likely to lock-up first.

This configuration can be beneficial for Automatic Traction Control (ATC) systems installed on reactive drive axle suspensions. The axle that spins first on acceleration does not usually lock first under braking. Therefore individual wheel sensing is desirable when ABS and ATC are both installed. A 6S/6M has the added benefit of independent wheel control. It is relatively uncommon. Many trucks with ATC have 4S/4M systems.

6S/6M—A fully controlled and modulated system for three-axle vehicles. It is commonly used on buses that have a rear-group axle with single tyres in front of a rear-group axle with dual tyres.

Trailers

2S/1M—Two wheel ends are sensed and all wheels on the group are controlled. This scheme is sometimes used on steerable axles at the front of a trailer (or dolly trailer). The advantage is that there is no steering effect arising from the modulation of the wheels on one side only.

2S/1M systems are widely used on North American trailers (which tend to have bogie axles, both of which are controlled) and occasionally used in Australia. When used in Australia, 2S/1M ABS is applied to steerable dolly trailer axles. However, it is more likely that a dolly will have a bogie or tri-axle group and it will have a 4S/3M system installed rather than a 2S/1M system.

2S/2M systems are commonly used on dual-axle and tri-axle axle groups on semi-trailers. It is occasionally used on dolly trailers. When used on a tri-axle group, it is common for the centre axle to be sensed. That is, the scheme is mid-way between Select-hi and Select-low.

4S/2M systems are commonly used on semi-trailers. Usually the front and the rear axles in the rear group are sensed independently. The controller therefore takes account of both Select-hi and Select-low control levels when determining the intervention points.

4S/3M—the usual 'dog' trailer configuration. It is rarely used on dual-axle or tri-axle semi-trailers. It can be used on a quad axle semi-trailer with a rear self-steering axle.

6S/3M is available although seldom used in Australia. It is applicable to dual-axle steerable groups.

4S/4M is not currently available for Australian trailers.

Technical Standards

All new heavy trucks and buses in Australia, with not more than four axles, must be equipped with ABS complying with the design and performance requirements in ADR 35/05. All new heavy trailers (except for some trailers meeting certain additional criteria) must be equipped with ABS or a Variable Proportioning Brake System (LP). Where fitted to a new heavy trailer, the ABS must comply with the design and performance requirements in ADR 38/04.

Both ADR 35/05 and ADR 38/04 require that at least one axle in each axle group must remain unlocked (above 15 km/h speed) when a full-force brake application is made. The test, which must be conducted for motive trucks/buses, is conducted in both laden and unladen states on a dry, sealed high-friction road surface at 40 km/h and at 80 km/h.

ADRs 35/05 and 38/04 both also allow UN R 13 as an alternative standard, and this includes UN ABS requirements. While the basic test is similar to the ADRs, there are additional adhesion utilisation tests, and heavy trucks and buses must have a Category 1 system and heavy trailers a Category A system. These are split-μ systems, which means they control left side braking and right side braking individually.

APPENDIX 6 — EFFECTIVENESS OF ANTILOCK BRAKE SYSTEMS FOR HEAVY VEHICLES

Multiple studies from around the world and over a long period of time have demonstrated the effectiveness of ABS in helping to reduce heavy vehicle crashes.

ABS has been mandated on both prime-movers and trailers in the US since March 1997 (model year 1998). In its Final Economic Assessment for the updated braking standard, FMVSS 121, the US used data from an earlier German study in 1984 by Otte et al. This study looked at crashes involving heavy vehicles in the Hamburg region and concluded that, as a consequence of ABS use, personal injuries suffered by occupants of commercial vehicles were preventable or reducible in severity in 8.7 per cent of cases. In the case of personal injuries suffered by others involved in the crash 7.2 per cent were estimated to be preventable and 3.6 per cent estimated to be reducible in severity (Hart, 2003). In re-examining the crash reports, NHTSA determined that for the US case, combination vehicles would have had 8.86 per cent and single-unit vehicles 5.83 per cent fewer crashes if they had been fitted with ABS (Hart, 2008). Other studies from Europe during the early 90s were around 10 per cent (National Road Transport Commission & the Federal Office of Road Safety, 1994).

NHTSA had previously studied the correlation between ABS application on passenger cars and their associated crash rates, finding little or no net crash reduction associated with ABS (Hart, 2003). This was reinforced by further statistical research by NHTSA in 2009 (Hart, 2008). However, extrapolating this to heavy truck-related ABS experience is not appropriate, because “heavy trucks experience great variations in weight that could affect wheel slip and potentially have more complex dynamic modes during heavy braking” (Hart, 2003).

In 2010, the US Office of Evaluation and Regulatory Analysis within NHTSA followed up its original FMVSS 121 analysis for heavy vehicles with a statistical analysis, using data from a number of states, of crashes between 1998 and 2007. The intent was to capture the expected effect of mandating the technology from the 1998 model years.

The best estimate of a reduction in all levels of police-reported crashes for air braked tractor trailers (truck/trailer combination) for a tractor unit (prime-mover) fitted with ABS was found to be 3 per cent. This represented a statistically significant 6 per cent reduction in the crashes where ABS is assumed to be potentially influential, relative to a control group, of about the same number of crashes, where ABS was likely to be irrelevant. In fatal crashes there was found to be a non-significant 2 per cent reduction in crash involvement, resulting from a 4 per cent reduction in crashes where ABS should be potentially influential (Hart, 2008).

The report noted that among the types of crashes ABS has the potential to influence: large reductions in jack-knives, off-road overturns, and at-fault crashes with other vehicles (except front-to-rear crashes) were observed. However, some increases in the number of involvements of hitting animals, pedestrians, or bicycles, and rear-ending lead vehicles (for fatal crashes only) were also observed.

Within Australia, there has been a series of studies undertaken in the mid-nineties by the National Road Transport Commission (NRTC, now the National Transport Commission, NTC) and the Federal Office of Road Safety (FORS, now the Vehicle Safety Standards Branch in the Department) relating to the regulatory case for an Australian Design Rule (ADR) for ABS on heavy vehicles.

The NRTC/FORS Stages 1 (National Road Transport Commission & the Federal Office of Road Safety, 1994) and 2 (National Road Transport Commission & the Federal Office of Road Safety, 1996) studies estimated potential reductions in crash rates by analysing 241 fatal Australian truck crashes from the year 1990 and 1992 from national data as well as fatal and non-fatal crashes for the years between 1987 and 1993, depending on the state or territory that the data was sourced from.

In Stage 1, FORS found that just under half of the fatal crashes involved braking or swerving and that eight per cent of all crashes in 1990 that involve articulated trucks would have been avoided if the trucks had ABS and a further two per cent of such crashes would be 'reduced to injury crashes'. These figures were five and eight per cent respectively for rigid vehicles, as well as six and seven per cent for buses. The total for all vehicles was seven per cent avoided and three per cent reduced to injury (National Road Transport Commission & the Federal Office of Road Safety, 1996). These figures were subsequently reviewed by an expert panel and upheld. The Australian Road Research Board (ARRB), acting as consultant to the NRTC, then analysed reported crashes (all injuries or property damage only) in NSW, Queensland and Victoria using the analysis from the fatal crashes. When the data was extrapolated Australia-wide the medium estimates of effectiveness were 6.1 per cent of all articulated crashes being avoided if the trucks had ABS, 1.4 per cent for rigid vehicles and 7.4 per cent for buses (National Road Transport Commission & the Federal Office of Road Safety, 1994 & National Road Transport Commission & the Federal Office of Road Safety, 1996). These were the final results used to calculate benefits. Potential savings in property damage crashes only, while anecdotally considered to be significant, were unable to be determined. At the time regulatory action was unable to clearly be justified on a benefit-cost basis. Stage 2 was then undertaken in an effort to determine more accurate estimates of the costs and benefits.

In Stage 2, it was found that just over three quarters of the fatal crashes involved braking or swerving and that 5.3 per cent of all crashes in 1992 that involve articulated trucks would have been avoided if the trucks had ABS and a further three per cent of such crashes would be 'reduced to injury crashes'. These figures were 8.3 and 2.8 per cent respectively for rigid vehicles, as well as one and two per cent for buses. The total for all vehicles was 6.2 per cent avoided and 2.9 per cent reduced to injury (National Road Transport Commission & the Federal Office of Road Safety, 1996). Again the ARRB performed more detailed work that gave medium estimates of effectiveness of 6.4 per cent for all articulated crashes being avoided if the trucks had ABS, 8.3 per cent for rigid vehicles and 2.8 per cent for buses. The variation in the results for rigid vehicles and buses when compared to Stage 1 was attributed to an increase in rigid vehicle crashes over the period as well as differences in state and territory reporting procedures.

The NRTC commissioned further work in 2003 (Stage 3) through the Prime Mover Ratings Project that was concerned with ABS requirements for prime-movers. It was assumed from the Stage 2 results that use of ABS on all parts of a heavy articulated truck would potentially reduce crash cost exposure by 6.1 per cent. This value was taken from the Stage 2 study. It was also assumed that a potential reduction in crash cost exposure of 3.05 per cent (i.e. half) will result if ABS is fitted to the motive vehicle only.

Summary

Table 20 summarises the effectiveness rates from each of the various studies. It can be seen that although the rates contain a wide variation, there is a consistently demonstrable benefit of fitment of ABS to heavy vehicles in the order of no less than 1 per cent to no more than 10 per cent.

For the analysis in this RIS, it was assumed that ABS (including as part on an RSC system) reduces the risk of a heavy vehicle injury crash (including fatal and serious injury crashes) by 5.5 per cent relative to basic pneumatic braking and 2 per cent relative to LP systems.

Table 20: Effectiveness of ABS for heavy vehicles

Study	Vehicle type	Crash Type	Effectiveness (per cent)
Billing, Lam & Vespa (1995)	B-train double tankers	Braking efficiency	Substantially improved
Otte et al (1984)	Commercial vehicles	Occupant personal injuries Preventable or reducible	8.7
		Other preventable	7.2
		Other reducible	3.6
Klusmeyer et al (1992) from NRTC Stage 1 (1994)			7
NHTSA (1995)	Articulated	Preventable	8.86
	Rigid	Preventable	5.83
NHTSA (2010)	Prime-mover	Preventable police reported crashes	3
		Preventable fatal	2
NRTC Stage 1 (1994)	Prime-mover	Preventable fatal	8.3
		Reducible to injury	2.3
	Rigid over 12t	Preventable fatal	5
		Reducible to injury	8
	Bus over 5t	Preventable fatal	6
		Reducible to injury	7
	All vehicles	Preventable fatal	7
		Reducible to injury	3
	Prime-mover	Preventable	6.1
	Rigid over 12t	Preventable	1.4
	Bus over 5t	Preventable	7.4
NRTC Stage 2 (1996)	Prime-mover	Preventable fatal	5.3
		Reducible to injury	3
	Rigid over 12t	Preventable fatal	8.3
		Reducible to injury	2.8
	Bus over 5t	Preventable fatal	1
		Reducible to injury	2
	All vehicles	Preventable fatal	6.2
		Reducible to injury	2.9
	Prime-mover	Preventable	6.4
	Rigid over 12t	Preventable	8.3
	Bus over 5t	Preventable	2.8
Robinson & Duffin (1993)			10

Source: see text

APPENDIX 7 — TYPES OF STABILITY CONTROL SYSTEMS FOR HEAVY VEHICLES

Two different types of stability control systems are available for heavy vehicles. One is Roll Stability Control or RSC, and the other is Electronic Stability Control or ESC. Both are driver assistance technologies, designed to improve heavy vehicle stability and control.

Roll Stability Control (RSC)

RSC is designed to reduce the chance of a vehicle (or combination) rolling over. Rollovers primarily occur when the lateral acceleration exceeds the rollover limit of a vehicle/combination. Common causes include entering corners at too high a speed, sudden steering manoeuvres to avoid other vehicles or obstacles and shifting of loads such as liquids in tanks. Heavy vehicles are usually much more prone to rollover than light vehicles, because they have a much higher gross mass together with an elevated centre of gravity.

Truck RSC systems typically consist of an electronic control unit, which monitors data received from a lateral acceleration sensor, ABS wheel speed sensors, and load sensors, as well as the driver's control inputs to the braking system and to the engine, together with the engine output (e.g. torque and speed) and the vehicle speed. These systems automatically reduce engine torque and apply the truck and any towed trailer brakes, whenever the system determines based on the truck lateral acceleration and wheel speed sensor data that the vehicle is at risk of rolling over. Measurement of the driver control inputs enables a better transition from driver commanded brake/engine input to automatically commanded inputs, including for the driver to brake more heavily than the automatic commanded input.

Trailer RSC systems typically consist of an electronic control unit, which monitors data received from a lateral acceleration sensor, ABS wheel speed sensors, and axle load sensors. These systems automatically apply the brakes on at least two wheels of each axle or axle group of the trailer, whenever the system determines based on the trailer lateral acceleration and wheel speed sensor data that the trailer is at risk of a rollover. The axle load sensing function enables adjustment of the brake signal relative to the load carried by the trailer (electronic load proportioning), during both system commanded and driver commanded braking. However, trailer RSC systems can only apply trailer brakes to slow a combination, whereas prime mover RSC/ESC systems can apply both the truck and the trailer brakes.

RSC systems for heavy vehicles also include a learning function, to account for the considerable difference in the unladen and fully laden mass of these vehicles as well as significant variations in the load distribution (including on each axle and the load height/centre of gravity). RSC systems are programmed with two pre-set lateral acceleration threshold (trigger) values. When the level 1 (lower) threshold is reached (or exceeded) (commonly 0.25g), the system will send a low-pressure test pulse to apply the brakes (ARTSA 2011). From these test pulses, the system determines based on the difference in wheel slip (measured by ABS wheel speed sensors) on each side of the vehicle how close the wheels on the inside of the turn are to leaving the ground. If it determines the wheels on the inside of the turn are close to lifting it will intervene to slow the vehicle/combination. If it determines the vehicle is not in danger of a rollover it will raise the level 1 lateral acceleration threshold a little, and will keep doing this until it determines the lateral

acceleration is approaching a value slightly below that at which it must brake the vehicle/combination to avoid a rollover. Whenever the level 2 (higher) lateral acceleration threshold is reached (or exceeded) the system will intervene to slow the vehicle/combination. If the load condition changes (as indicated by axle load sensors) or the RSC system power is turned off (e.g. at an ignition cycle), the level 1 threshold is reset and the learning process repeats (ARTSA 2011). Engine torque data may also be used in the estimation of vehicle mass for truck based RSC systems.

Electronic Stability Control (ESC)

ESC is designed to reduce the chance of a vehicle (or combination vehicle) understeering (ploughing out), oversteering (spinning out) or rolling over. Understeer or oversteer occur when there is not enough grip/friction between one or more tyres and the road to oppose lateral tyre forces. When the front tyres have utilised all available grip/traction the vehicle will tend to understeer (turn less sharply than the driver intends), and when the rear tyres have utilised all available grip/traction the vehicle will tend to oversteer (turn more sharply than the driver intends).

Truck and bus ESC systems typically consist of an electronic control unit that monitors data received from a steering-wheel-angle sensor, a combined yaw rate and lateral acceleration sensor, ABS wheel speed sensors, and load sensors, as well as the driver's control inputs to the steering and braking systems and to the engine, together with the engine output (e.g. torque and speed) and the vehicle speed.

ESC systems for heavy trucks/buses perform all the same functions as RSC systems. In addition, ESC systems automatically reduce engine torque and apply the truck and/or any towed trailer brakes, when the system determines based on the steering wheel angle and yaw rate sensor data that the vehicle is understeering or oversteering. Understeer is typically corrected for by selective application of the inside rear brake(s) of the vehicle, while oversteer is typically corrected for by selective application of the outside front brake of the vehicle together with automatic application of any towed trailer brakes. The combination of steering wheel angle and vehicle speed data can also help these systems detect rollover risk earlier than both truck and trailer based RSC systems (except for any truck based RSC system including a steering-wheel-angle sensor).

APPENDIX 8 — EFFECTIVENESS OF STABILITY CONTROL SYSTEMS FOR HEAVY VEHICLES

It was not possible to determine the effectiveness of stability control systems for heavy vehicles statistically from Australian road crash data. This is because the technology is still relatively new and there are not enough heavy vehicles fitted with these systems in operation yet. Nevertheless, there are a number of US studies, which provide a good basis for estimating the effectiveness of these systems for heavy vehicles in Australia.

Murray et al (2009) estimated RSC for heavy trucks is 37 to 53 per cent effective in preventing rollovers. The low effectiveness (37 per cent) was determined from feedback from operators, while the high effectiveness (53 per cent) was determined from computer simulations of rollover crashes resulting from excessive entry speed into a curve.

Woodrooffe et al (2009) estimated the effectiveness of ESC and RSC for tractor-semi-trailers in reducing rollover and loss of control crashes by road alignment (straight, curved) and road surface condition (wet, dry). These estimates were determined from in-depth analysis of 113 rollover cases and 46 loss of control cases (159 cases in total) from the US Federal Motor Carrier Safety Administration Large Truck Crash Causation Study (LTCCS) database. Effectiveness ratings for both ESC and RSC were determined for each case using either computer simulation (22 cases) or expert panel assessment (137 cases). Overall effectiveness estimates were established by averaging individual case ratings. Table 21 summarises the effectiveness results by crash type, road alignment and road surface condition from this study.

Table 21: Woodrooffe et al (2009) estimates of effectiveness (per cent) of ESC and RSC for tractor-semi-trailers by crash type, road alignment and road surface condition

Technology	Road Alignment	Surface Condition	LTCCS Cases		Effectiveness (per cent)	
			Rollover (R)	Loss of Control (LoC)	Rollover (R)	Loss of Control (LoC)
ESC	Straight	Dry	22	9	21.14	17.78
		Not Dry	3	17	0.00	20.59
	Curved	Dry	79	7	75.05	31.57
		Not Dry	9	13	55.56	39.62
RSC	Straight	Dry	22	9	16.36	0.56
		Not Dry	3	17	0.00	1.76
	Curved	Dry	79	7	71.15	14.00
		Not Dry	9	13	45.56	11.54
Total Cases			159			

Wang (2011) also estimated the effectiveness of ESC and RSC for truck tractors (prime movers) in reducing rollover and loss of control crashes. This study used the same 159 LTCCS cases as the study by Woodrooffe et al (2009). However, the results of this study were determined by first weighting the individual case ratings according to relative likelihood of occurrence, before calculating the average effectiveness values. Two cases were also reclassified from loss of control crashes to rollovers and the effectiveness estimates were revised down for six of the cases, following a review of all 159 cases. Table 22 summarises the effectiveness results by crash type, road alignment and road surface condition from this study.

Table 22: Wang (2011) estimates of effectiveness (per cent) of ESC and RSC for tractor-semi-trailers by crash type, road alignment and road surface condition

Technology	Road Alignment	Surface Condition	LTCCS Cases		Effectiveness (per cent)	
			Rollover (R)	Loss of Control (LoC)	Rollover (R)	Loss of Control (LoC)
ESC	Straight	Dry	22	9	15.27	6.74
		Not Dry	3	17	0.00	18.09
	Curved	Dry	80	6	75.07	18.70
		Not Dry	10	12	61.30	17.90
Total Cases / Overall Effectiveness			159		47	14
RSC	Straight	Dry	22	9	12.50	0.53
		Not Dry	3	17	0.00	3.05
	Curved	Dry	80	6	71.72	6.56
		Not Dry	10	12	55.90	1.98
Total Cases / Overall Effectiveness			159		44	3

Given the 44 per cent rollover effectiveness determined for RSC is close to the midpoint between the estimate by Murray et al (2009), Wang (2011) decided to adopt this same 37 to 53 per cent estimate for the rollover effectiveness of RSC. Similarly, given the 3 per cent incremental difference in the effectiveness of ESC and RSC for rollover crashes, Wang (2011) decided to adopt a 40 to 56 per cent estimate for the effectiveness of ESC for these crashes. Finally, Wang (2011) determined overall effectiveness values for ESC and RSC by weighting the individual effectiveness values for rollover and loss of control crashes, according to the annual average number of truck tractor (prime mover) crashes (fatal and non-fatal) of each type in the United States between 2006 and 2008. Table 23 summarises the ESC and RSC effectiveness estimates adopted by Wang (2011) for rollover and loss of control crashes.

Table 23: Wang (2011) estimates of effectiveness (per cent) of ESC and RSC for tractor-semi-trailers (prime mover towing a semi-trailer) by crash type

Technology	Rollover (R)	Loss of Control (LoC)	Overall (R & LoC)
ESC	40-56	14	28-36
RSC	37-53[1]	3	21-30

1 Adopted from Murray et al 2009

In its final regulatory impact analysis for FMVSS 136 (NHTSA, 2015), the US NHTSA estimated that ESC systems for truck tractors (prime movers) would have an overall effectiveness of 25-32 per cent in reducing rollover and loss of control crashes, while RSC systems would be 17-24 per cent effective overall in reducing these crashes. NHTSA established these overall effectiveness estimates by weighting individual effectiveness values derived for each crash type (i.e. rollover, loss of control) from the Wang (2011) study, according to the relative incidence of these crashes for truck tractors (prime movers) in the United States. The final values adopted by NHTSA were revised from those reported by Wang (2011) for two reasons. Firstly, NHTSA included an additional loss of control crash type (non-collision single-vehicle jackknife crashes). Secondly, because NHTSA added this additional loss of control crash type, they also reweighted the ratio of rollover to loss of control crashes. Based on experience testing stability control systems on heavy trucks and buses, NHTSA assumed the effectiveness of ESC and RSC by crash type would be similar on large buses as truck tractors (prime movers). Table 24 summarises the ESC and RSC effectiveness estimates adopted by NHTSA for rollover and loss of control crashes.

Table 24: NHTSA estimates of effectiveness (per cent) of ESC and RSC for heavy vehicles by crash type

Technology	Rollover (R)	Loss of Control (LoC)	Overall (R & LoC)
ESC	40-56[1]	14[1]	25-32[2]
RSC	37-53[1]	2[2]	17-24[2]

1 From Wang 2011
2 Revised from Wang 2011 due to inclusion of an additional LoC crash type

A Monash University Accident Research Centre (MUARC) study by Budd and Newstead (2014) investigated the potential benefits of a number of crash avoidance technologies, including ESC, for the heavy vehicle fleet in Australia. This included estimates of the percentage of heavy vehicle injury crashes involving a rollover or loss of control, from NSW, VIC, QLD, WA and SA road crash data for the period 2008-2010. Table 25 summarises this data.

Table 25: Percentage of heavy vehicle injury crashes (all severities) involving a rollover or loss of control by vehicle/combination type in five states of Australia (period 2008-2010)

Vehicle/Combination	Rollover (R)	Loss of Control (LoC)	Total (R + LoC)
Prime Mover ± Trailer	13	21	34
Rigid Trucks (no trailer)	4	12	16
Rigid Truck + Trailer	8	16	24
Road Train	19	33	52
Bus> 4.5t or >=10 seats	1	4	5

For the purposes of this RIS, overall effectiveness of ESC and RSC systems for heavy vehicles were estimated by weighting the individual effectiveness values adopted for each crash type (i.e. rollover, loss of control) by NHTSA, according to the relative incidence of these crashes in Australia by vehicle type using the above crash data from Budd and Newstead (2014). Table 25 details these estimates (including the calculation) of ESC and RSC overall effectiveness (bold values used in analysis) by heavy vehicle type for Australia.

Table 26: Estimates of overall effectiveness (per cent) of ESC and RSC by heavy vehicle type for Australia

	ESC Effectiveness (per cent)		RSC Effectiveness (per cent)	
	Overall (R & LoC)	*Calculation*	*Overall (R & LoC)*	*Calculation*
Prime Movers	**27**	= [(13 × 48) + (21 × 14)]/34	18.4	= [(13 × 45) + (21 × 2)]/34
Rigid Trucks	**22.5**	= [(4 × 48) + (12 × 14)]/16	12.8	= [(4 × 45) + (12 × 2)]/16
Rigid Truck + Trailer	**25.3**	= [(8 × 48) + (16 × 14)]/24	16.3	= [(8 × 45) + (16 × 2)]/24
Buses	**20.8**	= [(1 × 48) + (4 × 14)]/5	10.6	= [(1 × 45) + (4 × 2)]/5
Trailers	n/a	n/a	**18.4**	= [(13 × 45) + (21 × 2)]/34

APPENDIX 9 — AVAILABLE STANDARDS FOR STABILITY CONTROL SYSTEMS FOR HEAVY VEHICLES

International Standards – United Nations Regulation No.13

International vehicle standards (UN Regulations and UN Global Technical Regulations) are developed under the 1958 Agreement[1] and the 1998 Agreement[2] by the UN World Forum for the Harmonization of Vehicle Regulations (known as Working Party 29 or WP.29). Australia is a signatory to both the 1958 and 1998 agreements, and actively participates in WP.29.

The recognised international standard for heavy vehicle braking is the UN Regulation No. 13 (R13) – Uniform provisions concerning the approval of vehicles of categories M, N and O with regard to braking (UN, 2014). This regulation covers general braking including compatibility between towing vehicles and trailers, as well as ABS and ESC/RSC systems, and the fitment of standard connectors to provide power to electronic brake systems on trailers. To meet the latest version of this regulation (UN R13/11), medium and heavy trucks and buses (with limited exceptions) must be equipped with ESC, and medium and heavy trailers with air suspension and no more than three axles must be equipped with at least RSC.

The rollover control function within RSC/ESC systems is tested on and off in one of two test types. The directional control function within ESC systems is tested on and off in one of eight test types. However, the test procedures and pass/fail criteria are not defined in the regulation. These are instead determined through agreement between the approval authority and the vehicle manufacturer.

The ESC/RSC must also meet prescriptive/functional requirements, to help ensure that these systems will work effectively for a wider range of instability scenarios than are simulated by the tests alone. Further, the standard includes requirements for an optical warning signal to indicate ESC/RSC interventions to the driver as well as a warning signal to indicate any failure of these systems.

Approval to UN R13/11 is now a requirement for all new medium and heavy trucks, buses and trailers under the Regulation (EC) No. 661/2009 of the European Parliament and of the Council of 13 July 2009 concerning type-approval requirements for the general safety of motor vehicles, their trailers and systems, components and separate technical units intended therefor (European Union, 2009). The ESC and RSC requirements of UN R13/11 now apply on a mandatory basis to all new medium and heavy vehicles supplied to the European market.

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[1] The *Agreement concerning the Adoption of Harmonized Technical United Nations Regulations for Wheeled Vehicles, Equipment and Parts which can be Fitted and/or be Used on Wheeled Vehicles and the Conditions for Reciprocal Recognition of Approvals Granted on the Basis of these United Nations Regulations* of March 1958.

[2] The *Agreement concerning the Establishing of Global Technical Regulations for Wheeled Vehicles, Equipment and Parts which can be Fitted and/or be Used on Wheeled Vehicles.*

National Standards – United States Federal Motor Vehicle Safety Standard No. 136

The US FMVSS No. 136 – Electronic Stability Control Systems for Heavy Vehicles (NHTSA, 2016b) requires ESC to be fitted (with limited exemptions) to truck tractors (prime movers) and buses with a GVM over 11,793 kg (26,000 pounds). It commenced as a mandatory standard for certain three-axle prime movers manufactured on or after 1 August 2017 and will apply to all prime movers and buses (with a GVM > 11,793 kg) manufactured on or after 1 August 2019.

This standard includes a detailed series of clockwise and anticlockwise J-turn tests and pass/fail criteria to ensure the ESC system achieves a minimum level of performance. The J-turn test course consists of a straight entrance lane connected to a curved lane section with a radius of 45.7 meters (150 feet). The straight section of the lane is 3.7 metres wide, and the curved section of the lane is 3.7 metres wide for prime movers and 4.3 metres wide for buses. Figure 10 shows a J-turn test course configured for anticlockwise steering.

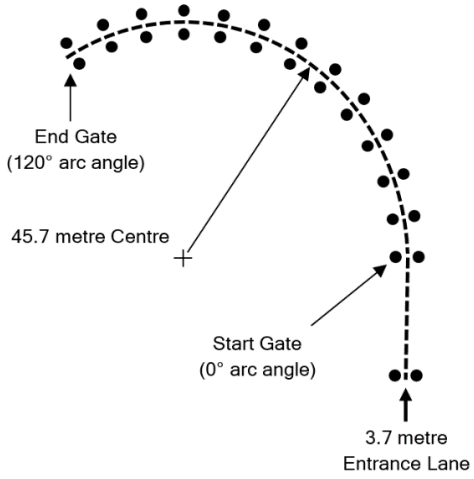

Figure 10: J-turn test course (anticlockwise direction shown)

In each J-turn test, the test driver accelerates the vehicle along the entrance lane before crossing the start gate at a designated entrance speed. The driver then attempts to keep all wheels of the vehicle within the test track by steering the vehicle through the curved section of track without braking. The minimum entrance speed at which the ESC activates (i.e. intervenes) must be no greater than 48 km/h (equivalent to approximately 0.4 g lateral acceleration). The ESC system must be capable of decelerating the vehicle to 47 km/h within 3 seconds after entering the curve and to 45 km/h within 4 seconds after entering the curve, from any entrance speed between 48 km/h and 1.3 times the minimum ESC activation speed. The ESC system must also automatically reduce the driver-requested engine torque by at least 10 per cent when the vehicle is driven through the J-turn at an entrance speed equal to the vehicle's minimum ESC activation speed.

There are also prescriptive/functional requirements for the ESC system, to help ensure it is effective in a wider range of instability scenarios than are simulated by the J-turn alone, and vehicles are required to be equipped with an optical warning signal to indicate any ESC failure to the driver. Each of these requirements is similar to those used in UN R13. Vehicles may also be equipped (as an option) with an optical warning to indicate ESC interventions to the driver.

A J-turn is the only dynamic manoeuvre type specified in UN R13 as suitable for demonstrating the effectiveness of both the directional control function and the rollover control function of a heavy vehicle ESC system. It is therefore possible, subject to agreement of a UN R13 approval authority, that a manufacturer may use an FMVSS 136 J-turn test for the demonstration of ESC effectiveness required for heavy trucks/buses under UN R13.

APPENDIX 10 — COMPATIBILITY

When braking as a combination of a towing vehicle and a towed vehicle, trucks need to provide trailer braking systems with the right signal to ensure that the trailer(s) contribute a similar amount of braking effort.

This compatibility of truck and trailer is specified in ADRs 35 and 38. However, as these requirements contain tolerance bands, consideration must always be given to in-service compatibility when different designs (including for example different brake technologies) are used together, or, more importantly, when new trucks and trailers are matched with older trucks and trailers that did not have to meet these requirements.

While ADRs 35 and 38 can and do specify primary compatibility levels, in practice only the careful matching of truck and trailer(s) can ensure optimum braking performance. To this end, industry codes and advisories play a vital role in the matching of vehicles with different levels of braking technology fitted, including when new and old vehicles are combined in-service.

Industry experts from the ALRTA, ARTSA, ATA, CVIAA, HVIA and TIC have recently worked together to develop a 'Guide to Braking and Stability Performance for Heavy Vehicle Combinations', which was released in May 2017. The aim of this guide is to assist the Australian road transport sector to achieve best practice in the braking and stability performance of heavy combination vehicles. It includes rating tables that provide an indication of the likely relative brake and stability performance when different brake technologies are used in truck and trailer combinations. This is to help heavy vehicle operators achieve better compatibility, including improvements over time as new equipment is purchased, or in the case of trailers, refurbished. The best braking and stability performance is achieved when EBS with ESC is used on trucks together with TEBS with RSC on trailers.

ARTSA has also worked with the ATA and with some state and territory governments to develop a Brake Code of Practice. The code deals with (amongst other things) issues of compatibility. The ATA have also previously produced an Australian Air Brake Code of Practice and more recently Technical Advisory Procedures for Truck and Dog Trailer Combinations and ESC and RSC technologies.

The codes and advisories above are a valuable part of the heavy commercial vehicle braking picture. The efforts made by industry in this regard are commendable. They are encouraged as a complement to regulated requirements, which due to the nature of the ADRs (single vehicle type approval) are unable to fully deal with combinations (truck and trailer(s) operating together).

APPENDIX 11— SUMMARY OF PROPOSED CHANGES TO THE CURRENT VERSIONS OF ADRS 35 AND 38

Changes to ADR 35 — overview

ADR 35/06 will replace ADR 35/05 in order to mandate Electronic Stability Control (ESC) to be fitted to all prime movers (with no more than three axles) and heavy buses (over 5 tonnes).

ESC will be required to have both directional and rollover control.

The technical requirements for ESC will closely align with United Nations Regulation 13 (UN R13) and performance requirements with US federal regulation FMVSS 136, which requires a J turn manoeuvre at 50km/h. Approvals to the UN R13 will also be accepted as an alternative.

While 12 and/or 24 volt systems will be permitted for all vehicles, prime movers designed for road train use will be required to have at least a 24 volt connector.

There are a number of minor requirements added to support the correct operation of ESC and there are some relaxations to ease the regulatory burden.

ADR 35 also covers light vehicles and there have been some incidental changes made around ESC and Brake Assist Systems for light vehicles. These changes are incorporated into this ADR version but in themselves are unrelated to the heavy vehicle changes.

1) Minor changes for clarification have been made to the ADR.
2) Changes to the numbering have been made to reflect the change of the first part from 0 to 1.

1. Legislative Provisions, 2. Function, 3. Applicability and 4. Definitions

3) Part *0. Legislative Provisions* renumbered to begin ADR 35 at part 1.
4) Changed title of part *2. Scope* to *2. Function*.
5) Changed title of part 3. Applicability and Implementation to 3. Applicability
6) Added clause 3.7. to require category MB, MC, and NA vehicles to be certified to both ADR 88/ Electronic Stability Control Systems and ADR 89/ Brake Assist Systems. This is to align with the separation of these standards from ADR 31 — this harmonises with the same process made to UN R13-H by WP.29.
7) Added clause 3.8., deemed to comply clause for NA vehicles types approved to UN R13 series 11.
8) Added clause 3.9., deemed to comply clause for MD, ME, NB and NC vehicles types approved to UN R13 series 11.

9) Applicability table updated.

10) Definitions: clause 4.1.2. added as reference to Appendix 1 for definitions of off road vehicle; clause 4.1.4. added reference to Appendix 5, clause 1 for definitions of electric regenerative and endurance braking systems.

5. Design Requirements

11) Former clause 4.1.1.1. removed. This was a reference to electronic stability control requirements for MB, NC and NA to meet former Appendix 2 (UN R13-H requirements — removed as per harmonisation of ADR 31).

12) Clause 5.1.4. has been changed to require automatic slack adjusters.

13) Clause 5.1.5. requires vehicles in category MD, ME, NB and NC to be equipped with an antilock system. Clause 5.1.6 requires each vehicle equipped with an 'Antilock System; to meet the requirements of Appendix 2.

14) Clause 5.1.7. reworded to also prohibit manual switching of an antilock system on category MD4 and ME vehicles, as per UN R13. Switching is allowed in 5.1.7.1. for category NB and NC vehicles that meet the off road requirements of Appendix 2.

15) Clause 5.1.8 requires ME vehicles, NC prime movers and NC short wheel base rigid vehicles to be equipped with a vehicle stability function. Articulated omnibuses and route service omnibuses are excluded from this requirement in clause 5.1.8.1. As are NC vehicles with four or more axles in clause 5.1.8.2 and off road vehicles in clause 5.1.8.3. Short wheel base NC rigid vehicles have been defined as having a wheelbase not exceeding 4.5 metres in the case of cab-over engine vehicles and all other NC rigid vehicles with a wheelbase not exceeding 5.0 metres. Cab-over engine vehicle has been defined in Appendix 3.

16) Clause 5.1.9. requires vehicles required to have a vehicle stability function to meet the requirements of Appendix 3.

17) For vehicles designed to tow trailers using air brakes — a new clause clause 5.1.12 has been added:

    i. 5.1.12. (a). requires the pressure at full application of the brake control (in line with UN R13) to be between 650 kPa and 850 kPa at the control line coupling and between 650 kPa and 900 kPa at the supply line coupling. The maximum control/supply pressures of 850 kPa and 900 kPa respectively are to alleviate industry concerns of higher than expected pressures at the couplings. This covers both pneumatic and electric control signals;

    ii. 5.1.12. (c) adds a minimum and a maximum of 650-850 kPa for the supply line pressure when there is no application of the service brake system;

    iii. 5.1.12. (d) a brake torque is required to be developed on at least one axle in each axle group of the towing vehicle (when unladen) before the control signal to the trailer reaches 100kPa or the equivalent digital demand value (in line with UN R13).

The conditions under 5.1.12. must be demonstrated through testsing.

18) Clause 5.1.14 includes changes to reflect removal of Figure 2 (unladen compatibility curve). Changes to 5.1.14.2 to clarify that both pneumatic and electric control lines need to meet the compatibility lines when fully laden (Figure 1.), but do not require to have the same characteristic curves when both are equipped.

19) Clause 5.2.10 now includes reference to ISO 7000 for the required brake failure symbol. The symbol itself has also been included.

20) Similarly, clause 5.4.4 no includes reference to ISO 7000 for the parking brake symbol and includes the symbol itself.

21) Clause 5.3.7 has clarification and changes to the conditions for the independent release of trailer parking brakes.

22) Clauses 5.7.2.1 and 5.7.2.2 were added to allow rated volumes of brake chambers as per Table 4. This was added to remove disincentive to fit long stroke brake chambers which generally don't use more air and can offer safety benefits (e.g. less susceptible to brake fade), and harmonises requirements with FMVSS 121 and CMVSS 121 (the requirements in the US/Canada for the past 20 years).

23) Clause 5.8 has been added to provide electrical supply for trailer brake systems (vehicles over 4.5 tonnes). 5.8.1.1 has required current capacity of each of the first five contacts on an ISO 7638 connector (this differs by voltage of the connector, or if the vehicles is designed to be used in B-Double and/or Road train combinations). Footnote provides guidance that more than one supply/connector may be provided (such as both 12 volt and 24 volt supplies/connectors).

    i. Clause 5.8.2 additionally requires that vehicles designed to be used as a Road Train will need to provide 24 volt supply for trailer braking. This does not prevent a manufacturer from supplying an additional 12 volt power supply for the same purpose.

24) Clause 5.9, Illumination of stop lamps, has been added to provide requirements on stop lamp activation. This includes clause 5.9.2 which requires automatically-commanded braking to generate the signal to illuminate the stop lamps, but can be supressed when the retardation is less than 0.7 m/s^2. Illumination is also required where the electric control signal message "illuminate stop lamps" is received; for example, when a trailer RSC system generates this message. Clause 5.9.5 covers vehicles fitted with an endurance braking system or electric regenerative braking systems which must meet the new Appendix 5.

6. Performance Requirements

25) Updates to references that reflect the changes in individual tests. Individual tests have been changed to allow test results from FMVSS 121 service and secondary brake effectiveness tests to be used.

26) Clause 6.1 includes the addition of Table 5, to allow for certain FMVSS 121 brake test results to be used, as an alternative to the equivalent tests in Table 1.

27) The sequence of testing (clause 6.2) has been modified by clause 6.2.1 to allow items 3 to 8 to be tested at any time. This is with conditions on the temperature the brakes should be at and that adjustment of brakes between tests is not allowed (except by clause 8.2) — if deviating from the original test sequence.

7. General Test Conditions

28) Clause 7.8 changes the average deceleration required to the minimum average deceleration as clarification.

29) Clause 7.12 adds a maximum tolerance to test speeds of 5 km/h, in addition to the minimum tolerance of 1 km/h.

30) Clause 7.14 is reworded for clarification.

31) Clause 7.15.1.1 adds a relaxation to clause 7.15.1 (requirement to take increased rolling resistance of combination into consideration) for item 6A of Table 5, as per the equivalent test in FMVSS 121.

8. Particular Test Conditions

32) Alternative tests from Table 5 are added to appropriate clauses where a test from Table 1 is referenced (clauses 8.3.1, 8.4.2, 8.6.1, 8.7.2).

33) Clause 8.7, Laden Secondary Brake Test, has been rewritten to provide clarity around the addition of the alternative test Item 7A from Table 5.

34) Clause 8.12.2.1 (under 8.12 Service Brake Actuation Time Test) has been rewritten to clarify that the Variable Proportioning Brake System needs to be tested either with the vehicle fully laden or with the device set to the fully laden operating condition.

35) Former clause 7.13.1.2 has been removed, which provided test conditions when a variable proportioning brake valve is used. This is no longer required as ABS will be fitted as standard, and compensates for lightly laden conditions where a load proportioning system is still fitted. Similarly, clause 8.13.2 removes the requirement for a separate test to be conducted at lightly laden test mass when a variable proportioning brake system is fitted. Reference to variable proportioning is also removed from clause 8.14.1 and 8.14.2.

9. Alternative Standards

36) The alternative standards have been rewritten to reflect both changes for NA vehicles (harmonisation of ADR 31 and moving of ESC and BAS to the new ADRs 88 and 89), and the need to update the acceptable alternative standards for other categories.

37) The technical requirements from the 10 series up to and including the 11 series of UN Regulation 13 are deemed to be acceptable for categories MD, ME, NB and NC. Exceptions to this are for specific requirements where a vehicle is designed to be used in B-Double or Road Train combination, and must still meet relevant clauses of the ADR.

38) Category ME over 12 tonne and NC prime movers are required to meet the stability control clauses of the ADR.

39) Clause 9.2.4 allows for an additional hand control to selectively brake the service brake system of a towed trailer independently of the service or secondary brake system of the towing vehicle. This was added due to raising the earliest allowable revision of UN R13 from 5 to 10.

Tables and figures

40) Table 1 restructured to provide clarification.

41) Table 2 updated to include four-axle axle-groups.

42) Table 3 updated to provide clarification.

43) Figure 2 removed

44) Table 4 added. This table provides a list of brake chamber rated volumes in line with that used in FMVSS 121.

45) Table 5 added. This provides alternative tests to those in Table 1. This allows for test results from some FMVSS 121 tests to be used.

Appendix 1

46) A new Appendix 1 was added to provide definitions for off road vehicles as used to determine if stability control is required.

47) The former Appendix 1 — Annex 1 has been moved to become Appendix 4 and expanded to provide clarity.

Appendix 2

48) The former Appendix 2 has been deleted (incorporation of Annex 9 of UN R13-H, ESC requirements for MB, MC or NA). This is in line with the harmonisation in ADR 31. It has been replaced with a revision of the former Appendix 1 for Antilock System requirements.

49) Clause 1.1.1. has been modified to include testing in accordance with part 7 and previous clause 1.1.3 has been removed due to this.

50) New clause 1.1.3. added to require that antilock systems meet the tests set out in Table 6. This is a revision of the requirements of ADR 35/05 where it was not completely clear what test procedures and to what levels of performance were required.

51) New clause 1.1.4. allows the tests to be combined with the laden and lightly laden service brake tests of clauses 8.3. and 8.6.

52) Clause 1.3, including sub-clause 1.3.1, 1.3.2 (ISO 7638 connector wiring requirements) and 1.3.3 (ABS warning lamp) have been deleted from this appendix, with these matters now covered in a new Appendix 4.

53) Clause 2 has been added. This covers switching provisions for ABS on category NB and NC vehicles designed for off road users, to ensure base braking with the system off, automatic restarting of the system, optical warning that the system is deactivated, and guidance given in the user's handbook of the consequences associated with this function (consistent with UN R13).

Appendix 3

54) A new Appendix 3 has been added to provide vehicle stability function requirements for category ME vehicles and category NC prime movers and short wheel base rigid vehicles.

55) Clause 1, Definitions, provides definitions based on UN R13. Additionally, a definition from UN R29 for cab-over engine vehicles has been included under clause 1.3.

56) Clause 2, provides functional requirements, based on UN R 13.

57) Clauses 2.3 to 2.5 allow for the vehicle stability function to be disabled. Clause 2.3 allows for manual disablement under a certain speed to prevent system activation in low speed manoeuvres, but will automatically be enabled once over that speed, or at the initiation of each new ignition cycle. Clause 2.4 allows for automatic disablement of the vehicle stability function where another mode or function has modified the drivetrain to increase traction. The disablement and re-instatement is required to be automatically linked to the mode/function that modifies the drivetrain. Clause 2.5 requires that where the vehicle stability function has been disabled, that a constant optical warning signal indicates that it is disabled.

58) Clause 3 provides requirements for tell-tales and warning signals associated with the vehicle stability system.

59) Clause 4 provides performance requirement for ME (GVM greater than 12 tonne) and NC prime movers. The performance requirements are in relation to the J-turn test procedure in Appendix 3 — Annex 1. An allowance is made to reduce or increase the radius within a range of 35 to 50 metres within Annex 1 to allow for suitable test facilities in Australia. The speeds change depending on the radius determined with formulas provided under this clause.

60) Clause 5 provides for the use of computer simulation to test stability control of variants of models that have undergone physical testing and are equipped with the same vehicle stability function. Annex 2 provides requirements and validation of the computer simulation. Annex 3 provides the test report required. Annex 2 and 3 are based on UN R13 requirements.

61) Annex 1 is the modified J-turn test from FMVSS 136. Modifications are kept to a minimum so that the test functions as designed by the National Highway Traffic Safety Authority (NHTSA). The test is designed to check that the vehicle stability function activates at an appropriate level of lateral acceleration (~0.4g for vehicles of this mass and design), and that the intervention through selective braking and engine torque reduction is acceptable (as required in clause 4 — see above). Following consultation, some allowances to adjust the test track size have been made while retaining the lateral acceleration component

Appendix 4

62) As mentioned above, Appendix 4 covers the electrical requirements for vehicles equipped to tow another vehicle (greater than 4.5 tonne). These requirements include contact allocation in accordance with ISO 7638 connectors (clause 1), and electric control line requirements in line with ISO 11992 (clause 2), and is in line with similar clauses used in UN R13.

Appendix 5

63) Requires vehicles with endurance braking systems or category A electric regenerative braking systems to illuminate the stop lamps when the retardation generated by these systems exceeds 1.3 m/s^2 (consistent with UN R13).

Changes to ADR 38 — overview

ADR 38/05 will replace ADR 35/04 in order to mandate Electronic Stability Control in the form of Roll Stability Control (RSC) to be fitted to all TD heavy trailers (with the exception of some trailers, including converter dollies). It will also require all trailers over 4.5 tonnes to be equipped with an anti-lock brake system (ABS) (with the exception of some trailers, including converter dollies). This replaces the current provision that allows load proportioning brake systems as an alternative to ABS. However, 'if fitted' requirements will remain.

The technical requirements for RSC will align with United Nations Regulation 13 (UN R13) and UN approvals will be accepted as an alternative.

Trailers designed to tow another trailer (ie road train capable) will be required to supply 24 volt connector for towed trailers. 12 volt power connectors may continue to be installed alongside, where the brake system supports both 12 and 24V.

There are a number of minor requirements added to support the correct operation of RSC and there are some relaxations to ease the regulatory burden.

1) Minor changes for clarification have been made to the ADR.
2) Changes to the numbering have been made to reflect the change of the first part from 0 to 1.

1. Legislative Provisions, 2. Function, 3. Applicability, 4. Definitions and 5. Design Requirements

3) Part *0. Legislative Provisions* renumbered to begin ADR 38 at part 1.

4) Changed title of part *2. Scope* to *2. Function*

5) Changed title of part *3. Applicability and Implementation* to *3. Applicability*

6) Definitions: clause 4.1.2 adds reference to definitions in clause 1 of Appendix 3 for stability control definitions.

6. General design requirements for trailers over 4.5 tonnes 'ATM'

7) Clause 6.12 has been amended to require automatic slack adjusters on all trailers, irrespective of if fitted with ABS.

8) Clause 6.16.1 clarifies that where a trailer is equipped with an electric control line, the electric Control Signal must be used instead of the pneumatic signal unless there is a failure with the electric control line and/or signal.

7. Service Brake System

9) Clause 7.1.2 (formerly clause 5.12) is rewritten to so that the required devices used to compensate for increased movement arising from wear are automatic. Previously the automatic requirement of these devices only applied to vehicles equipped with anti-lock systems.

10) New clauses 7.1.2.2 and 7.1.2.3 have been added to allow rated volumes of brake chambers as per Table 2. This was added to remove disincentive to fit long stroke brake chambers which generally don't use more air and can offer safety benefits (e.g. less susceptible to brake fade), and harmonises requirements with FMVSS 121 and CMVSS 121 (the requirements in the US/Canada for the past 20 years).

11) Clause 7.1.4 (formerly clause 6.4) has been amended by deleting the reference to road trains and 125 tonne limit, because heavier road train combinations than this are now being used in service.

12) A new clause 7.1.5 has been added to require a brake torque to be developed on at least one axle in each axle group of a trailer at UTM before the control signal to the trailer reaches 100kPa or the equivalent digital demand value (in line with UN R13).

13) Clause 7.1.6 has been modified to reflect the requirement to fit ABS and the removal of Variable Proportioning as an alternative to ABS and so must meet Figure 1. Where a trailer does not need to fit ABS (converter dollies and non-standard low loaders) but is fitted with a variable proportioning brake system, then figure 2 must also be met.

14) Clause 7.1.8 requires trailers that are fitted with variable proportioning brake systems (including as part of a vehicle stability function) to meet requirements in Appendix 1. Requirements for variable proportioning brake systems that used to reside in this section/part have been shifted to Appendix 1.

15) Clause 7.2 has been created as a new sub section for Electric 'Control Line', 'Antilock System' and 'Vehicle Stability Function' requirements.

i. 7.2.1 requires that all trailers be equipped with an ABS system on each axle group. Exceptions to this (clause 7.2.1.1) include converter dollies, or any trailer with an axle group arrangement consisting of more than four tyres in a row (to cover certain low loaders), or more than 4 axles in an axle group.

ii. Clause 7.2.2 requires category TD trailers to be fitted with a vehicle Stability Function that at a minimum has roll-over control (Appendix 3 covers these definitional requirements). Clause 7.2.2.1 allows converter dollies, or trailers to that are covered by clause 7.2.1.1 (see above) to be exempt from being equipped with a Stability Function. If fitted, it allows it to be manually disabled provided that it does not adversely affect the function of ABS, or the power supply and electric control signal to towed trailers.

iii. Clause 7.2.3 references requirements in Appendix 4 for trailers fitted with an electric control line.

iv. Clause 7.2.4 references clause 3 of Appendix 4 to require trailers that are designed to tow other trailers to be able to provide through power via an ISO 7638 connector to a towed trailer. This ensures through wiring is installed on trailers (including converter dollies) which are not equipped with electronic brake systems, but could tow trailers that are fitted with ABS or RSC.

8. Emergency Brake System 9. Parking Brake System

No changes.

10. General Performance Road Test Conditions

16) Adjusted text to reflect laden and unladen requirements where Variable Proportioning Brake Systems are optionally used. This is covered in clauses 10.6.1. to 10.6.3.

11. Service Brake Effectiveness Test Conditions

17) Clause 11.1 removes reference to ATM up to 45 tonnes, and sets the speed for the service brake testing for all trailers to between 58 and 64 km/h, with exception of trailers having a design speed less than 58 km/h, in which case the speed must not be less than the manufacturer's nominated design speed.

12. Dog Trailer Friction Utilisation, 13. Service Brake Fade Effectiveness Test and 14. Emergency Brake System Effectiveness Test

Editorial changes.

15. Parking Brake Effectiveness Test

18) 15.1 removes reference to the force used to operate certain types of park brake control. This is redundant as ADR 35 prescribes the control for operating the parking brake of a trailer.

16. Response and Release Time Measurement

19) Part title changed from *Time Response Measurement* to *Response and Release Time Measurement*.

20) Clause 16.2 (formerly clause 15.1.1) is reworded so that if a variable proportioning brake system device is present, then it needs to be set in the fully laden position while testing response times.

21) Former clause 15.2 (variants of unique trailer brake systems) has been moved and become clause 16.6.

22) Clause 16.3 adds requirement that both pneumatic and electric control line response times need to be tested independently (in line with UN R13). Requirements for pneumatic control lines are set in clause 16.4 and electric control line requirements are set in clause 16.5.

23) Former clause 15.9 (and sub clauses) specifying the configuration of the brake control valve on the test rig is moved to clause 16.4.2

24) Clause 16.4.7 re-adds time for pressure release requirements from ADR 38/03 (where applicable).

17. Service Brake Effectiveness Calculation 18. Service Brake Fade Calculation, 19. Emergency Brake System Calculation and 20. Parking Brake Calculation

Editorial changes.

21. Response and Release Times for Trailers Fitted with 'Approved' 'Control Systems'

25) Part title changed from Time Response to *Response and Release Times for Trailers Fitted with 'Approved' 'Control Systems'*.

26) Clause 21.1 (formerly clause 20.1) now refers directly to clauses 7.1.4 and 7.1.5 for clarity.

22. Specification of Brake System Components

Editorial changes.

Alternative Standards

27) The wording of the alternative standards requirements have been simplified and with redundant clauses removed. UN R13 incorporating the 11 series of amendments is the accepted alternative standard except for additional requirements under clauses: 7.1.5 in the case of brake release timing for trailers equipped to tow another trailer, including converter dollies; 7.2.2 in the case of trailers with more than 3 axles in an axle group; 7.2.2 in the case of trailers with more than three axles or trailers without air suspension, 7.2.3 in the case of equipped to tow another trailer (ATM greater than 4.5 tonnes), 9.2 to 9.4 for Australian unique parking brake requirements (prevents "parking on air").

Tables and figures

28) Table 1 — Updated to include 4 axles.

29) Table 2 — New table listing acceptable rated volume (allowance of rated volume brake chambers under clauses 7.1.2.2 and 7.1.2.3).

30) Figure 2 — retained for those trailers that do not need to be fitted with ABS (converter dollies and certain low loaders), but have been fitted with a variable proportioning brake system. Notes included to provide clarification and guidance on how to use the figure. Lower boundary has been moved slightly higher, and in accordance with UNR13/11, Annex 10, Diagram 2.

31) Figure 5 — Figure 5 gives an example for the setup of the electric control line test rig.

Appendices

Appendix 1

32) New appendix based on variable proportioning brake system requirements in the pervious ADR. Provides requirements for when fitted. Also includes requirements for electronic variable proportioning brake systems (ADR definition is broad enough that it defines both mechanical and electronic systems). Clause 1.3 adds requirements to prevent trailers with Antilock and Variable Proportioning from being under-braked when unladen (as Figure 2 does not apply for these).

Appendix 2

33) Formerly Appendix 1. Antilock installation and testing requirements. Includes requirements to meet selected base braking requirements including where there is a failure of the ABS. Clause 1.2 requires testing that the wheels do not lock during heavy braking (full application tests from 40 and 80km/h).

Appendix 3

34) Vehicle Stability Function requirements. These are definitional requirements in line with the UN R13 definitions. The functional requirements have no performance tests. Provides an allowance to turn the system off for distinct purposes, such as an off road mode, during low speed operation.

Appendix 4

35) Stability function and/or Antilock electrical system requirements. This covers the standards for connectors, communication, and function. Also includes additional requirements for connectors on trailers designed to tow another trailer.

36) Required minimum currents have been uprated.

37) Clause 2 requires electric control lines to meet ISO 11992 requirements.

38) Clause 3.1 requires that trailers designed to tow another trailer to be fitted with at least a ISO 7638-1 connector to supply throughput of 24V electrical supply (this doesn't preclude the 12V equivalent connector being installed separately). Clause 3.1.1 relaxes this requirement for trailers such as lead trailers or A-trailers not designed for road train use (i.e. to allow B-double combinations to not be forced to 24V where 12V is adequate).

APPENDIX 12 — BENEFIT-COST ANALYSIS — METHODOLOGY

The model used in this analysis was the Net Present Value (NPV) model. The costs and expected benefits associated with a number of options for government intervention were summed over time. The further the cost or benefit occurred from the nominal starting date, the more they were discounted. This allowed all costs and benefits to be compared equally among the options, no matter when they occurred.

The analysis was broken up into the following steps:

1. The number of registered prime movers, rigid trucks and buses in Australia, were established for each year between 1996 and 2016 inclusive, from Australian Bureau of Statistics Motor Vehicle Census (report series 9309.0) data (Australian Bureau of Statistics, 2017a).

2. The national population at 30 June of each year between 1996 and 2015 inclusive was established from Australian Historical Population Statistics (Australian Bureau of Statistics, 2014).

3. The number of registered prime movers, rigid trucks and buses per person in Australia, were established for each year between 1996 and 2016 inclusive, from the data determined in steps 1 and 2 above.

4. The registration per person data from step 3 was used to establish trends in the number of registered prime movers, rigid trucks and buses per person in Australia, over the period 1996 to 2016 inclusive.

5. Australian Bureau of Statistics population projections from 2012 to 2101 (Australian Bureau of Statistics, 2013) were used to establish a projected national population at 30 June of each year between 2016 and 2064 inclusive.

6. The data established in steps 4 and 5 above were used to determine projected numbers of registered prime movers, heavy rigid trucks and buses in Australia, for each year between 2016 and 2064 inclusive.

7. The proportion of total kilometres travelled by prime movers and rigid trucks while towing a trailer, including in single trailer, B-double and Road Train configurations, were determined using vehicle use data from the Australian Bureau of Statistics and the NTC (Australian Bureau of Statistics, 2017b; NTC, 2016).

8. The average number of trailers towed by prime movers and rigid trucks were then determined from the proportions of these vehicles towing one, two or three trailers and total kilometres travelled data established in step 7 above.

9. The number of heavy trailers in service was estimated by multiplying the number of registered prime movers and rigid trucks by the average number of trailers towed by prime movers and rigid trucks respectively.

10. New prime mover, rigid truck, bus and trailer sales in Australia for 2017 were estimated on the basis of data provided by TIC, BIC and ARTSA.

11. The number of prime movers, rigid trucks, buses and trailers leaving the fleet in 2017 (vehicle attritions) were determined by subtracting the increase in the number of vehicles in the fleet between 2016 and 2017 from the new vehicle sales in 2017, for each vehicle type (prime mover, rigid truck, bus, trailer etc.).

12. The annual numbers of prime movers, rigid trucks, buses and trailers entering and leaving the fleet (i.e. vehicle sales and attritions) in Australia were then estimated for each year between 2018 and 2070 inclusive, using the proportions of new sales and attritions relative to the net increase of each vehicle type in the fleet, established in step 11 above.

13. The number of prime mover, rigid truck and bus occupants killed and injured (including both serious and minor injuries) in single vehicle crashes (where loss of control was a factor) were established for each year between 2008 and 2014 inclusive, from data provided by BITRE.

14. The average annual number of fatalities and injuries (including both serious and minor injuries) in crashes involving the rollover and/or loss of control of a prime mover, rigid truck and/or bus, were then estimated for the period 2008 and 2014 inclusive. These estimates were determined by scaling the single vehicle crash data from step 13 above, using an average ratio of fatalities/injuries in all heavy vehicle rollover and/or loss of control crashes, to fatalities/injuries in crashes involving a single heavy vehicle only (where loss of control was a factor). The scaling factor/ratio was determined using data on heavy vehicle rollover and loss of control crashes from Budd and Newstead (2014) as well as single vehicle crash data from BITRE.

15. The average annual number of fatalities and injuries per registered prime mover, rigid truck and bus in crashes involving the rollover and/or loss of control of these vehicles over the period 2008-2014, were estimated using the data obtained in steps 3 and 14 above.

16. The average annual number of injuries (of any severity) per registered prime mover, rigid truck and bus over the period 2008-2014, were estimated from BITRE data.

17. BITRE heavy vehicle injury crash data for the period 2008-2014 was used to predict the distribution of injury crashes by vehicle age for prime movers, rigid trucks and buses.

18. The injury per registration estimates established in step 16 above, and the crashed vehicle age data obtained in step 17 above were used to predict the probability of injury (of any severity) by vehicle age in all crashes in Australia, for prime movers, rigid trucks and buses.

19. The injury per registration estimates established in step 15 above, and the crashed vehicle age data obtained in step 17 above were used to predict the probability of fatalities and injuries by vehicle age in rollover and loss of control crashes, for prime movers, rigid trucks and buses.

20. Voluntary fitment rates of ESC to new heavy trucks/buses, and ABS and RSC to new heavy trailers under BAU were estimated for the period 2019-2035 inclusive, based on advice from various industry sources.

21. Fitment rates of ESC to new heavy trucks/buses, and ABS and RSC to new heavy trailers were estimated for each of the options (2a, 2b, 6a, 6b and 6c) for the period 2019-2035 inclusive. These were higher than the BAU rate, with the actual rate for each option depending on the specifics of the proposed intervention. This accounted for the proportion of vehicles with and without stability control systems that enter and leave the fleet over this period.

22. For each option (2a, 2b, 6a, 6b and 6c), reductions in the number of fatalities and injuries were determined for each year from 2020 to 2064, using the applicable technology effectiveness estimate outlined in Section 4 of this RIS, the fitment rates under each option for each year (see steps 17 and 18 above), the discrete probability mass functions established (see step 16 above) and the heavy vehicle registrations projected for each year (see step 5 above)[1,2]. These calculations were done separately for each type of vehicle (i.e. prime mover, rigid truck or bus) and also accounted for the expected combinations of trucks and trailers.

23. Total annual costs associated with the implementation of each option (2a, 2b, 6a, 6b and 6c) were determined using the system development costs (per vehicle model), fitment of system costs (per vehicle supplied), maintenance of system costs, policy implementation and maintenance costs (per year of regulatory intervention) and savings (in the case of options 6a, 6b and 6c) outlined in Section 4 of this RIS.

24. The average costs to society of a fatality, serious injury and minor injury in heavy vehicle rollover and loss of control crashes were estimated using the value of a statistical life year from Abelson, P. (2007), BITRE fatal road crash data, and injury cost data and other road crash cost data from BITRE (2009).

[1] The effectiveness of the RSC on trailers towed by trucks with ESC was reduced to 6.75 per cent (0.25 × 27 per cent), to account for the truck ESC intervening first in most scenarios to brake the towed trailer(s) before the RSC intervention threshold on the trailer(s) is reached.

[2] An effectiveness of 5.5 per cent was applied for each trailer equipped with ABS instead of a conventional air brake system, and an incremental effectiveness of 2 per cent was applied for each trailer equipped with ABS instead of LP.

25. The gross annual financial benefits associated with implementation of each option (2a, 2b, 6a, 6b and 6c) were determined by multiplying lives saved and reductions in the number of injured persons by the casualty costs established in step 24 above. All calculated annual benefit and cost values were discounted (back to 2016 — present values) and summed, to determine the net present value of the total costs to business/government, the net benefit to society, and the benefit-cost ratio. A real discount rate of 7 per cent was assumed, this being in line with the Office of Best Practice Regulation Guidance Note on Benefit Cost Analysis (Australian Government, 2016). Real discount rates of 10 per cent as well as 3 per cent were also used as part of a sensitivity check, for the recommended Option 6c.

APPENDIX 13 — BENEFIT-COST ANALYSIS — DETAILS OF RESULTS

1. Establish the number of registered prime movers, rigid trucks and buses in Australia, for each year between 1996 and 2016 inclusive, from Australian Bureau of Statistics Motor Vehicle Census (report series 9309.0) data (Australian Bureau of Statistics, 2017a).

Table 27: Heavy vehicle registrations (1996-2016)

Date of Motor Vehicle Census	Prime Movers (NC)	Rigid Vehicles (NB & NC)	Buses (MD & ME)
31-Oct-96	58352	341037	58772
31-Oct-97	59292	342412	61143
31-Oct-98	62274	347214	64082
31-Oct-99	63295	346823	65891
31-Mar-01	62597	338411	67572
31-Mar-02	63905	341483	70196
31-Mar-03	64261	348673	70122
31-Mar-04	66300	357617	71314
31-Mar-05	69723	368520	72620
31-Mar-06	71860	383546	75375
31-Mar-07	74452	394542	77562
31-Mar-08	79132	410910	80581
31-Mar-09	81217	421702	84413
31-Mar-10	82436	431288	86367
31-Jan-11	85965	437762	87883
31-Jan-12	87995	446406	90599
31-Jan-13	90904	457145	93034
31-Jan-14	93853	465122	94131
31-Jan-15	94975	472324	95149
31-Jan-16	96185	480238	96582

2. Establish the national population at 30 June of each year between 1996 and 2015 inclusive from Australian Historical Population Statistics (Australian Bureau of Statistics, 2014).

Table 28: National population (1996-2015)

Date	Population
30-Jun-96	18,224,767
30-Jun-97	18,423,037
30-Jun-98	18,607,584
30-Jun-99	18,812,264
30-Jun-00	19,028,802
30-Jun-01	19,274,701
30-Jun-02	19,495,210
30-Jun-03	19,720,737
30-Jun-04	19,932,722
30-Jun-05	20,176,844
30-Jun-06	20,450,966
30-Jun-07	20,827,622
30-Jun-08	21,249,199
30-Jun-09	21,691,653
30-Jun-10	22,031,750
30-Jun-11	22,340,024
30-Jun-12	22,721,995
30-Jun-13	23,119,257
30-Jun-14	23,524,055
30-Jun-15	23,940,552

3. Establish the number of registered prime movers, rigid trucks and buses per person in Australia, for each year between 1996 and 2016 inclusive, from the data determined in steps 1 and 2 above.

4. Establish trends in the number of registered prime movers, rigid trucks and buses per person in Australia, over the period 1996 to 2016 inclusive.

Table 29: Number of registered heavy vehicles per person

Date	Prime Movers (NC) per person	Rigid Vehicles (NB & NC) per person	Buses (MD & ME) per person
31-Oct-96	0.003202	0.015121	0.002930
31-Oct-97	0.003218	0.014716	0.003225
31-Oct-98	0.003347	0.014671	0.003319
31-Oct-99	0.003365	0.014809	0.003444
31-Mar-01	0.003290	0.014541	0.003503
31-Mar-02	0.003315	0.014045	0.003551
31-Mar-03	0.003296	0.013864	0.003642
31-Mar-04	0.003362	0.013860	0.003597
31-Mar-05	0.003498	0.013915	0.003616
31-Mar-06	0.003562	0.014035	0.003643
31-Mar-07	0.003641	0.014278	0.003736
31-Mar-08	0.003799	0.014421	0.003793
31-Mar-09	0.003822	0.014653	0.003869
31-Mar-10	0.003800	0.014633	0.003973
31-Jan-11	0.003902	0.014542	0.003982
31-Jan-12	0.003939	0.014444	0.003989
31-Jan-13	0.004001	0.014419	0.004055
31-Jan-14	0.004060	0.014347	0.004094
31-Jan-15	0.004037	0.014251	0.004072
31-Jan-16	0.004018	0.014100	0.004045

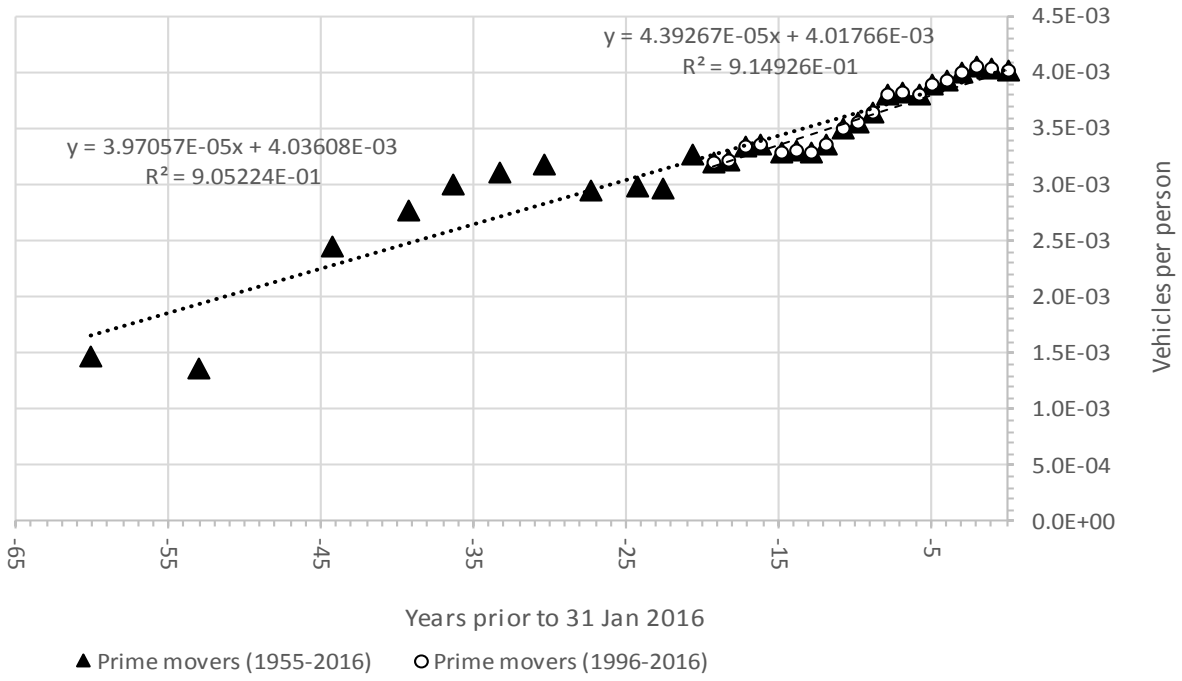

Figure 11: Registered prime movers (category NC vehicles) per person in Australia (1955-2016 and 1996-2016)

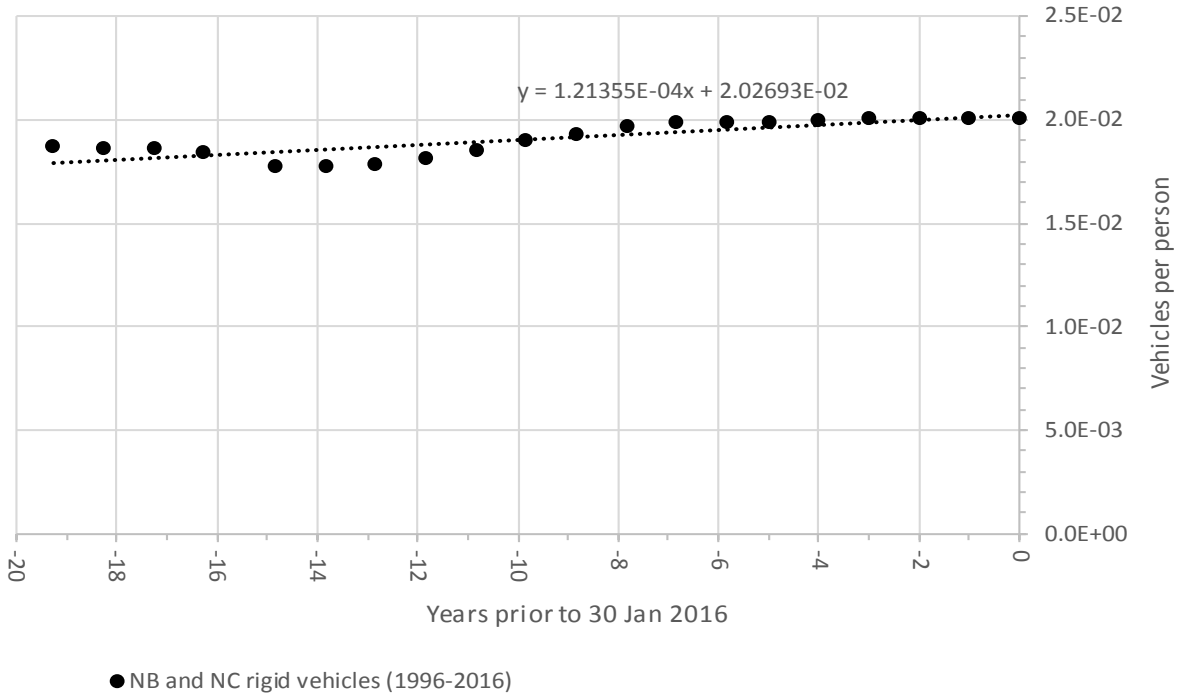

Figure 12: Registered rigid vehicles (category NB and NC vehicles) per person in Australia (1996-2016)

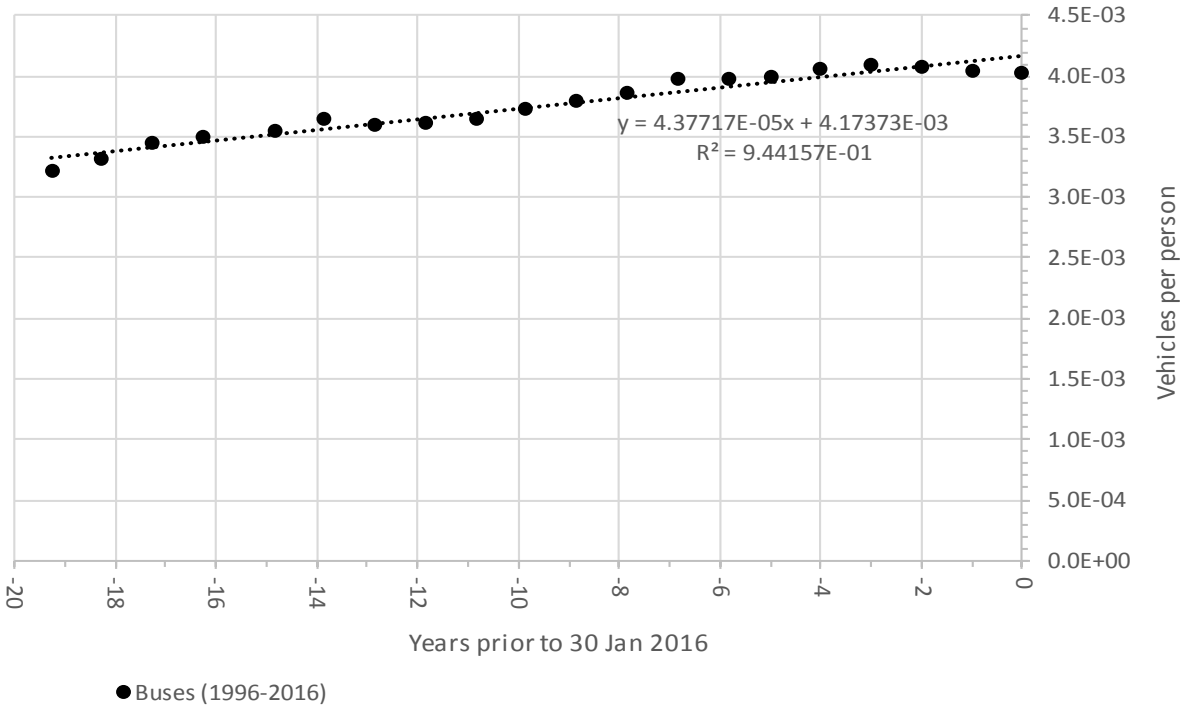

Figure 13: Registered buses (category MD and ME vehicles) per person in Australia (1996-2016)

5. Establish a projected national population at 30 June of each year between 2016 and 2064 inclusive.

6. Determine projected numbers of registered prime movers, heavy rigid trucks and buses in Australia, for each year between 2016 and 2064 inclusive.

Table 30: Projected population and heavy vehicle registrations for Australia (2016-2064)

Date	Population	Prime Movers (NC)	Rigid Vehicles (NB2 & NC)	Buses (MD & ME)
Jun-16	24,359,761	98,315	344,597	102,115
Jun-17	24,781,121	101,104	353,565	104,966
Jun-18	25,201,317	103,926	362,619	107,849
Jun-19	25,619,895	106,777	371,751	110,762
Jun-20	26,037,356	109,661	380,968	113,707
Jun-21	26,452,147	112,570	390,247	116,676
Jun-22	26,866,209	115,512	399,616	119,678
Jun-23	27,279,046	118,485	409,067	122,711
Jun-24	27,690,209	121,487	418,593	125,773
Jun-25	28,099,273	124,516	428,187	128,861
Jun-26	28,505,871	127,570	437,842	131,973
Jun-27	28,909,776	130,648	447,554	135,109
Jun-28	29,311,467	133,751	457,330	138,269
Jun-29	29,710,682	136,877	467,164	141,453
Jun-30	30,107,276	140,027	477,054	144,659
Jun-31	30,501,192	143,199	486,997	147,886
Jun-32	30,891,992	146,391	496,986	151,133
Jun-33	31,279,725	149,602	507,019	154,399
Jun-34	31,664,507	152,833	517,099	157,685
Jun-35	32,046,518	156,085	527,226	160,990
Jun-36	32,426,009	159,358	537,405	164,316
Jun-37	32,803,245	162,652	547,638	167,663
Jun-38	33,178,476	165,970	557,928	171,033
Jun-39	33,551,974	169,313	568,281	174,427
Jun-40	33,923,997	172,680	578,699	177,846
Jun-41	34,294,733	176,074	589,185	181,291
Jun-42	34,664,395	179,494	599,742	184,762
Jun-43	35,033,159	182,943	610,374	188,261
Jun-44	35,401,158	186,419	621,082	191,788
Jun-45	35,768,470	189,925	631,866	195,344
Jun-46	36,135,078	193,459	642,728	198,928
Jun-47	36,500,971	197,021	653,666	202,540
Jun-48	36,866,073	200,611	664,678	206,180
Jun-49	37,230,321	204,229	675,763	209,846
Jun-50	37,593,636	207,873	686,920	213,540
Jun-51	37,955,917	211,543	698,146	217,259
Jun-52	38,317,102	215,240	709,439	221,003
Jun-53	38,677,154	218,961	720,799	224,773
Jun-54	39,036,004	222,707	732,224	228,567
Jun-55	39,393,623	226,478	743,713	232,386
Jun-56	39,749,997	230,273	755,264	236,228
Jun-57	40,105,126	234,092	766,879	240,094
Jun-58	40,459,020	237,935	778,556	243,983
Jun-59	40,811,695	241,802	790,295	247,896
Jun-60	41,163,126	245,692	802,096	251,833
Jun-61	41,513,375	249,606	813,959	255,793
Jun-62	41,860,222	253,530	825,839	259,762
Jun-63	42,203,789	257,465	837,739	263,742
Jun-64	42,544,199	261,410	849,659	267,731

7. Determine the proportion of total kilometres travelled by prime movers and rigid trucks while towing a trailer, including in single trailer, B-double and Road Train configurations.

Table 31: Trailer configuration by kilometres travelled for prime movers and rigid trucks

Trailer Configuration	Prime Movers		Rigid Trucks	
	Kilometres Travelled ('000)	Proportion of Kilometres Travelled	Kilometres Travelled ('000)	Proportion of Kilometres Travelled
No trailer	25,378.7	0.32%	7,567,629.6	80.56%
Single trailer one axle	171,620.2	2.19%	516,020.8	5.49%
Single trailer two axles	429,862.7	5.50%	405,489.8	4.32%
Single trailer three axles	3,191,328.0	40.81%	492,777.9	5.25%
Single trailer four or more axles	151,702.9	1.94%	374,785.6	3.99%
B-double configuration	2,614,637.3	33.44%	0.0	n/a
B-triple configuration	60,347.3	0.77%	0.0	n/a
Road train configuration (with two trailers)	690,047.5	8.82%	36,482.8	0.39%
Road train configuration (with three trailers)	337,756.6	4.32%	0.0	0.00%
Other configuration	146,821.4	1.88%	754.9	0.01%
Total	**7,819,502.7**	**100%**	**9,393,941.4**	**100%**

8. Determine the average number of trailers towed by prime movers and rigid trucks from the proportions of these vehicles towing one, two or three trailers and total kilometres travelled data established in step 7 above.

Table 32: Average number of trailers towed by prime movers and rigid trucks

Type of Truck	Average Number of Trailers
Prime Mover	1.531
Rigid Truck	0.198

9. Estimate the number of heavy trailers in service by multiplying the number of registered prime movers and rigid trucks by the average number of trailers towed by prime movers and rigid trucks respectively.

10. Estimate new prime mover, rigid truck, bus and trailer sales in Australia for 2017.

11. Determine the number of prime movers, rigid trucks, buses and trailers leaving the fleet in 2017 (vehicle attritions).

12. Determine the annual numbers of prime movers, rigid trucks, buses and trailers entering and leaving the fleet (i.e. vehicle sales and attritions) in Australia for each year between 2018 and 2064 inclusive.

Table 33: Estimated heavy truck and bus registrations, sales and attrition — forward projections (2017-2064)

	Rigid Trucks (NB2)			Rigid Trucks (NC)			Prime Movers (NC)			Buses (MD4)			Buses (ME)		
Date	*Registrations*	*Estimated New Vehicle Sales*	*Estimated Attrition*	*Registrations*	*Estimated New Vehicle Sales*	*Estimated Attrition*	*Registrations*	*Estimated New Vehicle Sales*	*Estimated Attrition*	*Registrations*	*Estimated New Vehicle Sales*	*Estimated Attrition*	*Registrations*	*Estimated New Vehicle Sales*	*Estimated Attrition*
Jun-17	174,661	7,349	2,891	178,904	7,471	2,961	101,104	5,634	2,845	104,966	3,136	285	27,291	1,260	519
Jun-18	179,134	7,419	2,918	183,485	7,542	2,989	103,926	5,699	2,878	107,849	3,171	288	28,041	1,274	525
Jun-19	183,645	7,483	2,944	188,106	7,607	3,015	106,777	5,760	2,909	110,762	3,204	291	28,798	1,287	530
Jun-20	188,198	7,553	2,971	192,770	7,678	3,043	109,661	5,825	2,941	113,707	3,239	294	29,564	1,301	536
Jun-21	192,782	7,604	2,991	197,465	7,730	3,064	112,570	5,876	2,967	116,676	3,266	297	30,336	1,312	540
Jun-22	197,410	7,678	3,020	202,206	7,805	3,093	115,512	5,943	3,001	119,678	3,303	300	31,116	1,327	546
Jun-23	202,079	7,745	3,046	206,988	7,873	3,120	118,485	6,006	3,033	122,711	3,336	303	31,905	1,341	552
Jun-24	206,785	7,806	3,071	211,808	7,935	3,145	121,487	6,064	3,062	125,773	3,368	306	32,701	1,353	557
Jun-25	211,524	7,862	3,092	216,663	7,992	3,168	124,516	6,119	3,090	128,861	3,397	309	33,504	1,365	562
Jun-26	216,294	7,912	3,112	221,548	8,043	3,188	127,570	6,169	3,115	131,973	3,424	311	34,313	1,376	566
Jun-27	221,092	7,959	3,131	226,462	8,091	3,207	130,648	6,217	3,139	135,109	3,449	314	35,128	1,386	571
Jun-28	225,921	8,011	3,151	231,409	8,143	3,228	133,751	6,268	3,165	138,269	3,476	316	35,950	1,397	575
Jun-29	230,779	8,059	3,170	236,385	8,192	3,247	136,877	6,316	3,189	141,453	3,502	318	36,778	1,407	579
Jun-30	235,665	8,104	3,188	241,389	8,238	3,265	140,027	6,362	3,213	144,659	3,527	321	37,611	1,417	583
Jun-31	240,577	8,148	3,205	246,420	8,283	3,283	143,199	6,407	3,235	147,886	3,551	323	38,450	1,427	587
Jun-32	245,511	8,185	3,220	251,475	8,321	3,298	146,391	6,447	3,256	151,133	3,572	325	39,295	1,435	591
Jun-33	250,468	8,222	3,234	256,552	8,358	3,313	149,602	6,487	3,276	154,399	3,593	327	40,144	1,444	594
Jun-34	255,447	8,260	3,249	261,652	8,397	3,328	152,833	6,527	3,296	157,685	3,614	329	40,998	1,452	598
Jun-35	260,450	8,299	3,264	266,777	8,436	3,344	156,085	6,568	3,317	160,990	3,636	331	41,857	1,461	602
Jun-36	265,478	8,341	3,281	271,927	8,479	3,361	159,358	6,611	3,338	164,316	3,658	333	42,722	1,470	605
Jun-37	270,533	8,386	3,298	277,105	8,524	3,379	162,652	6,656	3,361	167,663	3,682	335	43,592	1,480	609
Jun-38	275,617	8,433	3,317	282,312	8,572	3,398	165,970	6,702	3,384	171,033	3,707	337	44,469	1,490	613
Jun-39	280,731	8,484	3,337	287,550	8,624	3,418	169,313	6,751	3,409	174,427	3,733	339	45,351	1,500	618
Jun-40	285,877	8,537	3,358	292,822	8,678	3,440	172,680	6,802	3,435	177,846	3,761	342	46,240	1,511	622

	Rigid Trucks (NB2)			Rigid Trucks (NC)			Prime Movers (NC)			Buses (MD4)			Buses (ME)		
Date	*Registrations*	*Estimated New Vehicle Sales*	*Estimated Attrition*	*Registrations*	*Estimated New Vehicle Sales*	*Estimated Attrition*	*Registrations*	*Estimated New Vehicle Sales*	*Estimated Attrition*	*Registrations*	*Estimated New Vehicle Sales*	*Estimated Attrition*	*Registrations*	*Estimated New Vehicle Sales*	*Estimated Attrition*
Jun-41	291,057	8,593	3,380	298,128	8,735	3,462	176,074	6,855	3,461	181,291	3,789	344	47,136	1,523	627
Jun-42	296,273	8,652	3,403	303,470	8,795	3,486	179,494	6,910	3,489	184,762	3,819	347	48,038	1,534	632
Jun-43	301,525	8,712	3,427	308,849	8,856	3,510	182,943	6,966	3,517	188,261	3,849	350	48,948	1,547	637
Jun-44	306,814	8,775	3,451	314,267	8,920	3,535	186,419	7,023	3,546	191,788	3,880	353	49,865	1,559	642
Jun-45	312,142	8,838	3,476	319,724	8,984	3,561	189,925	7,081	3,576	195,344	3,911	356	50,789	1,572	647
Jun-46	317,508	8,901	3,501	325,220	9,048	3,586	193,459	7,139	3,605	198,928	3,942	358	51,721	1,584	652
Jun-47	322,911	8,963	3,526	330,755	9,111	3,611	197,021	7,196	3,634	202,540	3,973	361	52,660	1,597	657
Jun-48	328,351	9,024	3,550	336,327	9,173	3,636	200,611	7,252	3,662	206,180	4,004	364	53,607	1,609	662
Jun-49	333,827	9,084	3,573	341,936	9,234	3,660	204,229	7,307	3,690	209,846	4,033	367	54,560	1,621	667
Jun-50	339,338	9,143	3,596	347,581	9,294	3,684	207,873	7,362	3,717	213,540	4,063	369	55,520	1,632	672
Jun-51	344,884	9,199	3,618	353,262	9,351	3,706	211,543	7,414	3,744	217,259	4,091	372	56,487	1,644	677
Jun-52	350,463	9,255	3,640	358,976	9,408	3,729	215,240	7,466	3,770	221,003	4,119	374	57,461	1,655	682
Jun-53	356,075	9,309	3,662	364,724	9,463	3,751	218,961	7,517	3,796	224,773	4,147	377	58,441	1,666	686
Jun-54	361,719	9,362	3,683	370,505	9,517	3,772	222,707	7,567	3,821	228,567	4,174	379	59,427	1,677	691
Jun-55	367,394	9,415	3,703	376,319	9,570	3,793	226,478	7,617	3,846	232,386	4,200	382	60,420	1,688	695
Jun-56	373,101	9,466	3,724	382,164	9,623	3,814	230,273	7,666	3,871	236,228	4,226	384	61,419	1,698	699
Jun-57	378,838	9,518	3,744	388,041	9,675	3,835	234,092	7,714	3,895	240,094	4,253	387	62,424	1,709	704
Jun-58	384,607	9,569	3,764	393,949	9,727	3,855	237,935	7,763	3,920	243,983	4,279	389	63,436	1,719	708
Jun-59	390,406	9,620	3,784	399,889	9,779	3,876	241,802	7,811	3,944	247,896	4,304	391	64,453	1,730	712
Jun-60	396,235	9,670	3,804	405,860	9,830	3,896	245,692	7,858	3,968	251,833	4,330	394	65,477	1,740	716
Jun-61	402,096	9,721	3,824	411,863	9,882	3,917	249,606	7,906	3,992	255,793	4,356	396	66,506	1,750	721
Jun-62	407,965	9,736	3,830	417,875	9,897	3,923	253,530	7,927	4,003	259,762	4,366	397	67,538	1,755	722
Jun-63	413,843	9,752	3,836	423,896	9,913	3,929	257,465	7,948	4,013	263,742	4,377	398	68,573	1,759	724
Jun-64	419,731	9,768	3,842	429,927	9,930	3,936	261,410	7,970	4,024	267,731	4,388	399	69,610	1,763	726

Authorised Version Explanatory Statement registered 29/05/2018 to F2018L00664

Table 34: Estimated heavy trailer registrations, sales and attrition — forward projections (2017-2064)

Date	Trailers (TC > 4.5 tonnes GTM)			Trailers (TD)		
	Registrations	*Estimated New Trailer Sales*	*Estimated Attrition*	*Registrations*	*Estimated New Trailer Sales*	*Estimated Attrition*
Jun-17	34624	1300	422	190273	6991	1821
Jun-18	35510	1312	426	195501	7067	1839
Jun-19	36404	1324	429	200783	7139	1857
Jun-20	37307	1336	433	206123	7215	1875
Jun-21	38216	1345	436	211508	7274	1889
Jun-22	39133	1358	440	216952	7354	1909
Jun-23	40059	1370	444	222453	7428	1927
Jun-24	40992	1381	448	228005	7496	1944
Jun-25	41931	1390	451	233606	7559	1959
Jun-26	42877	1399	454	239250	7617	1973
Jun-27	43828	1408	457	244937	7672	1986
Jun-28	44785	1417	460	250668	7732	2000
Jun-29	45748	1425	462	256442	7787	2013
Jun-30	46717	1433	465	262257	7841	2026
Jun-31	47690	1441	467	268111	7892	2038
Jun-32	48668	1448	470	274000	7938	2049
Jun-33	49651	1454	472	279924	7983	2060
Jun-34	50638	1461	474	285882	8029	2070
Jun-35	51630	1468	476	291877	8076	2081
Jun-36	52627	1475	478	297909	8125	2093
Jun-37	53629	1483	481	303980	8177	2105
Jun-38	54636	1491	484	310093	8231	2118
Jun-39	55650	1500	487	316249	8288	2132
Jun-40	56670	1510	490	322450	8348	2147
Jun-41	57697	1520	493	328698	8410	2162
Jun-42	58731	1530	496	334994	8474	2177
Jun-43	59772	1541	500	341341	8540	2194
Jun-44	60821	1552	503	347738	8608	2210
Jun-45	61877	1563	507	354187	8676	2227
Jun-46	62940	1574	511	360688	8744	2244
Jun-47	64012	1585	514	367239	8812	2260
Jun-48	65090	1596	518	373841	8878	2277
Jun-49	66176	1607	521	380492	8944	2293
Jun-50	67268	1617	524	387191	9008	2308
Jun-51	68367	1627	528	393937	9070	2324
Jun-52	69473	1637	531	400730	9131	2338
Jun-53	70586	1646	534	407567	9191	2353
Jun-54	71705	1656	537	414450	9250	2367
Jun-55	72830	1665	540	421376	9308	2382
Jun-56	73961	1674	543	428345	9365	2396
Jun-57	75098	1683	546	435357	9422	2409
Jun-58	76242	1692	549	442413	9479	2423
Jun-59	77391	1701	552	449511	9535	2437
Jun-60	78547	1710	555	456652	9591	2451
Jun-61	79709	1719	558	463835	9647	2464
Jun-62	80872	1722	558	471035	9669	2469
Jun-63	82037	1725	559	478253	9692	2474
Jun-64	83205	1728	560	485490	9716	2479

13. Establish the number of prime mover, rigid truck and bus occupants killed and injured (including both serious and minor injuries) in single vehicle crashes (where loss of control was a factor) for each year between 2008 and 2014 inclusive.

Table 35: Occupant fatalities and injuries in crashes of a single heavy vehicle (2008-2014)

Year	Prime Movers (NC)			Rigid Trucks (NB2 & NC)			Buses (MD4 & ME)		
	Fatalities	Serious Injuries	Minor Injuries	Fatalities	Serious Injuries	Minor Injuries	Fatalities	Serious Injuries	Minor Injuries
2008	11	148	103	3	103	77	1	59	24
2009	16	144	111	4	81	80	4	27	23
2010	13	180	158	5	106	88	2	36	29
2011	19	239	173	5	115	115	1	28	72
2012	21	203	127	4	123	93	1	23	52
2013	9	199	116	2	123	105	0	13	23
2014	15	57	183	7	56	135	0	12	64
Total 2008-2014	104	1170	971	30	707	693	9	198	287
Annual Average 2008-2014	15	186	139	4	109	99	1	31	41

14. Estimate the average annual number of fatalities and injuries (including both serious and minor injuries) in crashes involving the rollover and/or loss of control of a prime mover, rigid truck and/or bus for the period 2008 to 2014 inclusive.

Table 36: Estimated fatalities and injuries in crashes involving the rollover and/or loss of control of a heavy vehicle (2008-2014)

	Prime Movers (NC)			Rigid Trucks (NB2 & NC)			Buses (MD4 & ME)		
	Fatalities	Serious Injuries	Minor Injuries	Fatalities	Serious Injuries	Minor Injuries	Fatalities	Serious Injuries	Minor Injuries
Total 2008-2014	235	1824	1297	68	1102	926	20	309	383
Annual Average 2008-2014	34	289	185	10	169	132	3	48	55

15. Estimate the average annual number of fatalities and injuries per registered prime mover, rigid truck and bus in crashes involving the rollover and/or loss of control of these vehicles over the period 2008-2014.

Table 37: Estimated annual fatalities and injuries per registration in crashes involving the rollover and/or loss of control of a heavy vehicle (2008-2014)

	Prime Movers (NC)			Rigid Trucks (NB2 & NC)			Buses (MD4 & ME)		
	Fatalities	Serious Injuries	Minor Injuries	Fatalities	Serious Injuries	Minor Injuries	Fatalities	Serious Injuries	Minor Injuries
Annual Average 2008-2014	0.00039	0.00340	0.00215	0.00003	0.00053	0.00041	0.00013	0.00218	0.00237

16. Estimate the average annual number of injuries (of any severity) per registered prime mover, rigid truck and bus in all heavy vehicle injury crashes over the period 2008-2014.

Table 38: Estimated annual injuries per registration in heavy vehicle crashes (2008-2014)

	Prime Movers (NC)	Rigid Trucks (NB2 & NC)	Buses (MD4 & ME)
Annual Average 2008-2014	0.02116	0.00756	0.04386

17. Establish the distribution of injury crashes by vehicle age for prime movers, rigid trucks and buses from BITRE data.

Table 39: Distribution of injury crashes by vehicle age in Australia for prime movers, rigid trucks and buses

Age of Vehicle	Prime Movers (NC)			Rigid Trucks (NB2 & NC)			Buses (MD4 & ME)		
	Crash Frequency	Percentage	Cumulative Percentage	Crash Frequency	Percentage	Cumulative Percentage	Crash Frequency	Percentage	Cumulative Percentage
0	144	2.71	2.71	152	1.76	1.76	81	2.33	2.33
1	428	8.05	10.76	509	5.89	7.65	247	7.12	9.45
2	476	8.96	19.72	643	7.44	15.09	250	7.20	16.65
3	530	9.97	29.69	606	7.01	22.11	253	7.29	23.94
4	465	8.75	38.44	644	7.45	29.56	231	6.66	30.60
5	450	8.47	46.90	643	7.44	37.00	211	6.08	36.68
6	398	7.49	54.39	626	7.25	44.25	178	5.13	41.80
7	338	6.36	60.75	548	6.34	50.59	177	5.10	46.90
8	301	5.66	66.42	461	5.34	55.93	164	4.72	51.63
9	200	3.76	70.18	439	5.08	61.01	171	4.93	56.55
10	213	4.01	74.19	409	4.73	65.74	149	4.29	60.85
11	179	3.37	77.55	321	3.72	69.46	127	3.66	64.51
12	150	2.82	80.38	257	2.97	72.43	133	3.83	68.34
13	167	3.14	83.52	252	2.92	75.35	116	3.34	71.68
14	148	2.78	86.30	228	2.64	77.99	129	3.72	75.40
15	135	2.54	88.84	214	2.48	80.46	82	2.36	77.76
16	84	1.58	90.42	174	2.01	82.48	75	2.16	79.92
17	69	1.30	91.72	175	2.03	84.50	83	2.39	82.31
18	62	1.17	92.89	137	1.59	86.09	74	2.13	84.44
19	54	1.02	93.90	165	1.91	88.00	73	2.10	86.55
20	45	0.85	94.75	150	1.74	89.73	74	2.13	88.68
21	38	0.71	95.47	115	1.33	91.06	58	1.67	90.35
22	37	0.70	96.16	111	1.28	92.35	49	1.41	91.76
23	38	0.71	96.88	101	1.17	93.52	55	1.58	93.34
24	23	0.43	97.31	110	1.27	94.79	51	1.47	94.81
25	24	0.45	97.76	84	0.97	95.76	45	1.30	96.11
26	23	0.43	98.19	65	0.75	96.52	22	0.63	96.74
27	25	0.47	98.66	52	0.60	97.12	21	0.61	97.35
28	15	0.28	98.95	52	0.60	97.72	16	0.46	97.81
29	12	0.23	99.17	39	0.45	98.17	10	0.29	98.10
30	8	0.15	99.32	33	0.38	98.55	14	0.40	98.50
31	5	0.09	99.42	19	0.22	98.77	7	0.20	98.70
32	7	0.13	99.55	22	0.25	99.03	3	0.09	98.79
33	7	0.13	99.68	24	0.28	99.31	5	0.14	98.93
34	3	0.06	99.74	10	0.12	99.42	9	0.26	99.19
35	5	0.09	99.83	16	0.19	99.61	6	0.17	99.37
Total	**5,315**			**8,640**			**3,471**		

18. Establish the probability of injury by vehicle age in all crashes in Australia, for prime movers, rigid trucks and buses.

Table 40: Probability of injury by vehicle age in Australia for prime movers, rigid trucks and buses

Age of Vehicle	Prime Movers (NC)	Rigid Trucks (NB2 & NC)	Buses (MD4 & ME)
0	0.00057	0.00013	0.00102
1	0.00170	0.00045	0.00312
2	0.00189	0.00056	0.00316
3	0.00211	0.00053	0.00320
4	0.00185	0.00056	0.00292
5	0.00179	0.00056	0.00267
6	0.00158	0.00055	0.00225
7	0.00135	0.00048	0.00224
8	0.00120	0.00040	0.00207
9	0.00080	0.00038	0.00216
10	0.00085	0.00036	0.00188
11	0.00071	0.00028	0.00160
12	0.00060	0.00022	0.00168
13	0.00066	0.00022	0.00147
14	0.00059	0.00020	0.00163
15	0.00054	0.00019	0.00104
16	0.00033	0.00015	0.00095
17	0.00027	0.00015	0.00105
18	0.00025	0.00012	0.00094
19	0.00021	0.00014	0.00092
20	0.00018	0.00013	0.00094
21	0.00015	0.00010	0.00073
22	0.00015	0.00010	0.00062
23	0.00015	0.00009	0.00070
24	0.00009	0.00010	0.00064
25	0.00010	0.00007	0.00057
26	0.00009	0.00006	0.00028
27	0.00010	0.00005	0.00027
28	0.00006	0.00005	0.00020
29	0.00005	0.00003	0.00013
30	0.00003	0.00003	0.00018
31	0.00002	0.00002	0.00009
32	0.00003	0.00002	0.00004
33	0.00003	0.00002	0.00006
34	0.00001	0.00001	0.00011
35	0.00002	0.00001	0.00008

19. Establish the probability of fatalities and injuries by vehicle age in rollover and loss of control crashes, for prime movers, rigid trucks and buses.

Table 41: Probability of fatality and injury by vehicle age in rollover and loss of control crashes in Australia for prime movers, rigid trucks and buses

Age of Vehicle	Prime Movers (NC)			Rigid Trucks (NB2 & NC)			Buses (MD4 & ME)		
	Fatality	Serious Injury	Minor Injury	Fatality	Serious Injury	Minor Injury	Fatality	Serious Injury	Minor Injury
0	0.000011	0.000092	0.000058	0.000001	0.000009	0.000007	0.000003	0.000051	0.000055
1	0.000032	0.000274	0.000173	0.000002	0.000031	0.000024	0.000009	0.000155	0.000168
2	0.000035	0.000305	0.000193	0.000002	0.000040	0.000031	0.000009	0.000157	0.000170
3	0.000039	0.000340	0.000214	0.000002	0.000037	0.000029	0.000010	0.000159	0.000172
4	0.000034	0.000298	0.000188	0.000002	0.000040	0.000031	0.000009	0.000145	0.000157
5	0.000033	0.000288	0.000182	0.000002	0.000040	0.000031	0.000008	0.000133	0.000144
6	0.000029	0.000255	0.000161	0.000002	0.000039	0.000030	0.000007	0.000112	0.000121
7	0.000025	0.000217	0.000137	0.000002	0.000034	0.000026	0.000007	0.000111	0.000121
8	0.000022	0.000193	0.000122	0.000002	0.000028	0.000022	0.000006	0.000103	0.000112
9	0.000015	0.000128	0.000081	0.000002	0.000027	0.000021	0.000006	0.000107	0.000117
10	0.000016	0.000136	0.000086	0.000001	0.000025	0.000020	0.000006	0.000094	0.000102
11	0.000013	0.000115	0.000072	0.000001	0.000020	0.000015	0.000005	0.000080	0.000087
12	0.000011	0.000096	0.000061	0.000001	0.000016	0.000012	0.000005	0.000084	0.000091
13	0.000012	0.000107	0.000068	0.000001	0.000016	0.000012	0.000004	0.000073	0.000079
14	0.000011	0.000095	0.000060	0.000001	0.000014	0.000011	0.000005	0.000081	0.000088
15	0.000010	0.000086	0.000055	0.000001	0.000013	0.000010	0.000003	0.000052	0.000056
16	0.000006	0.000054	0.000034	0.000001	0.000011	0.000008	0.000003	0.000047	0.000051
17	0.000005	0.000044	0.000028	0.000001	0.000011	0.000008	0.000003	0.000052	0.000057
18	0.000005	0.000040	0.000025	0.000000	0.000008	0.000007	0.000003	0.000046	0.000050
19	0.000004	0.000035	0.000022	0.000001	0.000010	0.000008	0.000003	0.000046	0.000050
20	0.000003	0.000029	0.000018	0.000001	0.000009	0.000007	0.000003	0.000046	0.000050
21	0.000003	0.000024	0.000015	0.000000	0.000007	0.000006	0.000002	0.000036	0.000040
22	0.000003	0.000024	0.000015	0.000000	0.000007	0.000005	0.000002	0.000031	0.000033
23	0.000003	0.000024	0.000015	0.000000	0.000006	0.000005	0.000002	0.000035	0.000037
24	0.000002	0.000015	0.000009	0.000000	0.000007	0.000005	0.000002	0.000032	0.000035
25	0.000002	0.000015	0.000010	0.000000	0.000005	0.000004	0.000002	0.000028	0.000031
26	0.000002	0.000015	0.000009	0.000000	0.000004	0.000003	0.000001	0.000014	0.000015
27	0.000002	0.000016	0.000010	0.000000	0.000003	0.000002	0.000001	0.000013	0.000014
28	0.000001	0.000010	0.000006	0.000000	0.000003	0.000002	0.000001	0.000010	0.000011
29	0.000001	0.000008	0.000005	0.000000	0.000002	0.000002	0.000000	0.000006	0.000007
30	0.000001	0.000005	0.000003	0.000000	0.000002	0.000002	0.000001	0.000009	0.000010
31	0.000000	0.000003	0.000002	0.000000	0.000001	0.000001	0.000000	0.000004	0.000005
32	0.000001	0.000004	0.000003	0.000000	0.000001	0.000001	0.000000	0.000002	0.000002
33	0.000001	0.000004	0.000003	0.000000	0.000001	0.000001	0.000000	0.000003	0.000003
34	0.000000	0.000002	0.000001	0.000000	0.000001	0.000000	0.000000	0.000006	0.000006
35	0.000000	0.000003	0.000002	0.000000	0.000001	0.000001	0.000000	0.000004	0.000004

20. Determine the voluntary fitment rates of ESC to new heavy trucks/buses, and ABS and RSC to new heavy trailers under BAU for the period 2019-2035 inclusive.

21. Estimate fitment rates of ESC to new heavy trucks/buses, and ABS and RSC to new heavy trailers and all registered heavy trailers for each of the options (2a, 2b, 6a, 6b and 6c) for the period 2019-2035 inclusive.

Table 42: ESC fitment rates (per cent) for new heavy trucks under each option (2019-2035)

Year	New Vehicles											
	Prime Movers (NC)				Rigid Trucks (NC)				Rigid Trucks (NB2)			
	BAU	Opt.6a/6b/6c	Opt.2a	Opt.2b	BAU	Opt.6a/6b	Opt.2a	Opt.2b	BAU	Opt.6a	Opt.2a	Opt.2b
2019	32.5	32.5	32.5	32.5	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0
2020	35.0	49.1	77.0	35.0	32.5	47.3	77.0	32.5	32.5	47.3	77.0	32.5
2021	37.5	65.8	77.0	37.5	35.0	64.5	77.0	35.0	35.0	64.5	77.0	35.0
2022	40.0	82.4	40.0	40.0	37.5	81.8	37.5	37.5	37.5	81.8	37.5	37.5
2023	42.5	99.0	77.0	42.5	40.0	99.0	77.0	40.0	40.0	99.0	77.0	40.0
2024	45.0	99.0	45.0	45.0	42.5	99.0	42.5	42.5	42.5	99.0	42.5	42.5
2025	47.5	99.0	77.0	47.5	45.0	99.0	77.0	45.0	45.0	99.0	77.0	45.0
2026	50.0	99.0	50.0	54.0	47.5	99.0	47.5	47.5	47.5	99.0	47.5	47.5
2027	52.5	99.0	77.0	56.7	50.0	99.0	77.0	54.0	50.0	99.0	77.0	54.0
2028	55.0	99.0	55.0	59.4	52.5	99.0	52.5	56.7	52.5	99.0	52.5	56.7
2029	57.5	99.0	77.0	62.1	55.0	99.0	77.0	59.4	55.0	99.0	77.0	59.4
2030	60.0	99.0	60.0	64.8	57.5	99.0	57.5	62.1	57.5	99.0	57.5	62.1
2031	62.5	99.0	77.0	67.5	60.0	99.0	77.0	64.8	60.0	99.0	77.0	64.8
2032	65.0	99.0	65.0	70.2	62.5	99.0	62.5	67.5	62.5	99.0	62.5	67.5
2033	67.5	99.0	77.0	72.9	65.0	99.0	77.0	70.2	65.0	99.0	77.0	70.2
2034	70.0	99.0	70.0	75.6	67.5	99.0	67.5	72.9	67.5	99.0	67.5	72.9
2035	72.5	99.0	77.0	72.5	70.0	99.0	70.0	70.0	70.0	99.0	70.0	70.0

Table 43: ESC fitment rates (per cent) for new heavy buses under each option (excluding articulated and route service buses) (2019-2035)

Year	New Vehicles			
	Buses (ME)		Buses (MD4)	
	BAU	Opt.6a/6b/6c	BAU	Opt.6a
2019	85.0	85.0	85.0	85.0
2020	87.5	88.5	87.5	88.5
2021	90.0	92.0	90.0	92.0
2022	92.5	95.5	92.5	95.5
2023	95.0	99.0	95.0	99.0
2024	95.0	99.0	95.0	99.0
2025	95.0	99.0	95.0	99.0
2026	95.0	99.0	95.0	99.0
2027	95.0	99.0	95.0	99.0
2028	95.0	99.0	95.0	99.0
2029	95.0	99.0	95.0	99.0
2030	95.0	99.0	95.0	99.0
2031	95.0	99.0	95.0	99.0
2032	95.0	99.0	95.0	99.0
2033	95.0	99.0	95.0	99.0
2034	95.0	99.0	95.0	99.0
2035	95.0	99.0	95.0	99.0

Table 44: RSC fitment rates (per cent) for new heavy trailers and all registered heavy trailers under each option (2019-2035)

Year	New Heavy Trailers				All Registered Heavy Trailers			
	Trailers (TC > 4.5 tonnes GTM)		Trailers (TD)		Trailers (TC > 4.5 tonnes GTM)		Trailers (TD)	
	BAU	Opt.6	BAU	Opt.6	BAU	Opt.6	BAU	Opt.6
2019	40.0	40.0	40.0	40.0	17.9	17.9	17.8	17.8
2020	40.0	40.0	40.0	92.5	18.8	18.8	18.6	20.5
2021	40.0	40.0	40.0	92.5	19.6	19.6	19.4	23.0
2022	40.0	40.0	40.0	92.5	20.4	20.4	20.2	25.5
2023	40.0	40.0	40.0	92.5	21.2	21.2	21.0	27.9
2024	40.0	40.0	40.0	92.5	22.0	22.0	21.7	30.2
2025	40.0	40.0	40.0	92.5	22.7	22.7	22.4	32.3
2026	40.0	40.0	40.0	92.5	23.4	23.4	23.0	34.4
2027	40.0	40.0	40.0	92.5	24.1	24.1	23.7	36.5
2028	40.0	40.0	40.0	92.5	24.7	24.7	24.2	38.3
2029	40.0	40.0	40.0	92.5	25.2	25.2	24.8	40.2
2030	40.0	40.0	40.0	92.5	25.7	25.7	25.3	41.9
2031	40.0	40.0	40.0	92.5	26.2	26.2	25.7	43.5
2032	40.0	40.0	40.0	92.5	26.7	26.7	26.2	45.1
2033	40.0	40.0	40.0	92.5	27.2	27.2	26.6	46.5
2034	40.0	40.0	40.0	92.5	27.6	27.6	27.0	47.9
2035	40.0	40.0	40.0	92.5	28.0	28.0	27.4	49.3

Table 45: ABS fitment rates (per cent) (including where part of RSC) for new heavy trailers and all registered heavy trailers under each option (2019-2035)

Year	New Heavy Trailers				All Registered Heavy Trailers			
	Trailers (TC > 4.5 tonnes GTM)		Trailers (TD)		Trailers (TC > 4.5 tonnes GTM)		Trailers (TD)	
	BAU	Opt.6	BAU	Opt.6	BAU	Opt.6	BAU	Opt.6
2019	52.5	52.5	52.5	52.5	46.0	46.0	45.9	45.9
2020	52.5	100.0	52.5	95.0	46.3	48.0	46.2	47.7
2021	52.5	100.0	52.5	95.0	46.6	49.9	46.5	49.4
2022	52.5	100.0	52.5	95.0	46.9	51.8	46.7	51.0
2023	52.5	100.0	52.5	95.0	47.1	53.5	47.0	52.6
2024	52.5	100.0	52.5	95.0	47.4	55.3	47.2	54.1
2025	52.5	100.0	52.5	95.0	47.6	56.9	47.5	55.5
2026	52.5	100.0	52.5	95.0	47.9	58.5	47.7	56.9
2027	52.5	100.0	52.5	95.0	48.1	60.0	47.9	58.2
2028	52.5	100.0	52.5	95.0	48.3	61.4	48.1	59.5
2029	52.5	100.0	52.5	95.0	48.4	62.8	48.2	60.7
2030	52.5	100.0	52.5	95.0	48.6	64.1	48.4	61.8
2031	52.5	100.0	52.5	95.0	48.7	65.3	48.5	62.9
2032	52.5	100.0	52.5	95.0	48.9	66.5	48.6	63.9
2033	52.5	100.0	52.5	95.0	49.0	67.6	48.7	64.9
2034	52.5	100.0	52.5	95.0	49.1	68.7	48.8	65.8
2035	52.5	100.0	52.5	95.0	49.2	69.7	49.0	66.7

22. For each option (2a, 2b, 6a, 6b and 6c), determine the reductions in the number of fatalities and injured persons for each year from 2020 to 2064.

Table 46: Fatalities prevented due to a focused advertising campaign – Option 2a

Year	Vehicle Age																																		Lives Saved
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	
0	0.15																																				0.15
1	0.15	0.47																																			0.62
2	0.00	0.46	0.55																																		1.01
3	0.14	0.00	0.53	0.61																																	1.28
4	0.00	0.42	0.00	0.59	0.57																																1.58
5	0.12	0.00	0.49	0.00	0.55	0.57																															1.72
6	0.00	0.38	0.00	0.54	0.00	0.54	0.52																														1.98
7	0.11	0.00	0.44	0.00	0.50	0.00	0.50	0.46																													2.00
8	0.00	0.33	0.00	0.49	0.00	0.50	0.00	0.44	0.41																												2.16
9	0.09	0.00	0.38	0.00	0.45	0.00	0.46	0.00	0.40	0.30																											2.08
10	0.00	0.27	0.00	0.42	0.00	0.45	0.00	0.40	0.00	0.29	0.32																										2.15
11	0.07	0.00	0.32	0.00	0.39	0.00	0.41	0.00	0.36	0.00	0.31	0.27																									2.13
12	0.00	0.21	0.00	0.35	0.00	0.39	0.00	0.36	0.00	0.26	0.00	0.26	0.23																								2.07
13	0.05	0.00	0.25	0.00	0.33	0.00	0.36	0.00	0.32	0.00	0.28	0.00	0.22	0.25																							2.06
14	0.00	0.15	0.00	0.28	0.00	0.32	0.00	0.31	0.00	0.24	0.00	0.24	0.00	0.24	0.23																						2.01
15		0.00	0.17	0.00	0.26	0.00	0.30	0.00	0.28	0.00	0.25	0.00	0.20	0.00	0.22	0.22																					1.89
16			0.00	0.19	0.00	0.25	0.00	0.26	0.00	0.21	0.00	0.21	0.00	0.22	0.00	0.21	0.14																				1.70
17				0.00	0.18	0.00	0.23	0.00	0.23	0.00	0.22	0.00	0.18	0.00	0.20	0.00	0.14	0.13																			1.51
18					0.00	0.18	0.00	0.20	0.00	0.17	0.00	0.18	0.00	0.20	0.00	0.19	0.00	0.12	0.11																			1.36
19						0.00	0.16	0.00	0.18	0.00	0.18	0.00	0.15	0.00	0.18	0.00	0.13	0.00	0.11	0.11																		1.20
20							0.00	0.14	0.00	0.13	0.00	0.15	0.00	0.17	0.00	0.17	0.00	0.11	0.00	0.11	0.10																	1.08
21								0.00	0.13	0.00	0.14	0.00	0.13	0.00	0.16	0.00	0.11	0.00	0.10	0.00	0.09	0.08															0.93
22									0.00	0.09	0.00	0.12	0.00	0.14	0.00	0.15	0.00	0.10	0.00	0.10	0.00	0.08	0.08														0.85
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮		⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
43																													0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.02
44																														0.00	0.00	0.00	0.01	0.00	0.01	0.02

Table 47: Serious injuries prevented due to a focused advertising campaign – Option 2a

Year	Vehicle Age																																			SI Prevented
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	
0	1.51																																				1.51
1	1.45	4.73																																			6.18
2	0.00	4.57	5.58																																		10.15
3	1.34	0.00	5.39	6.10																																	12.82
4	0.00	4.20	0.00	5.88	5.77																																15.85
5	1.20	0.00	4.95	0.00	5.57	5.77																															17.50
6	0.00	3.78	0.00	5.40	0.00	5.57	5.38																														20.13
7	1.05	0.00	4.45	0.00	5.11	0.00	5.19	4.73																													20.53
8	0.00	3.30	0.00	4.85	0.00	5.10	0.00	4.55	4.23																												22.04
9	0.88	0.00	3.89	0.00	4.59	0.00	4.76	0.00	4.07	3.26																											21.44
10	0.00	2.76	0.00	4.23	0.00	4.58	0.00	4.17	0.00	3.14	3.37																										22.25
11	0.69	0.00	3.26	0.00	4.00	0.00	4.26	0.00	3.73	0.00	3.25	2.83																									22.02
12	0.00	2.17	0.00	3.54	0.00	3.99	0.00	3.74	0.00	2.87	0.00	2.72	2.39																								21.41
13	0.48	0.00	2.56	0.00	3.35	0.00	3.71	0.00	3.34	0.00	2.97	0.00	2.29	2.61																							21.30
14	0.00	1.51	0.00	2.77	0.00	3.34	0.00	3.25	0.00	2.57	0.00	2.49	0.00	2.50	2.37																						20.81
15		0.00	1.79	0.00	2.62	0.00	3.10	0.00	2.90	0.00	2.66	0.00	2.09	0.00	2.28	2.23																					19.68
16			0.00	1.93	0.00	2.62	0.00	2.72	0.00	2.24	0.00	2.22	0.00	2.28	0.00	2.14	1.55																				17.70
17				0.00	1.83	0.00	2.43	0.00	2.42	0.00	2.31	0.00	1.87	0.00	2.08	0.00	1.49	1.41																				15.85
18					0.00	1.83	0.00	2.13	0.00	1.87	0.00	1.93	0.00	2.04	0.00	1.95	0.00	1.35	1.22																			14.32
19						0.00	1.70	0.00	1.90	0.00	1.93	0.00	1.62	0.00	1.86	0.00	1.36	0.00	1.17	1.24																		12.78
20							0.00	1.49	0.00	1.47	0.00	1.61	0.00	1.77	0.00	1.74	0.00	1.23	0.00	1.19	1.10																	11.60
21								0.00	1.32	0.00	1.51	0.00	1.35	0.00	1.61	0.00	1.21	0.00	1.07	0.00	1.06	0.91																10.04
22									0.00	1.03	0.00	1.26	0.00	1.47	0.00	1.51	0.00	1.10	0.00	1.09	0.00	0.87	0.89															9.22
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮		⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
43																													0.00	0.08	0.00	0.09	0.00	0.05	0.00	0.22
44																														0.00	0.05	0.00	0.09	0.00	0.09		0.23

Table 48: Fatalities prevented due to a broad advertising campaign – Option 2b

Year	Vehicle Age																																	Lives Saved
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	
0	0.00																																				0.00
1	0.00	0.00																																			0.00
2	0.00	0.00	0.00																																		0.00
3	0.00	0.00	0.00	0.00																																	0.00
4	0.00	0.00	0.00	0.00	0.00																																0.00
5	0.00	0.00	0.00	0.00	0.00	0.00																															0.00
6	0.01	0.00	0.00	0.00	0.00	0.00	0.00																														0.01
7	0.02	0.04	0.00	0.00	0.00	0.00	0.00	0.00																													0.06
8	0.02	0.06	0.05	0.00	0.00	0.00	0.00	0.00	0.00																												0.13
9	0.02	0.06	0.06	0.06	0.00	0.00	0.00	0.00	0.00	0.00																											0.20
10	0.02	0.06	0.07	0.07	0.05	0.00	0.00	0.00	0.00	0.00	0.00																										0.28
11	0.02	0.07	0.07	0.08	0.07	0.05	0.00	0.00	0.00	0.00	0.00	0.00																									0.36
12	0.02	0.07	0.08	0.08	0.07	0.07	0.05	0.00	0.00	0.00	0.00	0.00	0.00																								0.44
13	0.03	0.08	0.08	0.09	0.08	0.07	0.06	0.04	0.00	0.00	0.00	0.00	0.00	0.00																							0.52
14	0.03	0.08	0.09	0.09	0.08	0.07	0.06	0.05	0.04	0.00	0.00	0.00	0.00	0.00	0.00																						0.60
15		0.09	0.09	0.10	0.09	0.08	0.07	0.06	0.05	0.02	0.00	0.00	0.00	0.00	0.00	0.00																					0.64
16			0.10	0.10	0.09	0.08	0.07	0.06	0.05	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.00																					0.62
17				0.11	0.10	0.09	0.08	0.06	0.05	0.04	0.04	0.02	0.00	0.00	0.00	0.00	0.00	0.00																				0.59
18					0.10	0.10	0.08	0.07	0.06	0.04	0.04	0.03	0.02	0.00	0.00	0.00	0.00	0.00	0.00																				0.53
19						0.10	0.09	0.07	0.06	0.04	0.04	0.03	0.03	0.02	0.00	0.00	0.00	0.00	0.00	0.00																			0.48
20							0.09	0.08	0.06	0.04	0.04	0.03	0.03	0.03	0.02	0.00	0.00	0.00	0.00	0.00	0.00																			0.43
21								0.08	0.07	0.05	0.05	0.04	0.03	0.03	0.03	0.02	0.00	0.00	0.00	0.00	0.00	0.00																	0.38
22									0.07	0.05	0.05	0.04	0.03	0.03	0.03	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00															0.34
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮		⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
43																													0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
44																														0.00	0.00	0.00	0.00	0.00	0.00	0.01

Table 49: Serious injuries prevented due to a broad advertising campaign – Option 2b

Year	Vehicle Age																																		SI Prevented
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	
0	0.00																																				0.00
1	0.00	0.00																																			0.00
2	0.00	0.00	0.00																																		0.00
3	0.00	0.00	0.00	0.00																																	0.00
4	0.00	0.00	0.00	0.00	0.00																																0.00
5	0.00	0.00	0.00	0.00	0.00	0.00																															0.00
6	0.13	0.00	0.00	0.00	0.00	0.00	0.00																														0.13
7	0.17	0.39	0.00	0.00	0.00	0.00	0.00	0.00																													0.56
8	0.19	0.55	0.44	0.00	0.00	0.00	0.00	0.00	0.00																												1.17
9	0.20	0.58	0.64	0.50	0.00	0.00	0.00	0.00	0.00	0.00																											1.93
10	0.21	0.63	0.69	0.70	0.45	0.00	0.00	0.00	0.00	0.00	0.00																										2.68
11	0.23	0.67	0.73	0.75	0.66	0.45	0.00	0.00	0.00	0.00	0.00	0.00																									3.48
12	0.24	0.71	0.78	0.80	0.70	0.66	0.40	0.00	0.00	0.00	0.00	0.00	0.00																								4.30
13	0.26	0.76	0.83	0.85	0.75	0.70	0.61	0.35	0.00	0.00	0.00	0.00	0.00	0.00																							5.12
14	0.27	0.80	0.89	0.91	0.80	0.75	0.65	0.53	0.32	0.00	0.00	0.00	0.00	0.00	0.00																						5.93
15		0.85	0.94	0.97	0.85	0.80	0.70	0.57	0.48	0.22	0.00	0.00	0.00	0.00	0.00	0.00																					6.37
16			0.99	1.02	0.91	0.85	0.74	0.61	0.51	0.36	0.23	0.00	0.00	0.00	0.00	0.00	0.00																					6.23
17				1.08	0.96	0.90	0.79	0.65	0.54	0.39	0.38	0.20	0.00	0.00	0.00	0.00	0.00	0.00																				5.90
18					1.02	0.96	0.84	0.69	0.58	0.41	0.40	0.32	0.17	0.00	0.00	0.00	0.00	0.00	0.00																				5.38
19						1.01	0.89	0.73	0.62	0.44	0.43	0.34	0.27	0.20	0.00	0.00	0.00	0.00	0.00	0.00																			4.91
20							0.94	0.77	0.65	0.47	0.46	0.36	0.28	0.29	0.18	0.00	0.00	0.00	0.00	0.00	0.00																			4.40
21								0.82	0.69	0.50	0.49	0.38	0.30	0.31	0.26	0.16	0.00	0.00	0.00	0.00	0.00	0.00																			3.92
22									0.73	0.53	0.51	0.41	0.32	0.33	0.28	0.25	0.10	0.00	0.00	0.00	0.00	0.00	0.00																			3.46
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮		⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
43																													0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.02
44																														0.00	0.00	0.00	0.00	0.00	0.00		0.01

Table 50: Fatalities prevented due to implementation of a mandatory standard (broad scope) under the MVSA – Option 6a

Year	Vehicle Age																																		Lives Saved
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	
0	0.06																																				0.06
1	0.12	0.18																																			0.29
2	0.18	0.36	0.21																																		0.75
3	0.24	0.55	0.42	0.23																																	1.45
4	0.24	0.75	0.64	0.47	0.21																																2.32
5	0.25	0.76	0.87	0.71	0.43	0.21																															3.23
6	0.25	0.76	0.88	0.97	0.66	0.43	0.19																														4.13
7	0.24	0.76	0.88	0.97	0.89	0.65	0.39	0.17																													4.96
8	0.24	0.76	0.88	0.97	0.90	0.89	0.60	0.34	0.15																												5.73
9	0.24	0.75	0.87	0.97	0.90	0.89	0.82	0.52	0.31	0.11																											6.38
10	0.24	0.75	0.87	0.96	0.89	0.89	0.82	0.71	0.47	0.23	0.12																										6.95
11	0.24	0.74	0.86	0.96	0.89	0.89	0.82	0.71	0.64	0.35	0.24	0.10																									7.42
12	0.23	0.73	0.85	0.95	0.88	0.88	0.81	0.71	0.64	0.47	0.36	0.20	0.08																								7.81
13	0.23	0.72	0.84	0.94	0.87	0.87	0.81	0.71	0.64	0.47	0.49	0.31	0.17	0.09																							8.17
14	0.22	0.71	0.83	0.93	0.86	0.87	0.80	0.70	0.63	0.47	0.49	0.42	0.26	0.19	0.08																						8.47
15		0.69	0.81	0.91	0.85	0.86	0.79	0.70	0.63	0.46	0.49	0.42	0.35	0.29	0.17	0.08																					8.51
16			0.80	0.89	0.84	0.84	0.78	0.69	0.62	0.46	0.49	0.41	0.35	0.39	0.26	0.16	0.05																				8.05
17				0.87	0.82	0.83	0.77	0.68	0.62	0.46	0.48	0.41	0.35	0.39	0.35	0.24	0.11	0.05																			7.44
18					0.80	0.81	0.76	0.67	0.61	0.45	0.48	0.41	0.35	0.39	0.35	0.33	0.16	0.09	0.04																			6.71
19						0.79	0.74	0.66	0.60	0.45	0.47	0.40	0.34	0.38	0.35	0.33	0.22	0.14	0.08	0.04																		6.01
20							0.72	0.64	0.59	0.44	0.47	0.40	0.34	0.38	0.35	0.33	0.22	0.20	0.13	0.08	0.03																	5.31
21								0.63	0.57	0.43	0.46	0.39	0.34	0.37	0.34	0.32	0.22	0.19	0.17	0.12	0.07	0.03															4.67
22									0.56	0.42	0.45	0.38	0.33	0.37	0.34	0.32	0.22	0.19	0.17	0.17	0.11	0.06	0.03														4.12
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮		⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
43																													0.04	0.03	0.02	0.02	0.02	0.01	0.02	0.16
44																														0.03	0.02	0.02	0.02	0.01	0.02	0.12

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Table 51: Serious injuries prevented due to implementation of a mandatory standard (broad scope) under the MVSA – Option 6a

Year	Vehicle Age																																		SI Prevented
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	
0	0.56																																				0.56
1	1.14	1.75																																			2.89
2	1.74	3.57	2.06																																		7.38
3	2.37	5.46	4.20	2.25																																	14.28
4	2.38	7.42	6.43	4.58	2.12																																22.93
5	2.37	7.43	8.73	7.00	4.32	2.12																															31.98
6	2.37	7.42	8.74	9.50	6.61	4.31	1.97																														40.92
7	2.35	7.39	8.72	9.50	8.97	6.59	4.01	1.73																													49.27
8	2.33	7.35	8.68	9.47	8.97	8.95	6.13	3.52	1.54																												56.94
9	2.31	7.28	8.62	9.42	8.93	8.94	8.32	5.37	3.14	1.19																											63.52
10	2.28	7.21	8.54	9.35	8.88	8.90	8.30	7.29	4.80	2.42	1.23																										69.18
11	2.25	7.11	8.45	9.25	8.81	8.84	8.26	7.27	6.51	3.69	2.50	1.03																									73.95
12	2.20	7.00	8.33	9.14	8.71	8.76	8.20	7.23	6.49	5.01	3.81	2.09	0.87																								77.84
13	2.16	6.87	8.20	9.01	8.60	8.66	8.12	7.17	6.44	4.99	5.17	3.19	1.76	0.94																							81.29
14	2.10	6.72	8.04	8.85	8.48	8.55	8.03	7.10	6.39	4.96	5.15	4.33	2.69	1.92	0.86																						84.15
15		6.55	7.86	8.67	8.33	8.41	7.92	7.01	6.32	4.91	5.11	4.30	3.65	2.93	1.75	0.80																					84.53
16			7.66	8.47	8.16	8.26	7.79	6.91	6.24	4.86	5.06	4.27	3.63	3.97	2.67	1.64	0.56																				80.14
17				8.24	7.97	8.09	7.65	6.80	6.15	4.80	5.00	4.23	3.59	3.94	3.61	2.49	1.14	0.51																				74.21
18					7.75	7.89	7.48	6.67	6.04	4.73	4.94	4.18	3.56	3.91	3.59	3.38	1.74	1.03	0.44																			67.32
19						7.68	7.30	6.52	5.92	4.65	4.86	4.12	3.51	3.86	3.55	3.35	2.35	1.58	0.90	0.45																		60.60
20							7.10	6.36	5.79	4.56	4.77	4.05	3.46	3.81	3.51	3.32	2.33	2.13	1.36	0.91	0.40																	53.87
21								6.18	5.64	4.46	4.68	3.98	3.40	3.75	3.46	3.28	2.31	2.12	1.85	1.39	0.81	0.33															47.62
22									5.48	4.35	4.57	3.89	3.34	3.68	3.41	3.23	2.28	2.09	1.83	1.88	1.23	0.66	0.32														42.24
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮		⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
43																													0.39	0.31	0.19	0.26	0.28	0.12	0.21	1.76
44																														0.30	0.19	0.25	0.27	0.12	0.20	1.33

Table 52: Fatalities prevented due to implementation of a mandatory standard (medium scope) under the MVSA – Option 6b

Year	Vehicle Age																																		Lives Saved
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	
0	0.05																																				0.05
1	0.11	0.17																																			0.28
2	0.17	0.34	0.19																																		0.70
3	0.23	0.52	0.39	0.21																																	1.35
4	0.23	0.70	0.60	0.44	0.20																																2.16
5	0.23	0.71	0.81	0.67	0.40	0.19																															3.01
6	0.23	0.71	0.81	0.91	0.61	0.40	0.18																														3.85
7	0.23	0.71	0.82	0.91	0.83	0.60	0.36	0.15																													4.62
8	0.23	0.71	0.82	0.91	0.83	0.82	0.55	0.31	0.14																												5.33
9	0.23	0.71	0.82	0.91	0.83	0.82	0.75	0.48	0.28	0.10																											5.93
10	0.23	0.70	0.81	0.91	0.83	0.82	0.75	0.65	0.43	0.20	0.11																										6.45
11	0.23	0.70	0.81	0.90	0.83	0.82	0.75	0.65	0.59	0.31	0.22	0.09																									6.90
12	0.22	0.69	0.80	0.90	0.82	0.82	0.75	0.65	0.59	0.42	0.33	0.18	0.08																								7.26
13	0.22	0.68	0.79	0.89	0.82	0.81	0.75	0.65	0.59	0.42	0.45	0.28	0.16	0.09																							7.59
14	0.22	0.67	0.78	0.88	0.81	0.81	0.74	0.65	0.59	0.42	0.45	0.38	0.24	0.17	0.08																						7.87
15		0.66	0.77	0.86	0.80	0.80	0.74	0.64	0.58	0.42	0.45	0.38	0.32	0.27	0.16	0.07																					7.91
16			0.75	0.85	0.79	0.79	0.73	0.64	0.58	0.42	0.44	0.38	0.32	0.36	0.24	0.15	0.05																				7.48
17				0.83	0.77	0.78	0.72	0.63	0.57	0.41	0.44	0.38	0.32	0.36	0.33	0.22	0.10	0.04																			6.90
18					0.76	0.76	0.71	0.62	0.57	0.41	0.44	0.37	0.32	0.36	0.32	0.30	0.15	0.08	0.04																			6.21
19						0.75	0.69	0.61	0.56	0.41	0.43	0.37	0.32	0.35	0.32	0.30	0.20	0.13	0.07	0.03																		5.55
20							0.68	0.60	0.55	0.40	0.43	0.37	0.31	0.35	0.32	0.30	0.20	0.17	0.11	0.07	0.03																	4.89
21								0.59	0.54	0.39	0.42	0.36	0.31	0.35	0.32	0.30	0.20	0.17	0.15	0.11	0.06	0.03															4.29
22									0.53	0.39	0.41	0.36	0.30	0.34	0.31	0.30	0.20	0.17	0.15	0.14	0.09	0.05	0.02														3.77
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮		⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
43																													0.03	0.02	0.01	0.02	0.02	0.01	0.02	0.14
44																														0.02	0.01	0.02	0.02	0.01	0.02	0.10

Table 53: Serious injuries prevented due to implementation of a mandatory standard (medium scope) under the MVSA – Option 6b

Year	Vehicle Age																																			SI Prevented
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	
0	0.50																																				0.50
1	1.02	1.55																																			2.57
2	1.56	3.16	1.80																																		6.52
3	2.12	4.83	3.67	1.99																																	12.60
4	2.13	6.55	5.61	4.06	1.85																																20.19
5	2.13	6.58	7.61	6.21	3.76	1.84																															28.13
6	2.13	6.59	7.64	8.42	5.75	3.74	1.69																														35.97
7	2.12	6.58	7.65	8.45	7.80	5.71	3.44	1.48																													43.23
8	2.11	6.56	7.64	8.44	7.82	7.75	5.26	3.01	1.33																												49.91
9	2.09	6.52	7.61	8.41	7.81	7.77	7.13	4.59	2.70	0.98																											55.62
10	2.07	6.47	7.56	8.37	7.79	7.76	7.14	6.22	4.13	1.99	1.03																										60.52
11	2.04	6.40	7.50	8.31	7.75	7.73	7.13	6.23	5.59	3.04	2.09	0.87																									64.67
12	2.01	6.31	7.42	8.22	7.69	7.68	7.10	6.21	5.59	4.12	3.19	1.77	0.74																								68.05
13	1.97	6.21	7.32	8.12	7.61	7.62	7.05	6.18	5.57	4.12	4.33	2.70	1.50	0.81																							71.12
14	1.93	6.09	7.20	8.00	7.52	7.54	6.99	6.14	5.54	4.11	4.32	3.65	2.28	1.65	0.74																						73.73
15		5.96	7.06	7.86	7.41	7.44	6.92	6.09	5.50	4.09	4.31	3.65	3.09	2.52	1.50	0.69																					74.09
16			6.90	7.70	7.28	7.33	6.83	6.02	5.44	4.06	4.28	3.63	3.09	3.42	2.29	1.40	0.46																				70.14
17				7.51	7.13	7.20	6.73	5.94	5.38	4.03	4.25	3.60	3.07	3.40	3.10	2.14	0.94	0.41																			64.83
18					6.96	7.05	6.60	5.84	5.30	3.99	4.20	3.57	3.04	3.38	3.09	2.89	1.44	0.83	0.36																			58.57
19						6.88	6.46	5.74	5.21	3.93	4.15	3.53	3.02	3.35	3.07	2.88	1.95	1.27	0.74	0.35																		52.53
20							6.31	5.61	5.11	3.87	4.09	3.48	2.98	3.32	3.04	2.86	1.94	1.72	1.12	0.72	0.31																	46.49
21								5.48	5.00	3.81	4.03	3.43	2.94	3.27	3.01	2.83	1.93	1.71	1.52	1.09	0.63	0.26																40.91
22									4.87	3.73	3.95	3.37	2.89	3.22	2.97	2.80	1.91	1.70	1.51	1.48	0.95	0.52	0.25															36.12
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮		⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
43																													0.32	0.24	0.15	0.21	0.22	0.10	0.17	1.41
44																														0.24	0.15	0.20	0.22	0.10	0.16	1.06

Table 54: Fatalities prevented due to implementation of a mandatory standard (narrow scope) under the MVSA – Option 6c

Year	Vehicle Age																																		Lives Saved
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	
0	0.05																																				0.05
1	0.10	0.15																																			0.26
2	0.16	0.31	0.18																																		0.65
3	0.21	0.48	0.36	0.20																																	1.25
4	0.22	0.65	0.55	0.41	0.18																																2.00
5	0.22	0.66	0.74	0.62	0.37	0.18																															2.79
6	0.22	0.66	0.75	0.84	0.56	0.36	0.16																														3.56
7	0.22	0.66	0.75	0.85	0.76	0.55	0.33	0.14																													4.27
8	0.22	0.66	0.76	0.85	0.76	0.75	0.50	0.29	0.13																												4.92
9	0.22	0.66	0.76	0.85	0.77	0.76	0.68	0.43	0.26	0.09																											5.47
10	0.22	0.66	0.76	0.85	0.77	0.76	0.68	0.59	0.39	0.18	0.09																										5.95
11	0.21	0.66	0.75	0.85	0.77	0.76	0.69	0.59	0.53	0.27	0.19	0.08																									6.35
12	0.21	0.65	0.75	0.84	0.76	0.76	0.69	0.59	0.54	0.37	0.29	0.16	0.07																								6.68
13	0.21	0.64	0.74	0.84	0.76	0.75	0.68	0.59	0.54	0.37	0.40	0.25	0.14	0.08																							6.99
14	0.20	0.63	0.73	0.83	0.75	0.75	0.68	0.59	0.54	0.37	0.40	0.34	0.21	0.16	0.07																						7.27
15		0.62	0.72	0.82	0.75	0.74	0.68	0.59	0.54	0.37	0.40	0.34	0.29	0.24	0.14	0.07																					7.30
16			0.71	0.80	0.74	0.74	0.67	0.59	0.53	0.37	0.40	0.34	0.29	0.33	0.22	0.13	0.04																				6.90
17				0.79	0.73	0.73	0.66	0.58	0.53	0.37	0.40	0.34	0.29	0.33	0.30	0.20	0.09	0.04																			6.35
18					0.71	0.71	0.66	0.57	0.52	0.37	0.39	0.34	0.29	0.33	0.30	0.27	0.13	0.07	0.03																			5.70
19						0.70	0.65	0.57	0.52	0.36	0.39	0.34	0.29	0.33	0.30	0.27	0.18	0.11	0.07	0.03																		5.08
20							0.63	0.56	0.51	0.36	0.39	0.33	0.29	0.32	0.29	0.27	0.18	0.15	0.10	0.06	0.02																	4.46
21								0.55	0.50	0.36	0.38	0.33	0.28	0.32	0.29	0.27	0.18	0.15	0.13	0.09	0.05	0.02															3.90
22									0.49	0.35	0.38	0.32	0.28	0.32	0.29	0.27	0.17	0.15	0.13	0.12	0.08	0.04	0.02														3.41
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮		⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
43																													0.03	0.02	0.01	0.02	0.02	0.01	0.01	0.12
44																														0.02	0.01	0.02	0.02	0.01	0.01	0.09

Table 55: Serious injuries prevented due to implementation of a mandatory standard (narrow scope) under the MVSA – Option 6c

Year	Vehicle Age																																			SI Prevented
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	
0	0.44																																				0.44
1	0.90	1.34																																			2.24
2	1.37	2.73	1.53																																		5.63
3	1.86	4.18	3.12	1.73																																	10.89
4	1.87	5.67	4.77	3.53	1.57																																17.40
5	1.88	5.71	6.46	5.40	3.19	1.55																															24.20
6	1.89	5.74	6.52	7.32	4.87	3.16	1.40																														30.89
7	1.89	5.75	6.55	7.36	6.60	4.82	2.86	1.22																													37.05
8	1.88	5.75	6.57	7.38	6.64	6.53	4.36	2.48	1.11																												42.71
9	1.87	5.74	6.56	7.38	6.67	6.57	5.91	3.79	2.26	0.76																											47.51
10	1.86	5.71	6.55	7.37	6.67	6.59	5.95	5.14	3.44	1.56	0.83																										51.64
11	1.84	5.67	6.52	7.33	6.66	6.59	5.97	5.16	4.66	2.37	1.68	0.71																									55.15
12	1.81	5.61	6.47	7.28	6.63	6.57	5.97	5.18	4.68	3.21	2.56	1.44	0.60																								58.02
13	1.79	5.54	6.41	7.22	6.59	6.54	5.95	5.17	4.68	3.24	3.46	2.19	1.23	0.68																							60.69
14	1.75	5.45	6.33	7.13	6.54	6.50	5.93	5.16	4.67	3.25	3.48	2.96	1.87	1.38	0.62																						63.02
15		5.35	6.23	7.03	6.47	6.44	5.89	5.13	4.66	3.25	3.49	2.97	2.53	2.11	1.25	0.57																					63.37
16			6.12	6.90	6.38	6.37	5.84	5.10	4.63	3.25	3.48	2.97	2.54	2.85	1.91	1.16	0.37																				59.87
17				6.76	6.27	6.28	5.77	5.05	4.59	3.24	3.47	2.96	2.53	2.85	2.58	1.77	0.75	0.31																			55.20
18					6.15	6.17	5.69	5.00	4.55	3.22	3.45	2.95	2.52	2.85	2.58	2.40	1.14	0.63	0.28																			49.58
19						6.05	5.60	4.93	4.49	3.20	3.43	2.93	2.51	2.83	2.57	2.39	1.54	0.96	0.57	0.25																		44.26
20							5.49	4.84	4.42	3.17	3.40	2.91	2.49	2.81	2.56	2.39	1.54	1.30	0.87	0.52	0.22																	38.91
21								4.75	4.34	3.13	3.36	2.87	2.47	2.78	2.54	2.37	1.53	1.30	1.18	0.79	0.44	0.19															34.05
22									4.25	3.09	3.31	2.84	2.44	2.75	2.52	2.35	1.53	1.30	1.18	1.06	0.67	0.38	0.18														29.85
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮		⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
43																													0.24	0.18	0.11	0.15	0.16	0.07	0.12	1.04
44																														0.17	0.11	0.15	0.16	0.07	0.12	0.79

23. Determine the total annual costs associated with the implementation of each option (2a, 2b, 6a, 6b and 6c).

Table 56: Truck development costs – implementation of regulation (broad scope) (2019-2035) – Option 6a

Year	Option 6a					
	Prime Movers (NC)			Rigid Trucks (NB2 & NC)		
	Best Case	Likely Case	Worst Case	Best Case	Likely Case	Worst Case
2019	-	-	-	-	-	-
2020	$2,450,000	$3,993,500	$5,537,000	$11,900,000	$19,397,000	$26,894,000
2021	$2,450,000	$3,993,500	$5,537,000	$11,900,000	$19,397,000	$26,894,000
2022	$2,450,000	$3,993,500	$5,537,000	$11,900,000	$19,397,000	$26,894,000
2023	-	-	-	-	-	-
2024	-	-	-	-	-	-
2025	-	-	-	-	-	-
2026	-	-	-	-	-	-
2027	-	-	-	-	-	-
2028	-	-	-	-	-	-
2029	-	-	-	-	-	-
2030	-	-	-	-	-	-
2031	-	-	-	-	-	-
2032	-	-	-	-	-	-
2033	-	-	-	-	-	-
2034	-	-	-	-	-	-
2035	-	-	-	-	-	-
NPV	**$5,248,447**	**$8,554,970**	**$11,861,492**	**$25,492,460**	**$41,552,711**	**$57,612,961**

Table 57: Truck development costs – implementation of regulation (medium scope) (2019-2035) – Option 6b

Year	Option 6b					
	Prime Movers (NC)			Rigid Trucks (NC)		
	Best Case	Likely Case	Worst Case	Best Case	Likely Case	Worst Case
2019	-	-	-	-	-	-
2020	$2,450,000	$3,993,500	$5,537,000	$2,450,000	$3,993,500	$5,537,000
2021	$2,450,000	$3,993,500	$5,537,000	$2,450,000	$3,993,500	$5,537,000
2022	$2,450,000	$3,993,500	$5,537,000	$2,450,000	$3,993,500	$5,537,000
2023	-	-	-	-	-	-
2024	-	-	-	-	-	-
2025	-	-	-	-	-	-
2026	-	-	-	-	-	-
2027	-	-	-	-	-	-
2028	-	-	-	-	-	-
2029	-	-	-	-	-	-
2030	-	-	-	-	-	-
2031	-	-	-	-	-	-
2032	-	-	-	-	-	-
2033	-	-	-	-	-	-
2034	-	-	-	-	-	-
2035	-	-	-	-	-	-
NPV	**$5,248,447**	**$8,554,970**	**$11,861,492**	**$5,248,447**	**$8,554,970**	**$11,861,492**

Table 58: Truck development costs – implementation of regulation (narrow scope) (2019-2035) – Option 6c

Year	Option 6c		
	Prime Movers (NC)		
	Best Case	Likely Case	Worst Case
2019	-	-	-
2020	$2,450,000	$3,993,500	$5,537,000
2021	$2,450,000	$3,993,500	$5,537,000
2022	$2,450,000	$3,993,500	$5,537,000
2023	-	-	-
2024	-	-	-
2025	-	-	-
2026	-	-	-
2027	-	-	-
2028	-	-	-
2029	-	-	-
2030	-	-	-
2031	-	-	-
2032	-	-	-
2033	-	-	-
2034	-	-	-
2035	-	-	-
NPV	$5,248,447	$8,554,970	$11,861,492

Table 59: Bus development costs – implementation of regulation (2019-2035) – Option 6a

Year	Option 6a		
	Buses (MD4 & ME)		
	Best Case	Likely Case	Worst Case
2019	-	-	-
2020	$3,750,000	$6,112,500	$8,475,000
2021	$3,750,000	$6,112,500	$8,475,000
2022	$3,750,000	$6,112,500	$8,475,000
2023	-	-	-
2024	-	-	-
2025	-	-	-
2026	-	-	-
2027	-	-	-
2028	-	-	-
2029	-	-	-
2030	-	-	-
2031	-	-	-
2032	-	-	-
2033	-	-	-
2034	-	-	-
2035	-	-	-
NPV	**$8,033,338**	**$13,094,341**	**$18,155,345**

Table 60: Bus development costs – implementation of regulation (2019-2035) – Options 6b and 6c

Year	Options 6b and 6c		
	Buses (ME)		
	Best Case	Likely Case	Worst Case
2019	-	-	-
2020	$3,625,000	$5,908,750	$8,192,500
2021	$3,625,000	$5,908,750	$8,192,500
2022	$3,625,000	$5,908,750	$8,192,500
2023	-	-	-
2024	-	-	-
2025	-	-	-
2026	-	-	-
2027	-	-	-
2028	-	-	-
2029	-	-	-
2030	-	-	-
2031	-	-	-
2032	-	-	-
2033	-	-	-
2034	-	-	-
2035	-	-	-
NPV	**$7,765,560**	**$12,657,863**	**$17,550,166**

Table 61: Fitment costs – implementation of targeted advertising campaign (2019-2035) – Option 2a

	Option 2a	
	Prime Movers (NC)	Rigid Trucks (NB2 & NC)
2019		
2020	$3,669,676	$10,166,995
2021	$3,481,538	$9,660,291
2022	-	-
2023	$3,108,118	$8,667,965
2024	-	-
2025	$2,707,494	$7,609,810
2026	-	-
2027	$2,284,566	$6,500,019
2028	-	-
2029	$1,847,436	$5,362,869
2030	-	-
2031	$1,393,572	$4,189,908
2032	-	-
2033	$924,401	$2,984,536
2034	-	-
2035	-	-
NPV	**$11,339,883**	**$31,958,166**

Table 62: Fitment costs – implementation of broad advertising campaign (2019-2035) – Option 2b

	Option 2b	
	Prime Movers (NC)	**Rigid Trucks (NB2 & NC)**
2019	-	-
2020	-	-
2021	-	-
2022	-	-
2023	-	-
2024	-	-
2025	-	-
2026	$370,136	-
2027	$391,640	$962,966
2028	$413,673	$1,017,724
2029	$435,806	$1,072,574
2030	$458,082	$1,127,640
2031	$480,542	$1,183,033
2032	$502,890	$1,237,962
2033	$525,449	$1,293,299
2034	$548,274	$1,349,187
2035	-	-
NPV	**$1,589,470**	**$3,448,505**

Table 63: Truck fitment costs – implementation of regulation (broad scope) (2019-2035) – Option 6a

Year	Option 6a					
	Prime Movers (NC)			Rigid Trucks (NB2 & NC)		
	Best Case	**Likely Case**	**Worst Case**	**Best Case**	**Likely Case**	**Worst Case**
2019	-	-	-	-	-	-
2020	$658,212	$1,234,147	$2,863,221	$1,797,311	$3,369,959	$7,818,305
2021	$1,327,979	$2,489,961	$5,776,710	$3,618,776	$6,785,204	$15,741,674
2022	$2,014,777	$3,777,706	$8,764,278	$5,480,713	$10,276,337	$23,841,102
2023	$2,714,724	$5,090,108	$11,809,050	$7,371,675	$13,821,891	$32,066,786
2024	$2,619,844	$4,912,208	$11,396,323	$7,115,256	$13,341,106	$30,951,365
2025	$2,520,877	$4,726,644	$10,965,813	$6,848,829	$12,841,554	$29,792,405
2026	$2,418,222	$4,534,167	$10,519,267	$6,573,561	$12,325,427	$28,594,991
2027	$2,312,541	$4,336,014	$10,059,552	$6,291,376	$11,796,331	$27,367,487
2028	$2,206,258	$4,136,734	$9,597,222	$6,009,416	$11,267,654	$26,140,958
2029	$2,096,919	$3,931,724	$9,121,599	$5,720,393	$10,725,738	$24,883,711
2030	$1,985,020	$3,721,913	$8,634,838	$5,425,745	$10,173,272	$23,601,991
2031	$1,870,911	$3,507,957	$8,138,461	$5,126,476	$9,612,142	$22,300,170
2032	$1,753,667	$3,288,126	$7,628,453	$4,819,800	$9,037,125	$20,966,130
2033	$1,634,731	$3,065,121	$7,111,081	$4,509,965	$8,456,185	$19,618,348
2034	$1,514,279	$2,839,274	$6,587,115	$4,197,471	$7,870,257	$18,258,997
2035	-	-	-	-	-	-
NPV	**$14,563,281**	**$27,306,153**	**$63,350,274**	**$39,697,675**	**$74,433,142**	**$172,684,888**

Table 64: Truck fitment costs – implementation of regulation (medium scope) (2019-2035) – Option 6b

Year	Option 6b					
	Prime Movers (NC)			Rigid Trucks (NC)		
	Best Case	Likely Case	Worst Case	Best Case	Likely Case	Worst Case
2019	-	-	-	-	-	-
2020	$658,212	$1,234,147	$2,863,221	$906,025	$1,698,796	$3,941,208
2021	$1,327,979	$2,489,961	$5,776,710	$1,824,225	$3,420,422	$7,935,378
2022	$2,014,777	$3,777,706	$8,764,278	$2,762,827	$5,180,301	$12,018,299
2023	$2,714,724	$5,090,108	$11,809,050	$3,716,061	$6,967,615	$16,164,867
2024	$2,619,844	$4,912,208	$11,396,323	$3,586,801	$6,725,251	$15,602,583
2025	$2,520,877	$4,726,644	$10,965,813	$3,452,495	$6,473,427	$15,018,352
2026	$2,418,222	$4,534,167	$10,519,267	$3,313,732	$6,213,248	$14,414,735
2027	$2,312,541	$4,336,014	$10,059,552	$3,171,483	$5,946,530	$13,795,950
2028	$2,206,258	$4,136,734	$9,597,222	$3,029,346	$5,680,025	$13,177,657
2029	$2,096,919	$3,931,724	$9,121,599	$2,883,650	$5,406,844	$12,543,879
2030	$1,985,020	$3,721,913	$8,634,838	$2,735,118	$5,128,346	$11,897,764
2031	$1,870,911	$3,507,957	$8,138,461	$2,584,257	$4,845,481	$11,241,516
2032	$1,753,667	$3,288,126	$7,628,453	$2,429,661	$4,555,615	$10,569,026
2033	$1,634,731	$3,065,121	$7,111,081	$2,273,473	$4,262,763	$9,889,609
2034	$1,514,279	$2,839,274	$6,587,115	$2,115,945	$3,967,397	$9,204,360
2035	-	-	-	-	-	-
NPV	**$14,563,281**	**$27,306,153**	**$63,350,274**	**$20,011,598**	**$37,521,747**	**$87,050,452**

Table 65: Truck fitment costs – implementation of regulation (narrow scope) (2019-2035) – Option 6c

Year	Option 6c		
	Prime Movers (NC)		
	Best Case	Likely Case	Worst Case
2019	-	-	-
2020	$658,212	$1,234,147	$2,863,221
2021	$1,327,979	$2,489,961	$5,776,710
2022	$2,014,777	$3,777,706	$8,764,278
2023	$2,714,724	$5,090,108	$11,809,050
2024	$2,619,844	$4,912,208	$11,396,323
2025	$2,520,877	$4,726,644	$10,965,813
2026	$2,418,222	$4,534,167	$10,519,267
2027	$2,312,541	$4,336,014	$10,059,552
2028	$2,206,258	$4,136,734	$9,597,222
2029	$2,096,919	$3,931,724	$9,121,599
2030	$1,985,020	$3,721,913	$8,634,838
2031	$1,870,911	$3,507,957	$8,138,461
2032	$1,753,667	$3,288,126	$7,628,453
2033	$1,634,731	$3,065,121	$7,111,081
2034	$1,514,279	$2,839,274	$6,587,115
2035	-	-	-
NPV	**$14,563,281**	**$27,306,153**	**$63,350,274**

Table 66: Bus fitment costs – implementation of regulation (2019-2035) – Option 6a

Year	Option 6a		
	Buses (MD4 & ME)		
	Best Case	Likely Case	Worst Case
2019	-	-	-
2020	$32,537	$39,044	$45,551
2021	$65,621	$78,745	$91,869
2022	$99,527	$119,433	$139,338
2023	$134,062	$160,874	$187,687
2024	$135,323	$162,388	$189,452
2025	$136,489	$163,786	$191,084
2026	$137,567	$165,080	$192,594
2027	$138,584	$166,301	$194,018
2028	$139,685	$167,622	$195,559
2029	$140,718	$168,862	$197,006
2030	$141,707	$170,048	$198,389
2031	$142,667	$171,201	$199,734
2032	$143,518	$172,221	$200,925
2033	$144,361	$173,233	$202,105
2034	$145,211	$174,254	$203,296
2035	-	-	-
NPV	**$874,546**	**$1,049,455**	**$1,224,365**

Table 67: Bus fitment costs – implementation of regulation (2019-2035) – Options 6b and 6c

Year	Options 6b and 6c		
	Buses (ME)		
	Best Case	Likely Case	Worst Case
2019	-	-	-
2020	$26,280	$31,536	$36,792
2021	$53,001	$63,602	$74,202
2022	$80,388	$96,465	$112,543
2023	$108,281	$129,937	$151,593
2024	$109,300	$131,159	$153,019
2025	$110,241	$132,289	$154,337
2026	$111,112	$133,334	$155,556
2027	$111,933	$134,320	$156,706
2028	$112,823	$135,387	$157,952
2029	$113,657	$136,389	$159,120
2030	$114,455	$137,346	$160,237
2031	$115,231	$138,277	$161,324
2032	$115,918	$139,102	$162,285
2033	$116,599	$139,919	$163,239
2034	$117,286	$140,743	$164,201
2035	-	-	-
NPV	**$706,364**	**$847,637**	**$988,910**

Table 68: Trailer fitment costs – implementation of regulation (2019-2035) – Options 6a, 6b, 6c

Year	Options 6a, 6b and 6c		
	Trailers (TC > 4.5 tonnes GTM & TD)		
	Best Case	Likely Case	Worst Case
2019	-	-	-
2020	$1,935,059	$2,877,361	$4,387,861
2021	$1,950,757	$2,900,653	$4,423,397
2022	$1,971,978	$2,932,164	$4,471,465
2023	$1,991,655	$2,961,377	$4,516,029
2024	$2,009,873	$2,988,420	$4,557,284
2025	$2,026,655	$3,013,326	$4,595,280
2026	$2,042,131	$3,036,289	$4,630,314
2027	$2,056,694	$3,057,894	$4,663,278
2028	$2,072,529	$3,081,393	$4,699,129
2029	$2,087,349	$3,103,383	$4,732,677
2030	$2,101,497	$3,124,374	$4,764,703
2031	$2,115,241	$3,144,763	$4,795,811
2032	$2,127,337	$3,162,702	$4,823,184
2033	$2,139,331	$3,180,488	$4,850,323
2034	$2,151,448	$3,198,458	$4,877,742
2035	-	-	-
NPV	**$15,111,248**	**$22,467,836**	**$34,263,231**

Table 69: Trailer maintenance costs (outer regional and remote areas) – implementation of regulation (2019-2035) – Options 6a, 6b and 6c

Year	Options 6a, 6b and 6c		
	Trailers (TC > 4.5 tonnes GTM & TD)		
	Best Case	Likely Case	Worst Case
2019	-	-	-
2020	$1,182,597	$1,406,332	$1,757,915
2021	$1,257,131	$1,494,966	$1,868,708
2022	$1,332,469	$1,584,558	$1,980,697
2023	$1,408,553	$1,675,036	$2,093,795
2024	$1,485,327	$1,766,334	$2,207,918
2025	$1,562,735	$1,858,388	$2,322,985
2026	$1,640,728	$1,951,136	$2,438,920
2027	$1,719,271	$2,044,539	$2,555,674
2028	$1,797,052	$2,137,035	$2,671,294
2029	$1,875,278	$2,230,060	$2,787,575
2030	$1,953,926	$2,323,588	$2,904,485
2031	$2,032,506	$2,417,034	$3,021,293
2032	$2,110,974	$2,510,348	$3,137,935
2033	$2,189,343	$2,603,543	$3,254,429
2034	$2,267,631	$2,696,643	$3,370,804
2035	-	-	-
NPV	**$12,078,532**	**$14,363,659**	**$17,954,574**

Table 70: Government costs – implementation of advertising campaigns (2019-2035) – Options 2a and 2b

Year	Option 2a	Option 2b
2019	-	-
2020	-	-
2021	$600,000	-
2022	$600,000	-
2023	-	-
2024	$600,000	-
2025	-	-
2026	$600,000	$18,000,000
2027	-	$18,000,000
2028	$600,000	$18,000,000
2029	-	$18,000,000
2030	$600,000	$18,000,000
2031	-	$18,000,000
2032	$600,000	$18,000,000
2033	-	$18,000,000
2034	$600,000	$18,000,000
2035	-	-
NPV	**$2,361,669**	**$63,789,384**

Table 71: Government costs – implementation of regulation (2019-2035) – Options 6a, 6b and 6c

Year	Options 6a, 6b and 6c		
	Best Case	Likely Case	Worst Case
2019	-	-	-
2020	$100,000	$100,000	$100,000
2021	$100,000	$100,000	$100,000
2022	$100,000	$100,000	$100,000
2023	$100,000	$100,000	$100,000
2024	$100,000	$100,000	$100,000
2025	$100,000	$100,000	$100,000
2026	$100,000	$100,000	$100,000
2027	$100,000	$100,000	$100,000
2028	$100,000	$100,000	$100,000
2029	$100,000	$100,000	$100,000
2030	$100,000	$100,000	$100,000
2031	$100,000	$100,000	$100,000
2032	$100,000	$100,000	$100,000
2033	$100,000	$100,000	$100,000
2034	$100,000	$100,000	$100,000
2035	-	-	-
NPV	**$743,477**	**$743,477**	**$743,477**

Table 72: Savings – implementation of regulation (2019-2035) – Options 6a, 6b and 6c

Year	Options 6a, 6b and 6c		
	Best Case	Likely Case	Worst Case
2019	-	-	-
2020	$6,564,823	$4,391,549	$2,218,274
2021	$6,612,017	$4,423,011	$2,234,006
2022	$6,678,352	$4,467,234	$2,256,117
2023	$6,739,375	$4,507,916	$2,276,458
2024	$6,795,398	$4,545,265	$2,295,133
2025	$6,846,514	$4,579,343	$2,312,171
2026	$6,893,185	$4,610,457	$2,327,728
2027	$6,936,775	$4,639,517	$2,342,258
2028	$6,984,802	$4,671,535	$2,358,267
2029	$7,029,395	$4,701,264	$2,373,132
2030	$7,071,741	$4,729,494	$2,387,247
2031	$7,112,759	$4,756,839	$2,400,920
2032	$7,148,192	$4,780,462	$2,412,731
2033	$7,183,343	$4,803,895	$2,424,448
2034	$7,128,986	$4,752,657	$2,376,329
2035	-	-	-
NPV	**$51,018,411**	**$34,123,795**	**$17,229,180**

25. Determine the average cost to society of a fatality, serious injury and minor injury in heavy vehicle rollover and loss of control crashes.

Table 73: Determination of average life years lost in fatal single heavy vehicle crashes

	Years
Life expectancy – males (note: over 90 per cent of heavy vehicle occupant fatalities are male)	80
Average age of heavy vehicle occupant fatality	46
Average life years lost	34

Table 74: Value of a Statistical Life Year

	Value (2007 Dollars)	Value (2016 Dollars)
Value of a Statistical Life Year	$151,000	$186,929

Table 75: Determination of the cost of a fatality

Component of Fatality Cost	Cost (2007 Dollars)	Cost (2016 Dollars)
Value of a statistical life (VSL) — assuming an average of 34 years of life lost and using a 3 per cent discount rate	$3,286,635	$4,068,657
Medical costs (hospital and ambulance)	$4,354	$5,390
Coronial costs	$2,010	$2,489
Premature funeral costs	$4,470	$5,534
Legal costs	$23,324	$28,874
Correctional services costs	$9,598	$11,881
Recruitment and retraining	$10,856	$13,439
Police costs	$1,922	$2,380
Costs of fire and rescue services	$2,939	$3,638
Total	**$3,346,108**	**$4,142,281**

Table 76: Determination of the cost of serious and minor injuries

Injury Type	Cost (2007 Dollars)	Cost (2016 Dollars)
Serious Injury	$218,922	$271,012
Minor Injury	$2,148	$2,659

Table 77: Determination of other road crash costs (i.e. repair, travel delay, lost productivity, salvage etc.)

Vehicle & Injury Type	Cost (2007 Dollars)	Cost (2016 Dollars)
Prime Movers (NC)		
Fatality	$69,985	$86,638
Serious Injury	$45,488	$56,311
Minor Injury	$45,488	$56,311
Rigid Trucks (NB2 & NC)		
Fatality	$48,861	$60,487
Serious Injury	$25,419	$31,467
Minor Injury	$25,419	$31,467
Buses (MD4 & ME)		
Fatality	$44,634	$55,254
Serious Injury	$22,848	$28,285
Minor Injury	$22,848	$28,285

Table 78: Estimated cost per fatality, serious injury and minor injury in heavy vehicle rollover and loss of control crashes

Vehicle & Injury Type	Cost of Injury (2016 Dollars)	Other Road Crash Costs (2016 Dollars)	Total Cost (2016 Dollars)
Prime Movers (NC)			
Fatality	$4,142,281	$86,638	$4,228,918
Serious Injury	$271,012	$56,311	$327,324
Minor Injury	$2,659	$56,311	$58,971
Rigid Trucks (NB2 & NC)			
Fatality	$4,142,281	$60,487	$4,202,768
Serious Injury	$271,012	$31,467	$302,480
Minor Injury	$2,659	$31,467	$34,127
Buses (MD4 & ME)			
Fatality	$4,142,281	$55,254	$4,197,534
Serious Injury	$271,012	$28,285	$299,297
Minor Injury	$2,659	$28,285	$30,944

26. Determine the gross and the net financial benefits, and the benefit-cost ratio for each option (2a, 2b, 6a, 6b and 6c).

Table 79: Benefits – implementation of targeted advertising campaign (2019-2035) – Option 2

Year	Option 2a		Option 2b	
	Gross Benefits	Net Benefits	Gross Benefits	Net Benefits
2019	-	-	-	-
2020	$1,194,762	-$12,641,909	-	-
2021	$4,881,917	-$8,859,912	-	-
2022	$7,967,828	$7,367,828	-	-
2023	$10,095,249	-$1,680,835	-	-
2024	$12,465,916	$11,865,916	-	-
2025	$13,680,573	$3,363,268	-	-
2026	$15,755,410	$15,155,410	$108,158	-$18,261,978
2027	$15,981,705	$7,197,119	$468,607	-$18,885,999
2028	$17,212,404	$16,612,404	$957,202	-$18,474,195
2029	$16,628,815	$9,418,510	$1,555,876	-$17,952,503
2030	$17,258,331	$16,658,331	$2,148,319	-$17,437,403
2031	$17,059,819	$11,476,339	$2,784,086	-$16,879,489
2032	$16,588,529	$15,988,529	$3,425,741	-$16,315,111
2033	$16,503,461	$12,594,523	$4,060,053	-$15,758,695
2034	$16,114,090	$15,514,090	$4,692,260	-$15,205,200
2035	$15,214,782	$15,214,782	$5,028,184	$5,028,184
2036	$13,650,247	$13,650,247	$4,910,550	$4,910,550
2037	$12,175,843	$12,175,843	$4,633,878	$4,633,878
2038	$10,974,541	$10,974,541	$4,214,243	$4,214,243
2039	$9,767,744	$9,767,744	$3,841,423	$3,841,423
2040	$8,811,336	$8,811,336	$3,434,472	$3,434,472
2041	$7,626,193	$7,626,193	$3,054,502	$3,054,502
2042	$6,972,717	$6,972,717	$2,697,464	$2,697,464
2043	$6,167,038	$6,167,038	$2,366,605	$2,366,605
2044	$5,699,969	$5,699,969	$2,165,852	$2,165,852
2045	$4,846,091	$4,846,091	$1,916,728	$1,916,728
2046	$4,576,703	$4,576,703	$1,724,213	$1,724,213
2047	$3,955,327	$3,955,327	$1,571,409	$1,571,409
2048	$3,616,168	$3,616,168	$1,367,787	$1,367,787
2049	$2,996,753	$2,996,753	$1,187,844	$1,187,844
2050	$2,721,758	$2,721,758	$999,730	$999,730
2051	$2,260,836	$2,260,836	$904,900	$904,900
2052	$2,079,428	$2,079,428	$821,445	$821,445
2053	$1,831,025	$1,831,025	$754,688	$754,688
2054	$1,563,343	$1,563,343	$671,120	$671,120
2055	$1,339,114	$1,339,114	$599,130	$599,130
2056	$1,152,678	$1,152,678	$538,567	$538,567
2057	$825,256	$825,256	$470,487	$470,487
2058	$769,643	$769,643	$397,494	$397,494
2059	$524,685	$524,685	$347,073	$347,073
2060	$494,328	$494,328	$295,142	$295,142
2061	$305,978	$305,978	$247,639	$247,639
2062	$288,888	$288,888	$191,422	$191,422
2063	$159,774	$159,774	$148,406	$148,406
2064	$166,041	$166,041	$114,066	$114,066
NPV	**$114,526,362**	**$68,866,643**	**$16,514,747**	**-$52,312,612**
BCR	**2.51**		**0.24**	

Table 80: Benefits – implementation of regulation (broad scope) (2019-2035) – Option 6a

Year	Gross Benefits	Net Benefits		
		Best Case	Likely Case	Worst Case
2019	-	-	-	-
2020	$448,271	-$16,792,622	-$33,690,024	-$55,212,308
2021	$2,309,603	-$17,498,644	-$36,619,916	-$64,364,750
2022	$5,873,614	-$16,547,498	-$37,952,349	-$72,073,149
2023	$11,365,252	$4,383,958	-$7,936,117	-$37,131,636
2024	$18,224,806	$11,554,580	-$500,385	-$28,882,404
2025	$25,406,694	$19,057,623	$7,282,339	-$20,248,703
2026	$32,503,643	$26,484,619	$15,002,001	-$11,644,714
2027	$39,110,243	$33,428,552	$22,248,681	-$3,487,507
2028	$45,184,133	$39,843,996	$28,965,229	$4,138,239
2029	$50,395,447	$45,404,185	$34,836,944	$10,946,011
2030	$54,881,895	$50,245,741	$39,998,196	$17,064,737
2031	$58,676,822	$54,401,780	$44,480,564	$22,522,272
2032	$61,781,657	$57,874,552	$48,291,596	$27,337,761
2033	$64,576,482	$61,042,095	$51,801,808	$31,864,645
2034	$66,933,087	$63,776,033	$54,881,859	$35,971,462
2035	$67,268,058	$67,268,058	$67,268,058	$67,268,058
2036	$63,710,906	$63,710,906	$63,710,906	$63,710,906
2037	$58,927,294	$58,927,294	$58,927,294	$58,927,294
2038	$53,298,079	$53,298,079	$53,298,079	$53,298,079
2039	$47,863,785	$47,863,785	$47,863,785	$47,863,785
2040	$42,418,840	$42,418,840	$42,418,840	$42,418,840
2041	$37,390,051	$37,390,051	$37,390,051	$37,390,051
2042	$33,066,643	$33,066,643	$33,066,643	$33,066,643
2043	$29,247,506	$29,247,506	$29,247,506	$29,247,506
2044	$26,433,787	$26,433,787	$26,433,787	$26,433,787
2045	$23,488,027	$23,488,027	$23,488,027	$23,488,027
2046	$21,056,695	$21,056,695	$21,056,695	$21,056,695
2047	$19,019,066	$19,019,066	$19,019,066	$19,019,066
2048	$16,735,304	$16,735,304	$16,735,304	$16,735,304
2049	$14,651,398	$14,651,398	$14,651,398	$14,651,398
2050	$12,684,412	$12,684,412	$12,684,412	$12,684,412
2051	$11,306,055	$11,306,055	$11,306,055	$11,306,055
2052	$10,038,525	$10,038,525	$10,038,525	$10,038,525
2053	$8,929,766	$8,929,766	$8,929,766	$8,929,766
2054	$7,798,627	$7,798,627	$7,798,627	$7,798,627
2055	$6,826,030	$6,826,030	$6,826,030	$6,826,030
2056	$5,993,439	$5,993,439	$5,993,439	$5,993,439
2057	$5,131,323	$5,131,323	$5,131,323	$5,131,323
2058	$4,266,986	$4,266,986	$4,266,986	$4,266,986
2059	$3,530,302	$3,530,302	$3,530,302	$3,530,302
2060	$2,867,461	$2,867,461	$2,867,461	$2,867,461
2061	$2,288,488	$2,288,488	$2,288,488	$2,288,488
2062	$1,732,114	$1,732,114	$1,732,114	$1,732,114
2063	$1,319,345	$1,319,345	$1,319,345	$1,319,345
2064	$995,587	$995,587	$995,587	$995,587
NPV	**$336,766,995**	**$265,942,398**	**$167,325,045**	**-$23,754,045**
BCR		**4.75**	**1.99**	**0.93**

Table 81: Benefits – implementation of regulation (medium scope) (2019-2035) – Option 6b

Year	Gross Benefits	Net Benefits		
		Best Case	Likely Case	Worst Case
2019	-	-	-	-
2020	$412,144	-$6,356,205	-$16,440,229	-$29,723,078
2021	$2,111,815	-$6,314,262	-$17,830,528	-$35,099,074
2022	$5,346,744	-$4,762,343	-$17,752,966	-$39,110,921
2023	$10,339,975	$7,040,075	-$2,076,181	-$22,218,901
2024	$16,557,707	$13,441,961	$4,479,600	-$15,164,287
2025	$23,057,486	$20,130,998	$11,332,755	-$7,787,109
2026	$29,477,804	$26,745,064	$18,120,087	-$453,260
2027	$35,424,569	$32,889,422	$24,444,788	$6,435,667
2028	$40,894,979	$38,561,774	$30,295,940	$12,849,993
2029	$45,570,021	$43,442,564	$35,362,886	$18,498,303
2030	$49,595,722	$47,677,446	$39,789,649	$23,520,942
2031	$53,010,249	$51,304,863	$43,613,576	$27,952,764
2032	$55,809,140	$54,319,774	$46,833,709	$31,800,988
2033	$58,371,258	$57,101,124	$49,823,320	$35,427,026
2034	$60,569,443	$59,521,839	$52,454,585	$38,701,550
2035	$60,895,810	$60,895,810	$60,895,810	$60,895,810
2036	$57,605,134	$57,605,134	$57,605,134	$57,605,134
2037	$53,203,021	$53,203,021	$53,203,021	$53,203,021
2038	$47,955,971	$47,955,971	$47,955,971	$47,955,971
2039	$42,941,119	$42,941,119	$42,941,119	$42,941,119
2040	$37,913,080	$37,913,080	$37,913,080	$37,913,080
2041	$33,299,273	$33,299,273	$33,299,273	$33,299,273
2042	$29,330,570	$29,330,570	$29,330,570	$29,330,570
2043	$25,815,882	$25,815,882	$25,815,882	$25,815,882
2044	$23,298,261	$23,298,261	$23,298,261	$23,298,261
2045	$20,627,730	$20,627,730	$20,627,730	$20,627,730
2046	$18,411,672	$18,411,672	$18,411,672	$18,411,672
2047	$16,552,423	$16,552,423	$16,552,423	$16,552,423
2048	$14,463,600	$14,463,600	$14,463,600	$14,463,600
2049	$12,570,222	$12,570,222	$12,570,222	$12,570,222
2050	$10,789,705	$10,789,705	$10,789,705	$10,789,705
2051	$9,573,183	$9,573,183	$9,573,183	$9,573,183
2052	$8,478,923	$8,478,923	$8,478,923	$8,478,923
2053	$7,512,593	$7,512,593	$7,512,593	$7,512,593
2054	$6,556,456	$6,556,456	$6,556,456	$6,556,456
2055	$5,741,488	$5,741,488	$5,741,488	$5,741,488
2056	$5,039,405	$5,039,405	$5,039,405	$5,039,405
2057	$4,312,321	$4,312,321	$4,312,321	$4,312,321
2058	$3,574,984	$3,574,984	$3,574,984	$3,574,984
2059	$2,978,815	$2,978,815	$2,978,815	$2,978,815
2060	$2,426,160	$2,426,160	$2,426,160	$2,426,160
2061	$1,933,959	$1,933,959	$1,933,959	$1,933,959
2062	$1,448,401	$1,448,401	$1,448,401	$1,448,401
2063	$1,103,890	$1,103,890	$1,103,890	$1,103,890
2064	$832,165	$832,165	$832,165	$832,165
NPV	**$303,348,975**	**$272,890,428**	**$204,454,458**	**$75,054,473**
BCR		**9.96**	**3.07**	**1.33**

Table 82: Benefits – implementation of regulation (narrow scope) (2019-2035) – Option 6c

Year	Gross Benefits	Net Benefits		
		Best Case	Likely Case	Worst Case
2019	-	-	-	-
2020	$375,275	-$3,037,049	-$10,784,802	-$20,281,739
2021	$1,909,991	-$2,241,861	-$10,618,430	-$21,828,520
2022	$4,809,065	-$87,195	-$9,116,844	-$22,093,301
2023	$9,293,629	$9,709,791	$3,845,088	-$7,100,380
2024	$14,855,632	$15,326,686	$9,502,776	-$1,263,779
2025	$20,657,304	$21,183,310	$15,406,001	$4,831,060
2026	$26,384,112	$26,965,104	$21,239,642	$10,867,782
2027	$31,653,914	$32,290,251	$26,620,664	$16,460,963
2028	$36,504,611	$37,200,752	$31,585,596	$21,637,282
2029	$40,628,481	$41,384,674	$35,828,190	$26,100,642
2030	$44,180,274	$44,997,116	$39,502,547	$30,003,257
2031	$47,203,157	$48,082,027	$42,651,965	$33,387,188
2032	$49,686,782	$50,627,077	$45,266,966	$36,247,656
2033	$52,008,548	$53,011,888	$47,723,373	$38,953,925
2034	$54,042,580	$55,110,922	$49,895,119	$41,379,048
2035	$54,358,453	$54,358,453	$54,358,453	$54,358,453
2036	$51,340,222	$51,340,222	$51,340,222	$51,340,222
2037	$47,330,479	$47,330,479	$47,330,479	$47,330,479
2038	$42,475,697	$42,475,697	$42,475,697	$42,475,697
2039	$37,892,681	$37,892,681	$37,892,681	$37,892,681
2040	$33,294,715	$33,294,715	$33,294,715	$33,294,715
2041	$29,109,865	$29,109,865	$29,109,865	$29,109,865
2042	$25,507,236	$25,507,236	$25,507,236	$25,507,236
2043	$22,306,200	$22,306,200	$22,306,200	$22,306,200
2044	$20,093,072	$20,093,072	$20,093,072	$20,093,072
2045	$17,705,998	$17,705,998	$17,705,998	$17,705,998
2046	$15,711,240	$15,711,240	$15,711,240	$15,711,240
2047	$14,034,088	$14,034,088	$14,034,088	$14,034,088
2048	$12,144,600	$12,144,600	$12,144,600	$12,144,600
2049	$10,445,001	$10,445,001	$10,445,001	$10,445,001
2050	$8,855,549	$8,855,549	$8,855,549	$8,855,549
2051	$7,804,438	$7,804,438	$7,804,438	$7,804,438
2052	$6,886,980	$6,886,980	$6,886,980	$6,886,980
2053	$6,065,561	$6,065,561	$6,065,561	$6,065,561
2054	$5,288,206	$5,288,206	$5,288,206	$5,288,206
2055	$4,633,977	$4,633,977	$4,633,977	$4,633,977
2056	$4,064,925	$4,064,925	$4,064,925	$4,064,925
2057	$3,475,776	$3,475,776	$3,475,776	$3,475,776
2058	$2,867,682	$2,867,682	$2,867,682	$2,867,682
2059	$2,414,879	$2,414,879	$2,414,879	$2,414,879
2060	$1,974,378	$1,974,378	$1,974,378	$1,974,378
2061	$1,571,029	$1,571,029	$1,571,029	$1,571,029
2062	$1,157,821	$1,157,821	$1,157,821	$1,157,821
2063	$883,274	$883,274	$883,274	$883,274
2064	$664,960	$664,960	$664,960	$664,960
NPV	**$269,128,136**	**$263,929,636**	**$216,310,336**	**$139,745,579**
BCR		**51.77**	**5.10**	**2.08**

Summary

Table 83: Summary of benefits, costs, lives saved and serious injuries avoided under each option

	Net Benefits ($m)	Cost to Business ($m)	Cost to Government ($m)	Benefit-Cost Ratio	Number of Lives Saved	Serious Injuries Avoided
Option 2a						
Best case	-	-	-	-		
Likely case	69	43	2.4	2.51	41	432
Worst case	-	-	-	-		
Option 2b						
Best case	-	-	-	-		
Likely case	-52	5.0	64	0.24	9	92
Worst case	-	-	-	-		
Option 6a						
Best case	266	70	0.7	4.75		
Likely case	167	169	0.7	1.99	148	1496
Worst case	-24	360	0.7	0.93		
Option 6b						
Best case	273	30	0.7	9.96		
Likely case	204	98	0.7	3.07	136	1292
Worst case	75	228	0.7	1.33		
Option 6c						
Best case	264	4.5	0.7	51.8		
Likely case	216	52	0.7	5.10	124	1084
Worst case	140	129	0.7	2.08		

APPENDIX 14 — BENEFIT-COST ANALYSIS — SENSITIVITIES

The following sensitivities were tested for the recommended option, Option 6c: regulation (narrow scope).

a) Base case

Table 84 Basic output (discount rate of 7 per cent)

	Net Benefit	Cost to Business	Cost to Government	Benefit-Cost Ratio	Number of Lives Saved	Serious Injuries Avoided
Best case	$264 m	$4.5 m	$0.7 m	51.8		
Likely case	**$216 m**	**$52 m**	**$0.7 m**	**5.10**	**124**	**1084**
Worst case	$140 m	$129 m	$0.7 m	2.08		

b) Changes to discount rate

Table 85 Discount rate of 3 per cent

	Net Benefit	Cost to Business	Cost to Government	Benefit-Cost Ratio	Number of Lives Saved	Serious Injuries Avoided
Best case	$520 m	$3.7 m	$1.1 m	109.8		
Likely case	**$452 m**	**$72 m**	**$1.1 m**	**7.19**	**124**	**1084**
Worst case	$341 m	$183 m	$1.1 m	2.85		

Table 86 Discount rate of 10 per cent

	Net Benefit	Cost to Business	Cost to Government	Benefit-Cost Ratio	Number of Lives Saved	Serious Injuries Avoided
Best case	$167 m	$4.5 m	$0.6 m	33.7		
Likely case	**$130 m**	**$42 m**	**$0.6 m**	**4.06**	**124**	**1084**
Worst case	$70 m	$101 m	$0.6 m	1.69		

c) Changes to effectiveness

Table 87 Low effectiveness

	Net Benefit	Cost to Business	Cost to Government	Benefit-Cost Ratio	Number of Lives Saved	Serious Injuries Avoided
Best case	$117 m	$4.5 m	$0.7 m	23.5		
Likely case	**$69 m**	**$52 m**	**$0.7 m**	**2.31**	**57**	**497**
Worst case	-$7.4 m	$129 m	$0.7 m	0.94		

Table 88 High effectiveness

	Net Benefit	Cost to Business	Cost to Government	Benefit-Cost Ratio	Number of Lives Saved	Serious Injuries Avoided
Best case	$388 m	$4.5 m	$0.7 m	75.7		
Likely case	**$341 m**	**$52 m**	**$0.7 m**	**7.45**	**181**	**1585**
Worst case	$264 m	$129 m	$0.7 m	3.04		

d) Changes to business as usual fitment rate

Table 89 Low BAU fitment

	Net Benefit	Cost to Business	Cost to Government	Benefit-Cost Ratio	Number of Lives Saved	Serious Injuries Avoided
Best case	$309 m	$8 m	$0.7 m	36.3		
Likely case	**$258 m**	**$58 m**	**$0.7 m**	**5.36**	**150**	**1304**
Worst case	$174 m	$143 m	$0.7 m	2.21		

Table 90 High BAU fitment

	Net Benefit	Cost to Business	Cost to Government	Benefit-Cost Ratio	Number of Lives Saved	Serious Injuries Avoided
Best case	$184 m	-$1.4 m	$0.7 m	n/a[7]		
Likely case	**$141 m**	**$41 m**	**$0.7 m**	**4.38**	**84**	**731**
Worst case	$79 m	$103 m	$0.7 m	1.76		

[7] Benefit-Cost ratio not applicable due to no net costs (i.e. savings are greater than costs).

APPENDIX 15— NHVBS OPERATOR/MAINTENANCE SURVEY JUNE 2015

Summary

An online and face-to-face survey was conducted in May/June 2015 with Australian heavy vehicle (Gross Vehicle Mass (GVM) and Aggregate Trailer Mass (ATM) of greater than 4.5 tonnes) operators and maintenance facilities, regarding the use and performance of advanced braking systems.

The survey covered a broad cross-section of the operator industry, including those driving exclusively in remote areas, exclusively in regional/city areas, or some combination of these. There was a variety of goods being carried, and road conditions encountered.

Advanced braking systems were believed to be good on winding roads and/or high speed conditions as well as slippery conditions. They were thought to be less effective on unsealed roads and there was some concern about the effect on these systems on other systems such as traction control.

The main reason for purchase was to improve safety. Other considerations were it being standard fitment on a vehicle, to reduce tyre wear, improve resale value and to be a good corporate citizen.

Regarding maintenance and reliability, issues are clearly centred around trailers rather than trucks, where there are few problems occurring. There may be scope for system suppliers to work with the industry to develop trailer installation guidelines. Regarding breakdowns, the more sensitive components are sensors/sensor rings, wiring and plugs. The frequency of failure however varies widely for operators.

Overall, operators recognised that there are added costs in running and maintaining advanced braking systems, but that these are outweighed by the prevention of rollovers and other crashes.

Regarding compatibility, there was less of an issue raised with this than expected. Solutions were being found in making adjustments to the systems. With the industry developing a code of practice, information should also soon be available to operators on using different brake technologies in multi-vehicle combinations.

Advanced braking systems offer the possibility of new ways of driver training, which are being used to various degrees by operators. Operators indicated that driver attitude towards them would often change after avoiding a crash through the activation of a stability system.

Introduction

This report is a summary of an online and face-to-face survey conducted in May/June 2015 with Australian heavy vehicle (Gross Vehicle Mass (GVM) and Aggregate Trailer Mass (ATM) of greater than 4.5 tonnes) operators and maintenance facilities, regarding the use and performance of advanced braking systems.

Under the *National Road Safety Strategy 2011-2020*, the *National Road Safety Action Plan 2015-2017* and the *National Heavy Vehicle Braking Strategy Phase II* (NHVBS II), the Department of Infrastructure and Regional Development (the Department) is considering the case for adopting the braking technology Electronic Stability Control (ESC) for new heavy vehicles[1].

Following the mandating of Antilock System (ABS)/ Variable Proportioning Brake System through the Australian Design Rules (ADRs) under the NHVBS I, the Department undertook to survey industry regarding the advantages and disadvantages, including reliability, of using other advanced braking systems, to support the development of a Regulatory Impact Statement (RIS) under the NHVBS II.

The initial online survey targeted operators and maintainers Australia wide in conjunction with the peak industry bodies, the ALRTA[2], ARTSA[3], ATA[4], CVIAA/HVIA[5] and TIC[6] via an industry reference group. The Department received over 70 responses and from this process and a shorter but more direct face-to-face survey was then designed. Interested operators/maintainers were then sought both from the initial survey, as well as through further consultation with the peak industry bodies.

Due to a variety of braking systems being considered and utilised, ranging from conventional brakes, through to ABS, ESC and Roll Stability Control (RSC) using EBS or TEBS, this report identifies all of these systems under the generic term advanced braking systems. There are further differences in functional ability within logic controlled systems such as ESC as well as a variety of different proprietary names, so some assumptions have been made in grouping of the systems into similar types.

Section 1 of this report outlines the nature of each operation in terms of types of haulage, roads, areas of operation, and operating conditions. This shows the diversity of operations for the 22 businesses that were interviewed.

Section 2 summarises the responses to the questions asked regarding advanced braking systems. In doing so it captures the experience of those that have implemented advanced braking systems (or have chosen not to) and any impacts, positive or negative, it has had on their operations.

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[1] National Road Safety Action Plan 2015-2017 Pg. 5 Action 8
http://transportinfrastructurecouncil.gov.au/publications/files/National_Road_Safety_Action_Plan_2015-2017.pdf

[2] Australian Livestock and Rural Transporters Association

[3] Australian Road Transport Suppliers Association Inc.

[4] Australian Trucking Association

[5] Commercial Vehicle Industry Association of Australia. Now also the Heavy Vehicle Industry Australia.

[6] Truck Industry Council

While this report will form part of the RIS for considering the case for adopting ESC for new heavy vehicles under the ADRs, it is also useful for industry and government alike to inform about the penetration of advanced braking systems into the Australian fleet. This is already happening outside of regulation, with industry adapting to the new technology in terms of running it alongside or along with older technology.

However, it is important to note that the survey does not replace the normal regulatory consultation process, which will include public distribution of the draft RIS for feedback, prior to the relevant Minister being asked to make any decision.

1. Diversity of Operations

Interviews with heavy vehicle operators around Australia were conducted over a period of two months (May and June 2015), at the operators' premises. In total there were 22 companies interviewed, following on from the 70 respondents of the initial online survey.

The candidates for interview were gathered in conjunction with the various peak industry bodies. There was an initial prospective list of 25 operators. As allowed for by the spread of locations and the time and travel logistics involved, 22 of these were able to be interviewed.

The map below shows the operator locations for the interviews: 5 in Queensland, 7 in New South Wales, 4 in Victoria, 4 in Western Australia and 2 in the Northern Territory. A mixture of different operating sectors, remoteness and fleet size was sought to try and capture the nature and diversity of operations across the country, including with regard to the area of operation. For example, one operator uses a route between Darwin and Townsville and another operates through the areas around the Goldfields and Port Hedland in Western Australia.

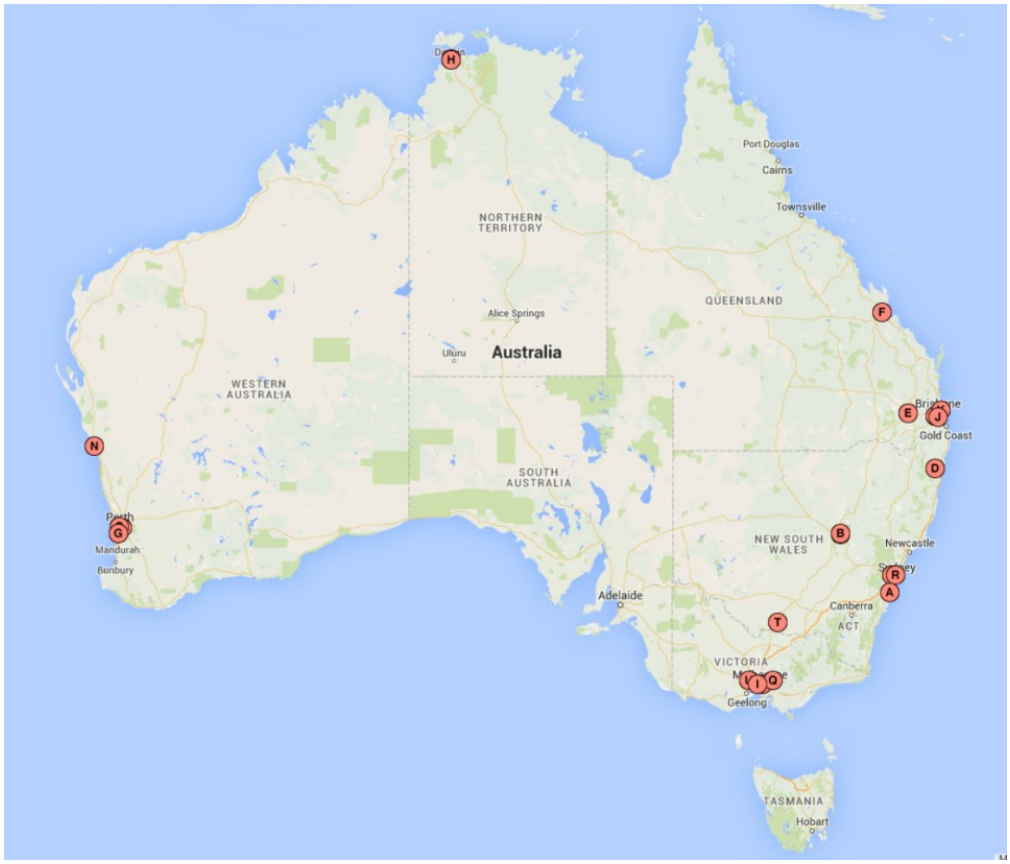


Figure 1: Locations of operators interviewed

1.1. Operator and fleet details

Details for those interviewed are shown in the table below. This includes the number of different types of heavy vehicles currently held in the operators' fleets.

Operator	Rigid Trucks	Prime Movers	Trailers	Converter Dollies
A	1	46	68	
B	8	12	48	6
C	3	12	22	3
D	4	21	30	0
E*	17	85	238	7
F		18	29	8
G	20	40	220	80
H				
I	50	100	330	6
J				
K		350	700	2
L		7	42	9
M	55	90	230	10
N		9	25	14
O	6	184	721	366
P	7		76	
Q	1	6	19	
R	115	90	200	12
S	3	81	252	6
T		30	70	8
U	7	91	115	2
V	7	150	163	
Total	342	1541	3919	677

*Includes other depots except those of F

Figure 2 below shows the combined distribution of these vehicles in this sector. The vehicles surveyed fall under the ADR NB2, NC, some TC and all TD categories of vehicles[7]

[7] These align with vehicle categories that have already been required to have ESC and/or RSC by the *United Nations Economic Commission for Europe* (UNECE) and the United States *National Highway Traffic Safety Administration* (NHTSA)).

Of the total number of vehicles identified, there were:

- 342 rigid trucks, 151 fitted with advanced braking systems.
- 1,541 prime movers, 575 fitted with advanced braking systems.
- 3,919 trailers, 1,080 fitted with advanced braking systems.

Also there were:

- 395 trailers fitted with load proportioning valves.
- 883 trailers fitted with conventional braking systems.

Not all operators were able to provide the fitment numbers for advanced braking systems within their fleets.

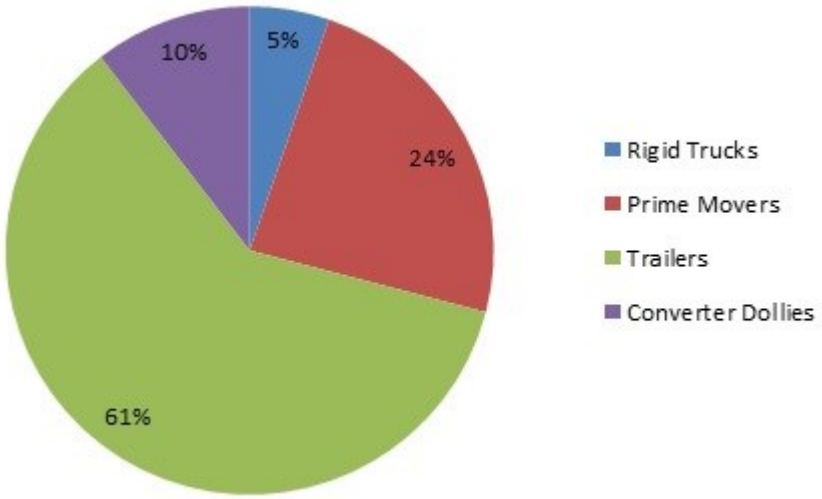
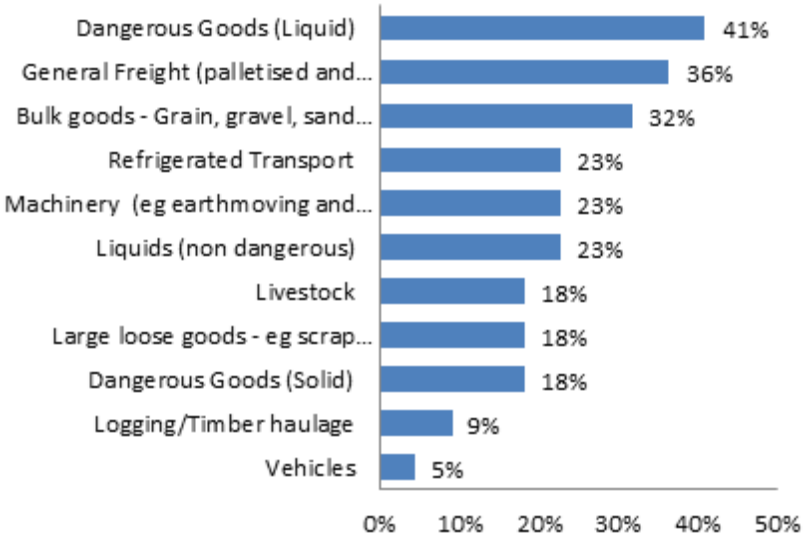


Figure 2: Distribution of vehicles

1.2. Nature of operations



Most operators carried a variety of goods, while only a few had specialised operations (such as gas or logging).

Operator	Local Delivery	Intrastate	Interstate	Notes
A	✓	✓		60% Wollongong / Newcastle /Sydney, 20% NSW country, 20% other.
B	✓	✓	✓	
C	✓	✓	✓	
D	✓	✓	✓	
E		✓	✓	East seaboard. Majority of work out of Oakey is livestock.
F	✓	✓	✓	
G		✓		Mostly within 400km radius of Perth.
H	✓	✓	✓	Specialising in remote delivery - community, mine sites.
I	✓	✓	✓	
J		✓		
K	✓	✓	✓	
L		✓		
M	✓	✓	✓	
N		✓		
O	✓			Usually within 100km of Port Headland within 100km of Kalgoorlie.
P	✓			All local Perth areas.
Q		✓		Wood planation around north west Melbourne.
R	✓	✓	✓	
S	✓	✓	✓	
T	✓	✓	✓	
U	✓	✓	✓	
V	✓	✓	✓	

Table 1 below provides a breakdown of the level of remoteness of the areas worked in. This was done using the remoteness map of Australia[8] as developed by the Australian Government Department of Health. This in turn is based on The Australian Standard Geographical Classification (ASGC) Remoteness Structure[9].

Table 1: Operational area by remoteness level

Operator	Very Remote (%)	Remote (%)	Outer Regional (%)	Inner Regional (%)	Major Cities (%)	Sealed Roads (%)	Unsealed Roads (%)	City /Town	State
A			10	30	60	98	2	Unanderra	NSW
B		10	45	35	10	90	10	Dubbo	NSW
C	50	10	10	15	15	70	30	Dubbo	NSW
D	5	10	55	20	10	95	5	Grafton	NSW
E		25	60	10	5	80	20	Oakey	QLD
F		20	50	30		90	10	Rockhampton	QLD
G		10	35	40	15	70	30	Hope Valley	WA
H						60	40	Berrimah	NT
I		5	15	60	20	98	2	Sunshine	VIC
J		20	40	30	10	90	10	Karawatha	QLD
K			100			80	20	Port of Brisbane	QLD
L	5	95				95	5	Berrimah	NT
M	5	5	5	70	15	98	2	Carole Park	QLD
N	20	40	40			80	20	Narngulu	WA
O	85	15				90	10	West Perth	WA
P				1	99	100		Perth Int. Airport	WA
Q			20	80		50	50	Heaslville	VIC
R	15	25	30	20	10	95	5	North Ryde	NSW
S	5	5	40	10	40	95	5	Camberwell	VIC
T	10	10	40	25	15	80	20	Beringan	NSW
U			15	70	15	97	3	Bacchus Marsh	VIC
V						95	5	Girraween	NSW

The data shows the variety of operating environments covered by the survey, with a mix of operators driving exclusively in remote areas, exclusively in regional/city areas, or some combination of these. Importantly, it also indicates that for those driving on unsealed roads, they do so for only part of their operations.

Of those operators that had vehicles driving on sealed roads, a few indicated that these can be poorly sealed secondary roads. Some of these roads have one middle bitumen lane, so the left-hand-side of the vehicle predominantly runs on the unsealed portion.

Table 2 below gives further details of the operating conditions regarding loading, traffic, road configurations and weather.

[8] ASGC Remoteness Areas http://www.doctorconnect.gov.au/internet/otd/Publishing.nsf/Content/locator

[9] The Australian Standard Geographical Classification (ASGC) Remoteness Structure
http://www.abs.gov.au/websitedbs/D3310114.nsf/home/remoteness+structure#Anchor2

Table 2: Types of operating conditions

Operator	Loading	Traffic conditions		Road surface			Road configuration				Weather conditions		
	Includes Travelling Empty	Local Traffic	Heavy Traffic	High Speed	Secondary Roads	Highway Conditions	Flat Roads	Hilly Roads	Winding-Flat Roads	Winding-Hilly Roads	Ice/Snow Conditions Roads	Slippery Conditions	Wet Conditions
A			✓		✓			✓			✓	✓	✓
B	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
C	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
D	✓				✓					✓	✓	✓	✓
E	✓												✓
F	✓		✓	✓				✓	✓				✓
G													
H	✓	✓	✓	✓	✓	✓		✓	✓	✓		✓	✓
I				✓	✓			✓	✓	✓		✓	✓
J	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓
K	✓		✓		✓			✓	✓	✓			✓
L	✓	✓	✓	✓	✓	✓	✓	✓					✓
M	✓	✓							✓	✓		✓	
N	✓	✓			✓			✓		✓			✓
O			✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
P	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
Q					✓								
R	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
S	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
T													
U	✓	✓		✓	✓	✓		✓		✓		✓	✓
V													
Total	15	10	11	12	14	10	8	15	12	13	8	12	16

The feedback in this case again shows the variety of conditions encountered and includes travelling empty, both high speed highway and winding, hilly roads as well as ice/snow and other slippery/wet conditions.

2. Advanced Braking Systems in Heavy Vehicle Operations

This section gives a summary of feedback around the use of advanced braking systems in operators' fleets. The questions focused on driver feedback, system reliability and any associated additional maintenance, as well as general views on advanced braking systems.

2.1. Effectiveness in various conditions

The most common views were that advanced systems were particularly effective on roads other than straight flat roads (that is; hilly roads, winding roads, undulations, change in camber, sweeping bends, downhill or combinations of these) and that it was not as effective off-road or on unsealed roads.

Others mentioned a benefit when travelling at high speed and when empty. It was recognised that there was improved control in slippery conditions, although this was regarding stability rather than quicker stopping. A specific benefit was suggested where hanging carcasses are being transported, due to the perceived advantage of EBS/ESC in dealing with swinging loads. A minority indicated they did not fit ESC as they believed that it was not effective on unsealed roads. A specific comment around the use of ESC on unsealed roads cited the inappropriate activation of traction control (as traction control shares some of the same components as advanced braking systems, there are some systems that have both traction control and EBS/ESC combined in the same package).

Overall, advanced systems were believed to be good on winding roads and/or high speed conditions as well as slippery conditions. They were thought to be less effective on unsealed roads and there was some concern about the effect on these systems on other systems such as traction control.

2.2. Reasons for purchasing

73 % of operators purchased advanced braking systems as they believed it improved safety. 41% indicated it was due to a regulatory requirement (for instance, requirements for carrying dangerous goods) 9% to trial their use, 5% to lower the costs of tyre wear and 5% because it was standard equipment with the vehicle they were purchasing. Other reasons included contract requirements, wanting to be a good corporate citizen, and improved resale value.

Overall, advanced braking systems were purchased for a number of reasons, most notably to improve safety.

2.3 Driver training

45% of operators provide some form of training on the advanced braking systems utilized in their fleet. Some instead provide information (pamphlets and other documents) while others do plan to start training. Level of training varies widely from basic knowledge of connections and warning lights to more knowledge of the system activation and safety implications (e.g. driving too close to the limit). Some use the data from the braking systems to counsel on driving behaviour. Others use live monitoring to counsel when an activation event occurs, while the incidence is still fresh in the driver's mind.

Advanced braking systems offer the possibility of new ways of training, from providing a basic knowledge of their operation to live monitoring and continuous feedback of driver and vehicle performance. The full range of training is being used by operators, to various degrees.

2.4. Crash avoidance

Most operators felt that advanced braking systems have prevented crashes occurring, but were often unable to give specific details. In many cases drivers were not coming forward with near-miss reports voluntarily, or were unaware of the automatic activations of braking systems at the time. Some operators use the historical data from braking systems to look for activations. In some organisations this data is then used to track drivers' performance and train and/or caution them.

Due to variations in road surfaces and construction, it was reported that trailers at the rear of longer combinations are on occasion becoming unsettled. One operator noted that they used to receive calls from concerned public complaining of swinging or swerving trailers on road trains, but this has stopped since fitting TEBS.

Another operator cited an example of a driver that had to make an emergency stop in a road train. The driver, who was initially sceptical of advanced braking systems, was surprised that he was able to pull up straight on the road, without flat-spotting any wheels, and without tipping a trailer. He felt that this would not have been possible with conventional brakes .

In another example, an operator with a truck carrying a hanging load of carcasses struck a trailer that had rolled in front of him. His vehicle continued on. After checking the EBS diagnostics he found that it had been activated and attributed this to his truck remaining upright – he believes it would have rolled otherwise as well.

In a final example, an operator had a road train fully equipped with EBS that was pushed off the road shoulder into bushland. The operator believed that if it had not been for the EBS, at least one of the trailers would have rolled. In this case no trailer rolled.

It is clear that advanced braking systems can and do prevent crashes, with an added benefit that system activations can help with training and prevention of incidents occurring. Concrete examples are available that show the ability for these systems to take-over in an emergency situation, with good results.

2.5. Breakdowns, maintenance and system/component reliability

The general consensus across operators was that trucks and prime movers have few issues with the operation and reliability of advanced braking systems. This was thought to because where trucks and prime movers are fitted with these systems, they have been fully designed into the vehicle.

The focus of the reliability issues was with trailers, where the systems are more of an add-on product. In this respect , the majority of operators reported a need to do a pre-operation check of trailers when new, to fix wiring and sensor issues such as hanging wires susceptible to debris strikes; sections of wire that need stress relief to prevent fatigue failures; improperly mounted sensors.

The majority of breakdowns specific to advanced braking systems were around wiring and speed sensors/pole rings. ABS/EBS plugs were considered somewhat susceptible to corrosion of the pins and to case damage.

Some operators noted the benefits of the electronics in advanced systems being able to provide a diagnostic feature. This enables them to more readily pick up any issues with a braking system as compared to conventional brakes.

When wiring or wheel/speed sensor damage does occur in operation, it is often due to debris strikes such as those by rocks and animals. Corrugations can also cause damage to wiring and sensors through vibration.

One operator in forestry work has had an issue on some trailers where the heat from the disc brake heated the debris cover plate, which then funnelled heat along the axle and caused the wheel sensor wiring to melt through. He uses factory genuine heat shields to protect the sensors but has not had much success in preventing the issue.

Another issue with EBS plugs relates to their depth for plugging in. In rural areas, where the combination stays together over long periods, a build-up of dirt can occur making it difficult to separate the connection. Drivers often then try to pry the plugs apart and in doing so damage them.

The following figure indicates which components of braking systems needed the most maintenance.

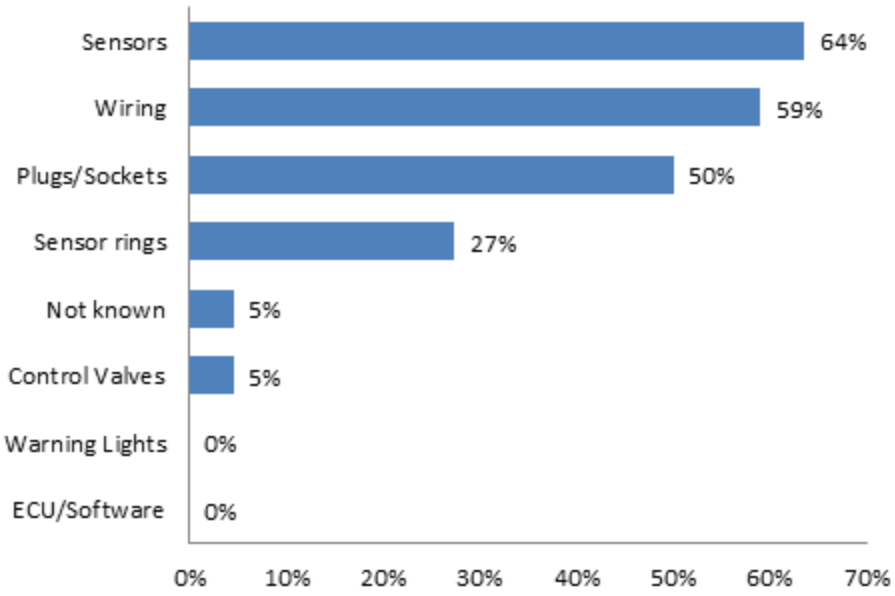


Figure 3: Components requiring the most maintenance

36% of respondents indicated that they had policies to fix ESC/ABS faults immediately or before the truck leaves the yard.

The rate of component failure or issues with advanced braking systems requiring repair before scheduled services varied greatly between respondents. Some had several issues per month while others have only had a few issues over years of operating. The sample size was too small to reliably determine a cause, especially given the range of variables including trailer design, operating conditions and maintenance decisions.

Looking at the components most likely to need replacement, wheel sensors and EBS plugs, wheel sensor costs (including labour for replacement) is around $200-$300, while an EBS plug is at least $35 (this can vary widely depending on what brand and casing is specified). Some operators keep stock of sensors and wiring due to their remote location (resulting in high lead times on parts).

Regarding maintenance resources, over half of the respondents indicated that they used a mix of in-house and dealer or third party maintenance, a third conducted all maintenance in-house, and the remainder used a dealer or third party exclusively. One of those that used a third part exclusively had the maintenance conducted onsite by repair staff contracted from a local dealer. Most of those that used a combination of maintenance methods used the third party or dealer for parts where they did not have the expertise or tools to conduct the maintenance. One example of this was a valve unit that needed reprograming by a dealer.

It was also generally reported that there is extra time needed to download data for diagnostics from the braking systems (up to 30 minutes). Diagnostic software can have a large upfront cost and high monthly costs (one operator claimed $200 per month). Pole rings can get clogged and need cleaning[10]. Most operators indicated the need for an extra 30 to 60 minutes for scheduled maintenance time per vehicle to check and maintain components.

Overall, operators recognised that there are added costs in running and maintaining advanced braking systems. However, they accept this as they believe that they have been saved from larger costs in the prevention of rollovers and other crashes.

Issues of reliability and maintenance are clearly centred on trailers rather than trucks. It is clear that the added complexity of advanced braking systems leads in some instances to an increased risk of breakdown in operation for trailers and in general a need for additional maintenance requirements (and more complex work that results in a need to contract out to a third party). The more sensitive components are sensors/sensor rings, wiring and plugs. The frequency of failure however varies widely for operators.

A consistent finding was that a lot of potential for failure appears to come from the original build of the trailers with regards to how the braking systems are installed. There may be scope for system suppliers to work with the industry to develop installation guidelines that could reduce some of these issues.

The final conclusion, as reported by those operators using advanced brake systems, is also clear: that the added cost is worth it when put against the savings in preventing rollovers and other crashes.

2.6. Brake performance

There was little feedback on the question of whether advanced braking systems generally improve brake performance over conventional systems

[10] One successful solution an operator has implemented is to use silicone to fill gaps in pole rings to prevent iron-rich soil from clogging them up.

One operator reported perception issues with a basic EBS system on new prime movers from a particular brand, with the drivers feeling like the systems wouldn't be able to control the combination well in an emergency braking situation. One operator questioned the availability of quality brake parts. They had difficulty trying to find genuine spares and were offered replacements that they felt would not be as durable.

Overall, operators were fairly neutral on this aspect of advanced braking systems.

2.7. Brake and tyre wear

Some operators commented that brake and tyre wear appears to have improved with EBS/ESC. Conversely one operator reported higher wear on truck brakes. Similar comments were made by a number of operators regarding both trucks and trailers and with a wide range of positive and negative experiences. Regarding tyre wear specifically, while one operator strongly agreed that tyres do not wear as quickly (in that they have noticed less flat spots), another felt that it was too hard to tell either way.

It was apparent that different operators have had different experiences with brake and tyre wear. While driving style could play a part in this, system design and settings would also affect it, as would the basic brake configuration that the systems were fitted to.

2.8. Automatic slack adjusters

There were some issues with automatic slack adjusters reported. Some were being converted back to manual slack adjusters, including where in combination with ESC systems. In some instances auto slack adjusters have not been working, leading to uneven braking performance within combinations. Dirt build up was thought to be the main reason for this in these cases.

One operator outlined an incident where auto slack adjusters locked up, causing extremely hot wheels. The driver tried to manually unlock them but was not able to. This same operator felt that service personnel pay less attention than they should to the brakes when auto slack adjusters are fitted.

Converting back to manual slack adjusters increases the probability for brakes to be out of adjustment. A study by the National Research Council of Canada, *Assessment of the Effect of Automatic Slack Adjusters*, found manual slack adjusters were put out-of-service at a rate 150 per cent higher than their population in the Ontario fleet[11].

While there were some incidences of problems with slack adjusters, overall they appeared to be working acceptably in the broader fleet.

2.9. Different combinations of brake technologies

[11] Assessment of the Effect of Automatic Slack Adjusters on Brake Adjustment https://www.tc.gc.ca/media/documents/roadsafety/tp14214es.pdf

Where there was a concern about combining technologies it was mainly related to the compatibility of different EBS/ESC systems. Two operators reported issues with different brands of systems. Regarding different braking technologies, one operator had issues with conventionally braked trailers behind EBS/ESC equipped trucks with disc brakes, with the prime mover doing more work when braking. Alternatively, another operator using EBS trailers behind conventionally braked prime movers reported that the trailer brakes were wearing out quicker. One operator felt the issue with combinations was the difference in the delay of the brake signal (i.e. an EBS prime mover braking by wire and then relaying the signal over air to a conventionally braked trailer). Some operators avoided mismatching technologies in combinations to avoid any potential problems.

However, 27% say they have had no issues, with one saying they are no worse off than conventional brakes and another saying that there is smoother braking even when using mismatched technologies (when compared to solely conventional brakes). One of these operators initially did have problems but was able to readjust the conventional brakes to behave well in conjunction with an EBS equipped vehicle. Another operator felt there were no issues within their fleet in mixing disc brakes on prime movers with drum brakes on trailers, or vice-versa.

There were different experiences with compatibility but for some, solutions were found in making adjustments to the systems involved. In this respect, the heavy vehicle industry is known to be developing a code of practice (advisory) that recognises the increased variety of braking systems available in the fleet and offers guidance on the best way to combine separate units together to optimise braking performance (i.e. advice for drivers/operators). This material will supplement other advisory material by the industry that gives guidance on setting up individual systems in (i.e. advice for designers/maintainers).

2.10. Load Proportioning (LP) systems

There was little comment on the use of LP systems, other than when laden. Trailers equipped with this feature appeared to perform worse than a conventional system when laden, possibly due to an increase in activation timing due to the extra valving. One operator confirmed this in his case by temporarily by-passing the valve for test purposes.

While this may be the case when laden, LP systems are primarily fitted to facilitate balanced braking when the combination is empty.

2.11. Traction control

A small number of issues were reported whereby traction control seems to interact with EBS/ESC systems to temporarily de-rate the engine. This is where the system detects wheel-slip when one set of wheels on one side of the vehicle is on the softer roadside verge, or otherwise when the vehicle is in slippery conditions.

Although this is primarily a traction control issue, it can appear to be related to EBS/ESC due to the shared componentry and where there is a shared on/off control for both systems.

3. Conclusions and recommendations

3.1. Conclusion

The Operator Maintenance/Survey aimed to explore the advantages and disadvantages, as well as aspects such as reliability, of advanced braking systems (ABS, ESC or Roll Stability Control (RSC) using EBS or TEBS) in Australia. It employed a range of questions in a written survey, followed by face-to-face interviews.

The survey covered a broad cross-section of the operator industry, including those driving exclusively in remote areas, exclusively in regional/city areas, or some combination of these. There was a variety of goods being carried, and road conditions encountered. This included short and long distances, travelling empty or full, high speed highway and winding, hilly roads, as well as ice/snow and other slippery/wet conditions.

Advanced systems were believed to be good on winding roads and/or high speed conditions as well as slippery conditions. Concrete examples are available that show the ability for these systems to take-over in an emergency situation, with good results. They were thought to be less effective on unsealed roads and there was some concern about the effect of these systems on other systems such as traction control. Where not required by regulation, the main reason for purchase was to improve safety. Other considerations were it being standard fitment on a vehicle, to reduce tyre wear, improve resale value and to be a good corporate citizen.

Advanced braking systems offer the possibility of new ways of training, from providing a basic knowledge of their operation to live monitoring and continuous feedback of driver and vehicle performance. The full range of training is being used by operators, to various degrees.

Regarding maintenance and reliability, issues are clearly centred around trailers rather than trucks, where there are few issues occurring. In addition, a lot of potential for failure appears to come from the original build of the trailers with regards to how the braking systems are installed. There may be scope for system suppliers to work with the industry to develop installation guidelines that could reduce some of these issues.

It is clear that the added complexity of advanced braking systems leads in some instances to an increased risk of breakdown in operation for trailers and in general a need for additional maintenance requirements (and more complex work that results in a need to contract out to a third party). The more sensitive components are sensors/sensor rings, wiring and plugs. The frequency of failure however varies widely for operators.

Overall, operators recognised that there are added costs in running and maintaining advanced braking systems. However, they accept this as they believe that they have been saved from larger costs in the prevention of rollovers and other crashes.

Regarding compatibility, there was less of an issue raised with this than expected and has been anecdotally reported in other forums. Solutions were being found in making adjustments to the systems involved. In this respect, the heavy vehicle industry is known to be developing a code of practice (advisory) that recognises the increased variety of braking systems available in the fleet and offers guidance on the best way to combine separate units together to optimise braking performance (i.e. advice for drivers/operators). This material will

supplement other advisory material by the industry that gives guidance on setting up individual systems (i.e. advice for designers/maintainers).

3.2. Recommendations

Subsequent to the conclusions to this survey, the following are considerations for both the development of a RIS in line with NHVBS II and general feedback for the heavy vehicle industry.

For the RIS, one key concern was the compatibility of varying levels of brake technologies in combinations of vehicles. The feedback from this survey indicated that this is less of an issue than previously thought and along with the industry developed code of practice, sufficient information should also be available to operators on using various brake technologies in combination. Operators should be aware that they may need to make adjustments to their braking systems to gain optimal performance for their vehicle combinations, and that conventionally braked vehicles may need to be adjusted to work in combination with newer brake technologies.

Although not directly brought up in this survey, some of the issues of compatibility could be due to the difference in voltages and standards used in CAN bus communication. Due to both an ISO and SAE standard for CAN bus communication, a previous ADR revision requiring 12 volt ABS power, and the availability of both 12 and 24 volt systems in Australia, future revisions of the ADRs could be used to clarify some of the technical details and requirements.

Of consideration to industry, and directly related to advanced braking systems, driver understanding of how and why the system activates is a key component in gaining acceptance of these systems throughout the industry. From the responses given, operators indicated that driver attitude towards advanced braking systems would often change after avoiding a crash through the activation of a stability system. When drivers understand why the system activates, they change their driving style to be more sympathetic towards the system and inherently become safer drivers. Whether through mandating ESC or the gradual uptake of technology by industry, driver education for the systems they are using is an important consideration that industry should keep actively developing and implementing.

There are some concerns from operators around the durability and installation of components used in advanced braking systems. Some of these might be alleviated through an industry guide to wiring, specifically installation to avoid being damaged from both strikes and areas where fatigue failures can occur. Beyond this, component manufacturers should look carefully at the design of components such as wheel sensors and plugs to ensure that they can best meet the working environment of Australia.

It is evident that automatic slack adjusters are a concern for some operators. While the ADRs require automatic slack adjusters for ABS equipped vehicles, some operators replace these with manual slack adjusters due to operational conditions. Although this is contrary to the intended effect of mandating automatic slack adjusters, and the overall improvement in safety it provides, a well maintained manual slack adjuster will be more effective than an automatic type in areas where conditions foul up the automatic mechanism. There were some concerns of automatic slack adjusters being thought to be self-maintaining and

requiring less servicing. There could be some scope for industry to educate mechanics, drivers, and operators on the need to properly maintain slack adjusters and the importance of keeping automatic slack adjusters installed where there is no operational need for manual adjusters. Operators should continue to consider what is best for their fleet with regards to slack adjusters, but regardless of type, make sure they are properly maintained.

References

[1] Transport and Infrastructure Council (2014), *National Road Safety Action Plan 2015-2017* http://transportinfrastructurecouncil.gov.au/publications/files/National_Road_Safety_Action_Plan_2015-2017.pdf

[8] Australian Government Department of Health, *ASGC Remoteness Areas* http://www.doctorconnect.gov.au/internet/otd/Publishing.nsf/Content/locator

[9] Australian Bureau of Statistics (2014), *The Australian Standard Geographical Classification (ASGC) Remoteness Structure* http://www.abs.gov.au/websitedbs/D3310114.nsf/home/remoteness+structure#Anchor2

APPENDIX 16 — TECHNICAL LIAISON GROUP (TLG)

Organisation

Manufacturer Representatives
Australian Road Transport Suppliers Association
Bus Industry Confederation
Caravan Industry Association of Australia Ltd
Commercial Vehicle Industry Association of Australia
Federal Chamber of Automotive Industries
Federation of Automotive Product Manufacturers
Heavy Vehicle Industry Association
Truck Industry Council

Consumer Representatives
Australian Automobile Association
Australian Automotive Aftermarket Association
Australian Motorcycle Council
Australian Trucking Association

Government Representatives
Department of Infrastructure, Regional Development and Cities, Australian Government
Department of Infrastructure, Energy and Resources, Tasmania
Department of Infrastructure, Planning and Logistics, Northern Territory
Department of Planning, Transport and Infrastructure, South Australia
Department of Transport, Western Australia
Department of Transport and Main Roads, Queensland
National Heavy Vehicle Regulator
New Zealand Transport Agency
Roads and Maritime Services, New South Wales
Transport for NSW, Centre for Road Safety, New South Wales
Transport Regulation, Justice & Community Safety, Australian Capital Territory
VicRoads, Victoria

Inter Governmental Agency
National Transport Commission

APPENDIX 17 — NHVBS PHASE II INDUSTRY REFERENCE GROUP (IRG)

NHVBS Phase II IRG Member Organisations

Industry (manufacturer) Representatives
Australian Road Transport Suppliers Association
Bus Industry Confederation
Commercial Vehicle Industry Association of Australia
Truck Industry Council
Heavy Vehicle Industry Australia

Operator Representatives
Australian Livestock and Rural Transporters' Association
Australian Trucking Association

Government Representatives
Department of Infrastructure, Regional Development and Cities, Australian Government
National Heavy Vehicle Regulator

APPENDIX 18 — SUMMARY OF PUBLIC COMMENTS

Correspondent	Comment Summary	Departmental Response
Air Brake Systems Pty Ltd	1. Supports Option 6c in the consultation RIS.	1. Agreed.
	2. Supports mandating of automatic slack adjusters on all trailer brake systems.	2. Agreed.
	3. Notes LPV and standard brake systems are often upgraded to electronic brake systems.	3. Noted.
	4. Understands practicalities of the proposal to exempt converter dollies from mandatory fitment of ABS and RSC. Notes that there is a much better safety outcome when converter dollies are also controlled by an electronic brake system.	4. Noted.
	5. Supports the proposed timeline for the implementation of ADR 38/05.	5. Agreed.
Australian Livestock and Rural Transporters' Association (ALRTA)	1. Considers that the ATA submission represents the ALRTA position on the consultation RIS proposals.	1. Noted.

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Correspondent	Comment Summary	Departmental Response
	2. In summary, supports: a. mandating ESC for trucks and RSC for trailers (including on spring suspension); b. a specific exemption for converter dollies (with a requirement for through wiring); c. a requirement for road train rated equipment to supply 24V; d. a manual off-switch that re-engages at speeds above 40 km/h; and e. automatic slack adjusters.	2. Notes the responses to the RIS questions and support for these changes.
	3. Recommends that the Australian Government adopt Option 6a, rather than the option recommended in the consultation RIS (Option 6c). Option 6a will deliver the safest outcome, with a very reasonable BCR of 1.99 and expected net benefits of $167m.	3. Acknowledges the decrease in trauma under Option 6a relative to Options 6b and 6c. However, under the Australian Government Guide to Regulation, the policy option offering the greatest net benefit should always be the recommended option. Further analysis and consultation was conducted to extend to short wheelbase NC rigids (see Appendix 19). ESC on heavy rigid vehicles may be included as part of a package when AEBS on heavy vehicles is considered (proposed action item under the 2018-2020 NRSAP).
Australian Trucking Association (ATA)	1. Supports Option 6a in the consultation RIS, because it is the option that would save the greatest number of lives and avoid the greatest number of accidents, and would do so at a reasonable cost.	1. Acknowledges the decrease in trauma under Option 6a relative to Options 6b and 6c. However, under the Australian Government Guide to Regulation, the policy option offering the greatest net benefit should always be the recommended option.

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Correspondent	Comment Summary	Departmental Response
	2. Would accept a reasonable extension of the implementation timetable for category NB2 vehicles.	2. Further analysis and consultation was conducted to extend to short wheelbase NC rigids (see Appendix 19). ESC on heavy rigid vehicles may be included as part of a package when AEBS on heavy vehicles is considered (proposed action item under the 2018-2020 National Road Safety Action Plan (NRSAP).
	3. Recommends the final version of the RIS, value the cost of a serious injury at $392,967, consistent with the willingness-to-pay based approach endorsed by governments.	3. The approach to cost of life and injury values used has been established through previous RISs including acceptance of these figures and methodology by OBPR. This is reviewed during each RIS. For this RIS, additional consideration was given to assessing the cost of heavy vehicles. The suggested change in serious injury value is based on the sensitivity analysis in BITRE (2009). Further analysis was conducted using this value in Appendix 19. This change does not affect the ranking of Option 6a, which remains the value with the lowest net benefit.
	4. Recommends the Government, if it were to decide to go ahead with Options 6b or 6c, put in place controls to reduce the risk of loss of control/rollover crashes involving new trucks not covered by the mandate. This could, for example, include the awareness campaign envisaged in Option 2 in the consultation RIS.	4. Noted. Item 9 of the NRSAP 2015-2017 is to promote the uptake of new vehicle technologies with high safety potential. This is likely to be continued in the next action plan, with action from relevant stakeholders required to maximise the potential of this item.

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Correspondent	Comment Summary	Departmental Response
	5. Notes that Australia's work health and safety laws generally require businesses to eliminate or minimise risk in so far as is reasonably practicable, that the Heavy Vehicle National Law will include a comparable requirement from mid-2018, and that cost must be grossly disproportionate to the risk for a control measure to be regarded as not reasonably practicable.	5. Noted.
	6. Considers that a typical work health and safety risk assessment, as well as the UK treasury framework for assessing proposals that affect public safety, would suggest that the risk of a rollover/loss of control crash involving a rigid truck is sufficiently high to warrant control measures to reduce it in so far as is reasonably practicable. Acknowledges that regulatory decisions are not within the ambit of work health and safety law, but considers that this approach can support government decision making.	6. Noted. As with the requirements under the NHVL, vehicle/fleet owners should assess the risks of operating a vehicle and their duties under legislation. This would include, were necessary, to introduce engineering solutions regardless of whether a particular technology is mandated.
	7. Recommends the National Heavy Vehicle Inspection Manual be amended before ADRs 35/06 and 38/05 come into force, to provide inspectors and the industry with guidance that: a. new trucks and trailers used in road train combinations must be wired for 24V power; and b. the power cables connecting new trucks and trailers in road train combinations must be	7. This would be a consideration for the NHVR. It has been involved in the IRG, and is consulted through SVSEG/SVTG and TLG/AMVCB on ADR changes.

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Correspondent	Comment Summary	Departmental Response
	configured and connected to supply 24V power.	
	8. Supports exemption from mandatory fitment of RSC for converter dollies. Suggests there is a safety case for requiring all of the units in PBS A-Doubles to be fitted with ABS/RSC, including converter dollies. The risk of a rollover or a loss of control crash faced by these A-Doubles could be treated by amending the PBS rules for new designs and new vehicles built under existing designs rather than altering the exemption in draft ADR 38/05.	8. Noted. This would be a consideration for the PBS authorities. Agree with leaving the exemption as is, until further work can be done on assessing braking for converter dollies.
	9. Supports mandating of RSC on trailers with air suspension as well as trailers with steel spring suspension. Notes there are steel spring trailers with stability control systems operating successfully in Australia already.	9. Notes the response to the RIS question. This acknowledges that there is a need for RSC on steel sprung trailers in Australia.
	10. Supports mandating automatic slack adjusters on all trailers.	10. Notes the response to the RIS question and support for this change.
	11. Supports the allowance provided in the draft ADRs for a manual ESC off-switch that re-engages at speeds above 40 km/h. Considers this function will help truck drivers negotiate creeks, paddocks and tight turns through farm gates.	11. Notes the response to the RIS questions and support for the inclusion of switch to aid operators in certain low speed manoeuvres.

Correspondent	Comment Summary	Departmental Response
Department of Planning, Transport and Infrastructure, South Australia	1. Supports adoption of Option 6c in the consultation RIS. Although Option 6a, which provides the greatest road safety benefit, would ultimately be the preferred option, understands and supports the reasoning behind the recommendation for Option 6c.	1. Agreed
	2. Supports the proposal to require RSC on trailers with air suspension as well as other types of suspension (such as steel springs). Notes trailers are a common initiator of heavy vehicle rollovers. Does not believe there are any significant barriers to fitting RSC to new trailers, including those with steel springs.	2. Notes the response to the RIS question. This acknowledges that there is a need for RSC on steel sprung trailers in Australia.
	3. Supports the proposal to extend the requirement for automatic slack adjusters to all category TC and TD trailers. Advises that Vehicle Inspectors regularly report occurrences of poor manual brake adjustment on heavy trailers.	3. Notes the response to the RIS question and support for this change.
	4. Notes that 'prime mover' is not an ADR vehicle category. Would prefer requirements to cover all category NC vehicles.	4. Noted. This would be similar to the Option 6b scenario. Further analysis and consultation was conducted to extend to short wheelbase NC rigids (see Appendix 19). ESC on heavy rigid vehicles may be included as part of a package when AEBS on heavy vehicles is considered (proposed action item under the 2018-2020 NRSAP).

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Correspondent	Comment Summary	Departmental Response
	5. Proposes common applicability dates of 1 July 2019 for new model vehicles and 1 July 2020 for all new vehicles, for both ADR 35/06 and ADR 38/05.	5. Noted. Trailer RSC is already able to be equipped to existing trailer models without the lead time needed to develop ESC systems for motorised vehicles. The brake kits are designed to fit a range of models with adjustments made to suit the specific model of trailer. This is why an earlier implementation date has been set for trailers than for motorised vehicles.
Department of Transport and Main Roads, Queensland	1. Supports adoption of Option 6b in the consultation RIS, varied to expand the proposed requirements for RSC on trailers, to apply to both category TC trailers with a GTM greater than 4.5 tonnes and category TD trailers.	1. Noted. This proposed extension would fall between options 6a and 6b, with net benefits also reducing below those of 6b but remaining higher than 6a. This is still below the recommended Option 6c.
	2. Would prefer ESC to be mandated for ADR category NC vehicles (as per UN R13), rather than just prime movers (like the US). Notes that 'prime mover' is not an ADR category.	2. Noted. This would be similar to Option 6b. Refer to response 1 above.
	3. Would prefer that RSC also be required for category TC trailers above 4.5 tonnes GTM.	3. Refer to response 1 above.
	4. Believes the readiness of manufacturers is likely to be high, considering that category NC vehicles in Australia are largely sourced from three markets (Europe, North America and Japan) or are locally assembled based on their overall design/origin from those three markets, and bus subassemblies in Australia are largely of European design/origin.	4. This has been considered in the benefit-cost analysis. Although chassis models are often sourced from both Europe and the US, there are still differences in the final Australian supplied configurations. The Department has consulted further with industry and believe the revised implementation times are the most appropriate.

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Correspondent	Comment Summary	Departmental Response
	5. Proposes common applicability dates of 1 July 2019 for new model vehicles and 1 July 2020 for all new vehicles, for both ADR 35/06 and ADR 38/05.	5. Noted. Trailer RSC is already able to be equipped to existing trailer models without the lead time needed to develop ESC systems for motorised vehicles. The brake kits are designed to fit a range of models with adjustments made to suit the specific model of trailer. This is why an earlier implementation date has been set for trailers than for motorised vehicles.
McLean Technical Services	1. Considers that the Australian road network is third world compared to Europe and the US, and that mandating of ABS, EBS or ESC should not be considered until the quality and consistency of Australian roads improves by several orders of magnitude.	1. Technical issues of the technology has been informed by the IRG which includes technical professionals involved in the heavy vehicle industry (refer to section 7.2). There has been no road issues raised that would prevent the use of these technologies and they have been used successfully for a number of years on a voluntary basis.
	2. Suggests the activation trigger level of stability control systems is typically set too low/conservative (around 0.25g), which can cause premature brake wear and subsequently reduce brake performance.	2. ESC systems that comply with the testing requirements suggested in this RIS are based on an ESC activation of around 0.4g.
	3. Considers ABS, EBS and ESC are complex, delicate and expensive components, completely incompatible with mud, bull dust, and other harsh/adverse road conditions in Australia.	3. There are a variety of ways to protect the sensitive components of a brake system using these technologies. This includes shielding and proper wiring of the system. This issue was explored in the NHVBS Operator/Maintenance Survey (Appendix 15).

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Correspondent	Comment Summary	Departmental Response
	4. Believes mandating of ABS, EBS and ESC on heavy vehicles will promote the continued operation of older vehicles and ageing of the heavy vehicle fleet due to the cost, complexity and adverse characteristics of newer vehicles.	4. Noted. However the systems being considered are a relatively small part of the overall purchase cost of a heavy vehicle and owners/operators increasingly recognise the benefits in terms of reduced crashes.
	5. Is concerned that breakdowns due to ABS, EBS or ESC malfunction in remote locations will result in the loss of perishable, high value or dangerous freight. Is also concerned freight insurance costs will skyrocket and drivers will lose income for failing to complete haulage tasks.	5. These systems are already in use across Australia. The NHVBS Operator/Maintenance Survey (Appendix 15) included operators such as meat haulage which were using the technology. Despite some technical issues, overall the responses were positive to the technology.
	6. Recommends mandating that all air suspended axle groups be fitted with dynamic load sharing inherently damped fractional feedback unitary ride height controlled suspension systems.	6. This technology has not been supported by any of the general or specialised consultative forums as a viable technical solution to the safety issues being considered by this RIS.
(NatRoad)	1. Supports adoption of Option 6a in the consultation RIS.	1. Acknowledges the decrease in trauma under Option 6a relative to Options 6b and 6c. However, under the Australian Government Guide to Regulation, the policy option offering the greatest net benefit should always be the recommended option. Further analysis and consultation was conducted to extend to short wheelbase NC rigids (see Appendix 19). ESC on heavy rigid vehicles may be included as part of a package when AEBS on heavy vehicles is considered (proposed action item under the 2018-2020

Correspondent	Comment Summary	Departmental Response
		NRSAP).
	2. States that changes to the law relating to heavy vehicle safety should not focus primarily on changes to regulations relating to heavy vehicles, as heavy vehicles are usually not at fault. However, is supportive of measures which, on the evidence, are likely to reduce the incidence of heavy vehicle crashes.	2. Noted. However, a significant proportion of heavy vehicle rollover or loss of control crashes are single vehicle accidents. ESC and RSC will aid in reducing the severity of or preventing these crashes.
	3. Supports the use of engineering controls to regulate risk. Believes these are far more effective than administrative controls.	3. Noted.
	4. Agrees that ESC and RSC substantially reduce rollover and loss of control crashes.	4. Agreed.
	5. Agrees that the take up of ESC and RSC for heavy vehicles in Australia has been limited to date and that Government action is needed to accelerate the process.	5. Noted.
	6. Supports conformity with overseas standards in jurisdictions where ESC and RSC have been mandated, as well as greater conformity with international standards.	6. Agreed.
	7. Believes the additional cost of Option 6a is not disproportionate to the benefits, and that this option would be more consistent with international	7. Noted. An issue with exclusive use of international standards is the lack of defined performance requirements in UN R13. This make it difficult to

Correspondent	Comment Summary	Departmental Response
	standards.	implement in countries such as Australia where there are no UN recognised Technical Services. This is why the US based FMVSS 136 standard has been incorporated as an option in ADR 35. The requirements target prime movers which are most at risk of rollover or loss of control and to heavy buses (exceeding 5 tonnes) which have a high potential for loss of life in the event of a rollover or loss of control crash.
	8. Suggests the Department further examine engineering issues associated with including converter dollies within the scope of the proposal.	8. Noted. The Department will look at dolly converters in the future through continued work to improve heavy vehicle safety under the ADRs.
Heavy Vehicle Industry Australia (HVIA)	1. Supports adoption of Option 6a in the consultation RIS. Although Option 6a is the HVIA's preferred option, which provides the greatest road safety benefit, it accepts the reasoning behind the recommendation for Option 6c.	1. Acknowledges the decrease in trauma under Option 6a relative to Options 6b and 6c. However, under the Australian Government Guide to Regulation, the policy option offering the greatest net benefit should always be the recommended option. Further analysis and consultation was conducted to extend to short wheelbase NC rigids (see Appendix 19). ESC on heavy rigid vehicles may be included as part of a package when AEBS on heavy vehicles is considered (proposed action item under the 2018-2020 NRSAP).

Correspondent	Comment Summary	Departmental Response
	2. Suggests that the stated benefits of Option 6 are underestimated. Explains that other technologies that are packaged with ABS/ESC/RSC should have also been included in the analysis. Notes that beyond the safety benefits, that the RIS does not consider benefits such as reduced wear and tear, and operational and vehicle information available through these systems.	2. Noted. Although there are often extra benefits reported when using ESC (reduced tyre and brake wear, etc.), these have not been quantified and are unable to be included in the benefit-cost analysis. Additional systems that are packaged with ESC are also difficult to quantify as there is no guarantee that a manufacturer will include these options alongside the inclusion of ABS or ESC. For example, ABS has been mandated on all heavy vehicles since the start of 2015, however there has been a low uptake of ESC despite also being available.
	3. Believes that Option 3, which looks at fleet purchasing policy, should be pursued in parallel with Option 6, and that further analysis should be done on this option. Suggests that this would reduce the fleet age and therefore increase the fitment of safety technologies. Acknowledges that requiring the Government heavy vehicle fleet be fitted with ESC would only affect a minor segment of the Australian fleet, believes that this could be extended to be a contractual requirement for heavy vehicles to work on federal, state and territory infrastructure projects.	3. Noted. Item 9 of the NRSAP 2015-2017 is to promote the uptake of new vehicle technologies with high safety potential. This is likely to be continued in the next action plan, with action from relevant stakeholders required to maximise the potential of this item.
	4. Supports proposal to make fitting automatic slack adjusters a requirement. Notes that there has been feedback from infield use that there can be problems with automatic slack adjusters, but believes this is not a wide spread issue.	4. Notes the response to the RIS question and support for this change.

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Correspondent	Comment Summary	Departmental Response
	5. Supports the proposal of fitment of RSC to non-air suspension trailers. Consulted HVIA members who supply brake systems, and they indicated that there are systems for use on trailers with steel sprung suspension.	5. Notes the response to the RIS question. This acknowledges that there is a need for RSC on steel sprung trailers in Australia.
	6. Supports the proposal to exempt ESC from prime movers with 4 or more axles. Notes that the number of vehicles affected would be small, and that new brake systems would need to be developed for these vehicles. It is not required in other overseas markets and would be a unique Australian requirement.	6. Notes the response to the RIS question.
Truck Industry Council (TIC)	1. Supports adoption of Option 6c in the consultation RIS, subject to some recommendations for change [as listed below].	1. Agreed. Further consultation was conducted with TIC after this submission on the items raised below.
	2. Proposes applicability dates for Option 6c of 1 November 2020 for new model trucks and 1 January 2022 for all new trucks. Considers this is a significant ADR change that will require more time for new models, and would prefer at least a 1 January all vehicles date to simplify enforcement, vehicle finance and insurance arrangements. Requests close alignment with the introduction of Euro VI (or equivalent) emissions requirements, as advanced safety features (including ESC) are only being fitted to Euro VI (or equivalent) trucks in other markets.	2. Agreed. Due to adjustments in timing to this phase of the NHVBS, it was agreed to reflect this by extending the new models date out to 1 November 2020. For the all models date, the small shift of 2 months from 1 November 2021 to 1 January 2022 was also agreed to assist with the financing and insurance concerns reported by TIC which would disincentivise purchases of those models with the previous year build date. This would be a relatively small shift in the implementation timing consulted on.

Correspondent	Comment Summary	Departmental Response
	3. Requests Government assist industry with the support and development of a test facility within Australia that is capable of undertaking the J-turn test in the draft ADR 35/06. Notes there is currently no facility capable of performing this test in Australia.	3. Noted. The draft ADR 35/06 test procedures have been revised to provide more opportunities to identify suitable test facilities and/or to allow for partial simulation testing instead.
	4. Suggests adding an optional rigid truck test method for the J-turn test in the draft ADR 35/06. This would allow other standards used in particular industries, for example AS 2809 (Dangerous Goods Vehicles), to refer directly to the ADR. Without this, other standards will likely refer directly to UN R13, which would disadvantage local manufacturers not accessing the UN testing/certification process.	4. Noted. Although rigids aren't included in the FMVSS 136 test, as buses are and there is a similarity in mass in dimensions, a clause allowing rigids to optionally test to this standard could be included in ADR 35/06.
	5. Requests as a matter of priority, a review of ADR 35 selection of test fleet criteria for trucks, including the types of simulation testing that would be acceptable. Considers manufacturers will need this detail to estimate the type and physical quantity of tests required, before they can commence any commercial negotiations to develop a local test facility.	5. Noted. An updated draft ADR 35/06 with provisions for simulation testing of the ESC system based on physical testing has been provided to TIC following further consultation. This is based on the requirements in UN R13.

Correspondent	Comment Summary	Departmental Response
	6. Requests Government consider measures, including incentives (e.g. rebates, increased depreciation, stamp duty concessions, reduced registration, increased axle mass limits), to accelerate the take-up of new trucks fitted with ESC systems. Notes, given the current average age of the truck fleet, that only 50 per cent of category NC prime movers on Australian roads in 2035 will have ESC.	6. Noted. Item 9 of the NRSAP 2015-2017 is to promote the uptake of new vehicle technologies with high safety potential. This is likely to be continued in the next action plan, with action from relevant stakeholders required to maximise the potential of this item.
	7. Suggests Government revisit adoption of Option 6a, as part of a future review of ADR 35, conducted in consultation with TIC and industry, and allowing for suitable introduction timelines. Considers as ESC is voluntarily fitted to more rigid trucks to meet customer/market demand, the cost of the systems will decrease, which would in-turn, make the outcome of any future benefit-cost analysis to mandate ESC on all trucks, more favourable.	7. Noted. As a number of correspondents supported Option 6a, further analysis was conducted (see Appendix 19) to consider including short wheelbase rigids – those that are often variants of prime movers. This would set a fitment and functional requirement only, with no physical testing of the ESC system required. Through further consultation with TIC, this was developed to cover short wheelbase rigids with a definition from UN Regulation 29 used to define the relevant wheelbase length for both cab-over engine vehicles and conventional bonneted vehicles. Further fitment of ESC on heavy rigid vehicles may be included as part of a package when AEBS on heavy vehicles is considered (proposed action item under the 2018-2020 NRSAP).
Roads and Maritime Services, NSW	1. Supports adoption of Option 6a in the consultation RIS.	1. Acknowledges the decrease in trauma under Option 6a relative to Options 6b and 6c. However, under the Australian Government Guide to Regulation, the

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Correspondent	Comment Summary	Departmental Response
Government		policy option offering the greatest net benefit should always be the recommended option. Further analysis and consultation was conducted to extend to short wheelbase NC rigids (see Appendix 19). ESC on heavy rigid vehicles may be included as part of a package when AEBS on heavy vehicles is considered (proposed action item under the 2018-2020 NRSAP).
	2. Feedback was provided by way of suggested changes to the draft ADRs 35 and 38. The suggested changes included those that would align the ADRs with Option 6a. In addition to changes relating to the RIS, NSW RMS made suggestions for ADR changes to requirements for light trailers (up to 4.5 tonnes).	2. Refer to response 1 above regarding changes to the draft ADRs that align with Option 6a. Suggested changes to ADR 38 for light trailers will be considered in the next phase of work to ADR 38. This will progress other issues that have been raised by industry such as dynamometer foundation brake testing and dolly converters.
Tyre Safe Australia	1. Supports adoption of Option 6a in the consultation RIS.	1. Acknowledges the decrease in trauma under Option 6a relative to Options 6b and 6c. However, under the Australian Government Guide to Regulation, the policy option offering the greatest net benefit should always be the recommended option. Further analysis and consultation was conducted to extend to short wheelbase NC rigid vehicles (see Appendix 19). ESC on heavy rigid vehicles may be included as part of a package when AEBS on heavy vehicles is considered (proposed action item under the 2018-2020

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Correspondent	Comment Summary	Departmental Response
		NRSAP).
	2. Suggests that in addition to technologies such as ABS and ESC, that tyre inflation should be considered important due to these technologies performing better when tyres are at the right inflation pressure. Believes that this can be addressed with tyre pressure monitoring systems.	2. Noted. In developing the NRSS, there were a number of rounds of consultation with road and vehicle safety professionals, the light and heavy vehicle industry, as well as with motoring and consumer groups. Particular emphasis was placed on the highest priority action items in terms of overall benefit to the community. In accordance with this approach, ESC for heavy vehicles was identified as a priority vehicle regulatory initiative for implementation under the National Road Safety Action Plan 2015-2017. The effectiveness of ESC systems for heavy vehicles is expected to vary according to the condition of each vehicles foundation brakes (including brake pads/shoes and rotors/drums) and tyres (including inflation pressures). This has been accounted for in the RIS by estimating all benefits relative to the BAU scenario. The RIS therefore provides an estimate of the overall benefit expected across the entire heavy vehicle fleet (for which the conditions of both brakes and tyres on individual vehicles vary). Maintenance practices that improve the BAU condition of the foundation brakes and/or tyres fitted to heavy vehicles in service would likely increase the average overall effectiveness of ESC for these vehicles.

APPENDIX 19— FURTHER EVALUATION OF OPTION 6 FOLLOWING CONSULTATION

The public consultation process raised some issues that warranted further analysis. This was done by reviewing Option 6 and the associated sub options, as the issues raised revolved around the difference between Option 6a and the recommended Option 6c.

Adjusting injury values to willingness to pay

It was suggested that the value of a serious injury be revised to a higher value — this would adjust the RIS value to a willingness to pay estimate. A sensitivity analysis on this higher value was conducted. Table 91 to Table 93 below show the results for each sub option 6a to 6c respectively.

Table 91: Comparison of different life and injury values — Option 6a

Alternative life and injury values	BCR	Net Benefit
High Fatality $9.6M + Serious injury $0.39M	3.66	$451,039,740
Fatality $6.5M + Serious injury $0.39M	2.88	$319,233,058
RIS fatality value $4.1M + Serious injury $0.39M	2.24	$209,359,341
RIS values Fatality $4.1M + Serious Injury $0.27M	1.99	$167,325,045
Fatality $3.7M + Serious injury $0.39M	2.18	$200,061,219

Table 92: Comparison of different life and injury values — Option 6b

Alternative life and injury values	BCR	Net Benefit
High Fatality $9.6M + Serious injury $0.39M	5.70	$464,446,431
Fatality $6.5M + Serious injury $0.39M	4.46	$342,340,534
RIS fatality value $4.1M + Serious injury $0.39M	3.44	$241,101,711
RIS values Fatality $4.1M + Serious Injury $0.27M	3.07	$204,454,458
Fatality $3.7M + Serious injury $0.39M	3.35	$231,979,230

Table 93: Comparison of different life and injury values — Option 6c

Alternative life and injury values	BCR	Net Benefit
High Fatality $9.6M + Serious injury $0.39M	9.56	$452,006,294
Fatality $6.5M + Serious injury $0.39M	7.43	$339,834,387
RIS fatality value $4.1M + Serious injury $0.39M	5.68	$247,438,542
RIS values Fatality $4.1M + Serious Injury $0.27M	5.10	$216,310,336
Fatality $3.7M + Serious injury $0.39M	5.52	$238,495,330

Only the unit costs of injury for fatal and serious were modified, in line with values indicated in the table. Minor injury costs were not changed. The additional damage and travel delay costs have not

been changed from the values used in the RIS. Option 6a never generates the greatest net benefit. Option 6b generates the greatest net benefit when higher willingness to pay values are used for fatalities and serious injuries. However, the gains are relatively small. Changing just the serious injury value, as suggested through the public consultation, results in no change in the order of options in terms of net benefits.

Option 6c Plus — Extending Option 6c to Short Wheelbase Rigid Vehicles

Feedback from the consultation had the majority of respondents preferring Option 6a, the broadest level of regulation. However, as this was not the option with the highest net benefits, it was decided to instead consider extending Option 6c (the recommended option) towards Option 6a in a way that would maintain or increase the net benefits. This was done by including NC rigid vehicles with a short wheelbase through a technical requirement only (no performance requirement). These vehicles are often variants of prime movers and used in 'tipper and dog' combinations — dump trucks with an attached dog trailer[1]. In the majority of cases, the short wheel base rigid variant of a prime mover would have the same ESC system. This would also alleviate concerns raised of in-service conversions from prime movers to rigid vehicles straight after supply to the market or later in the vehicle's life.

On comparing the wheelbase of NC prime movers and their rigid variants from data obtained from the road vehicle descriptor on the Department's RVCS website, a value of 4.5 to 5.0 metre wheelbase length was estimated as a suitable constraint to identify short wheelbase NC rigid vehicles in ADR 35. It was estimated that these vehicles would represent around 10 per cent of all NC rigid vehicles, and based on the MUARC study by Budd and Newstead (2014), have an increased risk factor to roll over or directional crashes of 1.136 relative to other NC rigid vehicles. It was also estimated that these vehicles would have a trailer 50 per cent of the time. Based on these assumptions, the benefit-cost analysis was extended to provide the following values under the likely case:

	Gross Benefits	Net Benefits	Costs	Overall decrease in Injuries		
NPV	$273,435,820	$216,780,296	$56,655,525	**Fatalities**	**Serious Injuries**	**Minor Injuries**
BCR		4.83		126	1101	801

After further consultation with the relevant stakeholders on the feasibility of this extended option, the wheelbase criteria was refined to cover cab-over (cabs placed above engine) trucks with a wheelbase less than 4.5 metres and conventional (bonneted trucks) (cabs placed behind the engine) with a wheelbase less than 5.0 metres. A UN Regulation 29 definition for *cab-over engine vehicle* was adopted to make the distinction between these vehicle designs.

[1] Refer to Appendix 2 diagrams 4 and 5.

APPENDIX 20 — ACRONYMS AND ABBREVIATIONS

ABS	Antilock Brake System
ADR	Australian Design Rule
ALRTA	Australian Livestock and Rural Transporters Association
AMVCB	Australian Motor Vehicle Certification Board
ARRB	Australian Road Research Board
ARTSA	Australian Road Transport Suppliers Association
ATA	Australian Trucking Association
BAU	Business as Usual
BCR	Benefit-Cost Ratio
BIC	Bus Industry Confederation
BITRE	Bureau of Infrastructure, Transport and Regional Economics
BTE	Bureau of Transport Economics (now BITRE)
CCA	Competition and Consumer Act 2010
CEO	Chief Executive Officer
CMVSS	Canadian Motor Vehicle Safety Standard
C'th	Commonwealth
CVIAA	Commercial Vehicle Industry Association Australia
EBS	Electronic Braking Systems
EPA	Environment Protection Authority
ESC	Electronic Stability Control
FCAI	Federal Chamber of Automotive Industries
FMVSS	Federal Motor Vehicle Safety Standard
FORS	Federal Office of Road Safety
GTM	Gross Trailer Mass
GVM	Gross Vehicle Mass
HVIA	Heavy Vehicle Industry Association
HVNL	Heavy Vehicle National Law
HVSPP	Heavy Vehicle Safety and Productivity Programme
IRG	Industry Reference Group
ISO	International Organization for Standardization
LP	Load Proportioning
MUARC	Monash University Accident Research Centre
MVSA	Motor Vehicle Standards Act 1989
NHTSA	National Highway Traffic Safety Administration
NHVBS	National Heavy Vehicle Braking Strategy
NPV	Net Present Value
NRSS	National Road Safety Strategy 2011-2020
NRTC	National Road Transport Commission (now NTC)
NTARC	National Truck Accident Research Centre
NTC	National Transport Commission
OBPR	Office of Best Practice Regulation
PBS	Performance Based Standards

RBM	Regulatory Burden Measurement
RIS	Regulation Impact Statement
RSC	Roll Stability Control
SAE	Society of Automotive Engineers
SPECTS	Safety, Productivity & Environment Construction Transport Scheme
SVSEG	Strategic Vehicle Safety and Environment Group
TEBS	Trailer Electronic Braking Systems
TIC	Truck Industry Council
TISOC	Transport and Infrastructure Senior Officials' Committee
TLG	Technical Liaison Group
UN	United Nations
US	United States
WP.29	World Forum for the Harmonisation of Vehicle Regulations

APPENDIX 21 — GLOSSARY OF TERMS

1958 Agreement	UN Agreement Concerning the Adoption of Harmonized Technical United Nations Regulations for Wheeled Vehicles, Equipment and Parts which can be Fitted and/or be Used on Wheeled Vehicles and the Conditions for Reciprocal Recognition of Approvals Granted on the Basis of these United Nations Regulations of March 1958.
Antilock Brake System (ABS)	A portion of a service brake system that automatically controls the degree of rotational wheel slip relative to the road at one or more road wheels of the vehicle during braking.
Articulated Truck	A motor vehicle primarily for load carrying, consisting of a prime mover that has no significant load carrying area but with a fifth wheel assembly which can be linked to one or more trailers.
Axle	One or more shafts positioned in a line across a vehicle, on which one or more wheels intended to support the vehicle turn.
Axle Group	Either a single axle, tandem axle group, triaxle group, or close coupled axle group.
Benefit-Cost Ratio (BCR)	The ratio of expected total (gross) benefits to expected total costs (in terms of their present monetary value) for a change of policy relative to business as usual.
B-Double	A combination of vehicles consisting of a prime mover towing two semi-trailers.
B-Triple	A combination of vehicles consisting of a prime mover towing three semi-trailers.
Brake Chamber or Actuator	A brake system component including an air chamber and a pushrod, to convert air pressure into mechanical actuation force.
Bus (or Omnibus)	A passenger vehicle having more than 9 seating positions, including that of the driver.
Certification	Assessment of compliance to the requirements of a regulation/standard. Can relate to parts, sub-assemblies, or a whole vehicle.
Close Coupled Axle Group	Two axles with centres not more than 1.0 m apart (regarded under the ADRs as a single axle); three axles with centres not more than 2.0 m apart (regarded under the ADRs as a tandem axle group); or four or more axles with centres not more than 3.2 metres apart (regarded under the ADRs as a tri-axle group).
Converter Dolly	A trailer with an axle group and a fifth wheel coupling near the middle of its load-carrying surface, designed to convert a semi trailer into a dog trailer.
Crash	Any apparently unpremeditated event reported to police, or other relevant authority, and resulting in death, injury or property

	damage attributable to the movement of a road vehicle on a public road.
Discount Rate	A rate of interest used to translate costs which will be incurred and benefits which will be received across future years into present day values.
Dog Trailer	A trailer with two axle groups of which the front axle group is steered by connection to the drawing vehicle.
Fatal Crash	A crash for which there is at least one death.
Fifth Wheel Assembly	A fifth wheel coupling including any turn-table, mounting plate, sliding assembly, load cell and other equipment mounted between the towing vehicle chassis and the trailer skid plate, but not including any attachment sections.
Fifth Wheel Coupling	A device, other than the skid plate and the kingpin (which are parts of a semi-trailer), used with a prime mover, semi-trailer or a converter dolly to permit quick coupling and uncoupling and to provide for articulation.
Gross Vehicle Mass (GVM)	The maximum laden mass of a motor vehicle as specified by the manufacturer.
Gross Trailer Mass (GTM)	The mass transmitted to the ground by the axle or axles of the trailer when coupled to a drawing vehicle and carrying its maximum load approximately uniformly distributed over the load bearing area, and at which compliance with the appropriate Australian Design Rules has been or can be established.
Heavy Vehicle	Any passenger or goods vehicles greater than 4.5 tonnes GVM or any trailer greater than 4.5 tonnes GTM.
Hospitalised Injury	A person admitted to hospital from a crash occurring in traffic. Traffic excludes off-road and unknown location.
Net Benefit	The sum of expected benefits (in monetary terms), less expected costs associated with a change of policy relative to business as usual.
Net Present Value (NPV)	The difference between the present economic value (determined using an appropriate discount rate) of all expected benefits and costs over time due to a change of policy relative to business as usual.
Prime Mover	A motor vehicle built to tow a semi-trailer.
Rigid Truck	A motor vehicle with a GVM greater than 4.5 tonnes constructed with a load carrying area. Includes a rigid truck with a tow bar, draw bar or other coupling on the rear of the vehicle.
Road Crash Fatality	A person who dies within 30 days of a crash as a result of injuries received in that crash.
Road Train	A combination of vehicles, other than a B-Double, consisting of a motor vehicle towing at least two trailers (counting as one trailer a converter dolly supporting a semi-trailer).

Semi-trailer	A trailer that has one axle group or a single axle towards the rear; and a kingpin and skid plate at the front for coupling to the fifth wheel assembly of a prime mover, another semi-trailer or a converter dolly.
Service Brake System	The brake system, which in proportion to the signal from the brake control or, in the case of a trailer in proportion to the control signal, applies a restraining torque to the vehicle's wheels in normal operation.
Single Axle	Either one axle, or two axles with centres between transverse, parallel, vertical planes spaced less than 1.0 m apart.
Slack Adjuster	A link between a brake chamber/actuator and a brake camshaft, which transforms force (from pressure within the brake chamber) into a brake torque via a brake camshaft. These include a manual and/or automatic mechanism for adjusting the initial clearance between the brake friction elements (e.g. brake shoes and drums), including to compensate for changes arising from wear.
Tandem Axle Group	A group of at least two axles, in which the horizontal distance between the centrelines of the outermost axles is at least 1.0 metre, but not more than 2.0 metre.
Triaxle Group	A combination of three axles in which the front and rear axles are not less than 2.0 m and not more than 3.2 m apart.
Truck Tractor	A prime mover.
Tractor Semi-trailer	A prime mover towing a semi-trailer.
Type Approval	Written approval of an authority/body that a vehicle type (i.e. model design) satisfies specific technical requirements.