



Regulation Impact Statement

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

Decorative cover figure

April 2018

Report Documentation Page

|  |  |  |  |
| --- | --- | --- | --- |
| Report No. | Report Date | File No. | OBPR Reference No. |
| INFRASTRUCTURE VSS 01/2018 | April 2018 | F16/742-01 | 23081 |
| Title and Subtitle | | | |
| Regulation Impact Statement Improving the Stability and Control of Heavy Vehicles | | | |
| Organisation Performing Analysis | | | |
| Standards Development and International Vehicle Safety Standards Branch Department of Infrastructure, Regional Development and Cities | | | |
| Regulatory Agency | | | |
| Department of Infrastructure, Regional Development and Cities GPO Box 594 Canberra ACT 2601 | | | |
| Key Words | | Distribution Statement | |
| Electronic Stability Control, ESC, Roll Stability Control, RSC, Heavy Vehicle, Braking, Australian Design Rule, ADR | | This document will be available to the public on the Federal Register of Legislation: <https://www.legislation.gov.au> | |
| Security Classification | | No. Pages | Price |
| Unclassified | | 202 | No charge |

# 

CONTENTS

Executive summary 5

1. What is the Problem? 10

1.1. Road Trauma from Crashes Involving Heavy Vehicles 10

1.2. Extent of the Problem in Australia 11

1.3. Government Actions to Address the Problem 13

1.4. The National Road Safety Strategy 2011-2020 16

2. Why is Government Action Needed? 17

2.1. Stability Control Systems for Heavy Vehicles 18

2.2. Current Market Fitment Rates 19

2.3. Available Standards 19

2.4. Objective of Government Action 20

3. What Policy Options are Being Considered? 21

3.1. Available Options 21

3.2. Discussion of the Options 21

4. What are the Likely Net Benefits of each Option? 32

4.1. Benefit-Cost Analysis 32

4.2. Economic Aspects—Impact Analysis 47

5. Regulatory Burden and Cost Offsets 54

6. What is the Best Option? 56

6.1. Net Benefits 56

6.2. Benefit-Cost Ratios 56

6.3. Casualty Reductions 56

6.4. Recommendation 57

6.5. Impacts 59

6.6. Scope of the Recommended Option 59

6.7. Timing of the Recommended Option 60

7. Consultation 61

7.1. General 61

7.2. The National Heavy Vehicle Braking Strategy 62

7.3. Public Comment 63

8. Implementation and Evaluation 65

9. Conclusion and Recommended Option 66

10. References 68

Appendix 1 — Heavy Vehicle Categories 72

Appendix 2 — Common Types of Heavy Trucks and Vehicle Combinations 74

Appendix 3 — Awareness Campaigns 77

Appendix 4 — Information Campaigns 80

Appendix 5 — Types of Antilock Brake Systems for Heavy Vehicles 81

Appendix 6 — Effectiveness of Antilock Brake Systems for Heavy Vehicles 84

Appendix 7 — Types of Stability Control Systems for Heavy Vehicles 88

Appendix 8 — Effectiveness of Stability Control Systems for Heavy Vehicles 90

Appendix 9 — Available Standards for Stability Control Systems for Heavy Vehicles 94

Appendix 10 — Compatibility 97

Appendix 11 — Summary of Proposed Changes to the Current Versions of ADRs 35 and 38 98

Appendix 12 — Benefit-Cost Analysis — Methodology 110

Appendix 13 — Benefit-Cost Analysis — Details of Results 114

Appendix 14 — Benefit-Cost Analysis — Sensitivities 155

Appendix 15 — NHVBS Operator/Maintenance Survey June 2015 157

Appendix 16 — Technical Liaison Group (TLG) 176

Appendix 17 — NHVBS Phase II Industry Reference Group (IRG) 177

Appendix 18 — Summary of Public Comments 178

Appendix 19 — Further Evaluation of Option 6 Following Consultation 196

Adjusting injury values to willingness to pay 196

Option 6c Plus — Extending Option 6c to Short Wheelbase Rigid Vehicles 197

Appendix 20 — Acronyms and Abbreviations 198

Appendix 21 — Glossary of Terms 200

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]](#footnote-2) — 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?

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.

# What is the Problem?

## 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.

## 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.

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

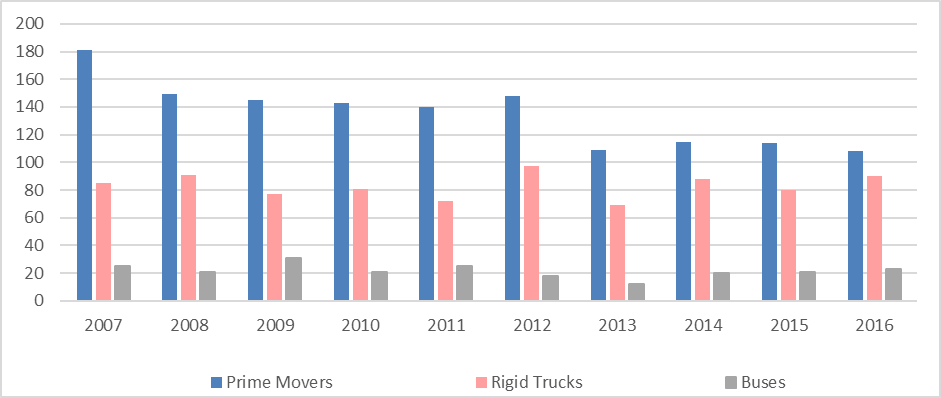


Figure 2: Fatalities in crashes involving heavy trucks and buses in Australia, annual totals 2007-2016 (source: Australian Road Deaths Database)

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.

## 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.

## 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.

# 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.

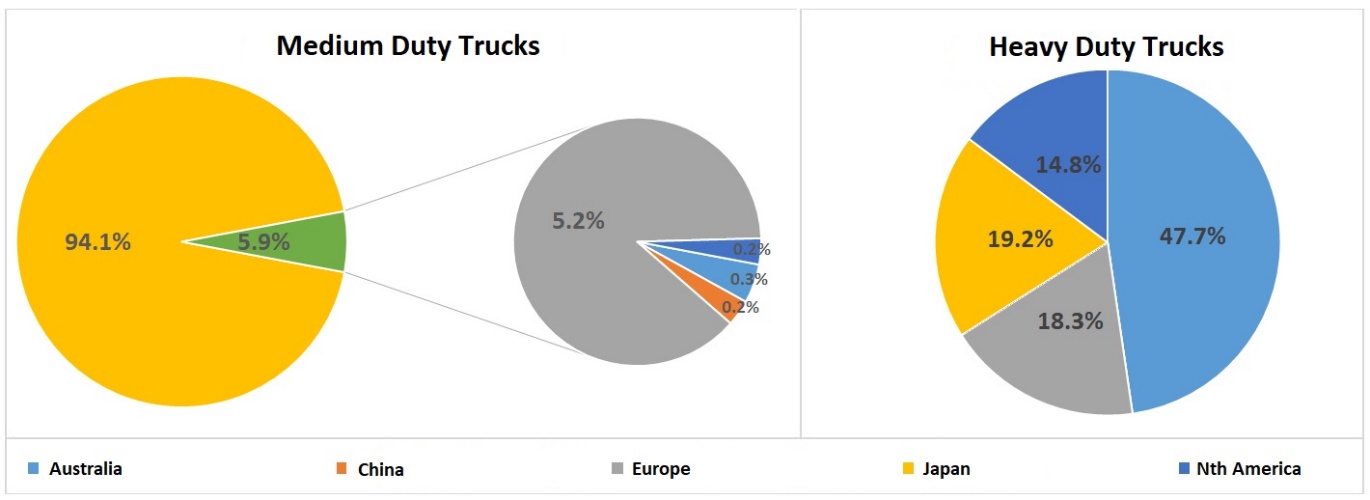


Figure 3: Truck Sales in Australia (2014) by Country/Region of Manufacture (source: TIC, 2015)[[2]](#footnote-3)

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.

## 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.

## 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.

## 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.

## 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).

# 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.

## 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).

## 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.

# What are the Likely Net Benefits of each Option?

## 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).

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 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

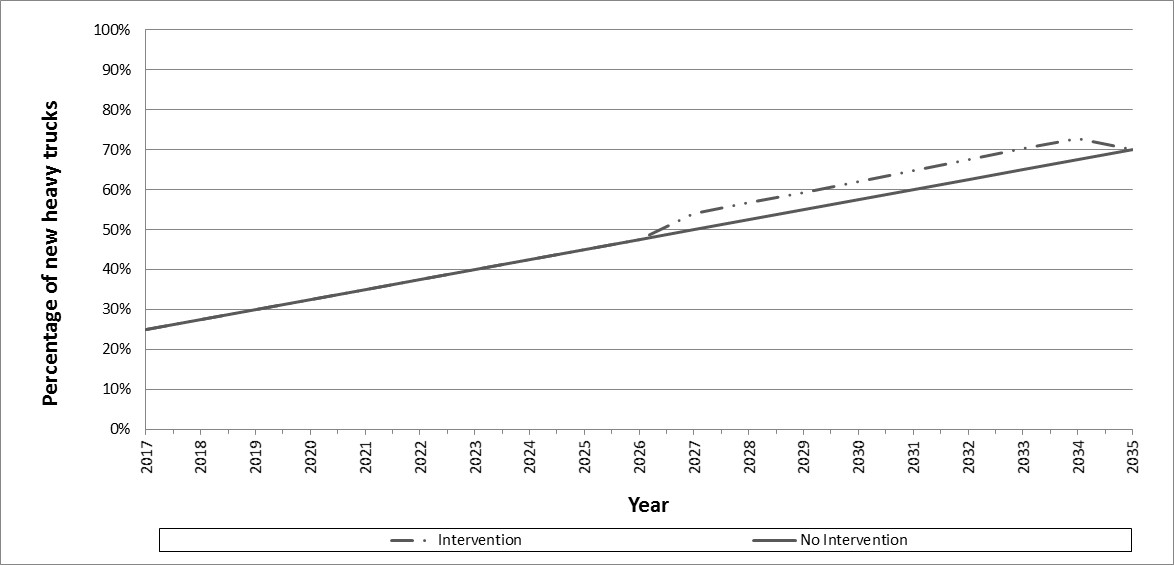


Figure 5: Percentage of new heavy trucks (over 4.5 tonnes GTM) fitted with ESC under BAU (no intervention) and Option 2b (intervention) scenarios in Australia

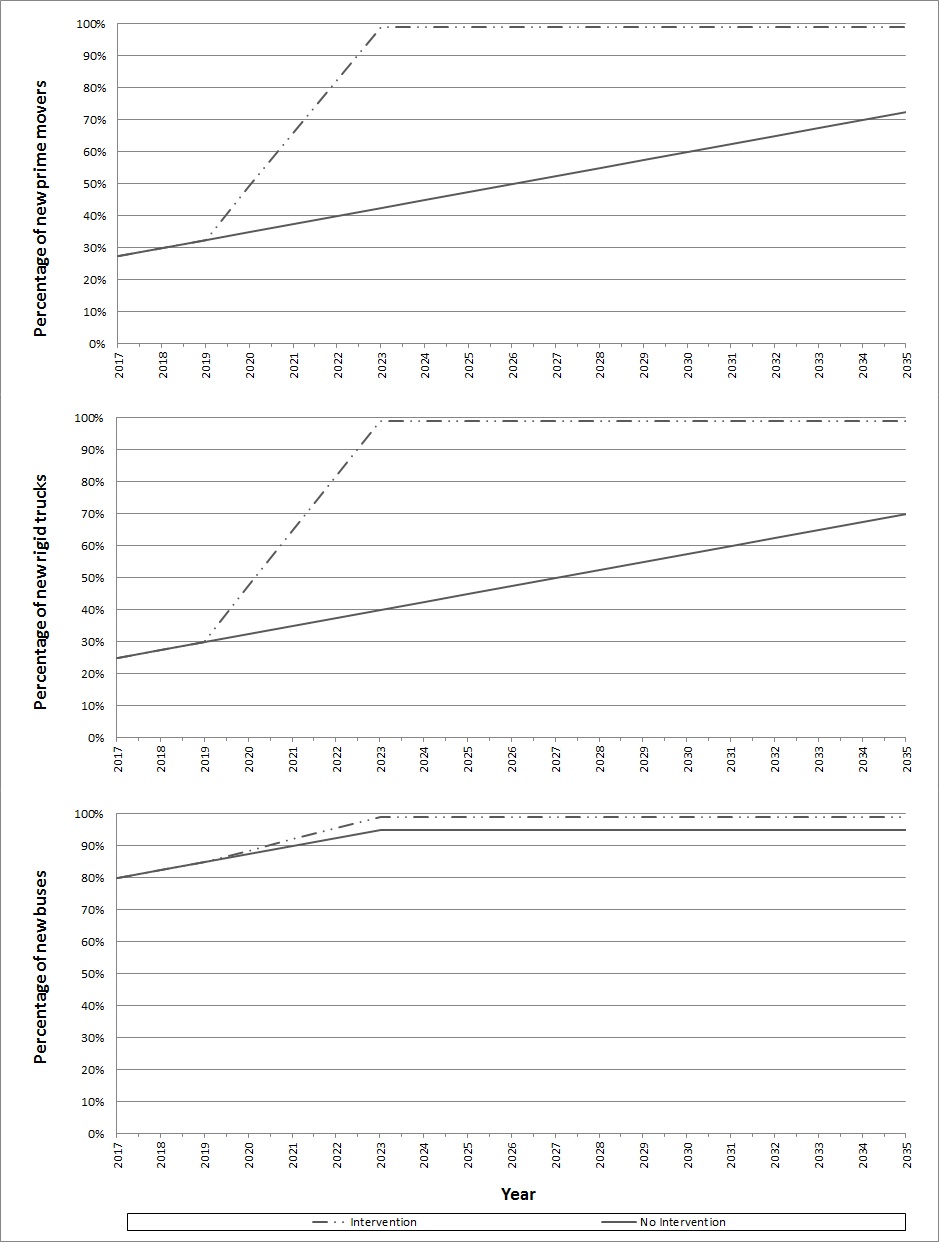


Figure 6: Percentage of new heavy trucks and buses (over 4.5 tonnes GVM) fitted with ESC under BAU (no intervention) and Option 6a (intervention) scenarios in Australia (excludes route service and articulated buses)

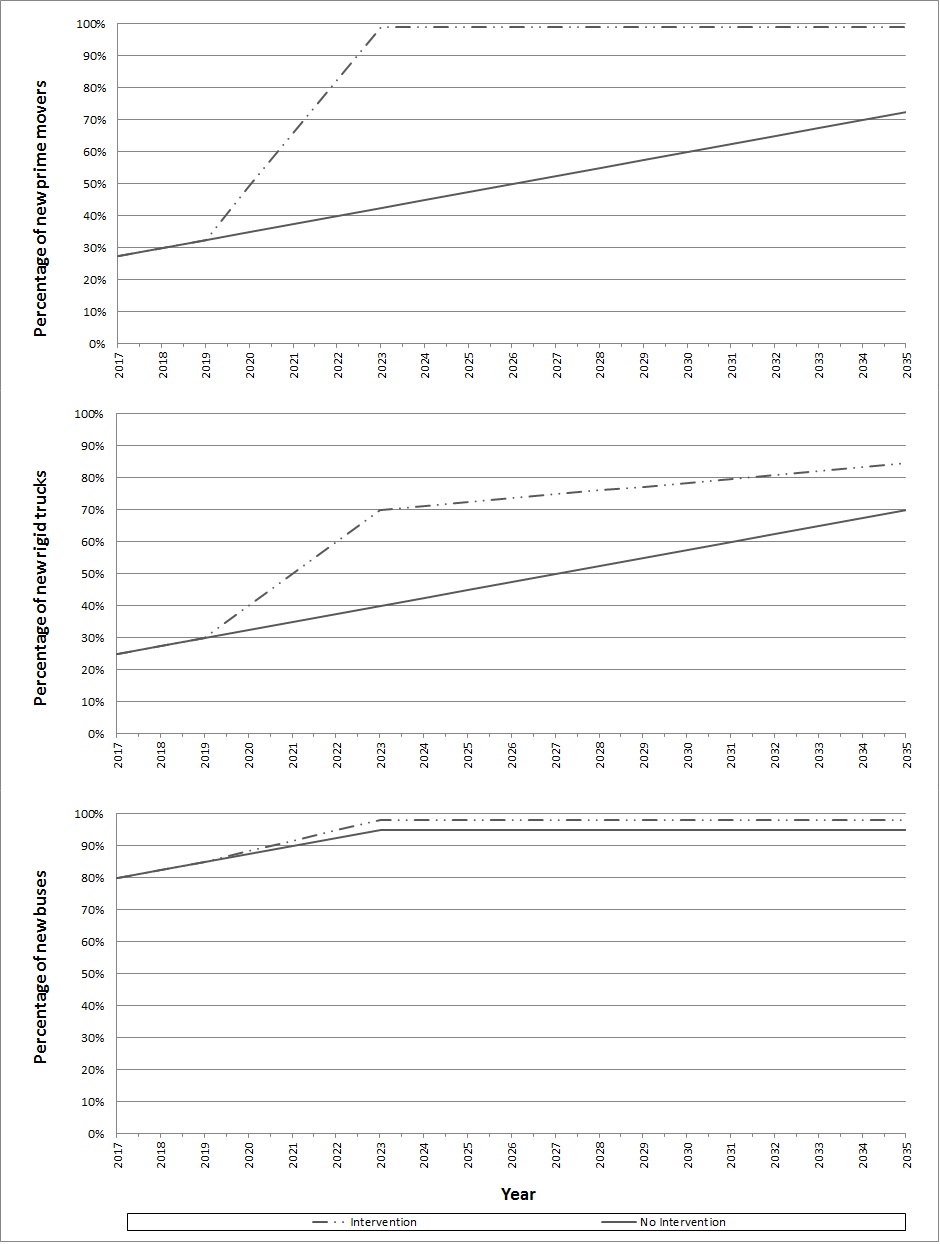


Figure 7: Percentage of new heavy trucks and buses (over 4.5 tonnes GVM) fitted with ESC under BAU (no intervention) and Option 6b (intervention) scenarios in Australia (excludes route service and articulated buses)

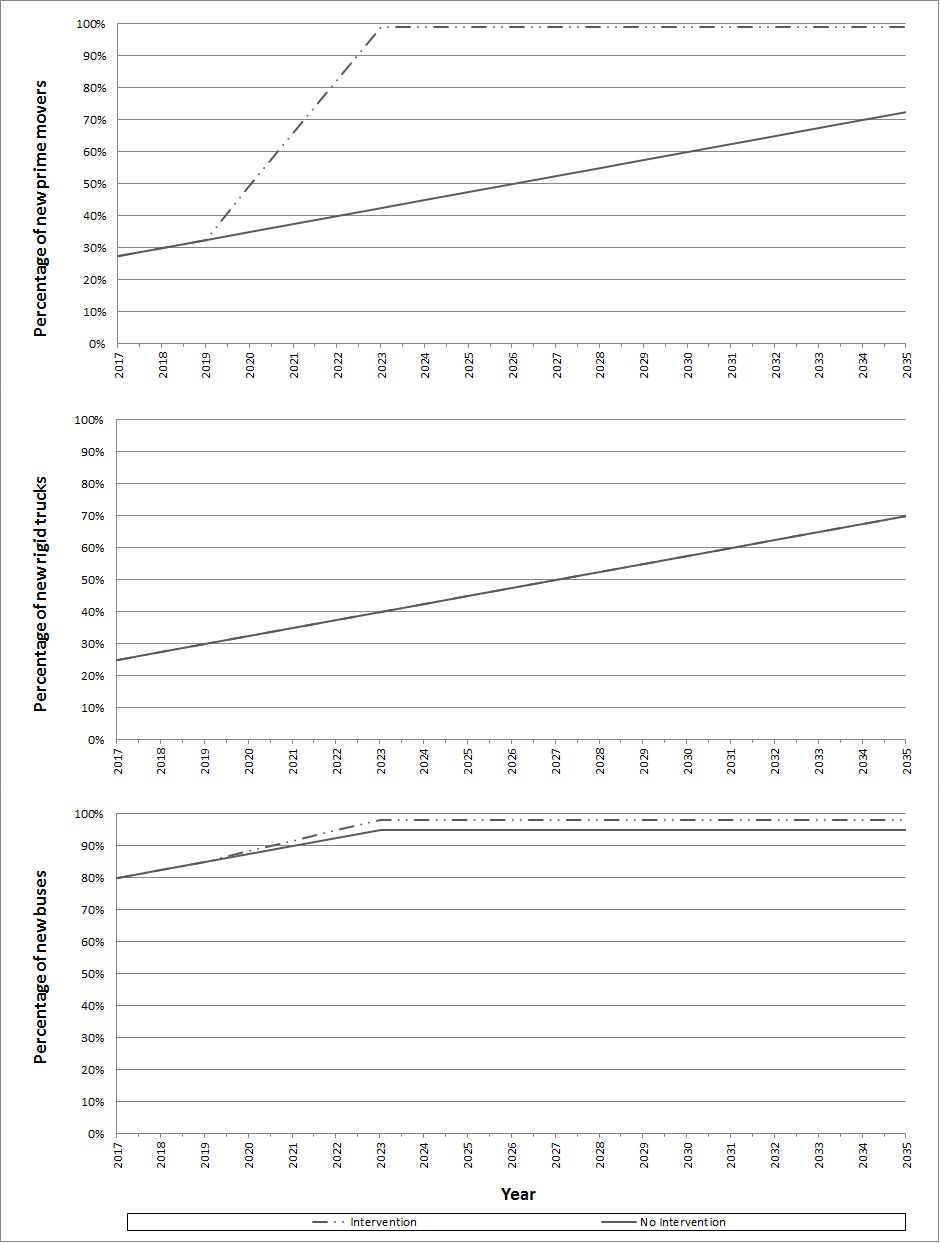


Figure 8: Percentage of new heavy trucks and buses (over 4.5 tonnes GVM) fitted with ESC under BAU (no intervention) and Option 6c (intervention) scenarios in Australia (excludes route service and articulated buses)

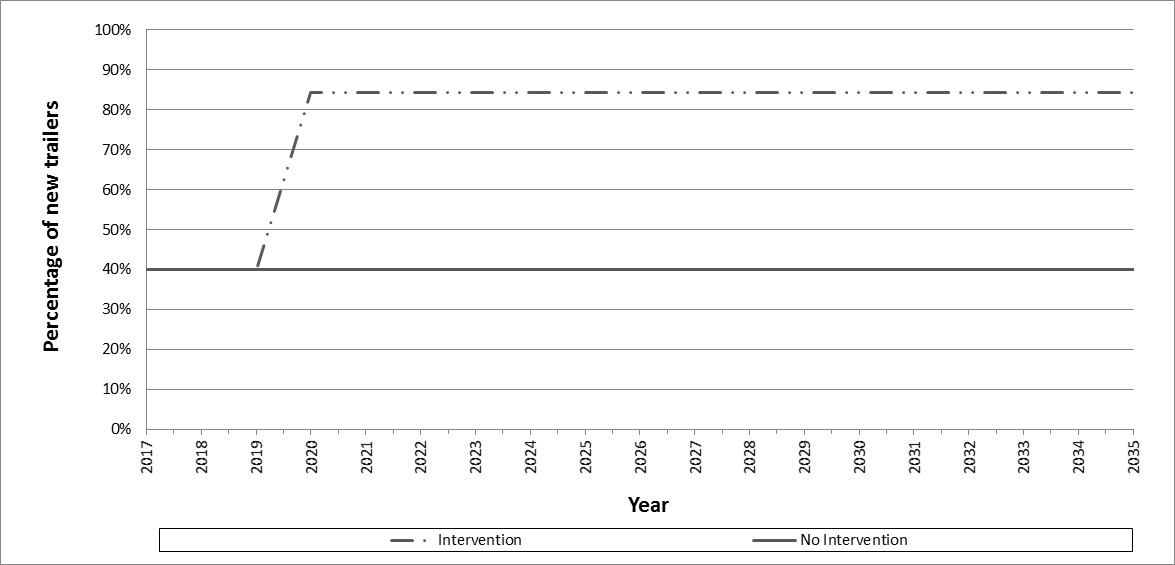


Figure 9: Percentage of new trailers (over 4.5 tonnes GTM) fitted with RSC under BAU (no intervention) and Options 6a, 6b and 6c (intervention) scenarios in Australia

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 |  |  | **27** |  |  | 18.4 |
| Rigid Trucks | 48  (40-56) | 14 | **22.5** | 45  (37-53) | 3 | 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 model1 | 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 vehicle2 | Business |
| Buses | | $2,500 | $3,000 | $3,500 |
| Trailers | RSC  ABS | $400  $50 ($1000)4 | $525  $175 ($1150)4 | $800  $300 ($1300)4 |  |  |  |
| Maintenance of systems | | Best Case | Likely Case | Worst Case |  |  |  |
| Trucks | | - | - | - | 6a, 6b, 6c, 6c Plus | Per vehicle each year3 | 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 | | | | | | | |
| 3Limited to 5 per cent of all new medium and heavy trailers estimated to be primarily used in outer regional/remote operations (various industry sources) | | | | | | | |
| 4Value 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 model1 | Business |
| Buses | - | - | - |
| Trailers | - | - | - |  |  |  |
| Fitment of systems | Best Case | Likely Case | Worst Case |  |  |  |
| Trucks | $1,500 | $1,000 | $500 | 6a, 6b, 6c, 6c Plus | Per vehicle2 | 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.

## 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 |  | Reduced road trauma — $303 m |  |
| Government | Cost of implementing and administering regulations — $0.7 m | None | Cost of implementing and administering regulations — $0.7 m | | None |
| Lives saved | 148 lives |  |  | 136 lives |  |  | |
| Serious Injuries prevented | 1496 cases |  |  | 1292 cases |  |  | |
| BCR | 1.99 |  |  | 3.07 |  |  | |

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

# 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.

# 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).

## 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.

## 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).

## 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.

## 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.

## 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.

## 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).

## 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.

# Consultation

## 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).

## 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.

## 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.197).

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. 196).

# 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.

# 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.

# References

Abelson, P. (2007). *Establishing a Monetary Value for Lives Saved: Issues and Controversies*. Paper presented at the 2007 ‘Delivering Better Quality Regulatory Proposals through Better Cost-Benefit Analysis’ Conference, Canberra, Australia.

ARTSA (2011). Combination Vehicle Brake Code of Practice: *Part 5—Review of Electronically-Controlled Brake Technologies for Heavy Vehicles*. Retrieved April 2017 from <http://www.artsa.com.au/assets/library/2011/Part_5_2011.docx>.

Australian Bureau of Statistics. (2013). *Population Projections, Australia, 2012 (base) to 2101, 2013*. Report No. 3220.0. Retrieved August 2016 from http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/3222.02012%20(base)%20to%202101?OpenDocument.

Australian Bureau of Statistics. (2014). *Australian Historical Population Statistics, 2014*. Report No. 3105.0.65.001. Retrieved August 2016 from http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/3105.0.65.0012014?OpenDocument.

Australian Bureau of Statistics. (2017a). *Motor Vehicle Census, Australia, 2017*. Report No. 9309.0. Retrieved October 2017 from <http://www.abs.gov.au/AUSSTATS/abs@.nsf/ViewContent?readform&view=productsbyCatalogue&Action=Expand&Num=11.3>.

Australian Bureau of Statistics. (2017b). *Survey of Motor Vehicle Use, Australia, 12 months ended 30 June 2016*. Report No. 9208.0. Retrieved October 2017 from <http://www.abs.gov.au/AUSSTATS/abs@.nsf/ViewContent?readform&view=productsbyCatalogue&Action=Expand&Num=11.2>.

Australian Government (2014a). *The Australian Government Guide to Regulation*. Retrieved April 2017 from <https://www.cuttingredtape.gov.au/handbook/australian-government-guide-regulation>.

Australian Government (2014b). *Vehicle Standard (Australian Design Rule 35/05 – Commercial Vehicle Brake Systems)*. Retrieved September 2017 from <https://www.legislation.gov.au/Details/F2014C01106>.

Australian Government (2014c). *Vehicle Standard (Australian Design Rule 38/04 – Trailer Brake Systems)*. Retrieved September 2017 from <https://www.legislation.gov.au/Details/F2014C01105>.

Australian Government (2016). *Guidance Note: Cost-Benefit Analysis*. Retrieved October 2017 from <https://www.pmc.gov.au/resource-centre/regulation/cost-benefit-analysis-guidance-note>.

Bibbings, R. (1997). *Occupational road risk: Toward a management approach*. Journal of the Institution of Occupational Safety & Health, Vol. 1 (1), pp.61-75.

Budd, L., & Newstead, S. (2014). *Potential Safety Benefits of Emerging Crash Avoidance Technologies in Australasian Heavy Vehicles.* Monash University Accident Research Centre.

Bureau of Transport Economics (BTE) (2000*). Road Crash Costs in Australia (Report No. 102)* Canberra, Australia.

Bureau of Infrastructure, Transport and Regional Economics (BITRE) (2009), *Cost of road crashes in Australia 2006, Report 118*, Canberra, Australia.

Bureau of Infrastructure, Transport and Regional Economics (BITRE) (2014), *Impact of road trauma and measures to improve outcomes, Report 140*, Canberra, Australia.

Bureau of Infrastructure, Transport and Regional Economics (BITRE) (2016), *Fatal heavy vehicle crashes Australia quarterly bulletin, Jul-Sep 2016*, Canberra, Australia.

Bureau of Infrastructure, Transport and Regional Economics (BITRE) (2017a), *Fatal heavy vehicle crashes Australia quarterly bulletin, Jan-Mar 2017*, Canberra, Australia.

Bureau of Infrastructure, Transport and Regional Economics (BITRE) (2017b), *Road trauma involving heavy vehicles 2016 statistical summary,* Canberra, Australia.

Commonwealth Interdepartmental Committee on Quasi Regulation. (1997). *Grey Letter Law*. Retrieved April 2017 from <http://www.pc.gov.au/research/supporting/grey-letter-law>.

European Union (2009). *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*. *.* Retrieved October 2017 from <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32009R0661>.

Hart, P. (2003). Prime Mover Standards Project: *ABS Braking Requirements (Stage 3)*.

Hart, P. (2008). *National Heavy Vehicle Braking Strategy: Final Report*. National Transport Commission. Retrieved September 2017 from <https://www.ntc.gov.au/publications/?year=2008>.

Murray, D., Shackelford, S., & Houser, A. (2009). *Analysis of Benefits and Costs of Roll Stability Control Systems for the Trucking Industry.* American Transportation Research Institute.

National Road Transport Commission & the Federal Office of Road Safety (1994). *Anti Lock Braking Systems for Heavy Vehicles: Stage 1.*

National Road Transport Commission & the Federal Office of Road Safety (1996). *Anti Lock Braking Systems for Heavy Vehicles: Stage 2*.

NHTSA (1995). *Federal Motor Vehicle Safety Standards; Air Brake Systems; Long-Stroke Brake Chambers Final Rulemaking (Docket No. 93-54, Notice 2).* Retrieved October 2017 from <https://www.gpo.gov/fdsys/pkg/FR-1995-01-12/pdf/95-752.pdf>.

NHTSA (2015). *Federal Motor Vehicle Safety Standards; Electronic Stability Control Systems for Heavy Vehicles Final Rulemaking (Docket No. NHTSA-2015-0056).* Retrieved August 2017 from <https://www.nhtsa.gov/staticfiles/rulemaking/pdf/FMVSS-136-Final-Rule-05182015%20final.pdf>.

NHTSA (2016a). *Federal Motor Vehicle Safety Standard No. 121; Air brake systems (49 CFR 571.121) 10-1-16 Edition.* US Government Publishing Office’s Federal Digital System.

NHTSA (2016b). *Federal Motor Vehicle Safety Standard No. 136; Electronic stability control systems for heavy vehicles (49 CFR 571.136) 10-1-16 Edition.* US Government Publishing Office’s Federal Digital System.

NSW EPA (2014a). *Determination: Transport of Dangerous Goods in Tank Trailers*. Retrieved September 2017 from <http://www.epa.nsw.gov.au/resources/dangerousgoods/140060TrailerDgList.pdf>.

NSW EPA (2014b). *Determination: Transport of Dangerous Goods in Tank Trailers*. Retrieved September 2017 from <http://www.epa.nsw.gov.au/resources/dangerousgoods/DGRoverdetAug2014.pdf>.

NTC (2010). *Heavy Vehicle Types and Charges*.

NTC (2016). *Who Moves What Where, Freight and Passenger Transport in Australia, August 2016.* Retrieved September 2016 from https://www.ntc.gov.au/Media/Reports/(D62E6EFC-36C7-48B1-66A7-DDEF3B04CCAE).pdf.

NTARC (2017). *2017 Major Accident Investigation Report: Covering major accidents in 2015.* Retrieved October 2017 from <https://www.nti.com.au/supporting/trucking/latest-report.php>.

Transport and Infrastructure Council (2011). *National Road Safety Strategy 2011-2020.* Retrieved April 2017 from <http://www.transportinfrastructurecouncil.gov.au/publications/>.

Transport and Infrastructure Council (2014). *National Road Safety Action Plan 2015–2017*. Retrieved April 2017 from <http://www.transportinfrastructurecouncil.gov.au/publications/>.

Transport Canada (2013). *Technical Standards Document No. 121, Revision 4R – Air Brake Systems*. Retrieved October 2017 from <https://www.tc.gc.ca/media/documents/roadsafety/121-TSD-EN-Rev-4R.pdf>.

TIC (2015). *Truck Industry Council Fleet Report 2015*. Retrieved November 2017 from <http://www.truck-industry-council.org/res/file/TIC%20Fleet%20report%202015%20screen%20view%20-%20A3%20format.pdf>.

UN (2014). *United Nations Regulation No. 13 – Revision 8 – Uniform provisions concerning the approval of vehicles of categories M, N and O with regard to braking*. Retrieved October 2017 from <https://www.unece.org/trans/main/wp29/wp29regs1-20.html>

VicRoads (2013). *Electronic braking and stability control system eliminates rollovers*. Retrieved August 2017 from https://www.nrspp.org.au/resources/vicroads-electronic-braking-and-stability-control-system-eliminates-rollovers/.

Wang, J. (2011). *Effectiveness of Stability Control Systems For Truck Tractors.* The National Highway Traffic Safety Administration. Retrieved October 2017 from http://www-nrd.nhtsa.dot.gov/Pubs/811437.pdf.

Woodrooffe, J., Blower, D., Gordon, T., Green, P., Liu, B., & Sweatman, P. (2009). *Safety Benefits of Stability Control Systems for Tractor-Semitrailers.* The University of Michigan Transportation Research Institute.

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

1. — 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.

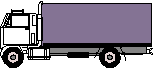
The various types of heavy commercial vehicles operating in Australia are detailed below. In summary, there are five main operating classes of heavy commercial vehicles. These are:

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

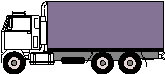
A B-Double combination consists of a prime mover towing two semi-trailers. The first trailer includes a turntable, which links to the second trailer, rather than using a dolly to link the trailers as in many road train configurations. A road train comprises of a prime mover hauling three or more trailers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

RIGID HEAVY COMMERCIAL VEHICLES

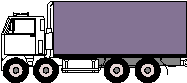
1. TWO AXLE



1. THREE AXLE



1. FOUR AXLE TWIN-STEER



1. TWO AXLE WITH TWO AXLE DOG TRAILER

Two Axle Rigid Truck with Two Axle Dog Trailer

1. THREE AXLE WITH THREE AXLE DOG TRAILER

Three Axle Rigid Truck with Three Axle Dog Trailer

Articulated Heavy Commercial Vehicles

1. THREE AXLE SEMI-TRAILER

Three Axle Semi-Trailer

1. FIVE AXLE SEMI-TRAILER

Five Axle Semi-Trailer

1. SIX AXLE SEMI-TRAILER

Six Axle Semi-Trailer

1. SEVEN AXLE B-DOUBLE

Seven Axle B-Double

1. EIGHT AXLE B-DOUBLE

Eight Axle B-Double

1. NINE AXLE B-DOUBLE

Nine Axle B-Double

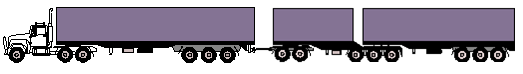
1. B-TRIPLE ROAD TRAIN

B-Triple Road Train

1. DOUBLE ROAD TRAIN (or A-DOUBLE)

Double Road Train (or A-double)

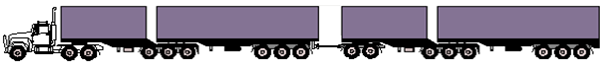
1. AB-TRIPLE ROAD TRAIN



1. TRIPLE ROAD TRAIN (or A-TRIPLE)

Triple Road Train (or A-Triple)

1. BAB QUAD ROAD TRAIN



1. ABB QUAD ROAD TRAIN



Images sourced/adapted from National Transport Commission (2010)

1. — 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.

1. — 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.

1. — 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.

1. — 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 | | | |

1. — 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).

1. — 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 | 37-531 | 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 | 40-561 | 141 | 25-322 |
| RSC | 37-531 | 22 | 17-242 |
| 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 |

1. — 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[[3]](#footnote-4) and the 1998 Agreement[[4]](#footnote-5) 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.

### 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.

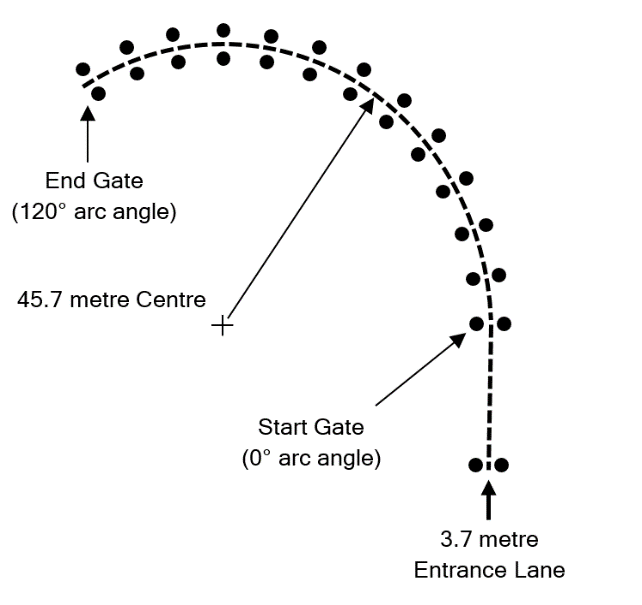


Figure 10: J-turn test course (anticlockwise direction shown)

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.

1. — 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).

1. — 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

1. Part *0. Legislative Provisions* renumbered to begin ADR 35 at part 1.
2. Changed title of part *2. Scope* to *2. Function*.
3. Changed title of part 3. Applicability and Implementation to 3. Applicability
4. 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.
5. Added clause 3.8., deemed to comply clause for NA vehicles types approved to UN R13 series 11.
6. Added clause 3.9., deemed to comply clause for MD, ME, NB and NC vehicles types approved to UN R13 series 11.
7. Applicability table updated.
8. 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

1. 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).
2. Clause 5.1.4. has been changed to require automatic slack adjusters.
3. 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.
4. 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.
5. 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.
6. Clause 5.1.9. requires vehicles required to have a vehicle stability function to meet the requirements of Appendix 3.
7. For vehicles designed to tow trailers using air brakes — a new clause clause 5.1.12 has been added:
   1. 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;
   2. 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;
   3. 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.

1. 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.
2. Clause 5.2.10 now includes reference to ISO 7000 for the required brake failure symbol. The symbol itself has also been included.
3. Similarly, clause 5.4.4 no includes reference to ISO 7000 for the parking brake symbol and includes the symbol itself.
4. Clause 5.3.7 has clarification and changes to the conditions for the independent release of trailer parking brakes.
5. 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).
6. 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).
   1. 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.
7. 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/s2. 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

1. 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.
2. 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.
3. 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

1. Clause 7.8 changes the average deceleration required to the minimum average deceleration as clarification.
2. Clause 7.12 adds a maximum tolerance to test speeds of 5 km/h, in addition to the minimum tolerance of 1 km/h.
3. Clause 7.14 is reworded for clarification.
4. 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

1. 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).
2. 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.
3. 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.
4. 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

1. 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.
2. 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.
3. Category ME over 12 tonne and NC prime movers are required to meet the stability control clauses of the ADR.
4. 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

1. Table 1 restructured to provide clarification.
2. Table 2 updated to include four-axle axle-groups.
3. Table 3 updated to provide clarification.
4. Figure 2 removed
5. Table 4 added. This table provides a list of brake chamber rated volumes in line with that used in FMVSS 121.
6. 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

1. A new Appendix 1 was added to provide definitions for off road vehicles as used to determine if stability control is required.
2. The former Appendix 1 — Annex 1 has been moved to become Appendix 4 and expanded to provide clarity.

#### Appendix 2

1. 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.
2. 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.
3. 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.
4. 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.
5. 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.
6. 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

1. 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.
2. 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.
3. Clause 2, provides functional requirements, based on UN R 13.
4. 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.
5. Clause 3 provides requirements for tell-tales and warning signals associated with the vehicle stability system.
6. 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.
7. 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.
8. 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

1. 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

1. 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/s2 (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

1. Part *0. Legislative Provisions* renumbered to begin ADR 38 at part 1.
2. Changed title of part *2. Scope* to *2. Function*
3. Changed title of part *3. Applicability and Implementation* to *3. Applicability*
4. 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’

1. Clause 6.12 has been amended to require automatic slack adjusters on all trailers, irrespective of if fitted with ABS.
2. 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

1. 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.
2. 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).
3. 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.
4. 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).
5. 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.
6. 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.
7. Clause 7.2 has been created as a new sub section for Electric ‘Control Line’, ‘Antilock System’ and ‘Vehicle Stability Function’ requirements.
   1. 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.
   2. 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.
   3. Clause 7.2.3 references requirements in Appendix 4 for trailers fitted with an electric control line.
   4. 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

1. 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

1. 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

1. 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

1. Part title changed from *Time Response Measurement* to *Response and Release Time Measurement*.
2. 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.
3. Former clause 15.2 (variants of unique trailer brake systems) has been moved and become clause 16.6.
4. 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.
5. 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
6. 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’**

1. Part title changed from Time Response to *Response and Release Times for Trailers Fitted with ‘Approved’ ‘Control Systems’*.
2. 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

1. 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

1. Table 1 — Updated to include 4 axles.
2. 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).
3. 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.
4. Figure 5 — Figure 5 gives an example for the setup of the electric control line test rig.

#### Appendices

#### Appendix 1

1. 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

1. 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

1. 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

1. 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.
2. Required minimum currents have been uprated.
3. Clause 2 requires electric control lines to meet ISO 11992 requirements.
4. 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).

# 

1. — 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)[[5]](#footnote-6),[[6]](#footnote-7). 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).
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.
26. — Benefit-Cost Analysis — Details of Results
27. 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 |

1. 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 |

1. 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.
2. 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 |

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

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

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

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

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

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

1. Establish a projected national population at 30 June of each year between 2016 and 2064 inclusive.
2. 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 |

1. 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% |

1. 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 |

1. 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.
2. Estimate new prime mover, rigid truck, bus and trailer sales in Australia for 2017.
3. Determine the number of prime movers, rigid trucks, buses and trailers leaving the fleet in 2017 (vehicle attritions).
4. 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 |
| 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 |

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 |

1. 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 |

1. 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 |

1. 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 |

1. 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 |

1. 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

|  | **Prime Movers (NC)** | | | **Rigid Trucks (NB2 & NC)** | | | **Buses (MD4 & ME)** | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Age of Vehicle** | **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** |  |  |

1. 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 |

1. 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

|  | **Prime Movers (NC)** | | | **Rigid Trucks (NB2 & NC)** | | | **Buses (MD4 & ME)** | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Age of Vehicle** | **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 |

1. 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.
2. 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)

|  | **New Vehicles** | | | | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Year** | **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)

|  | **New Vehicles** | | | |
| --- | --- | --- | --- | --- |
| **Year** | **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)

|  | **New Heavy Trailers** | | | | **All Registered Heavy Trailers** | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Year** | **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)

|  | **New Heavy Trailers** | | | | | **All Registered Heavy Trailers** | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Year** | **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 |

1. 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 |

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 |

1. 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**

|  | **Option 6a** | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| **Year** | **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**

|  | **Option 6b** | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| **Year** | **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**

|  | **Option 6c** | | |
| --- | --- | --- | --- |
| **Year** | **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**

|  | **Option 6a** | | |
| --- | --- | --- | --- |
| **Year** | **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**

|  | **Options 6b and 6c** | | |
| --- | --- | --- | --- |
| **Year** | **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**

|  | **Option 6a** | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| **Year** | **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**

|  | **Option 6b** | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| **Year** | **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**

|  | **Option 6c** | | |
| --- | --- | --- | --- |
| **Year** | **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**

|  | **Option 6a** | | |
| --- | --- | --- | --- |
| **Year** | **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**

|  | **Options 6b and 6c** | | |
| --- | --- | --- | --- |
| **Year** | **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**

|  | **Options 6a, 6b and 6c** | | |
| --- | --- | --- | --- |
| **Year** | **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**

|  | **Options 6a, 6b and 6c** | | |
| --- | --- | --- | --- |
| **Year** | **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** |

1. 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 |

1. 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

|  |  | **Net Benefits** | | |
| --- | --- | --- | --- | --- |
| **Year** | **Gross 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

|  |  | **Net Benefits** | | |
| --- | --- | --- | --- | --- |
| **Year** | **Gross 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

|  |  | **Net Benefits** | | |
| --- | --- | --- | --- | --- |
| **Year** | **Gross 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 |  |  |

1. — Benefit-Cost Analysis — Sensitivities

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

1. 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 |  |  |

1. 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 |  |  |

1. 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 |  |  |

1. 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]](#footnote-8) |  |  |
| **Likely case** | **$141 m** | **$41 m** | **$0.7 m** | **4.38** | **84** | **731** |
| Worst case | $79 m | $103 m | $0.7 m | 1.76 |  |  |

1. — 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[[8]](#footnote-9).

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[[9]](#footnote-10), ARTSA[[10]](#footnote-11), ATA[[11]](#footnote-12), CVIAA/HVIA[[12]](#footnote-13) and TIC[[13]](#footnote-14) 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.

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.

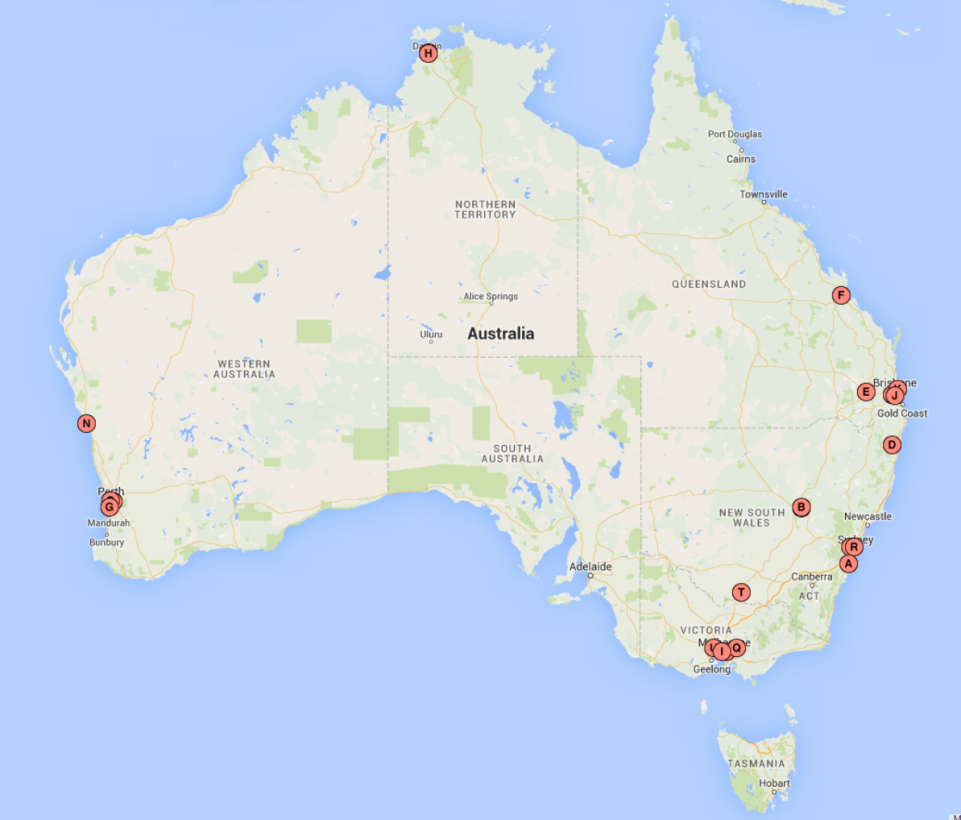
However, it is important to note that the survey does not replace the normal regulatory consultation process, which will include public distribution of the draft RIS for feedback, prior to the relevant Minister being asked to make any decision.

**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[[14]](#footnote-15)

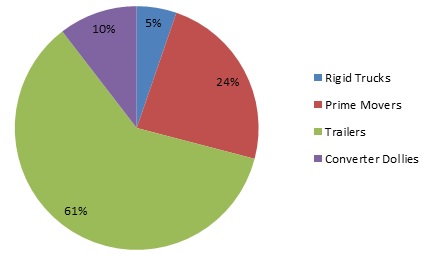
Of the total number of vehicles identified, there were:

* 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**

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[[15]](#footnote-16) as developed by the Australian Government Department of Health. This in turn is based on The Australian Standard Geographical Classification (ASGC) Remoteness Structure[[16]](#footnote-17).

**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.

**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.

Components requiring 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[[17]](#footnote-18). 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

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[[18]](#footnote-19).

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**

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

1. — 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 |
|  |

1. — 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 |
|  |
|  |

1. — Summary of Public Comments

| **Correspondent** | **Comment Summary** | **Departmental Response** |
| --- | --- | --- |
| Air Brake Systems Pty Ltd | 1. Supports Option 6c in the consultation RIS. | 1. Agreed. |
| 1. Supports mandating of automatic slack adjusters on all trailer brake systems. | 1. Agreed. |
| 1. Notes LPV and standard brake systems are often upgraded to electronic brake systems. | 1. Noted. |
| 1. 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. | 1. Noted. |
| 1. Supports the proposed timeline for the implementation of ADR 38/05. | 1. 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. |
|  | 1. In summary, supports:    1. mandating ESC for trucks and RSC for trailers (including on spring suspension);    2. a specific exemption for converter dollies (with a requirement for through wiring);    3. a requirement for road train rated equipment to supply 24V;    4. a manual off-switch that re-engages at speeds above 40 km/h; and    5. automatic slack adjusters. | 1. Notes the responses to the RIS questions and support for these changes. |
| 1. 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. | 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). |
| 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. |
| 1. Would accept a reasonable extension of the implementation timetable for category NB2 vehicles. | 1. 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). |
| 1. 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. | 1. 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. |
| 1. 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. | 1. 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. |
| 1. 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. | 1. Noted. |
| 1. 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. | 1. 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. |
| 1. 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: | 1. 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. |
| * 1. new trucks and trailers used in road train combinations must be wired for 24V power; and   2. the power cables connecting new trucks and trailers in road train combinations must be configured and connected to supply 24V power. |  |
| 1. 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. | 1. 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. |
| 1. 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. | 1. Notes the response to the RIS question. This acknowledges that there is a need for RSC on steel sprung trailers in Australia. |
| 1. Supports mandating automatic slack adjusters on all trailers. | 1. Notes the response to the RIS question and support for this change. |
| 1. 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. | 1. Notes the response to the RIS questions and support for the inclusion of switch to aid operators in certain low speed manoeuvres. |
| 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 |
| 1. 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. | 1. Notes the response to the RIS question. This acknowledges that there is a need for RSC on steel sprung trailers in Australia. |
| 1. 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. | 1. Notes the response to the RIS question and support for this change. |
| 1. Notes that ‘prime mover’ is not an ADR vehicle category. Would prefer requirements to cover all category NC vehicles. | 1. 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). |
| 1. 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. | 1. 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. |
| 1. 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. | 1. Noted. This would be similar to Option 6b. Refer to response 1 above. |
| 1. Would prefer that RSC also be required for category TC trailers above 4.5 tonnes GTM. | 1. Refer to response 1 above. |
| 1. 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. | 1. 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. |
| 1. 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. | 1. 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. |
| 1. 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. | 1. ESC systems that comply with the testing requirements suggested in this RIS are based on an ESC activation of around 0.4g. |
| 1. 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. | 1. 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). |
| 1. 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. | 1. 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. |
| 1. 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. | 1. 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. |
| 1. Recommends mandating that all air suspended axle groups be fitted with dynamic load sharing inherently damped fractional feedback unitary ride height controlled suspension systems. | 1. 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 NRSAP). |
| 1. 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. | 1. 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. |
| 1. Supports the use of engineering controls to regulate risk. Believes these are far more effective than administrative controls. | 1. Noted. |
| 1. Agrees that ESC and RSC substantially reduce rollover and loss of control crashes. | 1. Agreed. |
| 1. 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. | 1. Noted. |
| 1. Supports conformity with overseas standards in jurisdictions where ESC and RSC have been mandated, as well as greater conformity with international standards. | 1. Agreed. |
| 1. Believes the additional cost of Option 6a is not disproportionate to the benefits, and that this option would be more consistent with international standards. | 1. Noted. An issue with exclusive use of international standards is the lack of defined performance requirements in UN R13. This make it difficult to 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. |
| 1. Suggests the Department further examine engineering issues associated with including converter dollies within the scope of the proposal. | 1. 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). |
| 1. 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. | 1. 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. |
| 1. 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. | 1. 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. |
| 1. 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. | 1. Notes the response to the RIS question and support for this change. |
| 1. 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. | 1. Notes the response to the RIS question. This acknowledges that there is a need for RSC on steel sprung trailers in Australia. |
| 1. 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. | 1. 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. |
| 1. 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. | 1. 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. |
| 1. 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. | 1. 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. |
| 1. 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. | 1. 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. |
| 1. 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. | 1. 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. |
| 1. 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. | 1. 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. |
| 1. 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. | 1. 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 Government | 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 NRSAP). |
| 1. 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). | 1. 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 NRSAP). |
| 1. 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. | 1. 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. |

1. — 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[[19]](#footnote-20). 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. — 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

1. — 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.

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. [↑](#footnote-ref-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. [↑](#footnote-ref-3)
3. 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. [↑](#footnote-ref-4)
4. 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.* [↑](#footnote-ref-5)
5. 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. [↑](#footnote-ref-6)
6. 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. [↑](#footnote-ref-7)
7. Benefit-Cost ratio not applicable due to no net costs (i.e. savings are greater than costs). [↑](#footnote-ref-8)
8. 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> [↑](#footnote-ref-9)
9. Australian Livestock and Rural Transporters Association [↑](#footnote-ref-10)
10. Australian Road Transport Suppliers Association Inc. [↑](#footnote-ref-11)
11. Australian Trucking Association [↑](#footnote-ref-12)
12. Commercial Vehicle Industry Association of Australia. Now also the Heavy Vehicle Industry Australia. [↑](#footnote-ref-13)
13. Truck Industry Council [↑](#footnote-ref-14)
14. 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)). [↑](#footnote-ref-15)
15. ASGC Remoteness Areas <http://www.doctorconnect.gov.au/internet/otd/Publishing.nsf/Content/locator> [↑](#footnote-ref-16)
16. The Australian Standard Geographical Classification (ASGC) Remoteness Structure <http://www.abs.gov.au/websitedbs/D3310114.nsf/home/remoteness+structure#Anchor2> [↑](#footnote-ref-17)
17. 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. [↑](#footnote-ref-18)
18. Assessment of the Effect of Automatic Slack Adjusters on Brake Adjustment <https://www.tc.gc.ca/media/documents/roadsafety/tp14214es.pdf> [↑](#footnote-ref-19)
19. Refer to Appendix 2 diagrams 4 and 5. [↑](#footnote-ref-20)