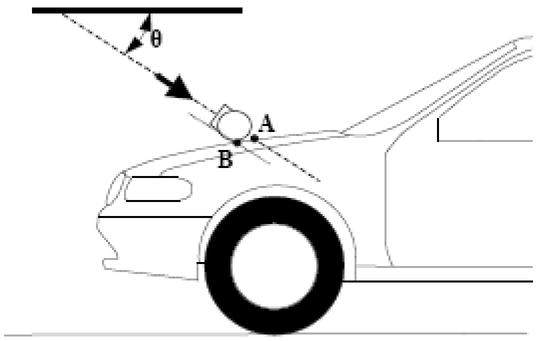
Australian Government

Department of Infrastructure and Transport

Regulation Impact Statement

for

Pedestrian Safety



Prepared by:

Vehicle Safety Standards Branch of the
Department of Infrastructure and Transport
Canberra, Australia

Department of Infrastructure and Transport

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ABSTRACT

In Australia, during the period of 2000 to 2009, an average of 232 pedestrians and 31 cyclists were killed each year as a result of collisions with vehicles. There have been a number of approaches to reducing the cost to the community of these crashes. However, the problem remains a long running one throughout the world.

Research has shown that modifications to the design of vehicle fronts can increase the chance of a vulnerable road user, such as a pedestrian or a cyclist, surviving a collision.

The Australian vehicle market has responded to the problem of pedestrian trauma by developing measures for pedestrian protection. However, manufacturers and importers in Australia have indicated that there is no overall plan for the future in this regard. In addition, as the measures reduce road trauma for pedestrians, there is little incentive for a vehicle owner to demand pedestrian friendly designs from the vehicle manufacturer. There are currently no vehicle regulations in Australia dealing explicitly with the safety of vulnerable road users such as pedestrians or cyclists.

This Regulation Impact Statement (RIS) examined the case for Australian Government intervention aimed at improving the pedestrian safety performance of the Australian new vehicle fleet. A total of six options, including both regulatory and non-regulatory options, were identified to address the problem. It was recommended that a mandatory standard, known as an Australian Design Rule (ADR) under the *Motor Vehicle Standards Act 1989 (Cwth)* (MVSA) be implemented. This would result in net benefits and a number of lives saved of $185m and 65 respectively, as well as over 3,000 serious injuries saved, assuming that the standard was active for fifteen years.

The recommended standard to be applied was the internationally accepted Global Technical Regulation (GTR) No. 9 Pedestrian Safety, as adopted by the United Nations (UN) through the UN Economic Commission for Europe (UNECE) regulations. The standard would be applied to the Australian vehicle categories of MA (passenger cars), MB (passenger vans), MC (four-wheel drives or Sports Utility Vehicles) and NA (light commercial vehicles) over a phase-in period of 2013 to 2019, depending on the vehicle mass and whether the vehicle was a new model or ongoing model. “Flat fronted” vehicles would be exempted.

Compliance with pedestrian safety requirements would in all certainty be affected by the practice of fitting aftermarket Vehicle Front Protection Systems (VFPS) (known as “bull bars”) to vehicles. Although this comes under state and territory legislation rather than Commonwealth legislation, it was proposed that the fitting of VFPS to new vehicles could be accommodated through the ADRs. Stringent requirements based on European Union Directive 2005/66/EC would be placed on VFPS fitted to passenger cars and two-wheel drive light commercial vehicles. Adjustments based on compliance to part or all of Australian Standard AS 4876.1 for VFPS (bull bars) would be applied to vehicles purposely designed for off-road use i.e. Sport Utility Vehicles and light commercial vehicles with four-wheel drive. The implementation timing would match that of the base vehicle, the intention being to maintain the pedestrian safety performance of the base vehicle, rather than set requirements for VFPS alone.

As part of the RIS process, the proposal will be circulated for 60 days public comment. The Federal Minister for Infrastructure and Transport may subsequently choose to determine an ADR under section 7 of the MVSA.

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EXECUTIVE SUMMARY

Between 2000 and 2009, an average of 232 pedestrians and 31 cyclists were killed each year in Australia as a result of a collision with a vehicle. Serious injuries averaged at 2732 for pedestrians and approximately 960 for cyclists each year over the period 2000 to 2007.

There have been a number of approaches to reducing the cost to the community of these crashes. Most of these have aimed at preventing crashes from occurring through the use of education programs, punitive measures and infrastructure improvements. Although they have met with some success, the problem remains a long running one throughout the world.

Research has shown that modifying the design of the front structure of a vehicle could increase the chance of a vulnerable road user, such as a pedestrian or a cyclist, surviving a collision with a vehicle. Europe and Japan have introduced mandatory standards which specify a minimum level of performance in a series of pedestrian impact tests.

The current voluntary fitment rate of passive pedestrian safety measures in the Australian vehicle market was estimated at 26 per cent for passenger cars and Sports Utility Vehicles (SUVs) and zero per cent for Light Commercial Vehicles (LCVs). Although the Australian vehicle market has responded to the problem by developing some of these measures, it may be for the most part a response to the European and Japanese regulation. Vehicle manufacturers in Australia have indicated that they have no overall plan for improving pedestrian safety into the future.

An international standard, Global Technical Regulation (GTR) No. 9 Pedestrian Safety, GTR 9, was adopted by the United Nations in November 2008. Australia, along with other signatory countries under the *Agreement Concerning the Establishing of Global Technical Regulations for Wheeled Vehicles Equipment and Parts which can be Fitted and/or be Used on Wheeled Vehicles* of June 1998, is obliged to review the case for adopting GTR 9 under its domestic legislation.

Australia is considering applying GTR 9 to the Australian vehicle categories of MA (passenger cars), MB (passenger vans), MC (four-wheel drives or Sports Utility Vehicles) and NA (light commercial vehicles). These categories are a subset of the categories covered by GTR 9 and are the same as the corresponding United Nations Economic Commission for Europe (UNECE) regulation. In addition, and in line with GTR 9 and the UNECE regulation, it is not proposed to apply the requirements to “flat fronted” vehicles of category NA as well as “flat fronted” vehicles of category MA, MB and MC that are above 2,500 kg and which are derived from NA category vehicles.

Alternatives to mandating GTR 9 include: no action (business as usual), adopting a user information campaign, requiring government fleets to purchase GTR 9 compliant vehicles, introducing a voluntary or mandatory code of practice for vehicle suppliers, and mandating a standard under the Trade Practices Act. Of these options, business as usual, a user information campaign and a fleet purchasing requirement were considered feasible and examined in more detail.

The voluntary fitment rate for the business as usual case started at 26 per cent for passenger cars and SUVs and zero per cent for LCVs, reaching levels of 60 per cent and 39 per cent respectively by 2018. The expected effectiveness of the other options was: 45 per cent (for a user information campaign), 41 per cent (for fleet purchasing policies – cars and SUVs), 50 per cent (for fleet purchasing policies – LCVs) and 100 per cent (for mandating GTR 9).

A summary of the benefits, costs, Benefit-Cost Ratios and number of lives saved is shown below.

Summary of Net Benefits, Total Benefits, Costs, Benefit-Cost Ratios and Lives Saved under various scenarios

	Net Benefits ($m)			**Total Benefits ($m)**		
	Best Case	Likely Case	Worst Case	Best Case	Likely Case	Worst Case
Option 1 No intervention	-	-	-	-	-	-
Option 2 Information campaigns	33	18	3	81	81	81
Option 3 Fleet policies	202	155	107	262	262	262
Option 6 Regulation	248	185	122	347	347	347

	Costs ($m)			**Benefit-Cost Ratio**		
	Best Case	Likely Case	Worst Case	Best Case	Likely Case	Worst Case
Option 1 No intervention	-	-	-	-	-	-
Option 2 Information campaigns	49	64	78	1.7	1.4	1.0
Option 3 Fleet policies	60	108	155	4.4	3.0	1.7
Option 6 Regulation	99	162	225	3.5	2.5	1.5

	Lives Saved		
	Best Case	Likely Case	Worst Case
Option 1 No intervention	-	-	-
Option 2 Information campaigns	8	8	8
Option 3 Fleet policies	29	29	29
Option 6 Regulation	65	65	65

Best Case - minimum costs; Likely Case - average costs; Worst Case - maximum costs

Option 6: Mandating GTR 9 in Australia gave the highest net benefits and number of lives saved at $185m and 65 respectively, as well as over 3,000 serious injuries saved, over a forty six year period of analysis (assuming that the standard was active for fifteen years within this period). This was under the assumption that the final voluntary level of take-up of pedestrian safety measures by the vehicle manufacturers would otherwise reach 60 per cent for passenger cars and SUVs and 39 per cent for LCVs (for those vehicles required to meet pedestrian safety regulations by 2018).

A sensitivity analysis was undertaken for Option 6: Mandating GTR 9 in Australia and was conducted on three variables: the effectiveness of pedestrian safety measures; the voluntary take-up rate of pedestrian safety measures; and the discount rate. The net benefits from Option 6 remained positive under all but one of the scenarios tested. However, this scenario was highly unlikely and the net benefits were only slightly negative.

It is proposed to recommend that Global Technical Regulation (GTR) No. 9 Pedestrian Safety, as adopted by the UN through the United Nations Economic Commission for Europe (UNECE) regulations be mandated in Australia and applied to the Australian vehicle categories of MA (passenger cars), MB (passenger vans), MC (four-wheel drives or Sports Utility Vehicles) and NA (light commercial vehicles). In line with GTR 9 and the UNECE regulation, the requirements would not apply to “flat fronted” vehicles of category NA as well as “flat fronted” vehicles of category MA, MB and MC that are above 2,500 kg and which are derived from NA category vehicles.

For vehicles of category MA, MB and MC not exceeding 2,500 kg and vehicles of category NA derived from them, the requirements should apply to new vehicle models as of 24 February 2013 and all new vehicles as of 24 February 2018. A longer lead-time should be allowed for vehicles of category MA, MB and MC exceeding 2,500 kg and category NA other than those mentioned above. In this case, requirements should apply to new vehicles models from 24 February 2015 and all new vehicles from 24 August 2019. The timing chosen by the UNECE would accommodate the relatively long lead time needed to redesign the front structure of the current models, or to supersede the current models where necessary.

Compliance with pedestrian safety requirements would in all certainty be affected by the practice of fitting Vehicle Front Protection Systems (VFPS) (known as “bull bars”) to vehicles. An analysis of this potential impact was discussed separately to the recommendation for the compliance of vehicles, as it mainly involved the fitting of aftermarket products which in turn come under state and territory legislation rather than Commonwealth legislation. The results generally showed that it is likely that there would still be net benefits gained by regulation of the base vehicles, regardless of whether compliance of VFPS to pedestrian safety requirements was also mandated.

Nevertheless, it is proposed that through the ADRs, the fitting of a VFPS could be considered in terms of whether the base vehicle has been designed for off-road operation and hence primarily rural/outback use. Adjustments for VFPS could be limited to vehicles purposely designed for off-road use (Sport Utility Vehicles (MC) and light commercial vehicles (NA) with four-wheel drive), with other vehicles (passenger cars (MA) and two-wheel drive light commercial vehicles (NA)) required to meet more stringent requirements, most likely achieved by owners fitting a deformable polymer VFPS or a nudge bar. These requirements would be similar to European Union (EU) Directive 2005/66/EC that directly addresses the pedestrian performance of VFPS and complements the requirements of the GTR. The adjustments to these requirements would involve adopting some or all parts of Australian Standard for VFPS (bull bars) AS 4876.1 2002. Motor Vehicle Frontal Protection Systems. Part 1: Road User Protection, Sections 1, 2 , 3.1 and 3.2. The implementation timing would be the same as that of the base vehicle, the intention being to maintain the pedestrian safety performance of the base vehicle, rather than set requirements for VFPS alone.

As part of the RIS process, the proposal will be circulated for 60 days public comment. The Department has already sought views, through the established ADR consultative forums, from the state and territory transport authorities regarding pedestrian protection and again separately regarding VFPS and any comment has been considered when writing this RIS. However, it is expected that a majority of the information and views will follow during the public comment period. A summary of public comment input and departmental responses will be included in the final RIS that is used for decision making.

1. STATEMENT OF 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, wage loss, 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 conservatively estimated to be at least $18 billion per annum (Australian Transport Council, 2008). This translates to an average of $805 for every person in Australia. The cost is borne widely by the general public, business, and government. It has a further impact on the wellbeing of families that is not possible to measure.

While the majority of pedestrian injuries in the road environment are not vehicle related (Frith and Thomas, 2010), around the world vulnerable road users such as pedestrians and cyclists make up between 13 and 45 per cent of all road related fatalities where a vehicle is involved. Within Australia, which has one of the lowest rates at around14 per cent, this still represents over 200 fatalities per year (Bosch, 2008).

There have been a number of approaches employed to reduce the cost to the community of crashes between vehicles and pedestrians. These have for the most part utilised initiatives to avoid the crashes from occurring, such as education programs, punitive measures and infrastructure improvements. These approaches have met with some success but the problem remains a long running one.

Over the past few decades research conducted in the area of vehicle safety and safety standards has been limited to improving the protection of vehicle occupants. More recently, it has now also started to consider the protection of vulnerable road users through changes to the design of vehicles. It has been shown that modifications to the design of vehicle fronts can increase the chance of a vulnerable road user such as a pedestrian or a cyclist surviving a collision with a vehicle. Some countries are now beginning to mandate a minimum level of pedestrian protection in new models of passenger vehicles. In Australia, there are currently no regulations dealing explicitly with vulnerable road user safety.

This Regulation Impact Statement (RIS) examines whether there is a need for Australian Government intervention, to be aimed at the new vehicle fleet, in order to reduce the number of fatalities and injuries sustained in collisions between vehicles and vulnerable road users such as pedestrians and cyclists.

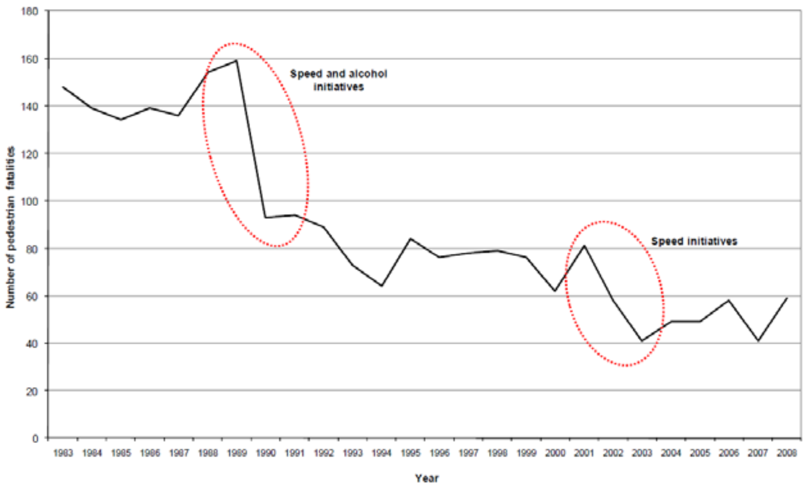
1.2. Background

Crashes that involve vulnerable road users such as pedestrians and cyclists represent a major road safety problem world-wide (Devlin et al, 2010). As already noted, between 13 and 48 per cent (14 per cent in Australia) of all road related fatalities in the world where a vehicle is involved impacts on this road user group. There is some evidence that vehicle drivers are largely to blame when collisions occur, at least with cyclists (Weston, 2010).

The most vulnerable subgroups of pedestrians continue to be: children, the elderly and the intoxicated, with the contributory risk factors varying between these three high risk pedestrian groups (Devlin et al, 2010).

In Australia, there have been some successes in reducing this number, for example the state of Victoria's two major speed (and alcohol) initiatives in 1990 and 2003 as shown in Figure 1. Educational, awareness and behaviour change programs are seen as vital to the success of improving pedestrian safe mobility, although very few programs have been developed for the purposes of educating adults about alcohol impairment and its effect on pedestrian safety (Devlin et al, 2010). Geometric countermeasures are also seen as important. This includes the separating where possible traffic and pedestrian flows.

Figure 1 Number of pedestrian fatalities from 1983 to 2008 in Victoria



Source: Devlin et al, 2010

However, it has been reported that the general trend for pedestrian deaths appears to be on the incline again in Victoria (Devlin et al, 2010) and this can also be seen in Figure 1. Given that walking, as an active transport mode, is being encouraged by both the Australian and New Zealand Governments as part of a push towards safe sustainable transport (Frith and Thomas, 2010) the problem is "likely to grow if initiatives that promote walking and public transport use are successful in increasing the amount of walking without concurrent improvements in road safety initiatives" (Devlin et al, 2010). It could therefore be expected that the problem will increase further, not only given the increase in the activity of vulnerable road users but also the increase in vehicle ownership predicted to occur over the coming years.

The National Road Safety Strategy sets out Australia's objectives, targets and priorities for road safety improvements. Using what is known as the Safe System approach, this "reflects international best practice as defined in the Organisation of Economic Cooperation and Development's landmark 2008 report *Towards Zero: Ambitious Road Safety Targets and the Safe System Approach*. This report was prepared with substantial involvement of Australian road safety officials and practitioners." (National Road Safety Council, 2010).

The Safe System approach was officially endorsed by the Australian Transport Council in 2004. It has guided the development of subsequent National Road Safety Action Plans and will underpin the development of the National Road Safety Strategy for 2011 to 2020

The approach is structured around four essential elements:

1. safe roads
2. safe vehicles
3. safe speeds
4. safe road users.

The Safe System approach is focused on making the road transport system more forgiving of human error. In designing and managing roads, vehicles and travel speeds, the aim is to reduce crash risk and ensure that road users can withstand the physical forces generated in crashes (National Road Safety Council, 2010). In a recent Austroads paper, it was argued that the approach of emphasizing behavioural interventions needs to be further complemented by the other factors (particularly vehicle and road countermeasures) and that “ direct behavioural strategies, certainly relative to road improvement programs, have a more modest role to play in achieving further road toll reductions” (Langford, 2005).

When it comes to pedestrian safety and vehicle design, there are two primary means of improving the safety of a vehicle. The first involves the use of active safety systems, such as those for braking and lighting, which assist the driver in preventing a crash. The second involves the use of passive safety systems, such as seatbelts and supplemental restraints which provide protection should a crash occur.

The most common type of collision between a pedestrian and a vehicle involves the pedestrian being struck by the front of the vehicle. The first point of contact is generally between the vehicle bumper and the leg. This is usually followed by the hip striking the edge of the bonnet, and then the head and chest striking the vehicle bonnet or windscreen. Consequently, many injuries that result from collisions between vehicles and pedestrians are inflicted by the frontal structures of vehicles.

This RIS examines passive safety measures to reduce the injury potential of the frontal structures of vehicles such as bumpers and bonnets. By modifying these structures, the energy transmitted to a pedestrian upon impact may be able to be reduced, thereby reducing the level of injury.

Pedestrian safety of vehicles is already being regulated in some overseas markets. In November 2003, the European Council introduced Directive 2003/102/EC, requiring that, from 1 October 2005, all new types of passenger vehicles sold in Europe meet a specified level of performance in what are known as headform and legform impact tests. These tests utilise instrumented head and leg shapes to replicate the forces on the human body when colliding with a vehicle. In Japan, all new models of passenger vehicles introduced after 1 September 2005 must comply with pedestrian headform impact performance requirements. However, there are currently no legform requirements.

Following the Directive, the United Nations Economic Commission for Europe (UNECE) established a new Global Technical Regulation (GTR) 9 on pedestrian safety in November 2008. This regulation is open for adoption by contracting parties (which includes Australia) under the international *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 (the 1998 Agreement). In addition, as a contracting party to the 1998 Agreement, Australia is obliged to consider the case for adopting GTR 9 as its national standard for pedestrian safety.

A second, more stringent phase of the Directive was due to be introduced in 2011. However, after the establishment of the GTR, Regulation EC 78/2009 was instead put in place. This regulation has been phased in from November 2009, repealing the original Directive 2003/102/EC and aligning the passive safety requirements with those of the GTR.

The UNECE is currently working towards adopting GTR 9 on pedestrian safety as a full UNECE regulation under the *Agreement concerning the Adoption of Uniform Conditions of Approval and Reciprocal Recognition of Approval for Motor Vehicle Equipment and Parts* of March 1958 (the 1958 Agreement). Australia is also contracting party to the 1958 agreement for developing UNECE regulations (separately to the 1998 Agreement for developing the GTRs). The (currently draft) UNECE regulation reflects most of the requirements of the GTR but has a narrower scope of vehicles that it applies to. It also adds implementation timing, something that the GTR does not contain in its role as template legislation.

Given the enduring problem of crashes between vehicles and vulnerable road users, despite the best efforts to date of governments around the world, there is still much to be achieved. The problem can only be expected to get worse as populations increase and there is a further push towards sustainable transport, leading to higher percentages of pedestrians interacting with vehicles. In not considering vehicle countermeasures such as GTR 9, the opportunity to reverse this trend could be lost.

As with any vehicle safety initiative in Australia, there are a number of options that need to be examined when considering Government intervention. These include both non-regulatory and/or regulatory means such as the use of market forces, manufacturers' commitments, codes of practice, public education campaigns, fleet purchasing policies and regulation through the Australian Design Rules (ADRs).

2. THE EXTENT OF THE PROBLEM

Over the past ten years, on average, 232 pedestrians were killed in collisions with vehicles each year (Department of Infrastructure, Transport, Regional Development and Local Government, 2009). During this same period, an average of 2732 pedestrians were seriously injured each year (Henley and Harrison, 2009). In 2009, pedestrian fatalities accounted for approximately 14 per cent of all fatalities on the roads. Table 1 shows the breakdown of vehicle types involved in fatal road crashes in Australia for the period of 1999 to 2001. The percentages shown remain current to 2009. It can be seen that 78 per cent of fatal pedestrian crashes involve either passenger cars, Forward Control Vans (FCVs), four-wheel drives (4WDs or Sports Utility Vehicles (SUVs)), including some Light Commercial Vehicles (LCVs). Under the ADRs, these vehicles are classed as MA, MB, MC and NA categories. Refer to Appendix 1 - Vehicle Categories for details on ADR categories.

Table 1 Vehicles involved in fatal road crashes, by crash type: 1999 to 2001

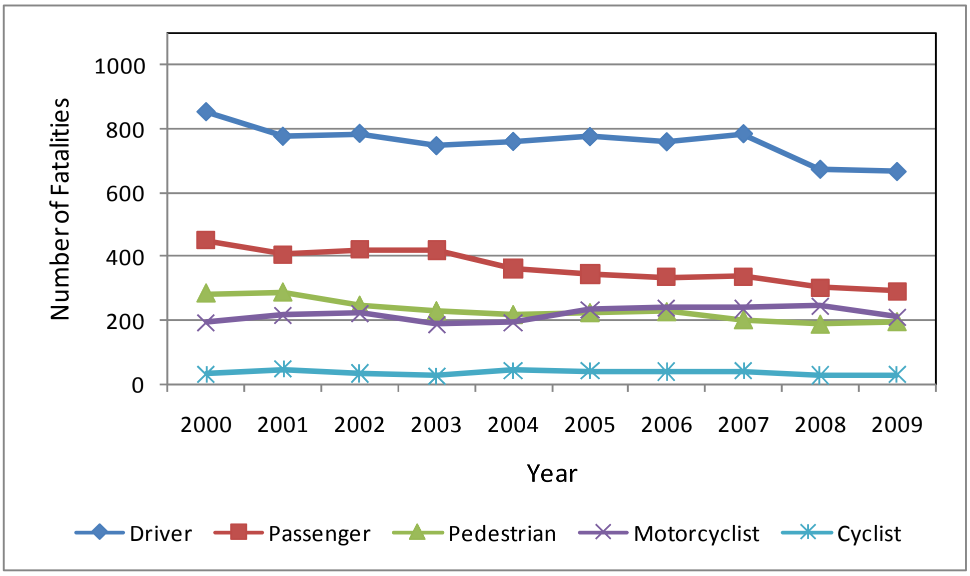
	Single Vehicle		**Multiple Vehicle**		**Pedestrian**	
Car	1122	71%	2021	62%	547	67%
4WD & FCV	273	17%	372	11%	89	11%
Bus	5	0%	45	1%	29	4%
Rigid truck	122	8%	475	15%	102	13%
Art. Truck	61	4%	354	11%	45	6%
Total	1583	100%	3267	100%	812	100%

Source: DITRDLG Australian Road Deaths Database

A review of fatal pedestrian crashes in South Australia reported that in 84 per cent of fatal pedestrian crashes the pedestrian was struck by the front of the vehicle (Anderson, 2008). Because passive pedestrian safety measures are targeted at vehicle fronts, 84 per cent of the above pedestrian crashes could therefore potentially be influenced by the implementation of passive pedestrian safety measures.

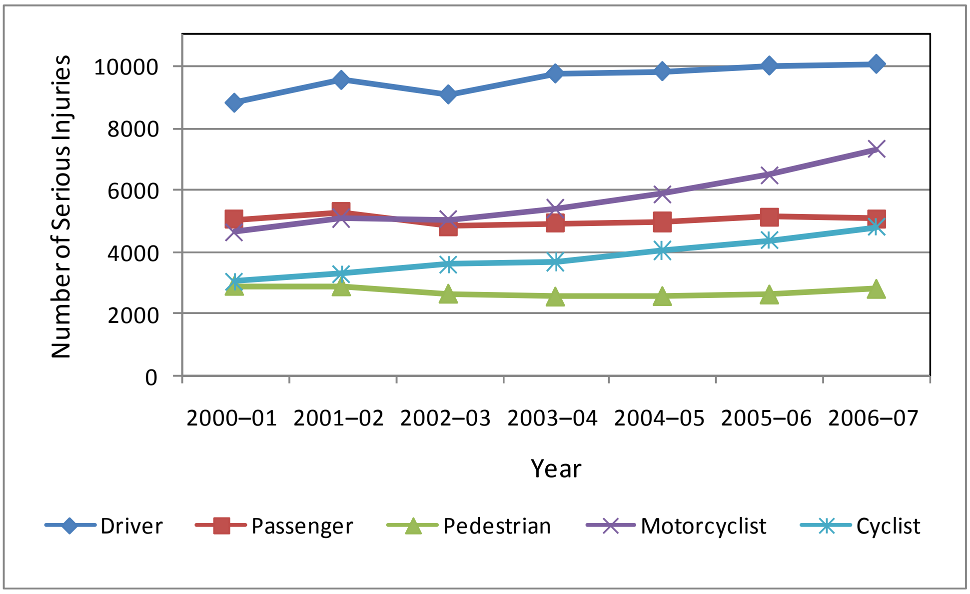
The number of pedestrian fatalities and serious injuries in Australia during the period of 1999 to 2009 are shown in Figure 2 and Figure 3 respectively. The typical ratio of serious injuries to fatalities of pedestrians in crashes can be seen by comparing these two figures. There were approximately 11 serious injuries for each fatality.

Figure 2 Road deaths by road user, Australia: 2000 to 2009



Source: DITRDLG Australian Road Deaths Database

Figure 3 Serious injuries by road user, Australia: 2000 to 2006



Source: Henley and Harrison, 2009

National data could not be obtained for minor injuries. However, over a ten year period, the Victorian CrashStats database showed that pedestrian crashes in Victoria resulted in 529 fatalities, 6299 serious injuries, and 7640 minor injuries. This equates to 11.9 serious injuries and 14.4 minor injuries per fatality. Given that the ratio of serious injuries to fatalities matched the national data reasonably well, it was assumed that the Victorian statistics would be representative of the national case for minor injuries. It was also assumed that the rate of fatalities and injuries would be proportional to vehicle sales into the future and so, as highlighted in Section 1.2, would not be expected to decline naturally in the future at an acceptable rate, if at all. Notwithstanding this, to better account for these assumptions an injury rate equal to only half of the above reported statistics was adopted later during the analysis.

Although research into vulnerable road users and vehicle safety measures has focused predominantly on improving the protection of pedestrians, several effectiveness studies have concluded that pedestrian safety measures would also be beneficial for cyclists. In Australia, on average, 31 cyclists are killed each year in crashes involving vehicles (DITRDLG, 2009). In addition, on average, 3830 cyclists are seriously injured each year in transport related accidents, with approximately quarter of these serious injuries resulting from collisions with vehicles (Henley and Harrison, 2009). The Victorian CrashStats database showed that by including cyclist crashes along with pedestrian crashes, the ratio of injuries to fatalities would become 15.6 serious injuries and 23.8 minor injuries per fatality. It was again assumed that the Victorian statistics would be representative of the national case for injuries.

3. WHY GOVERNMENT INTERVENTION MAY BE NEEDED

Government intervention may be needed when the market fails to provide the most efficient and effective solution to a problem. In the case of pedestrian safety in vehicle crashes, an externality exists that market forces may not be able to correct. This is because the individual who pays for the pedestrian protection does not receive the main benefit of it. The main benefit is received by the pedestrian, or other vulnerable road user, through the reduction of road trauma and not by the owner responsible for making the purchasing decision regarding the vehicle.

3.1. Market response

Research into pedestrian safety first began in the 1970s. Many of the early studies were aimed at reproducing the sequence of events observed in a collision between a vehicle and a pedestrian. This allowed for the identification of vehicle structures that most determine the injuries sustained by pedestrians and subsequently, the development of test methods to assess the level of pedestrian protection offered by a vehicle.

In addition to passive pedestrian safety (injury reduction once a collision has occurred), some manufacturers have been researching the use of active pedestrian safety systems. These systems act to prevent collisions in the first place. For example, Volvo has recently released the Collision Warning with Full Auto Brake and Pedestrian Detection system with its S60 model. This system detects pedestrians, warns the driver and applies the vehicle's brakes automatically if it determines that a collision is imminent.

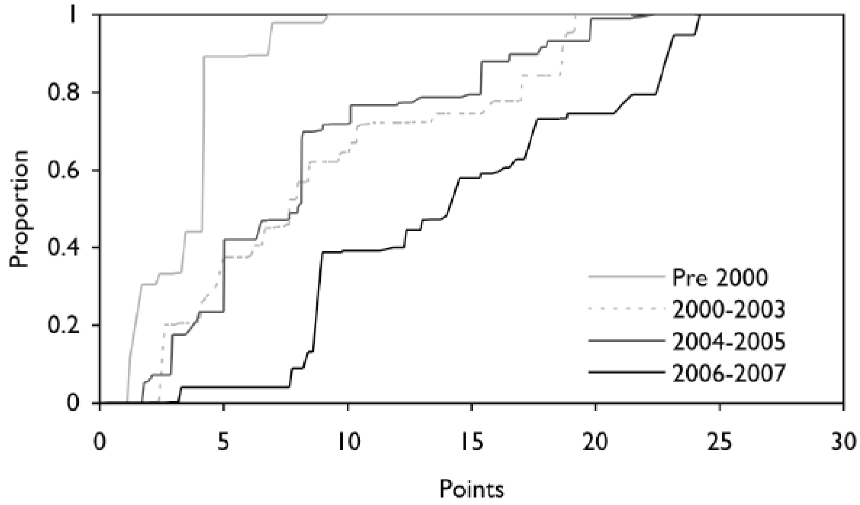
In 1992, the Australasian New Car Assessment Program (ANCAP) was established in Australia with the aim of providing consumers with information on the level of occupant protection provided by vehicles. Similarly, the European New Car Assessment Programme (EuroNCAP) commenced in 1997. Its test regime included a series of pedestrian impact tests and in 2000, ANCAP aligned itself with EuroNCAP by adding pedestrian safety to its own program. By providing consumers with information on the pedestrian safety of vehicles, these programs aim to increase consumer demand for pedestrian friendly vehicles. This provides vehicle manufacturers with an incentive to voluntarily produce vehicles to a higher level of pedestrian safety.

More recently, regulation was introduced in both Europe and Japan requiring that, as of late 2005, all new vehicle models manufactured in Europe and Japan comply with pedestrian safety standards.

New car assessment program ratings can provide a measure of the response of the market to these non-regulatory and regulatory actions. Based on the results of pedestrian impact tests under ANCAP/ EuroNCAP, a vehicle may be awarded a maximum of 36 points. In a recent study, Anderson et al (2008) of the Centre for Automotive Safety Research investigated whether there was a correlation between point scores under ANCAP/ EuroNCAP testing and the technical requirements of GTR 9. The authors estimated that a vehicle that would pass the GTR would score a minimum of 18 ANCAP/ EuroNCAP points.

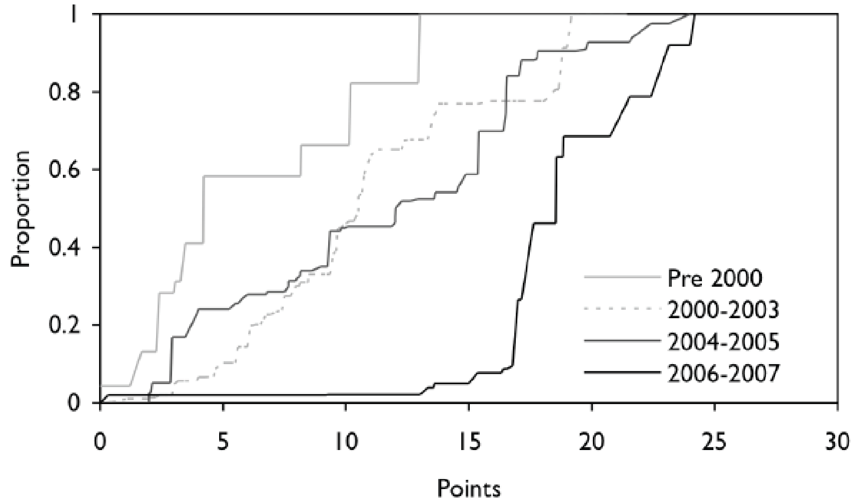
Anderson et al graphed the cumulative ANCAP/EuroNCAP performance of the Australian and European new car fleets by model release year, as shown in Figures 4 and 5 respectively. It can be seen that, in both jurisdictions, the ANCAP/EuroNCAP point score of vehicles released in more recent years is generally higher than that of vehicles released in earlier periods.

Figure 4 Cumulative Australian new car fleet performance by model release year



Source: Anderson et al, 2008

Figure 5 Cumulative European Union new car fleet performance by model release year



Source: Anderson et al, 2008

Using Anderson et al's correlation between ANCAP/EuroNCAP point scores and performance in GTR testing, the proportion of the new vehicle fleet both in Australia and Europe that would meet the GTR was estimated for various points in time. The results are summarised in Table 2.

Table 2 Percentage of new vehicle fleet estimated to pass the requirements of GTR 9

	Pre 2000 - No Intervention	**2004-2005 - Voluntary Programs**	**2006-2007 - EU Directive**
Australia	0%	8%	27%
Europe	0%	9%	54%

As seen in Table 2, of the vehicles released before the introduction of ANCAP pedestrian safety testing and overseas regulation, that is, before 2000, none scored the 18 points needed to pass the GTR. In fact, the majority of pre 2000 vehicles, approximately 90 per cent in Australia and 60 per cent in the EU, received a score of less than 5 points. During the period of 2000 to 2004, the new vehicle fleet performance, as measured by ANCAP/EuroNCAP ratings, improved considerably both in Australia and the EU. Approximately 8 per cent and 9 per cent of new vehicles released in 2004-2005 in Australia and the EU respectively were estimated to pass the GTR.

An even more notable improvement can be observed following the introduction of regulation in Europe and Japan. Of new vehicles released in 2006-2007 in the EU, 54 per cent were estimated to pass the GTR. During this same period, the pedestrian safety performance of the Australian new car fleet showed significant improvement in the absence of an Australian regulation on pedestrian safety. However, this was to a lesser extent than in the EU, with 27 per cent of new vehicles released in Australia in 2006-2007 estimated to pass the GTR. Furthermore, as a significant proportion of the Australian new car fleet is imported from Japan and Europe, it is possible that some of this improvement may have occurred as a result of the introduction of regulations in these countries. As more stringent requirements are due to be introduced in the EU in 2013 it is possible that, even without regulation in Australia, the pedestrian safety of the Australian fleet will improve in the future. However, there is no guarantee as to the extent of improvement that will be achieved without government intervention.

3.2. Objective of Government Intervention

A general objective of the Australian Government is to establish the most appropriate measure(s) for delivering safer vehicles to the Australian community. The specific objective of this RIS is to examine the case for government intervention to improve the pedestrian safety performance of the new vehicle fleet in Australia.

Where intervention involves the use of regulation, the Council of Australian Governments (COAG) has endorsed a set of Principles and Guidelines for Ministerial Councils and Standards Setting Bodies, for assessing new regulatory proposals or reviewing existing regulations (COAG, 2004). These Principles are shown in Box 1.

Box 1 Principles of good regulation

Principles of good regulation

- Minimising the impact of regulation
- Minimising the impact on competition
- Predictability of outcomes
- Adopt international standards and practices
- Regulations should not restrict international trade
- Regular review of regulation
- Flexibility of standards and regulations
- Standardise the exercise of bureaucratic discretion

Source: COAG, 2004

The Principles and Guidelines are available from:
<*http://www.finance.gov.au/obpr/docs/COAG_best_practice_guide_2007.pdf*>.

The Agreement on Technical Barriers to Trade, to which Australia is a signatory, requires contracting parties to adopt international standards where they are available or imminent.

4. EXISTING REGULATIONS

The Australian Government provides protection for new vehicle consumers through the *Trade Practices Act 1974* (C'th) (TPA) and the *Motor Vehicle Standards Act 1989* (C'th) (MVSA).

The TPA provides consumer protection and quality of supply of product. The MVSA provides mandatory vehicle safety, emission and anti-theft standards with which suppliers of new vehicles are required to comply. These are national standards and are known as the Australian Design Rules (ADRs).

There are currently no ADRs relating to the protection of pedestrians or other vulnerable road users in the event of a collision with a vehicle.

5. OPTIONS

The available options are listed below.

5.1. 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 pedestrian friendly vehicles using information campaigns (suasion).

Option 3: Fleet purchasing policies

Only allow vehicles that provide a certain level of pedestrian safety for government purchases (economic approach).

5.2. 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 pedestrian safety under the *Trade Practices Act 1974* (C'th) (TPA). Alternatively, mandate a code of practice under the TPA (regulatory – voluntary/mandatory).

Option 5: Mandatory standards under the TPA

Mandate standards for pedestrian safety under the *Trade Practices Act 1974* (C'th) (TPA) (regulatory – mandatory).

Option 6: Mandatory standards under the MVSA

Develop (where applicable) and mandate standards for pedestrian safety under the *Motor Vehicle Standards Act 1989* (C'th) (MVSA) based on the international standard adopted by the UNECE as GTR No. 9 (regulatory – mandatory).

6. DISCUSSION OF THE OPTIONS

6.1. Option 1: No intervention

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

The current level of pedestrian safety has been achieved without regulation in Australia. However, as previously noted, there have been a number of actions, both in Australia and overseas, that have likely contributed to the current position. The current voluntary compliance of the Australian new vehicle fleet with GTR 9 on pedestrian safety was estimated in more detail than previously (see Table 2) from the results of a recent study conducted by Searson et al (2009). The aim of this study was to evaluate how many vehicles tested by ANCAP would be expected to pass the GTR. Of the 33 current vehicle models examined, 23 were passenger cars or Sports Utility Vehicles (SUVs) and 10 were Light Commercial Vehicles (LCVs). Six of the passenger cars and SUVs (26 per cent) were estimated to pass the requirements of the GTR. None of the ten LCVs were estimated to pass.

To determine the proportion of the Australian vehicle fleet expected to meet the GTR into the future, Australian manufacturers and importers were requested late in 2009 through the Federal Chamber of Automotive Industries (FCAI) to indicate their future plans. However, the FCAI were unable to provide any overall plan for compliance to the GTR.

Therefore, the final level of compliance expected to be achieved without any form of intervention was estimated from the proportion of vehicles imported from the EU and Japan. The European Union pedestrian safety regulation is already aligned with the GTR and it is expected that the Japanese standard will soon follow. Passenger vehicles imported from the EU and Japan represent approximately 72 per cent of total imports of passenger vehicles to Australia (Department of Foreign Affairs and Trade, 2009). Since around 84 per cent of Australia's vehicles are imported, it was estimated that 60 per cent ($72\% \times 84\% = 60\%$) of the Australian passenger vehicle fleet is likely to meet the GTR in the future without Australian Government intervention. In a similar way, it was also estimated that 39 per cent of LCVs are likely to meet the GTR in the future.

6.2. Option 2: User Information Campaigns

Inform consumers about the benefits of pedestrian friendly vehicles using information campaigns (suasion).

User information campaigns can be used to promote the benefits of safer vehicles and so encourage consumer demand. Campaigns may be carried out by the private sector, the public sector, or a combination of the two. They can be effective where the information being provided is simple to comprehend and unambiguous. They can be targeted towards the single consumer or to those who make significant purchase decisions, such as private or government fleet owners.

Appendix 3 - Awareness and Advertising Campaigns, details two real life examples of awareness campaigns; a broad high cost approach and a targeted low cost approach. The broad high cost approach cost $6m and provided a benefit-cost ratio of 5. The targeted low cost approach cost $1m and generated an awareness of 77 per cent. It was run over a period of four months.

In the case of pedestrian safety, a targeted approach would be most suitable, as the target market would consist solely of new vehicle buyers. However, it was recognised that the figures provided could be indicative only, as the campaigns do not relate to pedestrian safety or even to automotive related topics. Furthermore, it does not necessarily follow that increased awareness will translate directly into increased sales. This is particularly true in the case of pedestrian safety, where the target of the awareness campaign (the vehicle buyer) does not receive the main benefit (reduction in pedestrian injuries). In relation to this, in a consumer survey conducted by EuroNCAP (EuroNCAP, 2005), approximately 58 per cent of respondents said that the protection of pedestrians would influence their choice in purchasing a vehicle. Therefore, it was assumed that a campaign that generates an awareness of 77 per cent would at best result in a 45 per cent (58% × 77%) take-up of pedestrian friendly vehicles. It is likely that an awareness campaign would need to be run on a continuous basis to maintain its effectiveness.

Advertising campaigns were also considered as a means of increasing the uptake of pedestrian friendly vehicles. A typical cost for a three month campaign consisting of television, newspaper and magazine advertisements is $5m (*Average Advertising Costs* n.d.). Some research into advertising showed that for general goods, advertising campaigns can lead to an increase of around 8 per cent in sales (Radio Ad Lab, 2005). This is consistent with a recent result achieved by a Mitsubishi campaign promoting the safety feature of Active Stability Control. Although not directly related to pedestrian safety, this campaign is considered relevant as it focused on the promotion of a vehicle safety feature. Again, however, in the case of pedestrian safety (where the car buyer does not receive the primary benefit of the safety feature), it is likely that an advertising campaign would not be as effective. This is underscored by the current minimal promotion of passive pedestrian safety features in advertising by vehicle manufacturers. Because of this, and because of the high cost of advertising campaigns, it was decided that an awareness campaign would be the more feasible option that should be considered further. Table 3 provides a summary of the cost and effectiveness of various information campaigns.

Table 3 Estimated cost and effectiveness of various campaign types

Campaign	Estimated cost ($m)	Expected effectiveness
Awareness - broad	6	$5 benefit/$1 spent
Awareness – targeted *	1 per four month campaign, or 3 per year	Total of 77% awareness and 45% sales (but no greater than existing sales if already more than 45%)
Advertising	1.5 per month campaign, or 18 per year	8 % increase in existing sales

* Subsequently used towards a benefit-cost analysis

6.3. Option 3: Fleet purchasing policies

Only allow vehicles that provide a minimum level of pedestrian safety for government purchases (economic approach).

According to the Australasian Fleet Managers Association (AFMA), some 50 per cent of new car purchases in Australia are made through fleet purchase programs ("Fleet safety upgrade to flow on", 2008). This includes vehicles that are provided as part of remuneration packages as well as those used as part of general fleets. Therefore, fleet purchasers wield large market power and can influence manufacturers to make certain features as standard (Koppel, Charlton & Fildes, 2007). The specifications of Holden's fleet buyer models are defined by the fleet buyers (Gearin, 2006).

The government could intervene through fleet purchasing by favouring vehicle models that provide a certain level of pedestrian safety and by persuading manufacturers to improve vehicles currently not meeting this level.

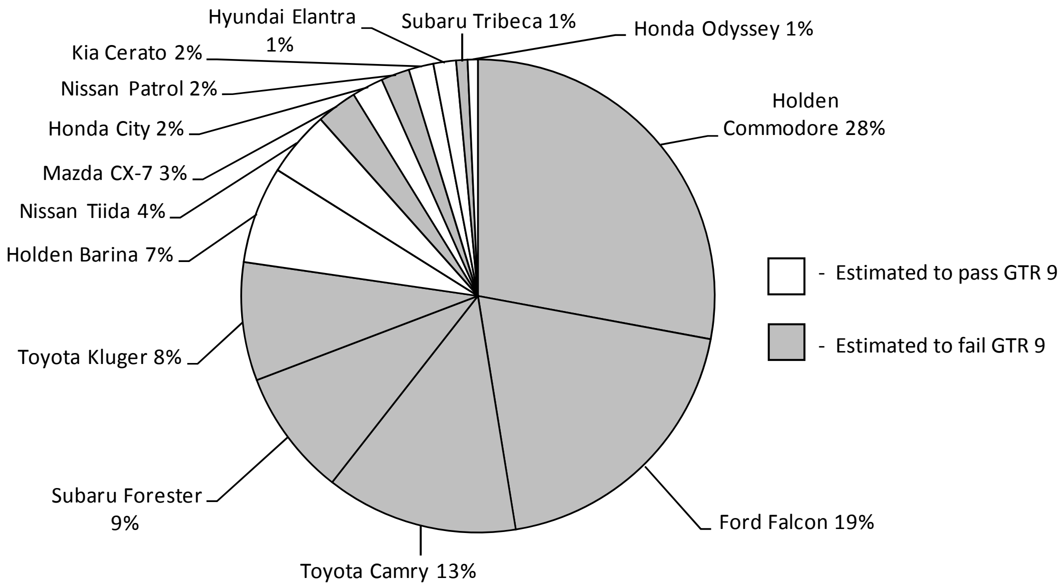
Further reasons for targeting fleet purchasing are:

- there is substantial evidence that fleet drivers have an increased crash risk compared to private registered vehicle drivers (Bibbings, 1997);
- ex-fleet vehicles are often sold after 2-3 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 National Road Safety Action Plan 2009 and 2010 (Australian Transport Council, 2008) lists fleet purchasing policies as one of its highest impact actions directed at accelerating the market penetration of advanced vehicle safety features. It specifies that these policies should have regard to high vehicle safety standards for both occupants and pedestrians. Currently, pedestrian safety is not a primary consideration in fleet purchasing policies. However, there are examples of governments, such as the South Australian government, listing a high pedestrian safety ANCAP rating as a desirable feature that should be given priority in the vehicle selection process.

The level of pedestrian safety offered by fleets can be estimated by considering the 33 current vehicle models assessed in the study discussed earlier by Searson et al (2009). Of the 23 passenger car and SUV models assessed, six were estimated to pass GTR 9 on pedestrian safety while eight were estimated to fail. The remaining nine models were considered likely to pass the GTR with little or no modification. Considering only those models assessed as a straight pass or fail, approximately 82 per cent by sales volume were estimated to fail the GTR. These are shown in Figure 6.

Figure 6 Estimated compliance of fourteen passenger car and SUV models with GTR 9, by sales volume



Source: Searson et al, 2009; FCAI, 2009

Given that 50 per cent of new car purchases are made through fleet purchase programs, it was assumed that fleet purchasing policies could potentially increase the number of passenger cars and SUVs expected to pass the GTR by 41 per cent (82% × 50%). Of the ten LCV models assessed by Searson et al, none were estimated to pass GTR 9. Therefore, it was assumed that fleet purchasing policies could potentially increase the number of LCVs expected to pass the GTR by 50 per cent (100% × 50%).

It is expected that vehicles purchased through fleet programs would flow through the vehicle fleet as ex-fleet vehicles are sold to the public. This would increase the resulting benefits. However, while 50 per cent of new vehicle purchases are made through fleet purchase programs, this includes both private and government fleets. Government fleet purchases alone account for only 7 per cent of new car purchases (Western Australian Office of Road Safety, 2009). Although the implementation of a government fleet purchasing policy may influence some private fleet purchasers to put in place similar policies, the extent of this influence is likely to be much reduced. Given this, it was decided that the initial estimate of a 41 per cent increase through fleet purchasing policies for passenger cars and SUVs and 50 per cent increase for LCVs would be a very generous value.

The cost of implementing a fleet purchasing policy would be minimal as it only involves a negotiated agreement with fleet managers to select only those vehicles that provide a certain level of pedestrian safety. The costs would be those relating to the negotiation processes (say $50,000 per year) plus any lost opportunity for the fleet in foregoing a vehicle model that may (other than for its pedestrian safety performance) be better placed to meet a particular fleet requirement (this latter aspect could not be estimated).

6.4. Option 4: Codes of practice

Allow road vehicle supplier associations, with government assistance, to initiate and monitor a voluntary code of practice for pedestrian under the *Trade Practices Act 1974* (C'th). Alternatively, mandate a code of practice under the *Trade Practices Act 1974* (C'th) (regulatory – voluntary/mandatory).

A code of practice can be either voluntary or mandatory as provided for under the *Trade Practices Act 1974* (C'th) (TPA). Part IVB – Industry Codes. There are 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 to legislated standards, voluntary codes of practice offer the opportunity for a high degree of industry involvement, 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 (Grey Letter Law, 1997)[1]. The Australian new vehicle industry is well placed to provide a collaborative voice on pedestrian safety. Of the manufacturers and importers involved with new passenger cars, the Federation of Automotive Product Manufacturers (FAPM) and the Federal Chamber of Automotive Industries (FCAI) represent 40 per cent and 99 per cent [2] respectively of the total.

Voluntary codes of practice work best when the industry itself gains from adhering to the code of practice. In the case of pedestrian safety, the main benefits would be received by the wider community and therefore there may be insufficient motivation for industry to participate. Furthermore, breaches would be difficult to detect and would usually only be revealed through failures in the field or by third party reporting. Therefore, any reduction in implementation costs over mandated intervention would need to be balanced against the consequences of these failures.

It would be difficult to separate this option from the no-intervention option and therefore it 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 design and construction of motor vehicles, the responsible government agency (Department of Infrastructure and Transport) has existing legislation, expertise, resources and well-established systems to administer a compliance regime that would be more effective than a mandatory code of practice. This option was not considered further.

[1] Grey Letter Law, Report to the Commonwealth Interdepartmental Committee on Quasi Regulation, 1997

[2] 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.

6.5. Option 5: Mandatory standards under the TPA

Mandate standards under the *Trade Practices Act 1974* (C'th) (regulatory – mandatory).

As with codes of practice, standards can be either voluntary or mandatory as provided for under the *Trade Practices Act 1974* (C'th) (TPA). Section 65C – Product safety standards and unsafe goods, allows the prescription of mandatory product safety standards. There are remedies for those who suffer loss or damage due to a product not meeting prescribed standards.

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

This option was not considered any further.

6.6. Option 6: Mandatory standards under the MVSA

Develop (where applicable) and mandate standards for pedestrian safety under the *Motor Vehicle Standards Act 1989* (C'th) (MVSA) based on the international standard adopted by the UNECE as GTR No. 9 (regulatory – mandatory).

In November 2008, the United Nations Economic Commission for Europe (UNECE) adopted Global Technical Regulation (GTR) No. 9 – Pedestrian Safety, under the *Agreement Concerning the Establishing of Global Technical Regulations for Wheeled Vehicles Equipment and Parts of June 1998* (the 1998 Agreement). GTR 9 is based largely on the work of the International Harmonised Research Activities (IHRA) Pedestrian Safety Working Group. As a contracting member to the 1998 Agreement, Australia must subject GTR 9 to its domestic rulemaking process and then advise the Secretary-General of the United Nations whether it has decided to adopt any or all of the requirements (ECE, 2002). For more details of GTR 9 refer to Appendix 4 - Overview of Global Technical Regulation No. 9.

The UNECE is currently working towards adopting GTR 9 on pedestrian safety as a UNECE regulation under the *Agreement concerning the Adoption of Uniform Conditions of Approval and Reciprocal Recognition of Approval for Motor Vehicle Equipment and Parts* of March 1958 (the 1958 Agreement). Australia is also contracting party to the 1958 agreement for developing UNECE regulations (separately to the 1998 Agreement for developing the GTRs).

A GTR functions as a global "template" regulation, and therefore does not contain any implementation timing. It is left to the contracting parties to determine their own timetable, including any phasing-in or delay in implementation. A UNECE regulation, on the other hand, is a working regulation that can give effect to GTR requirements at an international level, and includes implementation timing. Although the GTR does specify a scope, it also states that a contracting party may restrict application of the requirements to a narrower group of vehicles if it decides that such restriction is appropriate. The (currently draft) UNECE regulation reflects most of the requirements of the GTR but has a narrower scope of vehicles that it applies to.

Timing of the regulations

The draft UNECE regulation on pedestrian safety contains the same implementation timetable as the European based regulation EC 78/2009. As the GTR does not contain implementation timing, the draft UNECE regulation contains the only internationally agreed timing available. European Regulation EC 78/2009 sets out a phase-in approach. For vehicles of category M1 not exceeding 2,500 kg GVM and category N1 derived from them, requirements in line with those of the GTR will apply to new vehicle types as of 24 February 2013 and all new vehicles as of 24 February 2018. A longer lead-time has been allowed for vehicles of category M1 exceeding 2,500 kg and category N1 other than those mentioned above. In this case, requirements will apply to new vehicles types from 24 February 2015 and all new vehicles from 24 August 2019.

Scope of the regulations

Currently, the GTR on pedestrian safety applies to vehicle categories (as defined in 1998 Global Agreement Special Resolution No. 1): 1-1 with a gross vehicle mass (GVM) exceeding 500 kg; 1-2 with a GVM exceeding 500 kg but not exceeding 4,500 kg; 2 with a GVM exceeding 500 kg but not exceeding 4,500 kg. Power driven vehicles of category 1-2 and category 2, where the distance, measured longitudinally on a horizontal plane, between the transverse centre line of the front axle and the R-point of the driver's seat is less than 1,000 mm, are exempt from the requirements of the GTR.

The vehicle categories subject to GTR 9 translate closest to the Australian categories of MA (passenger cars), MB (passenger vans), MC (four-wheel drives or Sports Utility Vehicles) greater than 500 kg; MD1, MD2 and MD3 greater than 500 kg and less than or equal to 4,500 kg (small and medium buses); as well as NA and NB1 greater than 500 kg and less than or equal to 4,500 kg (light and medium commercial vehicles) (refer Appendix 1 - Vehicle Categories). However, the development text for the GTR recognises that a contracting party may limit domestic regulation to a narrower group of vehicles as appropriate.

The lighter NA category consists of passenger car based utilities such as those based on the Holden Commodore or Ford Falcon, as well as light vans such as the Volkswagen Transporter and Hyundai iLoad. It also includes slightly heavier cab-chassis based utilities, such as the Holden Rodeo, Toyota Hilux and the Mitsubishi Triton, as well as various campervans, hearses and some ambulances.

The heavier NB category consists of larger vans such as the Mercedes Sprinter and Iveco Daily, as well as conventional truck chassis such as the Mitsubishi Canter, Hino 300 and Isuzu NH. It also includes some heavy trucks that would straddle the US 4,536 kg limit, such as the Isuzu NPR 400, and Iveco Daily and Mercedes Sprinter vans, as well as a number of motorhomes based on these or other chassis.

The light bus category MD1 includes the Toyota Landcruiser bus and a low volume limousine. The Toyota Hiace bus is the only vehicle in the MD2 category and the MD3 category includes the Ford Transit, Mercedes Sprinter and some low volume limousines.

The draft UNECE regulation, like the EU regulation, applies to a narrower group of vehicles than the GTR, namely, vehicles of category M1 and N1 (as defined in Annex 7 to the Consolidated Resolution on the Construction of vehicles (R.E.3)). 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).

Currently, the draft UNECE regulation does not apply to vehicles of category N1 and vehicles of category M1 above 2,500 kg maximum mass and which are derived from N1 category vehicles, where the driver's position "R-point" is either forward of the front axle or longitudinally rearwards of the front axle transverse centreline by a maximum of 1100 mm. This is to exempt flat fronted vehicles from pedestrian safety requirements. These types of vehicles would not have a front structure suitable for pedestrian safety measures to be included.

This exemption is slightly more generous than an otherwise similar provision in GTR 9. However, a later UN proposal to amend the scope of the GTR was recently adopted. The proposal effectively aligned the GTR more closely with the UNECE requirements.

There is also a further UN proposal to amend the draft UNECE regulation to make the exemption of M1 optional rather than automatic. This would align the draft regulation with further recent amendments to GTR 9.

There is no equivalent vehicle categorisation in the Australian system for vehicles "where the driver's position "R-point" is either forward of the front axle or longitudinally rearwards of the front axle transverse centreline by a maximum of 1100 mm" - although this is likely to cover some MB category passenger vans at least - and so this exemption would have to be determined through manufacturers' data for each particular model. Flat fronted light commercial vans such as the Toyota Hiace and Mitsubishi Express would be likely to fall under this exemption.

Performance Requirements

GTR 9 consists of two sets of performance requirements, head impact requirements and leg impact requirements. The head impact tests involve propelling child and adult headforms at the bonnet (within a specified region) at a velocity of 35 km/h. The angle at which the headform is propelled depends on the headform used. The Head Injury Criterion (HIC) must not exceed 1,000 over one half of a child headform test area and must not exceed 1,000 over two thirds of a combined child and adult headform test areas. The HIC for the remaining areas must not exceed 1,700 for both headforms.

The leg impact test involves propelling a legform at the vehicle bumper at a velocity of 40 km/h. The height of the lower bumper determines whether a lower legform impactor or an upper legform impactor is used. In the lower legform to bumper test, vehicles must meet limits on lateral knee bending angle, knee shearing displacement, and lateral tibia acceleration. In the upper legform to bumper test, limits are placed on the instantaneous sum of the impact forces with respect to time and the bending moment on the test impactor.

Relationship to other legislated requirements

Where a standard has been mandated as an Australian Design Rule (ADR) under the *Motor Vehicle Standards Act 1989* (C'th) (MVSA), the ADR becomes applicable for new vehicles in accordance with its prescribed implementation scope and timing.

It was previously noted that there are currently no ADRs directly relating to the protection of pedestrians and other vulnerable road users in the event of a collision with a vehicle. Notwithstanding this, ADR 42/04 General Safety Requirements does specify design and construction requirements that prohibit any object fitted to a vehicle from increasing the risk of injury of any person. In the case of external protrusions at the front of the vehicle, this is a requirement that can affect pedestrian safety.

The relevant clauses are as follows:

> **11. EXTERNAL OR INTERNAL PROTRUSIONS**
> 11.1. No vehicle must be equipped with:
> 11.1.1. any object or fitting, not technically essential to such vehicle, which protrudes from any part of the vehicle so that it is likely to increase the risk of bodily injury to any person;
> 11.1.2. any object or fitting technically essential to such vehicle unless its design, construction and conditions and the manner in which it is affixed to the vehicle are such as to reduce to a minimum the risk of bodily injury to any person;
> 11.1.3. any object or fitting which, because it is pointed or has a sharp edge, is likely to increase the risk of bodily injury to any person; or
> 11.1.4. any bumper bar the end of which is not turned towards the body of the vehicle to a sufficient extent to avoid any risk of hooking or grazing.

Clauses 11.1.1 and 11.1.2 do not set a value for performance of a vehicle in terms of pedestrian safety. Instead, they only require that any additional "objects or fittings" must be technically essential and that the risk of injury in having them must be reduced as much as possible (in still allowing the objects to fulfil their function).

The fitting of extra equipment against this requirement is almost exclusively an aftermarket activity. Vehicle manufacturers rarely elect to certify such equipment during certification of the vehicle for supply to the market under the MVSA. Because of this, enforcement of the above clauses for the most part falls within state and territory vehicle standards requirements. These requirements are aligned to a greater or lesser degree with national in-service template regulations known as the Australian Vehicle Standards Rules (AVSRs). The AVSRs in turn require vehicles to continue to comply with the ADRs (that were in force when the vehicle was originally built) after they have been supplied to the market and used on the road. This is generally accepted as being from the point of registration onwards. The practical effect of this is that the issue of fitting extra equipment lies substantially beyond the scope of this RIS, which is only able to examine proposals for changing Commonwealth legislation (the ADRs).

However, it is acknowledged that there is an aftermarket industry in Australia that provides such extra equipment for vehicles. The Australian Automotive Aftermarket Association (AAAA) advises that there are currently 1250 manufacturers, distributors, wholesalers, importers and retailers of automotive parts and accessories, tools and equipment in the aftermarket industry in Australia, with an aggregate gross annual turnover of $5 billion and employing 30,000 people (AAAA, 2010). In particular, there are around 190 companies, including the major manufacturers, which have an interest in four-wheel drive accessories such as Vehicle Front Protection Systems (VFPS). VFPS are structures, commonly known as a “bull-bars”, which are fitted to the front of a vehicle. Their purpose is to provide a strong location point for recovery devices such as winches. They also provide a strengthening or energy absorbing capacity to minimise the damage to the front of a vehicle from animal strikes.

It is further acknowledged that due to the follow-on nature of ADRs and state and territory regulations (i.e. vehicles must continue to comply with the ADRs) aftermarket VFPS manufacturers could be affected by any changes to pedestrian safety requirements within the ADRs. While there are currently no VFPS certified in conjunction with a new vehicle, a number are available as dealer options and again as aftermarket products for vehicles that are already in use on the roads.

Therefore, VFPS were considered further as part of the analysis of impacts to business in Section 8.2 and also in Section 9.9.

7. ECONOMIC ASPECTS - BENEFIT-COST ANALYSIS

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 that the benefits are assumed to be generated over is the life of the vehicle(s). Benefit-Cost Ratios (BCRs) are also calculated to show whether the returns (benefits) on a project outweigh the resources outlaid (cost) and indicate what this difference is.

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

In the case of pedestrian safety, the construction of a vehicle with pedestrian safety measures would be fundamentally the same as a vehicle without these measures, and so the performance and aesthetics of the vehicle would not be affected. Therefore, there would be no opportunity costs for consumers associated with the purchase of a pedestrian friendly vehicle. Additionally, it is not expected that the repair costs would be affected. In 2008, NRMA Insurance conducted testing to look at the repair costs of nine of Australia's top selling small vehicles (NRMA, 2008). The Toyota Corolla, which performed well in the EURO NCAP pedestrian safety program, was the cheapest of the nine cars to repair. As noted by NRMA Insurance Head of Research Robert

McDonald “this proves that manufacturers can design vehicles that can perform well in both pedestrian safety and vehicle protection".

Calculations were started at the current estimated voluntary compliance rate of 26 per cent for passenger cars and SUVs and 0 per cent for LCVs. The results of each option were compared to what would happen if there was no government intervention, i.e. Option 1, the Business As Usual (BAU) case. Under the BAU case it was expected that the voluntary compliance rate would reach 60 per cent for passenger cars and SUVs and 39 per cent for LCVs by 2018.

The analysis model that was used had the capacity to calculate over a 46 year period of analysis. All options were given a starting point of 2010, but for Option 6 Regulation, which in reality would have a staggered introduction of the regulation between 2013 and 2018 for some types of vehicles and 2015 to 2019 for others (see Section 6.6), the starting point was set conservatively as 2015 to 2019 for all vehicles. By then running the analysis model such that the regulation option remained in force for 15 years (i.e. after 15 years from the first phase-in date of 2015) the regulation would be withdrawn or replaced), this took the analysis to 2030. All options were then set to have this same end date of implementation. There then followed a 26 year period for the full set of benefits from each option to be realised over the life of a cohort of vehicles. As the options other than the regulation option were able to be implemented straightaway from 2010, their period of effectiveness added to a total of 21 years. It was necessary to run the analysis over such a long period because in the general case, road safety benefits from improving the performance of vehicles are realised gradually as the fleet is first replaced and then the vehicles age and crash over a crash period of about 26 years for each vehicle. This is discussed further below.

The calculations used a method that accounted for variations in both crash likelihood and vehicle registrations over a possible 26 year vehicle crash life, as originally developed by Fildes (2002). Thus, the benefits were controlled for the risk that a crash would occur during a particular year of a vehicle’s life. The crash likelihoods represented historical crash rates and as such were a good approximation of the crash profile of an average vehicle. The average crash age of a vehicle under this model was around 10-15 years. It should be made clear that the average crash age of a vehicle is not the same as the average age of a vehicle. By way of example, a cohort of vehicles in the fleet crashes very little in the first few years of its life and, due to scrappage and/or reduced use, decreasingly in the last fifteen years of its life. Under this model, it was not necessary to determine the average age of a vehicle.

The benefits were calculated using established monetary values representing fatalities, serious injuries and minor injuries as well as associated vehicle repair and administration costs. It was assumed that these injuries would remain proportional to the expanding human population and vehicular population in Australia over the coming years, as discussed earlier in Section 2. These values represented an average cost of crashes. However, it was recognised that the crash rate used was based on Victorian data rather than the whole of Australia and that other efforts to reduce pedestrian fatalities (speed and alcohol initiatives, road design, education, etc) are expected to continue into the future. Given this, it is possible that the national trend of falling fatalities shown earlier in Figure 2, could continue (although the same could not be said of serious injury levels as shown in Figure 3). Therefore, to be very conservative, the crash rate used for the analysis was halved for all injury levels.

Vehicle repair costs were correlated to injury severity rather than crash type. Although there may have been an argument that vulnerable road users that are involved in crashes would be expected to result in less vehicle damage than if the crash had occurred with another vehicle, this was not shown to be true, due to evidence found of a generally high degree of post-crash towing where injuries were more severe, regardless of the crash type. Post-crash towing in turn was associated through insurance data with higher levels of vehicle damage and so vehicle repair costs (Bureau of Transport Economics, 2000). Notwithstanding the above, vehicle repair costs have been determined to be in the order of one quarter of the total cost of an average crash. This value in turn would be reduced by about two thirds if it was assumed that all tow-away crash damage became drive-away damage instead. This equates to around 15 per cent of the total crash costs (Bureau of Transport Economics, 2000). A very conservative position was again taken in the analysis by reducing the benefits by this 15 per cent.

A detailed explanation of the method can be found in Appendix 7 - Benefit-Cost Analysis – Methodology.

Vehicle fleet

In the Australian new vehicle market there are a number of vehicles registered each year that fall under an Australian Design Rule (ADR) vehicle category relevant to this analysis. These are detailed in Table 4 below.

Table 4 Details of the new vehicle fleet

ADR Category	Description	Number of Makes	Number of Models	Number of Vehicles
MA	Passenger car	61	246	540,562
MB	Passenger van			
MC	SUV		61	188,153
NA	Light goods van/ute/SUV	44	81	181,058

Source: FCAI, 2009; Dept of Infrastructure, Transport, Regional Development and Local Government, 2009

There is a model changeover approximately every five years. In assuming a five year model life, it was determined that there were an average of 49.2 new passenger car models, 12.2 new SUV models and 16.2 new LCV models per year.

Costs

For the non-regulatory options, the costs were discussed earlier in the RIS and summarised in Table 3 Estimated cost and effectiveness of various campaign types. These costs represented the non regulatory intervention methods (awareness campaigns, advertising campaigns etc). The actual fitment, development and (as relevant) regulatory costs are discussed in the following sections.

Source of the Costs

Obtaining costs associated with vehicles meeting the performance requirements of the GTR on pedestrian safety is generally difficult as they are a source of competitive advantage. However, the Transport Research Laboratory (TRL) in the United Kingdom conducted detailed research into these costs (Lawrence, 2006). This was done as part of a feasibility study into regulating pedestrian safety within the European Union (EU). TRL noted that accurate costs were not readily available as manufacturers were concentrating on meeting the (then) current requirements for pedestrian protection in the EU, which at the time were not the same as the GTR.

To estimate the costs, TRL estimated the modifications that would need to be carried out for vehicles within different market segments to meet the GTR, and then quantified them with the help of two detailed case studies involving a Landrover Freelander and a Ford Mondeo. These models were chosen as two common vehicles in the EU that between them could represent the typical range of modifications needed, under the assumption that manufacturers would meet any requirements with an additional twenty per cent tolerance. These modifications would satisfy the three design concepts needed for pedestrian protection, that is; 1) having sufficient crush depth, 2) having the appropriate deformation stiffness and 3) having the appropriate force distribution.

By adding detailed costs for modified parts and tooling to general development costs for pedestrian safety technology, TRL estimated an overall cost associated with meeting the GTR for both the Landrover and the Ford. They then tailored this cost to each vehicle market segment as shown in Table 5. In their analysis, TRL identified that, due to their streamlined styling, executive cars and sports cars may be unable to utilise conventional passive safety measures to meet pedestrian requirements. Therefore, the costs for these segments were based on the assumption that these vehicles would be fitted with pop-up bonnets or similar and so would include costs associated with these systems.

Table 5 Cost of vehicle modifications required to meet the GTR

Vehicle Style	**Cost per vehicle (€ 2006)**
Super Mini	45.98
Small Family Car	27.76
Large Family Car	36.93
Executive Car	129.55
Sports Car	397.40
Small MPV	30.80
Large MPV	34.53
Large Off-Roader	47.41

Source: Lawrence et al, 2006

As the costs were to be used for analysis of the Australian market, Australian manufacturers and importers were requested in late 2009 through the Federal Chamber of Automotive Industries (FCAI) for information towards confirming or otherwise the above costs of design, certification and production to GTR 9.

However, Australian manufacturers and importers were unable to directly allocate costs to meeting GTR 9. The FCAI contended that pedestrian protection is not an add-on feature or set of components that can simply be adapted to a vehicle. Design for it is very much integral and fundamental of the basic concept, style, structure and layout of the vehicle. It is impossible to isolate pedestrian protection from base vehicle development with respect to packaging, styling, structural integrity, endurance, durability, manufacturability, occupant protection, crashworthiness - all the fundamentals of auto design/development.

Because of this, the European costs shown in Table 5 have been used as a best estimate to determine costs for the Australian case. While it is not expected that the fundamental values of these costs would differ significantly between Europe and Australia, this has been discussed further below in terms of imported vehicles versus locally produced vehicles.

Magnitude of the Costs

The costs in Table 5 were averaged (according to the Australian sales volumes for each vehicle segment) to give a cost of $78 per vehicle. This was subsequently used in the benefit-cost analysis as the maximum cost to modify a vehicle to meet the GTR. It is important to note that this cost applies more to vehicles in Europe. To determine the (possibly reduced) costs that may be more relevant to the Australian market, the detailed costs for the Ford Mondeo were taken as a starting point. The required modifications for compliance were grouped into three categories (refer to Appendix 5 - Costs of Meeting Global Technical Regulation No. 9).

Firstly, those modifications which would be part of the normal design process for the front of the vehicle were identified. These modifications could be achieved through attention to the vehicle configuration and would require little in the way of additional components to be fitted. Modifications of this type include providing appropriate clearances around the front bumper/grill area and under the bonnet for crush depth, as well as designing these structures to provide more evenly spread deformation resistance. Modifications of this kind were uncosted.

Secondly, those modifications which, although additional to the normal design process and involving specialised design solutions, would still be integral to the vehicle and not easily removed were identified. Modifications of this type include the addition of crush cans and crush beams within the structure. It is likely that vehicles designed and certified in Europe to meet the GTR by way of the EU requirements would also be supplied to other world markets with these features intact, regardless of whether pedestrian safety requirements applied in that country as well. Similarly, other countries that manufacture vehicles would build them to meet the GTR by way of being able to also supply them to the EU. Therefore, vehicles imported to Australia would be expected to already have the basic pedestrian safety structure and so would not require any modifications that relate to the integral structure of the vehicle. Modifications of this kind would only need to be costed for locally manufactured vehicles, which represent approximately 16 per cent of the Australian vehicle market.

Thirdly, those modifications which are additional to the normal design process, involve specialised design solutions and which would not be integral to the vehicle were identified. These features could easily be left out or substituted during production for supply to a market that did not require pedestrian safety features. Modifications of this type include deformable headlamps and frangible mountings, dedicated bonnet latches and hinges as well as crushable mounts for underbonnet equipment. Modifications of this kind would need to be costed for both locally manufactured vehicles and imported vehicles.
The resulting adjusted costs are shown in Table 6 for each vehicle segment. Appendix 5 - Costs of Meeting Global Technical Regulation No. 9 contains a detailed calculation of these costs.

Table 6 Cost of vehicle modifications required to meet the GTR – modified for the Australian market

Vehicle Style	**Cost per vehicle (€ 2006)**
Super Mini	17.61
Small Family Car	10.63
Large Family Car	14.15
Executive Car	49.62
Sports Car	152.22
Small MPV	11.80
Large MPV	13.23
Large Off-Roader	19.60

The adjusted costs for the individual market segments were combined to give a sales weighted average cost of $30 per vehicle. This was used in the benefit-cost analysis as the minimum cost to modify a vehicle to meet the GTR.

A test facility estimated a cost of $35,000 to test a vehicle model to a pedestrian safety regulation. This is commensurate with other test costs shown in Appendix 6 - Typical Costs for Regulation Compliance in Australia and so was assumed.

Certification costs (costs to meet a regulation) were based on previous FCAI estimates and Department of Infrastructure and Transport experience. A cost of $15,000 was assumed for the type approval costs of pedestrian safety for a vehicle model as discussed in Appendix 5 - Costs of Meeting Global Technical Regulation No. 9.

Finally, an annual cost of $50,000 was assumed for the implementation and maintenance of a regulation based on Department of Infrastructure and Transport experience. This is also discussed further in Appendix 5 - Costs of Meeting Global Technical Regulation No. 9.

Table 7 provides a summary of the costs for various aspects of modifying vehicles to meet pedestrian safety requirements. It also includes the costs of the non-regulatory options from Table 3.

Table 7 Estimation of the costs of pedestrian safety

Type of cost	Estimated cost ($)	Notes
Pedestrian safety modifications (min)	30	per vehicle
Pedestrian safety modifications (max)	78	per vehicle
Information campaigns	3m	per year
Fleet purchasing policies	50,000	per year
Pedestrian safety testing	35,000	per model
Type approval	15,000	per model
Implement and maintain regulation	50,000	per year

Particular Costs for each Option

For Option 1: No intervention, there were no costs associated with this as it was the base or Business As Usual (BAU) case.

For the remaining options, there was a basic design and fitment cost associated with the number of vehicles that would need to be modified to meet pedestrian safety requirements due to the particular intervention method (option) used, above and beyond those that already comply voluntarily. For example, say that 60 per cent of newly registered vehicles already comply with pedestrian safety requirements, and an intervention method (option) was expected to raise this to 80 per cent. Then there would be a basic design and fitment cost associated with 80 – 60 = 20 per cent of these newly registered vehicles.

This basic design and fitment cost was added to any other costs related to the intervention method (e.g. cost of awareness campaigns).

For Option 2: User information campaigns, there was a basic design and fitment cost as well as a minimum cost of $3m per year ongoing for an awareness campaign. This was discussed earlier in the RIS.

For Option 3: Fleet purchasing policies, there was a basic design and fitment cost as well as a cost (as discussed earlier in the RIS) of $50,000 per year for the negotiation process.

For Option 6: Mandatory standards under the MVSA, there was a basic design and fitment cost as well as costs for the testing and for the submission and processing of the results. The testing costs were estimated at $35,000 per model, while type-approval submissions and processing costs (including other costs surrounding the use of the regulation) were estimated at $15,000 per model. There was also an estimated cost of $50,000 per year to governments to create, implement and maintain the regulation, as discussed above.

By their nature, regulations would be applied to all of the relevant models in the new passenger fleet (regardless of whether they already met pedestrian safety requirements when any regulation was first applied) and so regulation costs would be independent of the voluntary level of pedestrian safety in the current fleet. These costs represent designing, testing and proving compliance of a vehicle against regulated requirements. These costs would apply to every vehicle model under the scope of the regulation and would be above and beyond the design and testing associated with normal product development.

Appendix 5 - Costs of Meeting Global Technical Regulation No. 9 shows the particular costs for each option, including those for basic design and fitment.

7.1. Benefits and Costs of the Remaining Options

Four scenarios were prepared for estimating the benefits from pedestrian safety. These represented the four remaining options, Options 1, 2, 3 and 6. The four scenarios were based on the difference between the current voluntary fitment rate of passive pedestrian safety measures, and the final expected fitment rate under each particular option. The current voluntary fitment rate had been estimated at 26 per cent for passenger cars and SUVs and zero per cent for Light Commercial Vehicles (LCVs).

For Option 1: No intervention, there were no associated benefits or costs as this was the base or Business as Usual (BAU) case.

For Option 2: User information campaigns, there was an estimated increase from the Option 1 current fitment rate to a total of 45 per cent fitment rate (based on an awareness of 77 per cent generating a 45 per cent take-up of pedestrian friendly vehicles) for an ongoing targeted awareness campaign. The campaign would be stopped once the voluntary rate would have otherwise (through the BAU case) reached 45 per cent.

For Option 3: Fleet purchasing policies, there was an added flat 41 per cent increase for passenger cars and SUVs and 50 per cent for LCVs on top of the Option 1 voluntary fitment rate. This was capped at 100 per cent total.

For Option 6: Mandatory standards under the MVSA, there was an increase from the current fitment rate to a total of 100 per cent, with a pro-rata transition within the 2015-2019 period of implementing the regulation.

Effectiveness of Pedestrian Safety

Lawrence et al (2006) investigated the effectiveness of GTR 9 in reducing road trauma (Refer to Appendix 2 - Effectiveness of Pedestrian Safety Measures for further details). The reductions in the number of pedestrian fatalities and serious injuries sustained in pedestrian crashes were estimated to be around 4 per cent and 12 per cent respectively. The authors assumed that minor injuries would not be reduced. Lawrence et al also examined the effectiveness of the GTR in reducing cyclist fatalities and injuries. A summary of the effectiveness estimates is shown in Table 8.

Table 8 Effectiveness of GTR 9 in reducing vulnerable road user casualties

	Pedestrian	Cyclist
Fatal injury	3.9%	1.4%
Serious injury	12.0%	4.8%
Minor injury	0%	0%

Source: Lawrence et al, 2006

The estimates shown in Table 8 were derived using national statistics of the United Kingdom (UK) and so better reflect the characteristics of vulnerable road user crashes in the UK. Table 9 shows a comparison of the characteristics of vulnerable road user crashes between Australia and the UK.

Table 9 Proportions of pedestrians and cyclists hit by fronts of vehicles subject to regulation

		Fatal injury	Serious injury	Minor injury
Australia	Pedestrians	0.69	0.76	0.78
	Cyclists	0.52	0.77	0.79
The UK	Pedestrians	0.60	0.56	0.50
	Cyclists	0.44	0.45	0.44

Source: Lawrence et al, 2006; VicRoads CrashStats, 2010; Anderson, 2008

It can be seen that the proportion of crashes that involve the vulnerable road user being hit by the front of a vehicle subject to regulation is higher in Australia than in the UK. This means that regulation in Australia could potentially affect a slightly higher proportion of accidents than in the UK. For example, in the UK, 60 per cent of fatal pedestrian crashes involved the pedestrian being hit by the front of a vehicle subject to regulation. In comparison, 69 per cent of fatal pedestrian crashes in Australia were in this category. Therefore, the proportions in Table 8 were used to adjust the effectiveness estimates in Table 9 for the Australian context (e.g. $3.9\% \times 0.69/0.6 = 4.5\%$). The adjusted effectiveness estimates are shown in Table 10.

Table 10 Effectiveness of GTR 9 in reducing vulnerable road user casualties – adjusted for Australian case

	Pedestrian	Cyclist
Fatal injury	4.5%	1.7%
Serious injury	16.4%	8.2%
Minor injury	0%	0%

However, as noted by Lawrence et al, it may not be realistic to assume that what would have been a fatality could be converted to no injury or even a minor injury. It is more likely that a fatality would be converted to a serious injury. As such, the percentage reductions in Table 10 were adjusted using the ratio of injuries to fatalities (1 fatality, 11.9 serious injuries and 14.4 minor injuries for pedestrian crashes and 1 fatality, 40.7 serious injuries and 88.1 minor injuries for cyclist crashes) to account for the conversion of casualties from fatal to serious and serious to minor (e.g. $16.4\% - 4.5\% \times 1/11.9 = 16.0\%$). The negative values in Table 11 indicate an increase in minor injuries for both pedestrians and cyclists.

Table 11 Effectiveness of GTR 9 in reducing vulnerable road user casualties – adjusted for Australian case and conversion of injuries

	Pedestrian	Cyclist
Fatal injury	4.5%	1.7%
Serious injury	16%	8.2%
Minor injury	-13.5%	-3.8%

The pedestrian and cyclist effectiveness estimates were then averaged, according to the proportions of casualties resulting from pedestrian and cyclist crashes, shown in Table 12, to produce a combined effectiveness of 4.1 per cent for a fatal injury, 13.4 per cent for a serious injury, and -8.9 per cent for a minor injury (e.g. 4.5% × 0.87 + 1.7% × 0.13 = 4.1 %).

Table 12 Casualties resulting from pedestrian and cyclist crashes as a percentage of the total

	Pedestrian crash	Cyclist crash
Fatal injury	87%	13%
Serious injury	67%	33%
Minor injury	53%	47%

This can be summarised as an effectiveness that reduces fatalities and serious injuries, being particularly successful against the latter, but that has little effect on reducing minor injuries (the apparent increase in minor injuries being due to the reduction of serious injuries that then become minor injuries).

For the purposes of calculating the number of lives saved from any introduction of pedestrian safety, the effectiveness of 4.1 per cent as calculated above for a fatal injury was used. However, for the purposes of calculating the monetary value of benefits from the introduction of pedestrian safety, the monetary saving from a reduction of 4.1 per cent for a fatal injury, 13.4 per cent for a serious injury, and -8.9 per cent (an increase) for a minor injury were combined by considering the reduction in the cost of an "average" crash (refer Appendix 7 - Benefit-Cost Analysis – Methodology for details). This can be seen in Table 13.

Table 13 Monetary saving of an "average" crash resulting from pedestrian safety measures (rounded values)

	Average cost	Reduction
Fatal injury	$99,294	$4,090 (**4.1%**)
Serious injury	$191,812	$25,728 (**13.4%**)
Minor injury	$9,881	-$884 **(-8.9%)**
Total	$300,986	$28,934 (**9.6%**)

Therefore, an effectiveness of 4.1 per cent was used for the calculation of lives saved while an effectiveness of 9.6 per cent was used for monetary savings.

7.2. Results

Appendix 8 - Benefit-Cost Analysis – Details of Results shows the calculations for the benefit-cost analysis. These include the Best Case, Likely Case and Worst Case for each option.

The outputs were constructed by using the minimum cost of $30 for the Best Case and the maximum cost of $78 for the Worst Case. The Likely Case was an average within this range. All scenarios used a 7 per cent discount rate.

An overview of the total Net Benefits, the total Costs, the average Benefit-Cost Ratios (BCRs) and the total number of Lives Saved over the period of analysis is given in Table 14 for each option. The distribution of the (undiscounted) benefits and costs, and the BCR, is shown over time in Figure 7. The effect of each option on the BAU is shown over time in Figure 8.

Table 14 Summary of Net Benefits, Total Benefits, Costs, Benefit-Cost Ratios and Lives Saved from the improved pedestrian safety of new passenger cars, SUVs and LCVs

	Net Benefits ($m)			**Total Benefits ($m)**		
	Best Case	Likely Case	Worst Case	Best Case	Likely Case	Worst Case
Option 1 No intervention	-	-	-	-	-	-
Option 2 Information campaigns	33	18	3	81	81	81
Option 3 Fleet policies	202	155	107	262	262	262
Option 6 Regulation	248	185	122	347	347	347

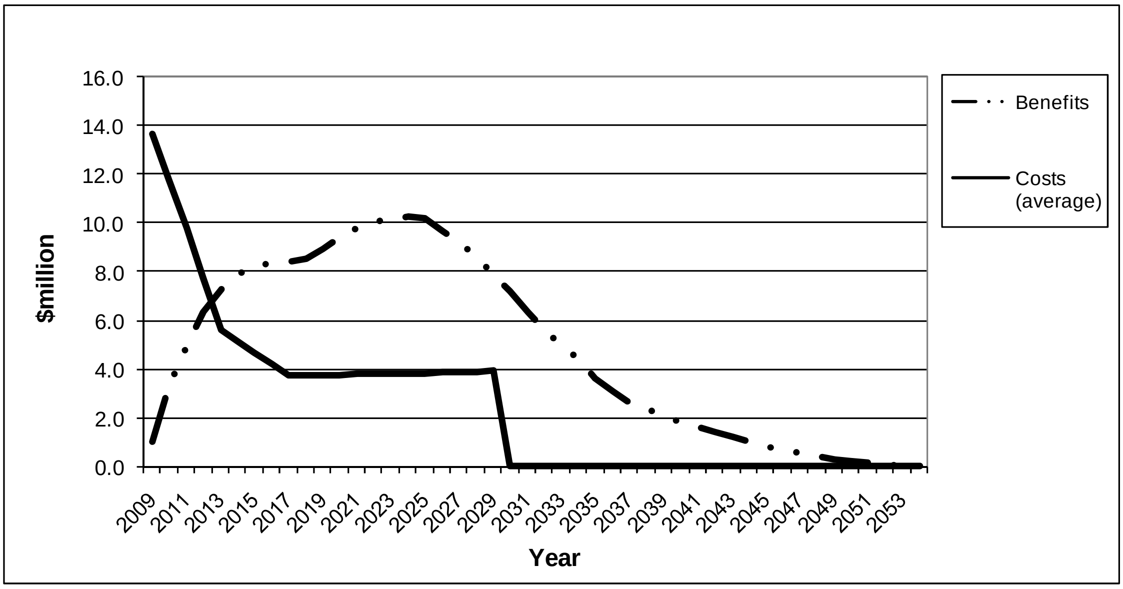
	Costs ($m)			**Benefit-Cost Ratio**		
	Best Case	Likely Case	Worst Case	Best Case	Likely Case	Worst Case
Option 1 No intervention	-	-	-	-	-	-
Option 2 Information campaigns	49	64	78	1.7	1.4	1.0
Option 3 Fleet policies	60	108	155	4.4	3.0	1.7
Option 6 Regulation	99	162	225	3.5	2.5	1.5

	Lives Saved		
	Best Case	Likely Case	Worst Case
Option 1 No intervention	-	-	-
Option 2 Information campaigns	8	8	8
Option 3 Fleet policies	29	29	29
Option 6 Regulation	65	65	65

Best Case - 7% discount rate, minimum costs
Likely Case - 7% discount rate, average costs
Worst Case - 7% discount rate, maximum costs

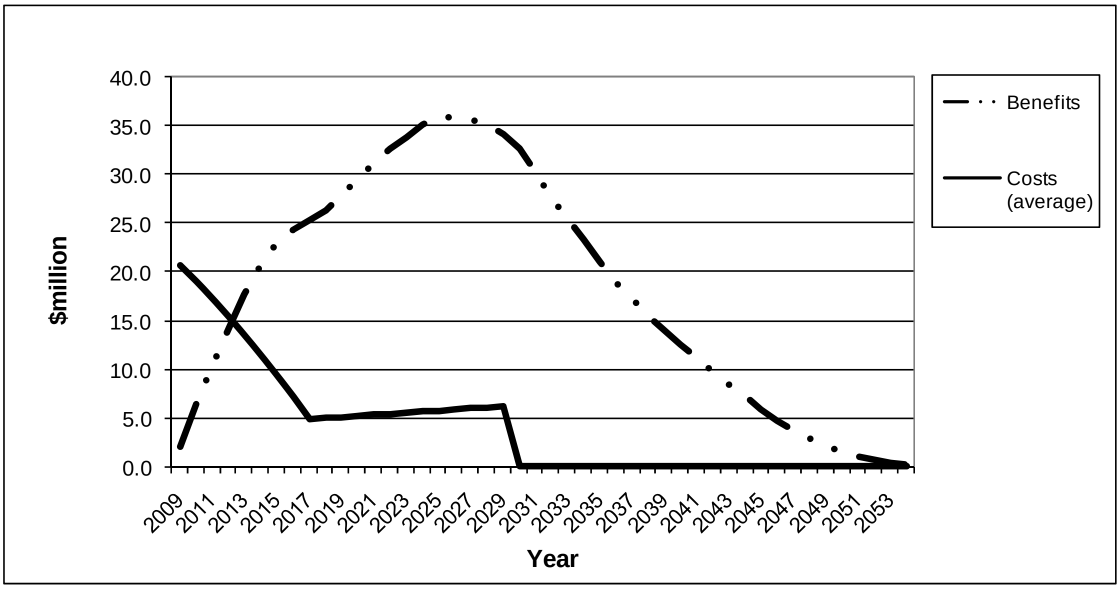
Figure 7 Undiscounted Benefits and Costs of various options over time

Option 2: User information campaigns – Awareness



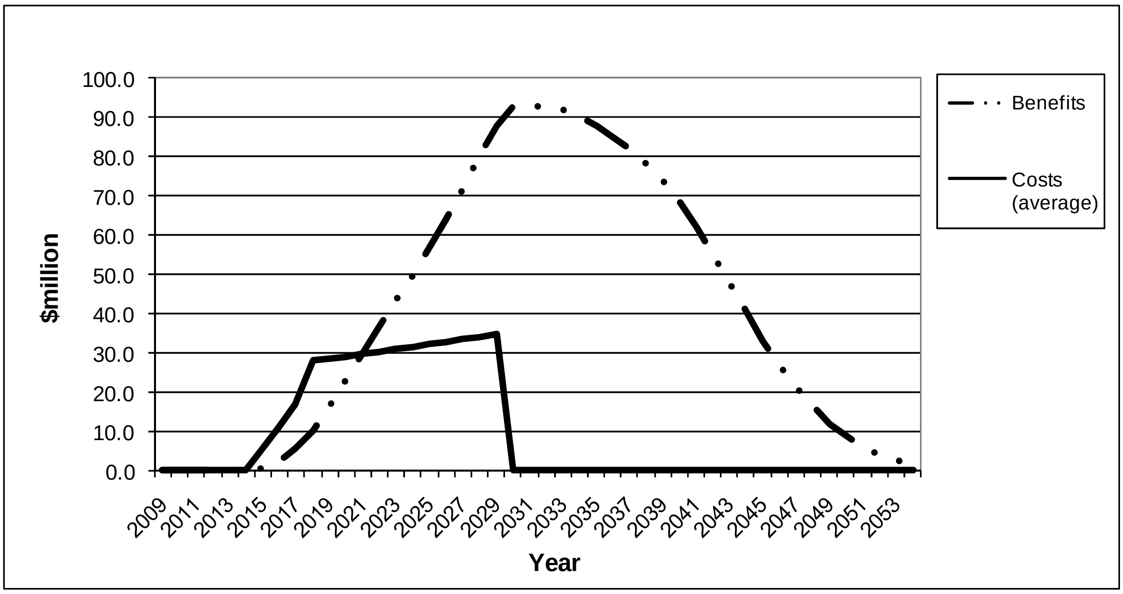
$30-$78 per vehicle cost for pedestrian safety modifications and $3m per year campaign cost.

Option 3: Fleet purchasing policies



$30-$78 per vehicle cost for pedestrian safety modifications and $50,000 per year negotiation cost.

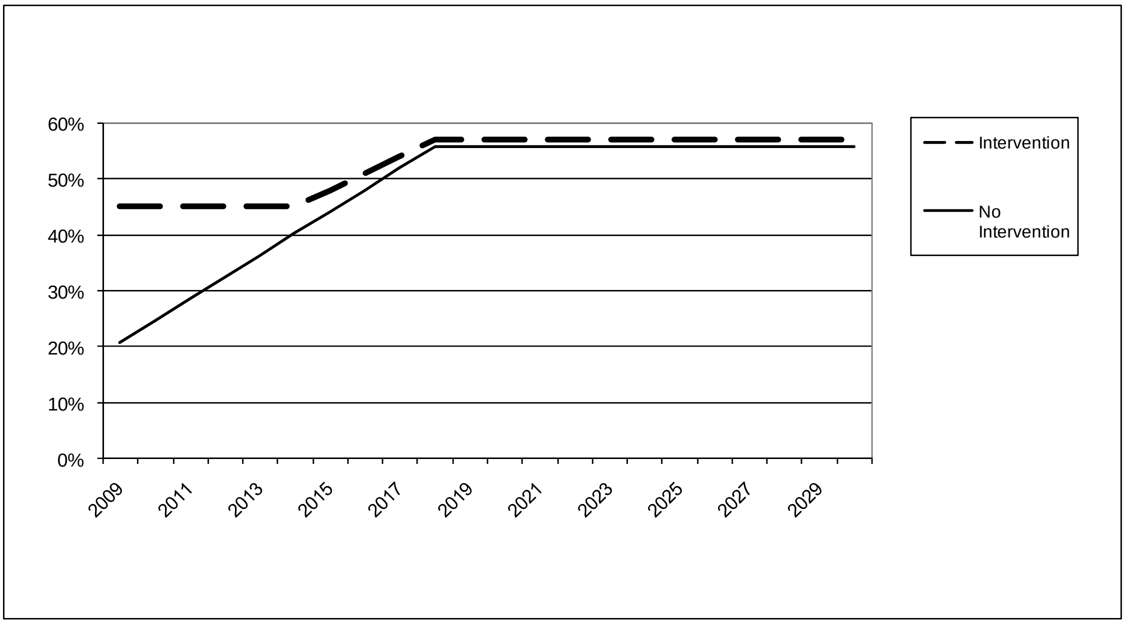
Option 6: Mandatory standards under the MVSA



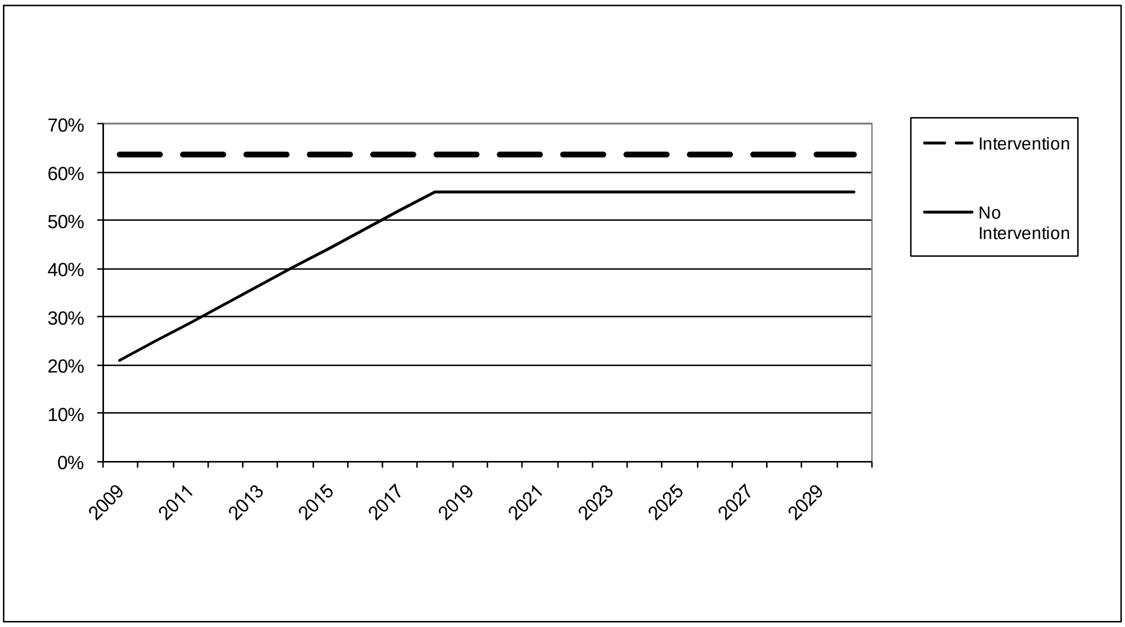
$30-$78 per vehicle cost for pedestrian safety modifications, $50,000 per model certification cost, and $50,000 per year regulation maintenance cost.

Figure 8 Comparison of the expected fitment rate of No intervention (Option 1) to Intervention (Options 2, 3 and 6) over time

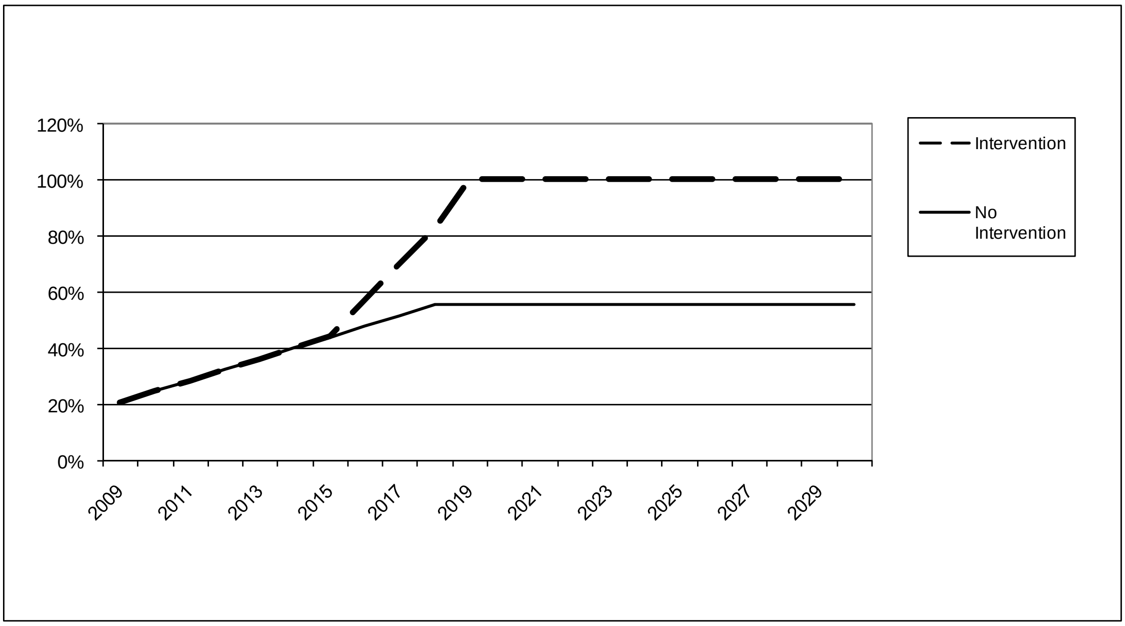
Option 2: User information campaigns – Awareness



Option 3: Fleet purchasing policies



Option 6: Mandatory standards under the MVSA



7.3. Summary of the Results

Option 2: User information campaigns, Option 3: Fleet purchasing policies, and Option 6: Mandatory standards under the MVSA, all gave positive net benefits for the Best, Likely and Worst cases. Option 6 gave the highest net benefits, followed by Option 3. The net benefits for Option 2 were significantly lower than for Options 3 and 6.

The Benefit-Cost Ratios (BCRs) were above one for all three options analysed, ranging from 1.4 to 3.0 for the Likely case. This means that each option will provide more benefits through reduced road trauma than it will cost to implement. The Option 3

BCR of 3.0 was the highest, followed by the Option 6 and Option 2 BCRs of 2.5 and 1.4 respectively.

In terms of costs over the assumed 15 year life of regulation, Option 6, the regulation option, was the most expensive to implement. The estimated cost to implement Option 6 was $162m (including costs to business and government). Option 3, the fleet purchasing policies option was next at $108m, while Option 2, the user information campaigns option was the cheapest at $64m.

In terms of the number of lives saved, Option 6: Mandatory standards under the MVSA was the highest by a considerable margin, at 65 lives saved over the assumed 15 year life of regulation. Option 2: User information campaigns and Option 3: Fleet purchasing policies saved 8 and 29 lives respectively.

Each option affected the Option 1 No intervention (or Business As Usual (BAU)) case in a different way, as discussed below.

Option 1: No intervention was the base case and so had no allocated benefits or costs associated with it. It was assumed that the voluntary fitment rate would reach 60 per cent for passenger cars and SUVs and 39 per cent for LCVs by 2018. This was based on the proportion of vehicles imported to Australia from Europe and Japan, where new vehicles will be required to meet pedestrian safety regulations by 2018. After that it was assumed that the rate would stay constant for the foreseeable future. This trend can be observed in the No intervention series within the graphs presented in Figure 8.

In Option 2: User information campaigns it was assumed that an ongoing awareness campaign, costing $3m per year, would bring the fitment rate up to 45 per cent, but do no more than maintain this level in the long term. Figure 8 shows that for the first five years the fitment rate is raised to 45 per cent. After five years, the passenger cars and SUV rate has gone beyond 45 per cent in the BAU scenario, while the LCV rate is still well below this level. In fact, the LCV rate remains below 45 per cent for the entire period of analysis and so the awareness campaign continues indefinitely. The benefits will continue to accrue as long as the LCV rate under the BAU case would have otherwise have remained at below 45 per cent.

In Option 3: Fleet purchasing policies a flat increase approach was used. Here it was assumed that initial fleet negotiations would increase the initial fitment rate by 41 per cent for passenger cars and SUVs and 50 per cent for LCVs. This reflects the potential gains identified earlier in the RIS. Because the BAU remains below this level for the entire period of analysis, fleet negotiations continue. The benefits will continue to accrue as long as the BAU rates would have otherwise have remained at below the level achieved through fleet purchasing policies.

In Option 6: Mandatory standards under the MVSA there is a pro-rata transition phase from the BAU fitment rate to 100 per cent between 2015 and 2019. As the final BAU fitment rate was assumed to be 56 per cent (the combined rate for passenger cars, SUVs, and LCVs), regulation is ongoing and forces compliance to 100 per cent. This can be seen in Figure 8. It can also be seen in Figure 7 that the costs begin with the introduction of the regulation in 2015 and steady at the end of the transition phase in

2019, followed by a gradual rise in line with the increasing overall fleet size expected for Australia. As with Options 2 and 3, the benefits will continue to accrue as long as the BAU level would have otherwise have remained below the level achieved through intervention, in this case 100 per cent.

7.4. 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 6 was tested as this was the option that gave the highest net benefits.

The possible range of costs for pedestrian safety modifications had already been considered in the main benefit-cost analysis through the Best, Likely and Worst case scenarios. The remaining uncertainties that could adversely affect the options were the effectiveness, the final expected voluntary fitment rate under the BAU (Option 1 No intervention) case and the discount rate of the benefits and costs. A sensitivity analysis was undertaken on each of these variables as presented below for the Likely case (i.e. average costs). Detailed results of the sensitivity tests can be found at Appendix 9 - Benefit- Cost Analysis – Sensitivities.

Effectiveness

The effectiveness of passive pedestrian safety measures was considered to be reasonably accurate, as it was taken from a comprehensive study and subsequently tailored to the Australian context. However, to account for any uncertainty, the effectiveness of 9.6% was varied by ±20%. As seen in Table 15, the net benefits are positive even when the effectiveness is reduced by 20%.

Table 15 Impacts of changes to effectiveness

Scenario	Net Benefits ($m)	Benefit-Cost Ratio
Low effectiveness (7.7%)	115	2.0
Base case effectiveness (9.6%)	185	2.5
High effectiveness (11.5%)	254	3.0

Business As Usual (BAU) voluntary fitment rate

As noted earlier in the RIS, the estimate for the future voluntary fitment rate was based on the proportion of vehicles imported to Australia from Europe and Japan, where new vehicles will be required to meet pedestrian safety regulations by 2018. After that it was assumed that the rate would stay constant for the foreseeable future. A sensitivity test was conducted with the final BAU fitment rate reaching 95 per cent. Although it is considered highly unlikely that the final BAU would reach 95 per cent, this was chosen as an extreme scenario. As shown in Table 16, there is a small net cost of $0.1m under this unlikely scenario.

Table 16 Impacts of changes to the BAU voluntary fitment rate

Scenario	Net Benefits ($m)	Benefit-Cost Ratio
Base case BAU fitment rate (60% passenger cars and SUVs, 39% LCVs)	185	2.5
High BAU fitment rate (95% passenger cars and SUVs, 95% LCVs)	-0.1	1.0

Discount rate

A sensitivity test was conducted using discount rates of 3 and 11 per cent. Table 17 shows that the net benefits are positive under all three discount rates.

Table 17 Impacts of changes to the discount rate

Scenario	Net Benefits ($m)	Benefit-Cost Ratio
Low discount rate (3%)	574	3.5
Base case discount rate (7%)	185	2.5
High discount rate (11%)	59	1.9

Assumptions

A number of assumptions were made in the benefit-cost analysis. Details of these can be found at Appendix 10 - Benefit- Cost Analysis – Assumptions.

8. 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 each option on the affected parties.

8.1. Identification of Affected Parties

In the case of pedestrian safety, the parties affected by the options are:

Business/Consumers

- vehicle manufacturers or importers;
- vehicle owners;
- vehicle operators;
- aftermarket product suppliers; and

Governments

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

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

- Federal Chamber of Automotive Industries (FCAI), that represents the automotive sector and includes vehicle manufacturers, vehicle importers and component manufacturers/importers;
- Federation of Automotive Product Manufacturers (FAPM) that represents the

automotive component manufacturers/importers;
- Australian Automobile Association (AAA) that represents vehicle owners and operators (passenger cars and derivatives) through the various automobile clubs around Australia (RAC, RACV, NRMA etc); and
- Australian Automobile Aftermarket Association (AAAA) that represents the after-market industry.

8.2. Impacts of the Remaining Options

There were four options that were considered feasible: 1) No intervention, 2) User information campaigns, 3) Fleet purchasing policies and 6) Mandatory standards (internationally based) under the MVSA. This section looks at the impact of each of the options in terms of quantifying the expected benefits and costs, and identifies how these would be distributed within the community. This is discussed below and summarised in Table 18 on page 48.

Option 1: No intervention

Allow market forces to provide a solution.

As this option is the base case (Business As Usual case), there are no benefits or costs allocated. All other options are calculated relative to this base case option.

Option 2: User information campaigns

Inform consumers about the benefits of pedestrian friendly vehicles using information campaigns (suasion).

As this option involves intervention only to influence consumer desire in the market place, the benefits and costs are those that are expected to occur on a voluntary basis, over and above those in the no intervention option (Option 1 above). The fitment of pedestrian safety measures would remain a commercial decision within this changed environment.

Benefits

Business

There would be no direct benefit to business (over and above that of Option 1) as a result of a reduction in road trauma caused by vehicles that are sold with pedestrian safety measures due to the user information campaign.

Consumers

There would be a direct benefit to consumers 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 vehicle with pedestrian safety measures due to the information campaign, and who avoid or minimise the effects of a crash due to the action of these measures.

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 a vehicle with pedestrian safety measures due to the user information campaign, and who avoid or minimise the effects of a crash due to the action of these measures.

This option would add approximately $81m over and above Option 1. This benefit would be shared with governments and so the community.

Costs

Business/Consumers

There would be a direct cost to business/consumers (over and above that of Option 1) as a result of additional design, fitment and testing costs for vehicles that are sold with pedestrian safety measures due to the user information campaign. This would add between $18m and $48m over and above Option 1.

Governments

There would be a cost to governments for funding or running user information campaigns that inform the consumer of the benefits of pedestrian safety measures. This is estimated at $30m.

Option 3: Fleet purchasing policies

Only allow vehicles that provide a certain level of pedestrian safety for government purchases (economic approach).

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 the no intervention option (Option 1 above). The fitment of pedestrian safety measures would remain a commercial decision within this changed environment.

Benefits

Business

There would be no direct benefit to business (over and above that of Option 1) as a result of a reduction in road trauma caused by vehicles that are sold with pedestrian safety measures due to fleet purchasing policies.

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 with pedestrian safety measures due to fleet purchasing policies, and who avoid or minimise the effects of a crash due to the action of these measures.

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 a vehicle with pedestrian safety measures due to fleet purchasing policies, and who avoid or minimise the effects of a crash due to the action of these measures.

This option would add $262m over and above Option 1. This benefit would be shared with governments and so the community.

Costs

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 vehicles that are sold with pedestrian safety measures due to fleet purchasing policies. This would add between $60m and $155m over and above Option 1. This cost would be passed on to the consumer.

Governments
There would be a cost to governments for administering fleet purchasing policies that require the purchase of vehicles with pedestrian safety measures. This is estimated at $0.51m.

Option 6: Mandatory standards under the MVSA

Mandate standards for pedestrian safety under the *Motor Vehicle Standards Act 1989* (C'th) (MVSA) based on international standards from the United Nations Economic Commission for Europe (UNECE) (regulatory – mandatory).

As this option involves direct intervention to change the specification of the product supplied to the market place, the benefits and costs are those that would occur on a mandatory basis, over and above those determined in the no intervention option (Option 1 above). The fitment of pedestrian safety measures would no longer be a commercial decision within this changed environment.

Benefits

Business
There would be no direct benefit to business (over and above that of Option 1) as a result of a reduction in road trauma on vehicles that are sold fitted with pedestrian safety measures due to the Australian Government mandating standards.

Consumers
There would be a direct benefit to vehicle 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 vehicle with pedestrian safety measures due to the Australian Government mandating standards, and who avoid or minimise the effects of a crash due to the action of these measures.

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 a vehicle with pedestrian safety measures due to the Australian Government mandating standards, and who avoid or minimise the effects of a crash due to the action of these measures.

This would add $347m over and above Option 1. This benefit would be shared with governments and so the community.

Costs

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 vehicles that are sold with pedestrian safety measures due to the Australian Government mandating standards. This would add between $99m and $225m over and above Option 1. This cost would be passed on to the consumer.

As discussed in Section 6.6, there may be a further direct cost to vehicle manufacturers - but more likely an indirect cost to aftermarket suppliers - where a Vehicle Front Protection System (VFPS) has been fitted to a vehicle. The fitting of a VFPS to a vehicle subject to GTR 9 through the Australian Design Rules (ADRs) would at least require re-testing of each vehicle model, as the performance characteristics of the front structure of the vehicle would be significantly altered with regards to pedestrian protection. This would be true whether the VFPS is fitted as original equipment or as an aftermarket item, given that state and territory regulations apply to in-service vehicles and generally require continued compliance to the ADRs.

For each vehicle model there would be a cost per matched VFPS model. In terms of the main types of vehicles that would be fitted with a VFPS, this would be the case for all models of vehicles in the MC category (four-wheel drives or sports utility vehicles) and the NA category (light commercial vehicles) for complete coverage of all vehicles. As there are currently 142 models of these vehicles (see Table 4), these testing costs could be significant. However, these costs were not used towards the main benefit-cost analysis as alternative solutions to the issue of VFPS have been explored further as part of the discussion in Section 9.9.

Governments

There would be a cost to governments for developing, implementing and administering regulations (standards) that require vehicles to meet a minimum level of pedestrian safety. This is estimated at $0.51m.

Table 18 Summary of the benefits and costs of pedestrian safety measures over a forty six year period of analysis

Affected Parties	Option 1 No intervention		Option 2 User information campaigns		Option 3 Fleet purchasing policies		Option 6 Mandatory standards under the MVSA	
	BENEFITS	**COSTS**	**BENEFITS**	**COSTS**	**BENEFITS**	**COSTS**	**BENEFITS**	**COSTS**
Business	-	-	None	Increased costs of vehicles $18m - $48m	None	Increased costs of vehicles $60m - $155m	None	Increased costs of vehicles and regulation compliance costs. $99m - $225m
Consumers	-		Reduced road trauma $81m		Reduced road trauma $262m		Reduced road trauma $347m	
Government		-		Cost of funding and running campaigns $30m		Cost of administering fleet purchasing policies $0.51m		Cost of implementing and administering regulations, does not include state and territory govts follow-on costs for in-service regulation $0.51m
Lives Saved	-		8		29		65	
Benefit/Cost Ratio	-		1.0-1.7		1.7-4.4		1.5-3.5	

Note: Total benefits are shown. The Summary in Appendix 8 - Benefit-Cost Analysis – Details of Results shows the split between Business/Consumers and Government costs.

9. DISCUSSION

The four scenarios that were prepared for estimating the benefits and costs from pedestrian safety represented the four options that were considered feasible:

- Option 1: No intervention;
- Option 2: User information campaigns;
- Option 3: Fleet purchasing policies; and
- Option 6: Mandatory standards under the *Motor Vehicle Standards Act 1989* (C'th) (MVSA) (Regulation).

9.1. Net Benefits

Option 6: Mandatory standards under the MVSA had the highest net benefits at a Likely value of $185m resulting from the assumed 15 year life of regulation. These benefits would be spread over a period that goes beyond the 15 years that the intervention was in place. Option 2: User information campaigns and Option 3: Fleet purchasing policies also had positive Net Benefits of $18m and $155m respectively for the Likely case.

9.2. Benefit-Cost Ratios

Option 3: Fleet purchasing policies had the highest Benefit-Cost Ratio (BCR) at a Likely value of 3.0. Option 6: Mandatory standards under the MVSA had the next highest BCR at a Likely value of 2.5, followed by Option 2: User information campaigns with a BCR of 1.4 for the Likely case. The high BCR of Option 3 reflects the relatively low cost needed to negotiate a fleet purchasing agreement.

9.3. Lives Saved

Option 6: Mandatory standards under the MVSA had the highest number of lives saved at 65 over the assumed 15 year life of regulation. This was more than twice the number lives saved under Option 3: Fleet purchasing policies. Option 2: User information campaigns saved the lowest number of lives at 8.

9.4. The Case for Intervention

This Regulation Impact Statement (RIS) has identified a current road safety problem for Australia. Over 200 fatalities and many additional injuries occur each year due to collisions of vehicles with pedestrians and other vulnerable road users. Research has shown that by modifying the construction of the front of vehicles, these fatalities and injuries could be reduced by between 4 and 13 per cent – provided certain performance requirements are met. It has been argued that there is an externality with regards to pedestrian safety and vehicle crashes that market forces may not be able to correct. This is because the individual who pays for pedestrian safety does not receive the main benefit of it. The main benefit is received by the pedestrian, or other vulnerable road user, through the reduction of road trauma. It is not received by the owner responsible for making the purchasing decision regarding the vehicle. Because of this, there is little incentive for the owner to demand pedestrian friendly designs from the vehicle manufacturer.

The pedestrian safety measures currently in Australian vehicles may be for the most part a response to regulation within the major vehicle producing economies of Europe and Japan. Although some active pedestrian safety systems are being developed and marketed (e.g. the Volvo S60), manufacturers in Australia have indicated that there is no defined program for improving pedestrian safety apart from through these regulations. The estimated voluntary rate of compliance reflects this, as does the negligible promotion of passive pedestrian safety features in vehicle advertising. Given the above, there is a case for intervention in order to reduce the fatalities and injuries associated with collisions of vehicles with pedestrians and other vulnerable road users.

There are advantages to intervention by regulation as compared to other non-regulatory means, especially in an environment of lower rates of voluntary take-up. Option 6: Mandatory standards under the MVSA (Regulation) was the only option that could guarantee 100 per cent fitment of pedestrian safety measures, both within the implementation timeframe (discussed in section 9.7), and thereafter. There would be no guarantee that non-regulatory options would deliver an enduring result. Furthermore, changing economic pressures could significantly impact the merits of these options. Monitoring the market would bring in added complications such as defining what is meant by a pedestrian friendly vehicle (in the absence of a mandatory standard), setting the lower limit at which point intervention would have to be reconsidered, and determining what minor digressions, if any, would be tolerated. If regulation did need to be reconsidered, there would also be a long lead time needed to bring it in at a later time. Therefore, if 100 per cent penetration with high confidence is the desired outcome, Option 6 is the only option that can deliver this.

Option 6 Regulation has the potential to offer positive net benefits of $185m and a saving of at 65 lives over a forty six year period of analysis (assuming that the standard was active for fifteen years within this period) if the final level of voluntary take-up were to reach the expected 60 per cent for passenger cars and SUVs and 39 per cent for LCVs by 2018, in line with the proportion of vehicles being imported to Australia from Europe and Japan (where they will be required to meet pedestrian safety regulations by 2018). These savings would be higher than any of the other options that were considered feasible. In addition to the lives saved it should be highlighted that the pedestrian safety measures under the regulation option would be particularly effective at reducing serious injuries, by some three times that of fatalities (refer Table 13 where fatalities are expected to be reduced by 4.1 per cent and serious injuries by 13.4 per cent). Given that there are 15.6 serious injuries for each vulnerable road user fatality (refer page 13), this means that a saving of 65 lives over the period of analysis will also result in a saving of well over 3,000 serious injuries (65 x [13.4% / 4.1%] x 15.6 / 1) as well. In terms of annual figures, Appendix 8 - Benefit-Cost Analysis – Details of Results show that lives saved will peak at around 3 per year. This would correspond to a saving of 150 serious injuries per year as well.

It is of course possible that the voluntary percentage take-up of pedestrian friendly vehicles could increase in anticipation of any regulatory intervention, both in Australia and overseas, resulting in a decrease in the net benefits of Option 6. However, as part of the sensitivity analysis, the Benefit-Cost Analysis was performed under the hypothetical scenario of a take-up rate reaching 95 per cent by 2018. Even under this extremely unlikely scenario, Option 6 is able to provide positive net benefits under all but one of the scenarios tested. However, this scenario was highly unlikely and the net benefits were only slightly negative. This demonstrates the potential that pedestrian safety measures have to make a difference.

Although Options 2 and 3 have been treated separately, they are not mutually exclusive and can continue in one form or another regardless of the recommendation of this RIS. In fact, it is possible that measures such as those proposed in Options 2 and 3 have already contributed to the current level of take-up of pedestrian friendly vehicles. However, it is important to note that the benefits of Options 2 and 3 are less assured than the benefits of Option 6 and so would lie somewhere between the base (business as usual) case and their calculated values. This would be similar for the costs. This reflects the fact that the response to these options relies on two factors; firstly that consumers will receive the message favourably and secondly that manufacturers will perceive any increased demand and act accordingly.

From an international perspective, and as a contracting party to the United Nations 1998 Agreement (see section 6.6), Australia must subject Global Technical Regulation No. 9 for Pedestrian Safety to its domestic rulemaking process. This RIS is part of that process. While Australia is not obliged to mandate pedestrian safety (even though it voted for the GTR to be established), if a regulatory option is chosen it is obliged to adopt the accepted international standard, in this case GTR 9.

Therefore, Option 6: Mandatory standards under the *Motor Vehicle Standards Act 1989* (C'th) (MVSA) represents an effective and robust option. It is also the only option with a guaranteed 100 per cent outcome both at the time of implementation and in the future.

9.5. Recommendation

Option 6: Mandatory standards under the *Motor Vehicle Standards Act 1989* (C'th) (MVSA) is the recommended option. Given the readily available benefits of pedestrian safety measures and their potential to save lives, even if there were reasonably high voluntary fitment rates, it represents an effective and robust option. It is also the only option with a guaranteed 100 per cent outcome both at the time of implementation and in the future.

9.6. Impacts

Business/Consumers

The four 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 negative externalities of road vehicle crashes) and the consumers. Governments would absorb much of the cost of the intervention (such as information programs, regulation etc).
Option 6: Mandatory standards under the MVSA would be the most difficult option for the vehicle manufacturing industry. This is because it involves regulation based development and testing with forced compliance of all applicable models. Manufacturers or those importing from the European Union or Japan would have the least difficulty. Vehicles imported from these markets represent around 60 per cent of Australia's passenger vehicles.

There may be a further direct cost to vehicle manufacturers - but more likely an indirect cost to aftermarket suppliers - where a Vehicle Front Protection System (VFPS) has been fitted to a vehicle. The implications of this were first raised in Section 6.6 and are discussed later in the RIS.

Governments

The Australian Government operates and maintains the vehicle certification system, which is used to ensure that vehicles first supplied to the market comply with the Australian Design Rules (ADRs). There are costs incurred in operating this service. A cost recovery model is used and so these costs are recovered from business.

State and territory governments need to review in-service regulations and the effect that a pedestrian safety regulation would have on allowable vehicle modifications, given the principle of continued compliance to the ADRs. With reference to VFPS in particular, this is discussed later in the RIS.

9.7. Timing of the Preferred Option

If Option 6: Mandatory standards under the *Motor Vehicle Standards Act 1989* (C'th) (MVSA) was to be adopted, it was concluded earlier that the recommended standard to be applied is the internationally accepted Global Technical Regulation (GTR) No. 9 Pedestrian Safety. However, as mentioned earlier in the RIS, the GTR does not prescribe a timetable for implementing the regulation.

The draft UNECE regulation on pedestrian safety, which incorporates the requirements of the GTR, does contain implementation timing. It sets out a phase-in approach as follows:

- For vehicles of category M1 not exceeding 2,500 kg GVM, and vehicles of category N1 derived from them, the regulation will apply to:
  - new vehicle types as from 24 February 2013, and
  - all new vehicles as from 24 February 2018.

- For vehicles of category M1 exceeding 2,500 kg GVM, as well as vehicles of category N1 other than those mentioned above, the regulation will apply to:
  - new vehicle types as from 24 February 2015, and
  - all new vehicles as from 24 August 2019.

As a contracting party to the 1958 Agreement, it is Australia's policy to harmonise the ADRs with the international regulations adopted by the UNECE under the 1958 Agreement, except where it is necessary to take account of unique Australian conditions. It is also important to align with internationally agreed timing under the UNECE 1958 Agreement. This is because the Australian market represents only 1 per cent of the global market and so the model range available to the consumer in Australia is sensitive to any unique Australian requirements. Around 84 per cent of vehicles are imported, with only 16 per cent locally manufactured. These two figures have reversed during the past twenty or so years. Europe represents around 25 per cent of Australia's imported passenger cars while the US only represents around 5 per cent. Therefore, an ADR should be internationally harmonised as much as possible. For this reason, the timetable set out in the draft UNECE regulation on pedestrian safety would be the most feasible timetable.

9.8. Scope of the Preferred Option

GTR 9 applies to vehicles of category 1-1, 1-2 and 2 (as defined in 1998 Global Agreement Special Resolution No. 1) with a gross vehicle mass exceeding 500 kg but not exceeding 4,500 kg. This translates to the UNECE categories of M1, M2 and N of 4,500 kg or less and the Australian categories of MA (passenger cars), MB (passenger vans), MC (four-wheel drives or Sports Utility Vehicles), MD1, MD2 and MD3 (small and medium buses), as well as NA and NB1 (light and medium commercial vehicles) (refer Appendix 1 - Vehicle Categories). However, the GTR states that contracting parties may restrict application of the requirements to a narrower group of vehicles if they decide that such restriction is appropriate.

In line with this, the draft UNECE regulation applies to a narrower group of vehicles, that is, vehicles of category M1 and N1 only. 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 important to highlight that the technical requirements are the same for all of the applicable categories. It is the implementation date that has been brought forward for lighter MA, MB and MC vehicles and any NA vehicles where their design has been derived from the lighter MA, MB or MC vehicles (see Section 9.7 above).

There is also an exemption that is in both the GTR and draft UNECE regulation. The requirements do not apply to vehicles of category N1 and (optionally as decided by the Contracting Parties) to vehicles of category M1 above 2,500 kg maximum mass and which are derived from N1 category vehicles, where the driver's position "R-point" is either forward of the front axle or longitudinally rearwards of the front axle transverse centreline by a maximum of 1100 mm.

It is recommended that the UNECE regulation is adopted for the scope of any Australian regulation.

9.9. Vehicle Front Protection Systems

As discussed in Sections 6.6 and 8.2, the fitting of a Vehicle Front Protection System (VFPS) such as a “bull bar” or “nudge bar” to a vehicle subject to GTR 9 through the Australian Design Rules (ADRs) would require re-testing of the vehicle, as the performance characteristics of the front structure of the vehicle would be likely to be altered in relation to pedestrian protection.

The analysis of this potential impact has been discussed separately to the recommendation for the compliance of vehicles (see Section 9.7 above), as it almost exclusively involves the fitting of aftermarket equipment. The requirements for aftermarket equipment for vehicles come under state and territory control and hence under its legislation. As this Regulation Impact Statement (RIS) was examining the possibility of intervention by the Australian Government, it was only able to consider the option of Commonwealth regulation. Therefore, the analysis has been presented in terms of how the fitting of aftermarket VFPS could affect the outcome of any intervention by the Australian Government on the issue of pedestrian safety.

However, it was also recognised that at some point a vehicle manufacturer may wish to supply a VFPS in conjunction with a new vehicle, in which case Commonwealth requirements would apply. Further, if the Commonwealth and the state or territory legislation

were not aligned in their respective requirements, a manufacturer may choose the least stringent path to certify a VFPS, whether it was by supplying the VFPS as an ADR certified item with a new vehicle purchase or as an aftermarket (post-registration) option.
It also became clear that this RIS offered the opportunity to propose an ADR based solution as to how Commonwealth and state and territory regulation could together best balance pedestrian protection with any genuine need for a VFPS.

An overview of the issue is presented below. A more comprehensive discussion of VFPS is also provided in Appendix 11 - Vehicle Front Protection Systems and this should be referred to for further detail.

VFPS are currently fitted to a number of vehicles in Australia. Their primary purpose is for use in a rural environment, to protect against animal strikes, to provide strong points for vehicle recovery and to provide mounting points for additional equipment such as winches, lights and aerials. However some VFPS, particularly those in used exclusively in an urban environment, are fitted for aesthetic reasons only, or to protect bodywork from minor parking accidents etc.

The majority of VFPS are fitted as aftermarket equipment. The Commonwealth controls the performance standards of vehicles through the Australian Design Rules (ADRs) for new vehicles only (apart from some concessional schemes). There are few if any VFPS certified in conjunction with a new model vehicle. This means that the control of VFPS primarily comes under state and territory legislation as aftermarket equipment rather than under Commonwealth legislation as original equipment.

The Commonwealth has examined the case for requiring the Australian categories of MA (passenger cars), MB (passenger vans), MC (four-wheel drives or sports utility vehicles) and NA (light commercial vehicles) to meet pedestrian safety performance requirements in the form of an Australian Design Rule (ADR). An ADR for pedestrian protection would indirectly impact on the fitting of aftermarket VFPS. This is because state and territory legislation generally requires continued compliance to the ADRs once a vehicle is registered and an aftermarket VFPS would alter the performance of the front of a vehicle in a collision with a pedestrian. It is also possible that a vehicle manufacturer would want to include a VFPS as part of certifying a new vehicle model. Therefore, this RIS needed to consider the impact of VFPS on the proposed pedestrian safety ADR.

The VFPS market is reported to be worth around $285m per year and is dominated by VFPS made of steel or aluminium alloy, although there is a growing proportion of deformable polymer type VFPS. These latter types currently represent only around 2 per cent of the market. However, they are increasingly being purchased for government fleets due to their improved performance in terms of pedestrian protection and their use is expected to increase in the future.

Analysis of the benefits and costs of adopting pedestrian safety requirements in an ADR revealed that it is likely that there would still be net benefits available, regardless of whether VFPS were made to continue to comply with the ADR or exempted from any further requirements, beyond compliance of the original base vehicle. However, in the first case the benefits had the potential to become a negative Net Benefit (although this was highly speculative) if the VFPS industry was unable to meet the full ADR requirements as they stood. In the second case the net benefits in road trauma reduction would be seriously eroded if some otherwise complying base vehicles were fitted with noncomplying VFPS. It was thought that the second case was the more feasible one, but that there should be adjustments rather than full exemptions and that these should only be for vehicles where a VFPS was providing an essential function.

An ADR for pedestrian safety would be based on the international standard Global Technical Regulation (GTR) 9. This regulation itself makes no reference to VFPS and so evaluating the compliance of a vehicle fitted with a VFPS would be problematic. However, there is a European Union (EU) Directive 2005/66/EC that directly addresses the pedestrian performance of VFPS and complements the requirements of the GTR. If this EU directive were also to be adopted it would still be difficult for current types of steel and aluminium alloy VFPS to comply, although it is known that there are currently complying steel nudge bars and full height (but not full width) polymer VFPS available in the United Kingdom at a similar cost to comparable types in Australia.

ADR 42/04 General Safety Requirements currently specifies design and construction requirements such that a) any additional “objects or fittings” must be technically essential and b) the risk of injury in having them must be reduced as much as possible in still allowing the objects to fulfil their function.

Whether VFPS are fitted for technically essential reasons depends mostly on where the vehicle is being used. In an urban environment, they are less essential; in a rural environment they are more essential. However, an ADR can only mandate requirements to apply to all vehicles, no matter where they are used in Australia. There has been some success by the states and territories in working with the community and industry to minimise the use of pedestrian unfriendly VFPS in urban environments. However, there is still room to improve and the addition of a new ADR for pedestrian safety would make this all the more pressing.

It is proposed that through the ADRs, the fitting of a VFPS could be considered in terms of whether the base vehicle has been designed for off-road operation and hence primarily rural/outback use. Adjustments for VFPS could be limited to vehicles purposely designed for off-road use (Sport Utility Vehicles (MC) and light commercial vehicles (NA) with four-wheel drive), with other vehicles (passenger cars (MA) and two-wheel drive light commercial vehicles (NA)) required to meet more stringent requirements, most likely achieved by owners fitting a deformable polymer VFPS or a nudge bar.

The adjustments mentioned above for VFPS would be in terms of at least meeting Australian Standard for VFPS (bull bars) AS 4876.1 2002. Motor Vehicle Frontal Protection Systems. Part 1: Road User Protection, Sections 1, 2, 3.1 and if possible the impact testing of Section 3.2, in lieu of the full ADR requirements. The Standard is a compromise of achievable pedestrian protection within the current capability of the VFPS industry and a number of peak bodies representing owners, pedestrians, academia, industry and government comprised the committee that developed it. The full proposal is shown in Table 19.

Table 19 Proposed pedestrian safety performance options for VFPS by vehicle type - subject to consultation (Note: this does not represent compliance options for the vehicle itself)

Pedestrian Safety Requirements for VFPS	**MA, MB (passenger cars/vans)**	**NA (2WD light commercial)**	**MC (4WD /SUV)**	**NA (4WD light commercial)**
(i) No requirements	N/A	N/A	N/A	N/A
(ii) AS 4876.1 2002 Sections 1, 2 and 3.1	N/A	N/A	N/A*/ Must Comply	N/A*/ Must Comply
(iii) AS 4876.1 2002 Sections 1, 2, 3.1 and 3.2.	N/A	N/A	Must Comply*/ May Comply	Must Comply*/ May Comply
(iv) EU Directive 2005/66/EC	Must Comply	Must Comply	May Comply	May Comply

*Preferred position.

Comment is sought during the public consultation process on this table and where the best balance of vehicle and occupant protection and pedestrian performance should be set. This is particularly so for the state and territory transport authorities as in 2008 the adoption of AS 4876.1 2002 was rejected in a separate vote on amendments to the Australian Vehicle Standards Rules.

10. CONSULTATION

10.1. General

Development of the Australian Design Rules (ADRs) under the *Motor Vehicle Standards Act 1989* (C'th) (MVSA) is the responsibility of the Vehicle Safety Standards Branch of the Department of Infrastructure and Transport. It is conducted in consultation with representatives of the Australian Government, the National Transport Commission, 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 behalf of the Federal Minister for Infrastructure and Transport. Under Part 2, section 8 of the MVSA the Minister may consult with state and territory agencies responsible for road safety, organizations and persons involved in the road vehicle industry and organisations representing road vehicle users before determining a design rule.

The Department has already sought views both formally and informally through the established ADR consultative forums, from the state and territory transport authorities regarding pedestrian safety requirements and again separately regarding Vehicle Front Protection Systems. Any comments have been considered when writing this Regulation Impact Statement (RIS). However, little was received at this stage and so it is expected that a majority of the information and views will follow during the public comment period.

10.2. 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 business and road user communities, as well as all other interested parties, to respond to the proposal by writing or otherwise submitting their comments to the department. Providing proposals with a RIS assists all stakeholders to identify the impacts of the proposals more precisely and enables more informed debate on the issues.

It is intended that the proposal be circulated for 60 days public comment. At this time, notification will also be sent to the World Trade Organisation as part of Australia's obligations under the Technical Barriers to Trade agreement.

A summary of public comment input and departmental responses will be included in the final RIS that is used for decision making.

11. CONCLUSION AND RECOMMENDED OPTION

Studies have shown that pedestrian safety measures have a significant potential to save lives, by reducing the problem of the severity of injuries during collisions between vehicles and pedestrians or other vulnerable road users by up to 13 per cent. These collisions account for over 200 fatalities and many additional injuries that occur each year in Australia.

The market response has been limited, due to the nature of pedestrian safety in that the individual who pays for the vehicle and hence for the pedestrian safety features does not receive the main benefit of them. The main benefit is received by the pedestrian, or other vulnerable road user, through the reduction of road trauma. Because of this, there is little incentive for the owner to demand pedestrian friendly designs from the vehicle manufacturer.

The Australian market is responding for the most part to existing or impending regulations for passive pedestrian safety measures within the major vehicle producing economies of Europe and Japan. The current compliance of the fleet was estimated at 26 per cent for passenger cars and Sports Utility Vehicles (SUVs), with no Light Commercial Vehicles (LCVs) estimated to pass.

A benefit-cost analysis found that there was a case for the provision of pedestrian safety measures for passenger cars, SUVs and LCVs through government intervention. The level of voluntary percentage take-up of these measures did not alter this finding.

Option 6 Regulation has the potential to offer positive net benefits of $185m and a saving of at 65 lives, as well as over 3,000 serious injuries, over a forty six year period of analysis (assuming that the standard was active for fifteen years within this period) if the final level of voluntary take-up were to reach the expected 60 per cent for passenger cars and SUVs and 39 per cent for LCVs by 2018, in line with the proportion of vehicles being imported to Australia from Europe and Japan (where they will be required to meet pedestrian safety regulations by 2018). These savings would be higher than any of the other options that were considered feasible.

Given the strong potential for pedestrian safety measures to reduce road trauma, preference was also given to Option 6 because it could assure the highest level of compliance. Option 6: Regulation was the only option that would guarantee 100 per cent fitment within the implementation timeframe of other major vehicle producing countries in the world and thereafter. There can be no guarantee that the other options would deliver an enduring result.

Therefore, the adoption of mandatory standards (Regulation) under the *Motor Vehicle Standards Act 1989* (C’th) (MVSA) was the recommended option. The recommended standard to be applied was the internationally accepted Global Technical Regulation (GTR) No. 9 Pedestrian Safety, as adopted by the UN through the UNECE regulations.

It was recommended that the standard be applied to the Australian categories of MA (passenger cars), MB (passenger vans), MC (four-wheel drives or Sports Utility Vehicles) and NA (light commercial vehicles) (refer Appendix 1 - Vehicle Categories). In line with the GTR and the corresponding UNECE regulation, the requirements would not apply to “flat fronted" vehicles of category NA and vehicles of category MA, MB and MC that are above 2,500 kg and which are derived from NA vehicles.

The recommended implementation timetable was as for the European Union's (and other countries under the United Nations Economic Commission for Europe (UNECE) 1958 Agreement) implementation timetable of 2013-2019 (depending on the vehicle mass). This would accommodate the relatively long lead time needed to redesign the front structure of the current models, or to supersede the current models where necessary.

Compliance to pedestrian safety requirements would be affected by the practice of fitting Vehicle Front Protection Systems (VFPS) (known as "bull bars") to vehicles. An analysis of this potential impact was discussed separately to the recommendation for the compliance of vehicles, as it mainly involved the fitting of aftermarket products which in turn come under state and territory legislation rather than Commonwealth legislation. The results generally showed that it is likely that there would still be net benefits, regardless of whether compliance of VFPS to pedestrian safety requirements was mandated.

Input on VFPS during the public comment period will form part of the final decision making. This may include whether there should be awareness campaigns run in conjunction with the aftermarket industry, about balancing any genuine need for VFPS for vehicle/vehicle occupant protection with the genuine need for vehicles to provide better pedestrian protection. The Department has already sought views, through the established ADR consultative forums, from the state and territory transport authorities regarding pedestrian protection and again separately regarding VFPS and any comment has been considered when writing this RIS. However, it is expected that a majority of the information and views will follow during the public comment period.

12. IMPLEMENTATION AND REVIEW

An ADR for pedestrian safety would be given force in law in Australia by determining it as a vehicle standard under the *Motor Vehicle Standards Act 1989*. It would be implemented under the type approval arrangements for new vehicles administered by the Vehicle Safety Standards branch of the Department of Infrastructure and Transport.

The arrangements in place for the on-going development of the ADRs are the same as those for initial development. This is the responsibility of the Vehicle Safety Standards branch of the department and is carried out in consultation with representatives of Australian Government, state and territory governments, manufacturing and operating industries, road user groups and experts in the field of road safety.

Where the stringency of a standard is increased or there is a change in applicable categories, a suitable lead-time would be negotiated with industry. This is typically 18 months for new models and 24 months for all other models, but may extend beyond this in the case of major redesigning of vehicle systems.

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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 goods 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 centof 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 - EFFECTIVENESS OF PEDESTRIAN SAFETY MEASURES

Lawrence et al (2006) from the Transport Research Laboratory in the United Kingdom evaluated the effectiveness of passive pedestrian safety measures that would meet the performance requirements of Global Technical Regulation (GTR) 9 Pedestrian Safety. Their evaluation was complex and should be referred to directly if more detailed information is desired. However, a brief description is given below.

Method:

Their starting point was a vehicle fleet that had no special consideration given to the protection of pedestrians. They then used detailed crash data to estimate the proportion of pedestrian and cyclist fatalities and injuries that could be prevented if the vehicles met the performance requirements of the GTR.

Lawrence et al's effectiveness estimates were derived from a series of steps as shown in Figure 9.

Figure 9 Method of determining the proportion of vulnerable road user casualties saved by passive pedestrian safety measures

1: VRU casualties with fatal or serious injuries, all vehicles involved
⇓
2: Of those VRU casualties, - proportion struck by 'cars'
⇓
3: Of those VRU casualties, - proportion struck by car *fronts*
⇓
4: Of those VRU casualties, - proportion struck within the speed range
⇓
5: Of those VRU casualties, - proportion with injuries due to tested areas
⇓
6: Of those VRU casualties, - proportion strong enough not to be injured
⇓
7: Hence, proportion of all VRU casualties that could be 'saved'

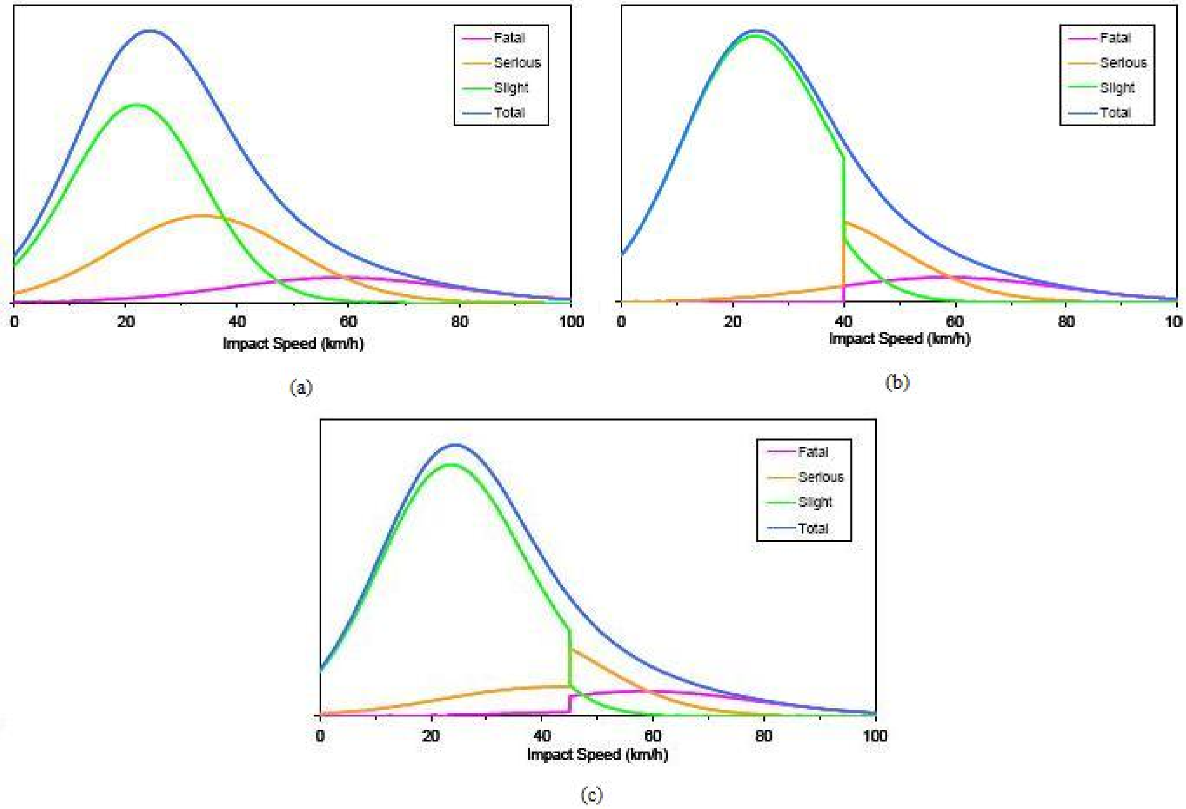
Source: Lawrence et al, 2006

Starting from a combined dataset of all vulnerable road users either fatally or seriously injured, the proportion of cases involving vehicle types that would be subject to regulation under the GTR were identified. Of those cases, only cases in which injury was caused by frontal impact, and more specifically, by a vehicle structure that would be subject to regulation under the GTR, were considered.

It was then assumed that passive pedestrian safety measures could only offer protection up to a certain vehicle speed. In taking this vehicle speed as being equivalent to the head impact speed and the lower legform speed, the value of 40 km/h was chosen.

The "equivalent car impact speed" method was used to calculate the proportion of injured casualties struck at speeds at which the test procedures could protect them. The method is illustrated in Figure 10. Figure 10 (a) shows a hypothetical speed and injury severity distribution curve. It can be seen that higher severity accidents are less frequent and peak at higher speeds, while accidents resulting in minor (or slight) injuries generally occur at lower speeds.

Figure 10 Equivalent car impact speed calculation method



Source: Lawrence et al, 2006

Since impact forces are a function of speed, it was predicted that pedestrian safety measures would result in a significant reduction in the numbers of fatally and seriously injured casualties below the equivalent car speed. No benefits were estimated for minor casualties as it was conservatively decided that the test procedures were not designed to prevent such injuries and so not expected to reduce their frequency. It was also argued that in protecting pedestrians through the safety measures, fatalities would be converted to serious injuries. Similarly, serious injuries would be converted to (and so subsequently added to the total of) minor injuries. The effect of this can be observed in Figure 10 (b) where, below the equivalent car speed, the original fatality curve converts to become the original serious injury curve while the original serious injury curve adds to the slight injury curve, the total of which comes close to representing the final number of injuries remaining at these lower speeds.

There was one more correction made in that an additional 5 km/h was added to the equivalent car speed to bring it up to 45 km/h. This was done because it was thought that there would not be an abrupt transition at the equivalent car speed, above which casualties would not be prevented and below which all would be prevented. In reality there would be a graduated transition. This transition was modelled by adding the additional 5 km/h, partly justified by assuming that on average vehicles would be tested to the pedestrian safety requirements with a tolerance of about 20 per cent of the regulated injury criteria. The final calculation method is shown in Figure 10 (c).

To determine the proportion of casualties that would not have been injured had the vehicle met the performance requirements of GTR 9, a computer program was then used to consider each casualty in turn and, within that casualty, each injury that would need to be reduced in order to reduce the severity of the casualty (fatal to serious or serious to minor).

It was recognised that injuries caused by contact with a non-tested area of the vehicle or the ground would not be affected. For casualties with multiple injuries it was also considered necessary to prevent all injuries of severity matching the casualty severity in order to reduce the casualty severity. also In addition it was assumed that the relaxation (or lower protection) zone, a zone comprising one third of the combined child and adult headform test area where the Head Injury Criterion must not exceed 1,700 rather than 1,000, would consist mostly of the wing and rear edge of the bonnet, as these areas tend to be difficult to make safe. A random number function was used to determine which zone, lower protection or higher protection, the casualty contacted to account for that fact that the two zones would have different injury risks associated with them.

The injury risk associated with a particular contact point on the vehicle, as determined by the GTR 9 requirement regulated limits, had previously been determined. If the 'strength' of the casualty for the case in question was found to be greater than the regulated limit then that injury was considered to be preventable by the regulation. A summary of the computation method is shown in Figure 11.

Figure 11 Summary of Lawrence et al's computation method

For each test option, severity (fatal or serious), 'strength' value, pass through the database and casualty:

Each injury considered would be 'saved' only if:

Injury was caused by a tested area,

Case impact speed was less than or equal to the transition speed (i.e. equivalent car speed plus 5 km/h), and

Casualty 'strength' was greater than injury risk (with higher and lower protection zones determined randomly in required proportion)

Each casualty would be 'saved' only if all injuries of severity matching the casualty severity were 'saved' (AIS 5-6 injuries for MAIS 5-6 casualties, AIS 2-4 injuries for MAIS 2-4 casualties).

Source: Lawrence et al, 2006

Results:

Lawrence et al found that passive pedestrian safety measures could result in a 4 per cent reduction in pedestrian fatalities and a 12 per cent reduction in serious injuries. Due to the injury model not allowing for any overall reduction in minor injuries, in conjunction with the transfer of any saved serious injuries over to become minor injuries instead, it was estimated that minor injuries would increase by 5.8 per cent. Therefore, the benefits from pedestrian safety measures depended more on the reduction of the total severity of injuries rather than any reduction in the overall number of injuries.

It was also found that injuries to cyclists would also decrease, although this was thought to be less than for pedestrians.

APPENDIX 3 - AWARENESS AND ADVERTISING CAMPAIGNS

Awareness Campaigns

Providing accurate costings of awareness campaigns is a difficult task. Each public awareness campaign consists of different target markets, different objectives and different reaches to name a few common differences. Two recent cases are examined below; the Department of Health & Ageing's Skin Cancer Awareness Campaign, and the Office of Transport Security's Liquids, Aerosols and Gels (LAGs) Awareness Campaign.

Broad High Cost Campaign

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

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

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

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

The costs of this campaign were from three sources:

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

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

Targeted Low Cost Campaign

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

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

- 14 million brochures were published in English, Japanese, Chinese, Korean & Malay and were distributed to airports, airlines, duty free outlets and travel agents
- 1200 Posters, 1700 counter top signs, 57000 pocket cards, 36 banners and 5000 information kits were prepared
- Radio and television interviews were conducted
- Items were placed in news bulletins
- Advertising in major metropolitan and regional newspapers
- A website, hotline number and email address were established to provide travellers with a ready source of information
- 5 million resealable plastic bags were distributed to international airports
- Training for 1900 airport security screeners and customer service staff was funded and facilitated by the department

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

The costs of this campaign were from three sources:

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

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

Should a pedestrian safety campaign be run, there would be a similar narrow target market; new car buyers. As a result, placement of similar marketing tools could be positioned in places where consumers search for information. Particular focus may be on new car yards.

Advertising Campaigns

A study conducted for the Radio Ad Lab (Radio Ad Lab, 2005) investigated the potential of advertising campaigns in increasing sales. The findings of the report indicated that, for general goods, advertising campaigns can lead to an around 8 per cent increase in sales.

An example of a real-world advertising campaign that featured a vehicle safety technology, in this case Electronic Stability Control, as a selling point is the Mitsubishi Outlander advertising campaign that was launched in February 2008. It focused solely on the fact that the car has "Active Stability Control as standard". This means that any change in sales is most easily attributable directly to the campaign to promote Active Stability Control. There was an immediate effect with sales of the Mitsubishi Outlander increasing by 9.1 per cent for the month of February. Although not directly related to pedestrian safety, this campaign is considered relevant as it focused on the promotion of a vehicle safety feature.

APPENDIX 4 - OVERVIEW OF GLOBAL TECHNICAL REGULATION NO. 9

The following is an overview of the requirements of Global Technical Regulation No. 9 Pedestrian Safety. For the full requirements refer to the United Nations Economic Commission for Europe at www.unece.org/trans/main/welcwp29.htm.

The purpose of the Global Technical Regulation (GTR) for pedestrian safety is to improve the design of certain parts of vehicle fronts which have been identified as causing injury when in collision with a pedestrian or other vulnerable road user. It does this by specifying performance requirements for bonnet tops and wings, and front bumpers.

The GTR applies to vehicles of categories: 1-1 with a gross vehicle mass (GVM) exceeding 500 kg; 1-2 with a GVM exceeding 500 kg but not exceeding 4,500 kg ; and 2 with a GVM exceeding 500 kg but not exceeding 4,500 kg.

However, power driven vehicles of categories 1-2 and 2, where the distance between the centre line of the front axle and the R-point of the driver's seat is less than 1,000 mm, are exempt from the requirements.

The test procedures are separated into headform and legform tests. Vehicles with a lower bumper height of less than 425 mm are tested with a lower legform, while vehicles with a lower bumper height of greater than or equal to 500 mm are tested with an upper legform . Vehicles with a lower bumper height between 425 mm and 500 mm are tested with either legform, as chosen by the manufacturer.

Performance Requirements

Legform to bumper:

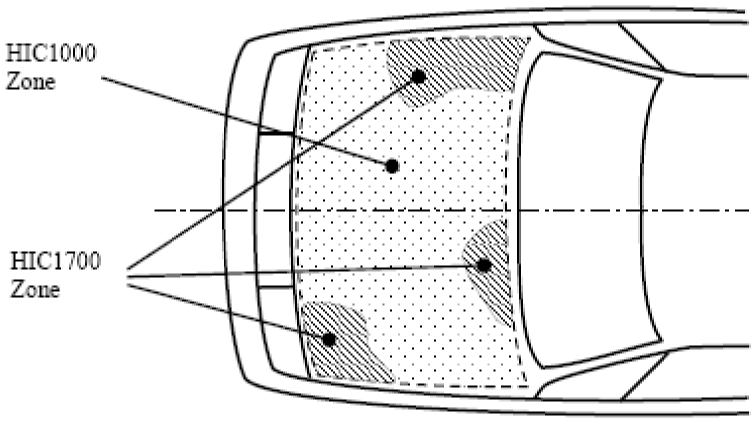
The maximum knee bending angle of the lower legform shall not exceed 19°, the maximum knee shearing displacement shall not exceed 6.0 mm, and the acceleration measured at the upper end of the tibia shall not exceed 170g.

The sum of the impact forces on the upper legform shall not exceed 7.5 kN and the bending moment on the test impactor shall not exceed 510 Nm.

Headform:

The Head Injury Criterion (HIC) must not exceed 1,000 over a minimum of one half of the child headform test area and 1,000 over two thirds of the combined child and adult headform test areas. The HIC for the remaining areas shall not exceed 1,700 for both headforms.

The manufacturer shall identify the zones of the bonnet top where the HIC must not exceed 1,000 (HIC1000 Zone) or 1,700 (HIC1700 Zone), see figure below.



Example of marking of HIC1000 zone and HIC1700 zone

The areas of HIC1000 Zone and HIC1700 Zone may consist of several parts, with the number of these parts not being limited.

Test Specifications

Test Conditions

The test facility and the vehicle or sub-system shall have a relative humidity of 40 per cent ± 30 per cent and temperature of 20 ± 4 ºC. The test site shall consist of a flat, smooth and hard surface with a slope not exceeding 1 per cent.

Vehicle Preparation

Either a complete vehicle or a cut-body may be used for the test. If a vehicle is used, it shall be either securely mounted or on a flat horizontal surface with the parking brake applied. If a cut-body is used, it must include all parts of the vehicle front structure that may be involved in a frontal impact with a vulnerable road user.

Test Impactor Specifications

The lower legform impactor shall consist of two foam covered rigid segments, representing femur (upper leg) and tibia (lower leg), joined by a deformable, simulated knee joint.

The upper legform impactor shall be rigid and foam covered at the impact side.

The child and adult headform impactors shall be made of aluminium, be of spherical shape, and least half of the impactor shall be covered with a synthetic skin.

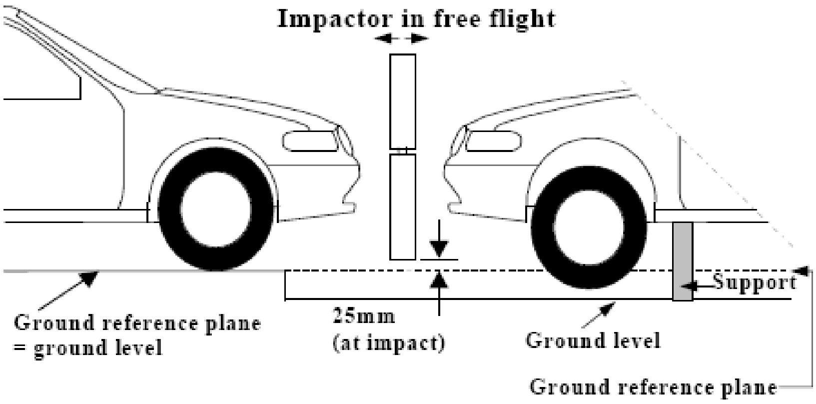
Further conditions relating to the dimensions, mass, materials, instrumentation, and storage of the impactors apply.

Test Procedures

Lower legform to bumper test procedure

The selected target points shall be in the bumper test area, defined as the frontal surface of the bumper limited by two longitudinal vertical planes intersecting the corners of the bumper and moved 66 mm parallel and inboard of the corners of the bumpers.

The direction of the impact velocity vector shall be in the horizontal plane and parallel to the longitudinal vertical plane of the vehicle. The axis of the impactor shall be perpendicular to the horizontal plane. The bottom of the impactor shall be at 25 mm above ground reference plane at the time of first contact with the bumper as shown in the figure below.



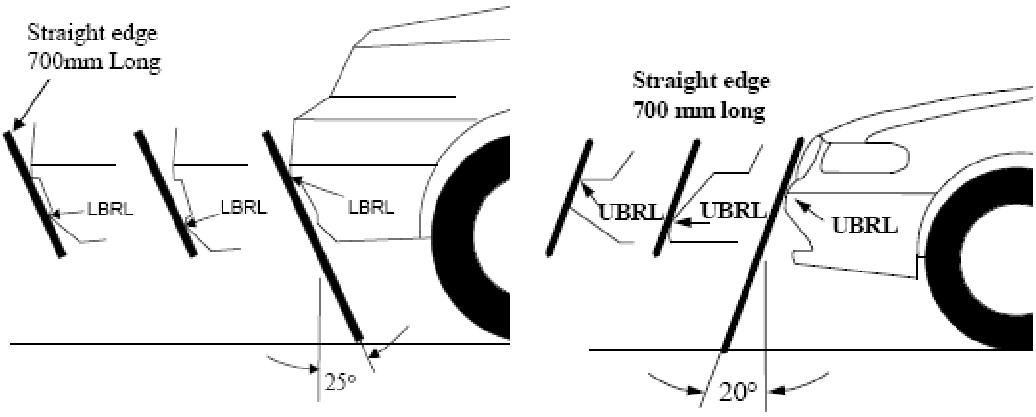
Lower legform to bumper tests for complete vehicle in normal ride attitude (left) and for cut-body mounted on supports (right)

The lower legform impactor for the bumper tests shall be in free flight at the moment of impact. The impact velocity of the impactor when striking the bumper shall be 11.1 ± 0.2 m/s.

Upper legform to bumper test procedure

The selected target points shall be in the bumper test area.

The direction of impact shall be parallel to the longitudinal axis of the vehicle, with the axis of the upper legform vertical at the time of first contact. At the time of first contact the impactor centre line shall be vertically midway between the upper bumper reference line and the lower bumper reference line (shown in the figure below) and the impactor vertical centre line shall be positioned laterally with the selected impact location. The impact velocity of the upper legform impactor when striking the bumper shall be 11.1 ± 0.2 m/s.



Lower bumper reference line, LBRL (left) and Upper bumper reference line, UBRL (right)

Child headform test procedures

Tests shall be made to the front structure within the child headform test area, an area bounded, by the front reference line for child headform, WAD1700 line, and the side reference lines.

For tests on the rear area of the bonnet top, the headform impactor shall not contact the windscreen or A-pillar before impacting the bonnet top. No impact point shall be located so that the impactor will impact the test area with a glancing blow resulting in a more severe second impact outside the test area.

Selected impact points on the bonnet for the child headform impactor shall be, at the time of first contact:

a) a minimum of 82.5 mm inside the defined side reference lines, and;

b) forward of the WAD1700 line, or, a minimum of 82.5 mm forwards of the bonnet rear reference line, - whichever is most forward at the point of measurement, and;

c) be rearward of the WAD1000 line, or, a minimum of 82.5 mm rearwards of the bonnet leading edge reference line, - whichever is most rearward at the point of measurement.

The point of first contact of the headform impactor shall be within a ± 10 mm tolerance to the selected impact point. The headform velocity shall be 9.7 ± 0.2 m/s at the time of impact. The direction of impact shall be in the longitudinal vertical plane of the vehicle at an angle of 50 ± 2° to the horizontal. The direction of impact of tests to the front structure shall be downward and rearward.

Adult headform test procedures

Tests shall be made to the front structure within the boundaries as defined in paragraph 3.1. For tests at the rear of the bonnet top, the headform impactor shall not contact the windscreen or A-pillar before impacting the bonnet top.

No impact point shall be located so that the impactor will impact the test area with a glancing blow resulting in a more severe second impact outside the test area.

Selected impact points on the bonnet for the adult headform impactor shall be, at the time of first contact:

a) a minimum of 82.5 mm inside the defined side reference lines, and;

b) forward of the WAD2100 line, or, a minimum of 82.5 mm forward of the bonnet rear reference line, whichever is most forward at the point of measurement, and;

c) rearward of the WAD1700 line.

The point of first contact of the headform impactor shall be within a ± 10 mm tolerance to the selected impact point. The headform velocity shall be 9.7 ± 0.2 m/s at the time of impact. The direction of impact shall be in the longitudinal vertical plane of the vehicle an angle of 65° ± 2° to the horizontal. The direction of impact of tests to the front structure shall be downward and rearward.

APPENDIX 5 - COSTS OF MEETING GLOBAL TECHNICAL REGULATION NO. 9

Cost of modifying a vehicle to meet GTR 9

Table 20 shows the modifications and associated costs required to modify a Ford Mondeo to meet the now revised phase two of the EC directive. These costs were used by TRL as the basis for determining the costs to meet the requirement of GTR 9.

Table 20 Costs of pedestrian safety modifications for a Ford Mondeo

Ref no	Report Section	PART DESCRIPTION	New Items	Compt & Assy Tool type	Additional Manufacture piece cost / Vehicle	Additional Tooling / Assy costs per Programme
1	FIGURE 1.7 FIGURE 1.8	FRONT BUMPER FACIA INCREASE DEPTH BY 28mm.		plastic	£3.00	£40,000
2	FIGURE 1.2	FRONT BUMPER ENERGY ABSORBING FOAM MATERIAL FOR LOW SPEED IMPACT		foam	£2.00	£2,000
3	FIGURE 1.9	FRONT UNDERTRAY UNDER TRAY TO SUPPORT FRONT LOWER SPOILER		plastic	£1.50	£10,000
4	1.1.2	HEADLAMPS - DESIGNED AS PEDESTRIAN IMPACT FRIENDLY REPAIR KIT WILL BE REQUIRED - NO COSTS FOR THIS REPORT	#	plastic plastic	£0.00	£0
5	1.1.2	FRONT HEAD LAMP - MOVED FOREWORD - NO COSTS FOR THIS REPORT - AFTER SALES. HEAD LAMP BRKT MODIFIED WITH CRUSHABLE FIXINGS-REQUIRED IF CLASS LENS ISUSED		pressed assy	£0.00	£0
6	FIGURE 1.1	ENERGY ABSORBING CRUSH CANS PRESSED SHEET METAL INNER AND OUTER LH & RH CRUSH CANS	#	pressed assy	£2.05 £0.80	£84,000 £11,200
7	FIGURE 1.3	PRESSED MAIN BUMPER BEAM TWO PIECE SHEET METAL PRESSED BEAM REQUIRED	#	pressed assy	£0.00 £0.00	£0 £0
8	FIGURE 1.4	PRESSED CRUSH BEAM TO FRONT BUMPER - ADD CRUSH INITIATION DEPRESSIONS. ADD FORM TOOL TO PRESS IN THE DEPRESSIONS.	#	pressed assy	£2.80 £1.12	£160,000 £7,500
9	FIGURE 1.10	BRACKET BONNET LATCH CUT OUTS TO BE ADDED TO PRODUCE A CRUSHABLE ZONE AREA		pressed assy	£0.25	£33,000
10	FIGURE 1.11	BONNET INNER PANEL - [SHEET METAL PRESSING] RAISE BONNET BY 35mm		pressed assy	£0.35	£18,000
11	FIGURE 1.12 FIGURE 1.13	BONNET OUTER PANEL - [SHEET METAL PRESSING] RAISE BONNET BY 35mm		pressed assy	£0.40 £0.30	£20,000 £4,900
12	FIGURE 1.15	MODIFY FRONT FENDER OUTERS LH & RH. REPOSITION FRONT EDGE TO HEAD LAMP - INCREASE HEIGHT OF TOP SURFACE.		pressed assy	£0.49	£58,000
13	FIGURE 1.17	BRAKE & FLUID RESERVOIRS & PIPES - CRUSHABLE BRAKE RESVR BRKT. FLUID RESERVOIRS & PIPES - CRUSHABLE FLUID RESVR BRKT.		pressed assy	£0.22	£23,000
14	FIGURE 1.17	AIR FILTER , CRUSHABLE PLASTIC HOUSING - ENGINE TOP COVER TO BE REMOVED. FUSE BOX - CRUSHABLE PLASTIC HOUSING - NO COSTS FOR THIS REPORT.		plastic plastic	£0.00 £0.00	£0 £0
15	FIGURE 1.17	ENGINE POSITION - ENGINE MOUNT - MODIFICATIONS. **[SEE DOCUMENT]**				
	FIGURE 1.14	OR RAISE BONNET 35 - THIS COST IS IN ITEM				
16	FIGURE 1.19 FIGURE 1.20	FRONT FENDER MOUNTING BRACKETS - LH & RH 2 OFF PER SIDE. DEFORMABLE WING EDGE BRACKETS REQUIRED	#	pressed assy	£3.52	£169,000
17	FIGURE 1.20 FIGURE 1.18	SHOT GUN LH & RH UPPER WHEEL ARCH LONG MEMBER BEAM MODIFY PART WITH AN UP STAND FLANGE TO MOUNT FENDER BRACKETS		pressed assy	£0.70 £1.74	£98,000 £9,000
18	1.1.3.3 FIGURE 1.21	BASE OF THE WINDSCREEN [FIREWALL SECTION] THE MODDEO ALREADY HAS A C-SHAPED PANEL THE SAME AS THE HONDA CIVIC.		pressed assy		
19	FIGURE 1.22	MODIFY FIREWALL / ENGINE BAY BULKHEAD, ADD SWAGE FORM TOOL SWAGES TO BE ADDED TO FORM CRUSH ZONE.		pressed assy	£0.24	£37,000
20	FIGURE 1.23 FIGURE 1.24	BONNET HINGE - TO BE FIXED WITH BREAK AWAY BOLTS - SHEAR BOLTS SPECIALS. NEW BRKT MOUNT HINGE FIXING TO BONNET WITH CRUSHABLE INITIATORS.		pressed assy	£1.13	£25,500
			TOTAL COSTS		£22.61	£810,100
			With Foam Bumper Excludes 8		**£18.69**	**£642,600**
			With Pressed Beam Excludes 2		**£20.61**	**£808,100**

Source: Lawrence et al, 2006

The costs in Table 20 were also used as a starting point in determining the costs relevant to the Australian case. These costs were examined in grouped into three categories; 1) those that could be done as part of the normal design process for the front of a vehicle, 2) those that would need to be done specifically for pedestrian safety but would be an integral part of the vehicle structure and 3) those that would need to be done specifically for pedestrian protection and would not be an integral part of the vehicle structure as so would be easily left out or substituted during production. The breakdown of the modifications into these three categories is shown in Tables 18 to 20.

Table 21 Category 1 – Part of normal development

TRL Reference Number	**Description**
1	Front bumper facia – increase depth
3	Front undertray
10	Bonnet inner panel – raise bonnet
11	Bonnet outer panel – raise bonnet
12	Modify front fender outers
15	Engine position - engine mounts

Table 22 Category 2 - Developed specifically for pedestrian safety, part of integral structure

TRL Reference Number	**Description**	**Piece Cost** (per vehicle)	**Tooling Cost** (5 yrs at 180000 vehicles/yr)
6	Energy absorbing crush cans Pressed sheet metal inner and outer LH and RH crush cans	£2.05 £0.80	£84,000 £11,200
7	Pressed main bumper beam	£0.00	£0
8	Pressed crush beam to front bumper Add form tool to press in crush initiation depressions	£2.80 £1.12	£160,000 £7,500
16	Front fender mounting brackets	£3.52	£169,000
17	Shot gun upper wheel arch long member beam Modify part with an up stand flange to mount fender brackets	£0.70 £1.74	£98,000 £9,000
18	Base of windscreen		
19	Modify firewall/engine bay bulkhead	£0.24	£37,000
	Total:	**£12.97**	**£575,700**

Table 23 Category 3 - Developed specifically for pedestrian safety, not part of integral structure

TRL Reference Number	**Description**	**Piece Cost** (per vehicle)	**Tooling Cost** (5 yrs at 180000 vehicles/yr)
4	Headlamps - designed as pedestrian impact friendly	£0.00	£0
5	Front headlamp - moved forward	£0.00	£0
9	Bracket bonnet latch Cutouts to be added to produce a crushable zone area	£0.25	£33,000
13	Brake and fluid reservoirs and pipes - reposition bracket with crushable mounts	£0.22	£23,000

14	Air filter and fuse box - crushable plastic housing	£0.00	£0
20	Bonnet hinge - to be fixed with break away bolts and crushable mounts	£1.13	£25,500
	Total:	**£1.60**	**£81,500**

It was assumed that the modifications in Table 21 would be done as part of the normal design process for the front of the vehicle. Therefore, these modifications were assigned a zero marginal cost.

Next it was assumed that vehicles designed and certified to meet the GTR by way of the EU requirements would be supplied to other markets with the same basic pedestrian friendly structure, regardless of whether pedestrian safety requirements also apply. Similarly, other markets would provide vehicles built to meet the GTR by way of being able to also supply them to the EU. Therefore, the costs of the modifications in Table 22 would apply only to locally manufactured vehicles, which represent approximately 16 per cent of the Australian vehicle market. The total cost per vehicle for these modifications would be (in 2004 £):

$$\left(£12.97 + \frac{£575{,}700}{5 \times 180{,}000}\right) \times 0.16 = £2.72$$

It was then noted that, where there is no requirement in Australia to meet the GTR, it is likely that vehicles would still be supplied with the basic pedestrian safety structure but without the individual components such as frangible mountings or deformable headlamps being fitted. Therefore, the costs for the modifications in Table 23 would apply to both imported and locally manufactured vehicles. The total cost per vehicle for these modifications would be (in 2004 £):

$$£1.60 + \frac{£81{,}500}{5 \times 180{,}000} = £1.69$$

The assumption was then made that executive cars and sports cars would need to be fitted with pop-up bonnets or other similar features, based on the statement by Lawrence et al (2006) that these vehicles may be unable to utilise conventional passive safety measures to meet pedestrian safety requirements. The corresponding Australian vehicle categories account for 2.4 per cent of the market (FCAI, 2009). Part costs and tooling costs of pop-up bonnets were estimated in Lawrence et al at €145 per vehicle and €220 per vehicle respectively. Therefore, the inclusion of pop-up bonnets would add a cost of €8.76 (€365 × 0.024) per vehicle.

The costs were converted to 2006 € and summed to give a total cost for parts and tooling of €13.44 per vehicle. However, this cost relates to solely to parts and tooling. To take into account development costs, the costs from Table 5, which include development costs, were multiplied by €13.44/€35.09, where €35.09 is the total cost for parts and tooling if the all of the costs from Table 20, plus those for pop-bonnets were summed.

The resulting adjusted costs for the Australian case are shown in the table below.

Vehicle Style	**Cost per vehicle (€ 2006)**
Super Mini	17.61
Small Family Car	10.63
Large Family Car	14.15
Executive Car	49.62
Sports Car	152.22
Small MPV	11.80
Large MPV	13.23
Large Off-Roader	19.60

Type approval costs

Under the type-approval certification system used in Australia, the cost of submitting and processing a model application has been estimated by the Department of Infrastructure and Transport as around $15,000. This estimate was guided by the estimates of some of the more complex tests given in Appendix 6 - Typical Costs for Regulation Compliance in Australia, as well as in recognition that the cost of the test itself has been accounted for in the testing costs.

Therefore, a cost of $15,000 for a vehicle model is considered a reasonable assumption for the type approval costs.

Implementing and maintaining the regulation costs

There is also an estimated cost of $50,000 per year to governments to create, implement and maintain the regulation, as well as for state and territory jurisdictions to develop processes for its in-service use (such as vehicle modification requirements etc). This includes the initial development cost, as well as ongoing maintenance and interpretation advice.

Therefore, a yearly cost of $50,000 is considered a reasonable assumption for the implementation and maintenance of a regulation.

A summary of the costs associated with meeting GTR 9 is given below.

Type of cost	**Estimated cost ($)**	**Notes**
Pedestrian safety modifications (min)	30	per vehicle
Pedestrian safety modifications (max)	78	per vehicle
Pedestrian safety testing	35,000	per model
Type approval costs	15,000	per model
Implement and maintain regulation	50,000	per year

APPENDIX 6 - TYPICAL COSTS FOR REGULATION COMPLIANCE IN AUSTRALIA

ADR	Category	Activity	Affected Party	Cost	Cost Basis
07/00	certification	certification to ADR	industry	1,500	per model
10/00	certification	certification to ADR	industry	50,000	per annum
10/00	test	dynamic or barrier crash component costs	industry	10,000	per model
10/00	test	cost to perform crash test	industry	3,000	per model
10/00	test	cost of vehicle and "body block" components to perform test	industry	25,000	per model
11/00	test	testing	industry	500	per model
11/00	sumbit test	submission of evidence	industry	500	per model
11/00	certification	certification to ADR	industry	9,000	per model
12/00	certification	certification to ADR	industry	500	per model
14/00	certification/ design + build	certify mirrors to ADR - development costs	industry	250000 - 350000	per model
14/00	test	testing - cost of small car	industry	15,000	per model
14/00	test	testing - cost of 4WD	industry	60,000	per model
15/00	certification	certification to ADR	industry	10,000	per model
15/00	administer test	administration of ADR	government	1,000	per annum
16/00	certification	certification to ADR	industry	10,000	per model
16/00	administer test	administration of ADR	government	1,000	per annum
17/00	test	impact tests - fuel tanks	industry	4,000	per model
17/00	certification	certification of other parts of the fuel system	industry	5,000	per model
20/00	test	compliance testing	industry	6,000	per model
20/00	submit test	compliance administration	industry	500	per model
21/00	test	head form impact certification test	industry	4,000	per model
21/00	test	10g instrument panel compartment door loading test	industry	1,500	per model
21/00	submit test	submission of evidence	industry	500	per model
23/00	certification	certification tests to ADR	industry	8,000	per model
23/00	submit test	compliance administration	industry	500	per model
23/00	test	UNECE R30 certification test	industry	2,500	per model
24/00	certification	certification	industry	1,000	per model
29/00	certification	full ADR 29 test and submission of certification information.	industry	2,000	per model
29/00	test	destructive testing cost - pre-production body unit (shell and doors)	industry	2,000	
29/00	submit test	Submission of evidence	industry	500	per model
29/00	design + build	cost to design and build a vehicle to ADR 29	industry	20	per vehicle / unit
31/01	test	test to ADR	industry	10,000	per model
31/01	submit test	administration - submiting evidence	industry	2,000	per model
31/01	administer test	administration of ADR	government	15,000	--
33/00	compliance	ADR 33 compliance testing	industry	10,000	per model
34/00	test	testing to ADR	industry	360,000	per annum
34/00	design + build	design, manufacture and installation of the anchorage fittings	industry	1,450,000	per annum
35/01	test	test to ADR	industry	10,000	per model
38/02	certification	certification	industry	1,200	per model
42/04	test	crash test	industry	4,000,000	per model
42/04	--	underrun barrier unit cost	industry	400	per vehicle / unit
43/04	test	product development - cost of car	industry	20,000	per model
43/04	test	product development- Cost of a used rigid truck	industry	40,000	per model
43/04	test	product development -Cost of crash test	industry	25,000	per model
43/04	design + test	product development - Cost towards design, analysis and testing	industry	30,000	per model
43/04	build	product development- Cost of constructing a rear under-run barrier	industry	5,000	per model
43/04	--	product development - Other costs	industry	5,000	per model
58/00	compliance	manufacturing and compliance costs to ADR	industry	1,000	per annum
59/00	compliance	comly with ADR - materials cost	industry	1,200	per vehicle / unit
59/00	test	align with UNECE - testing	industry	12,000	per vehicle / unit
59/00	compliance	align with UNECE - materials cost	industry	1,200	per vehicle / unit
61/00	certification	inspection and certification	government	400,000	per annum
61/00	compliance	industry compliance costs	industry	500,000	per annum
62/00	certification	certification to UNECE as alt standard	industry	10,000	per model
62/00	certification	certification to UNECE as alt standard	industry	20,000	per model
62/00	certification	certification to UNECE as alt standard	industry	18,000	per model
62/00	test	lab testing of coupling type	industry	25,000	per vehicle / unit
62/00	certification	lab testing of coupling type + ancillary costs + certification costs	industry	50,000	per vehicle / unit
63/00	compliance	compliance	industry	7,500	per annum
63/00	administer test	compliance	government	200	per model
64/00	compliance	compliance	industry	5,000	per annum
64/00	administer test	compliance	government	200	per model
65/00	test	ADR 65 compliance test costs	industry	1000-2000	per model
65/00	submit test	Submission of certification information	industry	15,000	per annum

APPENDIX 7 - 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 between the options, no matter at what point in time that they occurred. The analysis may be broken up in to the following parts:

1. The trend in new vehicle sales data for passenger cars and SUVs as well as LCVs was established for the years 1999-2009. Sales data for this period showed a rise in vehicles sales of around 2.1 per cent per year. This trend was then extrapolated to 2030 by assuming an annual growth rate in new vehicle sales of 2 per cent.

2. The voluntary fitment rate of passive pedestrian safety measures for the Business As Usual (BAU) case was established, starting at the current rate of 26 per cent for passenger cars and SUVs and zero per cent for LCVs, and reaching levels of 60 per cent and 39 per cent respectively by 2018. The fitment rates were then established for each of the options. These were higher than the BAU, the actual amount depending on the characteristics of the proposed intervention.

3. The likelihood of a registered car having a crash where a driver is injured in some way (including fatally) was established for each year of a car’s life using the method described in Fildes (2002). The method included historical data of crash rates over 26 years.

4. The differences between the BAU and each option were calculated, resulting in the net number of vehicles fitted with pedestrian safety measures that were attributable to each option in a particular year.

5. For each year, the net number of vehicles fitted with pedestrian safety measures for each option was then multiplied by the likelihood of a crash per registration in that first year. This was then added to the likelihoods of older cars crashing during that year.

6. The net number of vehicles from Part 4 was multiplied by the number of expected crashes for that year as determined in Part 5. The result was then multiplied by the effectiveness of passive pedestrian safety measures, the outcome being the number of pedestrian vehicle crashes that could be influenced by passive pedestrian safety measures due to the intervention option.

7. The crashes in Part 6 were multiplied by the combined ratio of fatalities, serious injuries and minor injuries determined for pedestrian and cyclist crashes, and then by the costs associated with each one of these crash types. This gave the savings associated with the reduction of the crash severity, which in turn became the benefits for each option. Research undertaken by the Bureau of Transport Economics (2000) in Australia found that the cost in 1996 dollars of a road crash was $1.65 million for a fatal crash, $407,990 for a serious injury crash, and $13,776 for a minor injury crash. These costs were updated to 2010 prices, using a historical annual inflation rate of 2.6

per cent (from the Reserve Bank of Australia's Inflation Calculator http://www.rba.gov.au/calculator/annualDecimal.html), to $2.37 million, $584,403, and $19,733 respectively. In addition, the cost of a fatality was then modified to reflect willingness to pay terms. This was done using a base cost of $3.587m (Abelson, 2007), with added other costs from the Bureau of Transport Economics (2000) to a value of $922, 551, to reach a final value for a fatal crash of $4.72m. These amounts were proportioned using the fatality and injury ratio for pedestrian/vehicle crashes as determined on page 13 to arrive at the cost of an average casualty crash of $300,986. This comprised $99,294 towards a fatal crash, $191,812 towards a serious injury crash and $9,881 towards a minor injury crash.

8. The fitment, regulation compliance and government costs (as relevant) with each particular option were then calculated. The fitment costs were based on the net number of vehicles in Part 4 and included system development costs. Regulation compliance costs (where applicable) were based on all passenger cars, SUVs and LCVs in the new fleet and government costs were determined separately and were recorded in Table 7.

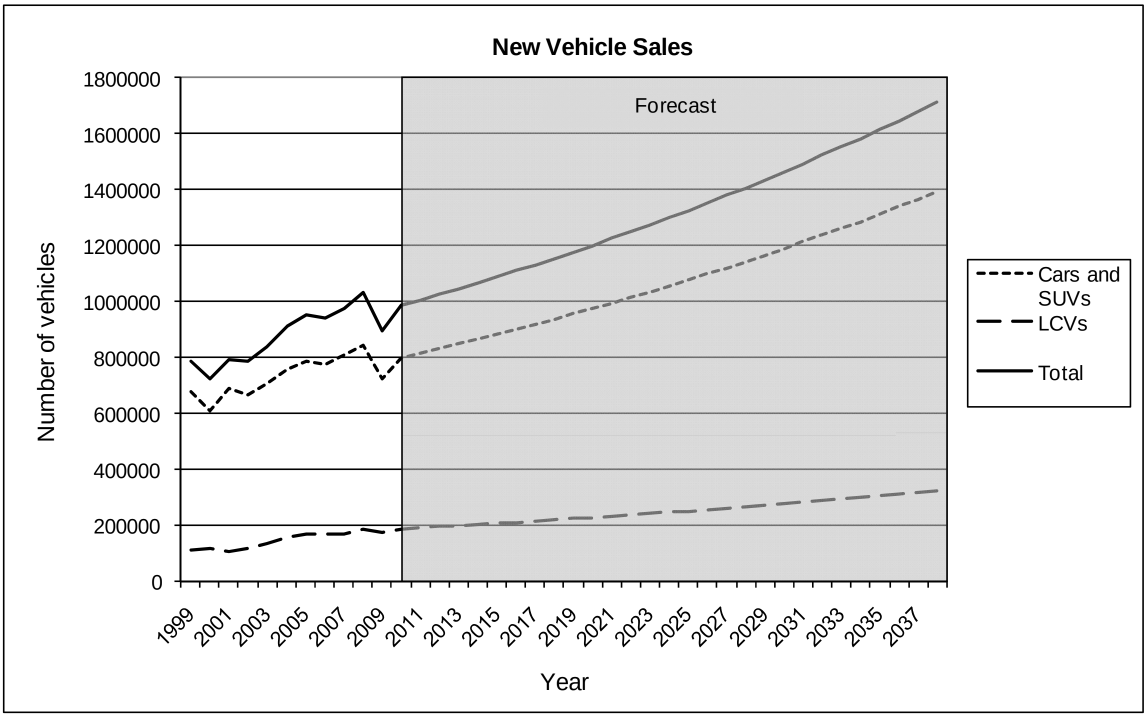
9. All the calculated values were discounted and summed, allowing calculations of Net Benefits, Total Costs, Benefit-Cost Ratios and lives saved. A discount rate of 7 per cent was assumed, this being in line with similar studies. However, discount rates of 3 per cent and 11 per cent were used as part of a sensitivity check.

APPENDIX 8 - BENEFIT-COST ANALYSIS – DETAILS OF RESULTS

1. Establish the trend in new vehicle sales data for passenger cars, SUVs and LCVs for the years 1998-2009. Extrapolate to 2038 by assuming a total increase in the current rate of 2 per cent per year.

New Vehicle Sales			
Year	**Cars and SUVs**	**LCVs**	**Total**
1998-99	677482	107703	785185
1999-00	607036	113779	720815
2000-01	685835	103113	788948
2001-02	666672	115744	782416
2002-03	704170	131253	835423
2003-04	755338	155098	910436
2004-05	785985	164348	950333
2005-06	772685	166748	939433
2006-07	804478	167388	971866
2007-08	842756	186868	1029624
2008-09	718834	174501	893335
2009-10	798308	186234	984542
2010-11	*814274*	*189959*	*1004233*
2011-12	*830560*	*193758*	*1024317*
2012-13	*847171*	*197633*	*1044804*
2013-14	*864114*	*201586*	*1065700*
2014-15	*881397*	*205617*	*1087014*
2015-16	*899024*	*209730*	*1108754*
2016-17	*917005*	*213924*	*1130929*
2017-18	*935345*	*218203*	*1153548*
2018-19	*954052*	*222567*	*1176619*
2019-20	*973133*	*227018*	*1200151*
2020-21	*992596*	*231559*	*1224154*
2021-22	*1012448*	*236190*	*1248637*
2022-23	*1032697*	*240914*	*1273610*
2023-24	*1053350*	*245732*	*1299082*
2024-25	*1074417*	*250646*	*1325064*
2025-26	*1095906*	*255659*	*1351565*
2026-27	*1117824*	*260773*	*1378596*
2027-28	*1140180*	*265988*	*1406168*
2028-29	*1162984*	*271308*	*1434292*
2029-30	*1186244*	*276734*	*1462978*
2030-31	*1209969*	*282269*	*1492237*
2031-32	*1234168*	*287914*	*1522082*
2032-33	*1258851*	*293672*	*1552524*
2033-34	*1284028*	*299546*	*1583574*
2034-35	*1309709*	*305537*	*1615246*
2035-36	*1335903*	*311647*	*1647550*
2036-37	*1362621*	*317880*	*1680501*
2037-38	*1389874*	*324238*	*1714111*
2038-39	*1417671*	*330723*	*1748394*

Source: ABS, 2009a



2. Establish the fitment rate of passive pedestrian safety measures for the Business As Usual (BAU) case. Establish the fitment rate for each of the options.

Benefit related to:	**Expected effectiveness**	**Notes**
Option 2: User information campaigns	45%	total awareness per new fleet per year (see p18 for details on effectiveness)
Option 3: Fleet purchasing policies (cars and SUVs)	41%	increase per new fleet per year (see p20 for details on effectiveness)
Option 3: Fleet purchasing policies (LCVs)	50.0%	increase per new fleet per year (see p20 for details on effectiveness)
Option 6: Mandatory standards under the MVSA (regulation)	100%	total per new fleet per year

For Option 2, there was an estimated increase from the Option 1 (BAU) fitment rate to fitment rate of 45 per cent (based on the assumption that a targeted awareness campaign would generate an awareness of 77 per cent which would translate into a 45 per cent take-up of pedestrian friendly vehicles).

For Option 3: Fleet purchasing policies, there was a 41 per cent increase for passenger cars and SUVs and 50 per cent for LCVs on top of the first year Option 1 (BAU) fitment rate. This was capped at 100 per cent total.

For Option 6: Mandatory standards under the MVSA, there was an increase from the Option 1 (BAU) fitment rate to a total of 100 per cent, with a pro-rata transition within the 2015-2019 period of implementing the regulation.

Option 2: User information campaigns

Fitment Rate						
	Cars and SUVs		LCVS		Total	
	BAU	Option	BAU	Option	BAU	Option
2009	0.260	0.450	0.000	0.450	0.208	0.450
2010	0.298	0.450	0.043	0.450	0.247	0.450
2011	0.336	0.450	0.087	0.450	0.286	0.450
2012	0.373	0.450	0.130	0.450	0.325	0.450
2013	0.411	0.450	0.173	0.450	0.364	0.450
2014	0.449	0.450	0.217	0.450	0.402	0.450
2015	0.487	0.487	0.260	0.450	0.441	0.479
2016	0.524	0.524	0.303	0.450	0.480	0.510
2017	0.562	0.562	0.347	0.450	0.519	0.540
2018	0.600	0.600	0.390	0.450	0.558	0.570
2019	0.600	0.600	0.390	0.450	0.558	0.570
2020	0.600	0.600	0.390	0.450	0.558	0.570
2021	0.600	0.600	0.390	0.450	0.558	0.570
2022	0.600	0.600	0.390	0.450	0.558	0.570
2023	0.600	0.600	0.390	0.450	0.558	0.570
2024	0.600	0.600	0.390	0.450	0.558	0.570
2025	0.600	0.600	0.390	0.450	0.558	0.570
2026	0.600	0.600	0.390	0.450	0.558	0.570
2027	0.600	0.600	0.390	0.450	0.558	0.570
2028	0.600	0.600	0.390	0.450	0.558	0.570
2029	0.600	0.600	0.390	0.450	0.558	0.570
2030	0.600	0.600	0.390	0.450	0.558	0.570

Option 3: Fleet purchasing policies

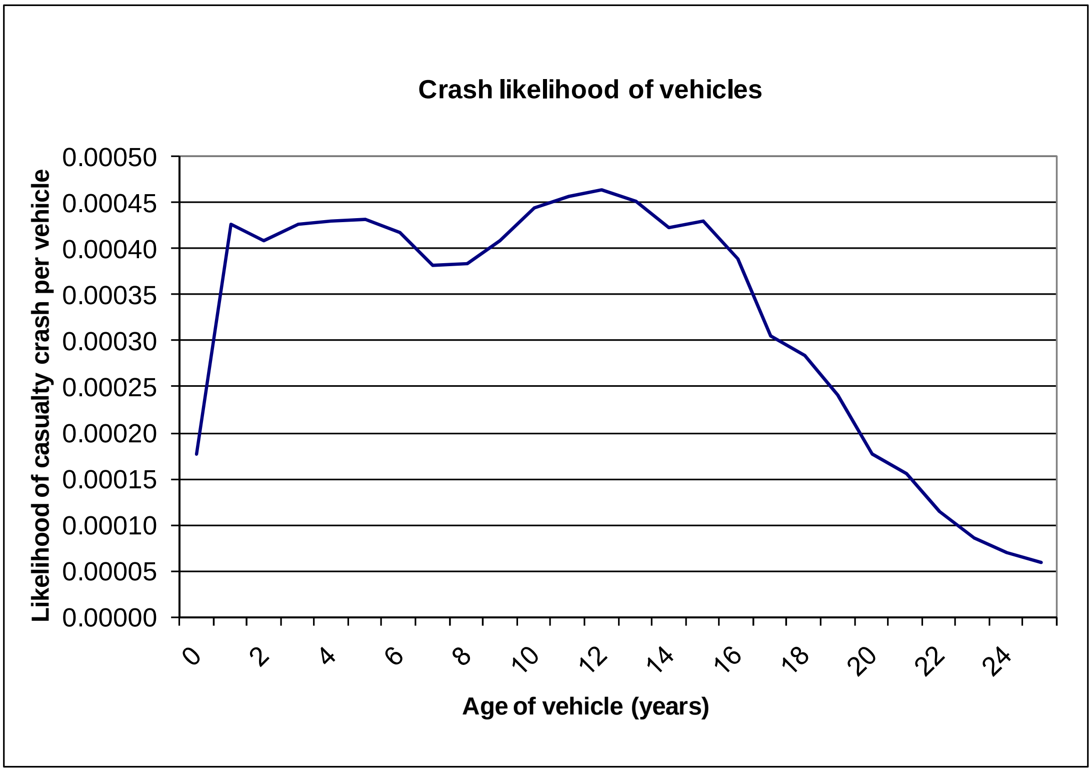
Fitment Rate						
	Cars and SUVs		LCVS		Total	
	BAU	Option	BAU	Option	BAU	Option
2009	0.260	0.670	0.000	0.500	0.208	0.636
2010	0.298	0.670	0.043	0.500	0.247	0.636
2011	0.336	0.670	0.087	0.500	0.286	0.636
2012	0.373	0.670	0.130	0.500	0.325	0.636
2013	0.411	0.670	0.173	0.500	0.364	0.636
2014	0.449	0.670	0.217	0.500	0.402	0.636
2015	0.487	0.670	0.260	0.500	0.441	0.636
2016	0.524	0.670	0.303	0.500	0.480	0.636
2017	0.562	0.670	0.347	0.500	0.519	0.636
2018	0.600	0.670	0.390	0.500	0.558	0.636
2019	0.600	0.670	0.390	0.500	0.558	0.636
2020	0.600	0.670	0.390	0.500	0.558	0.636
2021	0.600	0.670	0.390	0.500	0.558	0.636
2022	0.600	0.670	0.390	0.500	0.558	0.636
2023	0.600	0.670	0.390	0.500	0.558	0.636
2024	0.600	0.670	0.390	0.500	0.558	0.636
2025	0.600	0.670	0.390	0.500	0.558	0.636
2026	0.600	0.670	0.390	0.500	0.558	0.636
2027	0.600	0.670	0.390	0.500	0.558	0.636
2028	0.600	0.670	0.390	0.500	0.558	0.636
2029	0.600	0.670	0.390	0.500	0.558	0.636
2030	0.600	0.670	0.390	0.500	0.558	0.636

Option 6: Mandatory standards under the MVSA (regulation)

	Fitment Rate					
	Cars and SUVs		LCVS		Total	
	BAU	Option	BAU	Option	BAU	Option
2009	0.260	0.260	0.000	0.000	0.208	0.208
2010	0.298	0.298	0.043	0.043	0.247	0.247
2011	0.336	0.336	0.087	0.087	0.286	0.286
2012	0.373	0.373	0.130	0.130	0.325	0.325
2013	0.411	0.411	0.173	0.173	0.364	0.364
2014	0.449	0.449	0.217	0.217	0.402	0.402
2015	0.487	0.487	0.260	0.260	0.441	0.441
2016	0.524	0.615	0.303	0.388	0.480	0.570
2017	0.562	0.743	0.347	0.517	0.519	0.698
2018	0.600	0.872	0.390	0.645	0.558	0.826
2019	0.600	1.000	0.390	1.000	0.558	1.000
2020	0.600	1.000	0.390	1.000	0.558	1.000
2021	0.600	1.000	0.390	1.000	0.558	1.000
2022	0.600	1.000	0.390	1.000	0.558	1.000
2023	0.600	1.000	0.390	1.000	0.558	1.000
2024	0.600	1.000	0.390	1.000	0.558	1.000
2025	0.600	1.000	0.390	1.000	0.558	1.000
2026	0.600	1.000	0.390	1.000	0.558	1.000
2027	0.600	1.000	0.390	1.000	0.558	1.000
2028	0.600	1.000	0.390	1.000	0.558	1.000
2029	0.600	1.000	0.390	1.000	0.558	1.000
2030	0.600	1.000	0.390	1.000	0.558	1.000

3. Establish the likelihood of a registered car having a crash where a pedestrian or cyclist is injured in some way (including fatally) for each year of a car's life as given in Fildes (2002).

Age of vehicle	Crashes	Annual registrations	Likelihood of casualty crash
1	1087	760523	0.0002
2	2556	740998	0.0004
3	2572	778997	0.0004
4	2412	698916	0.0004
5	2194	630869	0.0004
6	2142	613261	0.0004
7	1990	588550	0.0004
8	1637	530947	0.0004
9	1635	526303	0.0004
10	1591	482099	0.0004
11	2038	567202	0.0004
12	2008	544296	0.0005
13	1790	477461	0.0005
14	1510	414467	0.0005
15	1636	478197	0.0004
16	2176	625061	0.0004
17	1827	579925	0.0004
18	1297	524515	0.0003
19	1330	580654	0.0003
20	1082	555753	0.0002
21	804	565653	0.0002
22	667	532710	0.0002
23	489	532473	0.0001
24	360	517449	0.0001
25	314	556300	0.0001
26	263	551011	0.0001



4. Calculate the net difference in the number of vehicles fitted with passive pedestrian safety measures between the BAU and each option.

5. For each year and each option, multiply the net number of vehicles fitted with passive pedestrian safety measures by the modified likelihood (see pg 88) of a crash per registration in that first year. Add this to the likelihoods of all older cars crashing during that year.

6. For each year and each option, multiply the result from step 5 by the effectiveness of passive pedestrian safety measures.

7. Multiply the result from 6 by the costs associated with the average vulnerable road user crash. This gives the benefits.

Option 2: User information campaigns

Year	Likelihood of crash per vehicle	Option minus BAU (V1)	Option minus BAU (V2)	Cars and SUVs Year																															Total vehicles
				0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
1	0.0002	121520	75735		22																														22
2	0.0004	93189	69018		52	16																													68
3	0.0004	63676	62003		50	40	11																												101
4	0.0004	32946	54678		52	38	27	6																											123
5	0.0004	960	47037		52	40	26	14	0																										132
6	0.0004	0	39067		53	40	27	13	0	0																									134
7	0.0004	0	30760		51	40	27	14	0	0	0																								133
8	0.0004	0	22106		46	39	28	14	0	0	0	0																							128
9	0.0004	0	13092		47	36	27	14	0	0	0	0	0																						124
10	0.0004	0	13354		50	36	24	14	0	0	0	0	0	0																					124
11	0.0004	0	13621		54	38	24	13	0	0	0	0	0	0	0																				130
12	0.0005	0	13894		56	41	26	13	0	0	0	0	0	0	0	0																			136
13	0.0005	0	14171		56	43	28	13	0	0	0	0	0	0	0	0	0																		141
14	0.0005	0	14455		55	43	29	15	0	0	0	0	0	0	0	0	0	0																	142
15	0.0004	0	14744		51	42	30	15	0	0	0	0	0	0	0	0	0	0	0																139
16	0.0004	0	15039		52	39	29	15	0	0	0	0	0	0	0	0	0	0	0	0															136
17	0.0004	0	15340		47	40	27	15	0	0	0	0	0	0	0	0	0	0	0	0	0														130
18	0.0003	0	15646		37	36	27	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0													115
19	0.0003	0	15959		34	29	25	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0												102
20	0.0002	0	16278		29	26	19	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											88
21	0.0002	0	16604		21	22	18	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0										72
22	0.0002	0	0		19	16	15	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0									60
23	0.0001	0	0		14	14	11	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0								48
24	0.0001	0	0		10	11	10	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							37
25	0.0001	0	0		8	8	7	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0						29
26	0.0001	0	0		7	7	5	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0					23
27	0.0000	0	0			6	4	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				13
28	0.0000	0	0				4	2	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
29	0.0000	0	0					2	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
30	0.0000	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
31	0.0000	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
32	0.0000	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
33	0.0000	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
34	0.0000	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
35	0.0000	0	0											0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	0.0000	0	0												0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	0.0000	0	0													0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38	0.0000	0	0														0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39	0.0000	0	0															0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40	0.0000	0	0																0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41	0.0000	0	0																	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
42	0.0000	0	0																		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43	0.0000	0	0																			0	0	0	0	0	0	0	0	0	0	0	0	0	0
44	0.0000	0	0																				0	0	0	0	0	0	0	0	0	0	0	0	0
45	0.0000	0	0																					0	0	0	0	0	0	0	0	0	0	0	0
46	0.0000	0	0																						0	0	0	0	0	0	0	0	0	0	0

Year	Likelihood of crash per vehicle	Option minus BAU (V1)	Option minus BAU (V2)	LCVs Year 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Total vehicles
1	0.0002	121520	75735		13																														13
2	0.0004	93189	69018		32	12																													45
3	0.0004	63676	62003		31	29	11																												71
4	0.0004	32946	54678		32	28	26	10																											97
5	0.0004	960	47037		33	29	25	23	8																										119
6	0.0004	0	39067		33	30	26	22	20	7																									138
7	0.0004	0	30760		32	30	27	23	19	17	5																								153
8	0.0004	0	22106		29	29	27	24	20	16	13	4																							161
9	0.0004	0	13092		29	26	26	24	20	17	13	9	2																						166
10	0.0004	0	13354		31	27	24	23	20	17	13	9	6	2																					171
11	0.0004	0	13621		34	28	24	21	20	17	13	9	5	6	2																				179
12	0.0005	0	13894		35	31	25	21	18	16	13	10	6	5	6	2																			188
13	0.0005	0	14171		35	32	28	22	18	15	13	10	6	6	6	6	3																		197
14	0.0005	0	14455		34	32	28	24	19	15	12	9	6	6	6	6	6	3																	206
15	0.0004	0	14744		32	31	29	25	21	16	12	8	5	6	6	6	6	6	3																212
16	0.0004	0	15039		33	29	28	25	21	17	13	9	5	6	6	6	6	6	6	3															219
17	0.0004	0	15340		30	30	26	25	22	18	14	9	5	5	6	6	6	6	6	6	3														222
18	0.0003	0	15646		23	27	27	23	21	18	14	10	5	5	5	6	6	6	6	6	7	3													219
19	0.0003	0	15959		21	21	24	24	20	18	14	10	6	5	5	5	6	6	6	6	6	7	3												215
20	0.0002	0	16278		18	20	19	21	20	17	14	10	6	6	6	5	5	6	6	6	7	6	7	3											209
21	0.0002	0	16604		13	17	18	17	18	17	13	10	6	6	6	6	5	6	6	7	7	7	7	7	3										200
22	0.0002	0	0		12	12	15	16	14	15	13	9	6	6	6	6	6	6	6	6	7	7	7	7	7	0									188
23	0.0001	0	0		9	11	11	13	13	12	12	10	6	6	6	6	6	6	6	6	6	7	7	7	7	0	0								172
24	0.0001	0	0		7	8	10	10	11	11	9	9	6	6	6	6	6	6	6	6	6	7	7	7	7	0	0	0							156
25	0.0001	0	0		5	6	7	8	8	9	9	7	5	6	6	6	7	7	7	6	6	6	7	7	7	0	0	0	0						141
26	0.0001	0	0		4	5	5	6	7	7	7	6	4	5	6	6	6	7	7	7	6	6	6	7	7	0	0	0	0	0					129
27	0.0000	0	0			4	4	5	5	6	5	5	4	4	5	6	6	7	7	7	7	6	6	6	7	0	0	0	0	0	0				113
28	0.0000	0	0				4	4	4	4	5	4	3	4	4	5	6	6	7	7	7	7	7	6	6	0	0	0	0	0	0	0			100
29	0.0000	0	0					3	3	3	3	3	2	3	4	4	6	6	6	7	7	7	7	7	6	0	0	0	0	0	0	0	0		90
30	0.0000	0	0						3	3	3	3	2	2	3	4	4	6	6	6	7	7	7	7	7	0	0	0	0	0	0	0	0	0	80
31	0.0000	0	0							2	2	2	1	2	2	3	4	4	6	6	6	7	7	7	7	0	0	0	0	0	0	0	0	0	72
32	0.0000	0	0								2	2	1	2	2	2	3	4	5	6	7	7	7	8	8	0	0	0	0	0	0	0	0	0	64
33	0.0000	0	0									1	1	1	2	2	2	3	4	5	6	7	7	7	8	0	0	0	0	0	0	0	0	0	56
34	0.0000	0	0										1	1	1	2	2	3	4	4	5	6	7	7	7	0	0	0	0	0	0	0	0	0	49
35	0.0000	0	0											1	1	1	2	2	3	4	4	5	6	7	7	0	0	0	0	0	0	0	0	0	42
36	0.0000	0	0												1	1	1	2	2	3	4	4	5	6	7	0	0	0	0	0	0	0	0	0	36
37	0.0000	0	0													1	1	1	2	2	3	4	5	5	6	0	0	0	0	0	0	0	0	0	30
38	0.0000	0	0														1	1	1	2	2	3	4	5	5	0	0	0	0	0	0	0	0	0	24
39	0.0000	0	0															1	1	1	2	2	3	4	5	0	0	0	0	0	0	0	0	0	19
40	0.0000	0	0																1	1	1	2	2	3	4	0	0	0	0	0	0	0	0	0	14
41	0.0000	0	0																	1	1	1	2	3	3	0	0	0	0	0	0	0	0	0	11
42	0.0000	0	0																		1	1	1	2	3	0	0	0	0	0	0	0	0	0	8
43	0.0000	0	0																			1	1	1	2	0	0	0	0	0	0	0	0	0	5
44	0.0000	0	0																				1	1	1	0	0	0	0	0	0	0	0	0	4
45	0.0000	0	0																					1	1	0	0	0	0	0	0	0	0	0	2
46	0.0000	0	0																						1	0	0	0	0	0	0	0	0	0	1

Option 3: Fleet purchasing policies

Year	Likelihood of crash per vehicle	Option minus BAU (V1)	Option minus BAU (V2)	Cars and SUVs Year 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Total vehicles
1	0.0002	297148	85047		53																														53
2	0.0004	272329	78516		127	48																													175
3	0.0004	246399	71690		121	116	44																												281
4	0.0004	219323	64560		127	111	105	39																											382
5	0.0004	191065	57116		128	116	101	94	34																										473
6	0.0004	161589	49348		129	117	105	90	82	29																									551
7	0.0004	130858	41247		124	118	106	94	78	69	23																								612
8	0.0004	98833	32802		113	114	107	94	82	66	56	17																							650
9	0.0004	65474	24002		114	104	103	95	82	69	54	42	12																						675
10	0.0004	66784	24482		121	105	94	92	83	70	56	40	28	12																					700
11	0.0004	68119	24972		132	111	95	84	80	70	56	42	27	29	12																				738
12	0.0005	69482	25471		136	121	101	84	73	68	57	43	28	27	29	12																			778
13	0.0005	70871	25981		138	124	110	90	73	62	55	43	28	29	28	30	13																		821
14	0.0005	72289	26500		134	126	113	98	78	62	50	41	28	29	29	28	30	13																	860
15	0.0004	73735	27030		126	123	114	100	85	66	50	38	27	29	29	30	29	31	13																891
16	0.0004	75209	27571		128	115	111	102	87	72	53	38	25	28	29	30	30	30	31	13															924
17	0.0004	76713	28123		116	117	104	99	89	74	58	40	25	25	29	30	31	31	30	32	14														944
18	0.0003	78248	28685		91	106	106	93	86	75	60	44	27	26	26	29	31	31	32	31	33	14													940
19	0.0003	79813	29259		84	83	96	95	81	73	61	45	29	27	26	27	30	31	32	32	31	33	14												931
20	0.0002	81409	29844		72	77	75	86	82	68	59	46	30	30	28	27	27	30	32	32	33	32	34	14											915
21	0.0002	83037	30441		52	66	70	67	75	70	55	45	30	31	30	28	27	28	31	33	33	33	33	35	15										886
22	0.0002	0	0		46	48	59	62	59	63	56	42	30	31	31	31	29	28	28	31	33	34	34	33	35	0									844
23	0.0001	0	0		34	42	43	53	54	49	51	43	28	30	32	32	32	30	28	29	32	34	34	35	34	0	0								778
24	0.0001	0	0		26	31	38	39	46	46	40	39	28	28	31	32	32	32	30	29	29	33	35	35	35	0	0	0							714
25	0.0001	0	0		21	23	28	34	34	39	37	30	26	29	29	31	33	33	33	31	30	30	33	35	36	0	0	0	0						654
26	0.0001	0	0		18	19	21	25	30	28	32	28	20	26	29	29	32	34	34	33	31	30	30	34	36	0	0	0	0	0					600
27	0.0000	0	0			16	17	19	22	25	23	24	19	20	27	30	30	33	34	34	34	32	31	31	35	0	0	0	0	0	0				535
28	0.0000	0	0				15	15	16	18	20	17	16	19	21	27	31	31	33	35	35	35	33	31	32	0	0	0	0	0	0	0			480
29	0.0000	0	0					13	13	14	15	15	12	16	19	21	28	31	31	34	36	36	36	33	32	0	0	0	0	0	0	0	0		435
30	0.0000	0	0						11	11	11	11	10	12	16	20	22	28	32	32	35	36	36	36	34	0	0	0	0	0	0	0	0	0	394
31	0.0000	0	0							10	9	9	7	10	12	17	20	22	29	32	32	35	37	37	37	0	0	0	0	0	0	0	0	0	356
32	0.0000	0	0								8	7	6	8	11	12	17	21	23	29	33	33	36	38	38	0	0	0	0	0	0	0	0	0	318
33	0.0000	0	0									6	5	6	8	11	12	17	21	23	30	34	34	37	39	0	0	0	0	0	0	0	0	0	281
34	0.0000	0	0										4	5	6	8	11	13	18	21	23	31	34	34	37	0	0	0	0	0	0	0	0	0	245
35	0.0000	0	0											4	5	6	8	11	13	18	22	24	31	35	35	0	0	0	0	0	0	0	0	0	212
36	0.0000	0	0												4	5	6	8	11	13	18	22	24	32	36	0	0	0	0	0	0	0	0	0	181
37	0.0000	0	0													4	5	6	8	12	14	19	23	25	32	0	0	0	0	0	0	0	0	0	148
38	0.0000	0	0														4	5	6	9	12	14	19	23	25	0	0	0	0	0	0	0	0	0	118
39	0.0000	0	0															4	5	6	9	12	14	20	24	0	0	0	0	0	0	0	0	0	94
40	0.0000	0	0																4	5	7	9	12	14	20	0	0	0	0	0	0	0	0	0	72
41	0.0000	0	0																	4	5	7	9	13	15	0	0	0	0	0	0	0	0	0	53
42	0.0000	0	0																		5	5	7	9	13	0	0	0	0	0	0	0	0	0	39
43	0.0000	0	0																			5	6	7	9	0	0	0	0	0	0	0	0	0	27
44	0.0000	0	0																				5	6	7	0	0	0	0	0	0	0	0	0	18
45	0.0000	0	0																					5	6	0	0	0	0	0	0	0	0	0	11
46	0.0000	0	0																						5	0	0	0	0	0	0	0	0	0	5

Year	Likelihood of crash per vehicle	Option minus	Option minus	LCVs Year 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Total vehicles
1	0.0002	297148	85047		15																														15
2	0.0004	272329	78516		36	14																													50
3	0.0004	246399	71690		35	34	13																												81
4	0.0004	219323	64560		36	32	31	11																											110
5	0.0004	191065	57116		37	34	29	28	10																										137
6	0.0004	161589	49348		37	34	31	26	24	9																									161
7	0.0004	130858	41247		36	34	31	28	23	21	7																								180
8	0.0004	98833	32802		32	33	31	28	24	20	18	6																							192
9	0.0004	65474	24002		33	30	30	28	25	21	17	14	4																						201
10	0.0004	66784	24482		35	30	27	27	25	21	18	13	10	4																					211
11	0.0004	68119	24972		38	32	28	25	24	21	18	14	10	10	4																				224
12	0.0005	69482	25471		39	35	29	25	22	21	18	14	10	10	11	5																			238
13	0.0005	70871	25981		39	36	32	26	22	19	17	14	10	10	10	11	5																		252
14	0.0005	72289	26500		38	36	33	29	23	19	16	14	10	11	11	10	11	5																	266
15	0.0004	73735	27030		36	35	33	29	25	20	16	13	10	11	11	11	11	11	5																277
16	0.0004	75209	27571		37	33	32	30	26	22	17	13	9	10	11	11	11	11	12	5															289
17	0.0004	76713	28123		33	34	30	29	27	23	18	13	9	9	10	11	11	11	11	12	5														298
18	0.0003	78248	28685		26	31	31	27	26	23	19	15	10	9	10	11	11	11	12	11	12	5													299
19	0.0003	79813	29259		24	24	28	28	24	22	19	15	11	10	10	10	11	11	12	12	11	12	5												299
20	0.0002	81409	29844		21	22	22	25	25	21	19	15	11	11	10	10	10	11	12	12	12	12	12	5											297
21	0.0002	83037	30441		15	19	20	20	22	21	17	15	11	11	11	10	10	10	11	12	12	12	12	13	5										291
22	0.0002	0	0		13	14	17	18	17	19	18	14	11	11	11	11	11	10	10	12	12	12	13	12	13	0									281
23	0.0001	0	0		10	12	13	16	16	15	16	14	10	11	12	12	12	11	10	11	12	12	13	13	12	0	0								261
24	0.0001	0	0		7	9	11	11	14	14	13	13	10	10	11	12	12	12	11	11	11	12	13	13	13	0	0	0							242
25	0.0001	0	0		6	7	8	10	10	12	12	10	9	11	11	11	12	12	12	11	11	11	12	13	13	0	0	0	0						224
26	0.0001	0	0		5	5	6	7	9	9	10	9	7	10	11	11	12	12	12	12	11	11	11	12	13	0	0	0	0	0					207
27	0.0000	0	0			5	5	6	6	8	7	8	7	7	10	11	11	12	13	13	13	12	11	11	13	0	0	0	0	0	0				187
28	0.0000	0	0				4	5	5	6	6	6	6	7	8	10	11	11	12	13	13	13	12	11	12	0	0	0	0	0	0	0			170
29	0.0000	0	0					4	4	4	5	5	4	6	7	8	10	11	11	12	13	13	13	12	12	0	0	0	0	0	0	0	0		155
30	0.0000	0	0						3	3	4	4	4	4	6	7	8	10	12	12	13	13	13	13	12	0	0	0	0	0	0	0	0	0	142
31	0.0000	0	0							3	3	3	3	4	4	6	7	8	11	12	12	13	14	14	14	0	0	0	0	0	0	0	0	0	129
32	0.0000	0	0								2	2	2	3	4	4	6	8	8	11	12	12	13	14	14	0	0	0	0	0	0	0	0	0	116
33	0.0000	0	0									2	2	2	3	4	5	6	8	8	11	12	12	13	14	0	0	0	0	0	0	0	0	0	103
34	0.0000	0	0										1	2	2	3	4	5	7	8	9	11	13	13	14	0	0	0	0	0	0	0	0	0	90
35	0.0000	0	0											1	2	2	3	4	5	7	8	9	11	13	13	0	0	0	0	0	0	0	0	0	78
36	0.0000	0	0												1	2	2	3	4	5	7	8	9	12	13	0	0	0	0	0	0	0	0	0	66
37	0.0000	0	0													2	2	2	3	4	5	7	8	9	12	0	0	0	0	0	0	0	0	0	54
38	0.0000	0	0														2	2	2	3	4	5	7	8	9	0	0	0	0	0	0	0	0	0	43
39	0.0000	0	0															2	2	2	3	4	5	7	9	0	0	0	0	0	0	0	0	0	34
40	0.0000	0	0																2	2	2	3	5	5	7	0	0	0	0	0	0	0	0	0	26
41	0.0000	0	0																	2	2	2	3	5	5	0	0	0	0	0	0	0	0	0	19
42	0.0000	0	0																		2	2	3	3	5	0	0	0	0	0	0	0	0	0	14
43	0.0000	0	0																			2	2	3	3	0	0	0	0	0	0	0	0	0	10
44	0.0000	0	0																				2	2	3	0	0	0	0	0	0	0	0	0	6
45	0.0000	0	0																					2	2	0	0	0	0	0	0	0	0	0	4
46	0.0000	0	0																						2	0	0	0	0	0	0	0	0	0	2

Option 6: Mandatory standards under the MVSA (regulation)

Year	Likelihood of crash per vehicle	Option minus BAU (V1)	Option minus BAU (V2)	Cars and SUVs Year																															Total vehicles
				0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
1	0.0002	0	0		0																														0
2	0.0004	0	0		0	0																													0
3	0.0004	0	0		0	0	0																												0
4	0.0004	0	0		0	0	0	0																											0
5	0.0004	0	0		0	0	0	0	0																										0
6	0.0004	0	0		0	0	0	0	0	0																									0
7	0.0004	81412	17827		0	0	0	0	0	0	14																								14
8	0.0004	166080	36367		0	0	0	0	0	0	35	29																							64
9	0.0004	254102	55642		0	0	0	0	0	0	33	71	45																						149
10	0.0004	381621	135766		0	0	0	0	0	0	35	68	109	68																					279
11	0.0004	389253	138481		0	0	0	0	0	0	35	71	104	163	69																				442
12	0.0005	397038	141251		0	0	0	0	0	0	35	72	109	156	166	70																			608
13	0.0005	404979	144076		0	0	0	0	0	0	34	72	109	163	159	170	72																		779
14	0.0005	413079	146957		0	0	0	0	0	0	31	70	110	164	166	162	173	73																	950
15	0.0004	421340	149896		0	0	0	0	0	0	31	63	106	165	168	170	166	176	75																1120
16	0.0004	429767	152894		0	0	0	0	0	0	33	64	97	160	168	171	173	169	180	76															1291
17	0.0004	438362	155952		0	0	0	0	0	0	36	68	98	146	163	172	174	177	172	184	78														1467
18	0.0003	447130	159071		0	0	0	0	0	0	37	74	104	147	149	166	175	178	180	176	187	79													1652
19	0.0003	456072	162253		0	0	0	0	0	0	38	76	113	156	150	152	170	179	181	184	179	191	81												1848
20	0.0002	465194	165498		0	0	0	0	0	0	37	77	116	170	159	153	155	173	182	185	187	183	195	82											2054
21	0.0002	474497	168808		0	0	0	0	0	0	34	75	118	174	173	162	156	158	176	186	189	191	186	199	84										2262
22	0.0002	0	0		0	0	0	0	0	0	35	70	115	177	178	177	165	159	161	180	190	193	195	190	203	0									2387
23	0.0001	0	0		0	0	0	0	0	0	32	72	108	172	181	181	180	169	162	164	184	193	196	199	194	0	0								2387
24	0.0001	0	0		0	0	0	0	0	0	25	65	110	162	176	184	185	184	172	165	167	187	197	200	203	0	0	0							2382
25	0.0001	0	0		0	0	0	0	0	0	23	51	99	165	165	179	188	189	187	176	169	171	191	201	204	0	0	0	0						2357
26	0.0001	0	0		0	0	0	0	0	0	20	47	78	149	168	168	183	192	192	191	179	172	174	195	205	0	0	0	0	0					2313
27	0.0000	0	0			0	0	0	0	0	14	40	72	117	152	171	172	186	196	196	195	183	175	178	199	0	0	0	0	0	0				2246
28	0.0000	0	0				0	0	0	0	13	29	61	108	119	155	175	175	190	200	200	199	186	179	181	0	0	0	0	0	0	0			2170
29	0.0000	0	0					0	0	0	9	26	45	92	110	122	158	178	178	194	204	204	203	190	183	0	0	0	0	0	0	0	0		2095
30	0.0000	0	0						0	0	7	19	39	67	94	113	124	161	182	182	198	208	208	207	194	0	0	0	0	0	0	0	0	0	2002
31	0.0000	0	0							0	6	14	29	59	69	96	115	126	164	185	186	202	212	213	211	0	0	0	0	0	0	0	0	0	1886
32	0.0000	0	0								5	12	22	43	60	70	98	117	129	168	189	189	206	216	217	0	0	0	0	0	0	0	0	0	1740
33	0.0000	0	0									10	18	33	44	62	71	100	120	132	171	193	193	210	220	0	0	0	0	0	0	0	0	0	1575
34	0.0000	0	0										15	27	34	45	63	73	102	122	134	174	197	197	214	0	0	0	0	0	0	0	0	0	1396
35	0.0000	0	0											23	27	34	46	64	74	104	124	137	178	201	201	0	0	0	0	0	0	0	0	0	1213
36	0.0000	0	0												23	28	35	47	65	76	106	127	140	181	205	0	0	0	0	0	0	0	0	0	1032
37	0.0000	0	0													23	28	36	48	67	77	108	129	142	185	0	0	0	0	0	0	0	0	0	844
38	0.0000	0	0														24	29	36	49	68	79	110	132	145	0	0	0	0	0	0	0	0	0	672
39	0.0000	0	0															24	29	37	50	69	80	112	135	0	0	0	0	0	0	0	0	0	537
40	0.0000	0	0																25	30	38	51	71	82	114	0	0	0	0	0	0	0	0	0	411
41	0.0000	0	0																	25	31	39	52	72	84	0	0	0	0	0	0	0	0	0	302
42	0.0000	0	0																		26	31	39	53	74	0	0	0	0	0	0	0	0	0	223
43	0.0000	0	0																			26	32	40	54	0	0	0	0	0	0	0	0	0	152
44	0.0000	0	0																				27	33	41	0	0	0	0	0	0	0	0	0	100
45	0.0000	0	0																					27	33	0	0	0	0	0	0	0	0	0	61
46	0.0000	0	0																						28	0	0	0	0	0	0	0	0	0	28

Year	Likelihood of crash per vehicle	Option minus BAU (V1)	Option minus BAU (V2)	LCVs Year 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Total vehicles
1	0.0002	0	0		0																														0
2	0.0004	0	0		0	0																													0
3	0.0004	0	0		0	0	0																												0
4	0.0004	0	0		0	0	0	0																											0
5	0.0004	0	0		0	0	0	0	0																										0
6	0.0004	0	0		0	0	0	0	0	0																									0
7	0.0004	81412	17827		0	0	0	0	0	0	3																								3
8	0.0004	166080	36367		0	0	0	0	0	0	8	6																							14
9	0.0004	254102	55642		0	0	0	0	0	0	7	16	10																						33
10	0.0004	381621	135766		0	0	0	0	0	0	8	15	24	24																					70
11	0.0004	389253	138481		0	0	0	0	0	0	8	16	23	58	25																				128
12	0.0005	397038	141251		0	0	0	0	0	0	8	16	24	56	59	25																			187
13	0.0005	404979	144076		0	0	0	0	0	0	7	16	24	58	57	60	25																		248
14	0.0005	413079	146957		0	0	0	0	0	0	7	15	24	58	59	58	62	26																	309
15	0.0004	421340	149896		0	0	0	0	0	0	7	14	23	59	60	60	59	63	27																371
16	0.0004	429767	152894		0	0	0	0	0	0	7	14	21	57	60	61	62	60	64	27															433
17	0.0004	438362	155952		0	0	0	0	0	0	8	15	21	52	58	61	62	63	61	65	28														494
18	0.0003	447130	159071		0	0	0	0	0	0	8	16	23	52	53	59	62	63	64	63	67	28													558
19	0.0003	456072	162253		0	0	0	0	0	0	8	17	25	55	53	54	60	64	65	65	64	68	29												627
20	0.0002	465194	165498		0	0	0	0	0	0	8	17	25	60	57	54	55	62	65	66	67	65	69	29											699
21	0.0002	474497	168808		0	0	0	0	0	0	8	16	26	62	62	58	55	56	63	66	67	68	66	71	30										774
22	0.0002	0	0		0	0	0	0	0	0	8	15	25	63	63	63	59	57	57	64	67	69	69	68	72	0									819
23	0.0001	0	0		0	0	0	0	0	0	7	16	24	61	64	65	64	60	58	58	65	69	70	71	69	0	0								820
24	0.0001	0	0		0	0	0	0	0	0	5	14	24	58	62	66	66	65	61	59	60	67	70	71	72	0	0	0							820
25	0.0001	0	0		0	0	0	0	0	0	5	11	22	59	59	64	67	67	67	62	60	61	68	72	73	0	0	0	0						815
26	0.0001	0	0		0	0	0	0	0	0	4	10	17	53	60	60	65	68	68	68	64	61	62	69	73	0	0	0	0	0					803
27	0.0000	0	0			0	0	0	0	0	3	9	16	42	54	61	61	66	70	70	69	65	62	63	71	0	0	0	0	0	0				782
28	0.0000	0	0				0	0	0	0	3	6	13	39	42	55	62	62	68	71	71	71	66	64	64	0	0	0	0	0	0	0			758
29	0.0000	0	0					0	0	0	2	6	10	33	39	43	56	63	64	69	72	73	72	68	65	0	0	0	0	0	0	0	0		735
30	0.0000	0	0						0	0	2	4	9	24	33	40	44	57	65	65	70	74	74	74	69	0	0	0	0	0	0	0	0	0	703
31	0.0000	0	0							0	1	3	6	21	24	34	41	45	58	66	66	72	75	76	75	0	0	0	0	0	0	0	0	0	664
32	0.0000	0	0								1	3	5	15	21	25	35	42	46	60	67	67	73	77	77	0	0	0	0	0	0	0	0	0	614
33	0.0000	0	0									2	4	12	16	22	25	35	43	47	61	69	69	75	78	0	0	0	0	0	0	0	0	0	557
34	0.0000	0	0										3	9	12	16	22	26	36	43	48	62	70	70	76	0	0	0	0	0	0	0	0	0	494
35	0.0000	0	0											8	10	12	16	23	26	37	44	49	63	71	72	0	0	0	0	0	0	0	0	0	431
36	0.0000	0	0												8	10	12	17	23	27	38	45	50	65	73	0	0	0	0	0	0	0	0	0	367
37	0.0000	0	0													8	10	13	17	24	27	38	46	51	66	0	0	0	0	0	0	0	0	0	300
38	0.0000	0	0														9	10	13	17	24	28	39	47	52	0	0	0	0	0	0	0	0	0	239
39	0.0000	0	0															9	10	13	18	25	29	40	48	0	0	0	0	0	0	0	0	0	191
40	0.0000	0	0																9	11	13	18	25	29	41	0	0	0	0	0	0	0	0	0	146
41	0.0000	0	0																	9	11	14	18	26	30	0	0	0	0	0	0	0	0	0	107
42	0.0000	0	0																		9	11	14	19	26	0	0	0	0	0	0	0	0	0	79
43	0.0000	0	0																			9	11	14	19	0	0	0	0	0	0	0	0	0	54
44	0.0000	0	0																				10	12	15	0	0	0	0	0	0	0	0	0	36
45	0.0000	0	0																					10	12	0	0	0	0	0	0	0	0	0	22
46	0.0000	0	0																						10	0	0	0	0	0	0	0	0	0	10

Option 2: User information campaigns

Year		Vehicle Sales			Option's Expected Fitment Rate			BAU Expected (Voluntary) Fitment Rate			Option minus BAU			Net Vehicle Crashes Influenced			Value of Net Vehicle Crashes Influenced		
		Cars and SUVs	LCVs	Total	Cars and SUVs	LCVs	Total	Cars and SUVs	LCVs	Total	Cars and SUVs	LCVs	Total	Cars and SUVs	LCVs	Total	Cars and SUVs	LCVs	Total
0	2009	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	2010	798,308	186,234	984,542	359,239	83,805	443,044	237,718	8,070	245,789	121,520	75,735	197,255	2	1	3	622,291	387,831	1,010,122
2	2011	814,274	189,959	1,004,233	366,423	85,481	451,905	273,234	16,463	289,697	93,189	69,018	162,207	7	4	11	1,979,039	1,289,421	3,268,460
3	2012	830,560	193,758	1,024,317	373,752	87,191	460,943	310,076	25,189	335,264	63,676	62,003	125,679	10	7	17	2,915,286	2,066,385	4,981,670
4	2013	847,171	197,633	1,044,804	381,227	88,935	470,162	348,281	34,256	382,538	32,946	54,678	87,624	12	9	21	3,560,586	2,799,152	6,359,739
5	2014	864,114	201,586	1,065,700	388,851	90,714	479,565	387,891	43,677	431,568	960	47,037	47,997	13	11	24	3,831,747	3,447,136	7,278,883
6	2015	881,397	205,617	1,087,014	428,946	92,528	521,474	428,946	53,461	482,407	-	39,067	39,067	13	13	26	3,870,805	4,002,566	7,873,371
7	2016	899,024	209,730	1,108,754	471,488	94,378	565,867	471,488	63,618	535,106	-	30,760	30,760	13	15	27	3,850,451	4,426,582	8,277,033
8	2017	917,005	213,924	1,130,929	515,561	96,266	611,827	515,561	74,160	589,721	-	22,106	22,106	12	16	28	3,690,530	4,667,023	8,357,553
9	2018	935,345	218,203	1,153,548	561,207	98,191	659,398	561,207	85,099	646,306	-	13,092	13,092	12	16	28	3,577,623	4,813,998	8,391,621
10	2019	954,052	222,567	1,176,619	572,431	100,155	672,586	572,431	86,801	659,232	-	13,354	13,354	12	16	28	3,588,605	4,958,422	8,547,027
11	2020	973,133	227,018	1,200,151	583,880	102,158	686,038	583,880	88,537	672,417	-	13,621	13,621	12	17	30	3,750,550	5,190,137	8,940,687
12	2021	992,596	231,559	1,224,154	595,557	104,201	699,759	595,557	90,308	685,865	-	13,894	13,894	13	18	31	3,936,090	5,443,833	9,379,923
13	2022	1,012,448	236,190	1,248,637	607,469	106,285	713,754	607,469	92,114	699,583	-	14,171	14,171	14	19	33	4,083,981	5,712,263	9,796,244
14	2023	1,032,697	240,914	1,273,610	619,618	108,411	728,029	619,618	93,956	713,574	-	14,455	14,455	14	20	33	4,115,073	5,949,815	10,064,889
15	2024	1,053,350	245,732	1,299,082	632,010	110,579	742,590	632,010	95,835	727,846	-	14,744	14,744	13	20	34	4,009,083	6,127,807	10,136,890
16	2025	1,074,417	250,646	1,325,064	644,650	112,791	757,441	644,650	97,752	742,403	-	15,039	15,039	13	21	34	3,944,364	6,324,211	10,268,575
17	2026	1,095,906	255,659	1,351,565	657,543	115,047	772,590	657,543	99,707	757,251	-	15,340	15,340	12	21	34	3,757,436	6,421,221	10,178,656
18	2027	1,117,824	260,773	1,378,596	670,694	117,348	788,042	670,694	101,701	772,396	-	15,646	15,646	11	21	32	3,339,062	6,333,041	9,672,103
19	2028	1,140,180	265,988	1,406,168	684,108	119,695	803,803	684,108	103,735	787,844	-	15,959	15,959	10	21	31	2,964,309	6,217,004	9,181,313
20	2029	1,162,984	271,308	1,434,292	697,790	122,088	819,879	697,790	105,810	803,600	-	16,278	16,278	9	20	29	2,560,411	6,044,730	8,605,141
21	2030	1,186,244	276,734	1,462,978	711,746	124,530	836,276	711,746	107,926	819,672	-	16,604	16,604	7	19	26	2,094,167	5,779,968	7,874,135
22	2031	-	-	-	-	-	-	-	-	-	-	-	-	6	18	24	1,742,761	5,449,450	7,192,212
23	2032	-	-	-	-	-	-	-	-	-	-	-	-	5	17	21	1,379,855	4,974,167	6,354,022
24	2033	-	-	-	-	-	-	-	-	-	-	-	-	4	15	19	1,069,659	4,516,581	5,586,240
25	2034	-	-	-	-	-	-	-	-	-	-	-	-	3	14	16	840,241	4,094,025	4,934,265
26	2035	-	-	-	-	-	-	-	-	-	-	-	-	2	12	15	667,702	3,720,835	4,388,537
27	2036	-	-	-	-	-	-	-	-	-	-	-	-	1	11	12	373,418	3,273,651	3,647,069
28	2037	-	-	-	-	-	-	-	-	-	-	-	-	1	10	10	177,913	2,897,251	3,075,164
29	2038	-	-	-	-	-	-	-	-	-	-	-	-	0	9	9	58,282	2,593,949	2,652,231
30	2039	-	-	-	-	-	-	-	-		-	-	-	0	8	8	1,642	2,328,792	2,330,434
31	2040	-	-	-	-	-	-	-	-		-	-	-	-	7	7	-	2,087,281	2,087,281
32	2041	-	-	-	-	-	-	-	-		-	-	-	-	6	6	-	1,853,142	1,853,142
33	2042	-	-	-	-	-	-	-	-		-	-	-	-	5	5	-	1,631,374	1,631,374
34	2043	-	-	-	-	-	-	-	-		-	-	-	-	5	5	-	1,420,344	1,420,344
35	2044	-	-	-	-	-	-	-	-		-	-	-	-	4	4	-	1,227,681	1,227,681
36	2045	-	-	-	-	-	-	-	-		-	-	-	-	3	3	-	1,044,639	1,044,639
37	2046	-	-	-	-	-	-	-	-		-	-	-	-	3	3	-	854,291	854,291
38	2047	-	-	-	-	-	-	-	-		-	-	-	-	2	2	-	680,212	680,212
39	2048	-	-	-	-	-	-	-	-		-	-	-	-	2	2	-	543,770	543,770
40	2049	-	-	-	-	-	-	-	-		-	-	-	-	1	1	-	415,658	415,658
41	2050	-	-	-	-	-	-	-	-		-	-	-	-	1	1	-	305,834	305,834
42	2051	-	-	-	-	-	-	-	-		-	-	-	-	1	1	-	225,703	225,703
43	2052	-	-	-	-	-	-	-	-		-	-	-	-	1	1	-	154,241	154,241
44	2053	-	-	-	-	-	-	-	-		-	-	-	-	0	0	-	101,600	101,600
45	2054	-	-	-	-	-	-	-	-		-	-	-	-	0	0	-	61,416	61,416
46	2055	-	-	-	-	-	-	-	-		-	-	-	-	0	0	-	28,395	28,395
														NPV 46 years			$33,708,154	$47,648,937	$81,357,091

Option 3: Fleet purchasing policies

Year		Vehicle Sales			Option's Expected Fitment Rate			BAU Expected (Voluntary) Fitment Rate			Option minus BAU			Net Vehicle Crashes Influenced			Value of Net Vehicle Crashes Influenced		
		Cars and SUVs	LCVs	Total	Cars and SUVs	LCVs	Total	Cars and SUVs	LCVs	Total	Cars and SUVs	LCVs	Total	Cars and SUVs	LCVs	Total	Cars and SUVs	LCVs	Total
0	2009	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	2010	798,308	186,234	984,542	534,866	93,117	627,983	237,718	8,070	245,789	297,148	85,047	382,195	5	1	7	1,521,661	435,515	1,957,176
2	2011	814,274	189,959	1,004,233	545,564	94,979	640,543	273,234	16,463	289,697	272,329	78,516	350,846	17	5	22	5,066,922	1,453,139	6,520,061
3	2012	830,560	193,758	1,024,317	556,475	96,879	653,354	310,076	25,189	335,264	246,399	71,690	318,090	27	8	35	8,142,499	2,343,529	10,486,028
4	2013	847,171	197,633	1,044,804	567,604	98,817	666,421	348,281	34,256	382,538	219,323	64,560	283,883	37	11	47	11,063,912	3,196,975	14,260,888
5	2014	864,114	201,586	1,065,700	578,957	100,793	679,749	387,891	43,677	431,568	191,065	57,116	248,181	45	13	59	13,673,498	3,968,941	17,642,439
6	2015	881,397	205,617	1,087,014	590,536	102,809	693,344	428,946	53,461	482,407	161,589	49,348	210,938	53	15	68	15,941,731	4,651,335	20,593,066
7	2016	899,024	209,730	1,108,754	602,346	104,865	707,211	471,488	63,618	535,106	130,858	41,247	172,105	59	17	76	17,717,072	5,201,132	22,918,204
8	2017	917,005	213,924	1,130,929	614,393	106,962	721,355	515,561	74,160	589,721	98,833	32,802	131,634	62	18	81	18,795,119	5,559,925	24,355,044
9	2018	935,345	218,203	1,153,548	626,681	109,101	735,783	561,207	85,099	646,306	65,474	24,002	89,476	65	19	84	19,528,663	5,828,401	25,357,064
10	2019	954,052	222,567	1,176,619	639,215	111,283	750,498	572,431	86,801	659,232	66,784	24,482	91,266	67	20	88	20,266,151	6,103,214	26,369,365
11	2020	973,133	227,018	1,200,151	651,999	113,509	765,508	583,880	88,537	672,417	68,119	24,972	93,091	71	22	92	21,348,625	6,477,698	27,826,323
12	2021	992,596	231,559	1,224,154	665,039	115,779	780,818	595,557	90,308	685,865	69,482	25,471	94,953	75	23	98	22,522,439	6,880,225	29,402,664
13	2022	1,012,448	236,190	1,248,637	678,340	118,095	796,435	607,469	92,114	699,583	70,871	25,981	96,852	79	24	103	23,758,857	7,302,458	31,061,315
14	2023	1,032,697	240,914	1,273,610	691,907	120,457	812,363	619,618	93,956	713,574	72,289	26,500	98,789	83	26	108	24,879,196	7,693,361	32,572,557
15	2024	1,053,350	245,732	1,299,082	705,745	122,866	828,611	632,010	95,835	727,846	73,735	27,030	100,765	86	27	112	25,770,371	8,020,363	33,790,734
16	2025	1,074,417	250,646	1,325,064	719,860	125,323	845,183	644,650	97,752	742,403	75,209	27,571	102,780	89	28	117	26,737,916	8,370,761	35,108,678
17	2026	1,095,906	255,659	1,351,565	734,257	127,830	862,087	657,543	99,707	757,251	76,713	28,123	104,836	91	29	119	27,321,948	8,613,807	35,935,755
18	2027	1,117,824	260,773	1,378,596	748,942	130,386	879,328	670,694	101,701	772,396	78,248	28,685	106,933	90	29	119	27,184,062	8,651,975	35,836,038
19	2028	1,140,180	265,988	1,406,168	763,921	132,994	896,915	684,108	103,735	787,844	79,813	29,259	109,071	89	29	118	26,936,687	8,658,735	35,595,422
20	2029	1,162,984	271,308	1,434,292	779,199	135,654	914,853	697,790	105,810	803,600	81,409	29,844	111,253	88	29	117	26,465,487	8,600,249	35,065,736
21	2030	1,186,244	276,734	1,462,978	794,783	138,367	933,150	711,746	107,926	819,672	83,037	30,441	113,478	85	28	113	25,625,517	8,434,017	34,059,534
22	2031	-	-	-	-	-	-	-	-	-	-	-	-	81	27	108	24,424,614	8,126,080	32,550,694
23	2032	-	-	-	-	-	-	-	-	-	-	-	-	75	25	100	22,511,575	7,560,545	30,072,120
24	2033	-	-	-	-	-	-	-	-	-	-	-	-	69	23	92	20,661,999	7,010,944	27,672,943
25	2034	-	-	-	-	-	-	-	-	-	-	-	-	63	22	84	18,922,435	6,482,598	25,405,034
26	2035	-	-	-	-	-	-	-	-	-	-	-	-	58	20	78	17,357,693	5,997,248	23,354,941
27	2036	-	-	-	-	-	-	-	-	-	-	-	-	51	18	69	15,487,719	5,418,974	20,906,693
28	2037	-	-	-	-	-	-	-	-	-	-	-	-	46	16	62	13,886,853	4,914,507	18,801,360
29	2038	-	-	-	-	-	-	-	-	-	-	-	-	42	15	57	12,578,125	4,495,645	17,073,770
30	2039	-	-	-	-	-	-	-	-	-	-	-	-	38	14	52	11,406,647	4,111,434	15,518,082
31	2040	-	-	-	-	-	-	-	-	-	-	-	-	34	12	47	10,305,077	3,738,700	14,043,777
32	2041	-	-	-	-	-	-	-	-	-	-	-	-	31	11	42	9,204,610	3,355,902	12,560,512
33	2042	-	-	-	-	-	-	-	-	-	-	-	-	27	10	37	8,138,489	2,977,641	11,116,130
34	2043	-	-	-	-	-	-	-	-	-	-	-	-	24	9	32	7,103,164	2,603,964	9,707,129
35	2044	-	-	-	-	-	-	-	-	-	-	-	-	20	7	28	6,139,656	2,250,749	8,390,405
36	2045	-	-	-	-	-	-	-	-	-	-	-	-	17	6	24	5,224,259	1,915,172	7,139,432
37	2046	-	-	-	-	-	-	-	-	-	-	-	-	14	5	19	4,272,325	1,566,201	5,838,525
38	2047	-	-	-	-	-	-	-	-	-	-	-	-	11	4	15	3,401,752	1,247,055	4,648,807
39	2048	-	-	-	-	-	-	-	-	-	-	-	-	9	3	12	2,719,405	996,912	3,716,318
40	2049	-	-	-	-	-	-	-	-	-	-	-	-	7	3	9	2,078,714	762,040	2,840,754
41	2050	-	-	-	-	-	-	-	-	-	-	-	-	5	2	7	1,529,481	560,696	2,090,177
42	2051	-	-	-	-	-	-	-	-	-	-	-	-	4	1	5	1,128,745	413,789	1,542,533
43	2052	-	-	-	-	-	-	-	-	-	-	-	-	3	1	4	771,362	282,775	1,054,137
44	2053	-	-	-	-	-	-	-	-	-	-	-	-	2	1	2	508,106	186,268	694,373
45	2054	-	-	-	-	-	-	-	-	-	-	-	-	1	0	1	307,145	112,597	419,742
46	2055	-	-	-	-	-	-	-	-	-	-	-	-	0	0	1	142,002	52,057	194,059
														NPV 46 years			$200,195,522	$62,239,157	$262,434,679

Option 6: Mandatory standards under the MVSA (regulation)

Year		Vehicle Sales			Option's Expected Fitment Rate			BAU Expected (Voluntary) Fitment Rate			Option minus BAU			Net Vehicle Crashes Influenced			Value of Net Vehicle Crashes Influenced		
		Cars and SUVs	LCVs	Total	Cars and SUVs	LCVs	Total	Cars and SUVs	LCVs	Total	Cars and SUVs	LCVs	Total	Cars and SUVs	LCVs	Total	Cars and SUVs	LCVs	Total
0	2009	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1	2010	798,308	186,234	984,542	237,718	8,070	245,789	237,718	8,070	245,789	-	-	-	-	-	-	-	-	-
2	2011	814,274	189,959	1,004,233	273,234	16,463	289,697	273,234	16,463	289,697	-	-	-	-	-	-	-	-	-
3	2012	830,560	193,758	1,024,317	310,076	25,189	335,264	310,076	25,189	335,264	-	-	-	-	-	-	-	-	-
4	2013	847,171	197,633	1,044,804	348,281	34,256	382,538	348,281	34,256	382,538	-	-	-	-	-	-	-	-	-
5	2014	864,114	201,586	1,065,700	387,891	43,677	431,568	387,891	43,677	431,568	-	-	-	-	-	-	-	-	-
6	2015	881,397	205,617	1,087,014	428,946	53,461	482,407	428,946	53,461	482,407	-	-	-	-	-	-	-	-	-
7	2016	899,024	209,730	1,108,754	552,900	81,445	634,345	471,488	63,618	535,106	81,412	17,827	99,239	1	0	2	416,899.87	91,290	508,190
8	2017	917,005	213,924	1,130,929	681,640	110,528	792,168	515,561	74,160	589,721	166,080	36,367	202,447	6	1	8	1,856,616	406,550	2,263,166
9	2018	935,345	218,203	1,153,548	815,309	140,741	956,050	561,207	85,099	646,306	254,102	55,642	309,744	14	3	17	4,316,805	945,268	5,262,073
10	2019	954,052	222,567	1,176,619	954,052	222,567	1,176,619	572,431	86,801	659,232	381,621	135,766	517,387	27	7	34	8,065,850	2,033,525	10,099,375
11	2020	973,133	227,018	1,200,151	973,133	227,018	1,200,151	583,880	88,537	672,417	389,253	138,481	527,734	42	12	55	12,783,443	3,717,033	16,500,476
12	2021	992,596	231,559	1,224,154	992,596	231,559	1,224,154	595,557	90,308	685,865	397,038	141,251	538,289	58	18	76	17,588,250	5,405,021	22,993,271
13	2022	1,012,448	236,190	1,248,637	1,012,448	236,190	1,248,637	607,469	92,114	699,583	404,979	144,076	549,055	75	24	99	22,534,704	7,164,681	29,699,385
14	2023	1,032,697	240,914	1,273,610	1,032,697	240,914	1,273,610	619,618	93,956	713,574	413,079	146,957	560,036	91	30	121	27,476,228	8,941,782	36,418,010
15	2024	1,053,350	245,732	1,299,082	1,053,350	245,732	1,299,082	632,010	95,835	727,846	421,340	149,896	571,237	108	36	143	32,407,478	10,733,351	43,140,829
16	2025	1,074,417	250,646	1,325,064	1,074,417	250,646	1,325,064	644,650	97,752	742,403	429,767	152,894	582,661	124	42	166	37,361,379	12,523,240	49,884,619
17	2026	1,095,906	255,659	1,351,565	1,095,906	255,659	1,351,565	657,543	99,707	757,251	438,362	155,952	594,315	141	48	188	42,433,762	14,297,439	56,731,200
18	2027	1,117,824	260,773	1,378,596	1,117,824	260,773	1,378,596	670,694	101,701	772,396	447,130	159,071	606,201	159	54	212	47,791,783	16,151,831	63,943,615
19	2028	1,140,180	265,988	1,406,168	1,140,180	265,988	1,406,168	684,108	103,735	787,844	456,072	162,253	618,325	178	60	238	53,476,816	18,127,657	71,604,473
20	2029	1,162,984	271,308	1,434,292	1,162,984	271,308	1,434,292	697,790	105,810	803,600	465,194	165,498	630,691	197	67	265	59,420,158	20,229,450	79,649,608
21	2030	1,186,244	276,734	1,462,978	1,186,244	276,734	1,462,978	711,746	107,926	819,672	474,497	168,808	643,305	217	74	292	65,446,441	22,383,384	87,829,825
22	2031	-	-	-	-	-	-	-	-	-	-	-	-	229	79	308	69,060,414	23,697,942	92,758,356
23	2032	-	-	-	-	-	-	-	-	-	-	-	-	229	79	308	69,051,257	23,730,647	92,781,904
24	2033	-	-	-	-	-	-	-	-	-	-	-	-	229	79	308	68,922,802	23,731,433	92,654,235
25	2034	-	-	-	-	-	-	-	-	-	-	-	-	227	78	305	68,203,931	23,579,316	91,783,246
26	2035	-	-	-	-	-	-	-	-	-	-	-	-	222	77	300	66,919,183	23,235,184	90,154,367
27	2036	-	-	-	-	-	-	-	-	-	-	-	-	216	75	291	64,974,532	22,614,984	87,589,516
28	2037	-	-	-	-	-	-	-	-	-	-	-	-	209	73	281	62,794,575	21,931,761	84,726,336
29	2038	-	-	-	-	-	-	-	-	-	-	-	-	201	71	272	60,629,875	21,254,186	81,884,061
30	2039	-	-	-	-	-	-	-	-	-	-	-	-	192	68	260	57,935,154	20,352,636	78,287,790
31	2040	-	-	-	-	-	-	-	-	-	-	-	-	181	64	245	54,570,801	19,220,650	73,791,451
32	2041	-	-	-	-	-	-	-	-	-	-	-	-	167	59	226	50,352,780	17,761,930	68,114,709
33	2042	-	-	-	-	-	-	-	-	-	-	-	-	151	54	205	45,581,117	16,106,843	61,687,959
34	2043	-	-	-	-	-	-	-	-	-	-	-	-	134	48	182	40,384,237	14,307,697	54,691,933
35	2044	-	-	-	-	-	-	-	-	-	-	-	-	117	41	158	35,083,746	12,481,429	47,565,175
36	2045	-	-	-	-	-	-	-	-	-	-	-	-	99	35	134	29,852,911	10,620,501	40,473,412
37	2046	-	-	-	-	-	-	-	-	-	-	-	-	81	29	110	24,413,284	8,685,294	33,098,578
38	2047	-	-	-	-	-	-	-	-	-	-	-	-	65	23	88	19,438,580	6,915,489	26,354,069
39	2048	-	-	-	-	-	-	-	-	-	-	-	-	52	18	70	15,539,457	5,528,333	21,067,790
40	2049	-	-	-	-	-	-	-	-	-	-	-	-	39	14	54	11,878,365	4,225,859	16,104,224
41	2050	-	-	-	-	-	-	-	-	-	-	-	-	29	10	39	8,739,893	3,109,313	11,849,206
42	2051	-	-	-	-	-	-	-	-	-	-	-	-	21	8	29	6,449,969	2,294,647	8,744,616
43	2052	-	-	-	-	-	-	-	-	-	-	-	-	15	5	20	4,407,782	1,568,117	5,975,899
44	2053	-	-	-	-	-	-	-	-	-	-	-	-	10	3	13	2,903,460	1,032,938	3,936,398
45	2054	-	-	-	-	-	-	-	-	-	-	-	-	6	2	8	1,755,114	624,401	2,379,515
46	2055	-	-	-	-	-	-	-	-	-	-	-	-	3	1	4	811,442	288,679	1,100,121
														NPV 46 years			$259,434,629	$87,469,320	$346,903,949

8. Calculate the fitment, regulation compliance and government costs (where relevant) for each particular option.

Cost related to:	**Estimated cost ($)**	**Option**	**Notes**	**Cost Impact**
Fitment of system – max (including development costs)	78	all	per vehicle	Business
Fitment of system – min (including development costs)	30	all	per vehicle	Business
Information campaigns – targeted awareness	1,000,000	2	per 4 month campaign, assume continuous campaign (3 per year)	Government
Fleet purchasing policies	50,000	3	per year	Government
Testing of system to a regulation	35,000	6	per model	Business
Type approval costs	15,000	6	per model	Business
Implement and maintain regulation	50,000	6	per year	Government

Option 2: User information campaigns

Year		Fitment Costs			System Development Costs			Regulation Compliance Costs			Government Costs		
		Min	Max	Average	Min	Max	Average	Min	Max	Average	Min	Max	Average
		30	78										
0	2009	-	-	-	-	-	-	-	-	-	-	-	-
1	2010	5,917,661	15,385,919	10,651,790	-	-	-	-	-	-	3,000,000	3,000,000	3,000,000
2	2011	4,866,224	12,652,183	8,759,204	-	-	-	-	-	-	3,000,000	3,000,000	3,000,000
3	2012	3,770,363	9,802,943	6,786,653	-	-	-	-	-	-	3,000,000	3,000,000	3,000,000
4	2013	2,628,720	6,834,672	4,731,696	-	-	-	-	-	-	3,000,000	3,000,000	3,000,000
5	2014	1,439,904	3,743,749	2,591,826	-	-	-	-	-	-	3,000,000	3,000,000	3,000,000
6	2015	1,172,019	3,047,250	2,109,634	-	-	-	-	-	-	3,000,000	3,000,000	3,000,000
7	2016	922,811	2,399,308	1,661,059	-	-	-	-	-	-	3,000,000	3,000,000	3,000,000
8	2017	663,165	1,724,230	1,193,698	-	-	-	-	-	-	3,000,000	3,000,000	3,000,000
9	2018	392,765	1,021,189	706,977	-	-	-	-	-	-	3,000,000	3,000,000	3,000,000
10	2019	400,620	1,041,613	721,117	-	-	-	-	-	-	3,000,000	3,000,000	3,000,000
11	2020	408,633	1,062,445	735,539	-	-	-	-	-	-	3,000,000	3,000,000	3,000,000
12	2021	416,805	1,083,694	750,250	-	-	-	-	-	-	3,000,000	3,000,000	3,000,000
13	2022	425,142	1,105,368	765,255	-	-	-	-	-	-	3,000,000	3,000,000	3,000,000
14	2023	433,644	1,127,475	780,560	-	-	-	-	-	-	3,000,000	3,000,000	3,000,000
15	2024	442,317	1,150,025	796,171	-	-	-	-	-	-	3,000,000	3,000,000	3,000,000
16	2025	451,164	1,173,025	812,094	-	-	-	-	-	-	3,000,000	3,000,000	3,000,000
17	2026	460,187	1,196,486	828,336	-	-	-	-	-	-	3,000,000	3,000,000	3,000,000
18	2027	469,391	1,220,416	844,903	-	-	-	-	-	-	3,000,000	3,000,000	3,000,000
19	2028	478,778	1,244,824	861,801	-	-	-	-	-	-	3,000,000	3,000,000	3,000,000
20	2029	488,354	1,269,720	879,037	-	-	-	-	-	-	3,000,000	3,000,000	3,000,000
21	2030	498,121	1,295,115	896,618	-	-	-	-	-	-	3,000,000	3,000,000	3,000,000
22	2031	-	-	-	-	-	-	-	-	-	-	-	-
23	2032	-	-	-	-	-	-	-	-	-	-	-	-
24	2033	-	-	-	-	-	-	-	-	-	-	-	-
25	2034	-	-	-	-	-	-	-	-	-	-	-	-
26	2035	-	-	-	-	-	-	-	-	-	-	-	-
27	2036	-	-	-	-	-	-	-	-	-	-	-	-
28	2037	-	-	-	-	-	-	-	-	-	-	-	-
29	2038	-	-	-	-	-	-	-	-	-	-	-	-
30	2039	-	-	-	-	-	-	-	-	-	-	-	-
31	2040	-	-	-	-	-	-	-	-	-	-	-	-
32	2041	-	-	-	-	-	-	-	-	-	-	-	-
33	2042	-	-	-	-	-	-	-	-	-	-	-	-
34	2043	-	-	-	-	-	-	-	-	-	-	-	-
35	2044	-	-	-	-	-	-	-	-	-	-	-	-
36	2045	-	-	-	-	-	-	-	-	-	-	-	-
37	2046	-	-	-	-	-	-	-	-	-	-	-	-
38	2047	-	-	-	-	-	-	-	-	-	-	-	-
39	2048	-	-	-	-	-	-	-	-	-	-	-	-
40	2049	-	-	-	-	-	-	-	-	-	-	-	-
41	2050	-	-	-	-	-	-	-	-	-	-	-	-
42	2051	-	-	-	-	-	-	-	-	-	-	-	-
43	2052	-	-	-	-	-	-	-	-	-	-	-	-
44	2053	-	-	-	-	-	-	-	-	-	-	-	-
45	2054	-	-	-	-	-	-	-	-	-	-	-	-
46	2055	-	-	-	-	-	-	-	-	-	-	-	-
		$18,457,922	$47,990,597	$33,224,259	$0	$0	$0	$0	$0	$0	$30,379,983	$30,379,983	$30,379,983

Option 3: Fleet purchasing policies

Year		Fitment Costs			System Development Costs			Regulation compliance costs			Government Costs		
		Min	Max	Average	Min	Max	Average	Min	Max	Average	Min	Max	Average
		30	78										
0	2009	-	-	-	-	-	-	-	-	-	-	-	-
1	2010	11,465,845	29,811,197	20,638,521	-	-	-	-	-	-	50,000	50,000	50,000
2	2011	10,525,372	27,365,966	18,945,669	-	-	-	-	-	-	50,000	50,000	50,000
3	2012	9,542,693	24,811,002	17,176,847	-	-	-	-	-	-	50,000	50,000	50,000
4	2013	8,516,497	22,142,892	15,329,695	-	-	-	-	-	-	50,000	50,000	50,000
5	2014	7,445,436	19,358,134	13,401,785	-	-	-	-	-	-	50,000	50,000	50,000
6	2015	6,328,126	16,453,128	11,390,627	-	-	-	-	-	-	50,000	50,000	50,000
7	2016	5,163,146	13,424,179	9,293,662	-	-	-	-	-	-	50,000	50,000	50,000
8	2017	3,949,035	10,267,490	7,108,262	-	-	-	-	-	-	50,000	50,000	50,000
9	2018	2,684,294	6,979,164	4,831,729	-	-	-	-	-	-	50,000	50,000	50,000
10	2019	2,737,980	7,118,747	4,928,364	-	-	-	-	-	-	50,000	50,000	50,000
11	2020	2,792,739	7,261,122	5,026,931	-	-	-	-	-	-	50,000	50,000	50,000
12	2021	2,848,594	7,406,345	5,127,469	-	-	-	-	-	-	50,000	50,000	50,000
13	2022	2,905,566	7,554,472	5,230,019	-	-	-	-	-	-	50,000	50,000	50,000
14	2023	2,963,677	7,705,561	5,334,619	-	-	-	-	-	-	50,000	50,000	50,000
15	2024	3,022,951	7,859,672	5,441,312	-	-	-	-	-	-	50,000	50,000	50,000
16	2025	3,083,410	8,016,866	5,550,138	-	-	-	-	-	-	50,000	50,000	50,000
17	2026	3,145,078	8,177,203	5,661,141	-	-	-	-	-	-	50,000	50,000	50,000
18	2027	3,207,980	8,340,747	5,774,363	-	-	-	-	-	-	50,000	50,000	50,000
19	2028	3,272,139	8,507,562	5,889,851	-	-	-	-	-	-	50,000	50,000	50,000
20	2029	3,337,582	8,677,713	6,007,648	-	-	-	-	-	-	50,000	50,000	50,000
21	2030	3,404,334	8,851,268	6,127,801	-	-	-	-	-	-	50,000	50,000	50,000
22	2031	-	-	-	-	-	-	-	-	-	-	-	-
23	2032	-	-	-	-	-	-	-	-	-	-	-	-
24	2033	-	-	-	-	-	-	-	-	-	-	-	-
25	2034	-	-	-	-	-	-	-	-	-	-	-	-
26	2035	-	-	-	-	-	-	-	-	-	-	-	-
27	2036	-	-	-	-	-	-	-	-	-	-	-	-
28	2037	-	-	-	-	-	-	-	-	-	-	-	-
29	2038	-	-	-	-	-	-	-	-	-	-	-	-
30	2039	-	-	-	-	-	-	-	-	-	-	-	-
31	2040	-	-	-	-	-	-	-	-	-	-	-	-
32	2041	-	-	-	-	-	-	-	-	-	-	-	-
33	2042	-	-	-	-	-	-	-	-	-	-	-	-
34	2043	-	-	-	-	-	-	-	-	-	-	-	-
35	2044	-	-	-	-	-	-	-	-	-	-	-	-
36	2045	-	-	-	-	-	-	-	-	-	-	-	-
37	2046	-	-	-	-	-	-	-	-	-	-	-	-
38	2047	-	-	-	-	-	-	-	-	-	-	-	-
39	2048	-	-	-	-	-	-	-	-	-	-	-	-
40	2049	-	-	-	-	-	-	-	-	-	-	-	-
41	2050	-	-	-	-	-	-	-	-	-	-	-	-
42	2051	-	-	-	-	-	-	-	-	-	-	-	-
43	2052	-	-	-	-	-	-	-	-	-	-	-	-
44	2053	-	-	-	-	-	-	-	-	-	-	-	-
45	2054	-	-	-	-	-	-	-	-	-	-	-	-
46	2055	-	-	-	-	-	-	-	-	-	-	-	-
		$59,539,970	$154,803,922	$107,171,946	$0	$0	$0	$0	$0	$0	$506,333	$506,333	$506,333

Option 6: Mandatory standards under the MVSA (regulation)

Year		Fitment Costs			System Development Costs			Regulation Compliance Costs			Government Costs		
		Min	Max	Average	Min	Max	Average	Min	Max	Average	Min	Max	Average
		30	78										
0	2009	-	-	-	-	-	-	-	-	-	-	-	-
1	2010	-	-	-	-	-	-	-	-	-	50,000	50,000	50,000
2	2011	-	-	-	-	-	-	-	-	-	50,000	50,000	50,000
3	2012	-	-	-	-	-	-	-	-	-	50,000	50,000	50,000
4	2013	-	-	-	-	-	-	-	-	-	50,000	50,000	50,000
5	2014	-	-	-	-	-	-	-	-	-	50,000	50,000	50,000
6	2015	-	-	-	-	-	-	1,940,000	1,940,000	1,940,000	50,000	50,000	50,000
7	2016	2,977,161	7,740,618	5,358,889	-	-	-	1,940,000	1,940,000	1,940,000	50,000	50,000	50,000
8	2017	6,073,408	15,790,860	10,932,134	-	-	-	1,940,000	1,940,000	1,940,000	50,000	50,000	50,000
9	2018	9,292,314	24,160,016	16,726,165	-	-	-	1,940,000	1,940,000	1,940,000	50,000	50,000	50,000
10	2019	15,521,597	40,356,153	27,938,875	-	-	-	3,880,000	3,880,000	3,880,000	50,000	50,000	50,000
11	2020	15,832,029	41,163,276	28,497,652	-	-	-	3,880,000	3,880,000	3,880,000	50,000	50,000	50,000
12	2021	16,148,670	41,986,541	29,067,606	-	-	-	3,880,000	3,880,000	3,880,000	50,000	50,000	50,000
13	2022	16,471,643	42,826,272	29,648,958	-	-	-	3,880,000	3,880,000	3,880,000	50,000	50,000	50,000
14	2023	16,801,076	43,682,798	30,241,937	-	-	-	3,880,000	3,880,000	3,880,000	50,000	50,000	50,000
15	2024	17,137,098	44,556,454	30,846,776	-	-	-	3,880,000	3,880,000	3,880,000	50,000	50,000	50,000
16	2025	17,479,839	45,447,583	31,463,711	-	-	-	3,880,000	3,880,000	3,880,000	50,000	50,000	50,000
17	2026	17,829,436	46,356,534	32,092,985	-	-	-	3,880,000	3,880,000	3,880,000	50,000	50,000	50,000
18	2027	18,186,025	47,283,665	32,734,845	-	-	-	3,880,000	3,880,000	3,880,000	50,000	50,000	50,000
19	2028	18,549,745	48,229,338	33,389,542	-	-	-	3,880,000	3,880,000	3,880,000	50,000	50,000	50,000
20	2029	18,920,740	49,193,925	34,057,333	-	-	-	3,880,000	3,880,000	3,880,000	50,000	50,000	50,000
21	2030	19,299,155	50,177,804	34,738,479	-	-	-	3,880,000	3,880,000	3,880,000	50,000	50,000	50,000
22	2031	-	-	-	-	-	-	-	-	-	-	-	-
23	2032	-	-	-	-	-	-	-	-	-	-	-	-
24	2033	-	-	-	-	-	-	-	-	-	-	-	-
25	2034	-	-	-	-	-	-	-	-	-	-	-	-
26	2035	-	-	-	-	-	-	-	-	-	-	-	-
27	2036	-	-	-	-	-	-	-	-	-	-	-	-
28	2037	-	-	-	-	-	-	-	-	-	-	-	-
29	2038	-	-	-	-	-	-	-	-	-	-	-	-
30	2039	-	-	-	-	-	-	-	-	-	-	-	-
31	2040	-	-	-	-	-	-	-	-	-	-	-	-
32	2041	-	-	-	-	-	-	-	-	-	-	-	-
33	2042	-	-	-	-	-	-	-	-	-	-	-	-
34	2043	-	-	-	-	-	-	-	-	-	-	-	-
35	2044	-	-	-	-	-	-	-	-	-	-	-	-
36	2045	-	-	-	-	-	-	-	-	-	-	-	-
37	2046	-	-	-	-	-	-	-	-	-	-	-	-
38	2047	-	-	-	-	-	-	-	-	-	-	-	-
39	2048	-	-	-	-	-	-	-	-	-	-	-	-
40	2049	-	-	-	-	-	-	-	-	-	-	-	-
41	2050	-	-	-	-	-	-	-	-	-	-	-	-
42	2051	-	-	-	-	-	-	-	-	-	-	-	-
43	2052	-	-	-	-	-	-	-	-	-	-	-	-
44	2053	-	-	-	-	-	-	-	-	-	-	-	-
45	2054	-	-	-	-	-	-	-	-	-	-	-	-
46	2055	-	-	-	-	-	-	-	-	-	-	-	-
		$78,703,969	$204,630,319	$141,667,144	$0	$0	$0	$20,044,778	$20,044,778	$20,044,778	$506,333	$506,333	$506,333

9. Sum and discount all the calculated values for each year using a discount rate of 7 per cent. Calculate the Net Benefits, Total Costs, Benefit-Cost Ratios and number of lives saved.

Option 2: User information campaigns

Year		Net Benefits			Lives Saved
		Min	Max	Average	
0	2009	-	-	-	-
1	2010	-17,375,797	-7,907,539	-12,641,668	0.04
2	2011	-12,383,723	-4,597,764	-8,490,743	0.12
3	2012	-7,821,272	-1,788,692	-4,804,982	0.18
4	2013	-3,474,933	731,019	-1,371,957	0.22
5	2014	535,134	2,838,980	1,687,057	0.26
6	2015	1,826,121	3,701,352	2,763,737	0.28
7	2016	2,877,725	4,354,222	3,615,974	0.29
8	2017	3,633,323	4,694,387	4,163,855	0.29
9	2018	4,370,432	4,998,856	4,684,644	0.30
10	2019	4,505,414	5,146,407	4,825,910	0.30
11	2020	4,878,242	5,532,054	5,205,148	0.32
12	2021	5,296,229	5,963,118	5,629,673	0.33
13	2022	5,690,876	6,371,103	6,030,989	0.35
14	2023	5,937,413	6,631,244	6,284,329	0.35
15	2024	5,986,865	6,694,572	6,340,718	0.36
16	2025	6,095,550	6,817,412	6,456,481	0.36
17	2026	5,982,171	6,718,470	6,350,320	0.36
18	2027	5,451,687	6,202,712	5,827,200	0.34
19	2028	4,936,489	5,702,535	5,319,512	0.32
20	2029	4,335,420	5,116,787	4,726,104	0.30
21	2030	3,579,020	4,376,014	3,977,517	0.28
22	2031	7,192,212	7,192,212	7,192,212	0.25
23	2032	6,354,022	6,354,022	6,354,022	0.22
24	2033	5,586,240	5,586,240	5,586,240	0.20
25	2034	4,934,265	4,934,265	4,934,265	0.17
26	2035	4,388,537	4,388,537	4,388,537	0.15
27	2036	3,647,069	3,647,069	3,647,069	0.13
28	2037	3,075,164	3,075,164	3,075,164	0.11
29	2038	2,652,231	2,652,231	2,652,231	0.09
30	2039	2,330,434	2,330,434	2,330,434	0.08
31	2040	2,087,281	2,087,281	2,087,281	0.07
32	2041	1,853,142	1,853,142	1,853,142	0.07
33	2042	1,631,374	1,631,374	1,631,374	0.06
34	2043	1,420,344	1,420,344	1,420,344	0.05
35	2044	1,227,681	1,227,681	1,227,681	0.04
36	2045	1,044,639	1,044,639	1,044,639	0.04
37	2046	854,291	854,291	854,291	0.03
38	2047	680,212	680,212	680,212	0.02
39	2048	543,770	543,770	543,770	0.02
40	2049	415,658	415,658	415,658	0.01
41	2050	305,834	305,834	305,834	0.01
42	2051	225,703	225,703	225,703	0.01
43	2052	154,241	154,241	154,241	0.01
44	2053	101,600	101,600	101,600	0.00
45	2054	61,416	61,416	61,416	0.00
46	2055	28,395	28,395	28,395	0.00
		NPV Benefits			**8**
		$2,986,511	**$32,519,186**	**$17,752,849**	
			BCR		
		1.0	**1.7**	**1.4**	

Option 3: Fleet purchasing policies

Year		Net Benefits Min	Net Benefits Max	Net Benefits Average	Lives Saved
0	2009	-	-	-	-
1	2010	- 27,904,021	- 9,558,669	- 18,731,345	0.07
2	2011	- 20,895,905	- 4,055,310	- 12,475,608	0.23
3	2012	- 14,374,973	893,335	- 6,740,819	0.37
4	2013	- 7,932,005	5,694,391	- 1,118,807	0.50
5	2014	- 1,765,694	10,147,003	4,190,655	0.62
6	2015	4,089,939	14,214,940	9,152,439	0.73
7	2016	9,444,025	17,705,058	13,574,542	0.81
8	2017	14,037,554	20,356,009	17,196,781	0.86
9	2018	18,327,900	22,622,770	20,475,335	0.89
10	2019	19,200,618	23,581,386	21,391,002	0.93
11	2020	20,515,201	24,983,584	22,749,392	0.98
12	2021	21,946,319	26,504,070	24,225,194	1.04
13	2022	23,456,843	28,105,749	25,781,296	1.09
14	2023	24,816,996	29,558,880	27,187,938	1.15
15	2024	25,881,062	30,717,783	28,299,422	1.19
16	2025	27,041,812	31,975,268	29,508,540	1.24
17	2026	27,708,552	32,740,677	30,224,614	1.27
18	2027	27,445,290	32,578,058	30,011,674	1.26
19	2028	27,037,860	32,273,283	29,655,571	1.25
20	2029	26,338,023	31,678,154	29,008,088	1.24
21	2030	25,158,267	30,605,200	27,881,733	1.20
22	2031	32,550,694	32,550,694	32,550,694	1.15
23	2032	30,072,120	30,072,120	30,072,120	1.06
24	2033	27,672,943	27,672,943	27,672,943	0.98
25	2034	25,405,034	25,405,034	25,405,034	0.90
26	2035	23,354,941	23,354,941	23,354,941	0.82
27	2036	20,906,693	20,906,693	20,906,693	0.74
28	2037	18,801,360	18,801,360	18,801,360	0.66
29	2038	17,073,770	17,073,770	17,073,770	0.60
30	2039	15,518,082	15,518,082	15,518,082	0.55
31	2040	14,043,777	14,043,777	14,043,777	0.49
32	2041	12,560,512	12,560,512	12,560,512	0.44
33	2042	11,116,130	11,116,130	11,116,130	0.39
34	2043	9,707,129	9,707,129	9,707,129	0.34
35	2044	8,390,405	8,390,405	8,390,405	0.30
36	2045	7,139,432	7,139,432	7,139,432	0.25
37	2046	5,838,525	5,838,525	5,838,525	0.21
38	2047	4,648,807	4,648,807	4,648,807	0.16
39	2048	3,716,318	3,716,318	3,716,318	0.13
40	2049	2,840,754	2,840,754	2,840,754	0.10
41	2050	2,090,177	2,090,177	2,090,177	0.07
42	2051	1,542,533	1,542,533	1,542,533	0.05
43	2052	1,054,137	1,054,137	1,054,137	0.04
44	2053	694,373	694,373	694,373	0.02
45	2054	419,742	419,742	419,742	0.01
46	2055	194,059	194,059	194,059	0.01
		NPV Benefits			**29**
		$107,124,423	**$202,388,376**	**$154,756,399**	
			BCR		
		1.7	**4.4**	**3.0**	

Option 6: Mandatory standards under the MVSA (regulation)

Year		Net Benefits Min	Net Benefits Max	Net Benefits Average	Lives Saved
0	2009	-	-	-	-
1	2010	- 50,000	- 50,000	- 50,000	-
2	2011	- 50,000	- 50,000	- 50,000	-
3	2012	- 50,000	- 50,000	- 50,000	-
4	2013	- 50,000	- 50,000	- 50,000	-
5	2014	- 50,000	- 50,000	- 50,000	-
6	2015	- 1,990,000	- 1,990,000	- 1,990,000	-
7	2016	- 9,222,428	- 4,458,971	- 6,840,699	0.02
8	2017	- 15,517,694	- 5,800,242	- 10,658,968	0.08
9	2018	- 20,887,943	- 6,020,241	- 13,454,092	0.19
10	2019	- 34,186,778	- 9,352,222	- 21,769,500	0.36
11	2020	- 28,592,800	- 3,261,553	- 15,927,176	0.58
12	2021	- 22,923,270	2,914,602	- 10,004,334	0.81
13	2022	- 17,056,887	9,297,742	- 3,879,573	1.05
14	2023	- 11,194,788	15,686,934	2,246,073	1.28
15	2024	- 5,345,624	22,073,732	8,364,054	1.52
16	2025	507,037	28,474,780	14,490,908	1.76
17	2026	6,444,666	34,971,764	20,708,215	2.00
18	2027	12,729,950	41,827,590	27,278,770	2.25
19	2028	19,445,135	49,124,728	34,284,931	2.52
20	2029	26,525,683	56,798,868	41,662,276	2.81
21	2030	33,722,022	64,600,670	49,161,346	3.09
22	2031	92,758,356	92,758,356	92,758,356	3.27
23	2032	92,781,904	92,781,904	92,781,904	3.27
24	2033	92,654,235	92,654,235	92,654,235	3.26
25	2034	91,783,246	91,783,246	91,783,246	3.23
26	2035	90,154,367	90,154,367	90,154,367	3.18
27	2036	87,589,516	87,589,516	87,589,516	3.09
28	2037	84,726,336	84,726,336	84,726,336	2.99
29	2038	81,884,061	81,884,061	81,884,061	2.89
30	2039	78,287,790	78,287,790	78,287,790	2.76
31	2040	73,791,451	73,791,451	73,791,451	2.60
32	2041	68,114,709	68,114,709	68,114,709	2.40
33	2042	61,687,959	61,687,959	61,687,959	2.17
34	2043	54,691,933	54,691,933	54,691,933	1.93
35	2044	47,565,175	47,565,175	47,565,175	1.68
36	2045	40,473,412	40,473,412	40,473,412	1.43
37	2046	33,098,578	33,098,578	33,098,578	1.17
38	2047	26,354,069	26,354,069	26,354,069	0.93
39	2048	21,067,790	21,067,790	21,067,790	0.74
40	2049	16,104,224	16,104,224	16,104,224	0.57
41	2050	11,849,206	11,849,206	11,849,206	0.42
42	2051	8,744,616	8,744,616	8,744,616	0.31
43	2052	5,975,899	5,975,899	5,975,899	0.21
44	2053	3,936,398	3,936,398	3,936,398	0.14
45	2054	2,379,515	2,379,515	2,379,515	0.08
46	2055	1,100,121	1,100,121	1,100,121	0.04
		NPV Benefits			**65**
		$121,722,519	**$247,648,869**	**$184,685,694**	
			BCR		
		1.5	**3.5**	**2.5**	

SUMMARY

Option 2: User information campaigns

	Net Benefit	Cost to Business	Cost to Government	Benefit Cost Ratio	Number of Lives Saved
Best Case	$32,519,186	$18,457,922	$30,379,983	1.7	
Likely Case	**$17,752,849**	**$33,224,259**	**$30,379,983**	**1.4**	**8**
Worst Case	$2,986,511	$47,990,597	$30,379,983	1.0	

Option 3: Fleet purchasing policies

	Net Benefit	Cost to Business	Cost to Government	Benefit Cost Ratio	Number of Lives Saved
Best Case	$202,388,376	$59,539,970	$506,333	4.4	
Likely Case	**$154,756,399**	**$107,171,946**	**$506,333**	**3.0**	**29**
Worst Case	$107,124,423	$154,803,922	$506,333	1.7	

Option 6: Mandatory standards under the MVSA (regulation)

	Net Benefit	Cost to Business	Cost to Government	Benefit Cost Ratio	Number of Lives Saved
Best Case	$247,648,869	$98,748,747	$506,333	3.5	
Likely Case	**$184,685,694**	**$161,711,922**	**$506,333**	**2.5**	**65**
Worst Case	$121,722,519	$224,675,097	$506,333	1.5	

Best Case - 7% discount rate, minimum costs
Likely Case - 7% discount rate, average costs
Worst Case - 7% discount rate, maximum costs

APPENDIX 9 - BENEFIT- COST ANALYSIS – SENSITIVITIES

The following sensitivities were tested for Option 6: Mandatory standards under the MVSA.

(a) Base case

	Net Benefit	Cost to Business	Cost to Government	Benefit Cost Ratio	Number of Lives Saved
Best Case	$247,648,869	$98,748,747	$506,333	3.5	
Likely Case	$184,685,694	$161,711,922	$506,333	2.5	65
Worst Case	$121,722,519	$224,675,097	$506,333	1.5	

(b) Changes to effectiveness

7.7% effectiveness (-20%)

	Net Benefit	Cost to Business	Cost to Government	Benefit Cost Ratio	Number of Lives Saved
Best Case	$178,268,079	$98,748,747	$506,333	2.8	
Likely Case	$115,304,904	$161,711,922	$506,333	2.0	52
Worst Case	$52,341,729	$224,675,097	$506,333	1.2	

11.5% effectiveness (+20%)

	Net Benefit	Cost to Business	Cost to Government	Benefit Cost Ratio	Number of Lives Saved
Best Case	$317,029,659	$98,748,747	$506,333	4.2	
Likely Case	$254,066,484	$161,711,922	$506,333	3.0	78
Worst Case	$191,103,309	$224,675,097	$506,333	1.8	

(c) Changes to the Business As Usual (BAU) voluntary fitment rate

BAU fitment rate of 95% for passenger cars and SUVs and 95% for LCVs

	Net Benefit	Cost to Business	Cost to Government	Benefit Cost Ratio	Number of Lives Saved
Best Case	$6,163,508	$27,884,251	$506,333	1.2	
Likely Case	-$108,070	$34,155,830	$506,333	1.0	7
Worst Case	-$6,379,649	$40,427,408	$506,333	0.8	

(d) Changes to the discount rate

3% discount rate

	Net Benefit	Cost to Business	Cost to Government	Benefit Cost Ratio	Number of Lives Saved
Best Case	$687,114,878	$176,296,603	$748,302	4.9	
Likely Case	$573,899,429	$289,512,052	$748,302	3.5	65
Worst Case	$460,683,980	$402,727,500	$748,302	2.1	

11% discount rate

	Net Benefit	Cost to Business	Cost to Government	Benefit Cost Ratio	Number of Lives Saved
Best Case	$95,580,583	$57,748,107	$363,742	2.6	
Likely Case	$59,053,709	$94,274,982	$363,742	1.9	65
Worst Case	$22,526,834	$130,801,856	$363,742	1.2	

APPENDIX 10 - BENEFIT- COST ANALYSIS – ASSUMPTIONS

A number of assumptions were made in the benefit-cost analysis. These are listed below (in no particular order).

1. The potential benefits were based on the identified cost of a fatality, serious injury and minor injury for a vulnerable road user crash in Australia. The ratio between fatalities and serious injuries in Australia for these crashes was known, however, the ratio to minor injuries could not be obtained at a national level. Therefore, this ratio was determined from statistics for pedestrian and cyclist crashes in Victoria, sourced from the Victorian CrashStats database. These statistics showed that, over a ten year period, these crashes resulted in 606 fatalities, 9,431 serious injuries, and 14,424 minor injuries. This equates to 15.6 serious injuries and 23.8 minor injuries per fatality. Given that the ratio of serious injuries to fatalities matched the national data reasonably well, it was assumed that the ratio calculated from the Victorian statistics is representative of the national case.

2. The effectiveness of passive pedestrian safety measures was based on a comprehensive study conducted by the Transport Research Laboratory in the United Kingdom. In line with the assumptions made in this study, it was assumed that passive pedestrian safety measures would have no effect on minor injuries and that all fatalities would be converted to serious injuries, and all serious injuries would be converted to minor injuries. It was also assumed that the speed profiles for pedestrian collisions in Australia and Europe are similar. This was supported by statistics for pedestrian fatalities which showed that, in Europe, approximately 35 per cent of fatalities occurred at impact speeds of 50km/h or less, while in Australia, approximately 27 per cent of fatalities occurred in areas with a posted speed limit of 50km/h or below. No adjustment was made to the effectiveness based on these statistics as the Australian data was for the posted speed limit and not impact speed.

3. A discount rate of 7 per cent was assumed, this being in line with similar studies. However, a rate of 11 per cent was used as part of the sensitivity checks. Also, the expected crash life of a vehicle was set at 26 years as per the historical data used for the calculations. Refer Appendix 7 - Benefit-Cost Analysis – Methodology. This would not affect the relative merits of the options but may change their final values slightly.

4. A historically based fleet profile was used to adjust the contribution that each vehicle fitted with passive pedestrian safety measures would provide towards the total benefit. This contribution was based on both the proportion of vehicles in the fleet of any particular age, and the tendency for vehicles of a particular age to be involved in road crashes. It was assumed that this profile could continue to represent the fleet into the future. Refer Appendix 7 - Benefit-Cost Analysis – Methodology. This would not affect the relative merits of the options but may change how rapidly the benefits would be realised and their final values slightly.

5. It was assumed in Option 3: Fleet Purchasing Policies that fleet policies would have the same influence on LCVs as on passenger cars and SUVs. However, the fleet sales

mechanism may be more relevant to passenger cars and SUVs than to LCVs. Therefore, the merits of this option may be slightly overestimated.

6. The proposed timing for the regulation was split into two cases. For lighter M1 and N1 vehicles regulation would be phased in between 2013 and 2018, while for heavier M1 and N1 vehicles regulation would be phased in between 2015 and 2019. In setting the fitment rates for the BAU scenario and Option 6: Mandatory standards under the MVSA (the regulation option) it was assumed that all vehicles being imported to Australia from the EU and Japan would comply with overseas regulation by 2018, but that regulation in Australia would not force compliance to 100 per cent until 2019. Therefore, the benefits of Option 6: Mandatory standards under the MVSA would be underestimated.

7. Certification costs were assumed to impact Business rather than Government as the certification scheme is in the most part cost recovered. This would not affect the results other than the distribution of costs slightly.

APPENDIX 11 - VEHICLE FRONT PROTECTION SYSTEMS

The fitting of a Vehicle Front Protection System (VFPS) such as a “bull bar” or “nudge bar” to a vehicle subject to GTR 9 through the Australian Design Rules (ADRs) would require re-testing of the vehicle, as the performance characteristics of the front structure of the vehicle would be likely to be altered in relation to pedestrian protection.

The National Transport Commission (NTC) has previously defined a bull bar as a specific type of protrusion/vehicle frontal protection system designed to protect the vehicle against damage in an animal strike. Bull bars are typically larger in size and cover a greater section of the vehicle frontal section than other types of vehicle frontal protection systems such as nudge bars (NTC, 2008).

The analysis of this potential impact has been discussed separately to the recommendation for the compliance of vehicles (see Section 9.7), as it almost exclusively involves the fitting of aftermarket equipment. The requirements for aftermarket equipment for vehicles come under state and territory control and hence under its legislation. As this Regulation Impact Statement (RIS) was examining the possibility of intervention by the Australian Government, it was only able to consider the option of Commonwealth regulation. Therefore, the analysis has been presented in terms of how the fitting of aftermarket VFPS could affect the outcome of any intervention by the Australian Government on the issue of pedestrian safety.

However, it was also recognised that at some point a vehicle manufacturer may wish to supply a VFPS in conjunction with a new vehicle, in which case Commonwealth requirements would apply. Further, if the Commonwealth and the state or territory legislation were not aligned in their respective requirements, a manufacturer may choose the least stringent path to certify a VFPS, whether it was by supplying the VFPS either as an ADR certified item with a new vehicle purchase or as an aftermarket (post-registration) option. It became clear that this RIS offered the opportunity to propose an ADR based solution as to how Commonwealth and state and territory regulation could together best balance pedestrian protection with any genuine need for a VFPS.

If Option 6: Mandatory standards under the Motor Vehicle Standards Act 1989 (C’th) (MVSA) were to be adopted, there would be two sub-options available to deal with the issue of VFPS. These would be A) the continued full compliance of the vehicle and VFPS or B) some form of part or full exemption from compliance of either the vehicle and/or the VFPS.

A) Continued compliance for all vehicles within the scope of the ADR when fitted with a VFPS

This sub-option would give no special treatment to a VFPS in terms of compliance to the ADR. Currently, if a vehicle were to be fitted with a VFPS, it would have to continue under state and territory legislation to meet any requirements set for VFPS by that ADR. As discussed above, although VFPS are rarely if ever certified as part of the new vehicle certification for supply to the market, there would likely be a flow on effect through state and territory legislation that would require continued compliance regardless at what point the VFPS was supplied at, the point of certification or after supply to the market and registration.

This could impose a direct cost to vehicle manufacturers - but more likely an indirect cost to aftermarket suppliers - for each VFPS model that is matched to a vehicle model. In Australia there are currently “deformable bar” VFPS available that are made from polymer materials and these are being advertised as pedestrian friendly. At around $1000 to $1500, these VFPS are a comparable cost to the more traditional steel or aluminium alloy VFPS that are sold without any claimed pedestrian safety performance. In the past, the polymer type of VFPS has excelled in experimental pedestrian protection tests in the United Kingdom (UK), in many cases providing better performance than the vehicles that they were mounted on (although at the time of the tests the vehicles themselves were not subject to any pedestrian protection requirements). It was concluded through these experimental tests that “deformable bars” such as polymer VFPS could be constructed to meet both bodywork protection and pedestrian protection at the same time (Lawrence, 2000).

More recently, there is now a full height (although not width) polymer VFPS available that has been tested to and passed a pedestrian impact VFPS standard that contains similar requirements to GTR 9, European Union (EU) Directive 2005/66/EC for frontal protection systems (as incorporated in EC 78/2009 Protection of pedestrians and other vulnerable road users). The particular VFPS, the Endura Frontal Protection System, is designed and manufactured by Concept Mouldings Limited in the UK. It is also a comparable cost to the more traditional steel or aluminium alloy equivalent VFPS in Australia and is certified in Europe for 17 makes such as Toyota, Mitsubishi and Ford, covering a range of 57 models. This suggests that the costs of testing and compliance to the directive are not prohibitive. This is also true of a number of smaller steel nudge bars that use energy absorbing mountings, being offered by a variety of manufacturers in the UK for around $500 as compliant to the EU directive. The availability of these products reflects the mandating of pedestrian safety requirements for VFPS within the EU.

The Australian Automotive Aftermarket Association (AAAA) was requested to provide costs for compliance with the EU directive for Australia. They advised that it was not possible to do so as they believed that compliance to the EU directive was not commercially viable within Australia. They did estimate research, development and tooling cost at $30m for compliance to a less stringent pedestrian impact VFPS standard Australian Standard for VFPS (bull bars) AS 4876.1 2002. Motor Vehicle Frontal Protection Systems. Part 1: Road User Protection (AAAA, 2010). Over a five year model life, this equates to $6m per year. Without an estimate for the cost for compliance of VFPS to GTR 9, the $6m per year was used as a substitute for the development costs. The AAAA also suggested that there would be an annual cost as high as $60m related to production. This may have been an overestimate, as it equates to upwards of $400 per VFPS unit. Given the comparable price of the currently compliant polymer VFPS with other Australian VFPS, it was hard to justify incorporating such an increase in unit cost into the estimates at this stage.

However, the VFPS discussed above that comply with the EU requirements may not offer the best protection for the vehicle as they are mounted close to the vehicle bodywork. While this would help towards compliance with pedestrian safety requirements, it may also compromise the protection of vehicle bodywork to some degree. To guarantee full bodywork protection from the impacts expected in rural Australia driving, the VPS would need an adequate gap between its structure and the vehicle bodywork. This would allow for deflection and energy absorption with minimal contact of the bodywork (Whiting, 2010).

Steel and aluminium alloy VFPS are very popular when compared to polymer type VFPS in Australia, with there being a perceived greater performance (accurate or otherwise) for bodywork and vehicle occupant protection from crashes and animal strikes, as well as the provision of robust strong points for the recovery of stranded vehicles. This is considered a necessity when driving exclusively in rural/outback areas (Whiting, 2010). Polymer VFPS represent only around 1-2 per cent of the market. However, the polymer type VFPS market is growing, with sales increasingly going to government fleets being used in semi-urban/rural locations. These VFPS appear to be proving themselves suitable for these conditions.

Given the preference for steel and aluminium alloy VFPS by the market, it becomes all the more important that research by the Centre for Automotive Safety Research (CASR) in Adelaide, has shown that most if not all conventionally constructed VFPS made of steel or aluminium alloy would likely be unable to meet the technical requirements of GTR 9 (CASR, 2006). In a series of tests involving commercial VFPS fitted to popular vehicles, the CASR concluded that:

"Overall, the steel bull bars tested were significantly more hazardous to a pedestrian than the front of the vehicle. This was also the case with aluminium/alloy bull bars, but to a lesser extent than the steel bull bars. The polymer bull bars of the type tested here were, in some tests, less hazardous for a pedestrian than the front of the vehicle that they are designed to protect." (CASR, 2006)

Notwithstanding the existing and potential performance of deformable polymer type VFPS, this means that adoption into the ADRs of GTR 9 or similar VFPS requirements, along with the requirement in state and territory legislation to continue to comply with the ADRs, would likely see the end of more conventional and popular steel and aluminium alloy VFPS from vehicles covered by the scope of the ADR, these being passenger cars, passenger vans, four-wheel drives or sports utility vehicles and light commercial vehicles. For example this would include vehicles such as the Toyota Camry, Holden Commodore, Ford Falcon, Ford Territory, Holden Captiva and Toyota Landcruiser. Heavier trucks would not be affected as they would not fall within the scope of the ADR in the first place.

The AAAA estimated that there are a total of 225,000 VFPS sold in Australia each year, worth around $285m (AAAA, 2010). Should these become no longer available, the lost sales would be $285m per year. The AAAA has indicated that this would have a significant impact on the business of VFPS suppliers. While this may well be the case, the value of lost sales is also an amount that the consumer would no longer be paying. Therefore, there would also be a reduction in costs to the consumer for their vehicles to the value of $285m. Because of this (and without yet considering the merits of the consumer no longer being able to fit a steel or aluminium alloy VFPS), there would be no overall loss or gain relating to the $285m. As a result this value, although undoubtedly a significant impact on VFPS suppliers, could not be factored into Benefit-Cost Analysis calculations for the purposes of this RIS.

What would constitute a loss is any benefit that a VFPS could provide in terms of minimising vehicle damage or facilitating the salvage of a vehicle (by providing a mounting point for a winch and other recovery points) that has been stranded, or for providing mounting points for additional equipment such as lamps and aerials. The AAAA estimated from a 2007 NRMA report that animal related collisions cost the NSW community alone $70m each year (AAAA, 2010). This figure, while indicative, does not translate into how much protection from crashes VFPS is able to offer. The Australian Transport Safety Bureau (ATSB) reviewed the use of VFPS in 2000 but the findings were inconclusive, mainly due to the lack of data available (ATSB, 2000). In particular, the ATSB was unable to confidently quantify the benefits in fitting a VFPS. They were able to, by comparing the fitment rate of VFPS in rural areas to the fatality involvement rate between the period between 1990 and 1997, estimate an approximate potential saving of around 9 lives (and other injuries) per year. Using the cost of a fatality from Appendix 7 - Benefit-Cost Analysis – Methodology of $4.72m, this gives a saving of approximately $42m, with an unknown additional amount attributable to preventing other injuries and to preventing stranding of vehicles as well as in providing an alternative means of mounting lamps and aerials. However, the limited amount calculated above was supported by the following statement:

"Analysis from first principles suggests that bull bars would not offer significant protection in most instances, though there may be some advantage to front seat occupants of forward control vehicles, by reducing the likelihood of intrusion into the cabin space. Animal strikes make up only 1% of crashes that result in serious injury or death. It is suggested that the number of lives saved is not a particularly large number in relation to the total road toll." (ATSB, 2000)

To extend the argument further, it has been proposed in some of the literature and by some researchers and other sectors of the community that not fitting VFPS to vehicles could lead to a reduction in pedestrian trauma. This would be because the addition of a typical steel or aluminium alloy VFPS almost always results in a more rigid structure than the underlying front end of the vehicle being presented during a crash. In addition, a poorly designed VFPS may concentrate forces at protruding or sharp regions of its structure. The debate on this issue is yet to be settled. The ATSB also found that the results were inconclusive regarding this, again mainly due to the lack of data available. As noted above, recent polymer VFPS have been shown to in some cases improve the performance of the underlying structure.

The report did note that:

"...the descriptive analysis confirms that pedestrians and the occupants of side impacted vehicles are the groups most at risk. There were approximately 30 pedestrians, 10 bicyclists and motor cyclists and 50 occupants of side impacted vehicles that were fatally injured in impacts with bull bars in 1997." (ATSB, 2000)

Although caution should be taken with this statement, *as it was not claiming that VFPS led to these injuries being sustained*, for the purposes of determining the range of possible scenarios in terms of pedestrian safety requirements for vehicles it may be estimated that VFPS could cause somewhere between zero and ninety (30+10+50) fatalities per year. Using the cost of a fatality as discussed above of $4.72m, this gives a saving of somewhere between zero and $425m in reduced road trauma by not having VFPS fitted to a vehicle.

In summary, if the GTR 9 requirements were mandated in full for vehicles, regardless of whether they were fitted with a VFPS, the VFPS manufacturers' response would range from performing design and testing to maintain compliance of the vehicle, estimated at a cost of $6m or more per year (depending on the final determined cost of compliance); to VFPS no longer being fitted to vehicles, with a value of somewhere between a cost of $42m to a benefit of $383m (425 – 42) per year, although these latter figures were highly speculative. It would also be likely that there would be an increase in the fitting of polymer type VFPS over steel and aluminium alloy VFPS.

Given that some of these figures were highly speculative, it is important to state that they were not intended to be used to argue the merits or otherwise of fitting VFPS to a vehicle. They were only used to explore how this sub-option would affect the case for mandating compliance of the vehicle itself with GTR 9 Pedestrian Safety.

B) Partial or full exemption from the ADR where a vehicle has a VFPS fitted

This sub-option would give special treatment to a VFPS in terms of compliance to the ADR. If a vehicle were to be fitted with a VFPS, it could be specified that only the vehicle would have to comply, that is, the addition of a VFPS would not require re-testing of the vehicle. Alternatively, it could be specified that neither the vehicle nor the VFPS need comply.

A full exemption of both the vehicle and the VFPS was rejected immediately. Such an exemption would result in a vehicle that continued not to comply even if the owner subsequently removed the VFPS. Of even more concern, it would also be an arrangement that could permit a vehicle manufacturer to fit a VFPS should it be difficult to get a particular vehicle design to comply, or to avoid designing for pedestrian safety in the first place.

A more effective arrangement would be a partial or complete exemption in terms of both the vehicle category affected and the technical requirements necessary for compliance. As a worst case, and for the purposes of determining all possible outcomes of the analysis, a VFPS that was fitted to a vehicle within the scope of the ADR could be completely exempted from pedestrian safety requirements – in other words, there would be no requirement to retest the vehicle with the VFPS fitted. In this scenario, the gross benefits from compliance of the vehicle to GTR 9 that were calculated earlier for the reduction of road trauma would have to be reduced by the proportion of vehicles fitted with a VFPS. The fitment rates of VFPS to different vehicle categories are shown in Table 24.

Table 24 VFPS fitment rate for different vehicle categories

Vehicle Category	Number of VFPS per year*	Number of new vehicles per year**	Fitment rate (%)
Passenger	8,372	540,562	1.5
LCV	117,589	181,058	64.9
SUV	99,090	188,153	52.7
Total	225, 051	909,773	24.7

* Taken from (AAAA, 2010)
** Taken from Table 4

According to the source of the table, the number of VFPS being fitted to vehicles was split almost equally between dealer fitted and aftermarket fitted, with virtually no VFPS being fitted as part of the certification arrangements for new vehicles under the ADRs. Regardless of at what point in a vehicle's life a VFPS was fitted, it was reasonable (and conservative, as aftermarket VFPS would be fitted later in the life of the vehicle, therefore preserving the initial pedestrian safety performance of the vehicle for a longer period) for the calculated fitment rate to be used against the new vehicle fleet.

Discussion of the Sub-options

The effects of *Sub-option A: Continued compliance for all vehicles within the scope of the ADR when fitted with a VFPS* and *Sub-option B: Partial or full exemption from the ADR where a vehicle has a VFPS fitted* on the net benefits from Option 6: Mandatory standards under the MVSA are shown in Tables 22 and 23 respectively.

Table 25 Net benefits and Benefit-Cost Ratio - VFPS required to maintain compliance (Sub-option A – net benefits not adjusted for VFPS costs, see text for discussion)

	Net Benefit	Cost to Business	Cost to Government	Benefit Cost Ratio	Number of Lives Saved
Best Case	$247,648,869	$98,748,747	$506,333	3.5	
Likely Case	$184,685,694	$161,711,922	$506,333	2.5	65
Worst Case	$121,722,519	$224,675,097	$506,333	1.5	

Table 26 Net benefits and Benefit-Cost Ratio - VFPS fully exempted from compliance (Sub-option B)

	Net Benefit	Cost to Business	Cost to Government	Benefit Cost Ratio	Number of Lives Saved
Best Case	$161,963,594	$98,748,747	$506,333	2.6	
Likely Case	$99,000,419	$161,711,922	$506,333	1.9	49
Worst Case	$36,037,244	$224,675,097	$506,333	1.2	

Regarding Sub-option A, the research and development costs were estimated earlier at $6m. For the unadjusted case, the net benefits as shown in Table 25 for the Likely Case were $185m. Distributing these net benefits over the fifteen years that VFPS would need to comply with pedestrian safety requirements gives a net benefit of $12.3m per year. Therefore, the benefits would be able to absorb these additional costs for fitting VFPS, giving a net benefit of $6.3m per year.

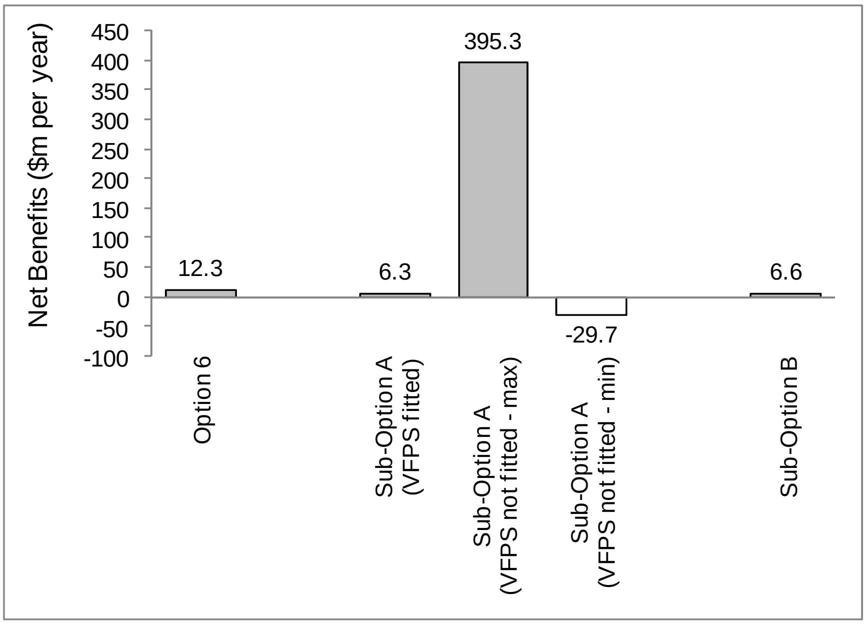
The further cost estimate of as high as $400 per VFPS unit proposed by the AAAA would not be able to be absorbed. However, as discussed previously, this cost was difficult to justify when compared to non steel or aluminium alloy VFPS currently available, which were already certified to European Union Directive 2005/66/EC for frontal protection systems. Further comment by the industry is sought during the public consultation process. There would be up to an additional $6.3m in benefits available to cover any increase in VFPS unit costs. This would allow for about $28 per unit, but would ultimately be undesirable in terms of the reduction in available benefits to the community.

For the case within Sub-option A where the costs for designing and testing a complying VFPS became commercially unviable, the resulting effect of not being able to fit a VFPS would range from a possible cost of $42m per year due to the VFPS not being able to carry out its intended function, to a possible (but highly speculative) benefit of $383m per year where it is assumed that all fatalities involving the presence of a VFPS could be avoided. Again taking the net benefits as shown in Table 25 of $185m over a fifteen year period (which equates to $12.3m per year) and adding the values from Sub-option A above, there would result a net benefit of somewhere between $395.3m and minus $29.7m per year.

To determine the effect of Sub-option B, the gross benefits from Option 6: Mandatory standards under the MVSA were reduced by the fitment rate of VFPS given in Table 24 (i.e. 24.7 per cent). This resulted in the reduced net benefits shown in Table 26 for the Likely Case of $99m over the assumed 15 year life of regulation, which equates to $6.6m per annum.

The potential effects that Sub-Option A and Sub-Option B could have on the previously calculated net benefits for Option 6 are shown in the figure below:

Figure 12 The Net Benefits remaining under Option 6, Sub-options A and B. (Note: The maximum benefits for Sub-option A are highly speculative).



The results generally show that the net benefits would for the most part still be positive and the Benefit-Cost Ratio would still be above 1, regardless of whether compliance of VFPS were not to be required (Sub-option B) or if full compliance was required (Sub-option A). However, under Sub-option A, this depends on the VFPS industry being able to provide a compliant product, with the $6.3m per year value for this option representing the overseas product being acceptable to the market in Australia and the only negative value representing the advice to date that compliance with a proposed ADR as it stands would not be possible, along with an assumption that the only effect of the market being unable to fit a VFPS would be a loss of benefits to the vehicle owner through animal strikes etc.

On balance, this demonstrated that the case for Option 6: Mandatory standards under the Motor Vehicle Standards Act 1989 (C'th) (MVSA) could still be justified, regardless of the sub-option chosen, provided the effect on aftermarket VFPS were managed appropriately through Commonwealth and state and territory legislation (or other mechanisms). In addition, as the issue of VFPS would affect each original option in a similar manner, Option 6 would remain the preferred option.

This outcome then allowed sub-options A and B to be dealt with as a separate consideration to the case for intervention for pedestrian safety. However, as the costs and benefits of Sub-option A were the more speculative and included the potential for a negative Net Benefit, Sub-option B was the more feasible of the two.

The finding that sub-options A and B could be dealt with separately was important, as these sub-options related primarily to VFPS being fitted as aftermarket items and regulation of the aftermarket falls under the scope of state and territory legislation. The Department has already sought views both informally and formally through the established ADR consultative forums, from the state and territory transport authorities regarding pedestrian protection and again separately regarding VFPS. Any comments have been considered when writing this Regulation Impact Statement (RIS). However, little was received at this stage and so it is expected that a majority of the information and views will follow during the public comment period.

Additional Initiatives

Although the case for Option 6 was demonstrated regardless of whether sub-option A or B were chosen, the benefits could be increased if VFPS was only fitted to vehicles where necessary. The AAAA have expressed their support for consumer education campaigns that address road safety and the implications of fitting VFPS, and indicated that they would be willing to collaborate with states and territories on such a campaign (AAAA, 2009). The campaign would not simply be about reducing the fitment of VFPS, but would be about providing information to consumers to help them balance the genuine need for VFPS for vehicle/vehicle occupant protection and the genuine need for vehicles to provide better pedestrian protection, particularly when used primarily in an urban environment.

As the majority of VFPS are fitted in the aftermarket, state and territory authorities are asked to comment during the public comment period on the continuation of any existing programs or the implementation of new programs, possibly in conjunction with the AAAA. This information was requested during the preparation of this RIS, but had yet to be provided at the time of writing. However, Western Australia and Victoria informally advised that they have worked with industry and vehicle owners in the past on encouraging VFPS that are more pedestrian friendly, including owners making an informed choice regarding urban versus rural use. Some of this work is discussed later.

Required level of compliance under sub-option B: Partial or full exemption from the ADR where a vehicle has a VFPS fitted

Only Sub-option B allowed any exemptions to compliance with an ADR for pedestrian safety. There were two issues to be considered for this. The first was whether an exemption should be granted based on vehicle type (i.e. passenger, commercial vehicle etc). The second was whether the requirements should be simply exempted or whether alternative technical requirements should be specified.

In Section 6.6 it was noted that there is an ADR that indirectly relates to the installation of extra equipment such as a VFPS. ADR 42/04 General Safety Requirements specifies design and construction requirements such that a) any additional “objects or fittings” must be technically essential and b) the risk of injury in having them must be reduced as much as possible in still allowing the objects to fulfil their function.

<u>VFPS that is technically essential</u>

The ATSB have reported on the typical reasons given for fitting a VFPS (ATSB, 2000). The primary reasons were:

- to ensure vehicle mobility after a collision with an animal; and
- for mounting winches, driving lights and radio aerials.

These reasons were supported by the AAAA in their 2009 position paper (AAAA, 2009) in stating that:

"Each year in Australia many thousands of collisions occur between motor vehicles and animals, resulting in considerable vehicle repair costs, injury to persons, and loss of animal life".

and in separate correspondence with the Department of Infrastructure, Transport, Regional Development and Local Government (AAAA, 2010);

"In addition the bull bar [VFPS] plays a vital role in the recovery of stranded vehicles in remote areas".

While it was clear that these are technically essential reasons for fitting a VFPS to a vehicle being used in a rural or semi-rural environment, the argument is much less compelling for VFPS being fitted to a vehicle being used exclusively in an urban environment. The ATSB also reported on the primary reasons given for fitting a VFPS to passenger cars by taxi drivers. These were:

- to protect against parking collisions,
- to make the vehicle more visually attractive; and
- to allow more aggressive driving in peak hours.

These responses represented the other end of the spectrum of reasons for fitting a VFPS, particularly in an urban environment – the technically non-essential ones.

VFPS serves three genuine purposes, protection against animal strikes, mounting of winches for recovery of stranded vehicles and providing mounting points for additional equipment such as lights and aerials. Whether these are technically essential reasons depends mostly on where the vehicle is being used. In an urban environment, they are less essential; in a rural environment they are more essential. However, the use of a vehicle is something that a vehicle standard such as an ADR cannot control. An ADR can only mandate requirements to apply to all vehicles, no matter where they are used in Australia.

In the normal course of events, where a vehicle may be used could only be determined by state and territory transport authorities and (for the majority of vehicles) only as far as the place of residence of the registered owner. These authorities could consider whether it is feasible to place controls on the equipment that can be fitted to vehicles, based on place of registration or use (urban or rural). The Victorian Government had previously investigated such as scheme regarding VFPS but found it impractical to implement and instead turned to information campaigns as well as pursuing further development of the current Australian Standard (see below). Assuming this to be the case, an alternative to this type of scheme could utilise vehicle design through the ADRs as a proxy to determine the likely intended use.

Design could be considered in terms of whether a vehicle has been designed for off-road operation and hence primarily rural use. For these types of vehicles, a VFPS would be expected to be as strong as possible in order to provide greater protection from animal strikes, as well as recovery of the vehicle should it become stranded. Steel and aluminium alloy are currently preferred for this purpose. This could be achieved by allowing vehicles designed for off-road use and fitted type with a VFPS to access some adjustments in terms of meeting pedestrian performance requirements. In particular, the use of the stronger and so currently more popular, but less pedestrian friendly, steel or aluminium alloy VFPS could be limited to vehicles designed for off-road use only, with other vehicles required to meet more stringent requirements, most likely achieved by owners fitting a deformable polymer VFPS or a nudge bar.

Western Australia has also worked with the VFPS community on reducing the aggressive nature of some VFPS and has had some success. In looking at the design of the vehicle and its intended use, they published recommendations (but do not mandate) that would be in line with the above; that is, for "City Vehicles" that a "nudge bar" is preferred, whereas for "Country Vehicles";

"Vehicles that travel extensively on country roads may need a higher level of protection against a collision with an animal such as a kangaroo or an emu. In this case the more traditional bull bar design may be desirable" (Western Australian Department of Transport, 2005).

Although this advice does not explicitly differentiate between the technical requirements between urban (city) and rural (country) vehicles, it would be similar in intent to a pedestrian safety ADR being applied in full to MA, MB and on-road designed NA category vehicles (passenger cars, passenger vans as well as light commercial vehicles that are not four-wheel drive), with reduced requirements for MC and off-road designed NA category vehicles (four-wheel drive or sports utility vehicles as well as four-wheel drive light commercial vehicles).

<u>Risk of injury to be reduced as much as possible</u>

Although GTR 9 and the corresponding draft UNECE regulation do not contain any reference to VFPS, there are practical alternative design and testing requirements available to reduce the risk of injury to pedestrians when a VFPS has been fitted. These would be, in order of increasing stringency:

- Australian Standard for VFPS (bull bars) AS 4876.1 2002. Motor Vehicle Frontal Protection Systems. Part 1: Road User Protection, Sections 1, 2 and 3.1.
- Australian Standard for VFPS (bull bars) AS 4876.1 2002. Motor Vehicle Frontal Protection Systems. Part 1: Road User Protection, Sections 1, 2, 3.1 and 3.2.
- European Union Directive 2005/66/EC for frontal protection systems (as incorporated in EC 78/2009 Protection of pedestrians and other vulnerable road users).

An overview of these standards is given in Annex 1 - Overview of Vehicle Front Protection System Standards . The first listed standard is the only one that does not require testing for pedestrian impact, relying instead on installation and geometry design to minimise injury. The second listed standard is the same as the first standard but includes an additional requirement for pedestrian impact testing. The third listed standard has been adopted by the European Union (EU) for VFPS and pedestrian safety performance and has particular requirements for configuration as well as performance of VFPS. This standard would be the closest to fully meeting the GTR.

<u>Combining essential VFPS and reduced risk of injury</u>

It was argued earlier that on balance, the case for Option 6: Mandatory standards under the Motor Vehicle Standards Act 1989 (C'th) (MVSA) could still be justified, regardless of the sub-option chosen, but provided the supply of VFPS were managed appropriately through the legislation (or by other means). In addition, as the costs and benefits of Sub-option A were the more speculative, Sub-option B (which involved exempting selected VFPS from the requirements) was the more feasible of the two.

Table 27 was produced to combine the different categories of compliance for VFPS. It shows the graded requirements that are proposed for pedestrian protection, by vehicle type and by level of technical performance. The requirements move towards increasing stringency for those vehicle types that are more likely to be used in a purely urban environment. Such vehicles would have less need for the protection offered by VFPS and would be more likely to benefit the community from greater pedestrian safety performance. Passenger cars, vans and two-wheel drive light commercial vehicles would have to meet EU Directive 2005/66/EC, which is similar to GTR 9 (Table entry (iv)). Four-wheel drive off-road passenger or light commercial vehicles would have to meet part or all of AS 4876.1 (Table entry (iii)). The part standard (Table entry (ii)) would not require pedestrian impact tests to be carried out, but would require the VFPS to meet installation and geometry requirements that minimise injury. The part standard could be an alternative to (iii). It is what is currently required to be met for VFPS by at least one state of Australia.

Table 27 Proposed pedestrian safety performance options for VFPS by vehicle type - subject to consultation (Note: this does not represent compliance options for the vehicle itself)

Pedestrian Safety Requirements for VFPS	**MA, MB (passenger cars/vans)**	**NA (2WD light commercial)**	**MC (4WD /SUV)**	**NA (4WD light commercial)**
(i) No requirements	N/A	N/A	N/A	N/A
(ii) AS 4876.1 2002 Sections 1, 2 and 3.1	N/A	N/A	N/A*/ Must Comply	N/A*/ Must Comply
(iii) AS 4876.1 2002 Sections 1, 2, 3.1 and 3.2.	N/A	N/A	Must Comply*/ May Comply	Must Comply*/ May Comply
(iv) EU Directive 2005/66/EC	Must Comply	Must Comply	May Comply	May Comply

*Preferred position.

In terms of current fitment rates (shown in Table 28), very few VFPS are fitted to passenger cars (MA category), with the majority being fitted to off-road designed vehicles. Therefore, there should not be an issue with requiring passenger cars to meet the more stringent pedestrian safety requirements of EU Directive 2005/66/EC. The composition of NA category regarding VFPS (two-wheel drive or four-wheel drive) was not known at this stage.

Table 28 Current fitment rates of VFPS by vehicle type

Vehicle Type (ADR category)	**Per cent fitment rate (as a proportion of all VFPS fitted)**
Passenger (MA, MB)	3.7
Sports Utility Vehicles (MC)	44
Light Commercial (NA)	52.3
Total	100

Source: AAAA, 2010

The alternatives of Table entry (ii) or (iii) should be commented on. Previous research found that most if not all conventionally constructed VFPS made of steel or aluminium alloy would likely be unable to meet the technical requirements of GTR 9 (see page 111) and so it could be expected that they would also have difficulty in meeting the pedestrian impact requirements of AS 4876.1. However, the Preface of the Standard indicates that this should not be the case when it states:

"Child head impact criteria have been included incorporating values that are considered achievable" (Standards Australia, 2002).

The opposite criticism - that the requirements may not be stringent enough – could be argued as the required Head Injury Criteria (HIC) is limited to 1500, whereas 1000 is generally accepted as the maximum acceptable level for head trauma. In addition, the Standard does not incorporate any lower body tests. However, it should be noted that GTR 9 allows for some rigid areas of the base vehicle to test to a HIC of 1700 (although this test is performed at a slightly higher velocity). Notwithstanding this, it is appreciated that the Standard remains a compromise of achievable pedestrian protection within the current capability of the VFPS industry and reflects the makeup of the committee that developed the Standard. A cross section of peak bodies was used, representing owners, pedestrians, academia, industry and government. This included the Australian Automobile Association, the Pedestrian Council of Australia, the University of Melbourne and University of Adelaide, the Federal Chamber of Automotive Industries, the Australian Automotive Aftermarket Association, the Society of Automotive Engineers and the Australian Motor Vehicle Certification Board.

The recommended lead time for compliance to the pedestrian impact part of AS 4876.1 may be deduced from the text of the Standard as being a three year period (2002-2005). There would be a similar period if incorporated into an ADR for pedestrian safety (currently proposed to be in line with the phased UNECE timing of 2013 to 2019) and would have the positive effect of aligning compliance of the VFPS to compliance of the base vehicle. Aligning VFPS and base vehicle compliance would be a reasonable step, given that the intent of incorporating VFPS requirements into an ADR would be simply in order to maintain the pedestrian safety performance of the base vehicle, rather than set requirements for VFPS alone.

Therefore, it is recommended that this alternative (Table entry (iii) Comply with AS 4876.1 2002 Sections 1, 2, 3.1 and 3.2.) be applied to the selected vehicle types shown in Table 27. Comment is sought during the public consultation process on Table 27 and where the best balance of vehicle and occupant protection and pedestrian performance should be set.

In 2008, the National Transport Commission (NTC) proposed amendments to the Australian Vehicle Standards Rules (AVSRs), which are template rules for the states and territories to adopt into local in-service legislation. The amendments included adopting Sections 1, 2 and 3.1 of AS 4876 for VFPS for vehicles from 2010 onwards. All states and territories rejected the amendment although some, such as NSW, incorporated Sections 1 and 2 into its legislation. At the time, the reasons for rejection by a majority of road authorities centred on there being insufficient justification for excluding the testing requirements of Section 3.2. However, the Northern Territory (NT) rejected the amendments due instead to the difficulty in justifying such a requirement, given the extensive use of VFPS and the lack of pedestrian traffic in that region of Australia. This latter reason can be seen in the pedestrian fatality statistics which show that the proportion of fatalities in the NT is limited to 4.7 per cent of those nationally. However, in terms of the pedestrian fatality rate per head of population, NT is amongst the highest in Australia.

From an industry point of view, it was argued at the time that there was no comparable pedestrian performance requirements in the ADRs for the vehicle itself and so additional performance should not be expected from a VFPS. Refer to Annex 2 - Excerpt from the Australian Vehicle Standards Rules Amendment Package 2009 Regulatory Impact Statement for individual comments.

Although VFPS are primarily an aftermarket item and therefore fall under state and territory control, this difference in views, particularly of the states and territories, would make it difficult to mandate a national standard such as an ADR without first resolving these issues. The views expressed during the vote for the amendments to the AVSRs may change in light of there being a proposed ADR for pedestrian protection. It should be restated that these requirements would affect VFPS fitted to new vehicles only and so not involve retrofitting of older vehicles.

The proposed graduated application of requirements as shown in Table 27 may be the best way of achieving this. It would limit vehicles that are designed more for an urban environment to VFPS that are also pedestrian friendly. These products would likely draw on deformable bar technology such as the polymer bull bars, or alternatively fully complying steel “nudge bars”. This would leave the vehicles that are designed more for a rural environment to meet reduced requirements and hence continue using the favoured steel or aluminium alloy bull bars. As an additional measure and as mentioned earlier, a supplemental information campaign, perhaps in conjunction with the AAAA, could educate vehicle owners in the goal of pedestrian protection and so urge them to consider using a more pedestrian friendly VFPS where an off-road vehicle is being used primarily in an urban environment.

Annex 1 - Overview of Vehicle Front Protection System Standards

AS 4876.1 2002 - Motor vehicle frontal protection systems - Part 1: Road user protection

Australian Standard 4876.1 was created on 17 September 2002 with the objective of providing manufacturers with performance requirements for Vehicle Front Protection Systems (VFPS) and addressing issues such as:

(a) applicable Australian Design Rules requirements;

(b) road user protection requirements;

(c) test methods; and

(d) marking and packaging.

It was subsequently partly adopted by some Australian state and territory transport regulators as part of their in-service requirements.

Australian Standard 4876.1 specifies geometric design requirements and pedestrian impact performance requirements for vehicle front protection systems (VFPS). The geometric design provisions require the design of VFPS to conform to the profile of the front of the vehicle to which it is attached. They also prohibit designs featuring exposed sharp edges that are likely to increase injury severity to unprotected road users.

The pedestrian impact performance requirements, contained in Section 3.2 of the standard, outline the procedure for an impact test between a child headform and the VFPS. All parts of the VFPS that are more than 1m above the road surface must be tested according to either a horizontal test or a vertical drop test. Both tests are performed at an impact speed of 30 km/h using a 2.5 kg test impactor. The Head Injury Criterion (HIC) must not exceed 1,500. This value was considered achievable by the committee that developed the standard. The committee comprised a number of peak bodies representing owners, pedestrians, academia, industry and government.

European Union Directive 2005/66/EC - Frontal protection systems

European Union Directive 2005/66/EC was introduced on 26 October 2005 with the aim of reducing the number of injuries to pedestrians and other road users caused by VFPS. The Directive required that, as of 25 May 2007, all new types of VFPS sold in Europe meet a specified level of performance in pedestrian impact tests.

Directive 2005/66/EC was subsequently combined with Directive 2003/102/EC, relating to the protection of pedestrians and other vulnerable road users in a collision with a vehicle, to form regulation EC 78/2009. Regulation EC 78/2009 requires VFPS to be tested using a lower legform, upper legform and a child headform. An adult headform test is not required. The limits placed on injury criteria are aligned with those in GTR 9 on pedestrian safety. It also contains provisions relating to the geometry and mass of the VFPS, as well as its positioning on the vehicle.

Annex 2 - Excerpt from the Australian Vehicle Standards Rules Amendment Package 2009 Regulatory Impact Statement

14.9 Withdrawn amendments

The following proposed amendments were included in the previous version of the regulatory impact statement that was circulated for public comment. They have been withdrawn from the current package of amendments to allow further consideration of the Maintenance Group.

14.9.1 Protrusions – Rule 30

<u>David Bowd:</u>

- A substantial amount of technical evidence was submitted, in support of the view that the regulatory impact statement had underestimated the contribution to road trauma of bull bars fitted to vehicles. The financial cost of such trauma in Australia was estimated to be $2 billion per annum.
- It was stated that the proposal would produce an inferior outcome, particularly in comparison to corresponding requirements of the European Union.
- That the proposed requirements were subjective rather than performance based and therefore, not supported.

<u>People for Ecologically Sustainable Transport (Alan Parker):</u>

- A substantial amount of technical evidence was presented in support of more stringent pedestrian protection requirements being imposed on the design of bull bars, than those proposed.

<u>Westgate Community Road Safety Council and Hobsons Bay City Council (Mike Hull):</u>

- It was proposed to regulate the fitting of bull bars on the basis of an individually demonstrated need for a given vehicle to be protected against the risk of animal strike.

<u>University of Adelaide (Centre for Automotive Safety Research):</u>

- The submission provided substantial evidence, highlighting concerns that the proposal was inadequate in achieving its objective of reducing the risk posed by bull bars to pedestrians.
- It was proposed to include a requirement for bull bars to provide a minimum level of impact protection for vulnerable road users. Furthermore, it highlighted international regulations applying to vehicles fitted with bull bars, arguing that the proposal fell short of those.

<u>Northern Territory (Department of Planning and Infrastructure):</u>

- The submission outlined the Northern Territory’s needs in relation to the fitting of bull bars, in order to reduce damage to vehicles as a result of animal collisions. Furthermore, the lack of pedestrian traffic, small population size and the use of bull bars in rural and remote settings were cited as factors that would make it difficult to agree to mandate compliance with the proposed rule.

South Australia (Department for Transport, Energy and Infrastructure):

- It was considered that the regulatory impact statement had provided inadequate justification for excluding clause 3.2 (the road user protection criterion) of Australian Standard AS 4876.1 from the proposed rule. Part of that justification, the cost of compliance for industry, was considered to be of a lower magnitude than the safety benefit resulting from its inclusion.
- It was pointed out that the original recommendation of the Australian Standard AS 4876.1 drafting committee to exclude clause 3.2 was not intended to be indefinite. In fact, the committee recommended that the clause apply to new model motor vehicles built from 1 January 2005 onwards.
- Doubt was also expressed on the continued compliance of bull bar-equipped vehicles with occupant protection requirements of the Australian Design Rules. With such compliance an explicit requirement of Australian Standard AS 4876.1, the high rate of compliance with Australian Standard AS 4876.1 estimated in the regulatory impact statement was questioned.

Western Australia (Department for Planning and Infrastructure):

- The submission outlined the regulatory environment in Western Australia in relation to vehicles fitted with bull bars. It stated that nationally uniform standards for bull bar design would be beneficial in reducing the level of road trauma, as well as the cost of compliance and enforcement.
- The proposed arrangement for applying the rule to new vehicles built from 2010 and fitted with bull bars was supported, so as to guard against unintended consequences for industry. The exclusion of clause 3.2 (the road user protection criterion) of Australian Standard AS 4876.1 from the proposed rule was not supported by the Western Australian Office of Road Safety, however the Western Australian Department for Planning and Infrastructure doubted whether it could be justified by a regulatory impact statement.

Victoria (VicRoads):

- The proposal to exclude clause 3.2 (the road user protection criterion) of Australian Standard AS 4876.1 was not supported. It stated that while some improvements by industry to the design of bull bars had been made, the inclusion of clause 3.2 was considered to be an important element to increasing pedestrian protection levels.
- The submission outlined international standards for pedestrian protection imposing more stringent requirements than Australian Standard AS 4876.1. Accordingly, VicRoads had recently approached members of the Australian Standard AS 4876.1 committee, seeking their agreement to strengthen the standard.

New South Wales (Roads and Traffic Authority):

- The submission highlighted the “overwhelming evidence that adding bull bars to the front of vehicles increases the risk to other road users”.
- It further stated that the proposal had not adequately accounted for the stated objective of the Rules for promoting the safe use of vehicles. In particular, it was stated that the regulatory impact statement had not justified excluding clause 3.2 (the road user protection criterion) of Australian Standard AS 4876.1 from the proposed amendment.

- It was also stated that the amendment should apply to all bull bars built from the proposed application date (2010 onwards), rather than as proposed, for bull bars fitted to vehicles built after that date.

Queensland (Queensland Transport):

- It was suggested that the proposed definition of a bull bar (or vehicle frontal protection system) be amended to reflect their purpose of reducing damage to the vehicle structure.
- It was recommended that the proposal require that applicable bull bars be permanently marked so as to indicate their compliance with the proposed rule.
- Noting that the Australian Standard AS 4876.1 drafting committee had originally recommended 2005 as an implementation date for clause 3.2 (the road user protection criterion) of Australian Standard AS 4876.1, it was requested that the proposal now set a date for its inclusion as a requirement of the Rules.
- Concern was expressed for the proposal to apply only to bull bars fitted to vehicles built after 1 January 2010, but not to bull bars built after that date and fitted to older vehicles.

Canberra Pedestrian Forum:

- It was proposed that the regulatory impact statement be redrafted, in order to consider the benefits of requiring full compliance with Australian Standard AS 4876.1.

Metropolitan Transport Forum:

- The introduction of new design standards to address the risks posed by bull bars to unprotected road users was supported.

NTC Response:

Taking into account the range of views and comments submitted on the proposal, it has been withdrawn from the regulatory impact statement and current package of amendments.

APPENDIX 12 - 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 Federation
Consumer Representatives
Australian Automobile Association
Australian Trucking Association
Australian Motorcycle Council
Government Representatives
Department of Infrastructure and Transport, Australian Government
Department of Transport, Energy and Infrastructure, South Australia
Queensland Transport
Roads and Traffic Authority, New South Wales
VicRoads, Victoria
Department of Planning and Infrastructure, Western Australia
Office of Transport, Australian Capital Territory
Department of Infrastructure, Energy and Resources, Tasmania
Department of Planning and Infrastructure, Northern Territory
Land Transport Safety Authority of New Zealand
Inter Governmental Agency
National Transport Commission

APPENDIX 13 - ACRONYMS

AAAA	Australian Automotive Aftermarket Association
ABS	Australian Bureau of Statistics
ADR	Australian Design Rule
ANCAP	Australasian New Car Assessment Program
ATC	Australian Transport Council
AVSRs	Australian Vehicle Standards Rules
BTE	Bureau of Transport Economics
COAG	Council of Australian Governments
DITRDLG	Department of Infrastructure, Transport, Regional Development and Local Government
ECE	Economic Commission for Europe
EU	European Union
EuroNCAP	European New Car Assessment Programme
FAPM	Federation of Automotive Product Manufacturers
FCAI	Federal Chamber of Automotive Industries
GTR	Global Technical Regulation
LCV	Light Commercial Vehicle
MVSA	Motor Vehicle Standards Act 1989
NTC	National Transport Commission
RIS	Regulation Impact Statement
SUV	Sports Utility Vehicle, Four-wheel-drive, 4WD,
TACE	Transport Agencies Chief Executives
TPA	Trade Practices Act 1974
TRL	Transport Research Laboratory
UN	United Nations
VFPS	Vehicle Front Protection Systems
WTO	World Trade Organisation