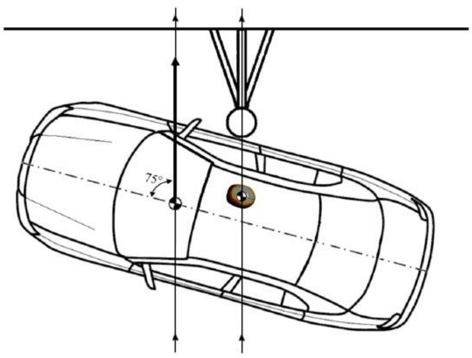
Australian Government

Department of Infrastructure and Regional Development

Regulation Impact Statement

Improved Protection of Vehicle Occupants in Side Impact Crashes



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EXECUTIVE SUMMARY

The impact of road crashes on society is significant, costing the Australian economy at least $27 billion per annum. Side impact crashes are one of the most substantial causes of road crash trauma in Australia and the specific road safety problem considered in this Regulation Impact Statement (RIS).

On average, just over 20 per cent (UNECE, 2013) of all Australian road deaths and around 10 per cent of hospital admissions from road crashes (Fitzharris and Stephan, 2013) are vehicle occupants involved in side impact crashes. It is estimated that there are around 225-250 light vehicle (i.e. light passenger and light commercial) occupant fatalities and over 3,000 hospital admissions per annum (as of 2014-15) in Australia due to side impact crashes. The overall cost of side impact crashes to the Australian economy is estimated to be at least $4.2 billion a year.

There have been significant efforts made by manufacturers and governments over a number of years to improve the protection of vehicle occupants in side impact crashes. Australia adopted Australian Design Rule (ADR) 72/00 – Dynamic Side Impact Occupant Protection as a national standard for new light vehicles, which is aligned with international standard United Nations (UN) Regulation No. 95. ADR 72/00 has been effective in reducing the number of deaths and injuries caused by side impact crashes. However, ADR 72/00 is primarily designed to address vehicle-to-vehicle crashes. It does not specifically address pole side impacts and does not necessitate protection for a vehicle occupant’s head during vehicle-to-vehicle and other side impacts.

A detailed investigation by Fitzharris and Stephan (2013) of fatal road crashes in Australia, found head injuries, thorax (chest) injuries and multiple injuries (usually including a head injury plus injury to one or more other body regions) are the three most common causes of death from side impact crashes. Further, it is estimated that non-fatal serious head injuries from side impact crashes are costing the Australian community around $1.8-1.9 billion per annum due to increased morbidity rates, permanent disability, lost productivity, and high health system and lifetime care costs – not to mention the impact they have on the individuals involved and their families.

In 2010, Australia proposed and led the development of a Global Technical Regulation (GTR) under the auspices of the peak international vehicle standards body, the UN World Forum for the Harmonization of Vehicle Regulations (WP.29), to provide for a new international standard dealing with pole side impacts, and head injuries in side impacts more generally. This is in line with Australia’s National Road Safety Strategy 2011-20 and Action Plan 2015-2017.

In November 2013, the UN established GTR 14 on Pole Side Impact, which sets performance requirements for occupant protection in an oblique vehicle-to-pole side impact test, using the cutting edge WorldSID crash dummy. Australia, as a Contracting Party to the UN 1998 Agreement[1], is obliged to review the case for adopting GTR 14 under its domestic legislation.

The development of GTR 14 prompted the European New Car Assessment Program (Euro NCAP) to move from a perpendicular vehicle-to-pole side impact test to an oblique vehicle-to-pole side impact test based on the test developed for the GTR. In November 2014, the Australasian New Car Assessment Program (ANCAP) announced that it would transition in the period 2015-2017 to alignment with the Euro NCAP rating system, meaning that it will use the same oblique vehicle-to-pole side impact test as part of its suite of tests from 2018.

Also in November 2014, the UN voted to adopt a new UN regulation on Pole Side Impact Performance (UN Regulation No. [135[2]] (UN R[135])) under the UN 1958 Agreement[3]. UN R[135] includes technical performance requirements in accordance with the regulatory text of the GTR and is the working regulation that Contracting Parties to the 1998 Agreement that apply type approval based certification systems (such as Australia), will consider using to regulate domestically.

This Regulation Impact Statement (RIS) examined the case for Australian Government intervention to improve future light vehicle occupant protection in side impact crashes in Australia. Any Australian Government intervention must be in accordance with its obligations under the World Trade Organisation and the 1958 and 1998 Agreements. These generally require any regulation to adopt internationally based standards where possible. Use of standards developed under the 1958 and/or 1998 Agreements meet this requirement, making it possible for consumers to enjoy access to a large range of the safest vehicles at the lowest possible cost.

The primary countermeasures used to improve vehicle-to-pole side impact performance are curtain side airbags in combination with thorax airbags. A requirement for vehicles to meet the oblique vehicle-to-pole side impact test as set out in GTR 14 and UN R[135] will both increase side airbag fitment rates and increase the effectiveness of many current airbag system designs in side impacts. It is estimated that this will reduce vehicle occupant fatalities and injuries in side impact crashes by around 30 per cent.

Under a business as usual scenario, it was estimated that by 2017 around 30 per cent of light passenger vehicles (LPVs) and 20 per cent of light commercial vehicles (LCVs) supplied to the Australian market would meet the performance requirements of the GTR/UN regulation. Given recently announced moves by NCAPs, including ANCAP, to move to an oblique vehicle-to-pole side impact test based on the test used in GTR 14/UN R[135], this is expected to steadily increase to around 70 per cent for all light vehicles (LPVs and LCVs combined by

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[1] *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* of June 1998.
[2] The proposal adopted by UN WP.29 in November 2014 was notified (by the UN Secretary-General) as draft Regulation [135] on 15 December 2014 – the provisional date of entry into force of UN R[135] is 15 June 2015.
[3] *Agreement concerning the Adoption of Uniform Technical Prescriptions for Wheeled Vehicles, Equipment and Parts which can be fitted and/or used on Wheeled Vehicles and the Conditions for Reciprocal Recognition of Approvals Granted on the basis of these Prescriptions* of March 1958.

sales volume) by 2023. However, without Australian Government action, it is not expected to increase any further beyond this.

Within the RIS, a total of six options, including both regulatory and non-regulatory, were explored: 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); and Option 6: mandatory standards under the *Motor Vehicle Standards Act 1989* (C'th) (MVSA) (regulation). Of these options, Option 1, Option 3 and Option 6 were considered viable and so were examined in more detail. Option 6 was separated into two further sub-options. In the first—Option 6a: regulation (broad scope)—mandatory standards would be applied to both LPVs and LCVs under the MVSA. In the second approach—Option 6b: regulation (narrow scope)—mandatory standards would be limited to LPVs only. The results of a benefit-costs analysis for these options, assuming an intervention period of 15 years, are summarised in Table 1 to Table 3.

Table 1 Summary of net benefits and gross benefits for each option based on 15 years of regulation

	Net benefits ($m)			Total benefits ($m)		
	Best case	Likely case	Worst case	Best case	Likely case	Worst case
Option 1: no intervention	-	-	-	-	-	-
Option 3: fleet purchasing policies	30	27	25	37	37	37
Option 6a: regulation (broad scope)	591	556	521	704	704	704
Option 6b: regulation (narrow scope)	487	468	448	553	553	553

Table 2 Summary of costs and benefit-cost ratios for each option based on 15 years of regulation

	Costs ($m)			Benefit-cost ratios		
	Best case	Likely case	Worst case	Best case	Likely case	Worst case
Option 1: no intervention	-	-	-	-	-	-
Option 3: fleet purchasing policies	8	10	12	4.9	3.8	3.1
Option 6a: regulation (broad scope)	113	148	183	6.2	4.7	3.8
Option 6b: regulation (narrow scope)	66	86	105	8.4	6.5	5.3

Table 3 Summary of number of lives saved and severe and moderate traumatic brain injuries (TBI) avoided based on 15 years of regulation

	Lives saved	Severe TBI avoided	Moderate TBI avoided
Option 1: no intervention	-	-	-
Option 3: fleet purchasing policies	7	9	4
Option 6a: regulation (broad scope)	158	153	87
Option 6b: regulation (narrow scope)	128	116	73

Option 6a: regulation (broad scope) generated the highest net benefits of the options examined ($556m) as well as the highest number of lives saved (158) and severe and moderate traumatic brain injuries avoided (240). This option had a likely benefit cost ratio of 4.7.

These are significant road trauma savings, especially when compared with other recent vehicle safety initiatives; and there are a number of reasons for this. Firstly, side impact crashes are the largest single contributor of any crash type (i.e. frontal impact, side impact, rollover, pedestrian, motorcycle etc.) to the annual Australian road toll.

Secondly, of those killed in pole side impacts, a relatively high proportion are young drivers (under 30), so on average there is a much larger loss of "life years". Furthermore, of those injured in pole side impacts, there is a high incidence of traumatic brain injuries, which are very costly to the community at between $2.5-5.6 million per incidence.

Thirdly, highly effective countermeasures (i.e. improved, airbags and/or sensors) are available through designs that meet the performance required by GTR 14 – the incremental cost of which is very low (no more than $50 for the majority of vehicle models).

While the adoption of GTR 14 by NCAPs (including ANCAP in Australia) will in itself deliver significant benefits, it can be seen in Table 1 to Table 3 that regulation is the only option able to guarantee that all of what is still a large pool of available benefits are realised.

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.

Option 6a: regulation (broad scope) is therefore the recommended option. Under this option, the fitment of enhanced side impact safety measures would in effect be mandated for LPVs and LCVs as a result of the stringent test requirements of a new ADR. The recommended standard to be applied is UN R[135], which in turn is based on the performance requirements of GTR 14. The indicative implementation timetable for consultative purposes is:

- for LPVs (ADR category MA, MB and MC vehicles)—1 January 2017 for new models and 1 January 2019 for all models; and
- for LCVs (ADR category NA vehicles)—1 January 2018 for new models and 1 January 2020 for all models.

A sensitivity analysis was undertaken on Option 6a and was conducted on three variables: effectiveness of enhanced side impact safety measures; the discount rate; and the expected business as usual compliance rate. The net benefits from the option remained positive under all scenarios with high benefit-cost ratios.

The RIS has been written in accordance with Australian Government RIS requirements, addressing the 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.

As part of the RIS process, the proposal will be circulated for a six-week public comment period. A summary of the feedback and departmental responses will be included in the final RIS that is used for decision making.

1. WHAT IS THE PROBLEM?

1.1 Introduction

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 (Department of Infrastructure and Regional Development, 2014a). This translates to an average of over $1,100 per annum for every person in Australia. The cost is borne widely by the general public, businesses, and government. It has a further effect on the wellbeing of families that is not possible to measure.

Side impact crashes are one of the most significant causes of global road crash trauma and the specific road safety problem (the problem) considered in this Regulation Impact Statement (RIS). Generally, side impact crashes account for between 12 and 25 per cent of most national road tolls (UNECE, 2013). On average, just over 20 per cent (UNECE, 2013) of all Australian road deaths and around 10 per cent of hospital admissions from road crashes (Fitzharris and Stephan, 2013) are vehicle occupants involved in side impact crashes. The Department estimates that side impact crashes are currently costing the Australian economy at least $4.2 billion a year.

Side impact crashes represent a relatively high injury risk, due to the proximity of the impact to the vehicle occupant(s). Side impacts with rigid narrow objects, such as poles and trees (collectively referred to throughout this RIS as ‘pole side impacts’) can be especially dangerous. First and foremost, this is due to the risk of direct occupant head contact with the pole/tree (which unlike the front of a passenger car, typically extend from the ground to above the roof of the vehicle). There is usually also significant occupant kinetic energy in pole side impact crashes, which unless absorbed by an advanced restraint system (e.g. a side airbag system) and/or interior padding, generally ends up being absorbed primarily through compression of the occupant thorax (chest) in particular.

Notably, Australia has the highest pole side impact fatality and serious injury rates (per capita) of all the countries (including Canada, France, Germany, Great Britain, Japan, the Netherlands, the Republic of Korea and the US) that provided side impact crash data to the UN informal working group responsible for the development of the GTR on pole side impact (UNECE, 2013).

1.2 Extent of the Problem in Australia

<u>Fatalities</u>

The Australian Fatal Road Crash Database (FRCD) provides a basis for the determination of light passenger vehicle (LPV) and light commercial vehicle (LCV) occupant fatalities in side impact crashes up until the end of the 2006 calendar year.

A detailed analysis of the FRCD (2001-2006)[4] by Fitzharris and Stephan (2013) showed that 2,095 occupants of LPVs and LCVs were killed in side impact crashes in Australia from 2001 to 2006 inclusive, representing 37 per cent of all light vehicle occupant fatalities for this period. Pole side impact crashes accounted for 898 fatalities (43 per cent of side impact fatalities and 16 per cent of the total number of fatalities in LPVs and LCVs). Figure 1 shows the total number of light vehicle occupant fatalities in Australia by crash type for the period 2001-2006.

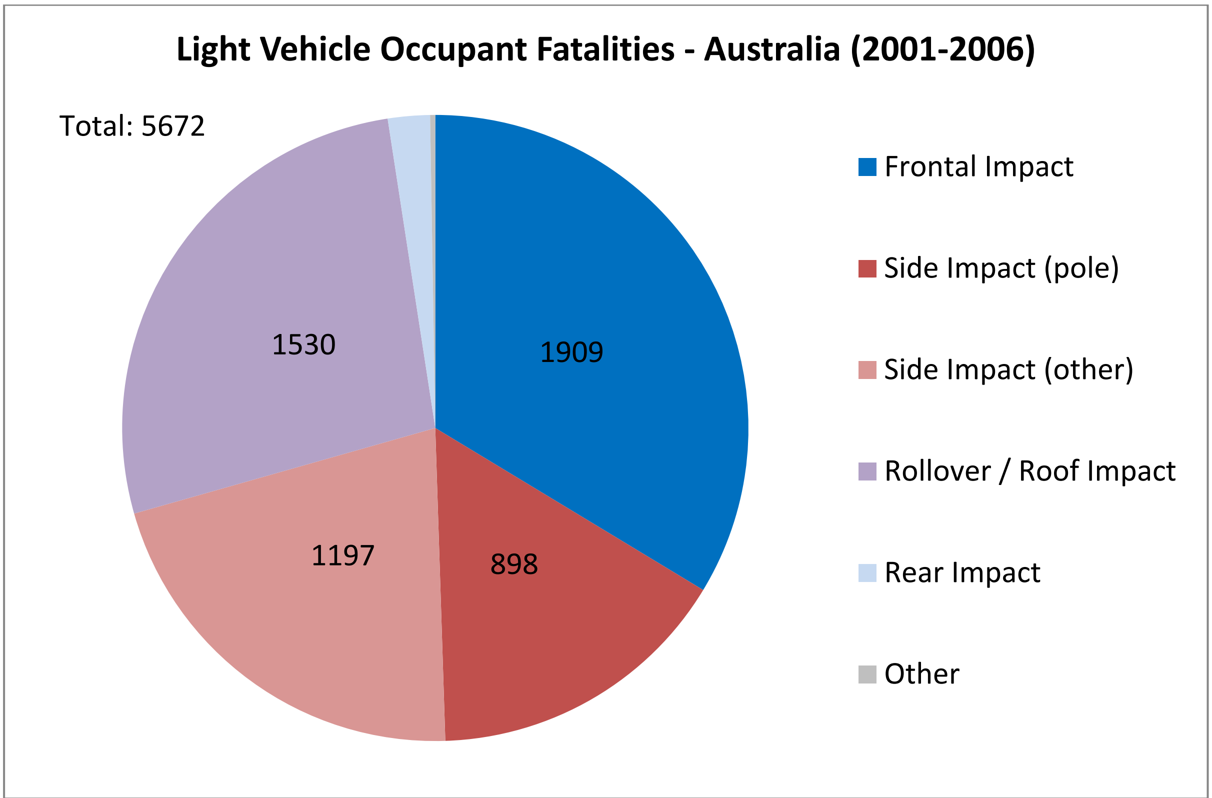

Figure 1 Light vehicle occupant fatalities in Australia by crash type, 2001-2006 (Fitzharris and Stephan, 2013)

Using the data from their FRCD analysis and a willingness to pay based value of life, Fitzharris and Stephan estimated vehicle occupant fatalities in side impact crashes cost the Australian community $10.3 billion (in 2008 dollar terms) in the period 2001-2006.

There is no national road crash database which can be used to determine the exact number of vehicle occupant fatalities in side impact crashes from the 2007 calendar year onwards. Most state and territory road crash databases also do not enable accurate determination of vehicle occupant fatalities in pole side impact and other side impact crashes. The most comprehensive side impact crash data available in Australia from 2007 onwards is from Victoria. Figure 2 shows light vehicle (LPV and LCV) occupant fatalities in pole side impact and other side impact crashes in Victoria, Australia from 2001-2010.

[4] Note: The Australian Fatal Road Crash Database comprises aggregate data from police reports, coroners reports etc. for fatal road crashes up until the end of 2007. However, the aggregate data included in this database for the post year 2006 crashes does not include sufficient point of impact detail to identify side impact crashes.

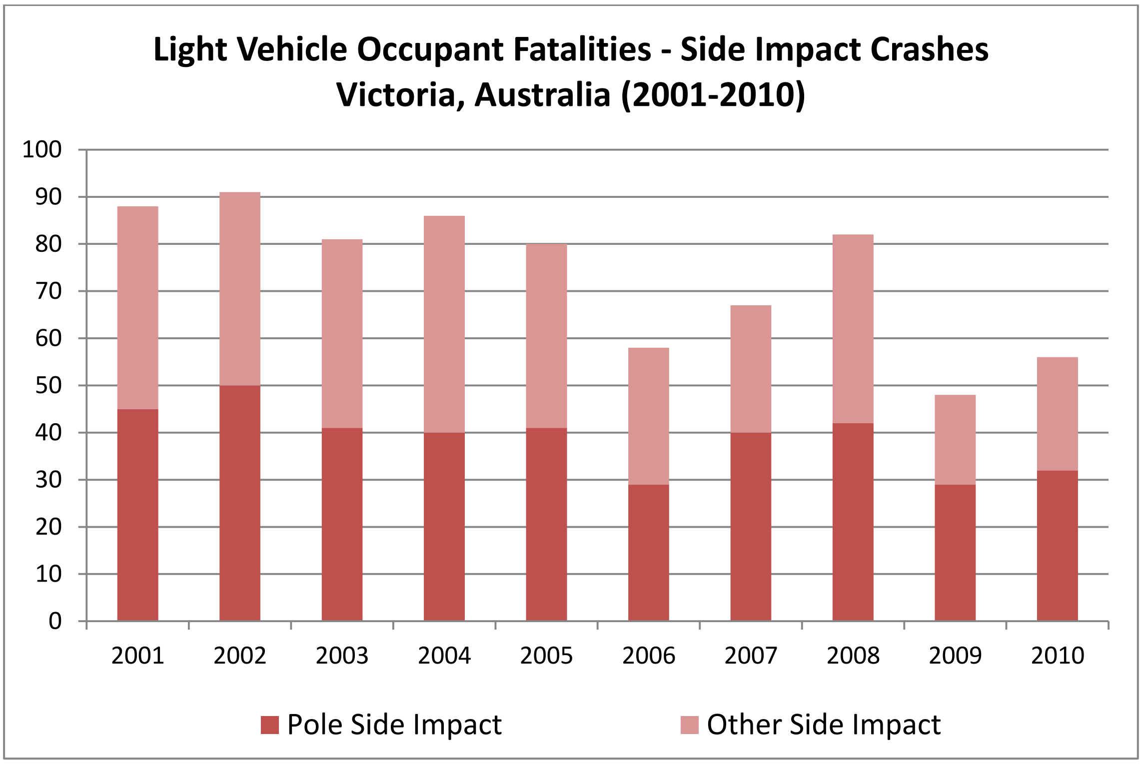

Figure 2 Light vehicle occupant fatalities in Victoria, by side impact crash type, during the period 2001-2010 (data provided by VicRoads)

In 2010, Victoria accounted for 20.9 per cent of all vehicle occupant fatalities in Australia. On this basis, the Department of Infrastructure and Regional Development (the Department) estimates there would have been around 155 and 115 light vehicle occupant fatalities in pole side impact and other side impact crashes respectively, for Australia during 2010. Similarly, Fitzharris and Stephan (2013) used detailed side impact crash data from Victoria to estimate light vehicle occupant fatalities in pole side impact and other side impact crashes in Australia for 2007-2009. Figure 3 shows light vehicle occupant fatalities in side impact crashes from FRCD data provided by BITRE for 2001-2006 together with the 2007-2009 estimates by Fitzharris and Stephan (2013) and the 2010 estimate by the Department.

As illustrated by Figure 3, total side impact crash fatalities have been gradually trending downwards, particularly since 2005. The average rate of decrease between 2005 and 2010 was approximately 2.5 per cent per annum. This immediately followed the full phase-in of ADR 72/00 (Dynamic Side Impact Occupant Protection) and also coincided with an increasing proportion of new vehicles entering the fleet being fitted with Electronic Stability Control (ESC) and side airbags. Side impact fatalities are expected to continue trending downwards under business as usual, primarily due to the fitment of both mandated ESC systems and voluntary side airbag systems to new light vehicles. Accordingly, the effect of both mandated ESC and voluntary side airbag fitment have been fully factored into the benefit-cost analysis undertaken in this Regulation Impact Statement (RIS).

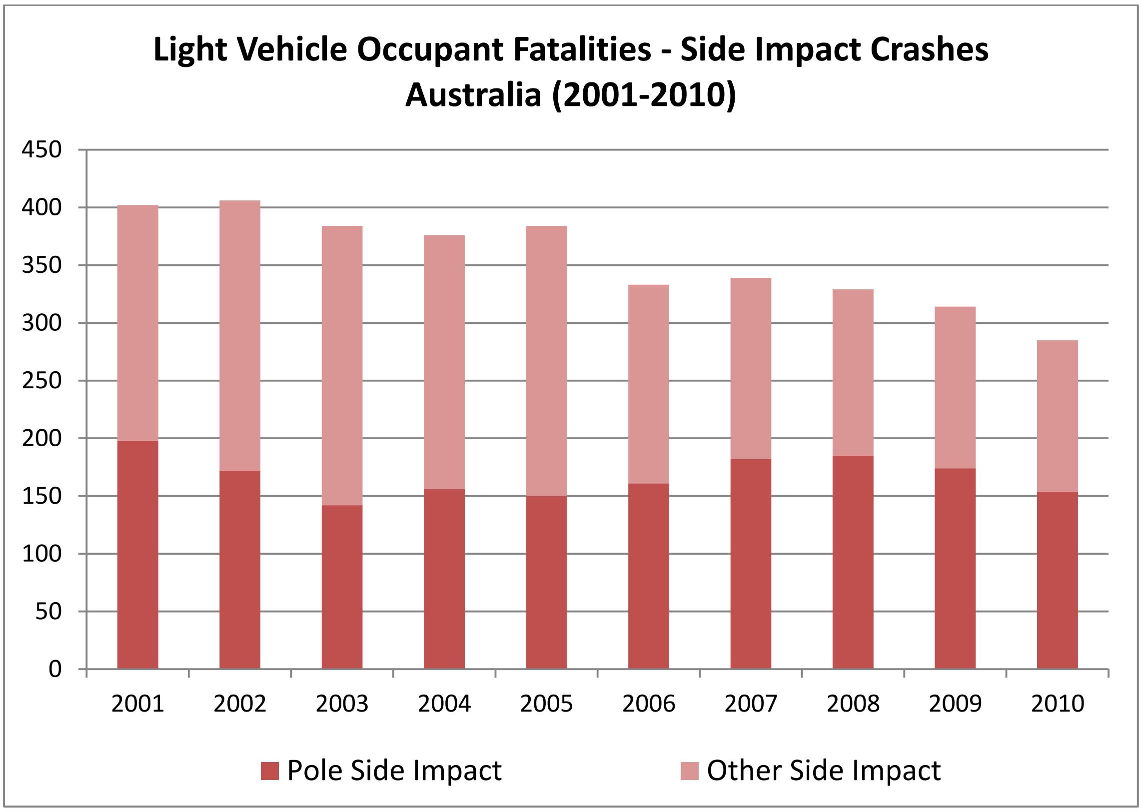

Figure 3 Light vehicle occupant fatalities in Australia, by side impact crash type, during the period 2001-2010 (2001-2006 data provided by BITRE; 2007-2010 data estimated by MUARC/the Department)

On the basis of the side impact crash fatality data available from Victoria, the Department estimates there would currently (as of 2014-15) be around 225-250 light vehicle occupant fatalities in side impact crashes in Australia per year.

In an analysis of Australian Coroner ruled causes of deaths for LPVs and LCVs for 2001-2006, Fitzharris and Stephan (2013) showed that head and thorax injuries are the two most commonly listed causes of death for both pole side impacts and other side impacts. Furthermore, multiple injuries, which mostly included a head injury, were the third most common cause of death. Hence it is essential that any government action to reduce future side impact crash trauma be targeted to address both head and thorax injury risk in side impact crashes.

Serious Injuries

There is no national road crash database from which light vehicle occupant serious injuries/hospital admissions due to pole side impact and other side impact crashes in Australia can be directly determined. As for fatalities, the best available data is for the state of Victoria. Figure 4 shows the number of light vehicle occupants hospitalised due to a side impact crash in Victoria for 2001-2009.

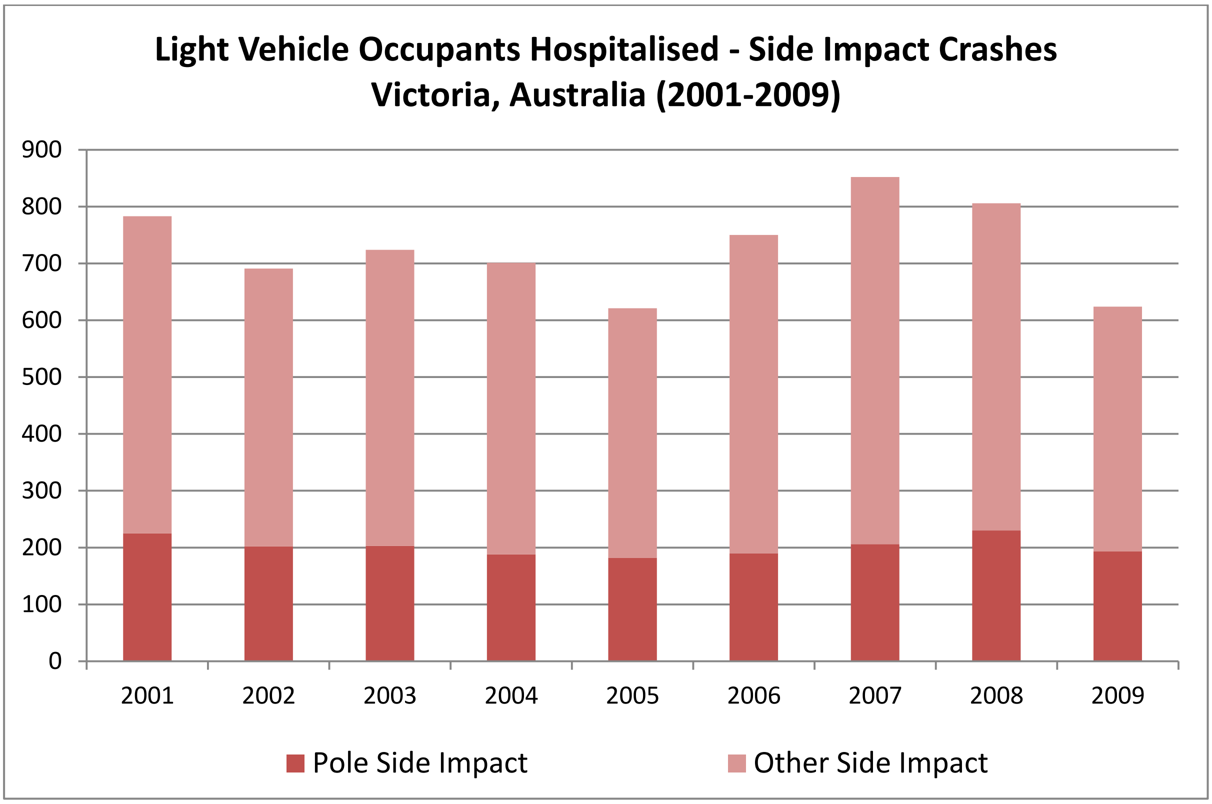

Figure 4 Light vehicle occupants hospitalised in Victoria, by side impact crash type, during the period 2001-2009 (data provided by VicRoads)

Victorian hospital admission data is therefore used (like Victorian fatality data) to estimate side impact crash serious injury rates for Australia in this RIS. On the basis of this hospitalisation data from Victoria, the Department estimates around 1,000 and 2,200 light vehicle occupants would currently be hospitalised in Australia each year due to pole side impact and other side impact crashes, respectively.

Fitzharris and Stephan (2013) determined, using the Victorian Transport Accident Commission (TAC) accident insurance claims database, that 14 per cent of LPV occupants and 18 per cent of LCV occupants hospitalised due to a side impact with a fixed object (i.e. pole/tree) sustained a moderate or severe traumatic brain injury. For vehicle-to-vehicle side impact crashes, 11.5 per cent of hospitalised LPV occupants and 16.6 per cent of hospitalised LCV occupants sustained a moderate or severe traumatic brain injury.

Serious head injuries are of particular concern. They not only severely affect the lives of the individuals involved and their families, but are often associated with long term morbidity and present a significant financial burden for the community in terms of permanent disability, lost productivity, and high health system and lifetime care costs. Access Economics (2009) established that moderate traumatic brain injuries cost $2.5 million per incidence case and severe traumatic brain injuries cost $4.8 million per incidence case, in Australia in 2008 (all costs in 2008 dollar terms).

Using the traumatic brain injury costs determined by Access Economics (2009), the incidence of traumatic brain injuries for hospitalised light vehicle occupants established by Fitzharris and Stephan (2013), and the number of light vehicle occupants hospitalised due to side impact crashes, the Department estimates the total cost of moderate and severe traumatic brain injuries sustained by light vehicle occupants in side impact crashes in Australia is significant at around $1.8-1.9 billion per annum (in 2014 dollar terms).

The incidence and cost of traumatic brain injuries in side impact crashes further demonstrates how important it is that any government action to reduce future side impact road crash trauma is well designed to particularly address the risk of head injury.

1.3 Government Actions to Address the Problem

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 Australian Design Rules (ADRs), before they can be offered to the market for use in transport in Australia. The ADRs set minimum standards for safety (including side impact occupant protection), emissions and anti-theft performance.

<u>Side Impact Occupant Protection</u>

Australian Design Rule (ADR) 72/00 – Dynamic Side Impact Occupant Protection, was determined in 1996 as a national standard for new light passenger vehicles (applicability dates 1 January 1999 and 1 July 2000 for new LPVs and LCVs respectively). This standard is harmonised with United Nations (UN) Regulation No. 95 (UN R95) and specifies minimum performance requirements in a crash test simulating a side impact from a passenger car. In this test, a deformable barrier representing the front of a passenger car is impacted at a 90 degree angle and 50 km/h into the side of a stationary test vehicle. The performance requirements to be met include head, thorax, abdominal and pelvic injury criteria response limits measured by an instrumented ES-2 dummy seated on the impact side of the vehicle.

ADR 72/00 primarily serves to limit injury risk for front-row occupants in vehicle-to-vehicle side impacts, especially those involving two passenger cars. Structural countermeasures (e.g. side intrusion bars, high strength b-pillars) to control the side door intrusion velocity and thereby reduce severity of side door interaction with an adjacent occupant are particularly effective for improving the performance of a vehicle in this type of test. Although head injury criteria limits are specified, head protecting side airbags are not typically needed to meet the performance requirements of ADR 72/00.

There are currently no ADRs that specify pole side impact performance requirements. In this type of test, a moving vehicle is impacted into a stationary pole. Side airbags are the primary countermeasure used in vehicles built to date to improve vehicle performance in pole side impacts. This is because they are used to prevent direct hard contact of the moving occupant's head with the stationary pole, as well as avoid excessive and concentrated impact loading of the moving occupant's thorax, abdomen and pelvis with the vehicle interior.

Side impacts with poles/trees and between geometrically incompatible vehicle types (e.g. large 4WDs and passenger cars, commercial vehicles and passenger cars) give rise to injury patterns not well represented by the current ADR 72/00 test, as it is more representative of side impacts between two passenger cars. Oblique pole side impact tests (in particular), where the vehicle approaches a pole like object at an angle, load the occupant (in this case a test dummy) head, thorax, abdomen and pelvis simultaneously, in a way which would complement the test already prescribed under ADR 72/00 in addressing the overall side impact crash problem.

This RIS examines whether there is a need for further Australian Government action, to be aimed at the new light vehicle fleet (LPVs and LCVs), to improve vehicle occupant protection in side impact crashes.

Electronic Stability Control

ESC is a driver assistance technology that assists in avoiding accidents from a loss of directional control. It automatically and individually controls the braking force of the left and right wheels of the vehicle, to correct its direction of travel, when input data is received (e.g. steering wheel angle, vehicle yaw rate) indicating that the actual direction is different to the driver’s intended direction.

In Australia, ESC has been mandatory (under ADRs 31/.. and 35/..) for all new LPVs since 1 November 2013 and will be mandatory on all new LCVs from 1 November 2017.

Fitzharris and Stephan (2013) note that increased fitment of ESC is expected to be effective in averting a number of single vehicle crashes involving a pole or other fixed object, as these types of crashes often involve directional loss of control events (i.e. excessive understeer or oversteer) which ESC can help protect against. However, as ESC is around 20 per cent effective in preventing LPV side impacts with poles/trees (Fitzharris and Stephan, 2013), many of these crashes will still occur in future. Further, ESC is not expected to significantly affect vehicle-to-vehicle side impacts, as these are predominantly intersection crashes which, in most cases, do not involve a loss of directional control.

In any event, the effect of mandatory ESC fitment is accounted for in the benefit-cost analysis undertaken as part of this RIS.

Roadside Design

It has long been recognised that roadside objects – such as light poles and trees – present a significant risk to vehicle occupants in run-off road situations.

Austroads, the association of Australian and New Zealand road transport and traffic authorities, have therefore developed a set of guidelines for best practice road design, including in relation to roadside design, safety and barriers to reduce the severity of run-off road crashes. Steps have been taken by all levels of government to reduce the risk of run-off road crashes. Examples include making roadside structures more forgiving (e.g. frangible poles) and more effective placement of safety barriers.

However, these are best practice guidelines and there are many roads, especially in rural areas, with trees right up to and along the roadside. Given Australia has a very large road network, considerable time and funds are required to upgrade even a small proportion of the overall road network and the cost of upgrading the entire network to meet best practice guidelines for roadside design would likely be prohibitive.

1.4 The National Road Safety Strategy 2011-20

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

A new National Road Safety Action Plan 2015-17 was recently developed cooperatively by federal, state and territory transport agencies, and was endorsed by the Transport and Infrastructure Council in November 2014. The Action Plan is intended to support the implementation of the NRSS, addressing key road safety challenges identified in a recent review of the strategy. It details a range of national actions to be taken over the next three years. One of the actions to be considered under the new plan is to 'mandate pole side impact occupant protection standards for new vehicles' (Transport and Infrastructure Council, 2014).

As with any vehicle safety initiative in Australia, there are a number of options that need to be examined. These include 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 an ADR.

2 WHY IS GOVERNMENT ACTION NEEDED?

Government action may be needed where the market fails to provide the most efficient and effective solution to a problem.

Road vehicles are complex machines which operate in a high risk environment, leading to a number of deaths and injuries around the world each year. In this respect it is not easy for vehicle buyers to independently obtain the information and understanding required to evaluate safety performance. For example, a buyer may research the number of side airbags fitted to a vehicle, but cannot be expected to know if the airbags will deploy rapidly enough, provide sufficient coverage and absorb sufficient energy to be effective in a typical crash. Likewise, a buyer is unlikely to be able to distinguish differences in the structural design of vehicles in terms of occupant protection, not least because many important components (e.g. side intrusion bars) are concealed and overall structural integrity is influenced by the mechanical properties (i.e. yield strength, stiffness etc.) of materials used, as well as the design geometry (i.e. thickness, width etc.) and weld properties.

Because of this, most governments throughout the developed world have converged over the past 20-30 years towards the use of a combination of regulatory (i.e. mandatory standards) and non-regulatory (i.e. New Car Assessment Programs (NCAPs)) performance based crash tests, as the primary policy means to improve the crashworthiness of vehicles entering the market.

Australia has a strong history of government actions aimed at increasing the availability and consumer uptake of safer vehicles and Australian consumers have come to expect high levels of safety. Australian Government intervention to reduce road trauma aims to balance these expectations for safety with the importance of focusing on the most efficient and effective means of bringing them into the marketplace. Importantly, there are actions the Australian Government can now take, in accordance with Australia's international obligations, to achieve significant net benefits for society.

2.1 International Standards

Following a comprehensive program of research, crash testing and rigorous consideration of options, the UN World Forum for the Harmonization of Vehicle Regulations (WP.29) established in November 2013 a Global Technical Regulation (GTR) on Pole Side Impact (GTR 14). GTRs are established under the UN 1998 Agreement[5]. The regulatory text of a GTR essentially provides model technical requirements for countries to transpose into domestic law/regulations and is written so as to allow for both manufacturer self-certification and type-approval based regulatory systems.

Australia is one of a number of Contracting Parties to the 1998 Agreement and is obliged to submit the technical regulatory requirements of this GTR to the process used by Australia to adopt such technical requirements into its own laws or regulations and to make an expeditious decision regarding adoption into its domestic laws/regulations.

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[5] *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* of June 1998.

Further, in November 2014, the UN voted to adopt a new UN regulation for the approval of vehicles in regard to their pole side impact performance (UN R[135]). UN regulations are adopted under the UN 1958 Agreement[6] . The UN regulation includes additional certification requirements for approval of vehicles in regard to their pole side impact performance as well as technical requirements and test methods in accordance with the regulatory text of the GTR.

Australia is also a Contracting Party to the 1958 Agreement and will be obliged to accept vehicles approved in accordance with the requirements of UN R[135] (this obligation does not extend to mandating its requirements, just accepting vehicles built to them).

The GTR and associated UN regulation are the recognised international standards available for vehicle-to-pole side impact performance. The UN regulation is the working regulation that most Contracting Parties applying type approval certifications systems (such as Australia) would consider under any examination of the case to mandate domestically.

Both the GTR and the UN regulation prescribe a 75 degree (oblique) vehicle-to-pole side impact test, in which a vehicle with a WorldSID (Worldwide harmonized Side Impact Dummy) 50th percentile adult male dummy positioned in the front-row outboard seat on the impact side of the vehicle is impacted into a stationary pole. A more detailed summary of the oblique vehicle-to-pole side impact test methods used in GTR 14 and UN R[135] is provided in Appendix 5.

GTR 14/UN R[135] provide benefits (where mandated domestically) by increasing both the fitment rate and the effectiveness of head curtain and thorax side airbags. In particular, it is expected manufacturers would employ wider head curtain and thorax side airbags, which are capable of absorbing greater impact energy and deploy more reliably across the broad spectrum of real world side impact crashes (note: for more detail see Appendix 4—Effectiveness of Enhanced Side Impact Protection Measures).

Taking these expected improvements together, Fitzharris and Stephan (2013) estimated that GTR 14 would (if mandated in Australia) deliver a ‘30 per cent incremental benefit over and above existing side impact protection levels’.

However, it is important to recognise that the adoption of a UN GTR and/or UN Regulation by WP.29 through the 1958 or 1998 Agreements does not guarantee that all vehicles in all markets in the future will be manufactured to comply with that regulation. The number of vehicles meeting a particular international standard can vary considerably from one market to another. This depends on the status of the international standard within each country’s domestic regulations (i.e. mandated, accepted as an alternative standard, not accepted), as well as differences in non-regulatory approaches such as consumer rating programs (i.e. NCAPs), government and private sector fleet purchasing policies, marketing campaigns, consumer knowledge/education and consumer preferences. Hence, vehicles from different markets, that may otherwise appear identical to the average consumer, are tailored by the

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[6] *Agreement concerning the Adoption of Uniform Technical Prescriptions for Wheeled Vehicles, Equipment and Parts which can be fitted and/or used on Wheeled Vehicles and the Conditions for Reciprocal Recognition of Approvals Granted on the basis of these Prescriptions* of March 1958.

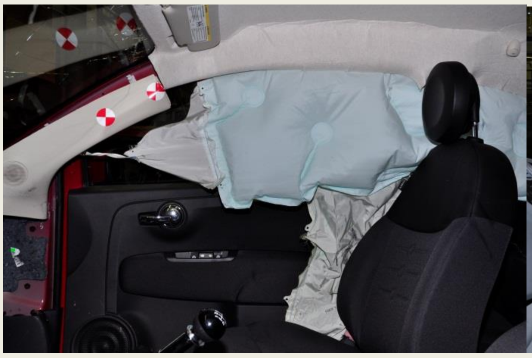
manufacturer to the requirements of each market. Examples of market variations in vehicle design for occupant protection are provided below.

Example 1 Market variation by model designation — pole side impact

Variation in occupant protection countermeasures for the same vehicle model sold in two different markets (one regulated)

In 2012, the Australian Government Department of Infrastructure and Regional Development and Transport Canada undertook a collaborative series of vehicle-to-pole side impact crash tests for the North American version of a small hatchback built during the phase-in of the US FMVSS 214 oblique pole side impact test requirements and the Australian market version of the same vehicle model not subject to any regulatory pole side impact performance requirements.

The images below show the deployed side airbags of the vehicle models supplied to the North American (below left) and Australian (below right) markets.



The image above shows the seat mounted thorax side airbags removed from the North American (larger airbag) and Australian (smaller airbag) market vehicles.

Differences in side impact sensors, airbag control modules, airbag deployment timing and vehicle-to-pole side impact performance were also observed for this vehicle model. For further detail and background see Appendix 4—Effectiveness of Enhanced Side Impact Protection Measures.

Example 2 Market variation by model designation — offset frontal impact

Variation in occupant protection countermeasures for the same vehicle model sold in two different markets (one regulated)

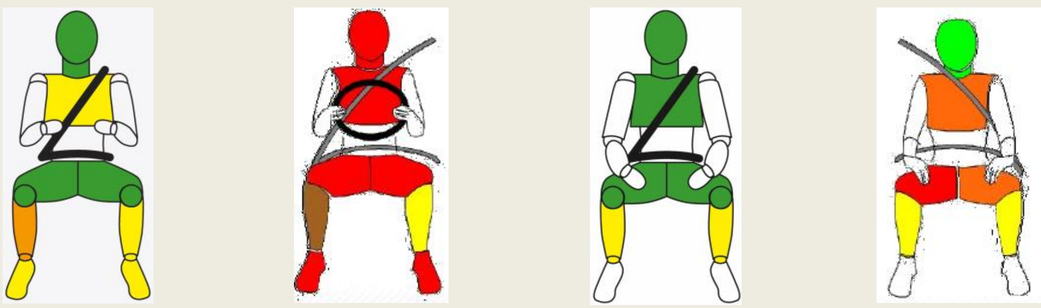
In 2013, Global NCAP undertook a research project on the passive safety performance of popular vehicle models sold in India. One of the vehicles Global NCAP tested as part of this project, the Hyundai i10 (a small passenger car), is also sold in Europe and had previously been tested by Euro NCAP.

The vehicles sold to the Indian market were not required to meet UN frontal or side impact crash test regulations (i.e. UN R94 and UN R95). The Indian vehicles were tested according to the Latin NCAP 2013 assessment protocols, which included a frontal offset test at 64 km/h. The Hyundai i10 for the Indian market was not equipped with any frontal airbags and scored zero out of a possible 17 points in terms of adult occupant protection (zero stars). (UNECE, 2014b & Global NCAP, 2014b)

In comparison, the Hyundai i10 for the Euro NCAP member countries was equipped with driver and passenger frontal airbags and scored 14 out of a possible 16 points for the same test (achieving 79 per cent for adult occupant protection and 4 stars overall) - (Euro NCAP 2014b). In Europe, LPVs with a maximum permissible operating mass not exceeding 2,500 kg (such as the Hyundai i10) are required to meet the frontal offset crash test requirements set out in UN R94 (Frontal Collision Protection).

The illustrations below show the differences in performance (in terms of mid-size adult male injury risk) between the Hyundai i10 models sold in Euro NCAP member countries (where such vehicles are required to meet UN R94 and are rated by Euro NCAP) and India (where vehicles are not required to meet UN R94 and there is no NCAP).

Driver **Front Passenger**



European model **Indian model** **European model** **Indian model**

Source: Euro NCAP, 2014b & Global NCAP, 2014b

2.2 New Car Assessment Program Test Protocols

Over the last twenty to thirty years there has been a major effort in many developed nations to provide vehicle safety ratings in order to encourage the supply and uptake of safer vehicles. This information has been provided mainly by New Car Assessment Programs (NCAPs) and complements the role of regulation in improving vehicle safety.

The first NCAP was created by the US National Highway Traffic Safety Administration (NHTSA) in 1978 (US NCAP). This was followed by the creation of the Australasian NCAP (ANCAP) in 1993 and the European NCAP (Euro NCAP) in 1997. There are now nine NCAPs internationally.

In publicly differentiating between the performances of different models, NCAPs provide an incentive to manufacturers to build safer cars. Typically they award stars based on a vehicle's performance in a variety of safety tests, with five stars representing the highest score.

Appendix 2—NCAP Tests Compared gives a comparison of the different NCAP test procedures. Some NCAPs, including US, European, Korean and Australasian NCAPs, have a vehicle-to-pole side impact test as part of their overall suite of tests.

Until recently, Euro NCAP, ANCAP and KNCAP test protocols have all included a perpendicular vehicle-to-pole side impact test, in which a vehicle with an ES-2 dummy positioned in the driver's seat is impacted at 29 ± 0.5 km/h into a stationary pole.

From January 2015, Euro NCAP have adopted a more stringent 75 degree (oblique) vehicle-to-pole side impact test, in which a vehicle with a WorldSID 50th percentile adult male dummy positioned in the driver's seat, is impacted at 32 ± 0.5 km/h into a stationary pole. This Euro NCAP pole test method was developed around the same time as the GTR and has been purposefully aligned with the GTR test method. (Euro NCAP, 2014a)

In November 2014, ANCAP announced that they would transition in the period 2015-2017 to greater alignment with the Euro NCAP rating system (ANCAP, 2014b). During this transition period, results from an oblique vehicle-to-pole test will be used in determining the overall ANCAP rating of those vehicle models for which the ANCAP rating is based on tests conducted by Euro NCAP test facilities. A perpendicular vehicle-to-pole side impact test will continue to be used for vehicle models rated on the basis of tests conducted by ANCAP test facilities. From 2018, results from an oblique vehicle-to-pole side impact test will be used in determining the ANCAP rating for all vehicle models, irrespective of whether the ANCAP rating is based on tests conducted by Euro NCAP or ANCAP test facilities.

KNCAP have also recently announced a transition to a 32 km/h oblique vehicle-to-pole side impact test with a WorldSID 50th percentile male dummy by 2017 (for further details see Appendix 2—NCAP Tests Compared).

2.3 Predicted Market Response

It is likely that most light vehicle manufacturers will use head curtain and thorax side airbag systems as the primary countermeasure to meet the performance requirements of GTR 14/UN R[135]. However, side airbag systems, including sensors and deployment algorithms are vehicle model specific and not all vehicles fitted with side airbags are guaranteed, in the absence of a mandatory standard, to meet the performance requirements of the GTR/UN regulation.

When crash test performance requirements are imposed through government action, manufacturers will often set their own internal performance limits, to ensure they are well within government requirements and in so doing limit the risk that any minor variations in production will result in individual vehicles which would not (if tested) pass the government requirements. For crash test regulations, industry experts commonly quote this as 80 per cent of the regulatory performance criteria limits.

For the purposes of this RIS, the Department has assumed that 30 per cent of LPVs and 20 per cent of LCVs supplied to the Australian market in 2017 will be well within the performance requirements of the GTR/UN regulation (i.e. not exceed 80 per cent of any performance criteria limit) under business as usual. Under such an assumption, Government action to implement the requirements of the GTR/UN regulation will not result in these manufacturers changing the side impact countermeasures for occupant protection they will otherwise use under business as usual for these vehicles.

In addition, the recent move by various NCAPs, particularly ANCAP, to the use of an oblique vehicle-to-pole side impact test is expected to increase, over time, the percentage of vehicles supplied to the Australian market meeting the performance requirements of GTR 14/UN R[135].

ANCAP typically provides ratings for new models around the time they are first introduced to the market. Compliance with the performance requirements of the GTR/UN regulation is therefore likely to increase in proportion to the number of new models for which results from an oblique pole test are used in determining the overall ANCAP rating. Given a typical model life of five years for LPVs and seven years for LCVs, the proportion of vehicles sitting well within the requirements of the GTR/UN regulation is assumed to increase linearly in the five years between 2018 and 2023 for LPVs and the seven years between 2018 and 2025 for LCVs.

Euro NCAP pole side impact test results available for 2014 show around 70 per cent of the new model LPVs tested, did not exceed 80 per cent of any (head, thorax, abdomen or pelvis) 50 per cent serious injury (AIS 3+) risk threshold value, corresponding to the level of injury risk used to establish the performance criteria limits in the GTR/UN Regulation.

On the basis of Euro NCAP and ANCAP pole side impact test results from 2014, it is assumed 75 per cent of new model LPVs (slightly higher than the proportion from the Euro NCAP pole tests above) and 55 per cent of new model LCVs (the proportion of LCVs receiving 5 stars under the current ANCAP rating system) will be well within the performance requirements of the GTR/UN regulation under business as usual (from 2017 onwards).

Figure 5 shows the resulting proportion of all new light vehicles supplied to the Australian market for the period 2017-2033, that are assumed not to exceed 80 per cent of any of the GTR 14/UN R[135] performance criterion limits under business as usual. Throughout this RIS these are referred to as the 'business as usual compliant' vehicles.

For the balance of LPVs and LCVs, which would either be non-compliant or marginal under business as usual, it is anticipated that manufacturers will respond to any other government action encouraging or requiring these vehicles to comply with the performance requirements of the GTR/UN regulation by designing and installing more effective side airbag systems.

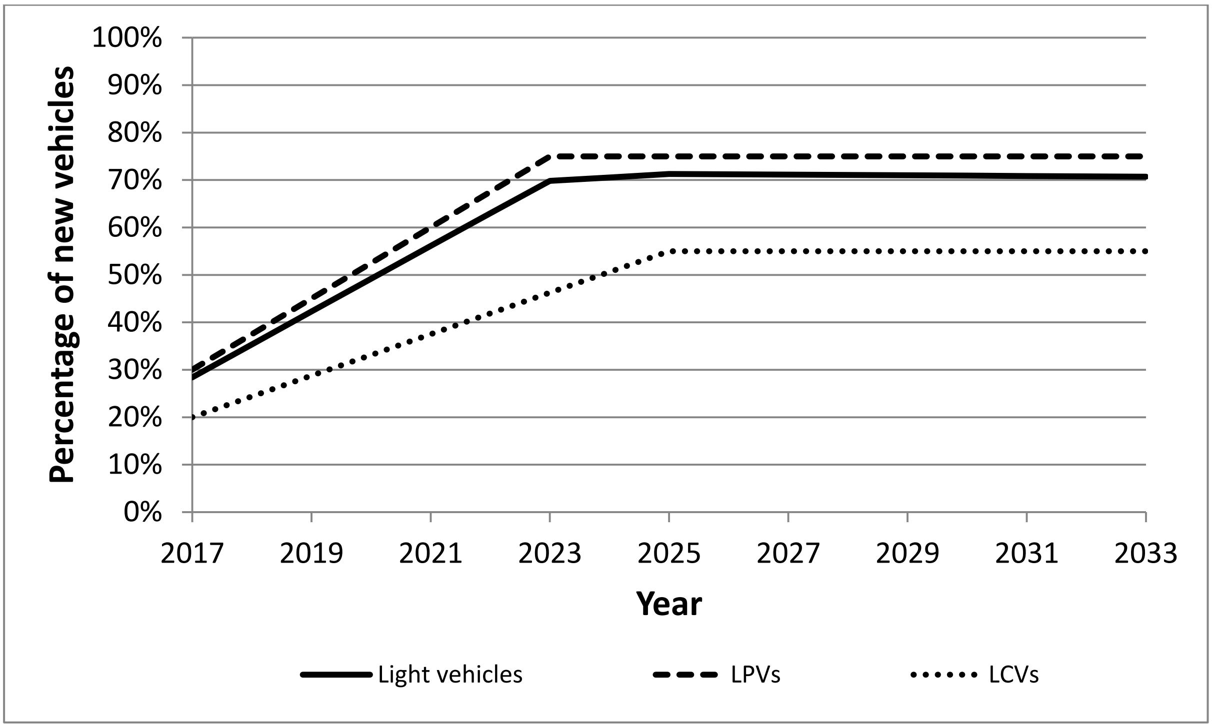


Figure 5 Estimated percentage of new light vehicles (LPVs and LCVs) not exceeding 80% of any GTR 14/UN R[135] WorldSID 50th percentile adult male performance criteria limit under the BAU scenario in Australia

Given that it is not possible to have absolute certainty about the future market response, high and low business as usual compliance scenarios are also investigated as part of the sensitivity analyses conducted for the recommended government action (see Section 4).

2.4 Objective of Government Action

A 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. Generally, 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 side impact occupant protection performance of the new light vehicle fleet in

Australia. This is in order to reduce the cost of road trauma to the community from side impact 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, 2014).

3 WHAT POLICY OPTIONS ARE BEING CONSIDERED?

3.1 Available Options

The available options are listed below.

3.1.1 Non-Regulatory Options

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

Option 2: user information campaigns
Inform consumers about the benefits of curtain and thorax airbag systems using education campaigns (suasion).

Option 3: fleet purchasing policies
Only allow vehicles that meet a certain level of side impact protection for government purchases (economic approach).

3.1.2 Regulatory Options

Option 4: codes of practice
Allow road vehicle supplier associations, with government assistance, to initiate and monitor a voluntary code of practice for enhanced side impact protection. Alternatively, mandate a code of practice (regulatory—voluntary or mandatory).

Option 5: mandatory standards under the C&C Act
Mandate standards for enhanced side impact protection under the C&C Act (regulatory—mandatory).

Option 6: mandatory standards under the MVSA (regulation)
Develop (where applicable) and mandate standards for enhanced side impact protection under the MVSA based on UN R[135] for pole side impact performance (regulatory—mandatory).

3.2 Discussion of the Options

3.2.1 Option 1: No Intervention (Business as Usual)

The business as usual case relies on the market fixing the problem, the community accepting the problem, or some combination of the two.

The design of light vehicles for the protection of occupants in side impact crashes has improved significantly in recent years. Examples of this include increased use of high strength steels to strengthen key structural components (e.g. b-pillars, side intrusion bars) and increasing fitment of side airbags to absorb impact energy.

There have been a number of regulatory and non-regulatory actions that have likely contributed to this. They include the implementation of an international standard for vehicle-to-vehicle side impact protection, UN R 95—which was subsequently adopted in 1996 through ADR 72/00—as well as the introduction of voluntary pole side impact type tests through some NCAPs, including ANCAP.

As discussed previously, head curtain and thorax side airbags are the primary countermeasure used to improve vehicle performance in pole side impact crash tests. The fitment of head curtain and thorax side airbags has been increasing steadily in recent years and is expected to reach 97 per cent for new LPVs by 2016 and 97 per cent for new LCVs by 2025. Nevertheless, not all vehicles fitted with side airbags will meet the occupant injury risk derived performance requirements of GTR 14/UN R[135].

As set out in Section 2.3, for the purpose of this RIS, the Department assumed that around 30 per cent of LPVs and 20 per cent of LCVs supplied to the Australian market in 2017 would meet the performance requirements of GTR 14/UN R[135] under business as usual. Government action to implement the requirements of the GTR/UN regulation will not create any need for manufacturers to change the side impact countermeasures for occupant protection they will use under business as usual for these vehicles.

Recently announced moves by NCAPs, particularly ANCAP, to move to an oblique vehicle-to-pole side impact test based on the test used in GTR 14/UN R[135] are expected to steadily increase the percentage of new light vehicles supplied to the Australian market meeting the performance requirements of the GTR/UN regulation to around 70 per cent by 2023. However, without further Australian Government action, compliance with all requirements of GTR 14/UN R[135] is not guaranteed to increase much beyond this.

Under Option 1, industry is expected to increase the fitment of countermeasures for improving side impact safety. This business as usual (no intervention) option was analysed further in terms of expected benefits to the community.

3.2.2 Option 2: User Information Campaigns

User information campaigns can be effective in promoting the benefits of a new technology and so increasing consumer demand. 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.

As discussed earlier, curtain and thorax side airbag systems are used as the primary countermeasures for the protection of occupants in pole side impact crashes. Two recent examples of campaigns to increase awareness of these systems are those carried out by NRMA Insurance and by the Transport Accident Commission of Victoria (TAC). In the first example, NRMA Insurance set up a website called Safer Choices where it shares safety tips for buying and owning a car. A featured article on the website is ‘what to ask when buying a car’, which encourages consumers to ask about certain safety features such as the fitment of front and rear side airbags (NRMA Insurance, 2014). In the second example, the TAC ran a television advertisement campaign encouraging consumers to purchase a vehicle only if it is fitted with both ESC and head protecting side airbags (TAC, 2011).

In their assessment of the need for enhanced side impact protection and based on recent trends, Fitzharris & Stephan (2013) estimated that by 2016, for LPVs and LCVs being fitted with curtain side airbags and thorax airbags as standard equipment:

- the fitment rate for LPVs is expected to peak at 96.7 per cent; and
- the fitment rate for LCVs (excluding those LCVs (most vans) with forward and high seating positions, satisfying the criteria outlined in paragraph 51 of the preamble of GTR 14) is expected to be around 61 percent.

The fitment rate for LCVs is expected to peak at about 97 per cent by around 2025.

It is clear that campaigns such as those described above have contributed to the increased fitment of curtain and thorax side airbag systems in LPVs and LCVs, which has then provided safety benefits to consumers. In these campaigns the performance of the systems matters less that the fact that a system is fitted to the vehicle in the first place.

In Section 2.1 it was reported that systems meeting the requirements of GTR 14 would perform significantly better in side impact crashes than the typical systems fitted to today's vehicles. Around 30 per cent improvement is achievable with careful design incorporating features such as larger airbags and improved impact detection systems. In such circumstances, awareness campaigns would be limited in their effectiveness. They would be unable to differentiate between average and better performing systems, as the differences would only be apparent to an expert in the field, or by carrying out carefully prescribed crash tests and distilling the results so that a non-expert could use the information in their purchasing decision. For this reason, awareness campaigns were not considered any further as an option in this RIS.

3.2.3 Option 3: Fleet Purchasing Policies

The government could intervene by requiring vehicle models to meet minimum pole side impact performance requirements to be eligible to be purchased for use in its fleet. This would create an incentive for manufacturers to provide more effective occupant side impact protection countermeasures in the vehicles not meeting this minimum level of performance under business as usual.

Advantages of targeting fleet purchasing are:

- there is substantial evidence that fleet drivers have an increased crash risk compared with privately registered vehicle drivers (Bibbings, 1997);
- ex-fleet vehicles are often sold after two to three years, giving the public the opportunity to buy a near new vehicle at a large discount (Nesbit & Sperling, 2001; Symmons & Haworth, 2005); and
- fleet vehicles are on average driven twice as far annually than household vehicles, thus maximising the use of any technology benefits (Nesbit & Sperling, 2001).

The NRSS promotes the adoption of nationally-agreed fleet purchasing policies with practical, evidence-based safety criteria that drive an increase in the safety features required for vehicle purchases (Transport and Infrastructure Council, 2011).

In May 2011, the Australian Government introduced requirements for ANCAP star ratings into its fleet purchasing policy, as did a number of other state and territory governments. As noted in Section 2.2, ANCAP publishes vehicle crash test results and awards star ratings indicating a vehicle's level of safety in a crash. The highest safety rating is five stars.

As of 1 July 2011, all new Australian Government fleet passenger vehicles must have a minimum five-star ANCAP rating, while, as of 1 July 2012, Australian Government fleet LCVs must have a minimum four-star rating, subject to operational requirements (Department of Finance, 2012). Some state and territory government agencies have already adopted similar fleet purchasing policies, while other agencies are considering this as an option.

The ANCAP Rating Road Map outlines the safety technologies required in vehicles in order to achieve different star ratings over the period 2011 to 2017. Under the Road Map, head protecting technology (side airbags) for front seats have been required for vehicles to achieve a five-star rating from 2011 and a four-star rating from 2014 (ANCAP, 2014a).

This option acts in a similar manner to the user information campaigns option discussed in Section 3.2.2 and so has the same advantages and disadvantages – although with an added incentive for manufacturers to provide the desired features or performance. Requiring the fitment of side airbags for front row seats (which is in effect, already a requirement for Commonwealth fleet vehicles) still suffers from the problem of defining their performance.

The current ANCAP tests, although able to be simplified down towards a star rating, do not represent a level of performance equal to or better than GTR 14. Therefore, at this stage, it would be assumed that the fleet purchasers would have to bear the costs of designing and testing to a GTR 14 level of performance as part of the purchase cost. This would be high as it would be spread across only a relatively small number of vehicles.

However, from 2018, ANCAP will be fully adopting an oblique pole side impact test based on GTR 14 (through alignment with Euro NCAP protocols). As discussed in Section 2.3, it is expected that vehicles that achieve five-star ratings under the new requirements would also comply with GTR 14. This means that compliance with the GTR would effectively be a requirement for Commonwealth fleet LPVs from 2018. There would therefore be no opportunity to further influence the rate of compliance through fleet purchasing policies for LPVs and so this option was not considered further for these vehicles. However, there would be an opportunity to require Commonwealth fleet LCVs to meet the GTR from 2018 by increasing the minimum star rating requirement from four to five stars.

By 2018, it is estimated that around 24 per cent of LCVs would comply with GTR 14 requirements under business as usual (76 per cent would therefore not comply). Approximately seven per cent of new LCV purchases are government fleet purchases (FCAI, 2014). In 2018, government fleet purchasing policies could therefore potentially increase the percentage of LCVs in the market that comply with GTR 14 by 76% × 7% = 5.3%.

However, it is expected that the implementation of a government fleet purchasing policy could influence some private fleet purchasers to put in place similar policies, although the extent of this influence is likely to be reduced. Approximately 54 per cent of new LCV purchases are for business and rental fleets (VFACTS, 2014). For the purposes of the analysis it was assumed that a government policy could influence around half of these fleet purchasers (27 per cent) to implement a similar policy. Therefore, in 2018, a government fleet purchasing policy could potentially increase the percentage of LCVs that comply with GTR 14 by approximately 76% × 34% = 26%. The compliance rate would therefore be 24% + 26% = 50%.

It is expected that the policy could continue to influence around 34 per cent of the non-compliant fleet each year over the length of the policy (set at 15 years). Under a business as usual scenario it is estimated that the compliance rate for LCVs will increase from 24 per cent in 2018 to a peak of 55 per cent from 2025. Under Option 3, the final compliance rate would therefore reach 55% + (34% ×45%) = 70% in 2025.

It is expected that vehicles purchased through fleet programs would flow through the vehicle fleet as ex-fleet vehicles are sold to the public.

The cost of implementing a fleet purchasing policy would be minimal as it would involve a negotiated agreement with fleet managers to select only LCVs that achieve five-star ANCAP ratings. The costs would be those relating to the negotiation processes estimated at $50,000 per year over the length of the policy plus any lost opportunity for the fleet in foregoing a vehicle model that may (other than not meeting the requirements of GTR 14) be better placed to meet a particular requirement (this latter aspect was not estimated).

This option was analysed further in terms of expected benefits to the community as well as costs to business and consumers.

3.2.4 Option 4: Codes of Practice

A code of practice can be either voluntary or 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). The Australian new vehicle industry is well placed to provide a collaborative voice in the case of enhanced side impact protection. Of the manufacturers and importers involved with new passenger cars, the Federation of Automotive Product Manufacturers (FAPM) and FCAI represent 40 per cent and 99 per cent [7] respectively of the total.

In this case, a voluntary code of practice could be an agreement by industry to fit side airbag systems that meet certain requirements for side impact performance to all nominated vehicle types by a certain date. In 2010 the FCAI did produce such a code and was able to report increased fitment of these systems from that time on (FCAI, 2010).

Detecting a 'breach' of a code could be difficult in the case of a reduced performance rather than a side airbag system simply not being fitted. This would usually only be revealed through failures in the field or by expert third party reporting. Therefore, any reduction in implementation costs over, say, mandated intervention would need to be balanced against the need to monitor compliance with the code and then the consequences of these failures. In the case of side impact requirements, these consequences could be serious in terms of injuries or deaths from road crashes.

Regarding compliance, any breaches would be difficult to control either by manufacturers' associations or by the Australian Government.

Due to the above reasons this sub-option was not considered 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 road vehicles, the responsible government agency (Department of Infrastructure and Regional Development) 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.

Because of the above, this sub-option was not considered further and so Option 4 was not considered further in this RIS.

3.2.5 Option 5: Mandatory Standards under the C&C Act

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

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

Therefore, Option 5 was not considered any further in this RIS.

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7 Membership base of the FCAI includes vehicle manufacturers and the FAPM. It does not include sectors such as tyre manufacturing, vehicle distribution, transport logistics and after-market supplies.

3.2.6 Option 6: Mandatory Standards under the MVSA—Regulation

Under Option 6, the Australian Government would mandate improved protection for vehicle occupants in side impact crashes, by determining a new ADR for pole side impact performance under the MVSA. The technical requirements of UN R[135], incorporating the 01 series of amendments (UN R[135/01]) would be implemented through an Appendix A to the ADR and accepted as an alternative standard for all applicable vehicles. UN R[135/00] would also be accepted as an alternative standard for vehicles with an overall width greater than 1.5 metres. Such an ADR would also conform to the agreed regulatory text of GTR 14.

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 the design of 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. Currently around 90 per cent of LPVs and 95 per cent of LCVs sold in Australia are imported. These percentages are expected to increase to 100 per cent in 2018.

A program of harmonising the ADRs with international standards, as developed through the UN, began in the mid-1980s. Harmonising with UN requirements provides consumers with access to vehicles meeting the latest levels of safety and innovation, at the lowest possible cost. The Australian Government has the skill and experience to adopt, whether by acceptance as alternative standards or by mandating, both UN GTRs and UN regulations into the ADRs.

As discussed earlier, in November 2013, WP.29 established GTR 14 under the 1998 Agreement. As a Contracting Party to the 1998 Agreement, Australia is obliged to review the case for mandating GTR 14 in its domestic legislation and then advise the UN Secretary-General whether it has decided to implement any or all of the requirements (UNECE, 2012). For further details about GTR 14, refer to Appendix 5—Overview of GTR 14 on Pole Side Impact.

In November 2014, WP.29 voted to adopt a transposition of GTR 14 into a UN regulation (UN R[135]) under the 1958 Agreement. UN R[135] provides an international standard suitable for certification of vehicles (and mutual recognition of approvals) under type approval based regulatory systems.

Scope

GTR 14 applies to the following vehicle categories, as defined in the 1998 Global Agreement Special Resolution No. 1 (S.R.1) (UNECE, 2005) concerning the common definitions of vehicle categories, masses and dimensions:

- Category 1-1 (passenger cars, passenger vans and Sports Utility Vehicles (SUVs)).
- Category 1-2 vehicles with a GVM of up to 4.5 tonnes (small and medium buses); and
- Category 2 vehicles with a GVM of up to 4.5 tonnes (light and medium commercial vehicles).

The GTR includes criteria that Contracting Parties may use to exempt certain Category 1-2 and Category 2 vehicles from the requirements. Statistics indicate that the types of vehicles meeting this suggested exemption criteria —vans with high and forward seating positions, mini-buses and mini-trucks—are rarely involved in pole side impact crashes. Furthermore, many of these vehicles have high seating positions, which reduce the likelihood of occupants being exposed to injurious head and thorax impact loadings in other side impact crashes. It is also understood that these vehicles are typically used for different purposes than other LPVs and LCVs, which reduces the risk of them being involved in pole side impact or other side impact crashes. (UNECE, 2013)

The international vehicle categories subject to GTR 14 translate closest to ADR categories MA (passenger cars), MB (passenger vans), MC (four-wheel drives or SUVs), MD1, MD2 and MD3 (small and medium buses), as well as NA and NB1 (light and medium commercial vehicles) (refer Appendix 1—Vehicle Categories).

UN R[135] applies to vehicles of UN category M1 (passenger vehicles) (as defined in the Consolidated Resolution on the Construction of Vehicles (R.E.3) (UNECE, 2014a)); as well as N1 (goods vehicles up to 3.5 tonnes) not meeting the exemption criteria option provided for vans with high-forward seating positions in GTR 14. Other Category M and Category N vehicles with a GVM of up to 4.5 tonnes may also be approved to the regulation if requested by the manufacturer.

The GTR and UN regulation, however, recognise that a Contracting Party may restrict domestic regulation to a narrower group of vehicles as appropriate. As outlined in Section 2.3, in Australia, the estimated level of compliance with GTR 14, as well as the fitment rate of curtain and thorax airbags generally, is considerably higher for M1 vehicles than for N1 vehicles. M1 vehicles also make up a much larger segment of the market. Two options were therefore considered for the scope of a new ADR under Option 6:

- Option 6a: regulation (broad scope)—the ADR would cover M1 and N1 vehicles (excluding those N1 vehicles covered by the exemption for vans etc. outlined in GTR 14), which translates to ADR categories MA, MB, MC and NA; and
- Option 6b: regulation (narrow scope)—the ADR would be limited to M1 vehicles only (ADR categories MA, MB and MC).

Both options (6a and 6b) were analysed further in terms of expected benefits to the community as well as costs to business and consumers.

Performance requirements

GTR 14 is a purely performance-based standard which contains three types of performance requirements: WorldSID 50th percentile adult male injury criteria; door latch and hinge system integrity; and fuel system integrity.

In terms of the WorldSID 50th male performance, the GTR sets out head injury criteria as well as shoulder, thorax, abdominal, and pelvis performance criteria. For the door latch and hinge system, any side door that impacts the pole must not totally separate from the vehicle and any door that does not impact the pole must remain latched. For fuel system integrity, fuel ballast leakage (if any) must not exceed specified limits in the 30 minutes (or 60 minutes in the case of hydrogen fuelled vehicles) after impact.

UN R[135] includes the same WorldSID 50th percentile adult male injury criteria; door latch and hinge system integrity; and fuel system integrity performance requirements as the GTR.

Timing

GTR 14 and UN R[135] do not specify implementation timing for its introduction in national legislation. It is a matter for the Contracting Parties to determine their own timetable, including any phasing-in of implementation. However, during the development of regulations it is usual for industry and governments to exchange positions that begin to form common views on what the appropriate timing should be.

While the GTR does not contain explicit timing, Section H of the preamble recommends that Contracting Parties implementing the GTR allow adequate lead time before full mandatory application, considering the necessary vehicle development time and product lifecycle (UNECE, 2013).

New UN regulations normally enter into force approximately six months after adoption by WP.29 (WP.29-163-16). UN R[135] in its original form (00 series of amendments) is set to enter into force on 15 June 2015. From the date of entry into force of a UN regulation, the Contracting Parties applying the regulation may begin issuing and must accept approvals in accordance with the regulation (i.e. the parties must mutually recognise approvals). The date of entry into force therefore also establishes the date from which manufacturers may begin obtaining approvals to a UN regulation.

The 00 series of amendments requires:

a) vehicles with a ‘vehicle width’ greater than 1.50 m to be impacted into a stationary pole at 32 ± 1 km/h; and

b) vehicles with a ‘vehicle width’ less than or equal to 1.50 m to be impacted into a stationary pole at 26 -0/+7 km/h. (Department of Infrastructure and Regional Development, 2014b)

WP.29 also voted in November 2014 to adopt a proposal for a 01 series of amendments to UN R[135], which, in short, enables Contracting Parties applying the regulation to require a vehicle-to-pole impact speed of 32 ± 1 km/h regardless of the vehicle width. The 01 series of amendments will enter into force approximately six months after the 00 series (i.e. around December 2015).

When a UN regulation moves to a new series of amendments, the date from which Contracting Parties may require compliance with the amended requirements is typically set out in transitional provisions. The key transition date for the 01 series of amendments is 1 September 2016. After this date, Contracting Parties applying the regulation are not obliged to accept vehicles having a width of 1.5 m or less which have been approved to the 00 series.

The usual lead time for an ADR change that results in an increase in stringency is 18 months for new models and 24 months for all other models.

4 WHAT ARE THE LIKELY NET BENEFITS OF EACH OPTION?

4.1 Benefit-Cost Analysis

General

Benefit-cost analysis is a useful tool for evaluating the feasibility of implementing new technology, but it does not replace the decision process itself. The model used in this analysis is the 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 modelling the adding of side impact protection countermeasures to vehicles, there would be an upfront cost to the manufacturer/consumer when the vehicles are first built, in the design of the systems and fitting of the components. Once in use there would be a series of benefits spread throughout the life of the vehicles as the costs of crashes are reduced. This pattern would be repeated as new vehicles are registered year after year and old vehicles leave the fleet. 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 3: fleet purchasing policies; and Option 6: mandatory standards under the MVSA (regulation)), were considered viable to analyse further. Calculations were started at current estimated rates of compliance with the performance requirements of UN R[135/01] of 30 per cent for LPVs and 20 per cent for LCVs. The results of each option were compared with what would happen if there was no government intervention, that is, Option 1: no intervention (business as usual). Under the business as usual case, the compliance rate is expected to reach 75 per cent by 2023 for LPVs and 55 per cent by 2025 for LCVs.

The overall period of analysis would be for the expected life of the option (around 15 years for regulation and fleet purchasing policies) plus the time it takes for benefits to work their way through the fleet (around 26-30 years, the maximum lifespan of a vehicle).

4.1.1 Benefits

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

For Options 3 and 6 the benefits were estimated based on the difference between the expected business as usual level of compliance with the performance requirements of UN R[135/01] and the level of compliance expected under implementation of each proposed option (in the case of Option 6a: 100 per cent for applicable vehicle types once fully phased in). Figure 6 to

Figure 8 show the anticipated level of compliance with the performance requirements of UN R[135/01] for each of the viable options (1, 3, 6a and 6b) across the intervention period (2017-2033).

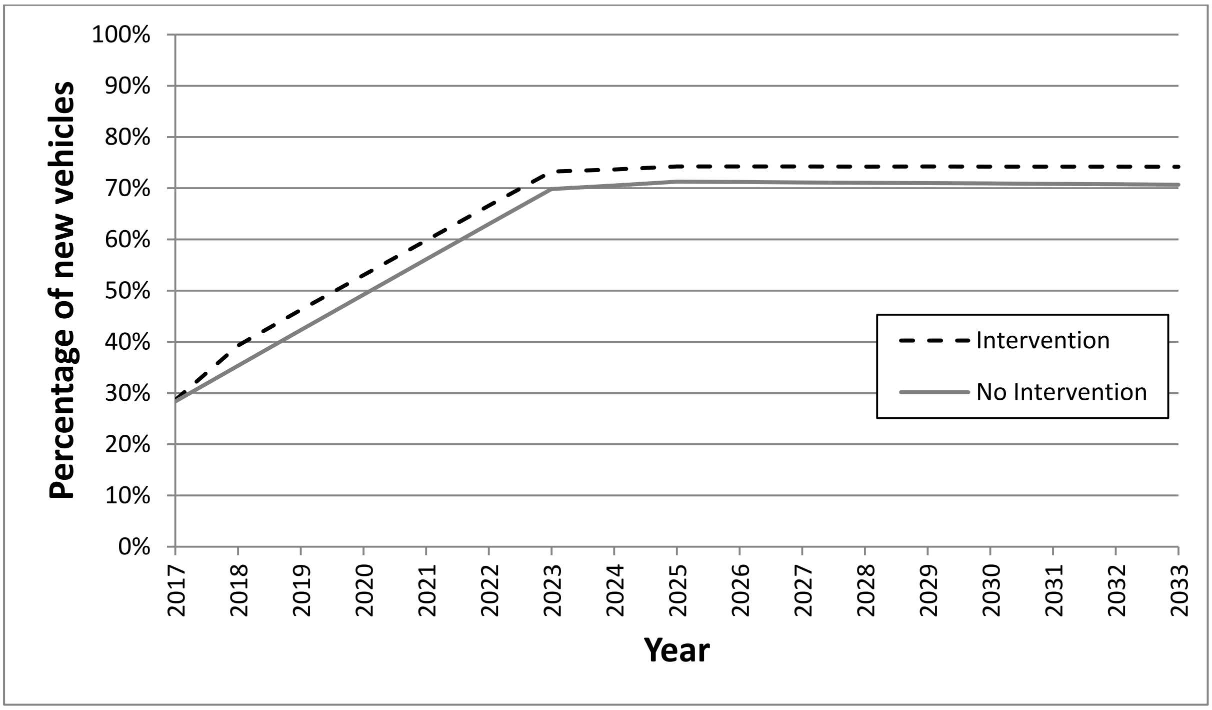

Figure 6 Percentage of new light vehicles (LPVs and LCVs) to which UN R[135] applies, assumed to meet UN R[135/01] performance requirements under BAU (no intervention) and Option 3 (intervention) scenarios in Australia

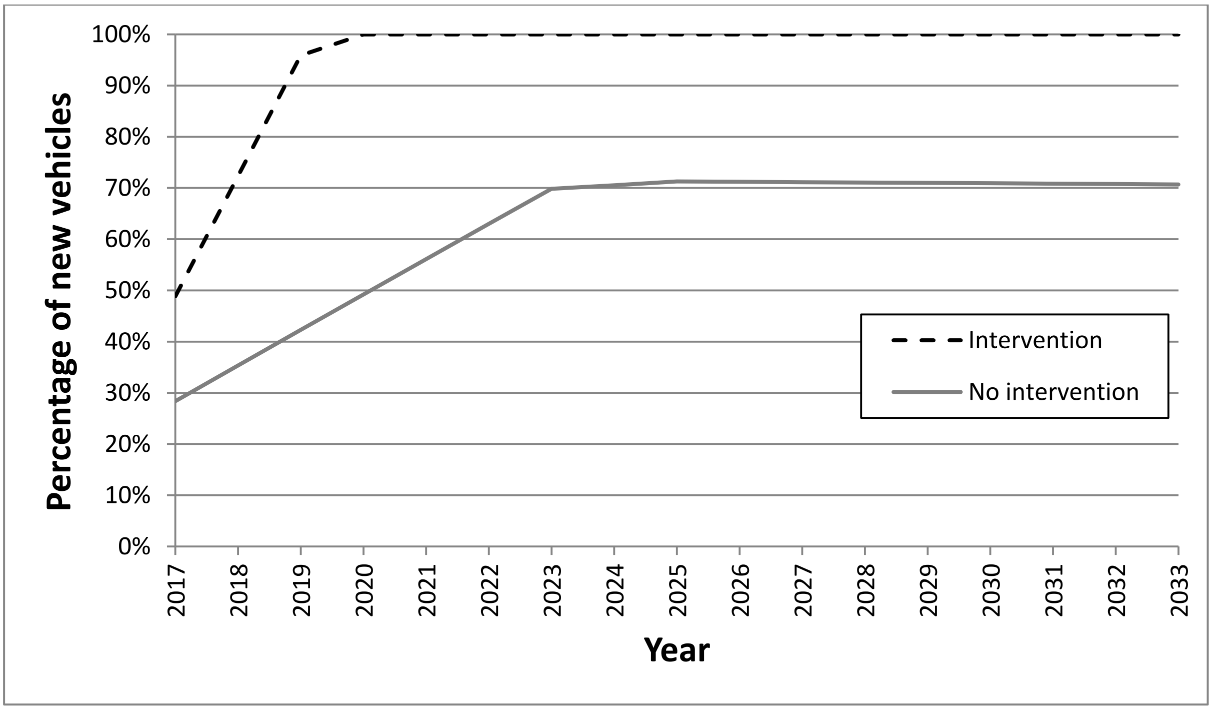

Figure 7 Percentage of new light vehicles (LPVs and LCVs) to which UN R[135] applies, assumed to meet UN R[135/01] performance requirements under BAU (no intervention) and Option 6a (intervention) scenarios in Australia

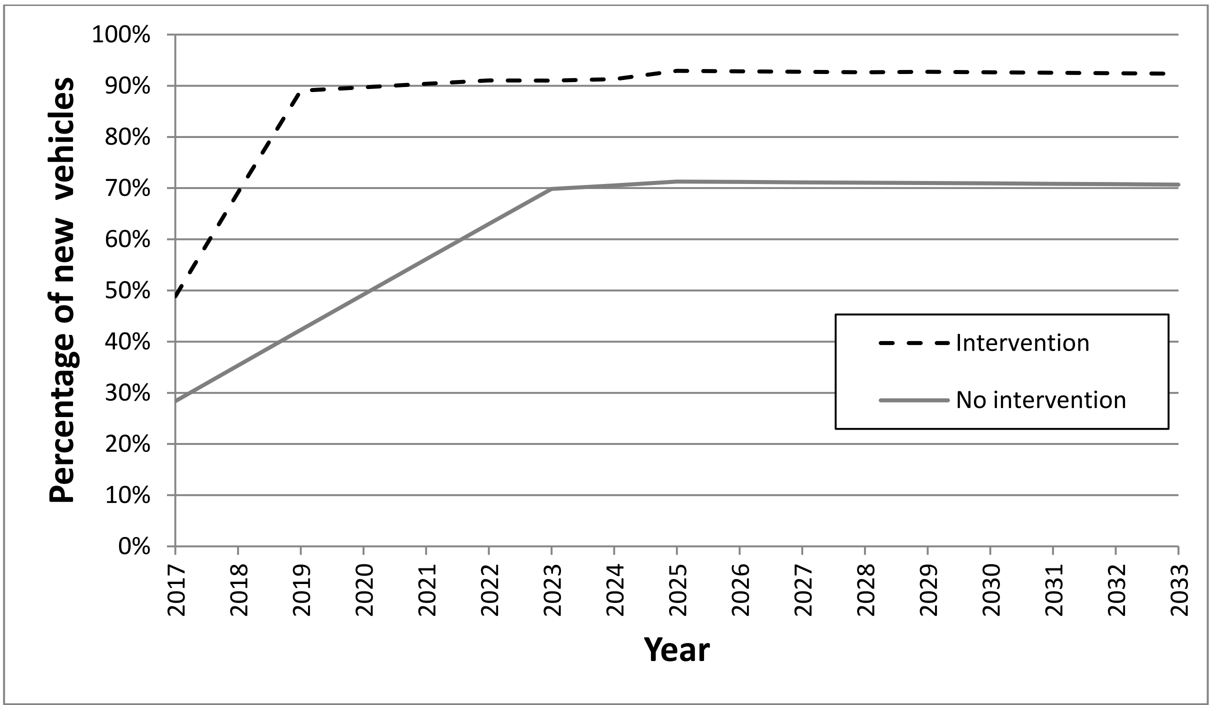

Figure 8 Percentage of new light vehicles (LPVs and LCVs) to which UN R[135] applies, assumed to meet UN R[135/01] performance requirements under BAU (no intervention) and Option 6b (intervention) scenarios in Australia

Where, under business as usual, vehicles were not expected to meet the performance requirements of UN R[135/01], airbag fitment rate data (from Fitzharris and Stephan, 2013) was used to categorise vehicles into one of three sub-groups, A, B, or C. Sub-group A is LCVs that are not fitted with any side airbags. Sub-group B is LPVs fitted with a narrow curtain airbag only or a combination side airbag system. Sub-group C is the remaining LPVs and LCVs assumed to be fitted with head curtain and thorax side airbags that would be considered as too narrow or having insufficient energy absorption capacity to meet the performance requirements of UN R[135/01]. Under Options 6a and 6b, it was considered that the performance requirements of UN R[135/01] would dictate the fitting of wide head curtain and thorax side airbag systems with enhanced energy absorption capacity to all vehicles in each sub-group. It was assumed Option 3 would only affect sub-group C LCVs.

Effectiveness of enhanced side impact protection

Effectiveness estimates for business as usual side airbag systems, in reducing the number of vehicle occupants killed and injured in side impact crashes, were estimated based on US Fatality Analysis Reporting System research by Kahane (2014) and a Crash Injury Research Engineering Network (CIREN) study by the University of Alabama (UAB CIREN Center, 2011) respectively.

It was estimated that the side airbag systems with sufficient energy absorption capacity and coverage to meet the performance requirements of UN R[135/01] would be 30 per cent more effective than head curtain and thorax side airbags installed in the sub-group C vehicles under business as usual. The same effectiveness values were used for reductions in serious and minor injuries. Based on the above, the following values for incremental side airbag system effectiveness were established for each vehicle sub-group, relative to business as usual.

Table 4 Incremental effectiveness of enhanced side impact protection measures

Vehicle Sub-group	Effectiveness Measure for side impact crashes (% reduction relative to BAU scenario)	Incremental Effectiveness
A	Fatalities	40.7%
	Serious injuries	44.2%
	Minor injuries	44.2%
B	Fatalities	20.1%
	Serious injuries	23.6%
	Minor injuries	23.6%
C	Fatalities	9.4%
	Serious injuries	10.2%
	Minor injuries	10.2%

Refer to Appendix 4—Effectiveness of Enhanced Side Impact Protection Measures for further details.

4.1.2 Costs

System development costs

Most system development costs that would be required to design and produce a vehicle likely to meet the performance requirements of the GTR/UN regulation are already occurring. This is because manufacturers are, by and large, already producing vehicles with side airbag systems, and have been doing their own perpendicular and/or oblique vehicle-to-pole side impact tests and other development activities (e.g. computer simulation and sled tests) as part of this process. These costs were therefore considered business as usual.

The most likely sources of additional development and certification costs under Options 6a and 6b are the cost of an additional pre-production vehicle and test program to demonstrate compliance with the GTR and/or obtain type approval to the UN regulation. Based on advice from industry sources, the average cost of a pre-production vehicle is about A$300,000. Using the Department of Infrastructure and Regional Development's experience in conducting crash test research, the average cost of an oblique vehicle-to-pole side impact crash test (i.e. similar to the GTR) is estimated to be A$50,000. Total development costs (over and above business as usual) are therefore estimated at A$350,000 per model.

GTR 14/UN R[135] are international vehicle standards. Implementation of international standards gives rise to efficiencies in costs to manufacturers. As the GTR/UN regulation are expected to be implemented in a number of countries, only a small percentage of the total cost to develop a model meeting the performance requirements of the GTR/UN regulation is likely to be passed on to Australian new vehicle buyers. The proportion of development costs likely to be passed on to Australian vehicle buyers was estimated using the following vehicle sales data obtained from OICA (2013).

Table 5 International passenger and commercial vehicle sales (OICA, 2013)

Passenger and Commercial Vehicle Sales in major markets			
Country/Region	**Sales (2013)**	**Relevance Factor**	**Relevant Sales**
Australia	1,136,227	1.0	1,136,227
Canada	1,779,860	0.8	1,423,888
EU 15 countries + EFTA	13,181,878	1.0	13,181,878
Japan	5,375,513	1.0	5,375,513
New Zealand	113,294	1.0	113,294
South Korea	1,543,564	1.0	1,543,564
United States	15,883,969	0.8	12,707,175
Australian Share of Total	**3.00 %**	**n/a**	**3.31 %**

The relevance factor in the above table is used to represent the proportion of vehicles sold in each market, for which it is assumed the side airbag designs will be the same as those used in corresponding Australian market vehicles to meet the performance requirements of the GTR/UN regulation. A factor of 0.8 was used for the US and Canada, as some differences in both regulatory and consumer evaluation requirements are expected to remain (at least in the short term), which may necessitate or at least encourage the development of different side airbag designs for some North American vehicles. For example, FMVSS 226 (ejection mitigation) has requirements relevant to side airbag design which are not implemented in any of the other countries listed in Table 5 or covered by the GTR.

In line with Table 5, it was estimated that 3.31 per cent of development costs for each model affected under each option would be passed on to Australian vehicle buyers. This equates to approximately $12,000 per model.

Using FCAI VFACTs and the Department’s Road Vehicle Certification System (RVCS) data it was estimated that an average of 58 LPV models and 6 LCV models are introduced to the Australian market each year. Hence, it was assumed that an average of 6, 64 and 58 models developed each year would be affected by implementation of options 3, 6a and 6b respectively. The total development of systems cost estimates for implementation of options 3, 6a and 6b in Australia were therefore $72,000, $768,000 and $696,000 per annum, respectively.

Costs to fit the systems

Additional fitment costs for vehicles in sub-groups A, B and C were derived from costs detailed by Fitzharris & Stephan (2013). These reflect the additional costs anticipated due to fitment of side airbag systems, including larger (enhanced) side airbags, with larger inflators, and additional and/or improved side impact sensors etc. to meet the performance requirements of the GTR/UN regulation. Reserve Bank of Australia (RBA) inflation rate data was used to convert the $2012 costs reported by Fitzharris and Stephan (2013) to $2014 values.

Table 6 Incremental fitment costs (source: derived from Fitzharris and Stephan, 2013, Table 8.7b, p 139)

Vehicle sub-group	Costs 2014 per vehicle	
	Wide curtain airbag, wide thorax airbag and a peripheral sensor on each side	Wide curtain airbag, wide thorax airbag and 2 peripheral sensors on each side
A (no side airbags under BAU)	$299	$344
B (head curtain only or combination side airbags under BAU)	$156	$202
C (narrow head curtain and narrow thorax side airbags under BAU)	$10	$56

For sub-group B (LPVs) and sub-group C (LPVs and LCVs), it was estimated that 62.5 per cent of vehicles would be fitted with a single peripheral sensor on each side, and 37.5 per cent would be fitted with two peripheral sensors on each side. This assumption was based on observations of the peripheral sensor systems used in North American LPVs tested as part of a joint pole side impact crash test research program between the Department and Transport Canada.

For sub-group A (LCVs), it was assumed 80 per cent would be fitted with a single peripheral sensor on each side, and 20 per cent would be fitted with two peripheral sensors on each side.

Based on these assumptions, average overall system costs were determined by weighting the relevant costs in Table 6 for each vehicle sub-group (A, B, and C). The likely fitment costs, and best/worst case costs (likely cost ± 20 per cent) for each vehicle sub-group are as follows:

Table 7 Likely fitment costs for enhanced side impact protection measures

Costs related to:	**Net Cost relative to BAU**			**Notes**	**Cost Impact**
Fitment of systems	**Sub-group A**	**Sub-group B**	**Sub-group C**		
Best Case	$231	$130	$20		
Likely Case	**$308**	**$173**	**$27**	Per vehicle	Business
Worst Case	$385	$216	$34		

The sub-group C costs above are consistent with advice provided to Fitzharris and Stephan (2013) by a local manufacturing industry expert, that the cost of meeting an enhanced side impact requirement (the GTR) would be "no more than $50 for additional parts and enhancements, like sensors, slightly more forward and rearward reaching bags and inflators" (p.140).

Other business costs

It was assumed there would be a total cost of $40,000 per year, for businesses/fleets to create, implement and maintain the private fleet purchasing policies assumed to follow on from any Australian Government action to implement the fleet purchasing Option 3 for LCVs.

The cost of regulation compliance, including submission of forms/applications and conformity of production audits are estimated based on Department experience in administering such a system to be $1,500 per new model certified each year to any mandatory standard implemented under Option 6.

Government costs

It was assumed there would be a cost of $10,000 per year for the Australian Government to create, implement and maintain the fleet purchasing policy Option 3 for LCVs.

It was assumed there would be an estimated annual cost of $50,000 to governments to create, implement and maintain a regulation under Option 6, as well as for state and territory jurisdictions 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 8 provides a summary of the various costs associated with the implementation of Options 3, 6a and 6b.

Table 8 Summary of costs associated with the implementation of each option

Costs related to:	Net Cost relative to BAU			Option(s)	Notes	Cost Impact
Development of systems – including test costs	$350,000 $12,000			3, 6a, 6b	Per model Per model (domestic share)	Business
Fitment of systems	**Sub-group A**	**Sub-group B**	**Sub-group C**			
Best Case	$231	$130	$20	3, 6a, 6b	Per vehicle	Business
Likely Case	**$308**	**$173**	**$27**			
Worst Case	$385	$216	$34			
Implement and maintain policy	$40,000			3	Per year	Business
Implement and maintain policy	$10,000			3	Per year	Government
Regulation compliance	$1,500			6a, 6b	Per model (domestic)	Business
Implementing and maintaining regulation	$50,000			6a, 6b	Per year	Government

4.1.3 Benefit-Cost Analysis Results

Appendix 7—Benefit-Cost Analysis—Details of Results shows the calculations for the benefit-cost analysis. A summary of the results is provided below in Table 9. A seven per cent discount rate was used for all options.

Table 9 Summary of benefits, costs, lives saved and traumatic brain injuries (TBI) avoided under Options 1, 3, 6a and 6b

	Net Benefits ($)	Cost to Business ($m)	Cost to Govern-ment ($m)	Benefit Cost Ratio	Number of Lives Saved	Severe TBI Avoided	Moderate TBI Avoided
Option 1							
Best case	-	-	-	-			
Likely case	-	-	-	-	-	-	-
Worst case	-	-	-	-			
Option 3							
Best case	30	7.5	0.1	4.9			
Likely case	27	9.6	0.1	3.8	7	9	4
Worst case	25	11.7	0.1	3.1			
Option 6a							
Best case	591	113	0.5	6.2			
Likely case	556	148	0.5	4.7	158	153	87
Worst case	521	183	0.5	3.8			
Option 6b							
Best case	487	66	0.5	8.4			
Likely case	468	85	0.5	6.5	128	116	73
Worst case	448	105	0.5	5.3			

Sensitivity Analysis

A sensitivity analysis was carried out to determine the effect on the outcome of some of the less certain inputs to the benefit-cost analysis. Only Option 6a was tested as this was the option that gave the highest net benefits.

The fitment costs and the costs of regulation were considered to be reasonably accurate, being provided through the appropriate industry and government sources.

An uncertainty that could adversely affect the options was the assumed 7 per cent discount rate of the benefits and costs. For Option 6a, the benefit-cost analysis was therefore also run with a real discount rate of 10 per cent and then with a real discount rate of 3 per cent. Table 10 shows that the net benefits are positive under all three discount rates.

Table 10 Impacts of changes to the real discount rate

	Net benefits ($m)	BCR
Low discount rate (3%)	1222	6.7
Base case (likely case) discount rate (7%)	556	4.7
High discount rate (10%)	325	3.8

The incremental effectiveness of enhanced side impact protection measures was also subjected to a sensitivity analysis, running both a high effectiveness and low effectiveness scenario. Under the high effectiveness scenario it was assumed the side airbag systems installed to meet the performance requirements of the GTR would on average be 40 per cent more effective than those installed in the sub-group C vehicles under business as usual. Under the low effectiveness scenario a 20 per cent increase in effectiveness relative to sub-group C under business as usual was used. As seen in Table 11 the net benefits are positive even for the low effectiveness scenario.

Table 11 Impacts of changes to effectiveness

	Net benefits ($m)	BCR
Low effectiveness	346	3.3
Base case (likely case) effectiveness	556	4.7
High effectiveness	766	6.2

Finally, the business as usual fitment rate was examined. For the benefit-cost analysis the following business as usual compliance rates were assumed:

- for LPVs—30 per cent in 2017 with a transition to 75 per cent from 2023 onwards; and
- for LCVs—20 per cent in 2017 with a transition to 55 per cent from 2025 onwards.

To account for uncertainty, the final compliance rates were varied by ±10 per cent. As shown in Table 12, the net benefits remain positive even with a higher compliance rate.

Table 12 Impacts of changes to the business as usual compliance rate

	Net benefits ($m)	BCR
Low BAU compliance rate	649	5.0
Base case (likely case) BAU compliance rate	556	4.7
High BAU compliance rate	463	4.5

More detailed results of the sensitivity analysis are available at Appendix 8—Benefit-Cost Analysis—Sensitivities.

4.2 Economic Aspects—Impact Analysis

Impact analysis considers the magnitude and distribution of the benefits and costs that have been calculated. It also looks at the impact of the option on the affected parties.

4.2.1 Identification of Affected Parties

In the case of enhanced side impact protection, the parties affected by the options are:

Business/consumers

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

Governments

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

The business/consumer parties are represented by several interest groups. Those relevant to the topic of this RIS include the:

- FCAI, that represents the automotive sector and includes vehicle manufacturers, vehicle importers and component manufacturers/importers;
- FAPM that represents the automotive component manufacturers/importers; and
- Australian Automobile Association (AAA) that represents vehicle owners and operators (passenger cars and derivatives) through the various automobile clubs around Australia (RACQ, RACV, NRMA, RAA etc).

4.2.2 Impact of Viable Options

There were three options that were considered feasible for further examination: Option 1: no intervention; Option 3: fleet purchasing policies; 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 within the community. This is discussed below and then summarised in Table 13.

Option 1: no intervention

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

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

Option 3: fleet purchasing policies

Under this option governments would require LCV models to meet minimum pole side impact performance requirements to be eligible to be purchased for use in its fleet. It is assumed that such a policy would influence around half of private fleet buyers to implement a similar policy.

As this option involves direct intervention to change demand in the market place, the benefits and costs are those that would occur on a voluntary basis, over and above those determined in Option 1. The fitment of enhanced side impact protection measures would remain a commercial decision within this changed environment.

<u>Benefits</u>

Business/consumers

There would be a direct benefit to fleet owners and the wider community (over and above that of Option 1), as a result of a reduction in road trauma for those who drive a fleet vehicle (or an ex-fleet vehicle in future) fitted with enhanced side impact protection measures due to fleet purchasing policies. For this option there would be an estimated saving of 7 lives, 9 severe traumatic brain injuries and 4 moderate traumatic brain injuries. The likely BCR is 3.8.

Governments

There would be an indirect benefit to governments (over and above that of Option 1) as a result of a reduction in road trauma for those who drive an LCV fitted with enhanced side impact protection measures due to fleet purchasing policies, in terms of the public health system and the general well-being of the community. This option would save $37m over and above Option 1. This benefit would be shared with governments and so the community.

<u>Costs</u>

Business/consumers

There would be a direct cost to business/fleet owners (over and above that of Option 1) as a result of additional design, fitment and testing costs for LCVs that are sold fitted with enhanced side impact protection measures due to fleet purchasing policies. This would add between $7m and $12m over and above Option 1. This cost would be passed on to the consumer.

There would also be a cost to the businesses it is assumed would follow the government lead in implementing fleet purchasing policies that require LCVs to achieve certain minimum levels of vehicle-to-pole side impact performance. This is estimated at $0.4m.

Governments

There would be a cost to governments for administering fleet purchasing policies that require LCVs to achieve certain minimum levels of vehicle-to-pole side impact performance. This is estimated at $0.1m.

Option 6: regulation

This option mandates standards for enhanced side impact protection under the MVSA for LPVs and LCVs, based on international standards developed by the UN (regulatory—mandatory).

As this option involves direct intervention to compel a change in the safety performance of vehicles supplied to the marketplace, the benefits and costs are those that would occur over and above those determined in Option 1. The fitment of enhanced side impact protection measures would no longer be a commercial decision within this changed environment.

Benefits

Business

There would be no direct benefit to business as a result of a reduction in road trauma caused by vehicles that are sold fitted with enhanced side impact protection measures due to the Australian Government mandating standards.

There would be an indirect benefit to business as a result of a reduction in the number of days work lost due to employees being injured in side impact crashes as well as a reduction in recruitment, training and development costs associated with the replacement of employees killed or permanently incapacitated due to side impact crashes.

There would also be an indirect benefit through the Australian Government encouraging, by example, the adoption of a globally harmonised regulation for pole side impact. This would strengthen the case for other regulatory and non-regulatory organisations around the world to consider a similar test, rather than continue with the variety of tests seen today. This in turn would lead to efficiencies and reduced costs for manufacturers in the design, testing and certification of new vehicle models. This benefit was unable to be quantified.

Consumers

There would be a direct benefit to vehicle owners and the wider community as a result of a reduction in road trauma for those who travel in a vehicle with enhanced side impact protection measures, due to the Australian Government mandating standards. Deaths and injuries due to crashes would be reduced, lessening the impact on the personal lives of road users as well as on insurance and other related systems. This benefit was able to be quantified in terms of lives saved and injuries reduced. For option 6 a) there would be a saving of an estimated 158 lives, 153 severe traumatic brain injuries and 87 moderate traumatic brain injuries over an assumed 15 year life of regulation. For option 6 b) there would be an estimated saving of 128 lives, 116 severe traumatic brain injuries and 73 moderate traumatic brain injuries. The BCRs determined were 4.7 for option 6 a) and 6.5 for option 6 b).

Governments

There would be an indirect benefit to governments as a result of a reduction in road trauma for those who travel in a vehicle with enhanced side impact protection measures, due to the Australian Government mandating standards, in terms of the public health system and the general well-being of the community. This benefit was able to be quantified in terms of costs reduced and would be shared between governments and the community. For option 6 a) there would be a saving of $704m, over an assumed 15 year life of regulation. For option 6 b) the saving would be $553m. These benefits would be shared with governments and so the community. They represent a monetised saving of the lives and injuries reported above.

Costs

Business/consumers

There would be a direct cost to business/consumers as a result of additional design, fitment and testing costs for vehicles that are sold fitted with enhanced side impact protection measures due to the Australian Government mandating standards. This cost was able to be quantified and would likely be passed onto the consumer by business. This would cost between $113m and $183m for option 6 a), and between $66m and $104m for option 6 b); over an assumed 15 year life of regulation.

Most manufacturers, particularly those supplying vehicles to the US, are already developing side airbag systems which would provide sufficient coverage and absorb sufficient energy to meet the performance requirements of the GTR/UN Regulation. Adoption of a mandatory standard (Options 6a and 6b) will result in an increased proportion of these manufacturers deciding to install these higher performance systems in the vehicle variants they supply to the Australian market. Those not supplying to the US market or otherwise not expected to meet the requirements under business as usual (including due to a number of NCAPs already deciding to adopt the GTR test), would promptly work in collaboration with major airbag system suppliers to make their vehicle models meet the requirements. Major structural design changes should not be necessary.

The additional side airbag fitment costs, of no more than $50 for most vehicles, should not be large enough to significantly affect the range of vehicle models supplied to the Australian market.

Governments

There would be a cost to governments for developing, implementing and administering regulations (standards) that require vehicles to meet the proposed minimum level of safety performance. This cost was able to be quantified and would cost $0.5m over an assumed 15 year life of regulation.

Table 13 Summary of the benefits and costs of enhanced side impact protection measures over a 44-year period of analysis (15 year life of policy/intervention)

<table>
<tr><th rowspan="2"></th><th colspan="2">Option 1: no intervention</th><th colspan="2">Option 3: fleet purchasing policies for LCV</th><th colspan="2">Option 6a: regulation (broad scope)</th><th colspan="2">Option 6b: regulation (narrow scope)</th></tr>
<tr><th>Gross benefits</th><th>Costs</th><th>Gross benefits</th><th>Costs</th><th>Gross benefits</th><th>Costs</th><th>Gross benefits</th><th>Costs</th></tr>
<tr><td>Business</td><td>n/a</td><td>n/a</td><td>None</td><td rowspan="2">Cost of administering fleet purchasing policies—$0.4m
Cost of vehicle countermeasures—$6-11m</td><td>None</td><td rowspan="2">Cost of vehicle countermeasures—$105-174m</td><td>None</td><td rowspan="2">Cost of vehicle countermeasures—$58-97m</td></tr>
<tr><td>Consumers</td><td>n/a</td><td>n/a</td><td rowspan="2">Reduced road trauma—$37m</td><td rowspan="2">Reduced road trauma—$704m</td><td rowspan="2">Reduced road trauma—$553m</td></tr>
<tr><td>Government</td><td>n/a</td><td>n/a</td><td>Cost of administering fleet purchasing policies—$0.1m</td><td>Cost of implementing and administering regulations—$0.5m</td><td>Cost of implementing and administering regulations—$0.5m</td></tr>
<tr><td>Lives saved</td><td>n/a</td><td>n/a</td><td colspan="2">7 lives</td><td colspan="2">158 lives</td><td colspan="2">128 lives</td></tr>
<tr><td>Severe TBI prevented</td><td>n/a</td><td>n/a</td><td colspan="2">9 cases</td><td colspan="2">153 cases</td><td colspan="2">116 cases</td></tr>
<tr><td>Mod TBI prevented</td><td>n/a</td><td>n/a</td><td colspan="2">4 cases</td><td colspan="2">87 cases</td><td colspan="2">73 cases</td></tr>
<tr><td>BCR</td><td>n/a</td><td>n/a</td><td colspan="2">3.1-4.9</td><td colspan="2">3.8-6.2</td><td colspan="2">5.3-8.4</td></tr>
</table>

5 REGULATORY BURDEN AND COST OFFSETS

The Australian Government has established a deregulation policy that aims to improve productivity growth and enhance competitiveness across the Australian economy. The Department is a key Commonwealth safety regulator and continuous improvement is at the core of the portfolio's regulatory vision. The portfolio is vigorously pursuing regulatory reforms, with a particular focus on achieving efficiencies through harmonising international and domestic regulatory requirements. This will maintain our high safety and security standards for Australia's transport systems while reducing unnecessary regulatory burden.

The Australian Government Guide to Regulation (2014) requires that all new regulatory options are costed using the Regulatory Burden Measurement Framework (RBM). The RBM is a different measure to the full cost benefit analysis as it does not capture the benefits of reduced injury and fatality rates for consumers and the wider community. The average annual regulatory costs were established by calculating the total undiscounted (nominal) cost (including development and fitment costs) for each option over the 10 year period 2015-2024 inclusive, and dividing by 10.

The average annual regulatory costs under the RBM of the four viable options, Options 1, 3, 6a and 6b, are set out in the following four tables. There are no costs associated with Option 1 as it is the business as usual case. The average annual regulatory costs associated with Options 3, 6a and 6b are estimated to be $1 million, $17 million and $10 million respectively.

Table 14 Regulatory burden and cost offset estimate table – Option 1

Average annual regulatory costs (from business as usual)				
Change in costs ($ million)	Business	Community organisations	Individuals	Total change in costs
Total, by sector	-	-	-	-
Cost offset ($ million)	Business	Community organisations	Individuals	Total, by source
Agency	N/A	N/A	N/A	N/A
Are all new costs offset? N/A				
Total (Change in costs – Cost offset) ($ million) = N/A				

Table 15 Regulatory burden and cost offset estimate table - Option 3

Average annual regulatory costs (from business as usual)				
Change in costs ($ million)	Business	Community organisations	Individuals	Total change in costs
Total, by sector	$1m[1]			$1m
Cost offset ($ million)	Business	Community organisations	Individuals	Total, by source
Agency	$1m			$1m
Are all new costs offset? ☑ Yes, costs are offset ☐ No, costs are not offset ☐ Deregulatory—no offsets required				
Total (Change in costs – Cost offset) ($ million) = $0				

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

Average annual regulatory costs (from business as usual)				
Change in costs ($ million)	Business	Community organisations	Individuals	Total change in costs
Total, by sector	$17m[1]			$17m
Cost offset ($ million)	Business	Community organisations	Individuals	Total, by source
Agency	$17m			$17m
Are all new costs offset? ☑ Yes, costs are offset ☐ No, costs are not offset ☐ Deregulatory—no offsets required				
Total (Change in costs – Cost offset) ($ million) = $0				

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

Average annual regulatory costs (from business as usual)				
Change in costs ($ million)	Business	Community organisations	Individuals	Total change in costs
Total, by sector	$10m[1]			$10m
Cost offset ($ million)	Business	Community organisations	Individuals	Total, by source
Agency	$10m			$10m
Are all new costs offset? ☑ Yes, costs are offset ☐ No, costs are not offset ☐ Deregulatory—no offsets required				
Total (Change in costs – Cost offset) ($ million) = $0				

1/ the costs to business are expected to be passed on to consumers.

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 and offset by the relevant portfolio.

The Infrastructure and Regional Development portfolio is accelerating the harmonisation of the ADRs with UN regulations as well as removing Australian-specific content from the ADRs, as agreed with industry.

Increased harmonisation with international vehicle standards will ensure new vehicle technology is available immediately in the Australian market, and will provide savings to manufacturers and therefore consumers.

It is estimated that these measures will provide $10-20 m in annual regulatory savings, which can be used to offset any regulatory costs of the chosen option.

6 WHAT IS THE BEST OPTION?

The scenarios prepared for estimating the benefits and costs from enhanced side impact protection represented the options considered viable:

- Option 1: no intervention;
- Option 3: fleet purchasing policies; and
- Option 6: mandatory standards under the MVSA (regulation).

6.1 Net Benefits

Option 6a: regulation (broad scope) had the highest net benefits of the options examined, at \$556m for the likely case. Option 6b: regulation (narrow scope) had the next highest net benefits, at \$468m for the likely case. The analysis for Options 6a and 6b represented 15 years of regulation followed by a period of around 30 years where the remaining cohort of improved vehicles in the fleet gradually exit out due to crashes or by reaching the end of their service life. Option 3: fleet purchasing policies also had positive (but significantly lower) net benefits, at \$27m for the likely case.

6.2 Benefit-Cost Ratios

Option 6b had the highest BCR at a likely value of 6.5. Option 6a had the next highest BCR at a likely value of 4.7, followed by Option 3 with a BCR of 3.8 for the likely case.

The higher BCR for Option 6b relative to 6a is a result of LPVs having higher business as usual probabilities of occupant fatalities and serious injuries in pole side impact and other side impact crashes, as well as lower average incremental technology fitment costs, relative to LCVs. However, the net benefit (total benefits minus total costs in present value terms) is a much better measure of the economic effectiveness of a policy option than the BCR. Accordingly, as noted, the Australian Government Guide to Regulation (2014) states that the policy option offering the greatest net benefit should always be the recommended option.

6.3 Lives Saved

Option 6a had the highest number of lives saved and severe and moderate traumatic brain injuries avoided at 158 and 240 respectively, followed by Option 6b with 128 lives and 189 traumatic brain injuries.

The lives and traumatic brain injuries saved under Option 3 were significantly lower, at 7 and 13 respectively.

6.4 Recommendation

This RIS identified a current road safety problem in Australia relating to side impact crashes, particularly vehicle-to-pole side impact crashes. The primary countermeasures used to improve vehicle-to-pole side impact performance are curtain side airbags in combination with thorax airbags. There is already increasing voluntary take-up of this technology, with an estimated 97 per cent fitment for new LPVs and 61 per cent fitment for new LCVs by 2016 (97 per cent for new LCVs by 2025).

With the recent development of international standards on the topic, GTR 14 and UN R135, there has been the opportunity to review what can be done to further reduce the trauma associated with these types of crashes.

A requirement for vehicles to meet the oblique vehicle-to-pole side impact test set out in GTR 14 and UN R[135] is not only expected to accelerate the fitment rates of side airbag systems, but also force improvements to existing system performance—increasing the effectiveness of some systems by up to 30 per cent.

It was estimated that, by 2017, around 30 per cent of LPVs and 20 per cent of LCVs supplied to the Australian market would meet the performance requirements of GTR 14/UN R135, without any intervention. Further, recently announced moves by NCAPs, particularly ANCAP, to move to an oblique vehicle-to-pole side impact test based on the test used in GTR 14/UN R[135] are expected to steadily increase these percentages.

Examining a case for government intervention to increase the fitment of enhanced side impact safety technology (curtain side airbags and thorax airbags) may at first appear to be of limited value. Generally, high voluntary fitment rates tend to reduce the need to intervene in the market, particularly through regulation. On the other hand there can be strong advantages to intervention by regulation, even given such rates.

In this case, Option 6 (regulation) would still offer positive and large net benefits of between $468m (Option 6b) and $556m (Option 6a) resulting from savings of 128 to 158 lives and 189 to 240 moderate and severe traumatic brain injuries over a 15-year period of regulation. While Option 3 also offered positive net benefits, these would be much less than those offered by Option 6.

In terms of efficiency of regulation, the BCR for Option 6 is between 4.7 (Option 6 a) and 6.5 (Option 6 b). This is high for a vehicle safety proposal—typically it is around 2.0. Overall, the large net benefits and high BCR are because:

- side impact crashes are the largest single contributor of any crash type to the road toll (see Figure 1);
- a relatively high proportion of the vehicle occupants killed in pole side impact crashes are aged under 30 (note: median age is around 24 years, so the life years lost are much higher than for all road crashes);
- there is a relatively high incidence of costly traumatic brain injuries ($2.5-5.6 million per incidence case depending on severity) in side impact crashes, especially pole side impact crashes;
- highly effective design solutions/countermeasures are available; and

- the incremental cost of the countermeasures (i.e. improved, airbags and/or sensors, in many vehicles) most likely to be used to meet the performance requirements is very low (no more than $50 for the majority of vehicle models).

Furthermore, the costs associated with better designs are minimised through harmonisation of requirements with the international regulation, which in turn was developed using the most human-like (cutting edge) side impact crash test dummy available. It is highly feasible for manufacturers to meet this regulation given the latest capability of in-vehicle technology.

Option 6 offers the important advantage of being able to guarantee 100 per cent provision of enhanced side impact protection measures to applicable vehicles. There would be no guarantee that non-regulatory options, such as Option 3, would deliver an enduring result, or that the predicted take-up of side impact protection measures would be reached and then maintained. Changing economic pressures, or the entry of new players into the market, could see a shift away from the current move to provide enhanced side impact protection measures in cars, particularly at the lower, more competitive end of the market. Monitoring the market would bring in added complications such as defining what the performance criteria should be (in the absence of a mandatory standard), setting the lower limit in the market at which point intervention would have to be reconsidered, and determining what minor digressions, if any, would be tolerated. If regulation did have to be reconsidered, 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 taking enhanced side impact systems from first concept to on the road) needed to bring it in at a later time.

It is likely that measures such as those described for Options 2, 3 and 4, e.g. the voluntary code of practice produced by the FCAI in 2010, have already contributed to the current level of take-up of side impact protection technology. These could continue in one form or another regardless of the recommendations of this RIS.

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. Option 6a: regulation (broad scope) is therefore the recommended option. It represents an effective and robust option that would guarantee on-going provision of enhanced side impact protection measures in the new light vehicle fleet (both LPVs and LCVs) in Australia.

While LPVs make up a much larger segment of the market than LCVs, the LCV market is growing in Australia, with an increasing number being purchased as both work and family vehicles. It is therefore important that these vehicles meet the same minimum level of safety performance as LPVs, which further supports Option 6a as the recommended option over Option 6b (LPVs only).

6.5 Impacts

Business/consumers

The three options considered would have varying degrees of impact on consumers, business and the government. The costs to business would be passed on to the consumers, as the vehicle industry is driven by margins. The benefits would flow to the community (due to the existing negative externalities of road vehicle crashes) and those consumers or their families that are directly involved in crashes. Governments or private organisations would absorb much of the cost of the intervention (such as information programs, regulation etc.). Option 6 (a and b) 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 pole side impact, one regulation would be replacing a patchwork of different existing and future regulatory and non-regulatory tests around the world. This would give manufacturers a common performance measure to achieve and so would be expected to lead to a reduction in the overall burden.

Governments

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

6.6 Scope of the Preferred Option

As discussed in Section 3.2.6, UN R[135] on pole side impact performance, which is based on GTR 14, applies to vehicles of UN categories M1 (passenger cars) as well as N1 (goods vehicles up to 3.5 tonnes) not meeting the exemption criteria option provided for vans with high-forward seating positions in GTR 14. This translates to Australian categories of MA (passenger cars), MB (passenger vans), MC (four-wheel drives or Sports Utility Vehicles) and NA (light commercial vehicles). It is recommended that this similarly be adopted for the scope of a new ADR (Option 6a).

6.7 Timing of the Preferred Option

The indicative implementation timetable for consultative purposes is:

- for LPVs (MA, MB and MC category vehicles)—1 January 2017 for new models and 1 January 2019 for all models; and
- for LCVs (NA category vehicles)— 1 January 2018 for new models and 1 January 2020 for all models.

As noted earlier, the usual lead time for an ADR change that results in an increase in stringency is 18 months for new models and 24 months for all other models. The indicative implementation timetable would meet this typical lead time. It also allows for the implementation timing of the 01 series of amendments to UN R135. The extended lead time for LCVs allows for their longer design cycle compared with passenger cars.

The final timing would be determined following more detailed discussions with industry and others during the consultation period for this RIS.

7 CONSULTATION

7.1 General

Development of the ADRs 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. Under Part 2, section 8 of the MVSA the Minister may consult with state and territory agencies responsible for road safety, organisations and persons involved in the road vehicle industry and organisations representing road vehicle users before determining a design rule.

Depending on the nature of the proposed changes, consultation could involve the Technical Liaison Group (TLG), Strategic Vehicle Safety and Environment Group (SVSEG), 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 Federal Chamber of Automotive Industries and the Australian Trucking Association) and of representative organisations of consumers and road users (particularly through the Australian Automobile Association).
- 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).
- 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 9—Technical Liaison Group (TLG).

The proposal to mandate pole side impact occupant protection standards for new light vehicles has already been discussed at a number of SVSEG and TLG meetings. To date, no substantive issues have been raised and there has been broad support given by the majority of the members of the consultative groups. It is accepted that the majority of feedback may still be provided during the public comment period.

7.2 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 writing or otherwise 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 debate on any issues.

In line with the Australian Government Guide to Regulation (2014) it is intended that the proposal be circulated for six weeks public comment. A summary of public comment input and Departmental responses will be included in the final RIS that is used for decision making.

8 IMPLEMENTATION AND EVALUATION

New ADRs or amendments to the ADRs are determined by the Assistant Minister for Infrastructure and Regional Development under section 7 of the MVSA. At the time that the amendment is signed by the Minister, registered subscribers to the ADRs are e-mailed directly notifying them of the new ADR or the amendment to the ADR. Registered subscribers to the ADRs include but are not limited to various industry groups such as vehicle manufacturers, designers and test facilities, and vehicle user organisations.

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 ADR would be scheduled for a full review on an ongoing basis and in line with this practice.

9 CONCLUSION AND RECOMMENDED OPTION

Side impact crashes are one of the most significant causes of road crash trauma in Australia, accounting for just over 20 per cent of all road crash fatalities and around 10 per cent of serious injuries. These crashes represent a relatively high injury risk due to the proximity of the impact to the vehicle occupant. Pole side impacts can be especially dangerous. This is firstly due to the risk of direct head contact with the pole/tree, and secondly because of the significant occupant kinetic energy, which, unless absorbed by an advanced restraint system (e.g. a side airbag system) ends up being absorbed through compression of the thorax.

There have been significant efforts by manufacturers, consumer organisations and governments over a number of years to improve the protection of vehicle occupants in side impact crashes.

Australia has previously adopted Australian Design Rule (ADR) 72/00 – Dynamic Side Impact Occupant Protection as a national standard for new light vehicles, which is aligned with international standard United Nations (UN) Regulation No. 95. ADR 72/00 plays an important role in reducing the number of deaths and injuries caused by side impact crashes, particularly in regard to side impact crashes between two passenger vehicles. However, not all injuries (e.g. head injuries) occurring in the range of side impact crashes, including pole side impact crashes and crashes between vehicles of different types (e.g. large 4WDs and passenger cars) are fully addressed by the type of test used in this ADR. An oblique vehicle-to-pole side impact test would complement this test in addressing the overall side impact crash problem.

The Australian market has been responding to some extent with increased fitment of head curtain and thorax airbags (97 per cent fitment for new LPVs by 2016 and 97 per cent for new LCVs by 2025). However, side airbag systems are vehicle model specific and not all vehicles fitted with side airbags will meet the performance requirements of the GTR/UN regulation under business as usual. The introduction of a mandatory oblique pole side impact test would not only increase fitment rates, but would also demand greater improvements in existing side airbag systems – increasing the effectiveness of some systems by up to 30 per cent.

This Regulation Impact Statement (RIS) examined the case for Australian Government intervention to improve future light vehicle occupant protection in side impact crashes in Australia. It found that there are significant vehicle side impact occupant protection benefits obtainable through implementation of a mandatory standard, which would not otherwise be realised through either the business as usual approach or various other non-regulatory options, for example through a government fleet purchasing policy.

Benefit cost analysis found that there was a case for the provision of enhanced side impact occupant protection for light vehicles through government intervention in the form of an ADR based on the newly developed UN R[135/01].

Option 6a: regulation (broad scope) generated the highest net benefits ($556m) of the options examined as well as the highest number of lives saved (158) and severe and moderate traumatic brain injuries avoided (240), with a likely benefit-cost ratio of 4.7. The net benefits are large and the benefit-cost ratio is high because side impact crashes are one of the most significant causes of road crash trauma (including a type that is particularly costly to the community – traumatic brain injuries), and highly effective solutions are available at a very low average incremental cost per vehicle.

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 6a: regulation (broad scope) is the recommended option. Under this option, the fitment of enhanced side impact occupant protection measures would in effect be mandated for LPVs and LCVs as a result of the performance requirements of a new ADR. The recommended standard to be applied is UN R[135] incorporating the 01 series of amendments, the technical requirements of which are in accordance with the regulatory text of GTR 14.

The indicative implementation timetable for consultative purposes is:

- for LPVs (ADR category MA, MB and MC vehicles) — 1 January 2017 for new models and 1 January 2019 for all models; and
- for LCVs (ADR category NA vehicles) — 1 January 2018 for new models and 1 January 2020 for all models.

The Australian Government would absorb much of the cost of administering the ADR through the existing new vehicle certification system under the MVSA.

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 those consumers or their families that are directly involved in crashes. However, in this case offsets have been identified to reduce or eliminate this cost through other deregulation initiatives.

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APPENDIX 1—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.

PASSENGER VEHICLES (OTHER THAN OMNIBUSES)

PASSENGER CAR (MA)

A passenger vehicle, not being an off-road passenger vehicle or a forward-control passenger vehicle, having up to 9 seating positions, including that of the driver.

FORWARD-CONTROL PASSENGER VEHICLE (MB)

A passenger vehicle, not being an off-road passenger vehicle, having up to 9 seating positions, including that of the driver, and in which the centre of the steering wheel is in the forward quarter of the vehicle's *'Total Length'*.

OFF-ROAD PASSENGER VEHICLE (MC)

A passenger vehicle having up to 9 seating positions, including that of the driver and being designed with special features for off-road operation. A vehicle with special features for off-road operation is a vehicle that:
(a) Unless otherwise '*Approved*' has 4-wheel drive; and
(b) has at least 4 of the following 5 characteristics calculated when the vehicle is at its '*Unladen Mass*' on a level surface, with the front wheels parallel to the vehicle's longitudinal centreline, and the tyres inflated to the '*Manufacturer's*' recommended pressure:
(i) '*Approach Angle*' of not less than 28 degrees;
(ii) '*Breakover Angle*' of not less than 14 degrees;
(iii) '*Departure Angle*' of not less than 20 degrees;
(iv) '*Running Clearance*' of not less than 200 mm;
(v) '*Front Axle Clearance*', '*Rear Axle Clearance*' or '*Suspension Clearance*' of not less than 175 mm each.

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.

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

LIGHT GOODS VEHICLE (NA)

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

MEDIUM GOODS VEHICLE (NB)

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

Subcategories

Light Omnibus (MD)

Sub-category

MD1—up to 3.5 tonnes '*GVM*', up to 12 '*Seats*'
MD2—up to 3.5 tonnes '*GVM*', over 12 '*Seats*'
MD3—over 3.5 tonnes, up to 4.5 tonnes '*GVM*'
MD4—over 4.5 tonnes, up to 5 tonnes '*GVM*'
MD5—up to 2.7 tonnes '*GVM*'
MD6—over 2.7 tonnes '*GVM*'

Light Goods Vehicle (NA)

Sub-category

NA1—up to 2.7 tonnes '*GVM*'
NA2—over 2.7 tonnes '*GVM*'

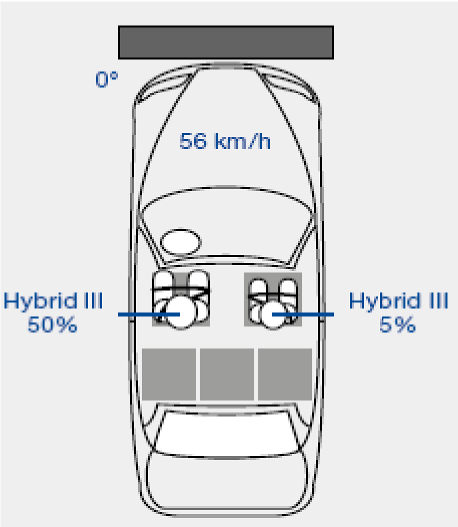
Medium Goods Vehicle (NB)

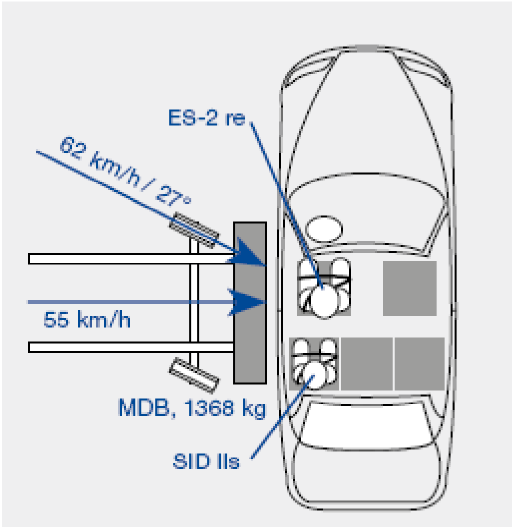
Sub-category
NB1 over 3.5 tonnes, up to 4.5 tonnes '*GVM*'
NB2 over 4.5 tonnes, up to 12 tonnes '*GVM*'

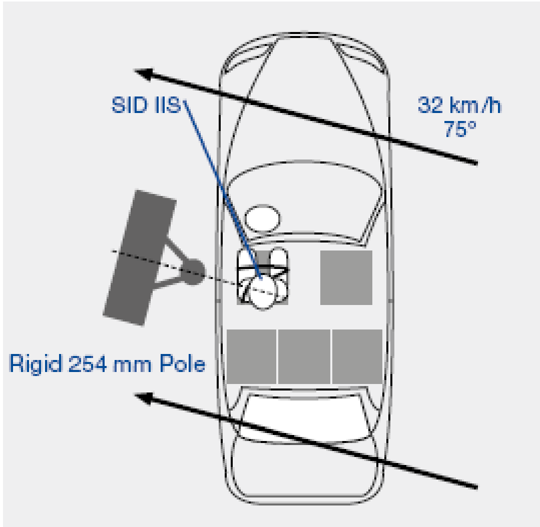
APPENDIX 2—NCAP TESTS COMPARED

2014 2015

US NCAP

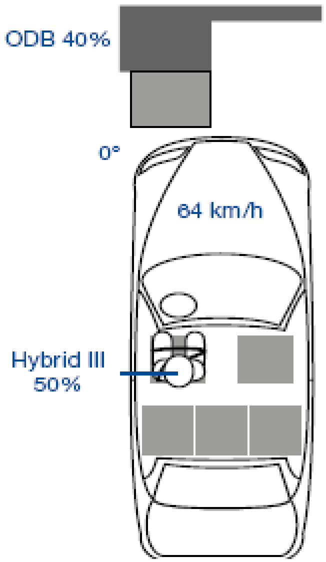


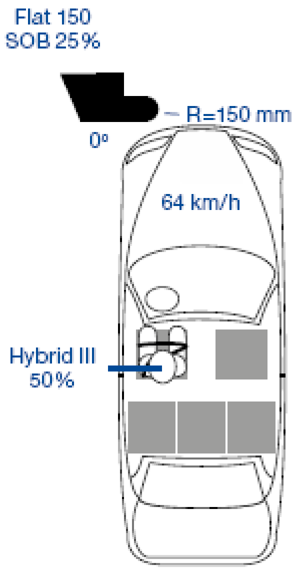


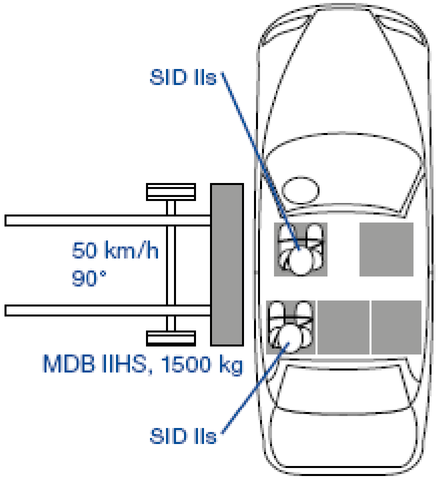


Rollover resistance tests:
SSF

IIHS



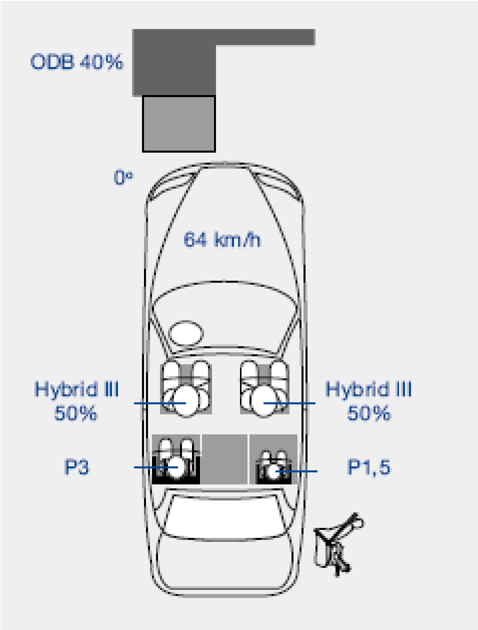




Rollover resistance tests:
Roof crush

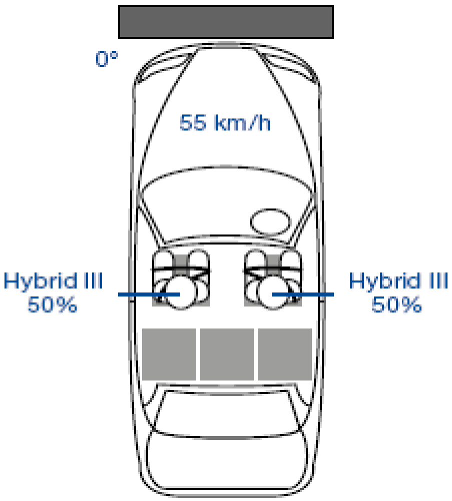
Whiplash mitigation tests:
Static, dynamic
(1 pulse)

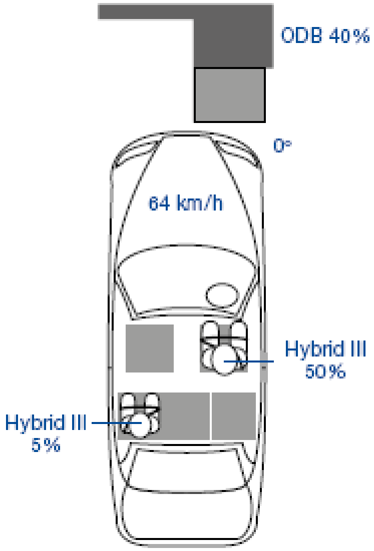
Latin NCAP

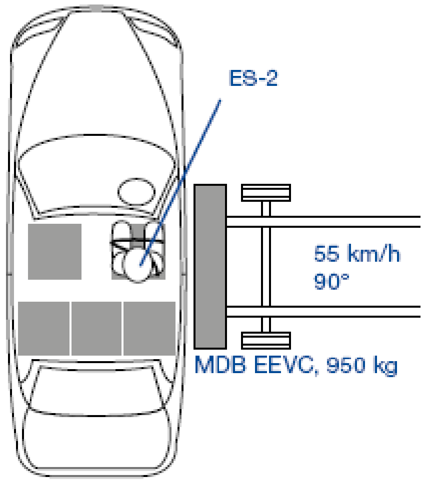


Child safety:
Frontal, CRS-based assessment, vehicle based assessment

JNCAP





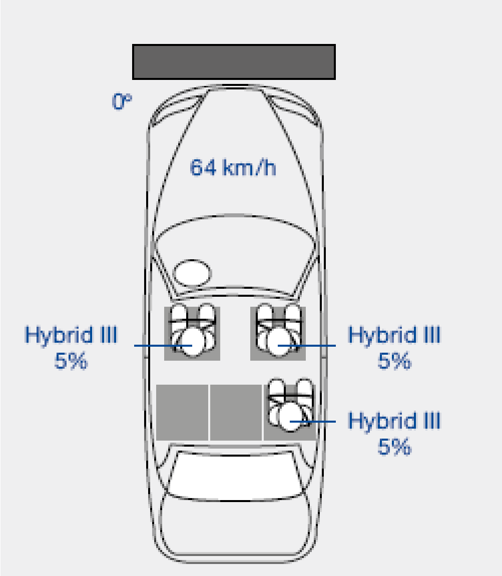


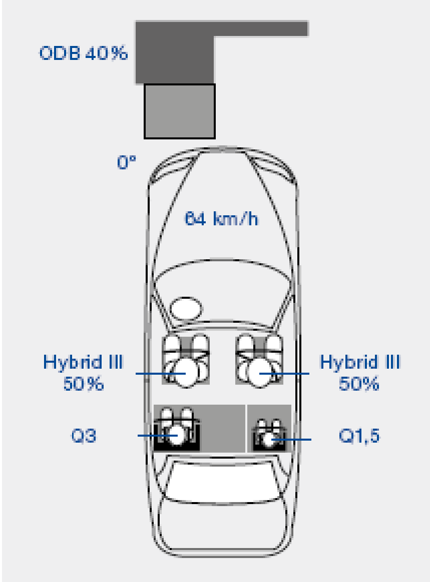
Pedestrian test:
Flex PLI, headforms

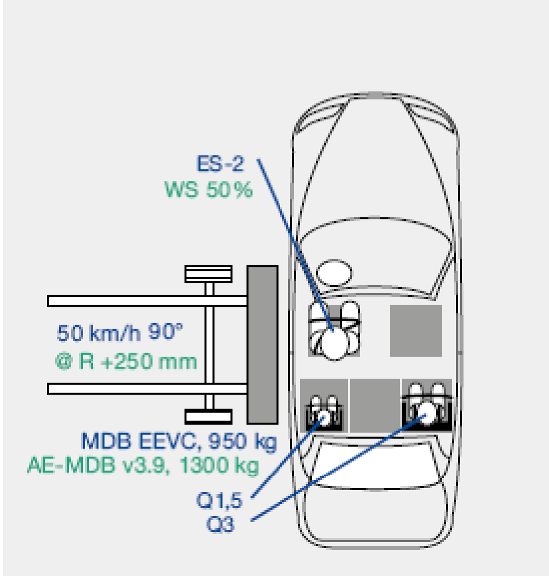
Whiplash mitigation tests:
Dynamic (1 pulse)

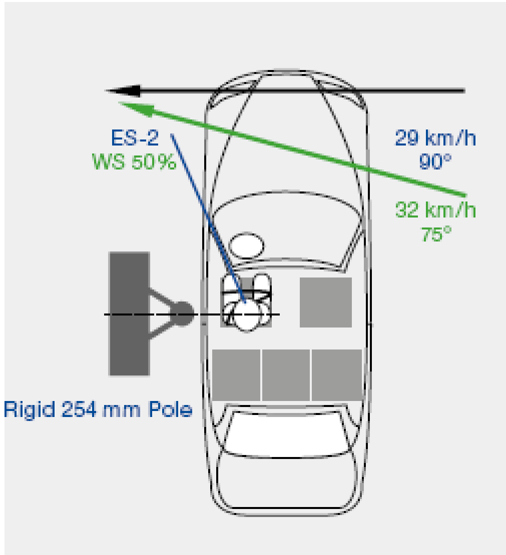
Others:
Brakes, usability rear belts, SBR

Euro NCAP









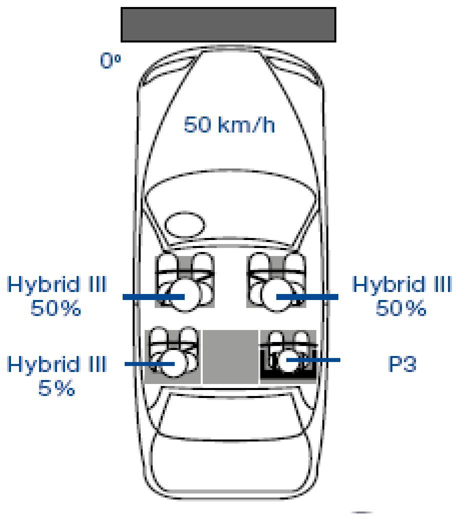
Pedestrian test:
EEVC legform, Flex PLI, upper legform, headforms

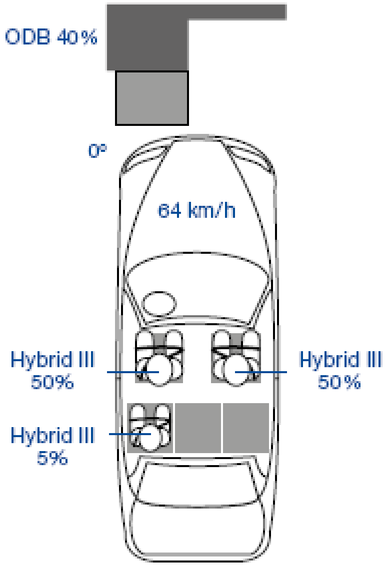
Child safety:
Frontal ODB, side MDB, CRS – installation, vehicle based assessment

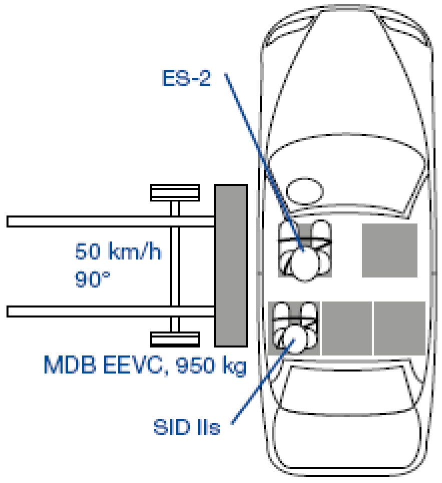
Whiplash mitigation tests:
Static front/rear, dynamic (3 pulses), AEB city

Assistance systems:
SBR, SAS, ESC…

C-NCAP





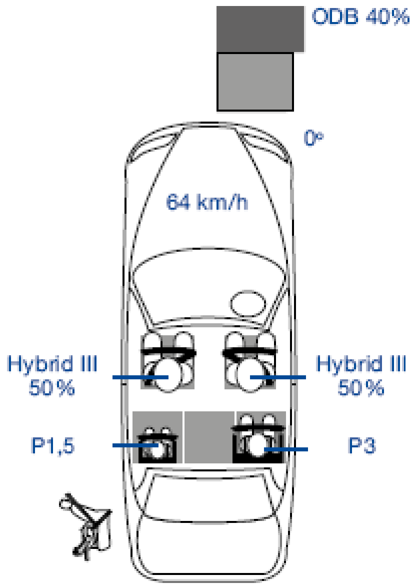


Rollover resistance tests:
Curtain airbag

Whiplash mitigation tests
Dynamic (1 pulse)

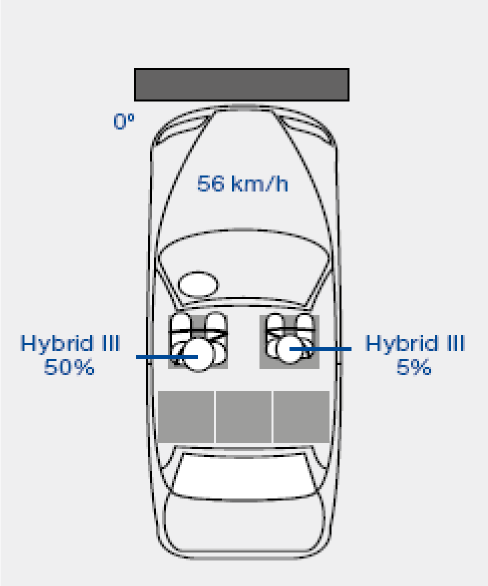
Others:
SBR, ESC

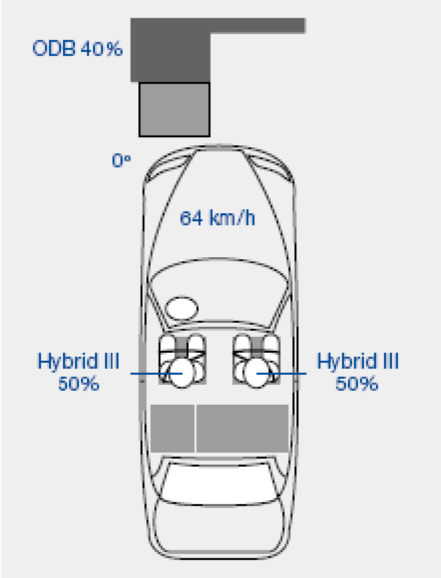
ASEAN NCAP

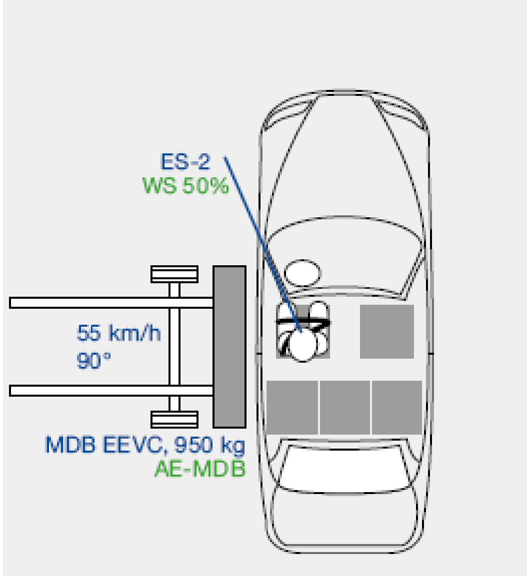


Child safety:
Frontal, CRS-based assessment, vehicle-based assessment

KNCAP





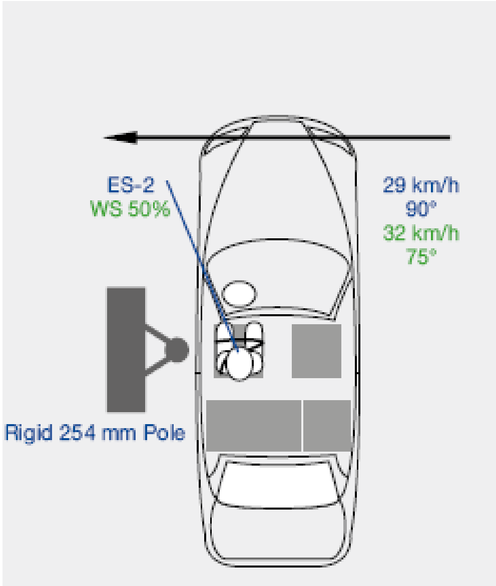


Rollover resistance tests:
SSF

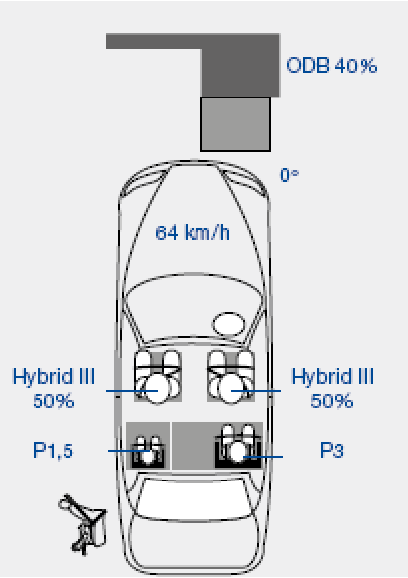
Pedestrian test:
EEVC legform, Flex PLI, upper legform, headforms

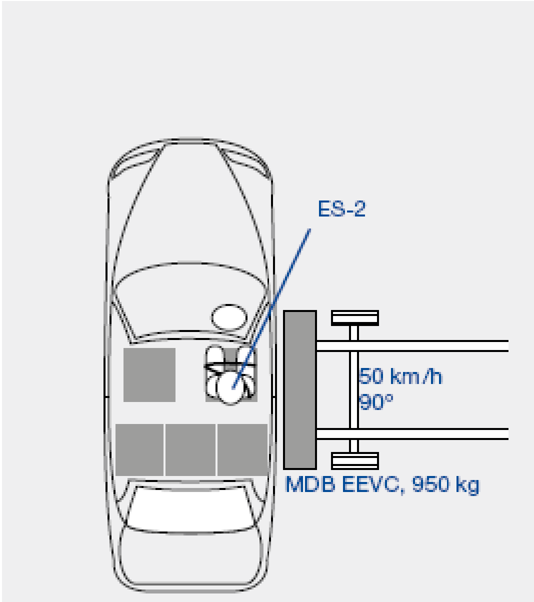
Whiplash mitigation tests:
Static, dynamic (1 pulse)

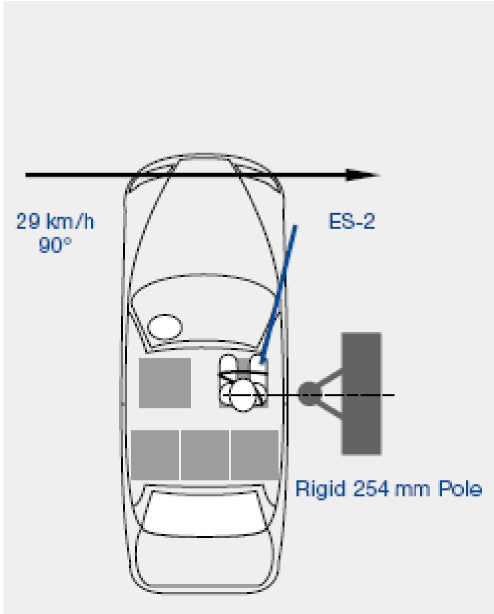
Others:
Brakes, FCWS, ACC, LDWS, SBR, eCall, SLD



ANCAP







Rollover resistance tests:
Roof crush

Pedestrian test
EEVC legform, upper legform, headforms

Child safety:
Frontal

Whiplash mitigation tests
Static, dynamic (1 pulse)

Others:
Assistance systems

Source: Global NCAP, 2014a

APPENDIX 3—WORLDSID

The World Side Impact Dummy (WorldSID) 50th percentile adult male (WorldSID 50th male) was developed by the International Organization for Standardization (ISO) WorldSID Task Group formed in 1997 and involving participants from vehicle manufacturers, national governments, test laboratories, dummy/instrumentation manufacturers and research organisations. The WorldSID 50th male is designed to represent a mid-sized adult male vehicle occupant (height: 175 cm) in an automotive seating posture and has a total assembled mass of 77 kg (ISO, 2013).

The WorldSID 50th male has been shown through separate evaluations by the ISO WorldSID Task Group and the United States National Highway Traffic Safety Administration (Rhule et al., 2009), to be significantly more biofidelic (human-like) than the ES-2 and ES-2re mid-sized adult male dummies used for current UN R95 and FMVSS 214 regulatory side impact tests, respectively. On the 10 point ISO TR9790 biofidelity rating scale, the ISO WorldSID Task Group found the WorldSID 50th male to have a superior overall rating of 8.0 (good), compared to both the ES-2 rating of 4.6 (fair), and the ES-2re rating of 4.2 (marginal). As part of this overall assessment, the WorldSID 50th male also achieved the highest (most biofidelic) single body region ratings of any side impact dummy for the head (10.0), shoulder (10.0), thorax (8.2) and abdomen (9.3) (ISO, 2013). The NHTSA BioRank evaluation by Rhule et al. (2009) showed the WorldSID 50th male more realistically replicates both human cadaver internal responses to side impact loadings as well as load transfer to the side impact environment/surrounds, than the ES-2re.

Figure 9 A WorldSID 50th percentile adult male positioned in a large passenger car

The WorldSID 50th male anthropometric characteristics also better match those of a mid-sized adult male than both the ES-2 and ES-2re. For example the ES-2/ES-2re have an disproportionately long torso, which means the thorax ribs of the dummy are located significantly higher than the majority of vehicle occupants in a crash. The WorldSID 50th male rib position is a much better representation of a mid-sized adult male. The ES-2/ES-2re half thorax width is also 30 mm less than the WorldSID 50th male. This means there is more space between the ES-2/ES-2re thorax and the side door for a seat mounted side airbag to deploy, than there is for the WorldSID 50th male or a typical vehicle occupant involved in a real-world side impact crash.

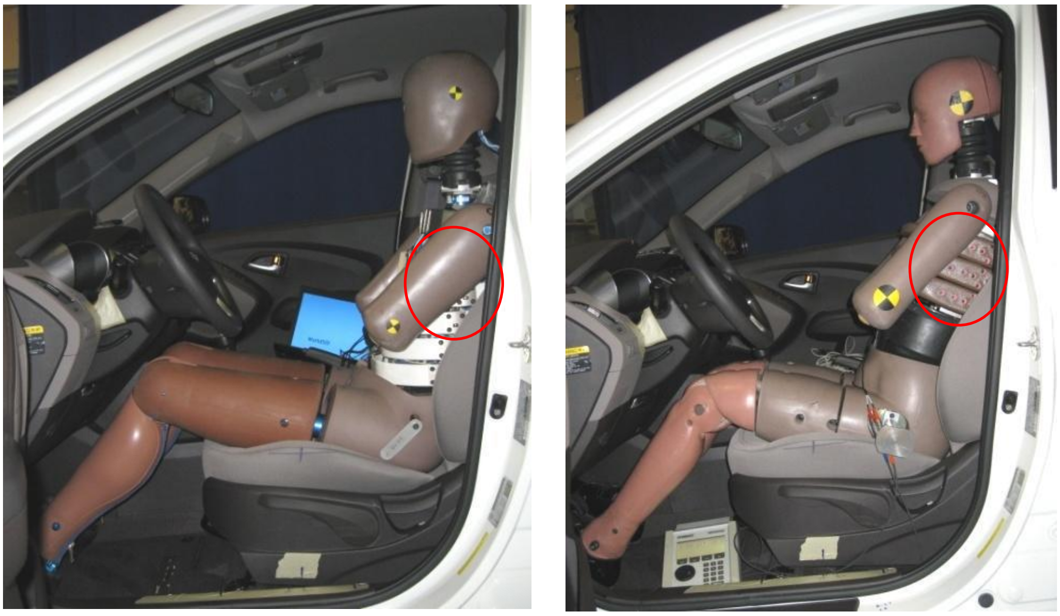


Figure 10 WorldSID 50th male (left) thorax rib location compared with ES-2re thorax rib location (source: NHTSA)

The development of more anthropomorphically correct and more biofidelic crash test dummies like the WorldSID 50th male provides an opportunity to improve the effectiveness of passive safety countermeasures in protecting human vehicle occupants involved in road crashes. This is because passive safety countermeasures (e.g. airbags) designed for optimal vehicle crash test performance will be more closely optimised for actual human vehicle occupants, when a dummy more closely replicating the anthropomorphic characteristics and biomechanical response of humans is used. Hence the use of the WorldSID 50th male, the most advanced and biofidelic side impact dummy available, in the global technical regulation on pole side impact, promotes development of better optimised passive safety countermeasures, including improved side airbag systems.

APPENDIX 4—EFFECTIVENESS OF ENHANCED SIDE IMPACT PROTECTION MEASURES

Available field crash studies into the effectiveness of side airbag systems provide the basis for assessing the likely incremental benefit associated with the implementation of GTR 14 and/or UN R[135/01].

A US National Highway Traffic Safety Administration (NHTSA) study by Kahane (2014) used US Fatality Analysis Reporting System (FARS) data for model year 1994 to 2011 passenger cars, light trucks and vans to estimate the effectiveness of various types of side airbag systems in reducing struck side occupant fatalities. Table 18 summarises the effectiveness estimates established by Kahane (2014).

Table 18 Estimated reduction struck-side occupant fatalities in side impact crashes

Side Airbag System Type	Point Estimate (per cent)	Confidence Interval (per cent)
Curtain + thorax	31.3	25.0 to 37.1
Combination	24.8	17.7 to 31.2
Curtain only	16.4	3.0 to 28.0
Thorax only	7.8	0.4 to 14.7

The above point estimates are likely to be representative of the effectiveness of side airbag systems in Australian market vehicles under business as usual, given all vehicles selected for the Kahane (2014) study were certified to comply with the FMVSS 214 mobile deformable barrier side impact requirements, but very few would have been required to be manufacturer self-certified to the FMVSS 214 oblique pole side impact requirements which are being phased in between 2010 and 2015.

Fitzharris and Stephan (2013) used effectiveness estimates of 32 per cent and 34 per cent respectively, for business as usual head curtain and thorax side airbag systems in reducing the number of occupants killed and seriously injured in side impact crashes. Their effectiveness estimate for reduction in fatalities was set towards the lower bound of a series of estimates established by McCartt and Kyrychenko (2007) from US FARS side impact crash data involving model year 1997 to 2004 passenger cars and SUVs. Their effectiveness estimate for reduction in the number of occupants seriously injured was obtained from a University of Alabama (UAB) Crash Injury Research Engineering Network (CIREN) study of head and thorax injury rates in side impact crashes involving model year 1998 and later vehicles.

However, to meet all performance requirements of the GTR/UN regulation, vehicle side airbag systems in many vehicle models will need to be enhanced to achieve greater vehicle-to-pole side impact performance than is otherwise likely to be provided under a continuation of the business as usual scenario. It is therefore expected that the effectiveness of side airbag systems in reducing vehicle occupant fatalities and injuries in side impact crashes would increase significantly, following implementation of a GTR 14 and UN R[135/01] aligned mandatory standard.

Compared to the perpendicular vehicle-to-pole side impact test procedure with an ES-2 dummy used in ANCAP tests of Australian market vehicles to date, the seating procedure used to position the WorldSID 50th male in the vehicle for the oblique vehicle-to-pole side impact test of the GTR, together with the more anthropometrically correct design of the WorldSID 50th male, provide a more representative positioning of the dummy head in relation to vehicle head protecting side airbags. A more representative test position of the dummy head in the vehicle can be expected to improve the real-world effectiveness of the head protecting side airbags.

Many thorax side airbags will need to be made larger, including by expanding the airbag coverage to other body regions such as the shoulder and pelvis and by extending the airbag more forward of the vehicle seat. It is anticipated that such airbags will be used to absorb more dummy kinetic energy (note the dummy has approximately 22 per cent more kinetic energy in the GTR 14 and UN R[135/01] test compared with the ANCAP test used to date) as well as distribute load more evenly, so as to avoid concentrated loading of the dummy thorax and excessive thorax rib deflection.

The oblique vehicle-to-pole side impact test in the GTR/UN regulation is also expected to encourage improved side impact detection systems to be developed and installed for many vehicles. Improved detection of side impact crashes leads to more reliable side airbag deployment and delivers benefits across a wider range of real-world crashes.

The WorldSID 50th male used in the GTR/UN regulation will more accurately predict occupant injury risk in side impact crashes due to its higher biofidelity and more accurate anthropometry compared to all other side impact crash test dummies used in regulatory and consumer evaluation tests to date. This more accurate prediction of real-world injury risk will also help to deliver an increase in the effectiveness of side airbag systems, as the systems with the most limited real-world effectiveness will be much less likely to be effective in keeping dummy injury criteria responses within required limits.

The informal working group that developed the GTR saw an example of likely side airbag system design changes when a North American market vehicle built in 2012 during the phase-in of the FMVSS 214 pole test requirements was compared with the same vehicle sold in the Australian market. Examples (i.e. supporting evidence) of the differences observed in the side airbag system design for the same vehicle make and model (Model A) in North America and Australia are shown in Figure 11 to Figure 14 below. The side airbags in the North American market vehicle were significantly larger and deployed earlier (see Figure 15) than the side airbags in the Australian market vehicle. The vehicles from each market were also fitted with different airbag control modules and the North American market vehicle was equipped with a door cavity pressure sensing system (for early detection of side impact crashes across a broad impact range) that the Australian market vehicle was not.

The North American model achieved superior overall vehicle crash test performance, most notably in regard to thorax protection. The peak thorax deflection results indicated the risk of a 45 year old male sustaining a serious (AIS 3+) thorax injury in the North American model would be around 5-10 per cent compared with around 40-50 per cent for the Australian model.

Figure 16 shows a second example of a North American market version of a particular vehicle make and model (Model B) fitted with a large pelvis-thorax side airbag compared with the Australian market version fitted with a smaller thorax side airbag.

Figure 11 North American market vehicle (left) and Australian market vehicle (right) head curtain and thorax side airbags, post deployment (Model A)

Figure 12 North American market vehicle (left) and Australian market vehicle (right) front-row door designs (note: pressure sensor (in red circle) fitted to the North American vehicle) (Model A)

Figure 13 North American market vehicle (left) and Australian market vehicle (right) airbag control modules (Model A)

Figure 14 North American market vehicle (bottom) and Australian market vehicle (top) thorax side airbags (Model A)

Figure 15 North American market vehicle (top row) and Australian market vehicle (bottom row) side airbag deployment, 15-25 milliseconds after first vehicle contact with the pole, during an oblique vehicle-to-pole side impact test (Model A)

Figure 16 North American market vehicle (left) and Australian market vehicle (right) thorax side airbags, post deployment (Model B)

Accordingly, Fitzharris and Stephan (2013) noted in their assessment of the benefits of the GTR that the oblique vehicle-to-pole side impact test would "require key changes to the design of current airbag and airbag sensor systems" and "would be expected to improve the effectiveness of side airbag systems by providing improved coverage for a broader range of occupants and would provide improved protection across a larger range of impact angles experienced in real-world crashes" (p. 125)

Considering all the likely design changes together, Fitzharris and Stephan (2013) established a 30 per cent increase in the effectiveness of side airbags in vehicles meeting the performance requirements of the GTR, relative to head curtain and thorax side airbag systems in vehicles under business as usual.

The Department in preparing this RIS has therefore assumed enhanced side airbag systems provided in vehicles to meet the performance requirements of the GTR/UN regulation will be 30 per cent more effective than the head curtain and thorax side airbag systems provided for vehicles not meeting all performance requirements of the GTR/UN regulation under business as usual. Table 19 details the calculation of incremental effectiveness values based on this 30 per cent increase in efficiency established by Fitzharris and Stephan (2013) and the airbag effectiveness point estimates (applicable to business as usual systems) established by Kahane (2014) and Fitzharris and Stephen (2013).

Table 19 Incremental effectiveness of enhanced side airbag system values (and calculation methods) used in this RIS

Side Airbag System Type under BAU	GTR 14/UN R[135/01] Compliant Fleet	
	Incremental Effectiveness Estimate (per cent)	Calculation of Incremental Effectiveness
Effectiveness Values Adopted for Reduction in Fatalities		
None	40.7	= (1.3 × 31.3) – 0.0
Combination or curtain only	20.1	= (1.3 × 31.3) - AVERAGE (24.8, 16.4)
Curtain + thorax	9.4	= (1.3 × 31.3) - 31.3
Effectiveness Values Adopted for Reduction in Number Occupants Injured (serious or minor)		
None	44.2	= (1.3 × 34.0) – 0.0
Combination or curtain only	23.6	= (1.3 × 34.0) - AVERAGE (24.8, 16.4)
Curtain + thorax	10.2	= (1.3 × 34.0) – 34.0

APPENDIX 5—OVERVIEW OF GTR 14 ON POLE SIDE IMPACT

The following is an overview of the requirements of Global Technical Regulation No. 14 on Pole Side Impact. For the full requirements refer to the UN website at www.unece.org/trans/main/welcwp29.htm.

Purpose

The purpose of Global Technical Regulation No. 14 (GTR 14) on Pole Side Impact is to reduce the risk of serious and fatal injury of vehicle occupants in side impact crashes by limiting the forces, accelerations and deflections measured by a WorldSID 50^{th} percentile adult male dummy (WorldSID 50^{th} male) in an oblique vehicle-to-pole side impact crash test and by other means (i.e. door and fuel system integrity requirements).

The GTR is intended to complement existing regulatory mobile deformable barrier side impact crash tests (for example in UN R94/ADR 72) which simulate a lateral (intersection type) impact by a passenger car.

Applicability and Scope

The GTR applies to all Category 1-1 vehicles, Category 1-2 vehicles with a GVM of up to 4,500 kg and Category 2 vehicles with a GVM of up to 4,500 kg.

In respect to scope, it is noted that Contracting Parties may restrict application of the requirements in their domestic legislation if they decide that such restriction is appropriate. A separate criterion is thus provided in the preamble of the GTR for Contracting Parties to use, if warranted by national safety need data, to exempt certain Category 1-2 and Category 2 vehicles from the requirements of the gtr at the time of implementation in domestic regulation. These vehicles are robustly characterized as Category 1-2 and Category 2 vehicles where the angle alpha (α), measured rearwards from the centre of the front axle to the R-point of the driver's seat is at least 22 degrees; and the ratio between the distance from the drivers' R-point to the centre of the rear axle (L101-L114) and the centre of the front axle and the drivers' R-point (L114) is greater than or equal to 1.3 (see Figure 17 below).

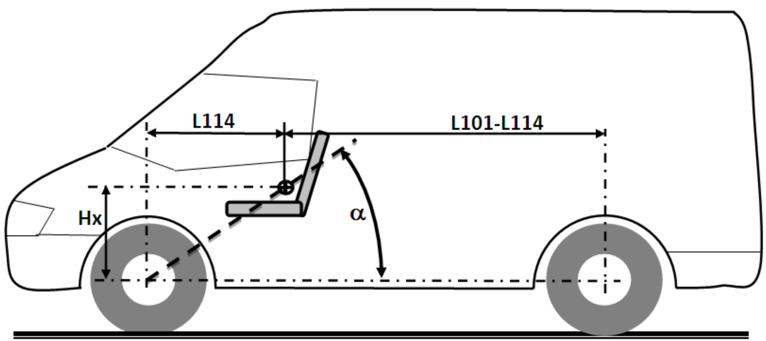


Figure 17 Category 1-2 & Category 2 vehicles exempt from requirements of GTR

<u>Performance Requirements</u>

The GTR is a purely performance based standard.

Dummy Performance Requirements

Risk of vehicle front-row outboard occupant injury due to rapid deceleration and impact related loading is limited by the following WorldSID 50th male performance criteria limits:

- The Head Injury Criteria (HIC 36) shall not exceed 1,000;
- Peak lateral shoulder force shall not exceed 3.0 kN;
- Maximum thorax rib deflection shall not exceed 55mm;
- Maximum abdominal rib deflection shall not exceed 65 mm;
- Resultant lower spine acceleration shall not exceed 75g, except for intervals whose cumulative duration is not more than 3ms; and
- Pubic symphysis (forward-mid pelvis) force shall not exceed 3.36 kN.

Compliance with each of these performance requirements is determined from data recorded by a WorldSID 50th male, seated in the front-row on the impact side of the vehicle, during an oblique vehicle-to-pole side impact test.

Door Latch and Hinge System Integrity Requirements

Door latch and hinge system integrity requirements are prescribed to minimise the risk of vehicle occupant ejection during a side impact.

- Any door which impacts the pole shall not separate totally from the vehicle.
- Any door (including a back door, but excluding a boot/trunk lid) that does not impact the pole shall meet the following requirements:
    - the door shall remain latched;
    - the latch must not separate from the striker;
    - hinge components must not separate from each other or the vehicle; and
    - neither the latch nor the hinge systems of the door shall pull out of their anchorages.

Fuel System Integrity Requirements

Post-crash fuel system leakage limits are prescribed to minimise the risk of fire related fatalities/serious injuries due to ignition of leaking fuel.

Dynamic Pole Side Impact Test Procedure

Vehicle Preparation

The test vehicle fuel tank is filled with fuel ballast (for example with water or Stoddard Solvent) equivalent to between 90% and 100% of the mass of fuel required to fill the useable capacity of the tank(s). Fuel ballast is also used to fill the entire fuel system from the fuel tank(s) through to the engine induction system. Other non-fuel liquids may be replaced and substituted with equivalent ballast masses.

The total vehicle test mass, including the WorldSID 50th male and any ballast mass (for example other test equipment and/or supplementary ballast mass), is adjusted within +/- 10kg of the unladen mass of the vehicle plus 136 kg or the rated cargo and luggage mass (whichever is less).

Seat Adjustments (for front-row outboard seat on impact side of vehicle)

Adjustable lumbar supports (if any) are adjusted to their lowest, retracted or most deflated position. All other adjustable seat supports (e.g. leg support systems) are adjusted to their rear most or most retracted positions.

Head restraints are adjusted to the manufacturer's nominal position for a 50th percentile adult male occupant or the uppermost position if no design position is nominated.

Any adjustable safety belt anchorages present at the dummy seating position shall be adjusted to the manufacturers nominal design position for a 50th percentile adult male occupant or the fully up position if no design position is available.

Seat Position (for front-row outboard seat on impact side of vehicle)

The GTR outlines a specific procedure for establishing the fore/aft location and pitch of the seat cushion and the seat back angle, prior to the installation of the WorldSID 50th male in the vehicle.

In summary, the test position of the seat cushion is characterised as follows:

- The fore/aft position of the seat cushion is set to 20 mm rear (or the first detent position at least 20 mm rear) of the mid-track position, after determining the full range of fore/aft adjustment.
- If the seat cushion has a pitch adjustment, it is set as close as practicable to the mid-pitch position.
- If the seat cushion has vertical (up/down) adjustment, it is set to the lowest position.

A 3 Dimensional H point machine (3-D H machine), is then used to measure the H point and torso (seat back) angle. The position of the seat back is adjusted so that the torso angle measured by the 3 D H machine is at the design angle ± 1o specified by the manufacturer. If no design angle is specified by the manufacturer, then the seat back is adjusted such that the torso angle is 23° ± 1° or if this is not possible, as close to 23° as possible.

The above adjustments are to be noted on the vehicles coordinate system such that when the anthropomorphic dummy is installed the adjustment position of the seat specified above can be duplicated.

Other Adjustments

Other pre-test adjustments made within the passenger compartment are as follows:

- Adjustable steering wheels are adjusted to the highest driving position, considering all telescopic and tilt adjustments positions available.
- Any adjustable pedals are placed in the full forward position (towards the front of the vehicle)
- The roof of convertible and open style vehicles, if any, is placed in the closed passenger compartment configuration.
- Doors including any back door (for example a hatch back or tailgate) are fully closed and latched, but not locked.
- The parking brake is engaged
- The vehicle master control switch (e.g. ignition) is set to the “on” position
- Movable vehicle windows and vents located on the impact side of the vehicle are placed in the fully closed position.
- Any sunroof(s) is placed in the fully closed position.

WorldSID 50th Male Installation in Vehicle

A WorldSID 50th male is positioned in the vehicle front-row seat on the impact side of the vehicle, such that:

- The mid-saggital plane of the dummy coincides with the vertical median plane of the seat;
- The H-point of the dummy is within ±5 mm of the point 20 mm forward of the H point determined using the 3-D H machine;
- The rib (thorax tilt sensor) angle of the dummy is within ±1° of the design rib angle specified by the manufacturer, or is -2º (±1°) if no design rib angle is specified and the torso angle determined using the the 3-D H machine is 23° ± 1°;
- The head (as adjusted at the neck bracket) is a close as possible to level; and
- The safety belt is fastened.

Vehicle to Pole Side Impact Test

The test vehicle prepared in accordance with above requirements is impacted into a stationary pole of 254 mm ± 6 mm diameter.

The GTR allows for a Contracting Party to require compliance at any test speed up to and including 32 km/h. There is provision for the maximum test speed to, at the option of Contracting Parties, be reduced to 26 km/h. A test speed of 32 km/h ± 1 km/h is recommended, for implementation in a UN Regulation and where implementing the GTR in a type approval based regulatory system.

The vehicle is propelled such that the direction of vehicle motion forms an angle of $75^{o} \pm 3^{o}$ with the vehicle longitudinal centre line and the impact reference line passes through the centre of gravity of the head of the WorldSID 50^{th} male (see Figure 18 below).

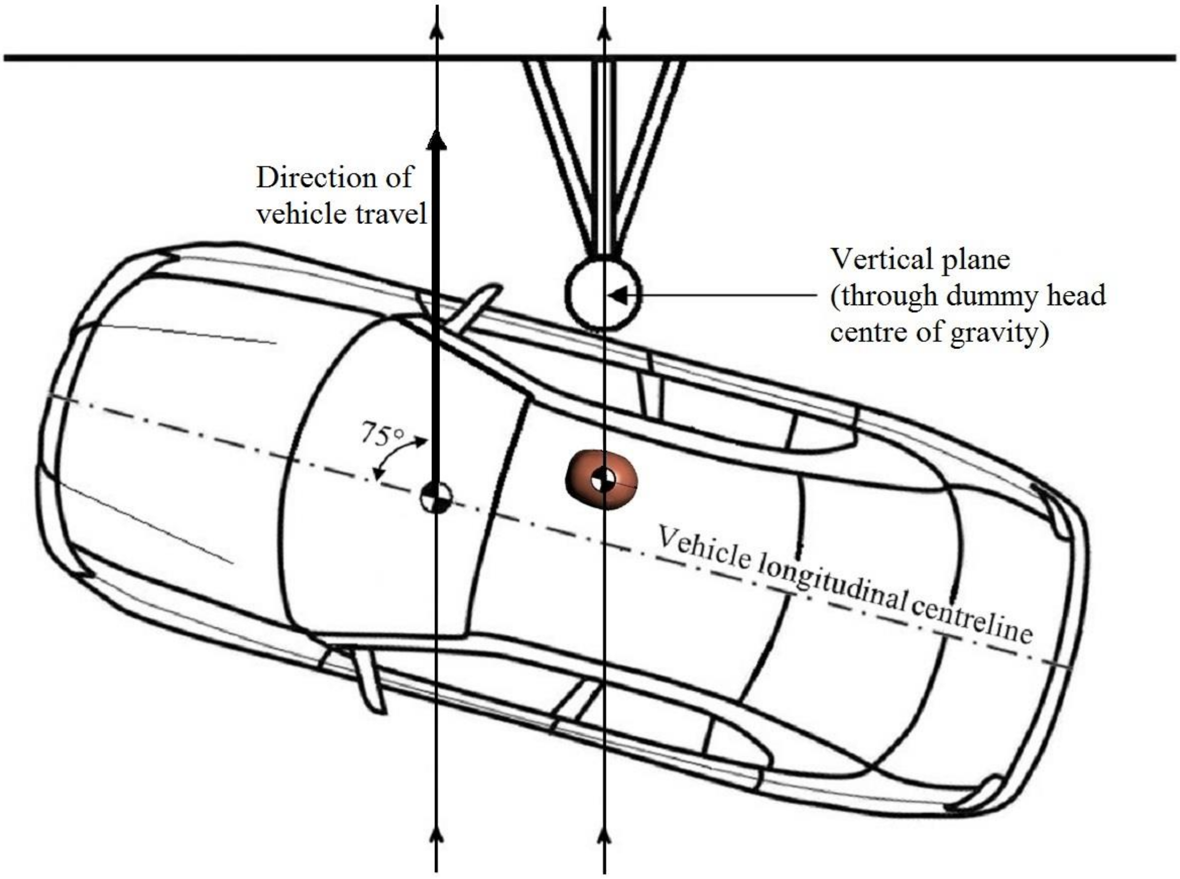


Figure 18 Overhead (plan view) schematic of an oblique vehicle-to-pole side impact

APPENDIX 6—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. National LPV and LCV sales were established using FCAI VFACTS data for each year between 2003 and 2013, inclusive. Average-per-annum increases in vehicle sales over this period (2.0 per cent for LPVs and 3.6 per cent for LCVs) were then used to estimate future LPV and LCV sales for each year of intervention.

2. The number of occupants killed and seriously injured in pole side impact and other side impact crashes in Australia were each estimated for the base analysis year (2007), by scaling corresponding five year central moving averages calculated from Victorian road crash data provided by VicRoads, according to the ratio of total vehicle occupant (driver and passenger) fatalities in Australia relative to Victoria.

3. Discrete probability mass functions were then established, using the above-mentioned base year estimates, together with crashed vehicle age data reported by Fitzharris and Stephan (2013), to predict the distribution of occupant fatalities and serious injuries in pole side impact and other side impact crashes, by vehicle age, for the registered LPV and LCV fleets.

4. The numbers of registered LPVs and LCVs (nationally) were established using ABS motor vehicle census data for each calendar year between 2003 and 2013, inclusive. Average per annum increases in the number of registered vehicles over this period (2.3 per cent for LPVs and 3.75 per cent for LCVs) were then used to estimate future numbers of registered LPVs and LCVs for the period 2017 to 2060.

5. Reductions in the number of occupants killed and injured in pole side impact crashes due to mandatory fitment of ESC to new LPVs and LCVs were then determined for each year from 2017 to 2060, using estimates of the effectiveness of ESC in combination with the discrete probability mass functions for pole side impact related casualties established for the base analysis year (see step 3 above) and the total LPV and LCV registrations projected for each year (see step 4 above).

6. Head curtain and thorax side airbag fitment rates and estimated rates of compliance (with the performance requirements of UN R[135/01]) were used to establish average incremental side impact restraint system effectiveness values (in reducing fatalities and injuries in side impacts) for vehicle sales affected by each intervention option.

7. For each option (3, 6a and 6b), reductions in the number of occupants killed and injured in pole side impact and other side impact crashes were determined for each year from 2017 to 2060, using the side impact restraint system effectiveness increases

established for implementation of each intervention option (see step 6 above), the discrete probability mass functions established for the base analysis year (see step 3 above) and the total LPV and LCV registrations projected for each year (see step 4 above). Casualty reduction estimates for pole side impact crashes were adjusted to account for expected future reductions in the number of pole side impact crashes (see step 5) due to mandatory fitment of ESC to new LPVs and LCVs entering the registered vehicle fleet.

8. Total annual costs associated with the implementation of each option (3, 6a and 6b) for business and government were determined using the system development costs (per vehicle model), fitment of system (per vehicle supplied), regulatory compliance costs (per vehicle model), and government implementation and regulation maintenance costs (per year of regulatory intervention) outlined in Section 4.

9. The total annual financial benefits associated with implementation of each option (3, 6a and 6b) were determined by multiplying lives saved and reductions in the number of injured vehicle occupants by the casualty costs outlined in Section 4.

10. For each option (3, 6a and 6b), all calculated annual benefit and cost values were discounted (back to 2014 — 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 seven per cent was assumed, this being in line with similar studies. However, real discount rates of 10 per cent as well as 3 per cent were used as part of a sensitivity check, for the recommended option 6a.

APPENDIX 7—BENEFIT-COST ANALYSIS—DETAILS OF RESULTS

1. Establish the trend in new LPV and LCV sales for the years 2003 to 2013. Extrapolate to 2035 by assuming ongoing (based on the 2003-2013 trend) 2.0 per cent and 3.6 per cent growth per annum in new LPV and LCV sales respectively.

Table 20 New vehicle sales 2003 to 2035 (source: FCAI, VFACTS)

	New Vehicle Sales	
Year	**Total LPVs**	**Total LCVs**
2003	739099	143285
2004	763072	161285
2005	789096	167174
2006	769241	162349
2007	835195	177057
2008	791225	185008
2009	728715	181058
2010	827407	179553
2011	803450	176940
2012	882680	197899
2013	899965	204566
2014	891428	199557
2015	909257	206742
2016	927442	214184
2017	945991	221895
2018	964910	229883
2019	984209	238159
2020	1003893	246733
2021	1023971	255615
2022	1044450	264817
2023	1065339	274351
2024	1086646	284227
2025	1108379	294459
2026	1130546	305060
2027	1153157	316042
2028	1176220	327420
2029	1199745	339207
2030	1223740	351418
2031	1248215	364069
2032	1273179	377176
2033	1298642	390754
2034	1324615	404821
2035	1351108	419395

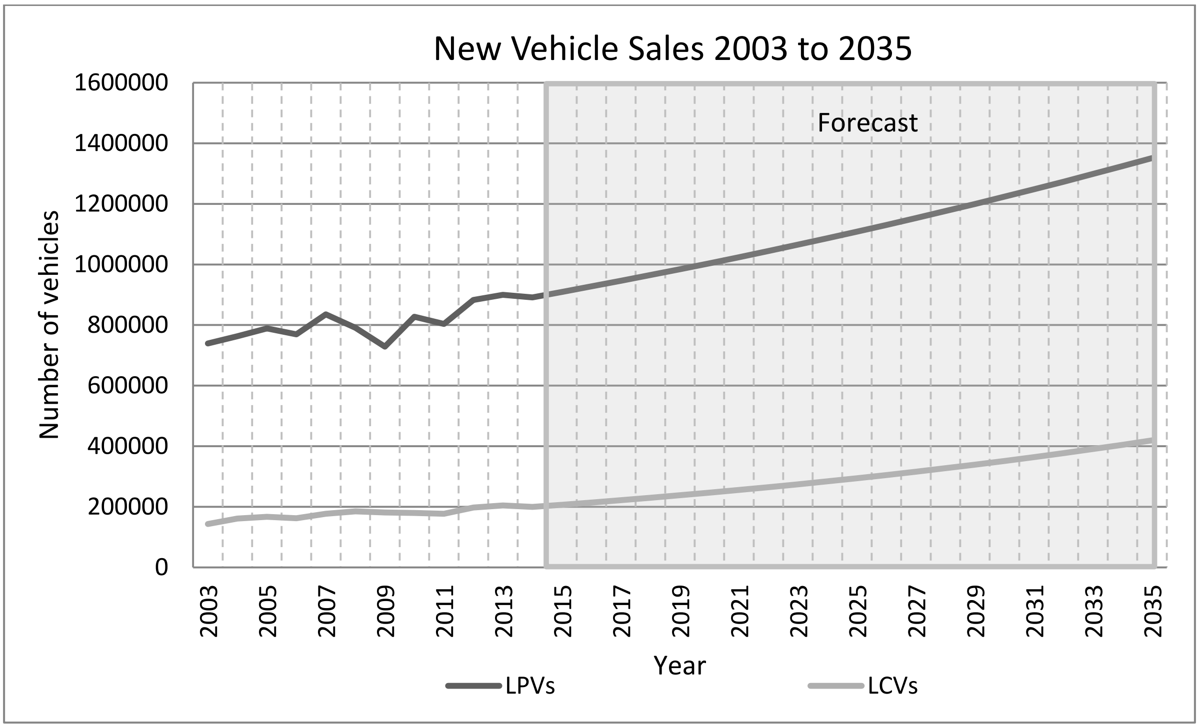


Figure 19 New vehicle sales from 2003 to 2035 (data from Table 20)

2. Establish the number of LPV and LCV occupants killed and seriously injured in pole side impact and other side impact crashes in Victoria between 2005 and 2009.

Table 21 LPV and LCV occupant fatalities in pole side impact and other side impact crashes, Victoria, 2005-2009 (data supplied by VicRoads)

Year	LPV occupant fatalities in pole side impact crashes	LCV occupant fatalities in pole side impact crashes			LPV occupant fatalities in other side impact crashes	LCV occupant fatalities in other side impact crashes		
		Utility	Panel Van	Light Truck		Utility	Panel Van	Light Truck
2005	35	6	0	0	35	4	0	0
2006	27	2	0	0	26	1	2	0
2007	39	1	0	0	26	1	0	0
2008	37	4	1	0	38	2	0	0
2009	25	4	0	0	17	2	0	0

Table 22 LPV and LCV occupants seriously injured in pole side impact and other side impact crashes, Victoria, 2005-2009 (data supplied by VicRoads)

Year	LPV occupants seriously injured in pole side impact crashes	LCV occupants seriously injured in pole side impact crashes			LPV occupants seriously injured in other side impact crashes	LCV occupants seriously injured in other side impact crashes		
		Utility	Panel Van	Light Truck		Utility	Panel Van	Light Truck
2005	170	12	0	0	401	24	13	1
2006	178	11	1	0	518	28	14	0
2007	190	16	0	0	618	20	7	1
2008	209	20	0	1	532	28	14	2
2009	176	16	0	1	398	23	8	2

3. Use the data established in step 2 to calculate Victorian five-year central moving averages for 2007. Estimate the corresponding Australian five-year central moving averages for 2007, using a scaling factor of 4.92 (note: determined as the number of driver and passenger fatalities for Australia between 2005 and 2009 (5349) divided by the number of driver and passenger fatalities for Victoria between 2005 and 2009 (1088)).

Table 23 LPV and LCV occupant fatalities in pole side impact and other side impact crashes (five year central moving averages), Victoria and Australia, 2007

	LPV occupant fatalities in pole side impact crashes	LCV occupant fatalities in pole side impact crashes			LPV occupant fatalities in other side impact crashes	LCV occupant fatalities in other side impact crashes		
		Utility	Panel Van	Light Truck		Utility	Panel Van	Light Truck
Victoria	32.6	3.4	0.2	0.0	28.4	2.0	0.4	0.0
Australia	160	17	1	0	140	10	2	0

Table 24 LPV and LCV occupants seriously injured in pole side impact and other side impact crashes (five year central moving averages), Victoria and Australia, 2007

	LPV occupants seriously injured in pole side impact crashes	LCV occupants seriously injured in pole side impact crashes			LPV occupants seriously injured in other side impact crashes	LCV occupants seriously injured in other side impact crashes		
		Utility	Panel Van	Light Truck		Utility	Panel Van	Light Truck
Victoria	184.6	15.0	0.2	0.4	493.4	24.6	11.2	1.2
Australia	908	74	1	2	2426	121	55	6

4. Establish crash frequency by age for LPVs and LCVs.

Table 25 Crash frequency by vehicle age (from Appendices 8a and 8c of Fitzharris and Stephan, 2013)

Crash Frequency by Vehicle Age						
	LPVs			LCVs		
Vehicle Age	**No.**	**% of Total**	**Cumulative %**	**No.**	**% of Total**	**Cumulative %**
0	3908	2.10%	2.10%	4,827	3.80%	3.80%
1	9153	4.93%	7.03%	12,860	10.12%	13.92%
2	9008	4.85%	11.89%	12,301	9.68%	23.60%
3	9078	4.89%	16.77%	11,375	8.95%	32.56%
4	9270	4.99%	21.77%	10,457	8.23%	40.79%
5	9482	5.11%	26.87%	9,159	7.21%	48.00%
6	9401	5.06%	31.94%	8,150	6.41%	54.41%
7	9335	5.03%	36.96%	7,523	5.92%	60.33%
8	9326	5.02%	41.99%	6,827	5.37%	65.70%
9	9279	5.00%	46.98%	6,054	4.76%	70.47%
10	9402	5.06%	52.05%	5,449	4.29%	74.76%
11	9410	5.07%	57.12%	4,954	3.90%	78.66%
12	9095	4.90%	62.01%	4,609	3.63%	82.29%
13	9209	4.96%	66.97%	4,063	3.20%	85.48%
14	8845	4.76%	71.74%	3,489	2.75%	88.23%
15	8596	4.63%	76.37%	3,001	2.36%	90.59%
16	7610	4.10%	80.47%	2,776	2.18%	92.78%
17	7043	3.79%	84.26%	2,489	1.96%	94.74%
18	6106	3.29%	87.55%	1,994	1.57%	96.30%
19	5173	2.79%	90.33%	1,496	1.18%	97.48%
20	4092	2.20%	92.54%	1,070	0.84%	98.32%
21	3261	1.76%	94.29%	755	0.59%	98.92%
22	2575	1.39%	95.68%	645	0.51%	99.43%
23	1957	1.05%	96.73%	381	0.30%	99.73%
24	1466	0.79%	97.52%	216	0.17%	99.90%
25	1106	0.60%	98.12%	90	0.07%	99.97%
26	792	0.43%	98.55%	42	0.03%	100.00%
27	600	0.32%	98.87%			
28	477	0.26%	99.13%			
29	409	0.22%	99.35%			
30	287	0.15%	99.50%			
31	237	0.13%	99.63%			
32	190	0.10%	99.73%			
33	154	0.08%	99.81%			
34	101	0.05%	99.87%			
35	73	0.04%	99.91%			
36	55	0.03%	99.94%			
37	37	0.02%	99.96%			
38	30	0.02%	99.97%			
39	20	0.01%	99.98%			
40	9	0.00%	99.99%			
41	11	0.01%	99.99%			
42	4	0.00%	100.00%			
Total	**185,672**	**100.0%**		**127,052**	**100.0%**	

5. Establish the percentages of occupants killed and seriously injured in side impact crashes in Victoria between 2000 and 2010 that were seated in the front row on the struck-side of the vehicle.

Table 26 Front-row struck-side impact fatalities/serious injuries as a percentage of all side impact fatalities/serious injuries, Victoria, 2000-2010 (data supplied by VicRoads)

All 4-Wheeled Vehicles	
Front-row struck-side impact fatalities as a proportion of all side impact fatalities (pole side impact crashes)	61.30%
Front-row struck-side impact fatalities as a proportion of all side impact fatalities (other side impact crashes)	60.10%
Front-row struck-side impact serious injuries as a proportion of all side impact serious injuries (pole side impact crashes)	53.50%
Front-row struck-side impact serious injuries as a proportion of all side impact serious injuries (other side impact crashes)	57.70%

6. Use the base year crash estimates (five year central moving averages for 2007) established for Australia in step 3, the crash frequency by vehicle age data established in step 4, the percentages established in step 5, and ABS motor vehicle census registration data for 2007, to determine discrete probability mass functions (of occupant fatalities and serious injuries in pole side impact and other side impact crashes) for the total registered LPV and LCV fleets.

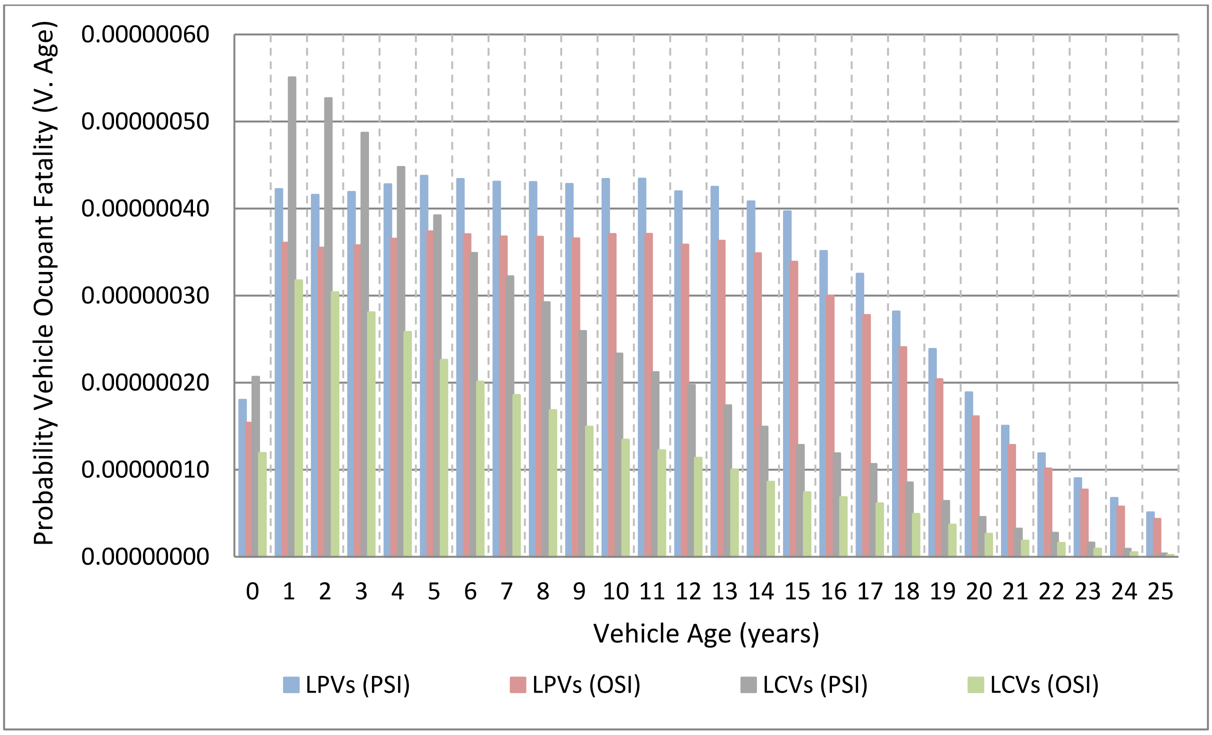


Figure 20 Probability mass distribution of occupant fatalities in described types of crashes for the registered LPV and LCV fleets

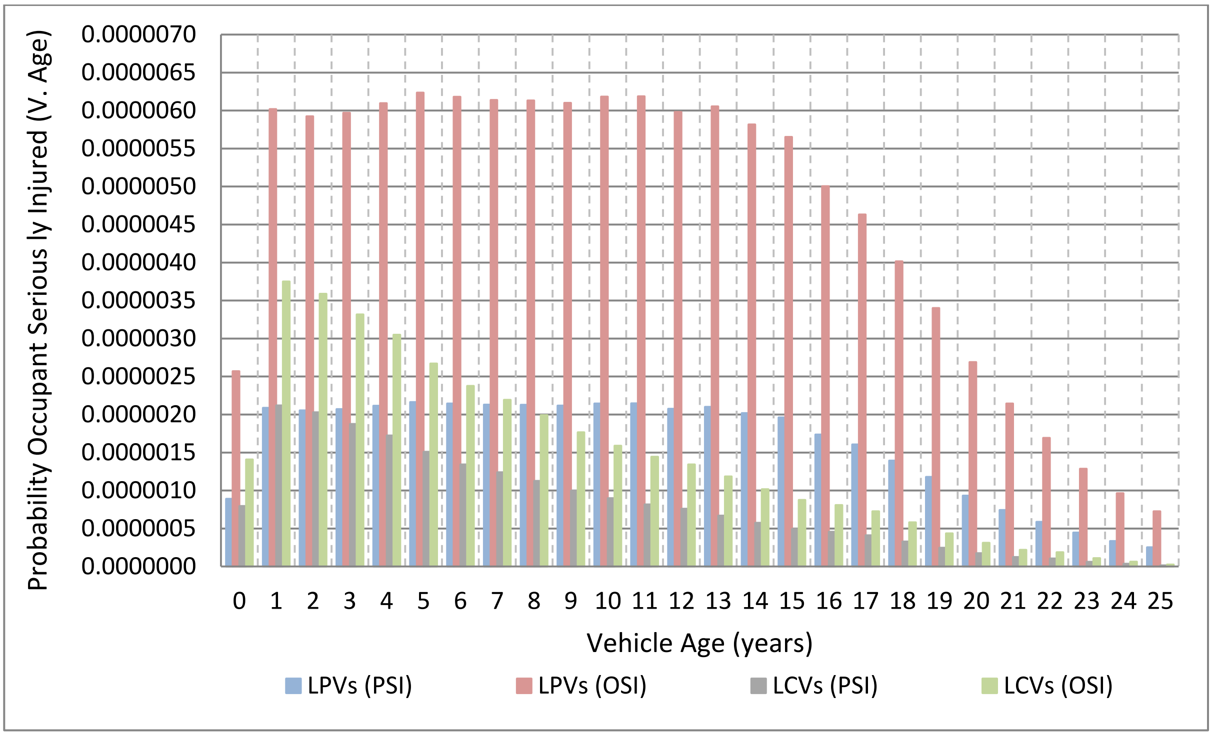


Figure 21 Probability mass distribution of occupants seriously injured in described types of crashes for the registered LPV and LCV fleets

7. Establish the trend in the total number of registered LPVs and LCVs for the years 2003 to 2013 (source: ABS). Extrapolate to 2060 by assuming (based on the 2003 to 2013 trend) 2.3 per cent growth in the total number of registered LPVs per annum and 3.75 per cent growth in the total number of registered LCVs per annum.

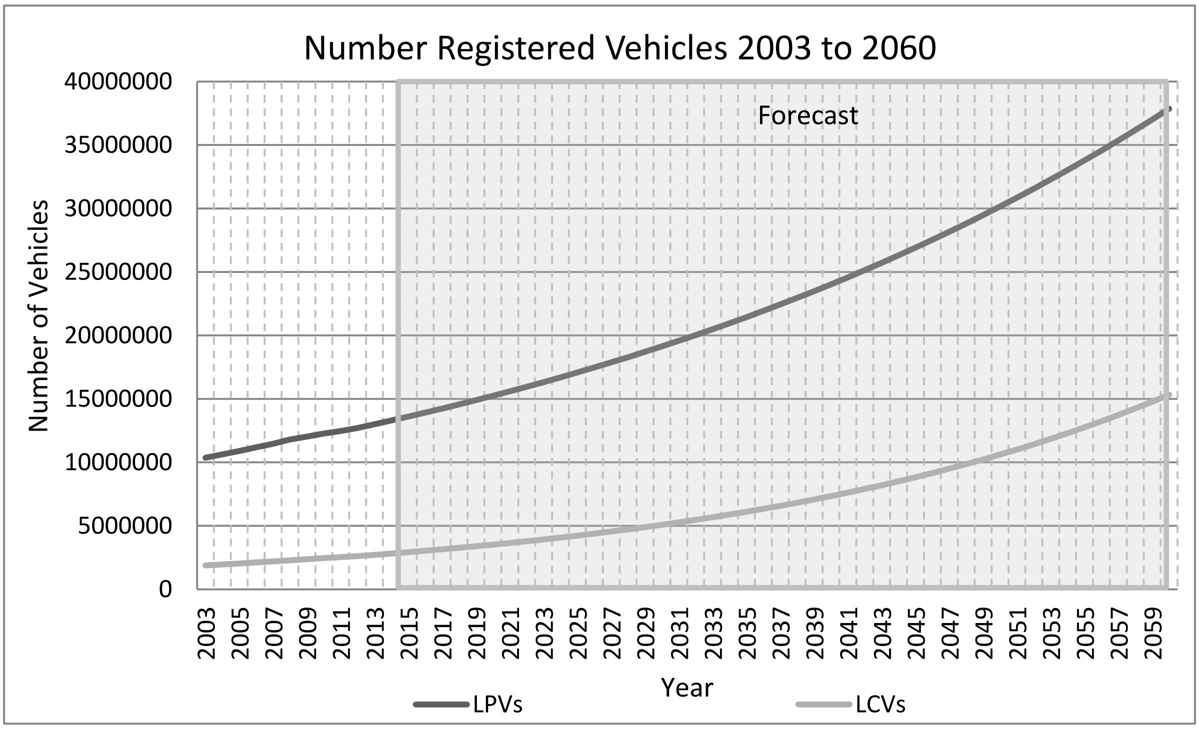


Figure 22 Total number of registered vehicles 2003 to 2060

8. Establish expected ESC fitment rates for new LPVs and new LCVs sold between 2006 and 2060.

Table 27 ESC Fitment Rates, LPVs and LCVs, 2006 to 2060

ESC Fitment Rate					
Year	**New LPVs**	**New LCVs**	**Year**	**New LPVs**	**New LCVs**
2006	0.222	0.019	2034	1.000	1.000
2007	0.366	0.017	2035	1.000	1.000
2008	0.478	0.015	2036	1.000	1.000
2009	0.633	0.167	2037	1.000	1.000
2010	0.713	0.213	2038	1.000	1.000
2011	0.809	0.268	2039	1.000	1.000
2012	0.868	0.561	2040	1.000	1.000
2013	0.927	0.631	2041	1.000	1.000
2014	1.000	0.706	2042	1.000	1.000
2015	1.000	0.780	2043	1.000	1.000
2016	1.000	0.850	2044	1.000	1.000
2017	1.000	0.920	2045	1.000	1.000
2018	1.000	1.000	2046	1.000	1.000
2019	1.000	1.000	2047	1.000	1.000
2020	1.000	1.000	2048	1.000	1.000
2021	1.000	1.000	2049	1.000	1.000
2022	1.000	1.000	2050	1.000	1.000
2023	1.000	1.000	2051	1.000	1.000
2024	1.000	1.000	2052	1.000	1.000
2025	1.000	1.000	2053	1.000	1.000
2026	1.000	1.000	2054	1.000	1.000
2027	1.000	1.000	2055	1.000	1.000
2028	1.000	1.000	2056	1.000	1.000
2029	1.000	1.000	2057	1.000	1.000
2030	1.000	1.000	2058	1.000	1.000
2031	1.000	1.000	2059	1.000	1.000
2032	1.000	1.000	2060	1.000	1.000
2033	1.000	1.000			

9. Estimate the number of pole side impact fatalities and serious injuries that will be prevented for each year between 2011 and 2060 due to new LPVs and LCVs entering the fleet with ESC, using the probability mass distributions established in step 6, the vehicle registration trends established in step 7, the ESC fitment rates established in step 8, and ESC effectiveness estimates of 20.7 per cent (source: Fitzharris and Stephan (2013)) and 32.0 per cent (source: Fitzharris, Scully, and Newstead (2010)) for LPVs and LCVs respectively (note: it is assumed ESC will have no effect on other side impacts as these are predominantly vehicle-to-vehicle intersection crashes, not single vehicle run-off road crashes for which ESC effectiveness values are established).

Table 28 Estimated pole side impact fatalities prevented due to fitment of ESC to LPVs (2011-2060)

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	
2011	0.4	0.8	0.7	0.5	0.4	0.3																									3.0
2012	0.4	0.9	0.8	0.7	0.5	0.4	0.3																								4.0
2013	0.5	1.0	0.9	0.8	0.7	0.6	0.4	0.3																							5.1
2014	0.5	1.1	1.0	0.9	0.8	0.8	0.6	0.4	0.3																						6.4
2015	0.5	1.2	1.1	1.0	1.0	0.9	0.8	0.6	0.4	0.3																					7.7
2016	0.5	1.2	1.2	1.1	1.1	1.0	0.9	0.8	0.6	0.5	0.3																				9.1
2017	0.5	1.2	1.2	1.2	1.2	1.1	1.0	0.9	0.8	0.6	0.5	0.3																			10.6
2018	0.5	1.3	1.3	1.3	1.3	1.2	1.1	1.1	0.9	0.8	0.6	0.5	0.3																		12.1
2019	0.6	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.1	0.9	0.8	0.6	0.5	0.3																	13.7
2020	0.6	1.3	1.3	1.3	1.4	1.4	1.4	1.3	1.2	1.1	1.0	0.9	0.6	0.5	0.3																15.4
2021	0.6	1.4	1.3	1.4	1.4	1.4	1.4	1.4	1.3	1.2	1.1	1.0	0.9	0.7	0.5	0.3															17.1
2022	0.6	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.3	1.2	1.2	1.0	0.9	0.6	0.5	0.3														18.8
2023	0.6	1.4	1.4	1.4	1.4	1.5	1.5	1.5	1.5	1.4	1.4	1.3	1.1	1.0	0.9	0.6	0.4	0.2													20.6
2024	0.6	1.5	1.4	1.4	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.4	1.3	1.2	1.0	0.9	0.6	0.4	0.2												22.3
2025	0.6	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.4	1.3	1.2	1.0	0.8	0.5	0.4	0.2											24.0
2026	0.7	1.5	1.5	1.5	1.5	1.6	1.6	1.6	1.6	1.5	1.6	1.6	1.5	1.4	1.3	1.2	0.9	0.7	0.5	0.3	0.2										25.7
2027	0.7	1.6	1.5	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.4	1.3	1.1	0.9	0.7	0.4	0.3	0.1									27.3
2028	0.7	1.6	1.6	1.6	1.6	1.7	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.5	1.4	1.2	1.0	0.8	0.6	0.3	0.2	0.1								28.8
2029	0.7	1.6	1.6	1.6	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.6	1.6	1.6	1.5	1.3	1.1	0.9	0.7	0.5	0.3	0.2	0.1							30.2
2030	0.7	1.7	1.6	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.6	1.6	1.4	1.2	1.0	0.8	0.5	0.4	0.2	0.1	0.1						31.6
2031	0.7	1.7	1.7	1.7	1.7	1.8	1.8	1.7	1.7	1.7	1.8	1.8	1.7	1.7	1.7	1.6	1.4	1.3	1.1	0.8	0.6	0.4	0.3	0.2	0.1	0.0					32.8
2032	0.7	1.8	1.7	1.7	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.7	1.8	1.7	1.6	1.5	1.3	1.2	0.9	0.7	0.5	0.4	0.2	0.1	0.1	0.0				34.0
2033	0.8	1.8	1.8	1.8	1.8	1.9	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.7	1.7	1.5	1.4	1.2	1.0	0.7	0.6	0.4	0.3	0.2	0.1	0.1	0.0			35.2
2034	0.8	1.8	1.8	1.8	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.8	1.8	1.8	1.7	1.5	1.4	1.2	1.0	0.8	0.6	0.4	0.3	0.2	0.1	0.1	0.0	0.0		36.3
2035	0.8	1.9	1.8	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.8	1.8	1.6	1.4	1.3	1.1	0.8	0.7	0.5	0.3	0.2	0.2	0.1	0.1	0.0	0.0	37.3
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
2059	1.4	3.2	3.2	3.2	3.3	3.4	3.3	3.3	3.3	3.3	3.3	3.3	3.2	3.3	3.1	3.0	2.7	2.5	2.2	1.8	1.4	1.2	0.9	0.7	0.5	0.4	0.3	0.2	0.2	0.1	65.2
2060	1.4	3.3	3.3	3.3	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.3	3.3	3.2	3.1	2.8	2.5	2.2	1.9	1.5	1.2	0.9	0.7	0.5	0.4	0.3	0.2	0.2	0.1	66.7

Table 29 Estimated reduction in number of occupants seriously injured in pole side impacts due to fitment of ESC to LPVs (2011-2060)

Year	Vehicle Age																														Reduction No. Occupants Seriously Injured
	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	
2011	1.9	3.8	3.4	2.6	2.0	1.2																									14.9
2012	2.0	4.4	3.9	3.5	2.7	2.1	1.3																								19.8
2013	2.2	4.9	4.5	4.0	3.6	2.8	2.1	1.3																							25.3
2014	2.4	5.3	4.9	4.6	4.2	3.8	2.8	2.1	1.3																						31.5
2015	2.5	5.8	5.4	5.1	4.8	4.3	3.8	2.9	2.2	1.3																					38.1
2016	2.6	6.0	5.8	5.5	5.3	5.0	4.4	3.9	2.9	2.2	1.4																				45.1
2017	2.6	6.2	6.1	6.0	5.8	5.5	5.1	4.5	4.0	3.0	2.3	1.4																			52.4
2018	2.7	6.3	6.2	6.2	6.3	6.0	5.6	5.2	4.6	4.0	3.1	2.4	1.4																		60.0
2019	2.7	6.4	6.3	6.4	6.5	6.6	6.1	5.7	5.3	4.7	4.2	3.2	2.3	1.4																	68.0
2020	2.8	6.6	6.5	6.5	6.7	6.8	6.7	6.2	5.8	5.4	4.8	4.3	3.1	2.4	1.4																76.1
2021	2.9	6.7	6.6	6.7	6.8	7.0	6.9	6.8	6.4	5.9	5.6	4.9	4.2	3.2	2.4	1.4															84.6
2022	2.9	6.9	6.8	6.8	7.0	7.1	7.1	7.0	6.9	6.5	6.1	5.7	4.9	4.4	3.2	2.4	1.3														93.1
2023	3.0	7.1	6.9	7.0	7.1	7.3	7.2	7.2	7.2	7.1	6.7	6.3	5.7	5.1	4.3	3.2	2.1	1.2													101.7
2024	3.1	7.2	7.1	7.2	7.3	7.5	7.4	7.4	7.4	7.3	7.3	6.9	6.2	5.9	5.0	4.3	2.9	2.0	1.1												110.3
2025	3.2	7.4	7.3	7.3	7.5	7.6	7.6	7.5	7.5	7.5	7.6	7.5	6.8	6.4	5.8	4.9	3.9	2.7	1.8	0.9											118.7
2026	3.2	7.6	7.4	7.5	7.6	7.8	7.8	7.7	7.7	7.7	7.8	7.8	7.4	7.0	6.3	5.7	4.5	3.7	2.4	1.6	0.7										126.9
2027	3.3	7.7	7.6	7.7	7.8	8.0	7.9	7.9	7.9	7.8	7.9	7.9	7.7	7.7	6.9	6.3	5.2	4.2	3.3	2.1	1.3	0.6									134.7
2028	3.4	7.9	7.8	7.8	8.0	8.2	8.1	8.1	8.1	8.0	8.1	8.1	7.9	8.0	7.5	6.9	5.7	4.9	3.8	2.8	1.7	1.0	0.5								142.2
2029	3.5	8.1	8.0	8.0	8.2	8.4	8.3	8.2	8.2	8.2	8.3	8.3	8.0	8.1	7.8	7.5	6.2	5.4	4.4	3.3	2.3	1.4	0.8	0.4							149.3
2030	3.5	8.3	8.1	8.2	8.4	8.6	8.5	8.4	8.4	8.4	8.5	8.5	8.2	8.3	8.0	7.8	6.8	5.9	4.8	3.8	2.6	1.9	1.1	0.6	0.3						155.9
2031	3.6	8.5	8.3	8.4	8.6	8.8	8.7	8.6	8.6	8.6	8.7	8.7	8.4	8.5	8.2	7.9	7.0	6.4	5.2	4.2	3.1	2.1	1.5	0.9	0.5	0.2					162.2
2032	3.7	8.7	8.5	8.6	8.8	9.0	8.9	8.8	8.8	8.8	8.9	8.9	8.6	8.7	8.4	8.1	7.2	6.7	5.7	4.5	3.4	2.5	1.7	1.2	0.7	0.4	0.2				168.2
2033	3.8	8.9	8.7	8.8	9.0	9.2	9.1	9.0	9.0	9.0	9.1	9.1	8.8	8.9	8.6	8.3	7.4	6.8	5.9	4.9	3.7	2.7	2.0	1.3	0.9	0.5	0.3	0.1			173.8
2034	3.9	9.1	8.9	9.0	9.2	9.4	9.3	9.2	9.2	9.2	9.3	9.3	9.0	9.1	8.8	8.5	7.5	7.0	6.0	5.1	4.0	3.0	2.2	1.6	1.0	0.7	0.4	0.2	0.1		179.2
2035	4.0	9.3	9.1	9.2	9.4	9.6	9.5	9.5	9.4	9.4	9.5	9.5	9.2	9.3	9.0	8.7	7.7	7.1	6.2	5.2	4.1	3.3	2.4	1.7	1.2	0.8	0.5	0.3	0.2	0.1	184.4
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
2059	6.8	16.0	15.7	15.9	16.2	16.6	16.4	16.3	16.3	16.2	16.4	16.4	15.9	16.1	15.5	15.0	13.3	12.3	10.7	9.0	7.2	5.7	4.5	3.4	2.6	1.9	1.4	1.0	0.8	0.7	322.3
2060	7.0	16.4	16.1	16.2	16.6	16.9	16.8	16.7	16.7	16.6	16.8	16.8	16.3	16.5	15.8	15.4	13.6	12.6	10.9	9.2	7.3	5.8	4.6	3.5	2.6	2.0	1.4	1.1	0.9	0.7	329.7

Table 30 Estimated pole side impact fatalities prevented due to fitment of ESC to LCVs (2011-2057)

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	
2011	0.2	0.3	0.3	0.0	0.0	0.0																					0.8
2012	0.3	0.4	0.3	0.2	0.0	0.0	0.0																				1.4
2013	0.4	0.9	0.4	0.3	0.2	0.0	0.0	0.0																			2.4
2014	0.5	1.1	0.9	0.4	0.3	0.2	0.0	0.0	0.0																		3.5
2015	0.5	1.3	1.1	0.9	0.4	0.3	0.2	0.0	0.0	0.0																	4.7
2016	0.7	1.5	1.3	1.0	0.9	0.4	0.3	0.2	0.0	0.0	0.0																6.2
2017	0.7	1.9	1.5	1.2	1.0	0.8	0.3	0.2	0.2	0.0	0.0	0.0															7.9
2018	0.8	2.0	1.9	1.4	1.2	0.9	0.7	0.3	0.2	0.2	0.0	0.0	0.0														9.6
2019	0.8	2.1	2.0	1.8	1.4	1.0	0.8	0.7	0.3	0.2	0.1	0.0	0.0	0.0													11.3
2020	0.8	2.2	2.1	1.9	1.8	1.2	1.0	0.8	0.6	0.3	0.2	0.1	0.0	0.0	0.0												12.9
2021	0.8	2.2	2.1	2.0	1.8	1.6	1.1	0.9	0.7	0.6	0.3	0.2	0.1	0.0	0.0	0.0											14.6
2022	0.9	2.3	2.2	2.0	1.9	1.6	1.5	1.1	0.9	0.7	0.5	0.2	0.2	0.1	0.0	0.0	0.0										16.2
2023	0.9	2.4	2.3	2.1	1.9	1.7	1.5	1.4	1.0	0.8	0.6	0.5	0.2	0.2	0.1	0.0	0.0	0.0									17.8
2024	0.9	2.5	2.4	2.2	2.0	1.8	1.6	1.5	1.3	0.9	0.7	0.6	0.5	0.2	0.1	0.1	0.0	0.0	0.0								19.4
2025	1.0	2.6	2.5	2.3	2.1	1.8	1.6	1.5	1.4	1.2	0.9	0.7	0.6	0.5	0.2	0.1	0.1	0.0	0.0	0.0							20.9
2026	1.0	2.7	2.5	2.4	2.2	1.9	1.7	1.6	1.4	1.3	1.1	0.8	0.7	0.5	0.4	0.2	0.1	0.1	0.0	0.0	0.0						22.5
2027	1.0	2.8	2.6	2.4	2.2	2.0	1.7	1.6	1.5	1.3	1.2	1.1	0.8	0.6	0.5	0.4	0.2	0.1	0.1	0.0	0.0	0.0					24.0
2028	1.1	2.9	2.7	2.5	2.3	2.0	1.8	1.7	1.5	1.3	1.2	1.1	1.0	0.7	0.5	0.4	0.3	0.1	0.1	0.1	0.0	0.0	0.0				25.6
2029	1.1	3.0	2.8	2.6	2.4	2.1	1.9	1.7	1.6	1.4	1.3	1.1	1.1	0.9	0.6	0.5	0.4	0.3	0.1	0.1	0.0	0.0	0.0	0.0			27.1
2030	1.2	3.1	2.9	2.7	2.5	2.2	1.9	1.8	1.6	1.4	1.3	1.2	1.1	1.0	0.8	0.6	0.5	0.4	0.3	0.1	0.1	0.0	0.0	0.0	0.0		28.6
2031	1.2	3.2	3.0	2.8	2.6	2.3	2.0	1.9	1.7	1.5	1.3	1.2	1.1	1.0	0.9	0.7	0.5	0.4	0.3	0.2	0.1	0.0	0.0	0.0	0.0	0.0	30.1
2032	1.2	3.3	3.1	2.9	2.7	2.3	2.1	1.9	1.7	1.5	1.4	1.3	1.2	1.0	0.9	0.8	0.7	0.5	0.4	0.2	0.2	0.1	0.0	0.0	0.0	0.0	31.5
2033	1.3	3.4	3.3	3.0	2.8	2.4	2.2	2.0	1.8	1.6	1.4	1.3	1.2	1.1	0.9	0.8	0.7	0.7	0.4	0.3	0.2	0.1	0.0	0.0	0.0	0.0	33.0
2034	1.3	3.5	3.4	3.1	2.9	2.5	2.2	2.1	1.9	1.7	1.5	1.4	1.3	1.1	1.0	0.8	0.8	0.7	0.5	0.3	0.2	0.1	0.1	0.0	0.0	0.0	34.4
2035	1.4	3.7	3.5	3.2	3.0	2.6	2.3	2.1	1.9	1.7	1.6	1.4	1.3	1.2	1.0	0.9	0.8	0.7	0.6	0.4	0.2	0.2	0.1	0.1	0.0	0.0	35.8
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
2056	0.8	2.0	1.9	1.8	1.6	1.4	1.3	1.2	1.1	0.9	0.8	0.8	0.7	0.6	0.5	0.5	0.4	0.4	0.3	0.2	0.2	0.1	0.1	0.1	0.0	0.0	19.8
2057	0.8	2.1	2.0	1.8	1.7	1.5	1.3	1.2	1.1	1.0	0.9	0.8	0.7	0.7	0.6	0.5	0.4	0.4	0.3	0.2	0.2	0.1	0.1	0.1	0.0	0.0	20.6

Table 31 Estimated reduction in number of occupants seriously injured in pole side impacts due to fitment of ESC to LCVs (2011-2057)

Year	Vehicle Age																										Reduction No. Occupants Seriously Injured
	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	
2011	0.1	0.3	0.2	0.0	0.0	0.0																					0.8
2012	0.3	0.4	0.3	0.2	0.0	0.0	0.0																				1.3
2013	0.4	0.9	0.4	0.3	0.2	0.0	0.0	0.0																			2.2
2014	0.4	1.0	0.9	0.4	0.3	0.2	0.0	0.0	0.0																		3.3
2015	0.5	1.2	1.0	0.8	0.4	0.3	0.2	0.0	0.0	0.0																	4.5
2016	0.7	1.4	1.2	1.0	0.8	0.3	0.2	0.2	0.0	0.0	0.0																5.9
2017	0.7	1.8	1.4	1.1	0.9	0.7	0.3	0.2	0.2	0.0	0.0	0.0															7.5
2018	0.7	1.9	1.8	1.3	1.1	0.9	0.7	0.3	0.2	0.1	0.0	0.0	0.0														9.1
2019	0.7	2.0	1.9	1.7	1.3	1.0	0.8	0.6	0.3	0.2	0.1	0.0	0.0	0.0													10.7
2020	0.8	2.1	2.0	1.8	1.7	1.2	0.9	0.8	0.6	0.3	0.2	0.1	0.0	0.0	0.0												12.3
2021	0.8	2.1	2.0	1.9	1.7	1.5	1.1	0.9	0.7	0.6	0.2	0.2	0.1	0.0	0.0	0.0											13.9
2022	0.8	2.2	2.1	2.0	1.8	1.6	1.4	1.0	0.8	0.7	0.5	0.2	0.2	0.1	0.0	0.0	0.0										15.5
2023	0.9	2.3	2.2	2.0	1.9	1.6	1.5	1.3	1.0	0.8	0.6	0.5	0.2	0.2	0.1	0.0	0.0	0.0									17.0
2024	0.9	2.4	2.3	2.1	1.9	1.7	1.5	1.4	1.3	0.9	0.7	0.6	0.5	0.2	0.1	0.1	0.0	0.0	0.0								18.6
2025	0.9	2.5	2.4	2.2	2.0	1.8	1.6	1.4	1.3	1.2	0.8	0.7	0.6	0.4	0.2	0.1	0.1	0.0	0.0	0.0							20.1
2026	1.0	2.6	2.4	2.3	2.1	1.8	1.6	1.5	1.4	1.2	1.1	0.8	0.6	0.5	0.4	0.2	0.1	0.1	0.0	0.0	0.0						21.6
2027	1.0	2.7	2.5	2.3	2.2	1.9	1.7	1.6	1.4	1.3	1.1	1.0	0.8	0.6	0.5	0.3	0.2	0.1	0.1	0.0	0.0	0.0					23.1
2028	1.0	2.8	2.6	2.4	2.2	2.0	1.7	1.6	1.5	1.3	1.2	1.1	1.0	0.7	0.5	0.4	0.3	0.1	0.1	0.1	0.0	0.0	0.0				24.7
2029	1.1	2.9	2.7	2.5	2.3	2.0	1.8	1.7	1.5	1.3	1.2	1.1	1.0	0.9	0.6	0.5	0.4	0.3	0.1	0.1	0.0	0.0	0.0	0.0			26.2
2030	1.1	3.0	2.8	2.6	2.4	2.1	1.9	1.7	1.6	1.4	1.3	1.1	1.1	0.9	0.8	0.6	0.5	0.4	0.3	0.1	0.1	0.0	0.0	0.0	0.0		27.7
2031	1.2	3.1	2.9	2.7	2.5	2.2	2.0	1.8	1.6	1.4	1.3	1.2	1.1	1.0	0.8	0.7	0.5	0.4	0.3	0.2	0.1	0.0	0.0	0.0	0.0	0.0	29.1
2032	1.2	3.2	3.1	2.8	2.6	2.3	2.0	1.9	1.7	1.5	1.4	1.2	1.1	1.0	0.9	0.7	0.7	0.5	0.3	0.2	0.1	0.1	0.0	0.0	0.0	0.0	30.6
2033	1.2	3.3	3.2	2.9	2.7	2.4	2.1	1.9	1.8	1.6	1.4	1.3	1.2	1.0	0.9	0.8	0.7	0.6	0.4	0.3	0.2	0.1	0.0	0.0	0.0	0.0	32.0
2034	1.3	3.4	3.3	3.0	2.8	2.4	2.2	2.0	1.8	1.6	1.5	1.3	1.2	1.1	0.9	0.8	0.7	0.7	0.5	0.3	0.2	0.1	0.1	0.0	0.0	0.0	33.5
2035	1.3	3.6	3.4	3.2	2.9	2.5	2.3	2.1	1.9	1.7	1.5	1.4	1.3	1.1	1.0	0.8	0.8	0.7	0.6	0.4	0.2	0.1	0.1	0.1	0.0	0.0	34.9
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
2056	2.9	7.7	7.4	6.8	6.3	5.5	4.9	4.5	4.1	3.6	3.3	3.0	2.8	2.4	2.1	1.8	1.7	1.5	1.2	0.9	0.6	0.5	0.4	0.2	0.1	0.1	76.3
2057	3.0	8.0	7.7	7.1	6.5	5.7	5.1	4.7	4.3	3.8	3.4	3.1	2.9	2.5	2.2	1.9	1.7	1.6	1.2	0.9	0.7	0.5	0.4	0.2	0.1	0.1	79.1

10. Establish fitment rates of head curtain and thorax side airbags under business as usual and Options 3, 6a and 6b for new LPVs and LCVs.

Table 32 Head curtain and thorax side airbag fitment rates under BAU and Options 3, 6a and 6b

Head Curtain and Thorax Side Airbag Fitment Rates						
	New LPVs			New LCVs		
Year	**BAU**	**Option 3**	**Option 6a/b**	**BAU**	**Option 3**	**Option 6a**
2016	0.970	0.970	0.970	0.612	0.612	0.612
2017	0.980	0.980	0.980	0.648	0.648	0.648
2018	0.990	0.990	0.990	0.687	0.687	0.766
2019	0.990	0.990	1.000	0.727	0.727	0.883
2020	0.990	0.990	1.000	0.770	0.770	1.000
2021	0.990	0.990	1.000	0.816	0.816	1.000
2022	0.990	0.990	1.000	0.864	0.864	1.000
2023	0.990	0.990	1.000	0.915	0.915	1.000
2024	0.990	0.990	1.000	0.969	0.969	1.000
2025	0.990	0.990	1.000	0.970	0.970	1.000
2026	0.990	0.990	1.000	0.970	0.970	1.000
2027	0.990	0.990	1.000	0.970	0.970	1.000
2028	0.990	0.990	1.000	0.970	0.970	1.000
2029	0.990	0.990	1.000	0.970	0.970	1.000
2030	0.990	0.990	1.000	0.970	0.970	1.000
2031	0.990	0.990	1.000	0.970	0.970	1.000
2032	0.990	0.990	1.000	0.970	0.970	1.000

11. Determine the proportion of new LPVs and LCVs sold compliant with the performance requirements of UN R[135/01] under business as usual and Options 3, 6a and 6b.

Table 33 Compliance with GTR performance requirements under BAU and Options 3, 6a and 6b

Compliance Rates – Performance Requirements UN R[135/01]						
	New LPVs			New LCVs		
Year	**BAU**	**Option 3**	**Option 6a/b**	**BAU**	**Option 3**	**Option 6a**
2016	0.300	0.300	0.300	0.200	0.200	0.200
2017	0.300	0.300	0.533	0.200	0.200	0.200
2018	0.390	0.375	0.767	0.244	0.501	0.467
2019	0.480	0.450	1.000	0.288	0.530	0.733
2020	0.570	0.525	1.000	0.331	0.559	1.000
2021	0.660	0.600	1.000	0.375	0.588	1.000
2022	0.750	0.675	1.000	0.419	0.616	1.000
2023	0.750	0.750	1.000	0.463	0.645	1.000
2024	0.750	0.750	1.000	0.506	0.674	1.000
2025	0.750	0.750	1.000	0.550	0.703	1.000
2026	0.750	0.750	1.000	0.550	0.703	1.000
2027	0.750	0.750	1.000	0.550	0.703	1.000
2028	0.750	0.750	1.000	0.550	0.703	1.000
2029	0.750	0.750	1.000	0.550	0.703	1.000
2030	0.750	0.750	1.000	0.550	0.703	1.000
2031	0.750	0.750	1.000	0.550	0.703	1.000
2032	0.750	0.750	1.000	0.550	0.703	1.000

12. Use the vehicle sales data established in step 1 and the compliance rates established in step 11 to estimate (for each year of intervention) the net increase in the number of LPVs and LCVs sold complying with the performance requirements of UN R[135/01] under Options 3, 6a and 6b, relative to the business as usual scenario.

13. Use the head curtain and thorax side airbag fitment rate data established in step 10 to estimate (for each year of intervention) the net increase in the number of LPVs and LCVs sold fitted with head curtain and thorax side airbags under Options 3, 6a and 6b, relative to the business as usual scenario. Designate the LCVs in this category as sub-group A and the LPVs as sub-group B.

14. Use the vehicle sales data established in steps 12 and 13 to estimate (for each year of regulatory intervention) the number of LPVs and LCVs sold for which head curtain and thorax side airbags are anticipated to be fitted under business as usual, but enhanced protections systems (e.g. enhanced sensors, wider airbags, larger inflators, improved deployment algorithms etc) are expected to be developed and fitted to comply with the performance requirements of the GTR under options 3, 6a and 6b. Designate the LPVs and LCVs in this category as sub-group C.

Table 34 Vehicle sales – implementation of fleet purchasing policy for LCVs (2016-2033) – Option 3

Year	Total vehicle sales		Vehicles sold compliant performance requirements UN R[135/01] – Option 3		Vehicles sold compliant performance requirements UN R[135/01] – BAU		No. new vehicles sub-group A	No. new vehicles sub-group B	No. new vehicles sub-group C	
	LPVs	LCVs	LPVs	LCVs	LPVs	LCVs	LCVs	LPVs	LPVs	LCVs
2016	-	-	-	-	-	-	-	-	-	-
2017	-	-	-	-	-	-	-	-	-	-
2018	-	197,699	-	99,023	-	48,189	-	-	-	50,833
2019	-	204,817	-	108,502	-	58,885	-	-	-	49,617
2020	-	212,190	-	118,535	-	70,288	-	-	-	48,247
2021	-	219,829	-	129,149	-	82,436	-	-	-	46,714
2022	-	227,743	-	140,375	-	95,367	-	-	-	45,008
2023	-	235,941	-	152,241	-	109,123	-	-	-	43,118
2024	-	244,435	-	164,780	-	123,745	-	-	-	41,035
2025	-	253,235	-	178,024	-	139,279	-	-	-	38,745
2026	-	262,351	-	184,433	-	144,293	-	-	-	40,140
2027	-	271,796	-	191,073	-	149,488	-	-	-	41,585
2028	-	281,581	-	197,951	-	154,869	-	-	-	43,082
2029	-	291,718	-	205,078	-	160,445	-	-	-	44,633
2030	-	302,220	-	212,460	-	166,221	-	-	-	46,240
2031	-	313,099	-	220,109	-	172,205	-	-	-	47,904
2032	-	324,371	-	228,033	-	178,404	-	-	-	49,629
2033	-	-	-	-	-	-	-	-	-	-

Table 35 Vehicle sales – implementation of a mandatory standard under the MVSA (2016-2033) – Option 6a

Year	Total vehicle sales		Vehicles sold compliant performance requirements UN R[135/01] – Option 6b		Vehicles sold compliant performance requirements UN R[135/01] – BAU		No. new vehicles sub-group A	No. new vehicles sub-group B	No. new vehicles sub-group C	
	LPVs	LCVs	LPVs	LCVs	LPVs	LCVs	LCVs	LPVs	LPVs	LCVs
2016	-	-	-	-	-	-	-	-	-	-
2017	945,991	-	504,528	-	283,797	-	-	-	220,731	-
2018	964,910	197,699	739,765	92,260	376,315	48,189	15,602	-	363,450	28,468
2019	984,209	204,817	984,209	150,199	472,420	58,885	31,866	9,842	501,946	59,448
2020	1,003,893	212,190	1,003,893	212,190	572,219	70,288	48,773	10,039	421,635	93,129
2021	1,023,971	219,829	1,023,971	219,829	675,821	82,436	40,543	10,240	337,910	96,850
2022	1,044,450	227,743	1,044,450	227,743	783,338	95,367	31,047	10,445	250,668	101,329
2023	1,065,339	235,941	1,065,339	235,941	799,004	109,123	20,144	10,653	255,681	106,674
2024	1,086,646	244,435	1,086,646	244,435	814,984	123,745	7,682	10,866	260,795	113,008
2025	1,108,379	253,235	1,108,379	253,235	831,284	139,279	7,597	11,084	266,011	106,359
2026	1,130,546	262,351	1,130,546	262,351	847,910	144,293	7,871	11,305	271,331	110,188
2027	1,153,157	271,796	1,153,157	271,796	864,868	149,488	8,154	11,532	276,758	114,154
2028	1,176,220	281,581	1,176,220	281,581	882,165	154,869	8,447	11,762	282,293	118,264
2029	1,199,745	291,718	1,199,745	291,718	899,809	160,445	8,752	11,997	287,939	122,521
2030	1,223,740	302,220	1,223,740	302,220	917,805	166,221	9,067	12,237	293,698	126,932
2031	1,248,215	313,099	1,248,215	313,099	936,161	172,205	9,393	12,482	299,572	131,502
2032	-	324,371	-	324,371	-	178,404	9,731	-	-	136,236
2033	-	-	-	-	-	-	-	-	-	-

Table 36 Vehicle sales – implementation of a mandatory standard under the MVSA (2016-2033) – Option 6b

Year	Total vehicle sales		Vehicles sold compliant performance requirements UN R[135/01] – Option 6b		Vehicles sold compliant performance requirements UN R[135/01] – BAU		No. new vehicles sub-group A	No. new vehicles sub-group B	No. new vehicles sub-group C	
	LPVs	LCVs	LPVs	LCVs	LPVs	LCVs	LCVs	LPVs	LPVs	LCVs
2016	-	-	-	-	-	-	-	-	-	-
2017	945,991	-	504,528	-	283,797	-	-	-	220,731	-
2018	964,910	-	739,765	-	376,315	-	-	-	363,450	-
2019	984,209	-	984,209	-	472,420	-	-	9,842	501,946	-
2020	1,003,893	-	1,003,893	-	572,219	-	-	10,039	421,635	-
2021	1,023,971	-	1,023,971	-	675,821	-	-	10,240	337,910	-
2022	1,044,450	-	1,044,450	-	783,338	-	-	10,445	250,668	-
2023	1,065,339	-	1,065,339	-	799,004	-	-	10,653	255,681	-
2024	1,086,646	-	1,086,646	-	814,984	-	-	10,866	260,795	-
2025	1,108,379	-	1,108,379	-	831,284	-	-	11,084	266,011	-
2026	1,130,546	-	1,130,546	-	847,910	-	-	11,305	271,331	-
2027	1,153,157	-	1,153,157	-	864,868	-	-	11,532	276,758	-
2028	1,176,220	-	1,176,220	-	882,165	-	-	11,762	282,293	-
2029	1,199,745	-	1,199,745	-	899,809	-	-	11,997	287,939	-
2030	1,223,740	-	1,223,740	-	917,805	-	-	12,237	293,698	-
2031	1,248,215	-	1,248,215	-	936,161	-	-	12,482	299,572	-
2032	-	-	-	-	-	-	-	-	-	-
2033	-	-	-	-	-	-	-	-	-	-

15. Establish incremental side impact restraint system effectiveness values by vehicle sub-group for options 3, 6a and 6b, relative to the business as usual scenario.

Table 37 Incremental effectiveness due to anticipated fitment of enhanced side impact protection systems to meet performance requirements of UN R[135/01]

Vehicle Sub-group	Effectiveness Measure (% reduction relative to BAU scenario)	Incremental Effectiveness
A	Reduction occupant fatalities in side impact crashes	40.7%
	Reduction number occupants seriously injured in side impact crashes	44.2%
	Reduction number occupants sustaining minor injuries in side impact crashes	44.2%
B	Reduction occupant fatalities in side impact crashes	20.1%
	Reduction number occupants seriously injured in side impact crashes	23.6%
	Reduction number occupants sustaining minor injuries in side impact crashes	23.6%
C	Reduction occupant fatalities in side impact crashes	9.4%
	Reduction number occupants seriously injured in side impact crashes	10.2%
	Reduction number occupants sustaining minor injuries in side impact crashes	10.2%

16. For each year of the period 2017-2060, determine weighted average incremental effectiveness increases (where applicable) for the regulated LPV and LCV fleet by age (0-29 years for LPVs and 0-25 years for LCVs) relative to business as usual, using the sub-group (A, B and C) sales estimates (established in steps 13 and 14) as a proportion of total sales (established in step 1), and the incremental effectiveness values established in step 15.

17. For each year of the period 2017-2060, determine the number of LPV and LCV occupants expected to be killed and seriously injured in pole side impacts, by vehicle age, under business as usual by adjusting the appropriate probability mass value

obtained in step 6 according to the number of lives saved and serious injuries prevented due to increasing fitment of ESC (established in step 9) and multiplying the result by the total number of registered LPVs/LCVs (as applicable).

18. For each year of the period 2017-2060, determine the number of LPV and LCV occupants expected to be killed and seriously injured in other side impacts, by vehicle age, under business as usual by multiplying the appropriate probability mass value obtained in step 6 by the total number of registered LPVs/LCVs (as applicable).
19. For each year of the period 2017-2060, multiply the weighted average incremental effectiveness increases established for the in step 16 by the business as usual fatality/serious injury predictions established in steps 17 and 18. This step yields the number of lives saved and the reduction in seriously injured occupants due to implementation of options 3, 6a and 6b, relative to the business as usual scenario.

Table 38 LPV occupant fatalities prevented in pole side impact crashes due to implementation of a mandatory standard under the MVSA (2017-2060) – Option 6a or 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	
2017	0.0																														0.0
2018	0.1	0.1																													0.2
2019	0.1	0.2	0.1																												0.4
2020	0.1	0.3	0.2	0.1																											0.7
2021	0.1	0.2	0.3	0.2	0.1																										0.9
2022	0.1	0.2	0.2	0.3	0.2	0.1																									1.1
2023	0.1	0.2	0.2	0.2	0.3	0.2	0.1																								1.3
2024	0.1	0.1	0.2	0.2	0.3	0.3	0.2	0.1																							1.4
2025	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.2	0.1																						1.6
2026	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.2	0.1																					1.8
2027	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.3	0.2	0.1																				2.0
2028	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.2	0.1																			2.2
2029	0.1	0.2	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.2	0.1																		2.3
2030	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.2	0.1																	2.5
2031	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.2	0.1																2.7
2032		0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.2	0.1															2.8
2033			0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.2	0.1														2.9
2034				0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.2	0.1													2.8
2035					0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.2	0.1												2.8
2036						0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.2	0.1											2.7
2037							0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1										2.6
2038								0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1									2.5
2039									0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.1	0.0								2.4
2040										0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.0							2.2
2041											0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0						2.0
2042												0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0					1.9
2043													0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0				1.7
⋮															⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮		⋮
2059																													0.0	0.0	0.0
2060																														0.0	0.0

Table 39 LPV occupant fatalities prevented in other side impact crashes due to implementation of a mandatory standard under the MVSA (2017-2060) – Option 6a or 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	
2017	0.0																														0.0
2018	0.1	0.1																													0.2
2019	0.1	0.2	0.1																												0.4
2020	0.1	0.3	0.2	0.1																											0.7
2021	0.1	0.3	0.3	0.2	0.1																										1.0
2022	0.1	0.2	0.3	0.3	0.2	0.1																									1.2
2023	0.1	0.2	0.2	0.3	0.3	0.2	0.1																								1.4
2024	0.1	0.1	0.2	0.2	0.3	0.3	0.2	0.1																							1.6
2025	0.1	0.2	0.1	0.2	0.2	0.3	0.3	0.2	0.1																						1.8
2026	0.1	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.2	0.1																					2.0
2027	0.1	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.2	0.1																				2.2
2028	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.4	0.2	0.1																			2.4
2029	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.4	0.3	0.1																		2.6
2030	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.4	0.3	0.2																	2.9
2031	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.4	0.3	0.1																3.1
2032		0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.4	0.3	0.1															3.3
2033			0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.4	0.3	0.1														3.3
2034				0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.4	0.2	0.1													3.3
2035					0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.2	0.1												3.3
2036						0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.2	0.1											3.2
2037							0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.2	0.1										3.1
2038								0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.2	0.1	0.1									3.0
2039									0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1								2.8
2040										0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.0							2.7
2041											0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.1	0.1	0.1	0.0						2.5
2042												0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0					2.3
2043													0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0				2.1
⋮															⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮		⋮
2059																													0.0	0.0	0.0
2060																														0.0	0.0

Table 40 Reduction number of seriously injured LPV occupants in pole side impact crashes due to implementation of a mandatory standard under the MVSA (2017-2060) – Option 6a or 6b

Year	Vehicle Age																														Reduction No. Occupants Seriously Injured
	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	
2017	0.2																														0.2
2018	0.4	0.6																													1.0
2019	0.6	1.0	0.6																												2.2
2020	0.5	1.4	1.0	0.6																											3.5
2021	0.5	1.3	1.4	1.0	0.6																										4.8
2022	0.4	1.1	1.3	1.5	1.0	0.6																									5.9
2023	0.3	0.9	1.1	1.3	1.5	1.1	0.6																								6.9
2024	0.3	0.7	0.9	1.1	1.4	1.6	1.1	0.6																							7.8
2025	0.3	0.8	0.7	0.9	1.2	1.4	1.6	1.1	0.7																						8.7
2026	0.3	0.8	0.8	0.8	1.0	1.2	1.4	1.6	1.1	0.7																					9.6
2027	0.3	0.8	0.8	0.8	0.8	1.0	1.2	1.4	1.6	1.1	0.7																				10.6
2028	0.3	0.8	0.8	0.8	0.8	0.8	1.0	1.2	1.5	1.7	1.2	0.7																			11.6
2029	0.4	0.8	0.8	0.8	0.8	0.8	0.8	1.0	1.3	1.5	1.7	1.2	0.7																		12.6
2030	0.4	0.8	0.8	0.8	0.8	0.9	0.8	0.8	1.1	1.3	1.5	1.7	1.2	0.7																	13.6
2031	0.4	0.9	0.8	0.8	0.9	0.9	0.9	0.8	0.8	1.1	1.3	1.5	1.7	1.2	0.7																14.7
2032		0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.8	1.1	1.3	1.5	1.7	1.2	0.7															15.3
2033			0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.1	1.3	1.5	1.7	1.1	0.6														15.4
2034				0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.1	1.3	1.5	1.7	1.0	0.6													15.3
2035					0.9	1.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.1	1.3	1.5	1.5	1.0	0.5												15.1
2036						1.0	1.0	0.9	0.9	0.9	0.9	0.9	0.9	0.9	1.1	1.3	1.3	1.4	0.8	0.4											14.8
2037							1.0	1.0	1.0	1.0	1.0	0.9	0.9	0.9	0.9	1.1	1.2	1.2	1.2	0.7	0.3										14.2
2038								1.0	1.0	1.0	1.0	1.0	0.9	0.9	0.9	0.9	1.0	1.1	1.1	1.1	0.6	0.3									13.6
2039									1.0	1.0	1.0	1.0	1.0	1.0	0.9	0.9	0.8	0.9	0.9	0.9	0.8	0.5	0.2								12.8
2040										1.0	1.0	1.0	1.0	1.0	0.9	0.9	0.8	0.7	0.8	0.8	0.8	0.7	0.4	0.2							11.9
2041											1.0	1.0	1.0	1.0	1.0	0.9	0.8	0.7	0.6	0.7	0.7	0.6	0.5	0.3	0.1						11.0
2042												1.1	1.0	1.0	1.0	0.9	0.8	0.8	0.6	0.5	0.5	0.5	0.5	0.4	0.2	0.1					10.1
2043													1.0	1.0	1.0	1.0	0.8	0.8	0.7	0.6	0.4	0.4	0.4	0.4	0.3	0.2	0.1				9.1
⋮														⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮		⋮
2059																													0.1	0.1	0.1
2060																														0.1	0.1

Table 41 Reduction number of seriously injured LPV occupants in other side impact crashes due to implementation of a mandatory standard under the MVSA (2017-2060) – Option 6a or 6b

Year	Vehicle Age																														Reduction No. Occupants Seriously Injured
	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	
2017	0.9																														0.9
2018	1.5	2.1																													3.6
2019	2.2	3.6	2.1																												7.9
2020	2.0	5.3	3.6	2.2																											13.0
2021	1.7	4.7	5.3	3.7	2.3																										17.6
2022	1.4	4.0	4.7	5.5	3.9	2.4																									21.9
2023	1.1	3.4	4.1	4.9	5.7	4.1	2.4																								25.6
2024	1.2	2.7	3.4	4.2	5.1	6.0	4.1	2.4																							29.1
2025	1.2	2.8	2.7	3.5	4.4	5.3	6.1	4.2	2.5																						32.6
2026	1.2	2.8	2.8	2.8	3.7	4.6	5.4	6.2	4.3	2.5																					36.2
2027	1.2	2.9	2.8	2.9	2.9	3.8	4.7	5.5	6.3	4.4	2.6																				40.0
2028	1.3	3.0	2.9	2.9	3.0	3.1	3.9	4.7	5.6	6.4	4.5	2.7																			43.9
2029	1.3	3.0	3.0	3.0	3.1	3.1	3.1	4.0	4.8	5.7	6.6	4.6	2.7																		48.0
2030	1.3	3.1	3.0	3.1	3.1	3.2	3.2	3.2	4.0	4.9	5.9	6.8	4.6	2.8																	52.2
2031	1.4	3.2	3.1	3.1	3.2	3.3	3.2	3.2	3.2	4.1	5.1	6.0	6.7	4.7	2.7																56.4
2032		3.2	3.2	3.2	3.3	3.4	3.3	3.3	3.3	3.3	4.3	5.2	6.0	7.0	4.7	2.7															59.2
2033			3.3	3.3	3.4	3.4	3.4	3.4	3.4	3.4	3.4	4.4	5.2	6.2	6.8	4.6	2.4														59.8
2034				3.4	3.4	3.5	3.5	3.5	3.4	3.4	3.5	3.5	4.3	5.3	6.1	6.8	4.2	2.3													60.1
2035					3.5	3.6	3.6	3.5	3.5	3.5	3.6	3.6	3.4	4.5	5.3	6.0	6.2	4.0	2.0												59.7
2036						3.7	3.6	3.6	3.6	3.6	3.6	3.6	3.5	3.6	4.4	5.2	5.5	5.8	3.5	1.8											58.7
2037							3.7	3.7	3.7	3.7	3.7	3.7	3.6	3.6	3.5	4.4	4.7	5.2	5.2	3.0	1.4										56.9
2038								3.8	3.8	3.8	3.8	3.8	3.7	3.7	3.6	3.5	4.0	4.5	4.6	4.5	2.5	1.2									54.6
2039									3.9	3.8	3.9	3.9	3.8	3.8	3.7	3.6	3.2	3.8	4.0	4.0	3.6	2.0	0.9								51.8
2040										3.9	4.0	4.0	3.9	3.9	3.8	3.6	3.2	3.0	3.3	3.4	3.2	3.0	1.6	0.7							48.6
2041											4.1	4.1	3.9	4.0	3.8	3.7	3.3	3.1	2.6	2.9	2.8	2.6	2.4	1.3	0.6						45.2
2042												4.2	4.0	4.1	3.9	3.8	3.4	3.1	2.7	2.3	2.3	2.3	2.1	1.9	1.0	0.4					41.5
2043													4.1	4.2	4.0	3.9	3.5	3.2	2.8	2.3	1.9	1.9	1.8	1.6	1.4	0.7	0.3				37.7
⋮														⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮		⋮
2059																													0.3	0.3	0.6
2060																														0.3	0.3

Table 42 LCV occupant fatalities prevented in pole side impact crashes due to implementation of a fleet purchasing policy for LCVs (2017-2057) – Option 3

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	
2017																											0.0
2018	0.0																										0.0
2019	0.0	0.0																									0.0
2020	0.0	0.0	0.0																								0.1
2021	0.0	0.0	0.0	0.0																							0.1
2022	0.0	0.0	0.0	0.0	0.0																						0.1
2023	0.0	0.0	0.0	0.0	0.0	0.0																					0.1
2024	0.0	0.0	0.0	0.0	0.0	0.0	0.0																				0.1
2025	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0																			0.1
2026	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0																		0.2
2027	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0																	0.2
2028	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0																0.2
2029	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0															0.2
2030	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0														0.2
2031	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0													0.2
2032	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0												0.2
2033		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0											0.2
2034			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0										0.2
2035				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0									0.2
2036					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0								0.2
2037						0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0							0.1
2038							0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						0.1
2039								0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					0.1
2040									0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				0.1
2041										0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.1
⋮											⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮		⋮
2056																									0.0	0.0	0.0
2057																										0.0	0.0

Table 43 LCV occupant fatalities prevented in pole side impact crashes due to implementation of a mandatory standard under the MVSA (2017-2057) – 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	
2017																											0.0
2018	0.0																										0.0
2019	0.0	0.0																									0.1
2020	0.1	0.1	0.0	-																							0.2
2021	0.1	0.2	0.1	0.0																							0.4
2022	0.0	0.1	0.2	0.1	0.0	-																					0.5
2023	0.0	0.1	0.1	0.1	0.1	0.0																					0.6
2024	0.0	0.1	0.1	0.1	0.1	0.1	0.0																				0.6
2025	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.0																			0.6
2026	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0																		0.7
2027	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0																	0.7
2028	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0																0.7
2029	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0															0.8
2030	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0														0.8
2031	0.0	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0													0.8
2032	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0												0.8
2033		0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0											0.8
2034			0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0										0.8
2035				0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0									0.7
2036					0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0								0.6
2037						0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0							0.6
2038							0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						0.5
2039								0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					0.4
2040									0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				0.4
2041										0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.3
⋮											⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮		⋮
2056																									0.0	0.0	0.0
2057																										0.0	0.0

Table 44 LCV occupant fatalities prevented in other side impact crashes due to implementation of a fleet purchasing policy for LCVs (2017-2057) – Option 3

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	
2017																											0.0
2018	0.0																										0.0
2019	0.0	0.0																									0.0
2020	0.0	0.0	0.0																								0.1
2021	0.0	0.0	0.0	0.0																							0.1
2022	0.0	0.0	0.0	0.0	0.0																						0.1
2023	0.0	0.0	0.0	0.0	0.0	0.0																					0.1
2024	0.0	0.0	0.0	0.0	0.0	0.0	0.0																				0.1
2025	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0																			0.1
2026	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0																		0.1
2027	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0																	0.2
2028	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0																0.2
2029	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0															0.2
2030	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0														0.2
2031	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0													0.2
2032	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0												0.2
2033		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0											0.2
2034			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0										0.2
2035				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0									0.2
2036					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0								0.2
2037						0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0							0.2
2038							0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						0.1
2039								0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					0.1
2040									0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				0.1
2041										0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.1
⋮											⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮		⋮
2056																									0.0	0.0	0.0
2057																										0.0	0.0

Table 45 LCV occupant fatalities prevented in other side impact crashes due to implementation of a mandatory standard under the MVSA (2017-2057) – 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	
2017																											0.0
2018	0.0																										0.0
2019	0.0	0.0																									0.1
2020	0.0	0.1	0.0																								0.2
2021	0.0	0.1	0.1	0.0																							0.3
2022	0.0	0.1	0.1	0.1	0.0																						0.4
2023	0.0	0.1	0.1	0.1	0.1	0.0																					0.5
2024	0.0	0.1	0.1	0.1	0.1	0.1	0.0																				0.6
2025	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.0																			0.6
2026	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0																		0.6
2027	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0																	0.7
2028	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0																0.7
2029	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0															0.7
2030	0.0	0.1	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.0	0.0														0.8
2031	0.0	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0													0.8
2032	0.0	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0												0.8
2033		0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0											0.8
2034			0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0										0.8
2035				0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0									0.7
2036					0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0								0.7
2037						0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0							0.6
2038							0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						0.6
2039								0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0					0.5
2040									0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				0.5
2041										0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.4
⋮											⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮		⋮
2056																									0.0	0.0	0.0
2057																										0.0	0.0

Table 46 Reduction number of seriously injured LCV occupants in pole side impact crashes due to implementation of a fleet purchasing policy for LCVs (2017-2057) – Option 3

Year	Vehicle Age																										Reduction No. Occupants Seriously Injured
	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	
2017																											0.0
2018	0.1																										0.1
2019	0.1	0.2																									0.2
2020	0.1	0.2	0.2																								0.4
2021	0.1	0.2	0.2	0.2																							0.5
2022	0.1	0.1	0.2	0.2	0.1																						0.7
2023	0.1	0.1	0.1	0.1	0.1	0.1																					0.8
2024	0.0	0.1	0.1	0.1	0.1	0.1	0.1																				0.9
2025	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1																			1.0
2026	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1																		1.0
2027	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1																	1.1
2028	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1																1.2
2029	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1															1.3
2030	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1														1.3
2031	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1													1.4
2032	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1												1.5
2033		0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1											1.5
2034			0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1										1.4
2035				0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1									1.3
2036					0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0								1.2
2037						0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0							1.1
2038							0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0						1.0
2039								0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0					1.0
2040									0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				0.9
2041										0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.8
⋮											⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮		⋮
2056																									0.0	0.0	0.0
2057																										0.0	0.0

Table 47 Reduction number of seriously injured LCV occupants in pole side impact crashes due to implementation of a mandatory standard under the MVSA (2017-2057) – Option 6a

Year	Vehicle Age																										Reduction No. Occupants Seriously Injured
	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	
2017																											0.0
2018	0.1																										0.1
2019	0.2	0.3																									0.5
2020	0.4	0.6	0.3																								1.3
2021	0.3	1.0	0.6	0.3																							2.2
2022	0.3	0.9	1.0	0.6	0.3																						3.0
2023	0.2	0.8	0.9	0.9	0.6	0.3																					3.6
2024	0.2	0.6	0.8	0.8	0.9	0.5	0.2																				4.0
2025	0.2	0.5	0.6	0.7	0.8	0.8	0.5	0.2																			4.3
2026	0.2	0.4	0.5	0.6	0.7	0.7	0.7	0.5	0.2																		4.5
2027	0.2	0.5	0.4	0.4	0.6	0.6	0.7	0.7	0.4	0.2																	4.7
2028	0.2	0.5	0.5	0.4	0.4	0.5	0.6	0.6	0.7	0.4	0.2																5.0
2029	0.2	0.5	0.5	0.4	0.4	0.4	0.5	0.6	0.6	0.6	0.4	0.2															5.2
2030	0.2	0.5	0.5	0.5	0.4	0.4	0.4	0.5	0.5	0.6	0.6	0.4	0.2														5.4
2031	0.2	0.5	0.5	0.5	0.4	0.4	0.3	0.3	0.4	0.5	0.5	0.5	0.3	0.2													5.7
2032	0.2	0.6	0.5	0.5	0.5	0.4	0.4	0.3	0.3	0.4	0.4	0.5	0.5	0.3	0.1												6.0
2033		0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3	0.3	0.4	0.4	0.5	0.5	0.3	0.1											6.0
2034			0.6	0.5	0.5	0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.2	0.1										5.6
2035				0.6	0.5	0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.2	0.1									5.2
2036					0.5	0.5	0.4	0.4	0.3	0.3	0.3	0.2	0.3	0.3	0.3	0.3	0.4	0.2	0.1								4.9
2037						0.5	0.4	0.4	0.4	0.3	0.3	0.3	0.2	0.2	0.3	0.3	0.3	0.3	0.2	0.1							4.5
2038							0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.3	0.3	0.3	0.1	0.1						4.1
2039								0.4	0.4	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.3	0.3	0.2	0.1	0.0					3.7
2040									0.4	0.4	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.0				3.3
2041										0.4	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.0			3.0
⋮											⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮		⋮
2056																									0.0	0.0	0.0
2057																										0.0	0.0

Table 48 Reduction number of seriously injured LCV occupants in other side impact crashes due to implementation of a fleet purchasing policy for LCVs (2017-2057) – Option 3

Year	Vehicle Age																										Reduction No. Occupants Seriously Injured
	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	
2017																											0.0
2018	0.1																										0.1
2019	0.1	0.3																									0.4
2020	0.1	0.3	0.3																								0.7
2021	0.1	0.3	0.3	0.3																							0.9
2022	0.1	0.3	0.3	0.3	0.3																						1.2
2023	0.1	0.3	0.3	0.3	0.3	0.2																					1.4
2024	0.1	0.2	0.3	0.3	0.2	0.2	0.2																				1.5
2025	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2																			1.7
2026	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2																		1.8
2027	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2																	2.0
2028	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2																2.1
2029	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2															2.2
2030	0.1	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2														2.4
2031	0.1	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1													2.5
2032	0.1	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1												2.7
2033		0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1											2.7
2034			0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1										2.5
2035				0.3	0.3	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1									2.4
2036					0.3	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1								2.2
2037						0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1							2.0
2038							0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0						1.8
2039								0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0					1.7
2040									0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0				1.5
2041										0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0			1.4
⋮											⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮		⋮
2056																									0.0	0.0	0.0
2057																										0.0	0.0

Table 49 Reduction number of seriously injured LCV occupants in other side impact crashes due to implementation of a mandatory standard under the MVSA (2017-2057) – Option 6a

Year	Vehicle Age																										Reduction No. Occupants Seriously Injured
	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	
2017																											0.0
2018	0.2																										0.2
2019	0.4	0.5																									0.9
2020	0.6	1.1	0.5																								2.3
2021	0.6	1.7	1.1	0.5																							3.9
2022	0.5	1.5	1.7	1.1	0.5																						5.3
2023	0.4	1.3	1.5	1.6	1.0	0.4																					6.4
2024	0.3	1.1	1.3	1.5	1.6	0.9	0.4																				7.1
2025	0.3	0.8	1.1	1.3	1.4	1.4	0.9	0.4																			7.6
2026	0.3	0.8	0.8	1.0	1.2	1.3	1.3	0.8	0.4																		8.0
2027	0.3	0.8	0.8	0.8	1.0	1.1	1.2	1.3	0.8	0.3																	8.4
2028	0.3	0.9	0.8	0.8	0.8	0.9	1.0	1.1	1.2	0.7	0.3																8.8
2029	0.3	0.9	0.8	0.8	0.7	0.7	0.8	1.0	1.1	1.1	0.7	0.3															9.2
2030	0.3	0.9	0.9	0.8	0.7	0.7	0.6	0.8	0.9	1.0	1.0	0.6	0.3														9.6
2031	0.4	1.0	0.9	0.8	0.8	0.7	0.6	0.6	0.8	0.8	0.9	1.0	0.6	0.3													10.1
2032	0.4	1.0	0.9	0.9	0.8	0.7	0.6	0.6	0.6	0.7	0.8	0.9	0.9	0.5	0.2												10.5
2033		1.0	1.0	0.9	0.8	0.7	0.7	0.6	0.5	0.5	0.7	0.7	0.8	0.8	0.5	0.2											10.6
2034			1.0	0.9	0.9	0.8	0.7	0.6	0.6	0.5	0.5	0.6	0.7	0.8	0.8	0.4	0.2										9.9
2035				1.0	0.9	0.8	0.7	0.6	0.6	0.5	0.5	0.5	0.6	0.7	0.7	0.7	0.4	0.2									9.3
2036					0.9	0.8	0.7	0.7	0.6	0.5	0.5	0.4	0.4	0.5	0.6	0.6	0.6	0.4	0.2								8.6
2037						0.8	0.8	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.5	0.5	0.6	0.6	0.3	0.1							7.9
2038							0.8	0.7	0.7	0.6	0.5	0.5	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.3	0.1						7.3
2039								0.7	0.7	0.6	0.5	0.5	0.5	0.4	0.3	0.3	0.4	0.5	0.4	0.4	0.2	0.1					6.6
2040									0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3	0.4	0.4	0.3	0.3	0.1	0.1				5.9
2041										0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.1	0.0			5.2
⋮											⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮		⋮
2056																									0.0	0.0	0.1
2057																										0.0	0.0

20. Determine the average number of new vehicle models expected to be introduced to the market each year.

Table 50 Overview of new vehicle sales and models – Australia (2014) (source: FCAI VFACTS)

Vehicle Category	Number of new vehicles sold	Total number of models	New models introduced per year
LPVs	891,428	288	58
LCVs	171,619	42	6
Total	1,063,048	330	64

21. Establish the development and fitment of systems, regulation compliance and government costs for Options 3, 6a and 6b, relative to the business as usual scenario.

Table 51 Cost overview – enhanced side impact protection measures

Costs related to:	Net Cost relative to BAU			Option(s)	Notes	Cost Impact
Development of systems – including test costs	$350,000			3, 6a, 6b	Per model	Business
	$12,000				Per model (domestic share)	
Fitment of systems	**Sub-group A**	**Sub-group B**	**Sub-group C**			
Best Case	$231	$130	$20	3, 6a, 6b	Per vehicle	Business
Likely Case	**$308**	**$173**	**$27**			
Worst Case	$385	$216	$34			
Implement and maintain policy	$40,000			3	Per year	Business
Implement and maintain policy	$10,000			3	Per year	Government
Regulation compliance	$1,500			6a, 6b	Per model (domestic)	Business
Implementing and maintaining regulation	$50,000			6a, 6b	Per year	Government

22. For each year of intervention, calculate:

    a. the total fitment cost by vehicle sub-group (A, B and C), by multiplying the vehicle sales estimates established in steps 13 and 14 by the appropriate per vehicle fitment costs established in step 21;

    b. the total system development cost, by multiplying the average number of new models introduced per year by the per model Australian share of the development cost (established in steps 20 and 21 respectively);

    c. the regulation compliance costs (options 6a and 6b only), by multiplying the average number of new models introduced per year by the per model regulation compliance cost (established in steps 20 and 21 respectively); and

    d. the government costs.

Determine the total net present value of all costs, by discounting and summing the costs incurred in each year after 2014 using a real discount rate of 7 per cent per annum.

Table 52 Fitment costs – implementation of fleet purchasing policies for LCVs (2016-2033) – Option 3

Year	Fitment Costs (sub-group A)			Fitment Costs (sub-group B)			Fitment Costs (sub-group C)		
	Best Case	Likely Case	Worst Case	Best Case	Likely Case	Worst Case	Best Case	Likely Case	Worst Case
2016	$0	$0	$0	$0	$0	$0	$0	$0	$0
2017	$0	$0	$0	$0	$0	$0	$0	$0	$0
2018	$0	$0	$0	$0	$0	$0	$1,029,378	$1,715,630	$1,372,504
2019	$0	$0	$0	$0	$0	$0	$1,004,741	$1,674,568	$1,339,654
2020	$0	$0	$0	$0	$0	$0	$976,996	$1,628,326	$1,302,661
2021	$0	$0	$0	$0	$0	$0	$945,951	$1,576,585	$1,261,268
2022	$0	$0	$0	$0	$0	$0	$911,405	$1,519,008	$1,215,207
2023	$0	$0	$0	$0	$0	$0	$873,146	$1,455,243	$1,164,194
2024	$0	$0	$0	$0	$0	$0	$830,950	$1,384,917	$1,107,934
2025	$0	$0	$0	$0	$0	$0	$784,585	$1,307,642	$1,046,114
2026	$0	$0	$0	$0	$0	$0	$812,830	$1,354,717	$1,083,774
2027	$0	$0	$0	$0	$0	$0	$842,092	$1,403,487	$1,122,790
2028	$0	$0	$0	$0	$0	$0	$872,408	$1,454,013	$1,163,210
2029	$0	$0	$0	$0	$0	$0	$903,814	$1,506,357	$1,205,086
2030	$0	$0	$0	$0	$0	$0	$936,352	$1,560,586	$1,248,469
2031	$0	$0	$0	$0	$0	$0	$970,060	$1,616,767	$1,293,414
2032	$0	$0	$0	$0	$0	$0	$1,004,982	$1,674,971	$1,339,977
2033	$0	$0	$0	$0	$0	$0	$0	$0	$0
NPV	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$6,392,704**	**$10,654,507**	**$8,523,606**

Table 53 Fitment costs – implementation of a mandatory standard under the MVSA (2016-2033) – Option 6a

Year	Fitment Costs (sub-group A)			Fitment Costs (sub-group B)			Fitment Costs (sub-group C)		
	Best Case	Likely Case	Worst Case	Best Case	Likely Case	Worst Case	Best Case	Likely Case	Worst Case
2016	$0	$0	$0	$0	$0	$0	$0	$0	$0
2017	$0	$0	$0	$0	$0	$0	$4,469,806	$5,959,741	$7,449,677
2018	$3,589,685	$4,786,247	$5,982,808	$0	$0	$0	$8,229,426	$10,972,568	$13,715,709
2019	$7,331,493	$9,775,324	$12,219,155	$1,277,011	$1,702,681	$2,128,351	$11,966,146	$15,954,862	$19,943,577
2020	$11,221,396	$14,961,862	$18,702,327	$1,302,551	$1,736,735	$2,170,918	$11,338,765	$15,118,354	$18,897,942
2021	$9,327,853	$12,437,137	$15,546,421	$1,328,602	$1,771,469	$2,214,337	$10,048,021	$13,397,362	$16,746,702
2022	$7,143,007	$9,524,010	$11,905,012	$1,355,174	$1,806,899	$2,258,623	$8,714,193	$11,618,924	$14,523,655
2023	$4,634,702	$6,179,603	$7,724,504	$1,382,278	$1,843,037	$2,303,796	$7,337,697	$9,783,596	$12,229,495
2024	$1,767,517	$2,356,689	$2,945,861	$1,409,923	$1,879,897	$2,349,872	$7,569,502	$10,092,669	$12,615,836
2025	$1,747,875	$2,330,500	$2,913,125	$1,438,122	$1,917,495	$2,396,869	$7,540,485	$10,053,980	$12,567,475
2026	$1,810,798	$2,414,398	$3,017,997	$1,466,884	$1,955,845	$2,444,807	$7,725,755	$10,301,006	$12,876,258
2027	$1,875,987	$2,501,316	$3,126,645	$1,496,222	$1,994,962	$2,493,703	$7,915,971	$10,554,628	$13,193,285
2028	$1,943,523	$2,591,364	$3,239,205	$1,526,146	$2,034,861	$2,543,577	$8,111,276	$10,815,035	$13,518,794
2029	$2,013,490	$2,684,653	$3,355,816	$1,556,669	$2,075,559	$2,594,448	$8,311,819	$11,082,426	$13,853,032
2030	$2,085,975	$2,781,300	$3,476,625	$1,587,802	$2,117,070	$2,646,337	$8,517,752	$11,357,003	$14,196,254
2031	$2,161,070	$2,881,427	$3,601,784	$1,619,558	$2,159,411	$2,699,264	$8,729,234	$11,638,978	$14,548,723
2032	$2,238,869	$2,985,158	$3,731,448	$0	$0	$0	$2,758,775	$3,678,367	$4,597,959
2033	$0	$0	$0	$0	$0	$0	$0	$0	$0
NPV	**$32,503,111**	**$43,337,481**	**$54,171,851**	**$8,434,775**	**$11,246,367**	**$14,057,959**	**$63,647,856**	**$84,863,808**	**$106,079,760**

Table 54 Fitment costs – implementation of a mandatory standard under the MVSA (2016-2033) – Option 6b

Year	Fitment Costs (sub-group A)			Fitment Costs (sub-group B)			Fitment Costs (sub-group C)		
	Best Case	Likely Case	Worst Case	Best Case	Likely Case	Worst Case	Best Case	Likely Case	Worst Case
2016	$0	$0	$0	$0	$0	$0	$0	$0	$0
2017	$0	$0	$0	$0	$0	$0	$4,469,806	$5,959,741	$7,449,677
2018	$0	$0	$0	$0	$0	$0	$7,652,946	$10,203,928	$12,754,911
2019	$0	$0	$0	$1,277,011	$1,702,681	$2,128,351	$10,762,322	$14,349,763	$17,937,203
2020	$0	$0	$0	$1,302,551	$1,736,735	$2,170,918	$9,452,906	$12,603,875	$15,754,844
2021	$0	$0	$0	$1,328,602	$1,771,469	$2,214,337	$8,086,809	$10,782,412	$13,478,015
2022	$0	$0	$0	$1,355,174	$1,806,899	$2,258,623	$6,662,286	$8,883,048	$11,103,811
2023	$0	$0	$0	$1,382,278	$1,843,037	$2,303,796	$5,177,548	$6,903,398	$8,629,247
2024	$0	$0	$0	$1,409,923	$1,879,897	$2,349,872	$5,281,099	$7,041,466	$8,801,832
2025	$0	$0	$0	$1,438,122	$1,917,495	$2,396,869	$5,386,721	$7,182,295	$8,977,869
2026	$0	$0	$0	$1,466,884	$1,955,845	$2,444,807	$5,494,456	$7,325,941	$9,157,426
2027	$0	$0	$0	$1,496,222	$1,994,962	$2,493,703	$5,604,345	$7,472,460	$9,340,575
2028	$0	$0	$0	$1,526,146	$2,034,861	$2,543,577	$5,716,432	$7,621,909	$9,527,386
2029	$0	$0	$0	$1,556,669	$2,075,559	$2,594,448	$5,830,760	$7,774,347	$9,717,934
2030	$0	$0	$0	$1,587,802	$2,117,070	$2,646,337	$5,947,375	$7,929,834	$9,912,292
2031	$0	$0	$0	$1,619,558	$2,159,411	$2,699,264	$6,066,323	$8,088,431	$10,110,538
2032	$0	$0	$0	$0	$0	$0	$0	$0	$0
2033	$0	$0	$0	$0	$0	$0	$0	$0	$0
NPV	**$0**	**$0**	**$0**	**$8,434,775**	**$11,246,367**	**$14,057,959**	**$49,965,882**	**$66,621,176**	**$83,276,470**

Table 55 Development, business and government costs – implementation of a fleet purchasing policy for LCVs (2015-2033)

Year	Option 3		
	System Development Costs	**Business Costs**	**Government Costs**
2015	$72,000	$0	$0
2016	$72,000	$40,000	$10,000
2017	$72,000	$40,000	$10,000
2018	$72,000	$40,000	$10,000
2019	$72,000	$40,000	$10,000
2020	$72,000	$40,000	$10,000
2021	$72,000	$40,000	$10,000
2022	$72,000	$40,000	$10,000
2023	$72,000	$40,000	$10,000
2024	$72,000	$40,000	$10,000
2025	$72,000	$40,000	$10,000
2026	$72,000	$40,000	$10,000
2027	$72,000	$40,000	$10,000
2028	$72,000	$40,000	$10,000
2029	$72,000	$40,000	$10,000
2030	$72,000	$40,000	$10,000
2031	$0	$40,000	$10,000
2032	$0	$40,000	$10,000
2033	$0	$0	$0
NPV	**$680,159**	**$390,529**	**$97,632**

Table 56 Development, compliance and government costs – implementation of a mandatory standard under the MVSA (2015-2033)

Year	Option 6a			Option 6b		
	System Development Costs	Regulation Compliance Costs	Government Costs	System Development Costs	Regulation Compliance Costs	Government Costs
2015	$768,000	$0	$0	$696,000	$0	$0
2016	$768,000	$96,000	$50,000	$696,000	$87,000	$50,000
2017	$768,000	$96,000	$50,000	$696,000	$87,000	$50,000
2018	$768,000	$96,000	$50,000	$696,000	$87,000	$50,000
2019	$768,000	$96,000	$50,000	$696,000	$87,000	$50,000
2020	$768,000	$96,000	$50,000	$696,000	$87,000	$50,000
2021	$768,000	$96,000	$50,000	$696,000	$87,000	$50,000
2022	$768,000	$96,000	$50,000	$696,000	$87,000	$50,000
2023	$768,000	$96,000	$50,000	$696,000	$87,000	$50,000
2024	$768,000	$96,000	$50,000	$696,000	$87,000	$50,000
2025	$768,000	$96,000	$50,000	$696,000	$87,000	$50,000
2026	$768,000	$96,000	$50,000	$696,000	$87,000	$50,000
2027	$768,000	$96,000	$50,000	$696,000	$87,000	$50,000
2028	$768,000	$96,000	$50,000	$696,000	$87,000	$50,000
2029	$768,000	$96,000	$50,000	$696,000	$87,000	$50,000
2030	$768,000	$96,000	$50,000	$0	$87,000	$50,000
2031	$0	$96,000	$50,000	$0	$87,000	$50,000
2032	$0	$96,000	$50,000	$0	$0	$0
2033	$0	$0	$0	$0	$0	$0
NPV	**$7,255,026**	**$937,269**	**$488,161**	**$6,339,108**	**$821,858**	**$472,332**

23. Establish the incidence of traumatic brain injuries by severity (moderate, severe) among occupants seriously injured in pole side impact and other side impact crashes for LPVs and LCVs.

Table 57 Incidence and severity of traumatic brain injuries amongst LPV and LCV occupants seriously injured in side impact crashes (from Table 8.5 of Fitzharris and Stephan 2013)

Serious Injury Categorisation	LPVs		LCVs	
	Pole Side Impact	Other Side Impact	Pole Side Impact	Other Side Impact
Seriously Injured (with severe TBI)	10.9%	6.5%	10.3%	13.3%
Seriously Injured (with moderate TBI)	3.1%	5.0%	7.7%	3.3%
Seriously Injured (without TBI)	86%	88.5%	82.0%	83.4%
Total	100%	100%	100%	100%

24. Estimate the number of minor injuries avoided for each year in the period 2017-2060, in pole side impacts and other side impacts, under Options 3, 6a and 6b, relative to the business as usual scenario, using the incremental side impact restraint system effectiveness values established in step 15, and assuming past ratios of minor injured LPV and LCV occupants per seriously injured occupant in pole and other side impact crashes remain the same in future.

25. Establish the average cost saving (benefit) for each life saved, and case of serious and minor injury (including those with severe and moderate traumatic brain injuries) avoided.

Table 58 Casualty costs

Casualty Type	Average Cost Saving (benefit per incidence case avoided)	Source(s)
Fatality – pole side impact	$4,995,126	Life expectancy: ABS Average age of fatality: VicRoads Value Statistical Life Year: Abelson (2007) Inflation: RBA
Fatality – other side impact	$4,095,408	Life expectancy: ABS Average age of fatality: VicRoads Value Statistical Life Year: Abelson (2007) Inflation: RBA
Seriously Injured with Severe TBI	$5,568,000	Severe TBI ($2008): Access Economics 2009 Inflation: RBA
Seriously Injured with Moderate TBI	$2,900,000	Moderate TBI ($2008): Access Economics 2009 Inflation: RBA
Seriously Injured without TBI	$495,000	Calculated from BTE 2000 road crash costs and RBA inflation data
Minor Injuries Only	$3,280	Calculated from BTE 2000 road crash costs and RBA inflation data

26. Use the benefit and costs data established in the preceding steps to determine net benefits for each year in the period 2015-2060.

27. Determine the net present value of benefits, by discounting and summing the net benefits for each year after 2014 using a real discount rate of 7 per cent per annum.

28. Calculate benefit-cost ratios for the best case, likely case and worst case scenarios.

Table 59 Benefits – implementation of a fleet purchasing policy for LCVs (2016-2060) – Option 3

Year	Net Benefits			Lives Saved	Severe TBI Cases Avoided	Moderate TBI Cases Avoided	Total Reduction No. Seriously Injured Occupants	Total Reduction Occupants with Minor Injuries
	Best Case	Likely Case	Worst Case					
2015	-$72,000	-$72,000	-$72,000	0.00	0.00	0.00	0.00	0.00
2016	-$122,000	-$122,000	-$122,000	0.00	0.00	0.00	0.00	0.00
2017	-$122,000	-$122,000	-$122,000	0.00	0.00	0.00	0.00	0.00
2018	-$869,103	-$1,212,229	-$1,555,355	0.02	0.02	0.01	0.16	0.40
2019	-$72,912	-$407,825	-$742,739	0.07	0.07	0.03	0.61	1.48
2020	$699,696	$374,030	$48,365	0.11	0.13	0.05	1.04	2.54
2021	$1,421,308	$1,105,991	$790,674	0.15	0.18	0.07	1.44	3.52
2022	$2,087,534	$1,783,733	$1,479,931	0.19	0.22	0.09	1.81	4.42
2023	$2,667,043	$2,375,995	$2,084,946	0.22	0.26	0.10	2.13	5.20
2024	$3,174,134	$2,897,150	$2,620,167	0.25	0.29	0.12	2.40	5.88
2025	$3,631,509	$3,369,980	$3,108,452	0.28	0.32	0.13	2.64	6.48
2026	$3,972,419	$3,701,476	$3,430,532	0.30	0.35	0.14	2.86	7.03
2027	$4,299,522	$4,018,825	$3,738,127	0.32	0.38	0.15	3.07	7.56
2028	$4,625,057	$4,334,254	$4,043,452	0.34	0.40	0.16	3.29	8.09
2029	$4,955,554	$4,654,282	$4,353,011	0.36	0.43	0.17	3.50	8.63
2030	$5,301,450	$4,989,333	$4,677,216	0.38	0.46	0.18	3.73	9.20
2031	$5,712,267	$5,388,913	$5,065,560	0.40	0.48	0.19	3.95	9.76
2032	$6,037,129	$5,702,135	$5,367,140	0.42	0.51	0.20	4.17	10.30
2033	$7,152,957	$7,152,957	$7,152,957	0.42	0.51	0.21	4.22	10.42
2034	$6,706,419	$6,706,419	$6,706,419	0.39	0.48	0.19	3.97	9.82
2035	$6,244,882	$6,244,882	$6,244,882	0.36	0.45	0.18	3.71	9.19
2036	$5,769,644	$5,769,644	$5,769,644	0.33	0.42	0.17	3.44	8.53
2037	$5,280,688	$5,280,688	$5,280,688	0.30	0.39	0.15	3.16	7.85
2038	$4,815,158	$4,815,158	$4,815,158	0.27	0.35	0.14	2.89	7.19
2039	$4,368,442	$4,368,442	$4,368,442	0.24	0.32	0.13	2.63	6.56
2040	$3,937,948	$3,937,948	$3,937,948	0.22	0.29	0.12	2.38	5.94
2041	$3,511,242	$3,511,242	$3,511,242	0.19	0.26	0.10	2.13	5.32
2042	$3,109,741	$3,109,741	$3,109,741	0.17	0.23	0.09	1.90	4.74
2043	$2,727,905	$2,727,905	$2,727,905	0.15	0.20	0.08	1.67	4.17
2044	$2,361,761	$2,361,761	$2,361,761	0.13	0.18	0.07	1.45	3.63
2045	$2,009,980	$2,009,980	$2,009,980	0.11	0.15	0.06	1.24	3.10
2046	$1,690,513	$1,690,513	$1,690,513	0.09	0.13	0.05	1.05	2.62
2047	$1,407,960	$1,407,960	$1,407,960	0.07	0.11	0.04	0.87	2.20
2048	$1,157,840	$1,157,840	$1,157,840	0.06	0.09	0.04	0.72	1.82
2049	$915,229	$915,229	$915,229	0.05	0.07	0.03	0.57	1.44
2050	$686,782	$686,782	$686,782	0.03	0.05	0.02	0.43	1.09
2051	$496,157	$496,157	$496,157	0.02	0.04	0.02	0.31	0.79
2052	$347,388	$347,388	$347,388	0.02	0.03	0.01	0.22	0.56
2053	$237,022	$237,022	$237,022	0.01	0.02	0.01	0.15	0.38
2054	$156,193	$156,193	$156,193	0.01	0.01	0.00	0.10	0.25
2055	$83,095	$83,095	$83,095	0.00	0.01	0.00	0.05	0.14
2056	$38,183	$38,183	$38,183	0.00	0.00	0.00	0.02	0.06
2057	$11,584	$11,584	$11,584	0.00	0.00	0.00	0.01	0.02
2058	$0	$0	$0	0.00	0.00	0.00	0.00	0.00
2059	$0	$0	$0	0.00	0.00	0.00	0.00	0.00
2060	$0	$0	$0	0.00	0.00	0.00	0.00	0.00
	NPV Benefits			**7**	**9**	**4**	**76**	**188**
	$29,575,486	**$27,444,585**	**$25,313,683**					
	BCR							
	4.9	**3.8**	**3.1**					

Table 60 Benefits – implementation of a mandatory standard under the MVSA (2016-2060) – Option 6a

Year	Net Benefits			Lives Saved	Severe TBI Cases Avoided	Moderate TBI Cases Avoided	Total Reduction No. Seriously Injured Occupants	Total Reduction Occupants with Minor Injuries
	Best Case	Likely Case	Worst Case					
2015	-$768,000	-$768,000	-$768,000	0.00	0.00	0.00	0.00	0.00
2016	-$914,000	-$914,000	-$914,000	0.00	0.00	0.00	0.00	0.00
2017	-$3,861,735	-$5,351,671	-$6,841,606	0.09	0.08	0.05	1.11	3.03
2018	-$5,946,204	-$9,885,908	-$13,825,611	0.41	0.38	0.22	4.87	13.22
2019	-$5,171,730	-$12,029,947	-$18,888,163	1.00	0.93	0.53	11.52	31.09
2020	$4,033,842	-$3,920,395	-$11,874,633	1.76	1.67	0.93	20.10	54.02
2021	$19,664,524	$12,763,032	$5,861,540	2.52	2.42	1.33	28.56	76.53
2022	$34,215,533	$28,478,075	$22,740,617	3.19	3.08	1.68	36.10	96.71
2023	$47,375,063	$42,923,504	$38,471,945	3.75	3.64	1.98	42.50	113.94
2024	$57,825,137	$54,242,823	$50,660,509	4.22	4.10	2.24	47.98	128.89
2025	$65,080,431	$61,504,937	$57,929,443	4.65	4.51	2.48	53.15	143.11
2026	$72,008,146	$68,340,334	$64,672,521	5.08	4.93	2.72	58.32	157.43
2027	$79,184,809	$75,422,082	$71,659,356	5.52	5.35	2.97	63.68	172.32
2028	$86,627,224	$82,766,909	$78,906,594	5.98	5.80	3.23	69.25	187.82
2029	$94,264,579	$90,303,920	$86,343,261	6.45	6.25	3.49	74.97	203.78
2030	$102,164,163	$98,100,319	$94,036,476	6.93	6.72	3.77	80.88	220.33
2031	$110,842,118	$106,672,164	$102,502,210	7.42	7.19	4.04	86.81	236.97
2032	$124,261,203	$122,595,322	$120,929,440	7.76	7.53	4.24	91.04	248.96
2033	$130,312,751	$130,312,751	$130,312,751	7.80	7.59	4.28	91.79	251.49
2034	$128,717,748	$128,717,748	$128,717,748	7.68	7.48	4.24	91.00	250.06
2035	$125,979,486	$125,979,486	$125,979,486	7.50	7.30	4.16	89.37	246.27
2036	$122,193,685	$122,193,685	$122,193,685	7.26	7.07	4.05	86.95	240.26
2037	$117,111,438	$117,111,438	$117,111,438	6.94	6.77	3.89	83.56	231.51
2038	$111,119,321	$111,119,321	$111,119,321	6.57	6.41	3.70	79.49	220.76
2039	$104,379,614	$104,379,614	$104,379,614	6.16	6.02	3.49	74.84	208.36
2040	$97,034,418	$97,034,418	$97,034,418	5.72	5.58	3.25	69.73	194.61
2041	$89,393,752	$89,393,752	$89,393,752	5.26	5.14	3.00	64.38	180.12
2042	$81,514,895	$81,514,895	$81,514,895	4.78	4.68	2.74	58.82	164.95
2043	$73,488,399	$73,488,399	$73,488,399	4.31	4.21	2.48	53.13	149.34
2044	$65,598,978	$65,598,978	$65,598,978	3.84	3.76	2.22	47.52	133.88
2045	$57,512,108	$57,512,108	$57,512,108	3.36	3.29	1.95	41.74	117.89
2046	$49,748,035	$49,748,035	$49,748,035	2.90	2.84	1.69	36.17	102.43
2047	$42,001,494	$42,001,494	$42,001,494	2.45	2.40	1.43	30.59	86.81
2048	$34,935,542	$34,935,542	$34,935,542	2.03	1.99	1.19	25.48	72.47
2049	$28,075,864	$28,075,864	$28,075,864	1.63	1.60	0.96	20.50	58.45
2050	$22,032,029	$22,032,029	$22,032,029	1.28	1.26	0.75	16.12	46.08
2051	$16,884,470	$16,884,470	$16,884,470	0.98	0.96	0.58	12.38	35.50
2052	$12,808,729	$12,808,729	$12,808,729	0.74	0.73	0.44	9.42	27.08
2053	$9,603,077	$9,603,077	$9,603,077	0.55	0.54	0.33	7.08	20.42
2054	$7,038,155	$7,038,155	$7,038,155	0.41	0.40	0.24	5.20	15.06
2055	$5,006,095	$5,006,095	$5,006,095	0.29	0.28	0.17	3.72	10.80
2056	$3,487,986	$3,487,986	$3,487,986	0.20	0.19	0.12	2.60	7.59
2057	$2,342,848	$2,342,848	$2,342,848	0.14	0.13	0.08	1.75	5.15
2058	$1,531,847	$1,531,847	$1,531,847	0.09	0.08	0.05	1.15	3.39
2059	$932,197	$932,197	$932,197	0.05	0.05	0.03	0.70	2.07
2060	$439,285	$439,285	$439,285	0.03	0.02	0.02	0.33	0.98
	NPV Benefits			**158**	**153**	**87**	**1,876**	**5,172**
	$590,817,698	**$555,955,784**	**$521,093,870**					
	BCR							
	6.2	**4.7**	**3.8**					

Table 61 Benefits – implementation of a mandatory standard under the MVSA (2016-2060) – Option 6b

Year	Net Benefits			Lives Saved	Severe TBI Cases Avoided	Moderate TBI Cases Avoided	Total Reduction No. Seriously Injured Occupants	Total Reduction Occupants with Minor Injuries
	Best Case	Likely Case	Worst Case					
2015	-$696,000	-$696,000	-$696,000	0.00	0.00	0.00	0.00	0.00
2016	-$833,000	-$833,000	-$833,000	0.00	0.00	0.00	0.00	0.00
2017	-$3,780,735	-$5,270,671	-$6,760,606	0.09	0.08	0.05	1.11	3.03
2018	-$2,232,469	-$4,783,451	-$7,334,433	0.38	0.34	0.21	4.56	12.47
2019	$876,223	-$3,136,888	-$7,149,999	0.84	0.75	0.46	10.04	27.48
2020	$11,045,553	$7,460,401	$3,875,248	1.38	1.23	0.76	16.54	45.32
2021	$20,457,261	$17,318,791	$14,180,320	1.87	1.67	1.03	22.45	61.60
2022	$29,177,900	$26,505,413	$23,832,927	2.31	2.07	1.28	27.81	76.45
2023	$37,052,835	$34,866,227	$32,679,618	2.69	2.42	1.50	32.52	89.53
2024	$42,831,102	$40,600,761	$38,370,420	3.05	2.74	1.70	36.87	101.66
2025	$48,741,768	$46,466,821	$44,191,873	3.41	3.07	1.90	41.32	114.10
2026	$54,780,963	$52,460,517	$50,140,070	3.78	3.41	2.11	45.86	126.85
2027	$61,058,967	$58,692,112	$56,325,257	4.17	3.75	2.33	50.59	140.16
2028	$67,601,547	$65,187,354	$62,773,162	4.57	4.12	2.56	55.52	154.06
2029	$74,321,823	$71,859,346	$69,396,870	4.98	4.49	2.79	60.59	168.38
2030	$81,948,192	$79,436,466	$76,924,740	5.40	4.88	3.03	65.82	183.20
2031	$88,860,777	$86,298,816	$83,736,856	5.82	5.26	3.27	71.04	198.05
2032	$101,420,449	$101,420,449	$101,420,449	6.10	5.52	3.44	74.56	208.25
2033	$102,254,719	$102,254,719	$102,254,719	6.15	5.57	3.47	75.23	210.54
2034	$102,481,764	$102,481,764	$102,481,764	6.15	5.58	3.48	75.46	211.58
2035	$101,616,575	$101,616,575	$101,616,575	6.09	5.53	3.46	74.88	210.36
2036	$99,668,659	$99,668,659	$99,668,659	5.97	5.43	3.39	73.49	206.89
2037	$96,444,296	$96,444,296	$96,444,296	5.77	5.25	3.29	71.17	200.73
2038	$92,273,427	$92,273,427	$92,273,427	5.51	5.03	3.15	68.14	192.55
2039	$87,352,877	$87,352,877	$87,352,877	5.21	4.76	2.98	64.55	182.74
2040	$81,837,690	$81,837,690	$81,837,690	4.88	4.46	2.80	60.51	171.64
2041	$75,958,864	$75,958,864	$75,958,864	4.52	4.14	2.60	56.20	159.71
2042	$69,693,655	$69,693,655	$69,693,655	4.15	3.80	2.39	51.60	146.91
2043	$63,198,885	$63,198,885	$63,198,885	3.76	3.44	2.17	46.82	133.56
2044	$56,762,840	$56,762,840	$56,762,840	3.37	3.09	1.95	42.08	120.27
2045	$50,075,974	$50,075,974	$50,075,974	2.97	2.73	1.72	37.15	106.39
2046	$43,573,509	$43,573,509	$43,573,509	2.58	2.37	1.50	32.35	92.84
2047	$36,903,571	$36,903,571	$36,903,571	2.18	2.01	1.27	27.42	78.86
2048	$30,765,232	$30,765,232	$30,765,232	1.82	1.68	1.06	22.88	65.93
2049	$24,786,247	$24,786,247	$24,786,247	1.46	1.35	0.86	18.44	53.27
2050	$19,563,309	$19,563,309	$19,563,309	1.15	1.07	0.68	14.57	42.17
2051	$15,100,973	$15,100,973	$15,100,973	0.89	0.82	0.52	11.26	32.65
2052	$11,559,999	$11,559,999	$11,559,999	0.68	0.63	0.40	8.62	25.07
2053	$8,751,072	$8,751,072	$8,751,072	0.51	0.48	0.30	6.54	19.05
2054	$6,476,700	$6,476,700	$6,476,700	0.38	0.35	0.23	4.84	14.14
2055	$4,707,400	$4,707,400	$4,707,400	0.28	0.26	0.16	3.52	10.31
2056	$3,350,733	$3,350,733	$3,350,733	0.20	0.18	0.12	2.51	7.37
2057	$2,301,206	$2,301,206	$2,301,206	0.13	0.13	0.08	1.73	5.08
2058	$1,531,847	$1,531,847	$1,531,847	0.09	0.08	0.05	1.15	3.39
2059	$932,197	$932,197	$932,197	0.05	0.05	0.03	0.70	2.07
2060	$439,285	$439,285	$439,285	0.03	0.02	0.02	0.33	0.98
	NPV Benefits			**128**	**116**	**73**	**1,571**	**4,418**
	$448,034,511	**$467,501,397**	**$486,968,282**					
	BCR							
	8.4	**6.5**	**5.3**					

Summary

Table 62 Summary –Options 3, 6a and 6b

	Net Benefit	Cost to Business	Cost to Government	Benefit-Cost Ratio	Number of Lives Saved	Severe TBI Avoided	Moderate TBI Avoided
			Option 3				
Best Case	$29,575,486	$7,463,392	$97,632	4.9			
Likely Case	**$27,444,585**	**$9,594,293**	**$97,632**	**3.8**	**7**	**9**	**4**
Worst Case	$25,313,683	$11,725,195	$97,632	3.1			
			Option 6a				
Best Case	$590,817,698	$112,778,037	$488,161	6.2			
Likely Case	**$555,955,784**	**$147,639,951**	**$488,161**	**4.7**	**158**	**153**	**87**
Worst Case	$521,093,870	$182,501,865	$488,161	3.8			
			Option 6b				
Best Case	$486,968,282	$65,561,624	$472,332	8.4			
Likely Case	**$467,501,397**	**$85,028,509**	**$472,332**	**6.5**	**128**	**116**	**73**
Worst Case	$448,034,511	$104,495,395	$472,332	5.3			

APPENDIX 8—BENEFIT-COST ANALYSIS—SENSITIVITIES

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

a) Base case

Table 63 Basic output

	Net Benefit	Cost to Business	Cost to Government	Benefit Cost Ratio	Number of Lives Saved	Severe TBI Avoided	Moderate TBI Avoided
Best case	$590,817,698	$112,778,037	$488,161	6.2			
Likely case	**$555,955,784**	**$147,639,951**	**$488,161**	**4.7**	**158**	**153**	**87**
Worst case	$521,093,870	$182,501,865	$488,161	3.8			

b) Changes to discount rate

Table 64 Discount rate of 3 per cent

	Net Benefit	Cost to Business	Cost to Government	Benefit Cost Ratio	Number of Lives Saved	Severe TBI Avoided	Moderate TBI Avoided
Best case	$1,273,048,160	$163,839,303	$658,306	8.7			
Likely case	**$1,222,072,017**	**$214,815,447**	**$658,306**	**6.7**	**158**	**153**	**87**
Worst case	$1,171,095,874	$265,791,590	$658,306	5.4			

Table 65 Discount rate of 10 per cent

	Net Benefit	Cost to Business	Cost to Government	Benefit Cost Ratio	Number of Lives Saved	Severe TBI Avoided	Moderate TBI Avoided
Best case	$351,687,932	$87,318,678	$401,078	5.0			
Likely case	**$324,841,265**	**$114,165,345**	**$401,078**	**3.8**	**158**	**153**	**87**
Worst case	$297,994,598	$141,012,011	$401,078	3.1			

c) Changes to effectiveness

Table 66 Low effectiveness

	Net Benefit	Cost to Business	Cost to Government	Benefit Cost Ratio	Number of Lives Saved	Severe TBI Avoided	Moderate TBI Avoided
Best case	$381,138,289	$112,778,037	$488,161	4.4			
Likely case	**$346,276,375**	**$147,639,951**	**$488,161**	**3.3**	**110**	**108**	**61**
Worst case	$311,414,461	$182,501,865	$488,161	2.7			

Table 67 High effectiveness

	Net Benefit	Cost to Business	Cost to Government	Benefit Cost Ratio	Number of Lives Saved	Severe TBI Avoided	Moderate TBI Avoided
Best case	$800,497,107	$112,778,037	$488,161	8.1			
Likely case	**$765,635,193**	**$147,639,951**	**$488,161**	**6.2**	**205**	**199**	**114**
Worst case	$730,773,279	$182,501,865	$488,161	5.0			

d) Changes to business as usual compliance rate

Table 68 Low BAU compliance

	Net Benefit	Cost to Business	Cost to Government	Benefit Cost Ratio	Number of Lives Saved	Severe TBI Avoided	Moderate TBI Avoided
Best case	$687,825,938	$123,741,798	$488,161	6.5			
Likely case	**$649,309,437**	**$162,258,299**	**$488,161**	**5.0**	**186**	**179**	**103**
Worst case	$610,792,936	$200,774,800	$488,161	4.0			

Table 69 High BAU compliance

	Net Benefit	Cost to Business	Cost to Government	Benefit Cost Ratio	Number of Lives Saved	Severe TBI Avoided	Moderate TBI Avoided
Best case	$493,809,459	$101,814,277	$488,161	5.8			
Likely case	**$462,602,132**	**$133,021,604**	**$488,161**	**4.5**	**129**	**127**	**72**
Worst case	$431,394,805	$164,228,931	$488,161	3.6			

APPENDIX 9—TECHNICAL LIAISON GROUP (TLG)

Organisation
Manufacturer Representatives
Australian Road Transport Suppliers Association
Commercial Vehicle Industry Association
Federal Chamber of Automotive Industries
Federation of Automotive Product Manufacturers
Truck Industry Council
Bus Industry Confederation
Consumer Representatives
Australian Automotive Aftermarket Association
Australian Automobile Association
Australian Trucking Association
Australian Motorcycle Council
Government Representatives
Department of Infrastructure and Regional Development, Australian Government
Department of Transport, Energy and Infrastructure, South Australia
Department of Transport and Main Roads, Queensland
Transport for NSW, Centre for Road Safety, New South Wales
VicRoads, Victoria
Department of Transport, Western Australia
Transport Regulation, Justice & Community Safety, Australian Capital Territory
Department of Infrastructure, Energy and Resources, Tasmania
Department of Lands and Planning, Northern Territory
National Heavy Vehicle Regulator
New Zealand Transport Agency
Inter Governmental Agency
National Transport Commission

APPENDIX 10—ACRONYMS AND ABBREVIATIONS

AAA	Australian Automobile Association
ABS	Australian Bureau of Statistics
ADR	Australian Design Rule
AIS	Abbreviated Injury Scale
ANCAP	Australasian New Car Assessment Program
ATA	Australian Trucking Association
BAU	Business as Usual
BCR	Benefit-Cost Ratio
BITRE	Bureau of Infrastructure, Transport and Regional Economics
C&C Act	Competition and Consumer Act 2010
CEO	Chief Executive Officer
CIREN	Crash Injury Research Engineering Network
C-NCAP	China New Car Assessment Program
ESC	Electronic Stability Control
EU	European Union
Euro NCAP	European New Car Assessment Program
FAPM	Federation of Automotive Product Manufacturers
FCAI	Federal Chamber of Automotive Industries
FMVSS	Federal Motor Vehicle Safety Standard
FRCD	Fatal Road Crash Database
GTR	Global Technical Regulation
GVM	Gross Vehicle Mass
IIHS	Insurance Institute for Highway Safety
JNCAP	Japan New Car Assessment Program
KNCAP	Korean New Car Assessment Program
LCV	Light Commercial Vehicle
LPV	Light Passenger Vehicle
MUARC	Monash University Accident Research Centre
MVSA	*Motor Vehicle Standards Act 1989*
NCAP	New Car Assessment Program
NHTSA	National Highway Traffic Safety Administration
NPV	Net Present Value
NRMA	National Roads and Motorists' Association
NRSS	National Road Safety Strategy 2011-2020
PSI	Pole Side Impact
RAC	Royal Automobile Club of Western Australia
RACV	Royal Automobile Club of Victoria
R.E.3	Consolidated Resolution on the Construction of Vehicles
RIS	Regulation Impact Statement
RVCS	Road Vehicle Certification System
S.R.1	1998 Global Agreement Special Resolution No. 1
SUV	Sports Utility Vehicle

SVSEG	Strategic Vehicle Safety and Environment Group
TAC	Transport Accident Commission of Victoria
TBI	Traumatic brain injury
TISOC	Transport and Infrastructure Senior Officials’ Committee
TLG	Technical Liaison Group
UN	United Nations
WorldSID	Worldwide harmonized Side Impact Dummy
WP.29	World Forum for the Harmonisation of Vehicle Regulations