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Analysis of the likely benefits to Australia of the fitment of electronic stability control (ESC) in light commercial vehicles

Dr Michael Fitzharris
Mr James Scully
Dr Stuart Newstead

Accident Research Centre
Monash University

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ABSTRACT

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Analysis of the likely benefits to Australia of the fitment of electronic stability control (ESC) in light commercial vehicles

Author(s)
Fitzharris, Michael; Scully, James; Newstead, Stuart.

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Accident Research Centre, Monash University

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Abstract

The safety benefits of electronic stability control (ESC) have been demonstrated in a relatively large number of studies conducted over a short time-span. These benefit studies have however focussed on the effectiveness of ESC in passenger cars and more recently 4WD vehicles. There is limited research as to the effectiveness of ESC in the light commercial vehicle range. This project aimed to determine the benefits, if any, of ESC fitment into light commercial vehicles for Australia for the period 2010 to 2039. The estimation of the effectiveness of ESC for light commercial vehicles was undertaken on the basis of two parameters: 1. ABS population projections used to estimate future vehicle sales, known as Projection Series A, B and C, and 2. ESC crash-injury reduction effectiveness. This determination entailed the estimation of the future number of light commercial vehicles sold, the future number of registered vehicles and the future number of crashes involving these vehicles. Using high future population growth (Series A) under a business-as-usual scenario – where it was assumed ESC would be fitted to all commercial vehicles by 2020 and hence nearly all registered vehicles in 2039 would have ESC fitted, the number of fatalities saved was 700 (range: 350 to 984) across the entire period, while it was estimated there would be 6934 fewer drivers seriously injured (range: 3467 to 9750). Large estimated savings with respect to minor injury crashes and property damage only crashes were also found. In financial terms, the savings to the community was estimated to be $A3.1 billion (range: $A1.575 billion to $A4.429 billion), depending on the ESC effectiveness value used. Additional benefits can be made by a more rapid installation of ESC into the light commercial fleet while the converse is also the case. BCR values using a $A450 fitment cost were positive across the effectiveness range, with little difference between future population projection series. These estimates were made with the best available evidence at the time of calculation however a range of assumptions were made. The information presented here provides only one of a number of inputs required for the determination of the mandatory fitment of ESC into Class NA vehicles in Australia.

Keywords: Crash, Electronic Stability Control, Light Commercial Vehicle, Benefits, Cost

CONTENTS

EXECUTIVE SUMMARY

On the 11th June 2009, Australian Design Rules (ADR) 31 and 35 were amended to mandate the fitment of Electronic Stability Control (ESC) to new passenger cars, passenger vans and passenger four-wheel drive vehicles. These changes were to apply from November 2011 for newly approved models and from November 2013 for existing models. These vehicles fall within the ADR categories Class MA, MB, and MC.

The amendments to ADR 31 and ADR 35 do not however apply to light commercial vehicles which are defined as Class NA vehicles under the ADR system. In determining whether further amendment to existing ADR's, or whether the creation of a new ADR is required, the Commonwealth of Australia Department of Infrastructure, Transport, Regional Development and Local Government (DITRDLG) commissioned the Monash University Accident Research Centre to undertake a study to estimate the likely benefits of mandating ESC for light commercial vehicles.

PROJECT SPECIFICATION

The present project provides the basis for determining the case as to the mandatory fitment of ESC into vehicles falling in the ADR Class NA category. A number of key tasks were undertaken, these being: the determination of the current and future vehicle market in Australia as well as current and future fitment rates of ESC; reviewing the effectiveness of ESC from international studies and supplementing this with an analysis of ESC effectiveness specific to the Australian context, and finally, determining under a business-as-usual model scenario the likely benefits of ESC for the Australian community.

CALULATED BENEFIT OUTCOMES

A series of successive analytical steps were required to arrive at the final estimates of the benefit of ESC fitted to light commercial vehicles, and in particular for Class NA vehicles.

Broadly, the estimation of the effectiveness of ESC for light commercial vehicles was undertaken on the basis of two parameters: 1. ABS population projections were used to estimate future vehicle sales, known as Projection Series A, B and C, and 2. ESC crash-injury reduction effectiveness.

Series A population projections assume higher fertility rates, longer life expectancy and higher migration compared to Series B which are in turn higher than the Series C population estimates. The effect on vehicle sales – and hence projections in crash numbers follows the same pattern.

Due to the limitations in the estimation of ESC effectiveness using real-world Australian crash data, a point estimate reduction benefit of 32% was used with a sensitivity analysis conducted using 16% and 45% as the lower and upper bounds of ESC effectiveness.

Given the volume of analysis and the finding that BCR values for each ESC effectiveness value *within* each projection series (A, B, or C) were similar, we present a summary table of the final benefit estimates with respect to driver injury reductions as well as financial savings for Projection Series A only (Table E.1). However it is important to realise that the actual number of lives saved, serious and minor injuries avoided, and fewer property-damage only crash avoided is less for the Series B and the Series C Projection Series.

Benefits associated with achieving an ESC fitment rate under business-as-usual scenario for crashes in the period 2010-2039.

Table E.1 presents the estimated savings – and fitment costs, for the three ESC effectiveness values of 32% as the point estimate and the lower and upper effectiveness values of 16% and 45% for the Series A Projection Series.

Using the ESC effectiveness point estimate value of 32%, it was estimated that fitment of ESC under a business-as-usual scenario would result in 700 fewer fatalities over the 30 year period. The fatality savings ranged from 350 (16% effectiveness) to as high as 984 (45% effectiveness); these estimations can be expressed as, '*fatalities avoided: 700 lives, range: 350 – 984'*. The financial benefits associated with the reduction in fatalities were estimated to be $A722 million, with the range suggesting savings of $A361 million (16% effectiveness) to as high as $A1 billion (45% effectiveness). Reductions in the number of seriously injured, those sustaining minor injuries, and fewer property damage crashes and the associated financial benefits can be observed.

In sum, using a 32% ESC effectiveness value, the estimated financial savings to the Australian community was $A3.1 billion, with this financial benefit ranging from $A1.575 billion (16% effectiveness) to as high as $A4.429 billion.

The fitment cost of ESC over the period – and discounted at 7%, was estimated to be $A1.346 billion assuming a device cost of $A450. The fitment cost is fixed, regardless of the ESC effectiveness value, as the number of vehicles to which the device is fitted is fixed.

The BCR value assuming a 32% ESC effectiveness was 2.34:1, with the BCR being as low as 1.17:1 (given 16% ESC effectiveness) to as high as 3.29:1 (given 45% ESC effectiveness). There was little difference in the calculated BCRs between Projection Series A, B and C.

Table E.1 Projection Series 'A' benefit under a business-as-usual scenario

		ESC effectiveness	
Benefit	**32%**	**Lower bound 16%**	**Upper bound 45%**
Reductions in injuries (people)			
Fatality savings	700	350	984
Serious injury savings	6,934	3,467	9,750
Minor injury savings	16,802	8401	23,628
Property damage savings	179,038	89,519	251,773
Financial savings (@ 7% discount rate)			
Fatality savings	$A722,321,915	$A361,160,957	$A1,015,765,193
Serious injury savings	$A1,550,164,038	$A775,082,019	$A2,179,918,179
Minor injury savings	$A138,699,064	$A69,349,532	$A195,045,559
Property damage savings	$A738,972,276	$A369,486,138	$A1,039,179,763
Total savings	$A3,150,157,293	$A1,575,078,647	$A4,429,908,694
Cost of fitment (device cost $A450 @ 7% discount rate)			
Total cost	$A1,346,962,647	$A1,346,962,647	$A1,346,962,647
BCR (saving & device cost of $A450 @ 7% discount rate)			
BCR	2.34:1	1.17:1	3.29:1

Figure E.1 presents the BCR for the three ESC effectiveness values by ESC fitment cost for Series A. Across the price range there are clear differences with respect to BCRs and the associated 'break-even' point given the ESC effectiveness value. The break-even point assuming a 32% crash-injury reduction was $A1050, $A505 for a 16% ESC effectiveness and $A1480 assuming a 45% ESC effectiveness value.

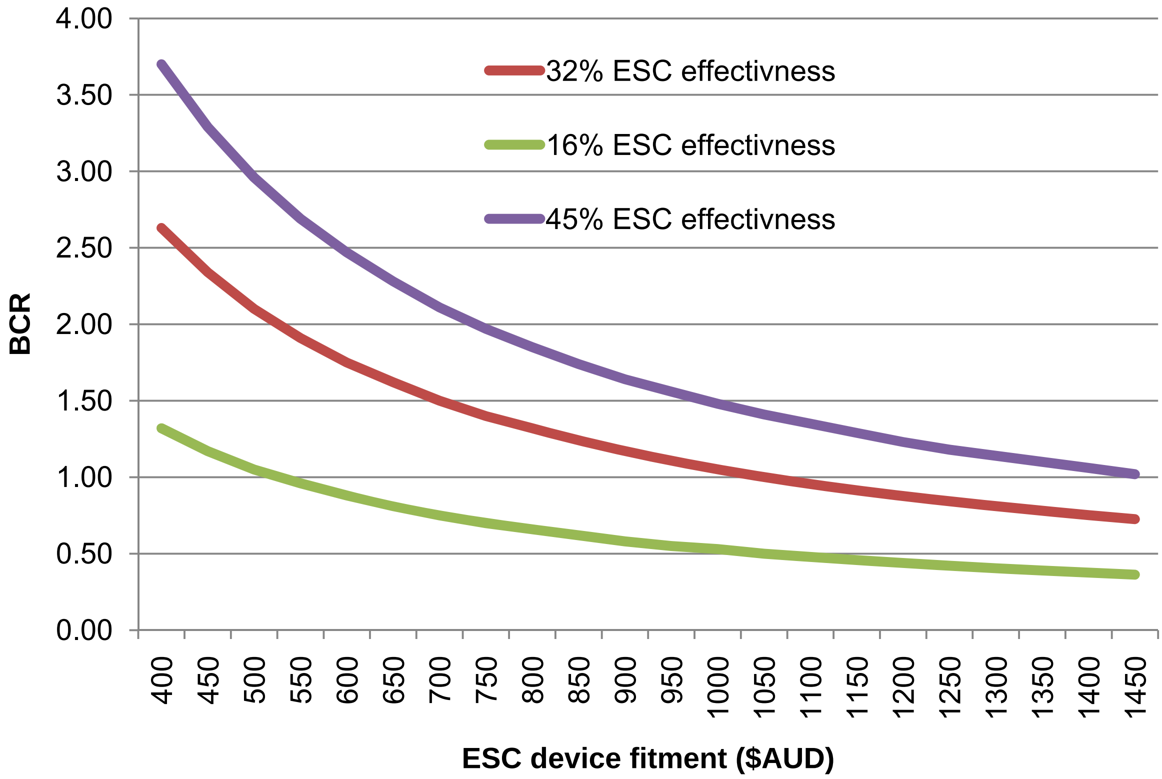


Figure E.1 BCR value given ESC device fitment cost and ESC effectiveness percent

Additional benefit due to earlier fitment

Table E.2 presents the additional savings benefits associated with earlier 100% fitment of ESC into the fleet. For this analysis, we assumed that all new light commercial vehicles sold and entering the fleet would have ESC fitted as standard equipment in the year 2013; this is seven years earlier than the business-as-usual scenario.

The additional lives saved by the earlier fitment was estimated to be 24 over the 30-year period, with this seen to range from 12 to 33 depending on the ESC effectiveness value assumed. Reductions in persons seriously injured, those sustaining minor injuries and property damage crashes can also be observed in Table E.2.

The additional financial benefit savings was estimated to be $A250 million, and ranged from $A126 million to as high as $A356 million for a 16% and 45% ESC effectiveness value respectively. The total *additional cost* of fitment associated with the earlier installation of ESC was estimated to be $A173 million. Consequently, the 32% point estimate BCR value for the *additional benefits and costs* was 1.46:1, while the overall BCR across the entire 30 year period was 2.24:1. The BCR values given a 16% effectiveness value and a 45% effectiveness value across the entire implementation period of 30 years was 1.12:1 and 3.15:1 respectively.

Table E.2 Additional benefits associated with achieving an ESC fitment rate of 100% by 2013, Projection Series A

	ESC effectiveness		
Benefit	**32%**	**Lower bound 16%**	**Upper bound 45%**
Aditional Reductions in injuries (people)			
Fatality savings	24	12	33
Serious injury savings	235	117	330
Minor injury savings	569	285	800
Property damage savings	6,064	3,032	8,528
Additional Financial savings			
Fatality savings	$A58,131,239	$A29,065,620	$A81,747,055
Serious injury savings	$A124,754,566	$A62,377,283	$A175,436,108
Minor injury savings	$A11,162,265	$A5,581,132	$A15,696,935
Property damage savings	$A59,471,232	$A29,735,616	$A83,631,420
Total savings	$A253,519,302	$A126,759,651	$A356,511,518
Total cost	$A173,323,653	$A173,323,653	$A173,323,653
BCR (for added savings/cost)	1.46:1	0.73:1	2.06:1
BCR for the entire 30 year period in the earlier fitment scenario	2.24:1	1.12:1	3.15

KEY DISCUSSION POINTS AND CONCLUSION

This report set out to provide the necessary inputs to assist in the determination of whether the mandatory fitment of ESC in the light commercial vehicle Class NA model segment is likely to be of benefit to the Australian society. The question of mandatory fitment has been driven by the reported on-road crash reduction associated with ESC in the passenger car and 4WD segments, as well as discussions locally and internationally following the acceptance of the Global Technical Regulation on ESC (GTR 8).

The savings estimates, which are significant, have been calculated on a range of assumptions and these are noted throughout. Two key factors have been used in the calculation of the benefits, these being 1. the future population of Australia – hence the volume of vehicle sales and associated crashes, and 2. the effectiveness of ESC itself in reducing crashes. Benefit estimates have been calculated for these combinations given the uncertainty surrounding population growth over the next 30 years in Australia and the limited ‘real-world’ evidence as to the effectiveness of ESC in light commercial vehicles in Australia.

While the benefits were calculated under a business-as-usual scenario, it remains important to note that a more rapid installation of ESC into vehicles would mean the cumulative impact of ESC fitment would be higher, while conversely, a slower than predicted rate of fitment would mean a more limited benefit to Australian society.

Finally and as previously stated, this report provides some of the inputs necessary for the determination of changing the ADR’s to mandate the fitment of ESC into Class NA vehicles. Any such decision relies on a range of other factors and consideration of these is beyond the scope of this report.

1 INTRODUCTION

1.1 Background

International evidence as to the effectiveness of electronic stability control (ESC) in preventing crashes was such that the Australian Government quickly moved to amend existing design rules to provide for ESC fitment. This move was underpinned by the 2008 Global Technical Regulation *Electronic Stability Control Systems (GTR 8),* which entered the United Nations Global Registry under the 1998 *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 which Australia is a signatory (United Nations, 2004)

On the 11th June 2009, Australian Design Rules (ADR) 31 and 35 were amended to mandate the fitment of Electronic Stability Control (ESC) to new passenger cars, passenger vans and passenger four-wheel drive vehicles. These changes were to apply from November 2011 for newly approved models and from November 2013 for existing models. These vehicles fall within the ADR categories Class MA, MB, and MC.

The amendments to ADR 31 and ADR 35 do not however apply to light commercial vehicles. These vehicles are defined as Class NA vehicles under the ADR system. In determining whether further amendment to existing ADR's, or the creation of a new ADR is required, the Commonwealth of Australia Department of Infrastructure, Transport, Regional Development and Local Government (DITRDLG) commissioned the Monash University Accident Research Centre to undertake a study to estimate the likely benefits for mandating ESC for light commercial vehicles.

1.2 Project specification and report structure

The present project aims to provide the basis for determining the case as to the fitment of ESC into light commercial vehicles (i.e., up to 3.5 tonnes). To this end, it was necessary to determine a range of key inputs so as to arrive at the final estimate values, these being:

Establishment of the 'Market'

1) The number of new light commercial vehicles currently supplied to the market, using the Federal Chamber of Automotive Industry (FCAI) 'light commercial' category which includes vans, pick-ups, light buses (Gross Vehicle Mass: GVM < 3,500 kg) and trucks with a GVM 2,500 – 3,500 kg;

2) Of the number of light commercial vehicles identified in 1), the number of vehicle models belonging to the ADR Class NA category;

3) The number of models and vehicles in the Class NA category with (standard or option) and without ESC;

4) The predicted future ESC fitment rate into Class NA vehicles, up to 30 years into the future.

Technology effectiveness

1) The effectiveness of ESC, based on published literature and any empirical evidence from Australia, with particular emphasis on light commercial vehicles;
2) Through the conduct of original research, an estimate for ESC effectiveness for light commercial vehicles in Australia, as per the analytical method of Scully and Newstead, Evaluation of electronic stability control effectiveness in Australia, *Accident Analysis and Prevention*, 40: 2050 – 2057.
3) Using the estimates derived in 1) and 2), the likely crash risk reduction benefits for relevant crash types;

Road trauma

1) Using current crash data – specifically, the Used Car Safety Rating Database, the number of crashes involving Class NA vehicles where ESC would be expected to have an influence, by crash severity;
2) The likely future number of crashes involving light commercial vehicles under a business-as-usual scenario, with Australian Bureau of Statistics population projection series serving as the basis of sensitivity analysis.
3) Current crash costs by injury severity, specifically serious injury crashes (fatal + serious injury), minor injury, and property damage only.

The report is structured into three broad sections in line with the project specification.

1.3 Use of the report

This report provides the relevant inputs for the assessment of fitting ESC to Class NA vehicles. The information and analysis considers the current market, current ESC penetration rates, and projects forward to determine the likely vehicle fleet.

We report established crash reduction benefits published elsewhere as well as estimates derived from empirical research (device effectiveness). The report considers the field of crashes (device relevance) and arrives at financial cost of crash data. Any and all assumptions and limitations of the analyses are detailed in relevant sections of this document.

The report has been prepared to provide guidance to the Department of Infrastructure, Transport, Regional Development and Local Government (DITRLG) in determining whether to mandate the fitment of ESC for Class NA vehicles. The analysis provided here was conducted to inform this process, and the decision to mandate is beyond the scope of this report.

2 ESTABLISHMENT OF THE ‘MARKET’

To determine the ‘market’ of light commercial vehicles where the fitment of ESC is relevant, four tasks were undertaken, these being:

1) Identify the number of new light commercial vehicles currently supplied to the market, using the FCAI ‘light commercial’ category which includes vans, pick-ups, light buses (GVM < 3,500 kg) and trucks with a GVM 2,500 – 3,500 kg;
2) Of the number of light commercial vehicle models identified in 1), determine those that met ADR Class NA criteira, and of these the number of models with standard or optional ESC fitment;
3) The number of new vehicles that are expected to be supplied to the market over the next 30 years;
4) The predicted future ESC fitment rate into Class NA vehicles, up to 30 years into the future.

The data described in each of these tasks builds on the preceding step, and will thus provide the basis for understanding the market picture, and ultimately the value of any future mandate for this class of vehicles. Each of these tasks is described and discussed in turn below. At the outset it is critical to note that while the best available information is used in undertaking these tasks, a range of assumptions are necessary in order to predict the future fitment of ESC into Class NA vehicles.

2.1 The number of new vehicles currently supplied to the market

The proportion of new vehicles supplied to the market by vehicle segmentation class for the period 2000 to 2009 is presented in Figure 2.1. It is evident that passenger vehicles represent the most new common vehicle sold, accounting for approximately 60% of sales since 2007, followed by Sports Utility / Four-wheel drive (SUV/4WD) vehicles (19.4% average) and then light commercial vehicles (18% average).

The growth in the total number of vehicle sales is evident, with 937,328 new vehicles sold in 2009 compared to 787,100 in 2000, representing a 16% total increase across the 10 years. As shown in Figure 2.1, the market share for passenger vehicles fell by 2.2% over the decade, while sales in the SUV/4WD class increased by 44%, as did light commercial vehicles (40.2%), and heavy commercial vehicles (29%).

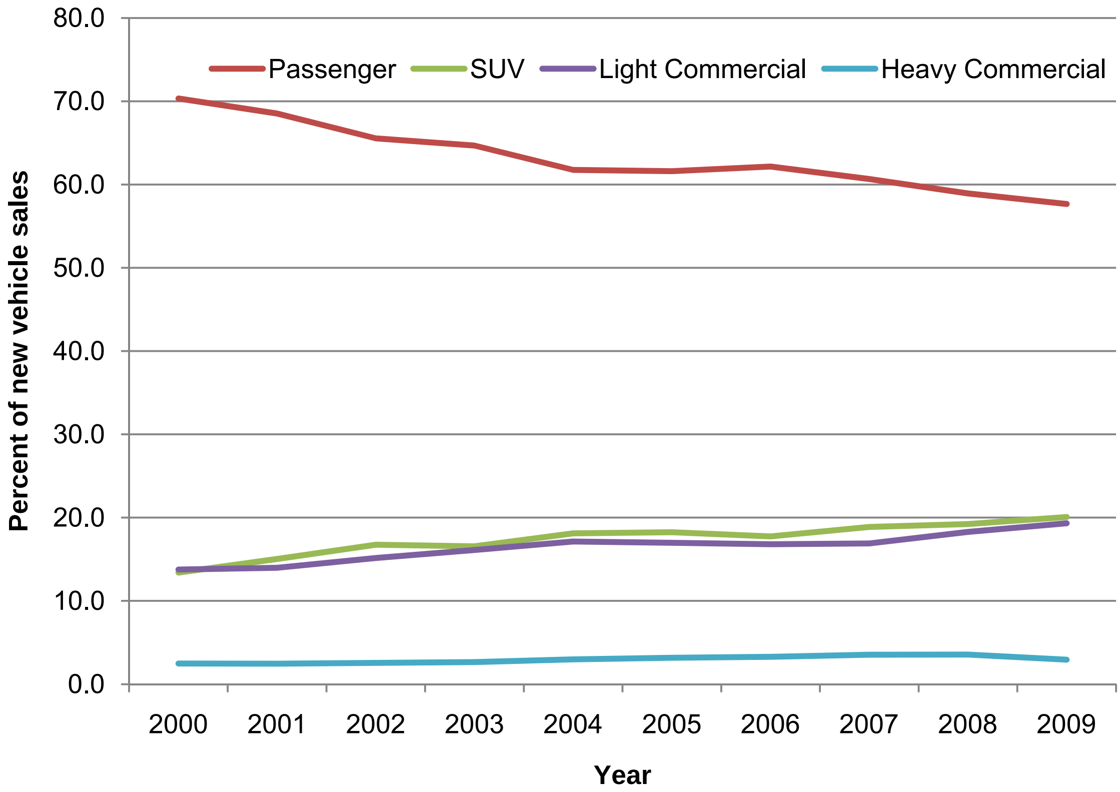


Figure 2.1 New vehicle sales by segmentation class, 2000-2009 (percent)

As this report is focussed on the fitment of ESC into light commercial vehicles certified under the Australian Road Vehicle Certification System (RVCS), we present detailed statistics regarding light commercial vehicle sales for the past three years.

The FCAI defines a 'light commercial' or 'light truck' vehicle as those 'designed principally for commercial [use] but many include designs intended for non-commercial applications'(FCAI, 2010). Vehicles included are:

1. Light buses: 8+ seats and a gross vehicle mass less than 3,500kg GVM
2. Vans: blind and window vans;
3. Pick-up / Cab-Chassis (PU/CC) 4x2: two-wheel drive, central control cab, utility, cab chassis, and crew cab;
4. Pick-up / Cab-Chassis (PU/CC) 4x4: four-wheel drive, central control cab, utility, cab chassis, and crew cab; &
5. Trucks with a gross vehicle mass of 2,500 to 3,500kg GVM.

Table 2.1 presents the number of new light commercial vehicles sold, with the percentage a function of the total number of vehicles sold in Australia. It is evident though, as noted above, that sales in the light commercial vehicle category have increased, and since 2005 there has been an average increase of 7.3% per annum. In 2009, a total of 181,058 light commercial vehicles were sold, with Pick-up / Chassis (PU/CC) 4x4 and Pick-up / Chassis (PU/CC) 4x2 vehicles representing 47.4% and 37.4% of light commercials sold, or 9.2% and 7.2% of all new vehicle sales. Vans represented 13.5% of light commercial sales (2.6% of all sales), while buses (in class 1.25%; all: 0.2%) and light trucks (in class: 0.6%; all: 0.2%) comprised a small number, and proportion of sales.

Table 2.1 Number and percent of new light commercial vehicles sold in Australia, by vehicle type and year

	2005		2006		2007		2008		2009	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Light Buses	2,298	0.2	2,622	0.3	2,465	0.2	3,417	0.3	2,259	0.2
Vans	21,571	2.2	20,453	2.1	20,300	1.9	24,299	2.4	24,557	2.6
PU/CC 4X2	83,378	8.4	73,051	7.6	70,674	6.7	72,812	7.2	67,393	7.2
PU/CC 4X4	62,728	6.3	67,639	7.0	82,691	7.9	83,308	8.2	85,813	9.2
Trucks 2.5-3.5 GVM	1,747	0.2	1,532	0.2	1,494	0.1	1,180	0.1	1,036	0.1
Total light commercial	171,722	17.4	165,297	17.1	177,624	16.9	185,016	18.3	181,058	19.3
Total vehicles sold in Australia	988,269	-	962,666	-	1,049,982	-	1,012,164	-	937,328	-

2.2 The number of certified models that are currently supplied to the market, and associated ESC fitment

It is necessary to determine which of the light commercial vehicles entering the fleet are certified as Class NA vehicles (*light goods vehicle)* under the RVCS (http://rvcs-prodweb.dot.gov.au/) for the purposes of the Australian Design Rule system.

The RVCS was used to establish the different models of new light commercial vehicles sold that belong to the NA ADR category. The RVCS Certification Search Menu was used and using the drop-down menu *Category NA* was specified to obtain a current list of 'certified vehicles' (http://rvcs-prodweb.dot.gov.au/pls/wwws/pubrvcs.Notify_Search). Searches for individual vehicles were also undertaken if the vehicle in question did not appear on the current Class NA list. Information for each vehicle was inspected manually and the full classification list is presented in Appendix A.

Table 2.2 presents the total number of vehicle sales in the light commercial segment and those certified as Class NA vehicles, as well as the number of models sold across the period. For instance, in the latest year (2009), 181,058 light commercial vehicles entered the fleet, representing 19% of all new vehicles sold. Of these, 96.5% (n=175,315) were Class NA vehicles. Expressed another way, 51 different light commercial vehicle makes / models were sold, with 49 (96.1%) being Class NA vehicles.

Table 2.2 also shows that from 2005 – 2009 there were 67 different make / model vehicles in the light commercial range, with 62 of these being Class NA vehicles.

An important point to make here is that the available sales data gives Make and Model of the vehicle sold, but provides no additional information regarding different specifications, hence the mix of base model variants to more highly specified variants is unknown.

Table 2.2 Total number of vehicle sales in the light commercial segment and those certified as Class NA vehicles

Year	Total light commercial (% all sales)†	Total NA vehicles (% of light com)	Number (%) NA vehicles / total models
2005	171,722 (17.0%)	163,147 (95%)	44 / 49 (89.8%)
2006	165,297 (16.8%)	157,279 (95%)	46 / 51 (90.1%)
2007	177,624 (16.9%)	171,922 (96.8%)	52 / 56 (92.8%)
2008	185,016 (18.3%)	178,584 (96.5%)	50 / 52 (96.1%)
2009	181,058 (19.3%)	175,315 (96.5%)	49 / 51 (96.1%)
Period	880,717 (17.6%)	846,317 (96.1%)	62 / 67 (92.5%)

† FCAI; ‡ RVCS

For the latest year of sales (2009), all model 2009/2010 year (MY) 'base' and 'top' model variants were classified as to whether they were available with Electronic Stability Control as standard equipment, optional equipment, or not available (N/A). Table 2.3 presents summary statistics for each ESC availability category and the number of vehicle sales this availability translates to assuming all base model sales and top variant sales.

Table 2.3 shows that only four (8.1%) 'base variant' models (lowest price) were fitted with ESC as standard equipment, with these four vehicle makes / models accounting for 8.4% of sales on the assumption that only the base model variant was purchased. By including top model variants, nine make / model vehicle types have ESC as standard equipment, and if all nine of these vehicles were purchased as the 'top variant', this would account for 27% of all Class NA vehicles sold.

At the base variant, ESC was unavailable in 77% of the vehicle make/models sold in 2009. It is not possible to determine which variants were sold and in what volume, hence it is not possible to definitively determine the number of Class NA vehicles sold with ESC fitted. The base variant statistics provide the minimum basis of fitment.

Table 2.3 Total number of vehicle sales in the light commercial segment and those certified as Class NA vehicles

ESC availability	Base variant		Top variant		Percent of vehicle sales for 'Base variant'	Availability if all sales were the 'Top variant'
	Num	%	Num	%		
Standard	4	8.1%	9	18.4%	8.4%	27%
Optional	6	12.2%	5	10.2%	8.7%	2.6%
Not available	38	77.5%	28	57.1%	82.7%	67.8%
Unknown	1	2.1%	-	-	0.2%	-
1 variant only	-	-	7	14.2%	-	
Total	49	100%	49	100%	-	2.6%

The option pricing for the fitment of ESC is of interest. Where available, the optional fitment ranged from $A450 to $A1100.

Appendix B provides a complete breakdown of the ESC fitment for 2009 and 2010 model year vehicles, alongside vehicle sales for the 2009 calendar year; this is sorted in volume of sales from highest number of sales to lowest.

2.3 Estimated number of new vehicles that are expected to be supplied to the market over the next thirty years

To derive an estimate of the number of new light commercial vehicles that are likely to enter the market over the next thirty years, simple linear regression (Dupont, 2002) was used to arrive at a prediction model using the number of light commercial vehicles as the 'dependent variable' and known population for Australia in the same period (Table 2.4).

Table 2.4 Number of new light commercial vehicle sales and Australian population

Year	Light Commercial vehicle sales†	Australian Population‡
2000	108,332	19,272,644
2001	108,034	19,533,972
2002	124,873	19,770,963
2003	146,589	20,011,882
2004	163,676	20,252,132
2005	171,722	20,544,064
2006	165,297	20,873,663
2007	177,624	21,263,271
2008	185,016	21,722,820
2009	181,058	22,155,429

† FCAI – VFACTS 2000-2009; ‡ (Australian Bureau of Statistics, 2010a)

Figure 2.2 shows the derived relationship between light commercial vehicle sales and the Australian population with a clear linear trend being evident. The linear regression model is a good 'fit' statistically, accounting for a very high proportion of known variance ($R^2_{adjusted}$ = 78%) and the model was highly statistically significant (p=0.0004). This model then serves as the basis for future predictions of the numbers of light commercial vehicles entering the fleet using population as the key predictor variable. The basic linear regression model is shown in Equation 2.1.

$$Y\ [vehicle\ sales] = \alpha + \beta x_i + \xi_i \qquad \text{[Equation 2.1]}$$

where:

α is an unknown parameter (model constant)

β_i is an unknown parameter, estimated using values of x

ξ_i is the *error term*

Equation 2.2 presents the linear regression model of population against vehicle sales. This model permits, with substitution of future population projection values, the number of estimated light commercial vehicles into the future.

$$Y\ [vehicle\ sales] = -419311.8 + 0.027874 * x_i \qquad \text{[Equation 2.2]}$$

where:

α is the model constant

β_i is the estimated population coefficient

x_i represents the (future) population values (via substitution).

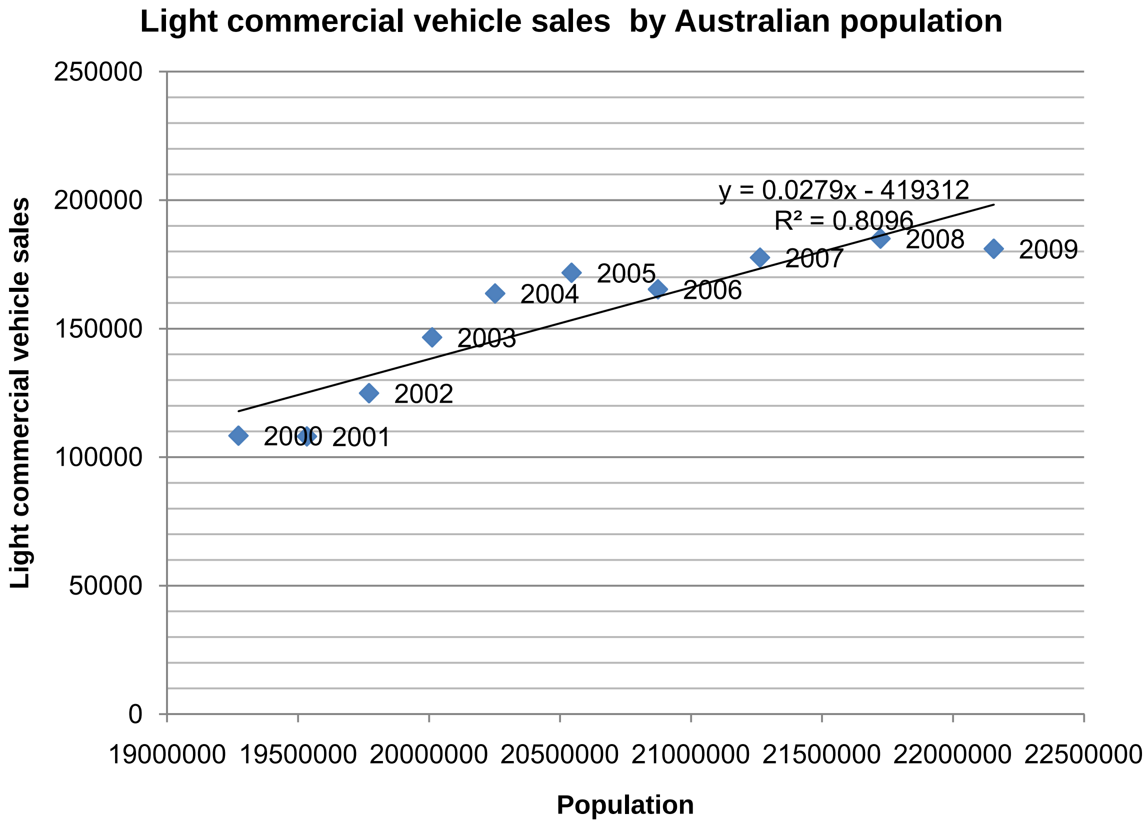


Figure 2.2 The relationship between light commercial vehicle sales and the Australian population

Using Equation 2.2, and the Australian Bureau of Statistics Population Projections (Australian Bureau of Statistics, 2010c - Series A; 2010d - Series C; 2010e - Series B)[1], we the substitute these future population values as x_i in the statistical model, the result of which provides an estimate of the annual number of light commercial vehicles sold in Australia.

1 Compared to Series B, Series A assumes higher levels of components of population change (fertility, life expectancy, and migration) while Series C assumes lower levels. As a result, Series A results in larger projected populations by 2056 and Series C results in lower populations. (Australian Bureau of Statistics, 2010b)

These projection results rely on a number of assumptions, these being:

1. observed economic growth will continue, on an average basis, into the future, over the life of the projections;
2. there is no change in the factors associated with the purchase of vehicles for individual buyers, that is, demand side factors remain constant;
3. there is no change in the factors relating to the production of light commercial vehicles, that is, supply side factors remain constant;
4. that the vehicle technology as of today remains constant with respect to the influence such technology has on vehicle purchasing choice;
5. the impact of any future regulatory change on light commercial purchasing cannot be accounted for, and
6. that the projected population estimates derived by the Australian Bureau of Statistics (ABS) are i. accurate within their stated assumptions and limitations, and ii. the analysis here does not account for the possibility of future re-estimation by the ABS.

Given these assumptions and caveats, the projected number of light commercial vehicle sales is presented in Figure 2.3, Table 2.5 (5 year intervals) and Appendix C (all years), using Series A, B, and C ABS population projections. The three Series were calculated to provide a range of projected sales for sensitivity analysis, given the assumptions of future population projections which incorporate fertility, life expectancy and migration patterns. Projections suggest that the number of light commercial vehicles sold in 2039 will range from 367,599 (Series C) to as high as 542,641 (Series A).

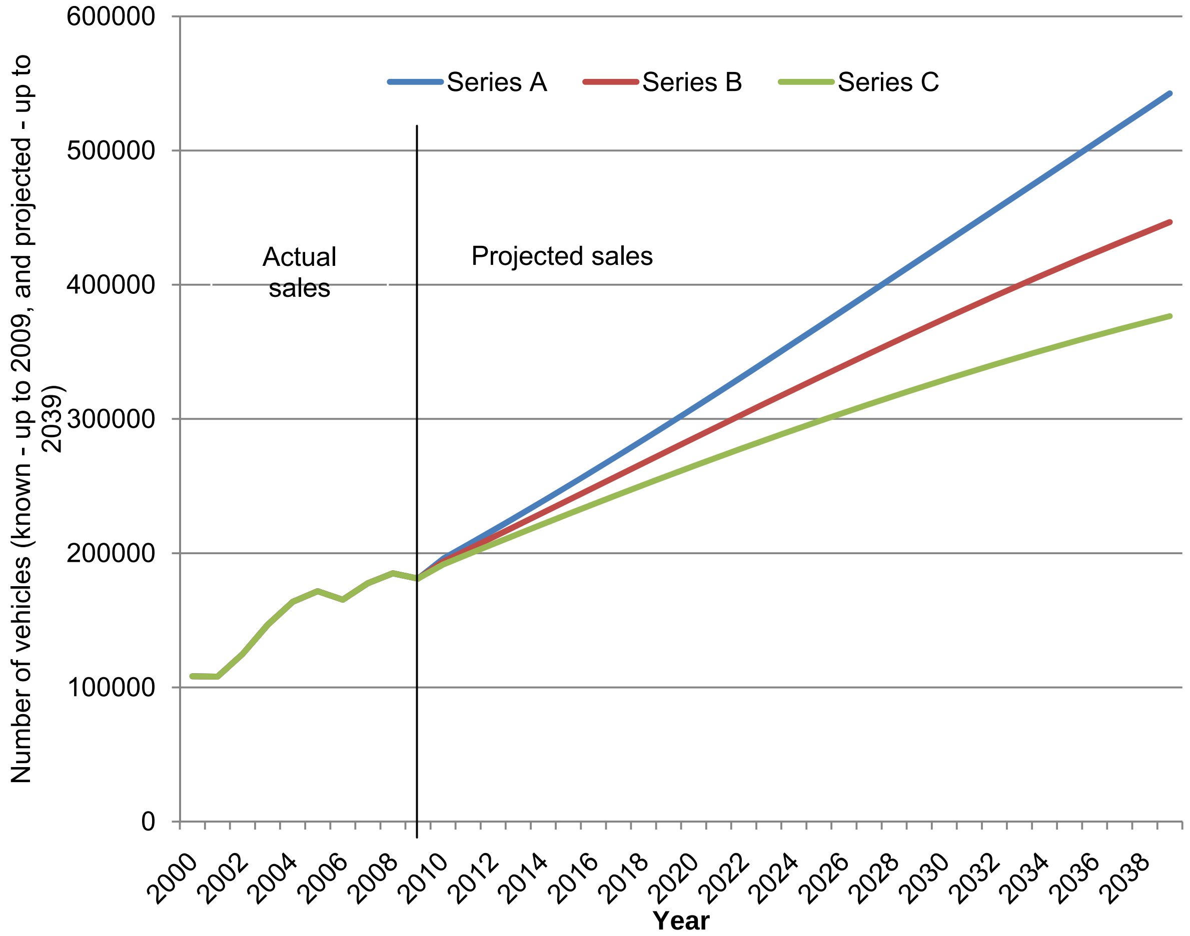


Figure 2.3 Actual (2000-2009) and projected (2010-2039) light commercial vehicle sales

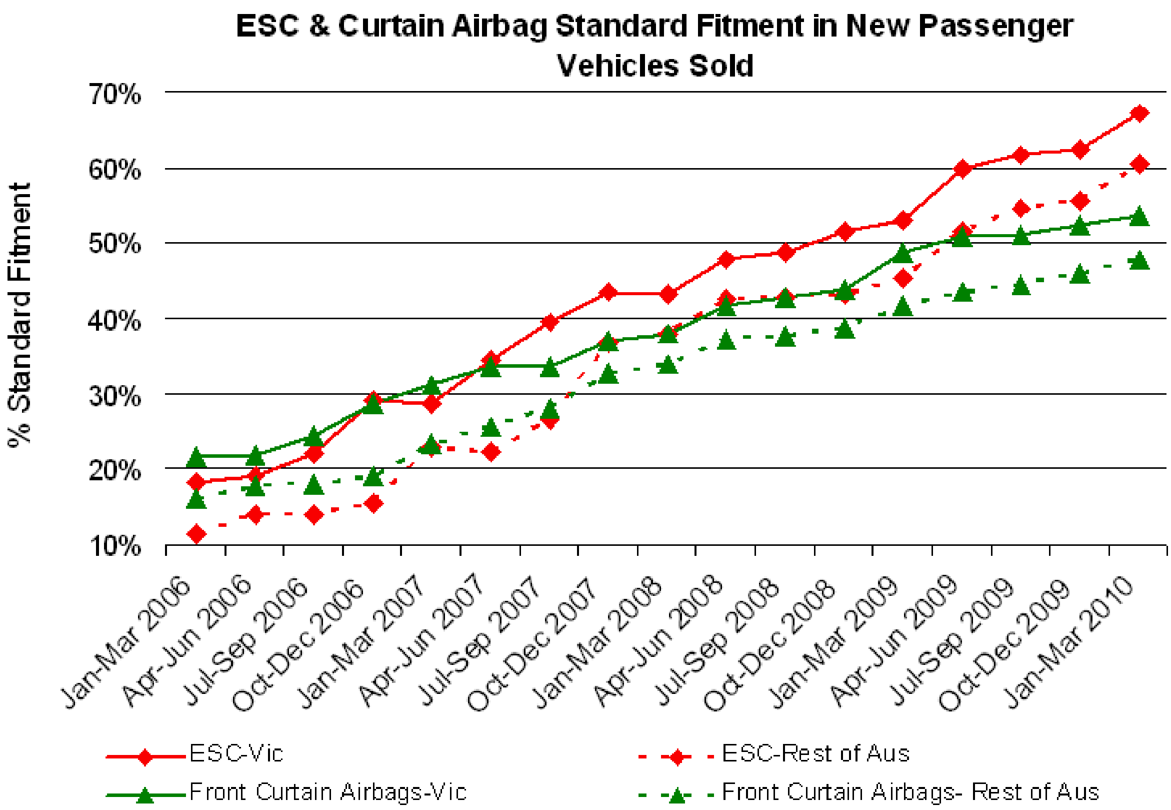
Table 2.5 Projected number of vehicles, by ABS population projection series (A, B,C)

Year	Series A	Series B	Series C
2010	195,800	193,665	191,509
2015	250,141	239,521	229,240
2020	308,154	285,568	264,937
2025	368,993	330,958	298,212
2030	430,844	374,655	329,147
2035	492,816	415,670	356,821
2039	542,641	446,691	376,591

2.4 An estimate of the number of new vehicles that are expected to be supplied to the market with ESC fitted over the next thirty years

The current level of ESC fitment was described earlier with the number of Class NA vehicles with ESC fitted as a standard option presented in Table 2.3. To recap, of the 49 new make/model vehicles currently available, only four (8.1%) were fitted with ESC as standard equipment, while this increased to nine vehicles (18.4%) when the 'top' model variant was considered. For the base model variant, ESC was available as optional equipment on 6 (12.2%), and unavailable for 77.5% of vehicles.

As ESC is a relatively new technology, the best available evidence of its likely penetration stems from standard fitment into the passenger vehicle segment as shown by Figure 2.4. Using the first quarter of each calendar year, we can observe that standard fitment rate rose from approximately 12% in 2006, to 22% (2007), to 38% (2008), to 45% (2009), and to approximately 60% in 2010. The average increase in the standard fitment rate was 9.6% per annum.



Source: Courtesy of the Transport Accident Commission, VicRoads Safety Initiative Reports.

Figure 2.4 ESC standard fitment in Australia, since January-March 2006 to January-March 2010

To estimate the proportion – and timeframe, of new vehicle models supplied in the Class NA segment with ESC fitted, we apply this 9.6% per annum average increase in the proportion of Class NA vehicles with ESC fitted as standard equipment currently offered into the market in terms of base variants – this is presently 4 of 49 vehicle makes/models.

Using the starting point of 4 of 49 vehicles presently fitted with ESC as standard into the base model variant, we apply the 9.6% increase on the total number of vehicle models available; that is, 4.7 models, on average per annum, enter the market with ESC fitted as standard. This is demonstrated in Table 2.6.

Under this approach, all vehicles in the Class NA category would be expected to have ESC fitted as standard equipment at some point in 2020. The principal caveat of this projection is that past fitment of ESC into passenger vehicles is indicative of future fitment into Class NA vehicles, despite differences in vehicle design use, purpose, vehicle engineering specification, and end-user use.

Table 2.6 Projected ESC fitment as standard equipment into Class NA vehicles, based on the fitment into passenger cars

	Number of Class NA models (base variant) with ESC fitted as standard	**New models with ESC added per annum (9.6% growth)**	**Cumulative number of Class NA models with ESC as Standard**	**Percent Class NA models with ESC as Standard**
Now 2010	4	-	4	8.3%
2011	-	4.7	8.704	18.13%
2012	-	4.7	13.404	27.93%
2013	-	4.7	18.104	37.72%
2014	-	4.7	22.804	47.51%
2015	-	4.7	27.504	57.30%
2016	-	4.7	32.204	67.09%
2017	-	4.7	36.904	76.88%
2018	-	4.7	41.604	86.68%
2019	-	4.7	46.304	96.47%
2020	-	4.7	51.004	106.26%

3 TECHNOLOGY EFFECTIVENESS

3.1 Brief review of the effectiveness of ESC in reducing road trauma overseas and in Australia

Since ESC was made available in mass-produced passenger cars in 1998, there has been considerable research that has documented its effectiveness in preventing different types of crashes across a range of road environments. While a distinction has recently been made between the effectiveness of ESC in passenger cars and SUV/4WD vehicles, few studies have specifically examined the benefit, if any, of ESC on crash risk for other vehicle sub-types. More specifically, few studies have examined the influence of ESC on the crash rates of light commercial vehicles.

It is important to state at the outset that until recently there has been little available data that would permit an assessment of the influence of ESC on the crash risk of commercial vehicles, as generally speaking the uptake of ESC within this market segment has lagged behind fitment into passenger vehicles. Anecdotally, the light commercial market is particularly sensitive to price increases, so it is possible that this may lead to few manufacturers offering ESC as standard equipment or as an optional feature in their light commercial range.

The recent evaluation studies that have consistently demonstrated the benefits of ESC when fitted to passenger cars and 4WDs have led to questions as to whether ESC would be effective in other vehicle types. In this vein, some manufacturers of heavy vehicles have commenced offering ESC systems as standard or optional equipment on a number of their models. This increased level of interest in fitting ESC into other vehicle types was exemplified at the 2009 Enhanced Safety Vehicle Conference (ESV) in Germany, where a series of presentations were given with the aim of determining how the benefits of fitting ESC to different types of heavy vehicles could be estimated (see Barickman, Elsasser, Albrecht, Church, & Guogang, 2009; Svenson, Grygier, Salaani, & Heydinger, 2009). Estimating the real-world benefits of ESC for heavy vehicles is a challenge as there is currently insufficient volume and quality data that is required for the conduct of standard statistical evaluation studies.

It can be expected that as ESC becomes a more popular feature in light commercial fleets there will increased research activity to determine its effectiveness in these market segments. On the basis of the literature reviewed here, we must extrapolate ESC effectiveness values derived for passenger cars and 4WDs when estimating the likely benefits of ESC for light commercial vehicles. With this in mind, the following brief review presents a summary of selected evaluations of ESC effectiveness research. A more in-depth review can be found in the two previous evaluations of ESC in Australasia conducted by Scully and Newstead (2007, 2008), from where much of this earlier literature has been derived.

A study by Sferco et al (2001) used in-depth data from the European Accident Causation Survey (EACS) to identify the proportion of in-depth crashes in the EACS dataset for which it was judged that the presence of ESC would have influenced the outcome of the crash. Experts in crash reconstruction familiar with ESC technology provided their opinion on the likely influence of ESC on the outcomes of each of the loss-of-control crashes in the dataset. Estimated crash reduction values ranged from 18% for ‘all injury crashes’ to 67% for loss of control fatality crashes (refer Table 3.1).

Langwieder and colleagues (2003) also used crash data to identify the proportion of crashes where ESC would be considered to have had a positive influence if fitted. Certain critical situations, such as crashes involving skidding or crashes on curved sections of road, that ESC was likely to activate and hence influence vehicle dynamics were identified. In each case, assumptions regarding driver behaviour were made which then permitted estimation of the likely influence of ESC, and thus the proportion of crashes where ESC would be of benefit. Crash reduction benefits of 20-25% for 'all crashes' and between 42-60% of single vehicle skid crashes were estimated.

It is essential to note that the early studies by Sferco et al (2001) and Langwieder et al (2003) relied upon expert knowledge of how ESC works in order to determine the proportion of crashes that ESC was likely to influence. This is a reasonable approach given the paucity of crash data involving vehicles with ESC fitted and the need to advance vehicle safety policy. This approach does however have a number of limitations, perhaps the two most important being the representativeness of crashes examined in a case-by-case approach, and the quality of the data itself.

With the increase in ESC fitment rates it has recently become possible to use mass crash data to estimate the effectiveness of ESC across a broad range of crash types. This approach has the principle advantage that the benefit estimates can be tested statistically with appropriate control of extraneous or other influential factors, such as the fitment of other safety devices. The ideal statistical approach is a 'case-control' type design, where the probability of vehicles being involved in a crash with and without ESC fitted can be estimated and then compared.

Studies by Aga and Okada (2003), Page and Cuny (2006) and Farmer (2004, 2006) compared the crashes of different releases of the same vehicle model. Each of these studies compared the crash experiences of vehicles manufactured before and after the installation of ESC as standard equipment. These studies reported benefit reduction values of 35-50% (Aga & Okada, 2003), 44% (Page & Cuny, 2006), and between 32-59% depending on the crash type (Farmer 2004, 2006). A particular criticism levelled at these type of studies – where only one or a small number of vehicle models is used – is the generalisability of the findings to the entire fleet, or even the market segment to which those vehicles belong. It is also the case that later model releases often have additions or modifications other than the addition of ESC alone. For instance, in the Page and Cuny (2006) study, the comparison vehicle in question was fitted with Emergency Brake Assist and a tyre pressure monitoring system along with ESC.

In an attempt to overcome these limitations and sources of bias, Farmer (2006) compared crash risk for models that were identical in every way apart from ESC fitment. This could be achieved as the US mass crash databases contain a large number of cases, however even so the exclusion of a large number of crashes had the effect of reducing the statistical power of the study to the point where the hypothesis that ESC reduced serious single vehicle crashes could not be tested. In an earlier study, Farmer (2004) was able to estimate that ESC reduced the risk of single vehicle crashes of all severities by 41%, while, in a similar study, Bahouth (2005) estimated that ESC was effective in reducing 52% of single vehicle crashes.

As might be evident, a number of methods have been used to estimate the effectiveness of ESC, each with certain limitations. The classic pre-post design, where a range of factors important to the estimation of crash risk can be controlled for, is ideal. In this model however, the inclusion of some measure of vehicle exposure is required. The ideal exposure measure would be the kilometres travelled by ESC fitted vehicles compared with the non-fitted vehicles. However, such data are rarely available. Indeed, in none of the studies reviewed here was a measure of exposure used in the calculation of ESC benefits. It is acknowledged that exposure data is frequently difficult to acquire, and while relatively easier to obtain, registration data is not as strong as distance travelled for the purposes required.

To overcome the lack of exposure data, many studies have used an indirect measure of exposure. This is done by identifying of a type of crash in which it can be assumed that ESC will not have an influence. Specifically, by calculating the percentage of ESC fitted vehicles that were involved in the type of crash where ESC is assumed to have no influence, the expected number of other types of crashes if ESC also did not have an influence on crash risk for these crashes can be estimated. This method referred to as an 'induced exposure method' and has been used by many international evaluations of ESC (e.g. Bahouth, 2005; Dang, 2004; Green & Woodrooffe, 2006; Kreiss, Schüler, & Langwieder, 2005; Lie, Tingvall, Krafft, & Kullgren, 2006; Page & Cuny, 2006).

Frampton and Thomas (2007) utilised an induced exposure method when examining the effectiveness of ESC in preventing a range crashes in Great Britain using the STATS19 crash database. The authors estimated that ESC was effective in reducing 'all crashes' by 7%, while a 25% reduction for fatality crashes was observed. Higher benefits were reported for single vehicle crashes (27% reduction), rollover crashes (36% reduction) and crashes that involved skidding (23% reduction). The authors reported that ESC offered higher levels of benefit on wet (9%) and icy (20%) roads than when compared to dry roads (5%). The estimated financial savings associated with a 100% take-up of ESC was nearly £1 billion, or 7800 fewer crashes.

Table 3.1 highlights the range of effectiveness values for across a variety of crash types, vehicle types, and environments in studies that have used induced exposure methods. Separate effectiveness estimates have been reported for different types of crashes (Bahouth, 2005; Green & Woodrooffe, 2006), different types of vehicles (Dang, 2004; Green & Woodrooffe, 2006), different types of road environments (Lie, Tingvall, Krafft, & Kullgren, 2004; Lie, et al., 2006) and crashes at different levels of injury severity (Dang, 2004; Lie, et al., 2004, 2006)). Some studies suggest that ESC is more effective in preventing single vehicles crashes than multiple vehicle crashes (Bahouth, 2005), while Lie et al (2004) report that ESC is particularly effective in preventing crashes on wet roads. Similarly, several studies suggest that ESC is more effective at preventing single vehicle crashes involving 4WDs than single vehicle crashes involving cars (Dang, 2004; Green & Woodrooffe, 2006).

Table 3.1 Summary of Early Published Studies of ESC Effectiveness

Jurisdiction, Author & Year	*Target Crash Type*	*Estimated Reduction*
Europe (Sferco et al, 2001)	All Injury Crashes All Fatal Crashes Loss of Control Injury Crashes Loss of Control Fatal Crashes	18% 34% 42% 67%
Germany (Langwieder et al, 2003)	Single Vehicle Skidding Crashes All Crashes	42-60% 20-25%
Germany (Kreiss et al, 2005)	All ESC Sensitive Crashes Fatal ESC Sensitive Crashes	32.4% 55.5%
Germany (Becker et al, 2003)	All Crashes	45%
Japan (Aga & Okada, 2003)	Single Car Crashes Severe Single Car Crashes Head-On Crashes Severe Head-On Crashes	35% 50% 30% 40%
USA (Dang, 2004)	Single Vehicle Car Crashes Single Vehicle SUV Crashes Fatal Single Vehicle - Car Fatal Single Vehicle – SUV	35% 67% 30% 63%
France (Page & Cuny, 2006)	All Crashes	44% (not sig)
USA (Bahouth, 2005)	Multi Vehicle Frontal Crashes Single Vehicle Crashes	11.2% 52.6%
USA (Green & Woodrooffe, 2006)	Single car crashes (dry road) Single SUV Crashes (dry road) Rollover car crashes (dry road) Rollover SUV crashes (dry road) Run off road car Run off road SUV (middle aged car drivers & older SUV drivers benefited most)	30.5% 49.5% 39.7% 72.9% 54.5% 70.3%
Sweden (Lie et al, 2004)	All Crashes All crashes - wet road All crashes - snow & ice on road	22.1% 31.5% 38.2%
Sweden (Lie et al, 2006)	All injury crashes (not rear end) All serious and fatal crashes Fatal + Serious loss of control – wet road Fatal + Serious loss of control – ice or snow	16.7% 21.6% 56.2% 49.2%
USA (Farmer, 2004)	All single vehicle crashes Single vehicle fatal crashes	41% 56%
USA (Farmer, 2006)	All single vehicle – SUV All single vehicle – cars Fatal single vehicle – SUV Fatal single vehicle – car Multiple vehicle – SUV Multi vehicle – car	49% 33% 59% 53% 32%-37% 25%

(Note: originally published in Scully & Newstead, 2007)

Examination of Table 3.1 highlights significant variation in benefit estimates. These differences between studies might result of a combination of different analysis methods and exposure values used, as well as differences in vehicle populations, road environments and driver behaviours. It is also the case that the ESC systems available likely differ across jurisdictions. For these reasons, it is important that the likely effectiveness of ESC is derived from crash data from the jurisdiction in question.

Other studies have sought to determine the effectiveness of ESC by using methods other than the statistical analysis of mass crash data. For example, Papelis (2010) used a high-fidelity driving simulator to determine effectiveness and found that ESC assisted drivers by reducing the likely loss of control vehicle, resulting in a 25% lower crash risk; these benefits were similar irrespective of the age and sex of the drivers.

Some studies have also attempted to differentiate between different types of ESC systems when estimating effectiveness. Dang (2007) compared effectiveness estimates for two channel and four channel systems and found that four channel ESC systems were significantly more effective at preventing single vehicle run off road crashes of all severities, while two channel systems were more effective at preventing fatal crashes, although this result was not statistically significant.

In a recent Australian study, Mackenzie and Anderson (2009) used in-depth real world rural crashes to determine how ESC intervenes to reduce the risk of high speed single vehicle crashes. Data from twelve loss-of-control crashes were reconstructed and in each case the vehicle's assumed trajectory had it been fitted with ESC was modelled and compared with the actual trajectory. The authors concluded that ESC offered safety benefits in scenarios that would likely result in high speed single vehicle crashes.

Finally, and from a behavioural perspective, as the proportion of new cars fitted with ESC has increased, so too has the public's knowledge of the safety benefits of the technology. This has raised some concerns among the road safety industry that drivers may drive more aggressively if they know their car is fitted with ESC. Two recent studies from Canada (Rudin-Brown, Jenkins, Whitehead, & Burns, 2009) and Sweden (Vadeby, Wiklund, & Forward, 2009) surveyed drivers regarding their knowledge of ESC and, for drivers of vehicles fitted with ESC, how they believed ESC had affected their driving. In both studies there was evidence that drivers could be more likely to take risks if they know their cars are fitted with ESC. Furthermore, both studies reported that males and young drivers were more likely to be involved in risk taking behaviour than females.

3.2 Original research of the effectiveness of ESC in reducing road trauma in Australia and overseas

As part of the work program funded by the Used Car Safety Ratings (UCSR) program sponsors, MUARC undertook an evaluation of ESC in Australasia, the results of which were published in *Accident Analysis and Prevention* (2008). The Scully and Newstead (2008) study formed the basis of the updated benefit calculations presented in Table 3.2. For the purposes of this report, we present the estimated effectiveness for all crashes, given that the rationale is to feed into the regulatory review agenda.

Following the original ESC evaluation in 2008, Scully and Newstead (2010) used three additional years of crash data (2006-2008) to further disaggregate the total fleet to determine the benefit, if any, of ESC for passenger cars, 4WD vehicles, and of direct relevance here, the effectiveness of ESC for light commercial vehicles. The statistical methods used to derive these effectiveness estimates is as per Scully and Newstead (2008) and these methods are not presented here for sake of brevity.

Table 3.2 presents the estimates of effectiveness of ESC in reducing the risk of all types of crashes (excluding rear impacts) for commercial vehicles and 4WD vehicles derived from the updated USCR database. None of the estimates of effectiveness for commercial vehicles were statistically significant and the low quantity of data meant that the estimated reduction in serious injury crashes was not calculated for commercial vehicles. This is the result of only 442 vehicles in the crash database being fitted with ESC. While not statistically significant, there was an indicative reduction in driver injury by 29.28% associated with ESC, with the 95% confidence bands suggesting that this could range from a reduction as high as 62% to a 32.8% increase. These estimates have been adjusted for year of manufacture and vehicle market class, as explained by Scully and Newstead (2008).

Table 3.2 Estimated percentage reduction in crash occurrence attributable to ESC

	# vehicles	% Crash reduction		Stat.	95% CL	
	with ESC	Unadjusted	Adjusted	sig.	Lower	Upper
Commercials only						
All severities	365	11.43	10.31	0.535	-11.34	27.75
Driver injury	42	30.54	29.28	0.281	-32.78	62.33
Driver ser. inj.	***	***	***	***	***	***
4WDs only						
All severities	4,210	14.30	12.79	<0.001	5.89	19.19
Driver injury	566	43.66	34.04	<0.001	18.23	46.79
Driver ser. inj.	64	24.31	6.01	0.902	-151.18	64.83

Source: Scully & Newstead (2010)

Estimates of effectiveness for 4WDs showed that ESC was associated with a significant 12.8% reduction in crashes of all severities and a 34.0% reduction in driver injury crashes. The estimate of the reduction in driver serious injury of 6% was not statistically significant.

It is clear then that there is insufficient Australian crash data available at present to derive a statistically reliable effectiveness value of ESC for light commercial vehicles. There was however some evidence of benefit for 4WD vehicles. While it could be assumed that the general vehicle dynamics and the high centre of gravity of the commercial vehicles and the 4WD vehicles are comparable, this remains uncertain. To derive an effectiveness estimate of ESC for light commercial vehicles additional years of crash data is required.

3.3 The overall likely effectiveness of ESC in reducing road trauma for use in this report

Based on the literature review and the limited information available in the Australian context specific to light commercial vehicles, it was determined that a benefit reduction value of 32% across all crash severities where ESC is likely to be relevant is most appropriate. To supplement this, a sensitivity analysis with a lower benefit value of 16% and an upper benefit value of 45% is to be undertaken in this report.

Confidence in these values can be derived in the selected range of 16% - (32%) - 45% given that:

a) the point estimate of 32% is comparable to:

   a. the currently available 'best' driver injury crash reduction benefit estimate of 29.28% for commercial vehicles in Australia (Section 3.2);

   b. the observed 34% reduction benefit in serious injury for 4WD vehicles in Australia (Section 3.2);

   c. the reported 34% benefit for 'all fatal crashes' in a European study (Sferco et al, 2001);

   d. the reported 32% benefit for 'ESC sensitive crashes' in a German study (Kreiss et al, 2005);

   e. the reported 31.5% benefit for 'all crashes in a wet road' in a Swedish study (Lie et al, 2004);

   f. the lower bound of the reported (32%) benefit for multiple vehicle crashes in the US (Farmer et al., 2006);

b) the point estimate is lower than the mean reduction value of 40% for all studies reviewed in Table 3.1;

c) the lower bound (16%) is the lowest reported benefit for 'all injury crashes' (Lie et al., 2006) of the studies reviewed in Table 3.1, and

d) the upper bound (45%) is the highest reported benefit for 'all injury crashes' (Becker et al., 2003) of the studies reviewed in Table 3.1.

It is recognised that these benefit values include effectiveness values relating to passenger cars and 4WD's, as well as light commercial vehicles. In lieu of this, we examined the crash profile by urban / rural location and speed zone to assess comparability in the crash distribution across vehicle types. Data for 1,079,098 drivers (rural: 19%, n = 209,436) involved in a police-reported crashes in the period 2001 to 2008 inclusive in New South Wales (NSW), Queensland (QLD), South Australia (SA), Victoria (Vic), Western Australia (WA) and New Zealand (NZ) were examined with the results presented in Figure 3.1.

Of 1,079,098 vehicles involved in all crashes (irrespective of severity) in the period (80.5% urban), 83.5% were passenger cars (n = 901,167; 80% urban), 7.6% were 4WD vehicles (n = 82,026; 75% urban) and 8.9% were light commercial vehicles (n = 95,905; 72% urban). As can be observed in Figure 3.1, the distribution across urban / rural location and speed zone were similar, however there was a somewhat higher proportion of light commercial vehicles involved in crashes occurring on 100 km/h rural roads (7.7%) than 4WD vehicles (5.6%) and passenger cars (4.7%); the proportional difference is even greater in the 110 km/h rural locations. Notably, 41.4%, 37% and 34.6% of passenger car, 4WD and light commercial vehicle injury crashes, respectively, occur in metropolitan locations on 60 km/h roads.

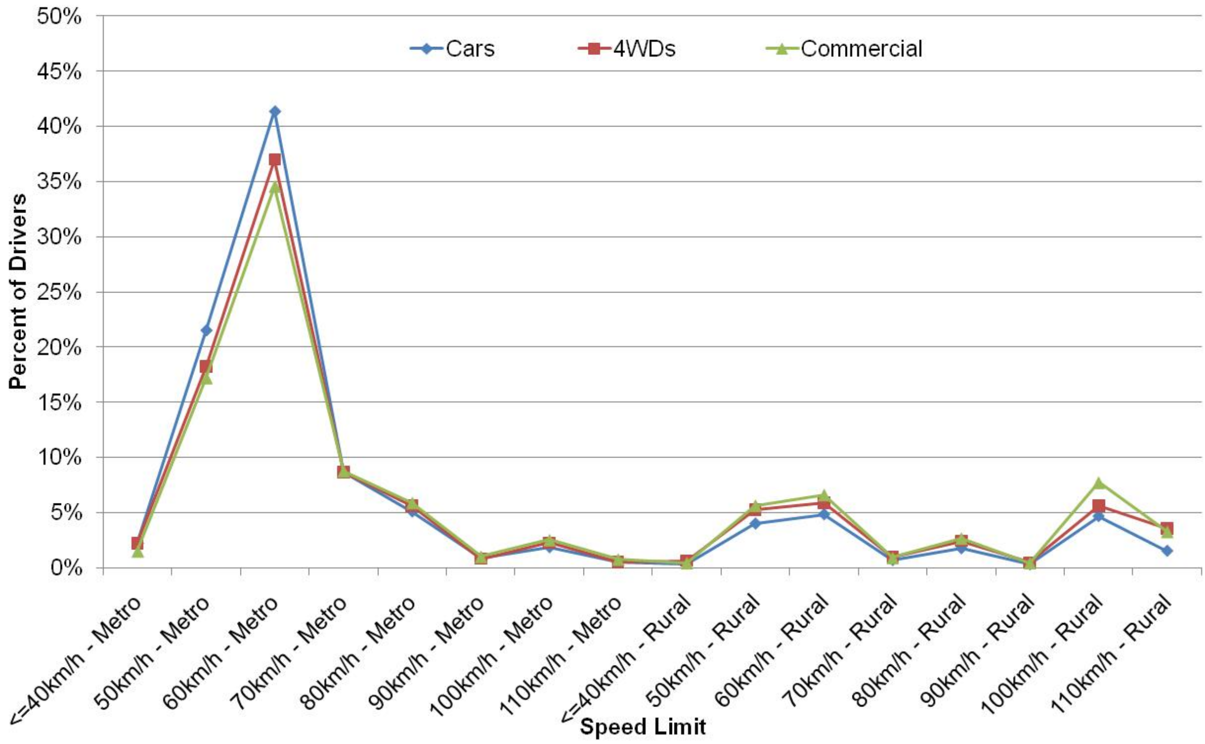


Figure 3.1 Passenger car, 4WD and light commercial vehicle crash distribution by urban and rural location and speed zone for *all injury severities*, 2001-2008.

Figure 3.2 presents the crash distribution by urban / rural location by speed zone for serious injury 24,868 crashes for passenger cars (n = 20,864, 80%), 4WD (n = 1,712, 7%) and light commercial vehicles (n = 2,292, 9%). The crash distribution is different to that for 'all severities' observed in Figure 3.1, with peaks in crash-involved vehicles in urban 60 km/h zones and rural 100 km/h zones. One-fifth (21.6%) of passenger cars involved in serious injury crashes occurred in urban locations on 60 km/h speed limit posted roads, while 15.2% and 12.5% of crash-involved 4WD and light commercial vehicles, respectively, occurred in these types of locations.

Crashes in rural locations clearly represent a significant contribution to the number of serious injury and fatality crashes. Approximately one-third of passenger car serious injury crashes occurred in rural location on roads with a posted limited of 100 km/h or 110 km/h, while 42.8% of 4WD and 46.5% of light commercial vehicle serious injury crashes occurred on rural roads with a posted limit of 100 km/h or 110 km/h.

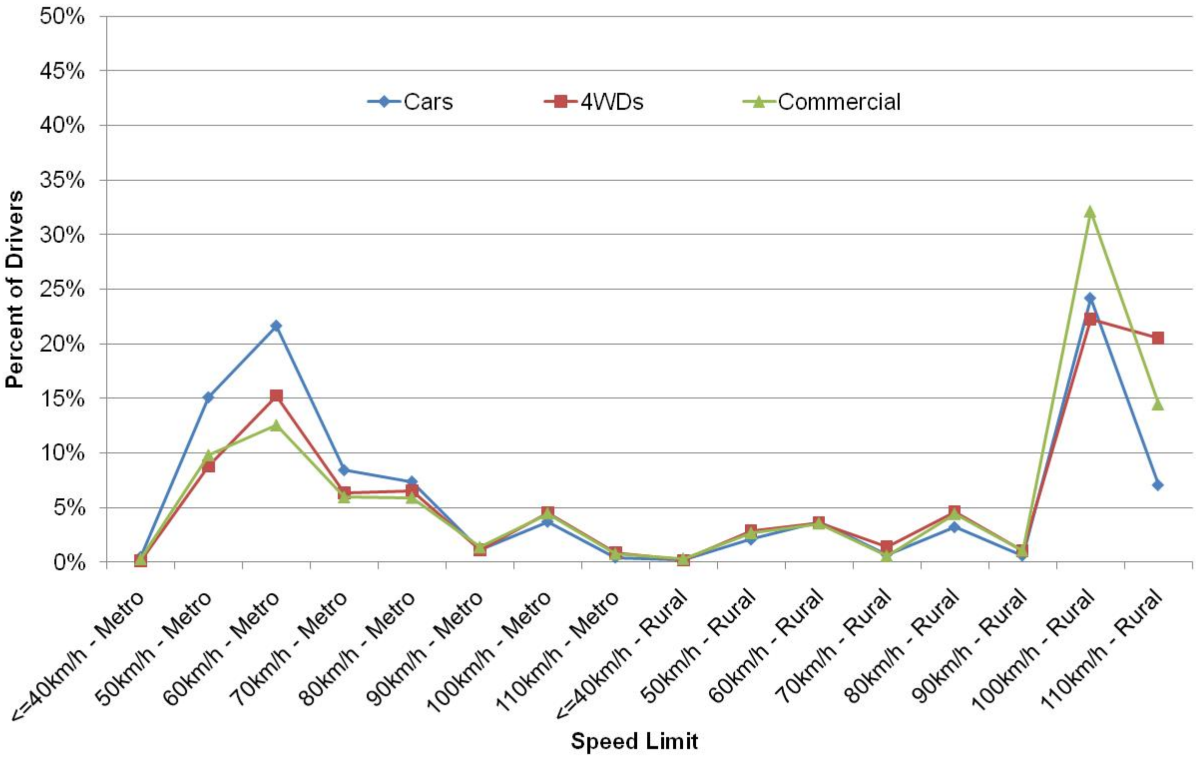


Figure 3.2 Passenger car, 4WD and light commercial vehicle crash distribution by urban and rural location and speed zone for *serious injury (+fatality) crashes*, 2001-2008.

The differential crash distribution of passenger cars, 4WD and light commercial vehicles at the more severe injury level has implications for method and interpretation of the benefit analysis reported here. It would be optimal to disaggregate total crash numbers by severity level and apply an ESC location and speed zone specific benefit value however this is not possible at this time due to a lack of Australia specific ESC benefit information.

There are two points to be made here:

1. the general distribution of crashes across vehicles types is *relatively* similar, and
2. by using a ‘flat’ ESC benefit estimate and not considering the crash distribution for light commercial vehicles, it is likely that the benefit estimates derived here are conservative, particularly if the high benefit estimates for ESC were to hold for light commercial vehicles in the high speed zones where the benefits of ESC would likely to be the greatest given the findings of international research.

3.4 Summary

For the analysis undertaken in this report a benefit reduction value of 32% across all crash severities will be used, with sensitivity analysis conducted using a lower benefit value of 16% and an upper benefit value of 45%.

4 ROAD TRAUMA COSTS AND ESC BENEFITS

This section of the report outlines the present crash picture, provides estimates of the future number of crashes involving light commercial vehicles and then derives the potential injury reduction benefits of ESC using known effectiveness estimates, as outlined in Section 3.

4.1 Present crash numbers and associated injury severity

The Used Car Safety Ratings (UCSR) database was used to determine the number of crashes Class NA vehicles were involved in during the period 2001 and 2008 (the latest year available). Crashes in NSW, Victoria, South Australia, Queensland and Western Australia were included in the analysis.

The identification of Class NA vehicles in the database was via the make and model, the year of manufacture and the VIN of the crashed vehicle, the latter which permitted the determination of whether ESC was fitted to the vehicle.

Table 4.1 and Figure 4.1 show the number of Class NA vehicles involved in crashes captured by the UCSR database, by Australian State. It is evident that the number of vehicles involved in crashes has increased and this is likely to be a function of the reported increased number of vehicles in this class being purchased. An interesting observation is that NSW and WA each account for approximately 30% of crash involved vehicles, while Victoria has the fewest number involved, ranging from 5% to 10%.

Table 4.2 disaggregates the data based on 'not injured', 'injured but not seriously' (herein referred to as minor) and 'seriously injured' (serious plus fatal) for the driver. As presented in Table 4.2, 89.4% of crash-involved Class NA vehicles resulted in no injury to the driver, while 7.9% resulted in a 'minor' injury and 2.7% of Class NA crashes resulted in the driver being seriously injured.

Table 4.1 Number of Class NA vehicles – hence drivers - involved in crashes, by State and year of crash

Year	NSW		VIC		QLD		WA		SA		Total	
	N.	%	N.	%	N.	%	N.	%	N.	%	N.	%
2001	3,694	28.5	681	5.3	2,079	16.1	3,677	28.4	2,808	21.7	12,939	100
2002	3,444	25.1	798	5.8	2,184	15.9	4,066	29.7	3,217	23.5	13,709	100
2003	3,566	25.9	903	6.6	2,434	17.7	4,120	29.9	2,752	20.0	13,775	100
2004	4,144	27.9	1,008	6.8	2,658	17.9	4,794	32.3	2,257	15.2	14,861	100
2005	5,588	35.5	1,674	10.6	1,228	7.8	4,984	31.6	2,284	14.5	15,758	100
2006	5,426	29.6	1,280	7.0	3,488	19.0	5,861	31.9	2,303	12.5	18,358	100
2007	5,002	26.7	742	4.0	4,045	21.6	6,329	33.7	2,639	14.1	18,757	100
2008	5,941	31.0	809	4.2	3,205	16.7	6,388	33.3	2,829	14.8	19,172	100
Total	36,805	28.9	7,895	6.2	21,321	16.7	40,219	31.6	21,089	16.6	127,329	100

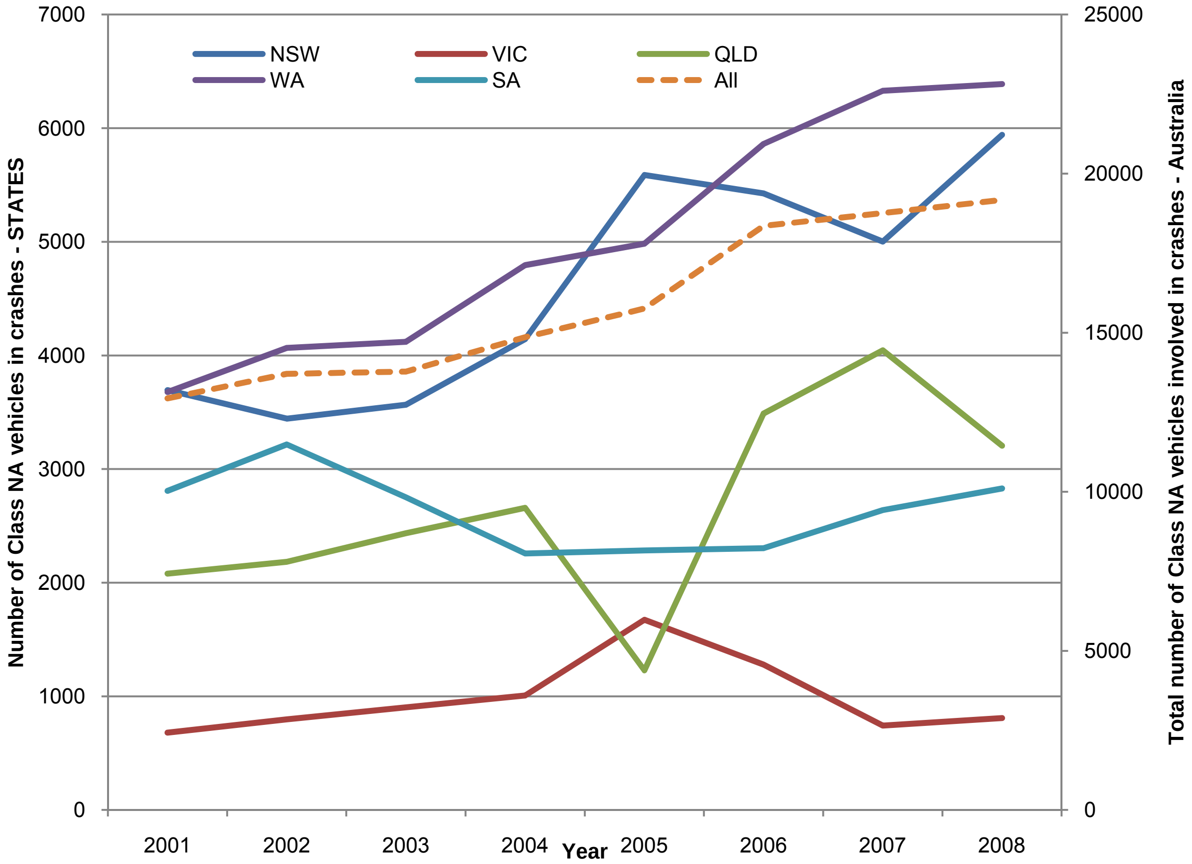


Figure 4.1 Total number of Class NA vehicles involved in crashes in 5 states (dashed line), and for each state individually

Table 4.2 Number of Class NA vehicles involved in crashes, by driver injury severity

Year	Uninjured		Injured – minor		Injured – serious		All severities	
2001	11,736	90.7%	952	7.4%	251	1.9%	12,939	100
2002	12,421	90.6%	972	7.1%	316	2.3%	13,709	100
2003	12,337	89.6%	1,078	7.8%	360	2.6%	13,775	100
2004	13,315	89.6%	1,146	7.7%	400	2.7%	14,861	100
2005	14,066	89.3%	1,274	8.1%	418	2.7%	15,758	100
2006	16,149	88.0%	1,543	8.4%	666	3.6%	18,358	100
2007	16,636	88.7%	1,585	8.5%	536	2.9%	18,757	100
2008	17,162	89.5%	1,547	8.1%	463	2.4%	19,172	100
Total	113,822	89.4%	10,097	7.9%	3,410	2.7%	127,329	100
Average	14,227	89.4%	1,262	7.9%	426	2.7%	15,916	100

4.2 Prediction of the future number of crashes

This section derives estimates of the future number of crashes in the light commercial category, which is then to be used as the basis for determining the crash-based benefit of ESC for Australia into the future.

4.2.1 Derivation of the future number of crash involved Class NA vehicles

To arrive at the end-point of determining the crash reduction effect of ESC on the total crash population, we must undertake a number of estimations, these being:

1. the total number of registered Class NA vehicles in the Australian fleet into the future, 2010-2039
2. of the total number of registered Class NA vehicles in the future fleet, the number involved in crashes

Estimation of the total number of registered light commercial vehicles in Australia

According to the ABS Motor Vehicle Census, in 2008 there were a total of 2,288,216 light commercial vehicles registered in Australia (excludes 132,637 registrations in the Australian Capital Territory (ACT), Tasmania (Tas), Northern Territory (NT); total: 2,371,082 – as we do not have crash data for these jurisdictions).

It is also known from VFACTS that there were 185,016 new light commercial vehicles registered in that year. *Hence, new light commercial vehicle sales represented 0.081 of the total Australian light commercial vehicle population in 2008.*

To estimate the total number of registered light commercial vehicles based on new vehicle sales for future years, we derive the reciprocal of 1 / 0.081 = 12.34567 (Variable B, Table 4.3, 4.4, 4.5). Using the multiplier of 12.34567 we can estimate the total number of light commercial vehicles at any point in the future, assuming constancy of de-registration. This step is necessary to then determine the number of vehicles involved in crashes, given the average probability of being involved in a crash.

Using the projected number of new Class NA vehicle sales from Section 2.3 - Table 2.5 (shown as Variable A, Table 4.3, 4.4, 4.5), we then derive the total number of Class NA vehicles registered for the period 2010 – 2039, as per below:

*[Total number of Class NA vehicles in Australia (C) = Future new sales (A) * Fleet multiplier (B)]*

Estimation of the number of light commercial vehicles involved in crashes in the future

Having estimated the total number of new light commercials to the fleet and the total light commercial fleet size, it is possible to then estimate the future number of Class NA vehicles involved in future crashes.

To calculate the future number of crashes, we used the entire light commercial fleet however we could also have used an estimation of the probability of a vehicle being involved in a crash in its first year of life. Both figures provide can the basis of any future calculation, however the first is preferable as it represents an average probability of being involved in a crash across all crashes and registered vehicles; it is thus likely to be more reliable.

If we consider that there were 19,172 light commercial vehicles involved in crashes in 2008 (Table 4.2), the proportion of registered vehicles being involved in a crash was 0.0085, or 8.5 vehicles involved in crashes for every 1000 registered vehicles (Variable D, Table 4.3, 4.4, 4.5). Thus, the proportion of 0.0085 can be used as the average basis for crash involvement, and over the life of the vehicle and given the fleet, allows for deregistration of vehicles. For this report it is preferable to base the proportion of crashes experienced by new vehicles into the future as it relies on all registrations and crashes occurring in the 5 Australian jurisdictions.

It is also necessary to inflate the number of crashes in order to account for the registration and crash profile of the ACT, Tasmania and the Northern Territory. This factor (1.055939; Variable F, Table 4.3, 4.4, 4.5) is derived by taking the reciprocal (1/x) of the proportion of registrations in these three jurisdictions (n=132,637) per the number of registered vehicles in Australia (n= 2,371,082).

Table 4.3 – 4.5 presents the estimated number of vehicles involved in crashes projected to 2039 (Series A, B, C), using the new vehicle sales, the fleet multiplier – which accounts for present new vehicle: registration ratio, and the proportion of registered vehicles involved in crashes. We see from Table 4.3 that an estimated 20,547 light commercial vehicle involved in crashes might be expected in 2010 using the ABS Series A population projection as the basis for the future, and this number of crashes increases to 2039. Inclusion of the ACT, NT and Tasmania increases this by a uniform factor of 1.055939. By way of example, the total number of light commercial vehicles involved in crashes is estimated to be 21,696 in 2039, using the Series A projection values.

Under Series A the number of crashes is predicted to increase by a factor of 2.7 while the increase using Series C was a factor of 1.94.

Assumptions relevant to the estimation of the number of light commercial vehicles involved in crashes

Assumption: that the general road safety performance, both generally and specifically to the vehicle class, is constant over the period

Assumption: that the relationships between new vehicle sales and total registrations is constant, using 2008 as the basis of estimation.

Assumption: that the relationship, or the probability of crashing, is constant over the period, using 2008 as the basis of estimation (this assumes crash reduction benefits through active safety technology is the same in other market segments)

Assumption: that the crash distribution in the ACT, NT and Tasmania is similar, on average, to the Rest of Australia, and assumes a perfect proportional relationship between crash numbers and registration.

Table 4.3 Projected number of vehicles, by ABS population projection series A

Year	Series A projected sales (A)†	Fleet multiplier (B)‡	Total registered vehicles (C = A*B)	Class NA crash-involvement as a proportion of all registered vehicles in crashes (D)Ω	Total number of NA vehicles involved in crashes (E = C*D)*	Multiplier for Tas, NT and ACT (F)*	Total number of light commercial vehicles involved in crashes, Australia (G=E*F)
2010	195,800	12.34567	2,417,277	0.0085	20,547	1.055939	21,696
2015	250,141	12.34567	3,088,161	0.0085	26,249	1.055939	27,718
2020	308,154	12.34567	3,804,372	0.0085	32,337	1.055939	34,146
2025	368,993	12.34567	4,555,463	0.0085	38,721	1.055939	40,887
2030	430,844	12.34567	5,319,058	0.0085	45,212	1.055939	47,741
2035	492,816	12.34567	6,084,147	0.0085	51,715	1.055939	54,608
2039	542,641	12.34567	6,699,271	0.0085	56,943	1.055939	60,129

†See Section 2.3, Estimation of new vehicles to be supplied to market over next 30 years- population-based prediction
‡ Reciprocal of the proportion of Class NA vehicles in the total Australian vehicle fleet – derived from ABS Motor Vehicle Census and number of new registered vehicles for 2008 (VFACTS)
Ω Estimated by number of Class NA vehicles in crashes (see Table 4.2) and total Australian vehicle fleet, per ABS Motor Vehicle Census
** Multiplier estimated as the reciprocal of the proportion of registrations from Tasmania, NT and ACT of the total vehicle registrations in Australia, per the ABS Motor Vehicle Census*

Table 4.4 Projected number of vehicles, by ABS population projection series B

Year	Series B projected sales (A)†	Fleet multiplier (B)‡	Total registered vehicles (C = A*B)	Class NA crash-involvement as a proportion of all registered vehicles in crashes (D)Ω	Total number of NA vehicles involved in crashes (E = C*D)*	Multiplier for Tas, NT and ACT (F)*	Total number of light commercial vehicles involved in crashes, Australia (G=E*F)
2010	193,665	12.34567	2,390,924	0.0085	20,322	1.055939	21,459
2015	239,521	12.34567	2,957,047	0.0085	25,134	1.055939	26,540
2020	285,568	12.34567	3,525,528	0.0085	29,966	1.055939	31,643
2025	330,958	12.34567	4,085,898	0.0085	34,730	1.055939	36,672
2030	374,655	12.34567	4,625,366	0.0085	39,315	1.055939	41,514
2035	415,670	12.34567	5,131,724	0.0085	43,619	1.055939	46,059
2039	446,691	12.34567	5,514,699	0.0085	46,874	1.055939	49,497

†See Section 2.3, Estimation of new vehicles to be supplied to market over next 30 years- population-based prediction
‡ Reciprocal of the proportion of Class NA vehicles in the total Australian vehicle fleet – derived from ABS Motor Vehicle Census and number of new registered vehicles for 2008 (VFACTS)
Ω Estimated by number of Class NA vehicles in crashes (see Table 4.2) and total Australian vehicle fleet, per ABS Motor Vehicle Census
** Multiplier estimated as the reciprocal of the proportion of registrations from Tasmania, NT and ACT of the total vehicle registrations in Australia, per the ABS Motor Vehicle Census*

Table 4.5 Projected number of vehicles, by ABS population projection series C

Year	Series C projected sales (A)†	Fleet multiplier (B)‡	Total registered vehicles (C = A*B)	Class NA crash-involvement as a proportion of all registered vehicles in crashes (D)Ω	Total number of NA vehicles involved in crashes (E = C*D)*	Multiplier for Tas, NT and ACT (F)*	Total number of light commercial vehicles involved in crashes, Australia (G=E*F)
2010	191,509	12.34567	2,364,306	0.0085	20,096	1.055939	21,220
2015	229,240	12.34567	2,830,121	0.0085	24,056	1.055939	25,401
2020	264,937	12.34567	3,270,824	0.0085	27,802	1.055939	29,357
2025	298,212	12.34567	3,681,626	0.0085	31,293	1.055939	33,044
2030	329,147	12.34567	4,063,540	0.0085	34,540	1.055939	36,472
2035	356,821	12.34567	4,405,194	0.0085	37,444	1.055939	39,538
2039	376,591	12.34567	4,649,268	0.0085	39,518	1.055939	41,729

†See Section 2.3, Estimation of new vehicles to be supplied to market over next 30 years- population-based prediction
‡ Reciprocal of the proportion of Class NA vehicles in the total Australian vehicle fleet – derived from ABS Motor Vehicle Census and number of new registered vehicles for 2008 (VFACTS)
Ω Estimated by number of Class NA vehicles in crashes (see Table 4.2) and total Australian vehicle fleet, per ABS Motor Vehicle Census
** Multiplier estimated as the reciprocal of the proportion of registrations from Tasmania, NT and ACT of the total vehicle registrations in Australia, per the ABS Motor Vehicle Census*

4.2.2 Accounting for ESC device ‘crash relevance’

As described in Section 3, ESC is effective, or relevant, for particular crash types, such as loss-of-control run-off-road crashes and irrelevant for others crash types, specifically rear impact crashes. It is also known that the types of crashes that ESC is relevant for differ in their proportions based on crash severity.

Using the UCSR database, it is estimated the ESC would be ‘relevant’ in the following proportions:

- 88.8% of vehicles involved in serious injury crashes
- 66.8% of minor injury crashes, and
- 62.9% of non-injury / property damage crashes.

Using these proportions, we reduce the number of Class NA vehicles involved in crashes – as shown in Table 4.6, by the ‘device relevant proportion’ once the overall predicted crash number is disaggregated into serious injury, minor injury and non-injury crashes. The next section accounts for ‘ESC device relevance’ when disaggregating the predicted number of light commercial vehicles involved in crashes shown in Table 4.3, 4.4 and 4.5 into crash severity categories.

4.2.3 Estimation of the future number of crashes by severity

Section (4.2.1) estimated the *total* number of light commercial vehicles involved in crashes into the future, based on population growth estimates and historical trends in the vehicle fleet. It is necessary to disaggregate the total number into fatal, serious injury, minor injury and property damage only crashes. This represents an essential step given the differential cost on the basis of crash-injury severity.

The distribution of crashes by severity in Australia is as follows:

- Serious injury crashes (fatal plus serious injury): 2.7%
    - Fatalities: 9.17%
    - Serious injury: 90.83%
- Minor injury: 7.9%
- Property damage only: 89.4%

To arrive at the total number of light commercial vehicles involved in crashes by severity, we apply the known severity distribution *and* the ESC relevance factor (Section 4.2.2) to the projected number of crash-involved Class NA vehicles (Table 4.3, 4.4. 4.5).

Using Projection Series A as an example where it was estimated that in 2010 that there would be 21,696 Class NA vehicles involved in crashes in Australia, we estimate that there will be:

- 520 Class NA vehicles involved in Serious Injury crashes, and of these:
    - 48 involve a driver fatality
    - 472 involve a driver serious injury
- 1,145 Class NA vehicles involved in Minor Injury crashes (to the driver)
- 12,200 Class NA vehicles involved in Serious Injury crashes (to the driver)

Following the above calculations, we estimate that in 2010 there will be 13,865 crash-involved vehicles amenable to mitigation due to ESC (of the estimated 21,696 crash-involved vehicles).

Table 4.6 Estimated total number of light commercial vehicles involved in crashes by driver injury severity amenable to ESC, Series A

Year	*Serious injury crashes (fatal + serious)*	Fatal	Serious	Minor	Property damage only	Total crash-involved vehicle amenable to ESC
2010	520	48	472	1,145	12,200	13,865
2011	548	50	498	1,207	12,860	14,615
2012	577	53	524	1,270	13,528	15,375
2013	606	56	550	1,333	14,205	16,144
2014	635	58	577	1,397	14,891	16,923
2015	665	61	604	1,463	15,586	17,714
2016	695	64	631	1,529	16,291	18,515
2017	725	66	659	1,596	17,005	19,326
2018	756	69	687	1,664	17,728	20,148
2019	787	72	715	1,732	18,461	20,980
2020	819	75	744	1,802	19,201	21,822
2021	851	78	773	1,872	19,949	22,672
2022	883	81	802	1,943	20,704	23,530
2023	915	84	831	2,014	21,463	24,392
2024	948	87	861	2,086	22,226	25,260
2025	980	90	890	2,158	22,992	26,130
2026	1,013	93	920	2,230	23,760	27,003
2027	1,046	96	950	2,302	24,530	27,878
2028	1,079	99	980	2,374	25,301	28,754
2029	1,112	102	1,010	2,447	26,073	29,632
2030	1,145	105	1,040	2,519	26,846	30,510
2031	1,178	108	1,070	2,592	27,619	31,389
2032	1,211	111	1,100	2,664	28,391	32,266
2033	1,243	114	1,129	2,737	29,163	33,143
2034	1,276	117	1,159	2,809	29,935	34,020
2035	1,309	120	1,189	2,882	30,708	34,899
2036	1,342	123	1,219	2,954	31,481	35,777
2037	1,375	126	1,249	3,027	32,256	36,658
2038	1,408	129	1,279	3,100	33,033	37,541
2039	1,442	132	1,309	3,173	33,812	38,426

For purposes of brevity, the Series B and Series C disaggregation numbers are presented in Appendix D (Series B) and Appendix E (Series C).

4.3 Calculation of the influence of ESC: adjusting for the effect of fitment rates and vehicle penetration into the fleet over time

Having determined an estimate of the composition of the fleet for every year from 2010 until 2039 and the predicted number of Class NA vehicles involved in a crash by severity (Table 4.6), the next step was to incorporate the influence of ESC fitment, the penetration of new vehicles into the fleet – and hence their involvement in crashes, and the estimated crash reduction benefit of ESC itself.

The sub-sections below present the various derived variables required to link future crashes with the installation of ESC and its associated crash benefit.

4.3.1 Derivation of ESC benefit multipliers – ESC effectiveness

This section provides estimates of the influence of ESC on 'ESC-amenable' crashes, by deriving two benefit multipliers (Table 4.7), these being:

a) Base multiplier (M-base) using the proportion of vehicles likely to be fitted with ESC, and the penetration of these vehicles into the fleet and by extension involved in crashes, and

b) ESC penetration-effectiveness multiplier (M-x, where x is the % ESC crash reduction effect value) using the percent crash reduction benefit of ESC as per Section 3.3 and Section 3.4.

These multipliers form the basis of determining the crash reduction effects of ESC.

Likely ESC fitment and penetration was estimated in Table 2.6 of this report, the basis of which was the observed historical fitment of ESC into passenger cars. To recap, it was estimated that by 2020, all new light commercial Class NA vehicles sold would be fitted with ESC as standard equipment.

As we are deriving benefits for the next 30 years, we must derive benefit multipliers for every year until 30 years from now that account for vehicle penetration rates and the age of the vehicle. The age-based vehicle penetration rate (i.e., the proportion by age vehicles represent in the fleet) was obtained using the Used Car Safety Ratings Database (USCRD) which included 127,000 drivers of Class NA vehicles. We can then determine for every year the proportion these vehicles would represent in crashes in a cumulative fashion. For instance, 78.7% of crash-involved light commercial vehicles would be equal to or less than 10 years of age.

Using the ESC device fitment rate into new vehicles (Column A, Table 4.7) and the age-based distribution into the vehicle fleet, the *'base multiplier'* is derived (Column C; Table 4.7) by multiplication. This represents the proportion of crash-involved Class NA vehicles that would have ESC fitted for every year until 2039.

It is then necessary to incorporate the estimated crash reduction benefit into the base multiplier (Column C, Table 4.7) to derive the likely benefits of ESC on crashes and their associated costs in Australia. As noted in Section 3.3 and 3.4, we used a point estimate of 32% benefit (Column D, Table 4.7) and values of 16% and 45% for the sensitivity analysis. The ESC penetration effectiveness *benefit multiplier* is then a product of the proportion of the fleet with ESC fitted at the specified period and the crash-injury reduction benefit for the driver (Table 4.7). Given the movement of vehicles through the fleet and the estimation that by 2020 all new Class NA vehicles would have ESC fitted as standard equipment, it would not be until 2034 that the full 32% crash reduction effect of ESC would be felt throughout the entire Class NA fleet under the predicted business-as-usual fitment scenario.

Table 4.7 Derivation of ESC benefit multipliers for a 32% ESC crash reduction benefit

Year	ESC device penetration (proportion new vehicles fitted with ESC)	Age of vehicle (year 0 is its first year of life)	Vehicle age /new vehicle penetration (based on % in crash)	Multiplier (M-base)	% ESC crash reduction benefit	ESC penetration effectiveness Multiplier (M-32)
	(A)		(B)	(C) = (A*B)	(D)	(E) = (C*D)
2010	0.083	0	0.038	0.003154	32%	0.001009
2011	0.183	1	0.139	0.025437	32%	0.00814
2012	0.2793	2	0.236	0.065915	32%	0.021093
2013	0.3772	3	0.408	0.153898	32%	0.049247
2014	0.4751	4	0.48	0.228048	32%	0.072975
2015	0.573	5	0.544	0.311712	32%	0.099748
2016	0.6709	6	0.603	0.404553	32%	0.129457
2017	0.7688	7	0.657	0.505102	32%	0.161633
2018	0.8668	8	0.705	0.611094	32%	0.19555
2019	0.9647	9	0.748	0.721596	32%	0.230911
2020	1	10	0.787	0.787	32%	0.25184
2021	1	11	0.823	0.823	32%	0.26336
2022	1	12	0.855	0.855	32%	0.2736
2023	1	13	0.882	0.882	32%	0.28224
2024	1	14	0.906	0.906	32%	0.28992
2025	1	15	0.928	0.928	32%	0.29696
2026	1	16	0.947	0.947	32%	0.30304
2027	1	17	0.963	0.963	32%	0.30816
2028	1	18	0.975	0.975	32%	0.312
2029	1	19	0.983	0.983	32%	0.31456
2030	1	20	0.989	0.989	32%	0.31648
2031	1	22	0.994	0.994	32%	0.31808
2032	1	23	0.997	0.997	32%	0.31904
2033	1	24	0.99	0.99	32%	0.3168
2034	1	25	1	1	32%	0.32
2035	1	26	1	1	32%	0.32
2036	1	27	1	1	32%	0.32
2037	1	28	1	1	32%	0.32
2038	1	29	1	1	32%	0.32
2039	1	30	1	1	32%	0.32

Note: for the sensitivity analysis, multiple is obtained as the product of M-base and the percent ESC benefit level (i.e., 16%, 45%)

4.4 Derivation of crash reduction effects of ESC in Australia by severity

The final step in calculating the number of crashes reduced by severity is obtained by multiplying the future estimated number of crash-involved Class NA vehicles – where ESC is likely to be relevant for each year (Table 4.6) by the ESC penetration-effectiveness Multiplier (Table 4.7). Provided below are workings for the year 2010, Series A.

For each year going forward from 2010 to 2039 inclusive, we have estimated the number of injury crashes where ESC will influence, based on vehicle fleet projections. For 2010 Series A, we estimate that there will be 520 Class NA vehicles involved in a crash resulting in a serious injury to the driver (see Table 4.6, and below for 2010).

From Table 4.6

Year	*Serious injury crashes*	Fatal	Serious	Minor	Property damage only
2010	520	48	472	1,145	12,200

For each year, and the associated number of Class NA vehicles involved in crashes, we apply the year specific ESC penetration-effectiveness multiplier. This accounts for increasing fitment of ESC, the movement of these vehicles through the fleet over 30 years, and the percent crash reduction effect of ESC itself (see Table 4.7, and below for 2010).

From Table 4.7

Year	ESC device penetration (proportion new vehicles fitted with ESC)	Age of vehicle (year 0 is its first year of life)	Vehicle age /new vehicle penetration (based on % in crash)	Multiplier (M-base)	% ESC crash reduction benefit	**ESC penetration effectiveness Multiplier (M-32)**
	(A)		(B)	(C) = (A*B)	(D)	**(E) = (C*D)**
2010	0.083	0	0.038	0.003154	32%	**0.001009**

Using the above, we derive the expected reductions for each year. As an e*xample, we use 2010, Series A to show the arithmetic:*

- *Serious injury reduction = 520 ** 0.001009 = 0.53 fewer
    - *Fatal injury reduction = 48 ** 0.001009 = 0.05 fewer
    - *Serious injury reduction = 472 ** 0.001009 = 0.48 fewer
- *Minor injury reduction = 1,145 ** 0.001009 = 1,16 fewer
- *PDO reduction = 12,200 ** 0.001009 = 12.31 fewer

Table 4.8a, b and c presents the savings associated with ESC fitment for each year by projection series. The aggregate saving in fatalities due to ESC fitment, under a business-as-usual fitment scenario using Series A projections, and assuming no further changes to the present day factors associated with the road toll, is estimated to be 700 fewer deaths in Class NA vehicles, 6933 fewer serious injuries, 16,802 fewer minor injury cases, and

179,038 fewer PDO crashes. These savings form the basis of financial benefit calculations, and associated BCR calculations.

Table 4.8a Predicted reductions in the number of light commercial vehicles involved in crashes by severity for each year, 2010 – 2039, Series A projection.

Year	Series A				
	Fatal + Serious	Fatal	Serious	Minor	PDO
2010	0.53	0.05	0.48	1.16	12.31
2011	4.46	0.41	4.05	9.82	104.68
2012	12.17	1.12	11.05	26.78	285.35
2013	29.83	2.74	27.09	65.65	699.56
2014	46.33	4.25	42.08	101.98	1,086.69
2015	66.29	6.08	60.21	145.90	1,554.71
2016	89.92	8.25	81.67	197.92	2,108.97
2017	117.19	10.75	106.44	257.94	2,748.56
2018	147.81	13.55	134.26	325.34	3,466.79
2019	181.75	16.67	165.09	400.04	4,262.76
2020	206.18	18.91	187.27	453.80	4,835.64
2021	224.01	20.54	203.47	493.06	5,253.89
2022	241.53	22.15	219.38	531.61	5,664.66
2023	258.29	23.69	234.60	568.50	6,057.85
2024	274.75	25.19	249.55	604.73	6,443.88
2025	291.12	26.70	264.42	640.75	6,827.73
2026	306.99	28.15	278.84	675.70	7,200.14
2027	322.30	29.55	292.74	709.39	7,559.06
2028	336.58	30.86	305.71	740.82	7,893.97
2029	349.70	32.07	317.63	769.69	8,201.67
2030	362.26	33.22	329.04	797.34	8,496.24
2031	374.56	34.35	340.22	824.43	8,784.92
2032	386.20	35.41	350.79	850.04	9,057.82
2033	393.92	36.12	357.80	867.03	9,238.84
2034	408.43	37.45	370.98	898.97	9,579.23
2035	418.97	38.42	380.55	922.17	9,826.43
2036	429.52	39.39	390.14	945.39	10,073.90
2037	440.09	40.36	399.74	968.66	10,321.84
2038	450.69	41.33	409.36	991.99	10,570.44
2039	461.33	42.30	419.03	1,015.40	10,819.90
30 year total	7,633.69	700.02	6,933.68	16,802.02	179,038.42

Table 4.8b Predicted reductions in the number of light commercial vehicles involved in crashes by severity for each year, 2010 – 2039, Series B projection.

Year	Series B				
	Fatal + Serious	Fatal	Serious	Minor	PDO
2010	0.52	0.05	0.47	1.14	12.18
2011	4.39	0.40	3.98	9.65	102.86
2012	11.88	1.09	10.79	26.14	278.58
2013	28.93	2.65	26.28	63.68	678.57
2014	44.65	4.09	40.56	98.28	1,047.28
2015	63.47	5.82	57.65	139.71	1,488.70
2016	85.55	7.85	77.71	188.30	2,006.49
2017	110.77	10.16	100.62	243.82	2,598.07
2018	138.81	12.73	126.08	305.52	3,255.55
2019	169.55	15.55	154.01	373.19	3,976.66
2020	191.07	17.52	173.55	420.54	4,481.21
2021	206.21	18.91	187.30	453.88	4,836.44
2022	220.86	20.25	200.61	486.12	5,179.94
2023	234.65	21.52	213.13	516.46	5,503.30
2024	247.99	22.74	225.25	545.85	5,816.40
2025	261.11	23.94	237.16	574.71	6,123.95
2026	273.64	25.09	248.55	602.29	6,417.85
2027	285.50	26.18	259.32	628.40	6,696.03
2028	296.31	27.17	269.14	652.19	6,949.54
2029	305.97	28.06	277.91	673.44	7,176.03
2030	315.01	28.89	286.13	693.35	7,388.21
2031	323.73	29.69	294.04	712.53	7,592.58
2032	331.75	30.42	301.33	730.19	7,780.76
2033	336.32	30.84	305.48	740.26	7,888.01
2034	346.60	31.78	314.81	762.87	8,129.00
2035	353.38	32.41	320.98	777.81	8,288.18
2036	360.09	33.02	327.07	792.57	8,445.40
2037	366.71	33.63	333.08	807.15	8,600.78
2038	373.27	34.23	339.04	821.57	8,754.50
2039	379.76	34.82	344.93	835.86	8,906.73
30 year total	6,668.45	611.50	6,056.94	14,677.48	156,399.78

Table 4.8c Predicted reductions in the number of light commercial vehicles involved in crashes by severity for each year, 2010 – 2039, Series C projection.

Year	Series C				
	Fatal + Serious	Fatal	Serious	Minor	PDO
2010	0.51	0.05	0.47	1.13	12.04
2011	4.31	0.40	3.91	9.48	101.03
2012	11.59	1.06	10.53	25.51	271.82
2013	28.05	2.57	25.47	61.73	657.79
2014	43.01	3.94	39.06	94.66	1,008.71
2015	60.75	5.57	55.18	133.71	1,424.81
2016	81.37	7.46	73.90	179.09	1,908.33
2017	104.70	9.60	95.10	230.45	2,455.57
2018	130.38	11.96	118.43	286.97	3,057.93
2019	158.28	14.51	143.76	348.38	3,712.21
2020	177.26	16.26	161.01	390.16	4,157.46
2021	190.14	17.44	172.70	418.50	4,459.45
2022	202.41	18.56	183.85	445.52	4,747.36
2023	213.80	19.61	194.19	470.57	5,014.31
2024	224.69	20.60	204.08	494.54	5,269.71
2025	235.27	21.57	213.70	517.84	5,518.03
2026	245.26	22.49	222.77	539.82	5,752.16
2027	254.57	23.34	231.22	560.31	5,970.51
2028	262.87	24.11	238.77	578.59	6,165.34
2029	270.10	24.77	245.33	594.51	6,334.93
2030	276.75	25.38	251.37	609.13	6,490.78
2031	283.06	25.96	257.10	623.02	6,638.72
2032	288.72	26.48	262.24	635.48	6,771.51
2033	291.35	26.72	264.63	641.27	6,833.22
2034	298.88	27.41	271.47	657.85	7,009.86
2035	303.35	27.82	275.54	667.69	7,114.78
2036	307.72	28.22	279.50	677.29	7,217.06
2037	311.97	28.61	283.36	686.65	7,316.80
2038	316.12	28.99	287.13	695.78	7,414.07
2039	320.16	29.36	290.80	704.69	7,508.98
30 year total	5,897.38	540.80	5,356.58	12,980.33	138,315.29

5 FINANCIAL BENEFITS OF ESC FITMENT

Having obtained the estimated reductions in the number of fatalities, serious injuries, minor injuries and property damage crashes, the translation of these savings into financial benefits is straightforward. In the first instance, the calculation of the present day value of crash costs by severity is required. Once done, and with appropriate discounting, these values are applied to the number of injury crashes saved, as described in Section 4.

5.1 Derivation of the present day value of crashes

To derive the economic benefit associated with these predicted reductions presented in Table 4.8a-c, we use the Australian Government *Best Practice Regulation Guidance Note: Value of statistical life* which stipulated an economic cost of $A3.5 million in 2007 dollars. This value was inflated by a factor of 1.0610358 to bring this value to 2010 dollar values (ABS, CPI values). It is necessary to derive the cost of serious injury, minor injury and property damage only crashes by using the ratio of the BTE costs shown in Table 5.1 and applying this to the cost of a fatality.

Using the cost of crashes estimated by the Bureau of Transport Economics (BTE, 2000), which were based on 1996 crashes and associated costs (Australian Bureau of Statistics, 2010f), we then determine the cost ratio for other crash types and apply this to the updated cost of a fatality. Table 5.1 presents the BTE crash costs in 1996 and the updated cost of injury inflated to 2010 values.

Table 5.1 BTE crash costs in 1996, their ratio to fatalities and the derived updated cost for each injury severity

Severity	$A(1996)	Ratio	CPI indexation factor	$A2007, Dept of Finance, Australian Government (Fatal: $A3.5m, 2007)
Fatal	$A1,500,000	1 (reference)	1.06103	$A3,713,625.15
Serious	$A325,000	0.21667	1.06103	$A804,618.78
Minor	$A12,000	0.008	1.06103	$A29,709.00
Property damage	$A6,000	0.004	1.06103	$A14,854.50

5.2 Reductions in crash costs due to the installation of ESC over the next 30 years

The information presented thus far provides the basis for the calculation of the bottom line cost savings associated with the installation of ESC under a 'business-as-usual scenario', assuming a 32% ESC effectiveness value. Use of the information in Tables 4.8a-c in combination with Table 5.1 permits the total benefit savings by injury severity and hence the aggregate financial benefit in today's terms. The aggregate savings associated with ESC – assuming 32% crash reduction effectiveness, are presented in Table 5.2.

The benefit values presented in Table 5.2 have been *discounted* through per the practice as articulated by the Office of Best Practice Regulation (Department of Finance and Deregulation, 2008). A 7% discount factor was used calculated for each year so that the total benefit in each of the 30 years can be determined. The discount rate is calculated by the following: $[1/(1.07)^{\text{number of years}}]$).

After applying the discount factor, the total cost saving associated with the installation of ESC to light commercial vehicles under the business-as-usual scenario was estimated to range from $A3.1 billion (Series A projection) to $A2.5 billion (Series A projection) over the 30 year period.

Table 5.2 Financial cost savings ($A) associated with ESC installation from 2010 – 2039 under a business-as-usual scenario, assuming 32% ESC crash reduction effectiveness

Series	Fatal	Serious	Minor	PDO	Total
A	$722,321,915	$1,550,164,038	$138,699,064	$738,972,276	$3,150,157,293
B	$643,856,355	$1,381,770,298	$123,632,237	$658,697,994	$2,807,956,883
C	$579,149,613	$1,242,904,146	$111,207,355	$592,499,686	$2,525,760,799

5.3 Derivation of Benefit – Cost ratio for ESC (BCR)

Having obtained the aggregate financial benefits associated with ESC the determination of costs follows which then permits the calculation of BCR for ESC.

Across the entire period, 2010 – 2039, the following numbers of light commercial vehicles are projected to enter the fleet:

- Series A: 10,948,405
- Series B: 9,724,606
- Series C: 8,735028

As the benefits are derived on the basis of standard ESC fitment, the number of new vehicles entering the fleet fitted with ESC for each year must be used rather than the overall total. We therefore use the product of the estimated number of new Class NA vehicles (Table 4.3, 4.4, 4.5) by the ESC fitment rate for each year as shown in Table 4.7. The number of new Class NA vehicles entering the fleet is hence shown in Table 5.3.

Following the derivation of the number of vehicles fitted with ESC by calendar year, and using the fitment value of $A450, as per the current price of optional fitment of ESC for a Citroen and Peugeot (see Appendix B) with a 7% discount factor applied for each year, we derive the yearly and hence total cost over the 30 year period of ESC fitment (Table 5.4).

There are two observations to be made:

1. the yearly cost is initially small and increases, and is highest at 2020 – which coincides with all new vehicles being fitted with ESC as standard equipment, and
2. from 2021, the total cost of installation falls per year, despite the increasing number of vehicles, a feature that is in accord with the 7% discounting of the device cost.

Table 5.3 Projected number of Class NA vehicles and the number of ESC fitted, by year

	Projected number of Class NA vehicles sold			ESC BAU rate	Projected number of Class NA vehicles sold with ESC fitted		
YEAR	Series A(i)	Series B(i)	Series C(i)	% vehicle	Series A(ii)	Series B(ii)	Series C(ii)
2010	195,800	193,666	191,510	0.083	16,251	16074	15,895
2011	206,386	202,810	199,201	0.183	37,769	37,114	36,454
2012	217,109	211,964	206,817	0.2793	60,639	59,201	57,764
2013	227,973	221,131	214,361	0.3772	85,991	83,411	80,857
2014	238,983	230,317	221,836	0.4751	113,541	109,424	105,394
2015	250,141	239,521	229,241	0.573	143,331	137,246	131,355
2016	261,447	248,744	236,574	0.6709	175,405	166,882	158,718
2017	272,908	257,965	243,817	0.7688	209,811	198,324	187,446
2018	284,517	267,181	250,962	0.8668	246,620	231,593	217,534
2019	296,269	276,385	258,005	0.9647	285,811	266,628	248,898
2020	308,154	285,568	264,937	1	308,154	285,568	264,937
2021	320,162	294,724	271,751	1	320,162	294,724	271,751
2022	332,275	303,842	278,468	1	332,275	303,842	278,468
2023	344,460	312,927	285,123	1	344,460	312,927	285,123
2024	356,704	321,970	291,708	1	356,704	321,970	291,708
2025	368,993	330,958	298,212	1	368,993	330,958	298,212
2026	381,312	339,883	304,629	1	381,312	339,883	304,629
2027	393,669	348,723	310,938	1	393,669	348,723	310,938
2028	406,051	357,471	317,133	1	406,051	357,471	317,133
2029	418,445	366,117	323,205	1	418,445	366,117	323,205
2030	430,844	374,656	329,147	1	430,844	374,656	329,147
2031	443,242	383,083	334,956	1	443,242	383,083	334,956
2032	455,636	391,396	340,628	1	455,636	391,396	340,628
2033	468,028	399,597	346,162	1	468,028	399,597	346,162
2034	480,419	407,686	351,560	1	480,419	407,686	351,560
2035	492,816	415,670	356,821	1	492,816	415,670	356,821
2036	505,227	423,555	361,951	1	505,227	423,555	361,951
2037	517,662	431,347	366,953	1	517,662	431,347	366,953
2038	530,130	439,057	371,832	1	530,130	439,057	371,832
2039	542,641	446,691	376,591	1	542,641	446,691	376,591
Total	**10,948,405**	**9,724,606**	**8,735,028**		**9,872,040**	**8,680,819**	**7,723,019**

Table 5.4 Projected cost of fitment of ESC, assuming a 2009 $A450 device fitment cost and a 7% discount rate

YEAR	2009 MY price	Cost at 7% discount rate†	Cost of installation of ESC (using current price $A450) Series A	Series B	Series C
2010	$A450	$A421	$A6,834,687	$A6,760,198	$A6,684,944
2011	$A450	$A393	$A14,844,882	$A14,587,642	$A14,328,046
2012	$A450	$A367	$A22,274,591	$A21,746,703	$A21,218,666
2013	$A450	$A343	$A29,521,118	$A28,635,160	$A27,758,456
2014	$A450	$A321	$A36,428,900	$A35,107,853	$A33,815,066
2015	$A450	$A300	$A42,978,357	$A41,153,640	$A39,387,293
2016	$A450	$A280	$A49,155,009	$A46,766,646	$A44,478,657
2017	$A450	$A262	$A54,950,439	$A51,941,824	$A49,092,939
2018	$A450	$A245	$A60,365,134	$A56,686,967	$A53,245,865
2019	$A450	$A229	$A65,381,318	$A60,993,184	$A56,937,102
2020	$A450	$A214	$A65,880,863	$A61,052,175	$A56,641,396
2021	$A450	$A200	$A63,970,147	$A58,887,396	$A54,297,335
2022	$A450	$A187	$A62,046,996	$A56,737,617	$A51,999,432
2023	$A450	$A175	$A60,114,430	$A54,611,402	$A49,759,026
2024	$A450	$A163	$A58,178,750	$A52,513,521	$A47,577,705
2025	$A450	$A152	$A56,245,777	$A50,448,158	$A45,456,656
2026	$A450	$A142	$A54,321,113	$A48,419,155	$A43,396,931
2027	$A450	$A133	$A52,412,589	$A46,428,569	$A41,397,952
2028	$A450	$A124	$A50,524,363	$A44,479,676	$A39,460,504
2029	$A450	$A116	$A48,660,367	$A42,575,239	$A37,585,023
2030	$A450	$A109	$A46,824,515	$A40,717,933	$A35,772,012
2031	$A450	$A102	$A45,020,493	$A38,910,065	$A34,021,759
2032	$A450	$A95	$A43,251,763	$A37,153,697	$A32,334,446
2033	$A450	$A89	$A41,521,543	$A35,450,607	$A30,710,124
2034	$A450	$A83	$A39,832,555	$A33,802,154	$A29,148,547
2035	$A450	$A77	$A38,187,335	$A32,209,435	$A27,649,348
2036	$A450	$A72	$A36,587,901	$A30,673,266	$A26,212,019
2037	$A450	$A68	$A35,035,895	$A29,194,014	$A24,835,743
2038	$A450	$A63	$A33,532,464	$A27,771,777	$A23,519,565
2039	$A450	$A59	$A32,078,352	$A26,406,253	$A22,262,270
Total cost of installation			**$A1,346,962,647**	**$A1,212,821,923**	**$A1,100,984,827**

†Discount rate=1/1.07^year in future

As shown in Table 5.4, across the entire 30 year period the estimated total cost of ESC fitment into the fleet in today's terms was estimated to be:

- Series A: $A1,346,962,647 ($A1.3 billion)
- Series B: $A1,212,821,923 ($A1.2 billion)
- Series C: $A1,100,984,827 ($A1.1 billion)

Using these ESC fitment cost values and the financial savings, we can then determine the BCR for each year and across the entire period.

The calculated BCR using a $A450 ESC fitment cost across the entire period, assuming the business-as-usual fitment scenario and a 7% discount rate across the 30 year period was 2.34:1 (Series A), 2.32:1 (Series B) and 2.29:1 (Series C).

Notably, by 2034 when it is projected that 100% of the light commercial fleet would be fitted with ESC, the BCR under each projection scenario was estimated to be 2.81:1. This occurs at this point as the relativities and proportions all coincide at 100% fitment.

Table 5.5 BCR's for ESC fitment in the Class NA vehicle fleet, by year, and the aggregate ratio

Year	Series A	Series B	Series C
2010	0.107	0.107	0.107
2011	0.390	0.390	0.390
2012	0.662	0.662	0.662
2013	1.145	1.145	1.145
2014	1.347	1.347	1.347
2015	1.526	1.526	1.526
2016	1.692	1.692	1.692
2017	1.843	1.843	1.843
2018	1.978	1.978	1.978
2019	2.099	2.099	2.099
2020	2.208	2.208	2.208
2021	2.309	2.309	2.309
2022	2.399	2.399	2.399
2023	2.475	2.475	2.475
2024	2.542	2.542	2.542
2025	2.604	2.604	2.604
2026	2.657	2.657	2.657
2027	2.702	2.702	2.702
2028	2.736	2.736	2.736
2029	2.758	2.758	2.758
2030	2.775	2.775	2.775
2031	2.789	2.789	2.789
2032	2.797	2.797	2.797
2033	2.778	2.778	2.778
2034	2.806	2.806	2.806
2035	2.806	2.806	2.806
2036	2.806	2.806	2.806
2037	2.806	2.806	2.806
2038	2.806	2.806	2.806
2039	2.806	2.806	2.806
Entire Period	2.339	2.315	2.294

6 OVERALL BENEFITS FOR EACH PROJECTION SERIES AND VARIABLE ESC CRASH REDUCTION EFFECTIVENESS

This Section consolidates the information pertaining to benefit reductions – both in terms of injuries and financial benefits, as well as cost. The additional benefits associated with earlier fitment of ESC are also presented.

The ESC effectiveness value of 32% is considered to be the principal analysis (Section 6.1), with a sensitivity analysis using a lower bound of 16% and an upper 45% ESC effectiveness value being assumed. The savings and costs associated with these effectiveness values are presented below.

6.1 32% ESC crash reduction benefit

6.1.1 Principal findings: savings by Projection Series

Table 6.1 presents a summary of the benefits associated with achieving an ESC fitment rate under business-as-usual scenario for the three future new vehicle Projection Series.

The number of fatalities saved was seen to range from 700 (Series A) to 541 (Series C) while the number of serious injuries saved was 6,934 (Series A), 6057 (Series B) and 5,357 (Series C). The magnitude of reductions reflects the assumptions made by the ABS in future population estimates, and this is reflected in the projection of new vehicle sales and hence the size of the fleet, and in turn the number of crashes in the future.

The total cost savings were $A3.1 billion for Series A, $A2.8 billion (Series B) and $A2.5 billion for Series C. When a device cost of $A450 was used, the costs of fitment, given the business-as-usual fitment scenario were $A1.3 billion (Series A), $A1.2 billion (Series B) and $A1.1 billion (Series C). Given the estimated financial benefits and aggregate device fitment costs, BCR’s were estimated to be 2.34:1 (Series A), 2.32:1 (Series B) and 2.29:1 (Series C).

Table 6.1 Benefits associated with achieving an ESC fitment rate under business-as-usual scenario.

Benefit	Series A	Series B	Series C
Reductions in injuries (people)			
Fatality savings	700	612	541
Serious injury savings	6,934	6,057	5,357
Minor injury savings	16,802	14,677	12,980
Property damage savings	179,038	156,400	138,315
Financial savings (@ 7% discount rate)			
Fatality savings	$A722,321,915	$A643,856,355	$A579,149,613
Serious injury savings	$A1,550,164,038	$A1,381,770,298	$A1,242,904,146
Minor injury savings	$A138,699,064	$A123,632,237	$A111,207,355
Property damage savings	$A738,972,276	$A658,697,994	$A592,499,686
Total savings	$A3,150,157,293	$A2,807,956,883	$A2,525,760,799
Cost of fitment (device cost $A450 @ 7% discount rate)			
Total cost	$A1,346,962,647	$A1,212,821,923	$A1,100,984,827
BCR (saving & device cost of $A450 @ 7% discount rate)			
BCR	2.34:1	2.32:1	2.29:1

Figure 6.1 presents the BCR for each projection series by ESC fitment cost (discounted at 7% across the 30 year period). Across the price range there is little difference between the Projection Series with respect to BCRs. A device cost of $A1050 in today's terms represents the 'break-even' point assuming a 32% crash reduction effectiveness value.

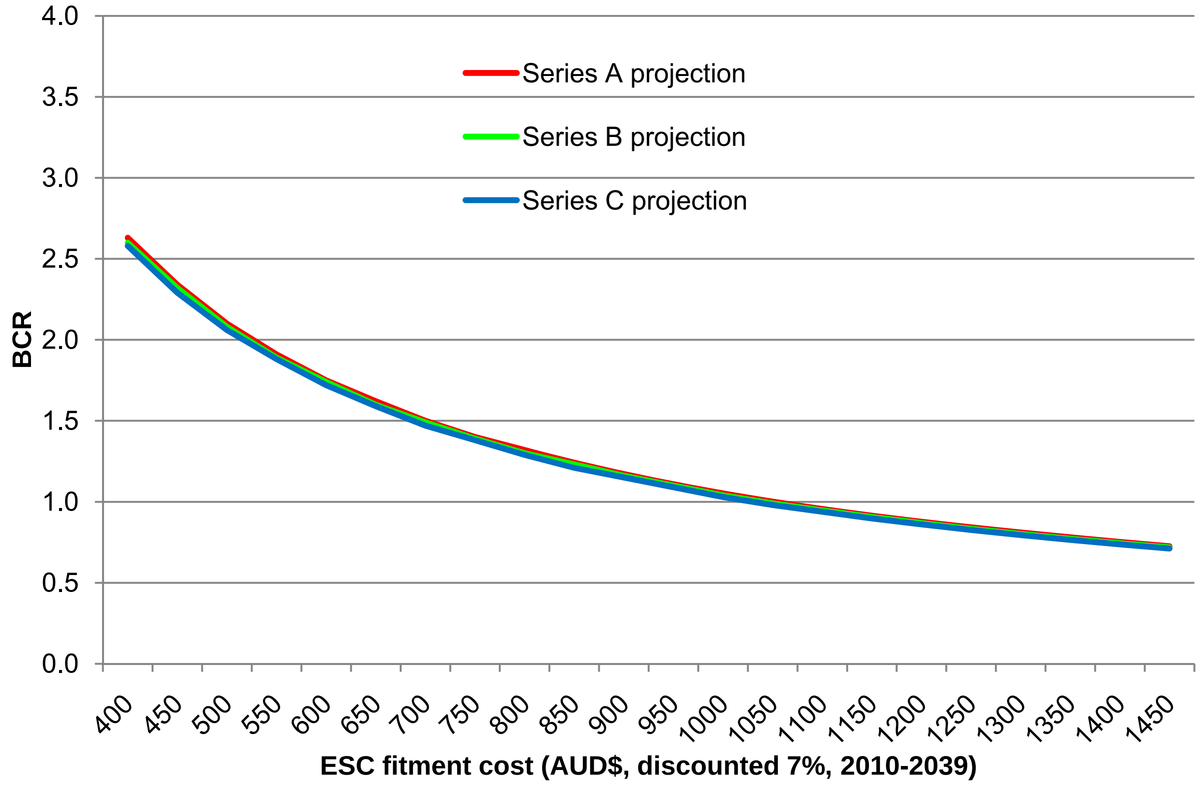


Figure 6.1 BCR estimates by ESC fitment cost with 7% discount rate applied, 2010-2039, for a 32% crash reduction benefit

6.1.2 Additional benefit due to earlier fitment: 100% all new vehicles in 2013 at 32% device effectiveness

An assumption in this report was that ESC penetration into the light commercial fleet would mirror the historical fitment trend into passenger cars (Class MA vehicles). Any deviation to this would influence the calculated BCRs.

It is thus possible to examine the influence of earlier fitment on crash reductions and financial savings. As an example, we used 2013 as the reference year as the year that all new vehicles would be fitted with ESC - as distinct from the 'business-as-usual' scenario which assumed that this would be achieved only in 2020. With reference to Table 4.7, this 'advance fitment' is done computationally by simply by changing the penetration factor to 1.0 at 2013 (see Table 4.7, p.35)

This change influences a host of estimates and outcomes, with the following result:

- the ‘base multiplier’ is changed, and hence the ESC penetration-benefit multiplier itself is altered;
- the number of vehicles fitted with ESC is more rapid and hence greater in volume;
- the crash reduction benefits are greater overall, and for all injury severities
- there are higher financial savings over the 30 years;
- there are higher total costs over the 30 years, and
- stable BCR’s due to the change in the benefits but also the costs given fitment to a larger number of vehicles, and sooner and hence the impact of discounting is less.

Table 6.2 provides a summary of the additional benefit of the mandate, which is a simple subtraction of the savings calculated for 2013 and the business-as-usual approach under which it was expected that by 2020 all new vehicles would be fitted with ESC.

Series A estimations indicate 24 additional lives saved, 235 additional serious injuries avoided, 569 additional minor injuries avoided and 6064 fewer PDO crashes due to an earlier fitment of ESC into all new vehicles.

Additional cost savings amount to $A173 million and a positive BCR for the earlier fitment (BCR 1.46:1) as well as a marginal difference in the overall BCR, which remains at 2.24:1 over the entire 30 years.†

Additional benefits associated with Series B and Series C projections were slightly less than those estimated for the Series A projections.

Table 6.2 Additional benefits associated with achieving an ESC fitment rate of 100% by 2013.

Benefit	Series A	Series B	Series C
Aditional Reductions in injuries (people)			
Fatality savings	24	23	22
Serious injury savings	235	225	215
Minor injury savings	569	544	520
Property damage savings	6,064	5,798	5,543
Additional Financial savings			
Fatality savings	$A58,131,239	$A55,650,029	$A53,259,471
Serious injury savings	$A124,754,566	$A119,429,677	$A114,299,338
Minor injury savings	$A11,162,265	$A10,685,827	$A10,226,796
Property damage savings	$A59,471,232	$A56,932,827	$A54,487,164
Total savings	$A253,519,302	$A242,698,359	$A232,272,769
Total cost	$A173,323,653	$A166,239,396	$A159,390,991
BCR (for added savings/cost)	1.46:1	1.46:1	1.46:1
BCR for the entire 30 year period in the earlier fitment scenario	2.24:1	2.21:1	2.19:1
BCR difference	-0.1	-0.1	-0.1

†Note: The reductions in numbers saved and difference in financial values do not equal one another due to the influence of the 7% discount factor commencing at different periods in time; The non-discounted financial benefits associated with earlier fitment compared to BAU is the same as the percent difference in injuries saved.

6.2 Sensitivity analysis: Lower and Upper bounds of ESC effectiveness

As discussed in Section 3, '*Technology Effectiveness',* it was determined to use 32% as the reduction effectiveness value for ESC, with a sensitivity analysis conducted using a lower bound of 16% and an upper bound of 45%. A full explanation for the rationale in selecting these values is provided in Section 3.3, '*The overall likely effectiveness of ESC in reducing road trauma for this project' (p.21).*

6.2.1 Lower bound savings associated with ESC: 16% crash reduction benefit

Table 6.3 presents a summary of the benefits associated with achieving an ESC fitment rate under business-as-usual scenario for the three vehicle projection series using a 16% ESC crash reduction benefit. At this lower bound ESC effectiveness value, the injury reductions remain sizeable although the BCR values are only slightly above 1.

Table 6.3 Benefits associated with achieving an ESC fitment rate under business-as-usual scenario assuming 16% ESC effectiveness

Benefit	Series A	Series B	Series C
Reductions in injuries (people)			
Fatality savings	350	306	270
Serious injury savings	3,467	3,028	2,678
Minor injury savings	8,401	7,339	6,490
Property damage savings	89,519	78,200	69,158
Financial savings (@ 7% discount rate)			
Fatality savings	$A361,160,957	$A321,928,177	$A289,574,806
Serious injury savings	$A775,082,019	$A690,885,149	$A621,452,073
Minor injury savings	$A69,349,532	$A61,816,118	$A55,603,677
Property damage savings	$A369,486,138	$A329,348,997	$A296,249,843
Total savings	$A1,575,078,647	$A1,403,978,441	$A1,262,880,400
Cost of fitment (device cost $A450 @ 7% discount rate)			
Total cost	$A1,346,962,647	$A1,212,821,923	$A1,100,984,827
BCR (saving & device cost of $A450 @ 7% discount rate)			
BCR	1.17	1.16	1.15

Figure 6.2 presents the BCR for each projection series by ESC fitment cost. Across the price range there is little difference between the Series with respect to BCRs. A device cost of $A525 in today's terms represents the 'break-even' point.

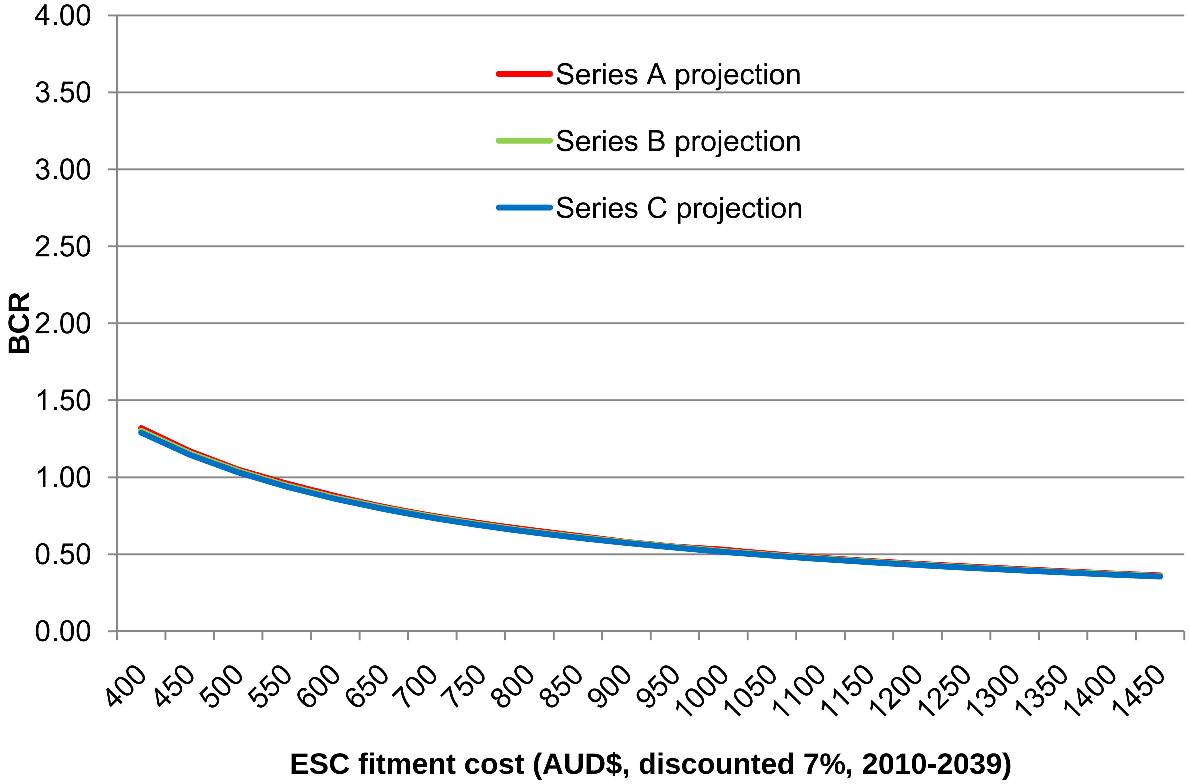


Figure 6.2 BCR estimates by ESC fitment cost with 7% discount rate applied, 2010-2039, for a 16% crash reduction benefit

Table 6.4 provides a summary of the additional benefit of the mandate, which is a simple subtraction of the savings calculated for 2013 and the business-as-usual approach under which it was expected that by 2020 all new vehicles would be fitted with ESC, using the 16% ESC effectiveness value.

Series A estimations indicate 12 additional lives saved, 117 additional serious injuries avoided, 285 additional minor injuries avoided and 3032 fewer PDO crashes due to an earlier fitment of ESC into all new vehicles.

Additional cost savings amount to $A126 million and a negative BCR for the earlier fitment period (BCR 0.73:1) and a lower – though still positive, overall BCR, of 1.12:1 over the entire 30 years.

Additional benefits associated with Series B and Series C projections were slightly less than those estimated for the Series A projections.

Table 6.4 Additional benefits associated with achieving an ESC fitment rate of 100% by 2013 (16% device effectiveness)

Benefit	Series A	Series B	Series C
Aditional Reductions in injuries (people)			
Fatality savings	12	11	11
Serious injury savings	117	112	107
Minor injury savings	285	272	260
Property damage savings	3,032	2,899	2,771
Additional Financial savings			
Fatality savings	$A29,065,620	$A27,825,014	$A26,629,736
Serious injury savings	$A62,377,283	$A59,714,839	$A57,149,669
Minor injury savings	$A5,581,132	$A5,342,913	$A5,113,398
Property damage savings	$A29,735,616	$A28,466,413	$A27,243,582
Total savings	$A126,759,651	$A121,349,179	$A116,136,385
Total cost	$A173,323,653	$A166,239,396	$A159,390,992
BCR (for added savings/cost)	0.73:1	0.73:1	0.73:1
BCR for the entire 30 year period in the earlier fitment scenario	1.12:1	1.11:1	1.09:1
BCR difference	-0.05	-0.05	-0.06

6.2.2 Upper bound savings associated with ESC: 45% crash reduction benefit)

Table 6.5 presents a summary of the benefits associated with achieving an ESC fitment rate under business-as-usual scenario for the three vehicle projection series using an ESC effectiveness value of 45%. It is evident that the injury reductions are significant, ranging from 984 fewer fatalities over the period – or approximately 33 fewer on average per annum (Series A) to 760 fewer deaths using the Series C projection series. The non-fatal injury reductions are significant, with the total estimated financial benefits being $A4.4 billion at a cost of $A1.3 billion, for a BCR of 3.29 (Series A). The overall benefits for Series B and Series C are also high.

Table 6.5 Benefits associated with achieving an ESC fitment rate under business-as-usual scenario assuming 45% ESC effectiveness.

Benefit	Series A	Series B	Series C
Reductions in injuries (people)			
Fatality savings	984	860	760
Serious injury savings	9,750	8,518	7,533
Minor injury savings	23,628	20,640	18,254
Property damage savings	251,773	219,937	194,506
Financial savings (@ 7% discount rate)			
Fatality savings	$A1,015,765,193	$A905,422,999	$A814,429,143
Serious injury savings	$A2,179,918,179	$A1,943,114,481	$A1,747,833,955
Minor injury savings	$A195,045,559	$A173,857,833	$A156,385,342
Property damage savings	$A1,039,179,763	$A926,294,053	$A833,202,683
Total savings	$A4,429,908,694	$A3,948,689,366	$A3,551,851,124
Cost of fitment (device cost $A450 @ 7% discount rate)			
Total cost	$A1,346,962,647	$A1,212,821,923	$A1,100,984,827
BCR (saving & device cost of $A450 @ 7% discount rate)			
BCR	3.29	3.25:1	3.23:1

Figure 6.3 presents the BCR for each projection series by ESC fitment cost. Across the price range there is little difference between the Series with respect to BCRs. A device cost of $A1480 in today's terms represents the 'break-even' point.

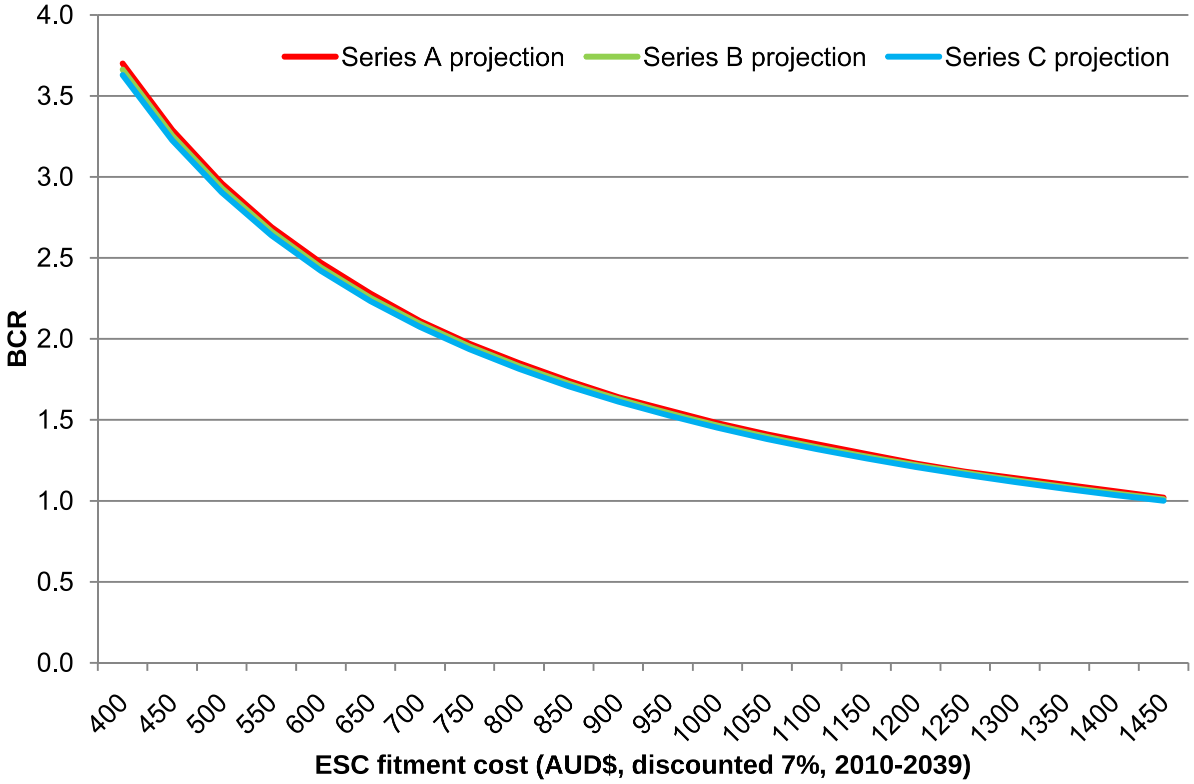


Figure 6.3 BCR estimates by ESC fitment cost with 7% discount rate applied, 2010-2039, for a 45% crash reduction benefit

Table 6.6 provides a summary of the additional benefit of the mandate, which is a simple subtraction of the savings calculated for 2013 and the business-as-usual approach under which it was expected that by 2020 all new vehicles would be fitted with ESC.

Series A estimations indicate 33 additional lives saved, 330 additional serious injuries avoided, 800 additional minor injuries avoided and 8528 fewer PDO crashes due to an earlier fitment of ESC into all new vehicles.

Additional cost savings amount to $A356 million and a positive BCR for the earlier fitment (BCR 2.06:1) though a slightly lower overall BCR of 3.15:1 over the entire 30 years.†

Additional benefits associated with Series B and Series C projections were slightly less than those estimated for the Series A projections.

Table 6.6 Additional benefits associated with achieving an ESC fitment rate of 100% by 2013 (45% device effectiveness)

Benefit	Series A	Series B	Series C
Aditional Reductions in injuries (people)			
Fatality savings	33	32	30
Serious injury savings	330	316	302
Minor injury savings	800	765	731
Property damage savings	8,528	8,154	7,794
Additional Financial savings			
Fatality savings	$A81,747,055	$A78,257,853	$A74,896,131
Serious injury savings	$A175,436,108	$A167,947,983	$A160,733,444
Minor injury savings	$A15,696,935	$A15,026,944	$A14,381,432
Property damage savings	$A83,631,420	$A80,061,787	$A76,622,574
Total savings	$A356,511,518	$A341,294,567	$A326,633,582
Total added cost	$A173,323,653	$A166,239,396	$A159,390,992
BCR (for added savings/cost)	2.06	2.05	2.05
BCR for the entire 30 year period in the earlier fitment scenario	3.15	3.11	3.08
BCR difference	-0.14	-0.14	-0.15

6.3 Summary of derived benefits and costs by Projection Series

The estimation of the effectiveness of ESC for light commercial vehicles was undertaken on the basis of two parameters: 1. ABS population projections used to estimate future vehicle sales, and 2. ESC crash-injury reduction effectiveness.

To recap, Series A population projections assume higher fertility rates, longer life expectancy and higher migration compared to Series B and then Series C population estimates. The effect on vehicle sales – and hence projections in crashes, follows the same patterns. Thus far we have presented the analysis on the basis of these projection series and it is evident that there is little difference in benefits between the series within a given ESC crash-injury reduction benefit value, such as 32%, or the 16% and 45% lower and upper bounds of ESC effectiveness values. It is clear though that the crash reduction effectiveness percent values is the critical driver of estimated injury reduction values, while the cost of fitment within each of the projection series is constant. In this section we provide a summary of the findings presented by projection series so that the estimated benefits can be observed given the ESC effectiveness values.

6.3.1 Projection Series A

Table 6.7 presents the estimated savings – and fitment costs, for the three ESC effectiveness values of 32% as the point estimate and the lower and upper effectiveness values of 16% and 45% for the Series A Projection Series.

Using the ESC effectiveness point estimate value of 32%, it was estimated that fitment of ESC under a business-as-usual scenario would result in 700 fewer fatalities over the 30 year period. The fatality savings ranged from 350 (16% effectiveness) to as high as 984 (45% effectiveness); these estimations can be expressed as, *fatalities avoided: 700 lives saved, range: 350 – 984).* The financial benefits associated with the reduction in fatalities were estimated to be $A722 million, with the range suggesting $A361 million (16% effectiveness) to as high as $A1 billion (45% effectiveness).

Table 6.7 also presents estimated reductions in the number of seriously injured, those sustaining minor injuries, and fewer property damage crash savings. The associated financial benefits associated with these reductions are also presented.

In sum, using a 32% ESC effectiveness value the estimated financial saving was $A3.1 billion, with this financial benefit ranging from $A1.575 billion (16% effectiveness) to as high as $A4.429 billion.

The fitment cost of ESC over the period – and discounted at 7%, was estimated to be $A1.346 billion assuming a device cost of $A450. The fitment cost is fixed, regardless of the ESC effectiveness value, as the number of vehicles to which the device is fitted is fixed.

The BCR value assuming a 32% ESC effectiveness was 2.34:1, with the BCR being as low as 1.17:1 (given 16% ESC effectiveness) to as high as 3.29:1 (given 45% ESC effectiveness).

Figure 6.4 presents the BCR for the three ESC effectiveness values by ESC fitment cost for Series A. Across the price range there are clear differences with respect to BCRs and the associated ‘break-even’ point given the ESC effectiveness value assumed.

Table 6.7 Projection Series ‘A’ benefit under a business-as-usual scenario

	ESC effectiveness		
Benefit	**32%**	**Lower bound 16%**	**Upper bound 45%**
Reductions in injuries (people)			
Fatality savings	700	350	984
Serious injury savings	6,934	3467	9,750
Minor injury savings	16,802	8,401	23,628
Property damage savings	179,038	89,519	251,773
Financial savings (@ 7% discount rate)			
Fatality savings	$A722,321,915	$A361,160,957	$A1,015,765,193
Serious injury savings	$A1,550,164,038	$A775,082,019	$A2,179,918,179
Minor injury savings	$A138,699,064	$A69,349,532	$A195,045,559
Property damage savings	$A738,972,276	$A369,486,138	$A1,039,179,763
Total savings	$A3,150,157,293	$A1,575,078,647	$A4,429,908,694
Cost of fitment (device cost $A450 @ 7% discount rate)			
Total cost	$A1,346,962,647	$A1,346,962,647	$A1,346,962,647
BCR (saving & device cost of $A450 @ 7% discount rate)			
BCR	2.34:1	1.17:1	3.29:1

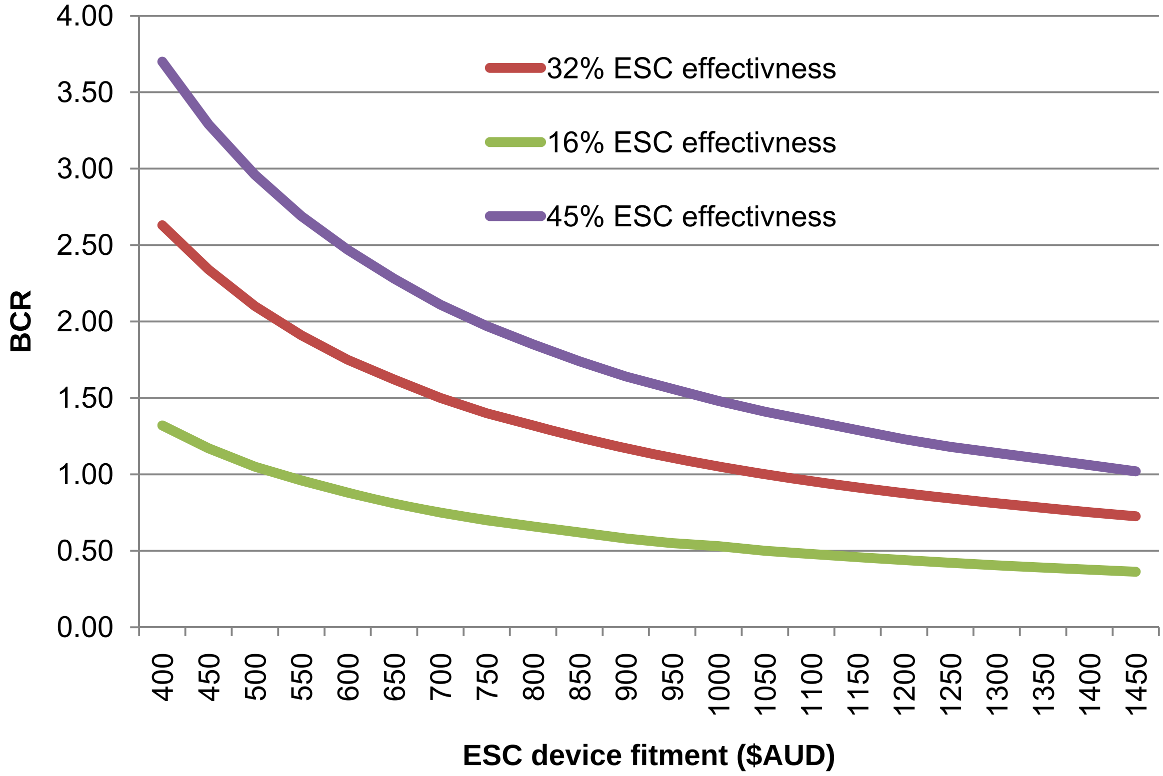


Figure 6.4 BCR value given ESC device fitment cost and ESC effectiveness percent

Table 6.8 presents the additional savings benefits associated with earlier 100% fitment of ESC into the fleet. For this analysis, we assumed that all new light commercial vehicles sold and entering the fleet would have ESC fitted as standard equipment in the year 2013; this is seven years earlier than the business-as-usual scenario.

The additional lives saved by the earlier fitment was estimated to be 24 over the 30 year period, with this seen to range from 12 to 45 depending on the ESC effectiveness value assumed. Reductions in persons seriously injured, those sustaining minor injuries and property damage crashes can also be observed.

The additional financial benefit savings was estimated to be $A250 million, and ranged from $A126 million to as high as $A356 million for a 16% and 45% ESC effectiveness value respectively. The total *additional cost* of fitment associated with the earlier installation of ESC was estimated to be $A173 million. Consequently, the 32% point estimate BCR value for the *additional benefits and costs* was 1.46:1, while the overall BCR across the entire 30 year period was 2.24:1. The BCR values given a 16% effectiveness value and a 45% effectiveness value across the entire implementation period of 30 years was 1.12:1 and 3.15:1 respectively.

Table 6.8 Additional benefits associated with achieving an ESC fitment rate of 100% by 2013, Projection Series A

	ESC effectiveness		
Benefit	**32%**	**Lower bound 16%**	**Upper bound 45%**
Aditional Reductions in injuries (people)			
Fatality savings	24	12	33
Serious injury savings	235	117	330
Minor injury savings	569	285	800
Property damage savings	6,064	3,032	8,528
Additional Financial savings			
Fatality savings	$A58,131,239	$A29,065,620	$A81,747,055
Serious injury savings	$A124,754,566	$A62,377,283	$A175,436,108
Minor injury savings	$A11,162,265	$A5,581,132	$A15,696,935
Property damage savings	$A59,471,232	$A29,735,616	$A83,631,420
Total savings	$A253,519,302	$A126,759,651	$A356,511,518
Total cost	$A173,323,653	$A173,323,653	$A173,323,653
BCR (for added savings/cost)	1.46:1	0.73:1	2.06
BCR for the entire 30 year period in the earlier fitment scenario	2.24:1	1.12:1	3.15
BCR difference	-0.10	-0.05	-0.14

6.3.2 Projection Series B

The Series B projections are based in mid-range population growth estimates, and hence the new vehicle sales and hence crashes are lower than that for the Series A projection series.

Table 6.9 presents the estimated savings – and fitment costs, for the three ESC effectiveness values of 32% as the point estimate and the lower and upper effectiveness values of 16% and 45% for the Series B Projection Series.

Using the ESC effectiveness point estimate value of 32%, it was estimated that fitment of ESC under a business-as-usual scenario would result in 612 fewer fatalities over the 30 year period. The fatality savings ranged from 306 (16% effectiveness) to as high as 860 (45% effectiveness). The financial benefits associated with the reduction in fatalities were estimated to be $A643 million, with the range suggesting $A322 million (16% effectiveness) to as high as $A900 million (45% effectiveness).

Table 6.9 also presents estimated reductions in the number of seriously injured those sustaining minor injuries, and fewer property damage crash savings. The associated financial benefits associated with these reductions are also presented.

In sum, using a 32% ESC effectiveness value the estimated financial saving was $A2.8 billion, with this financial benefit ranging from $A1.4 billion (16% effectiveness) to as high as $A3.9 billion.

The fitment cost of ESC over the period – and discounted at 7%, was estimated to be $A1.212 billion assuming a device cost of $A450. The fitment cost is fixed, regardless of the ESC effectiveness value, as the number of vehicles to which the device is fitted is fixed.

The BCR value assuming a 32% ESC effectiveness was 2.32:1, with the BCR being as low as 1.16:1 (given 16% ESC effectiveness) to as high as 3.25:1 (given 45% ESC effectiveness).

Figure 6.5 presents the BCR for the three ESC effectiveness values by ESC fitment cost for Series B. Across the price range there are clear differences with respect to BCRs and the associated 'break-even' point given the ESC effectiveness value assumed.

Table 6.9 Projection Series 'B' benefit under a business-as-usual scenario

	ESC effectiveness		
Benefit	**32%**	**Lower bound 16%**	**Upper bound 45%**
Reductions in injuries (people)			
Fatality savings	612	306	860
Serious injury savings	6,057	3,028	8,518
Minor injury savings	14,677	7,339	20,640
Property damage savings	156,400	78,200	219937
Financial savings (@ 7% discount rate)			
Fatality savings	$A643,856,355	$A321,928,177	$A905,422,999
Serious injury savings	$A1,381,770,298	$A690,885,149	$A1,943,114,481
Minor injury savings	$A123,632,237	$A61,816,118	$A173,857,833
Property damage savings	$A658,697,994	$A329,348,997	$A926,294,053
Total savings	$A2,807,956,883	$A1,403,978,441	$A3,948,689,366
Cost of fitment (device cost $A450 @ 7% discount rate)			
Total cost	$A1,212,821,923	$A1,212,821,923	$A1,212,821,923
BCR (saving & device cost of $A450 @ 7% discount rate)			
BCR	2.32:1	1.16	3.25:1

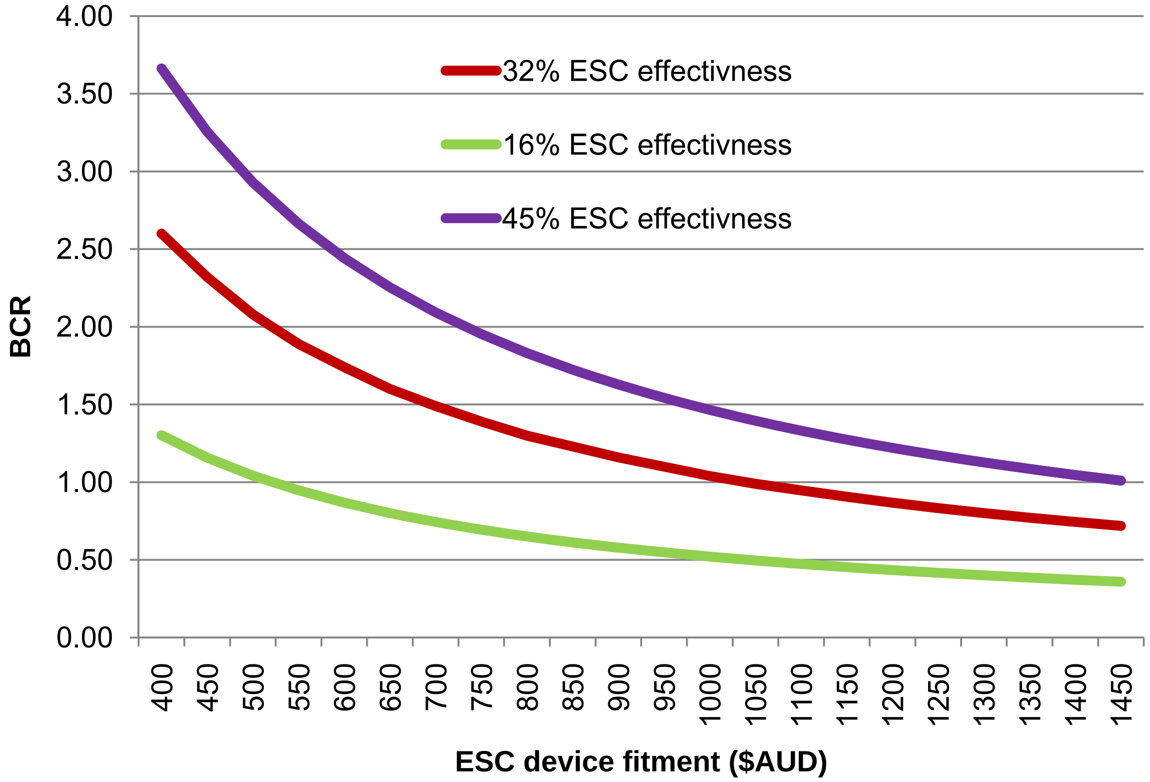


Figure 6.5 BCR value given ESC device fitment cost and ESC effectiveness percent

Table 6.10 presents the additional savings benefits associated with earlier 100% fitment of ESC into the fleet. For this analysis, we assumed that all new light commercial vehicles sold and entering the fleet would have ESC fitted as standard equipment in the year 2013; this is seven years earlier than the business-as-usual scenario.

The additional lives saved by the earlier fitment was estimated to be 23 over the 30 year period, with this seen to range from 11 to 32 depending on the ESC effectiveness value assumed. Reductions in persons seriously injured, those sustaining minor injuries and property damage crashes can also be observed.

The additional financial benefit savings was estimated to be $A242 million, and ranged from $A121 million to as high as $A341 million for a 16% and 45% ESC effectiveness value respectively. The total *additional cost* of fitment associated with the earlier installation of ESC was estimated to be $A166 million. Consequently, the 32% point estimate BCR value for the *additional benefits and costs* was 1.46:1, while the overall BCR across the entire 30 year period was 2.21:1. The BCR values given a 16% effectiveness value and a 45% effectiveness value across the entire implementation period of 30 years was 1.11:1 and 3.1:1 respectively.

Table 6.10 Additional benefits associated with achieving an ESC fitment rate of 100% by 2013, Projection Series B

	ESC effectiveness		
Benefit	**32%**	**Lower bound 16%**	**Upper bound 45%**
Aditional Reductions in injuries (people)			
Fatality savings	23	11	32
Serious injury savings	225	112	316
Minor injury savings	544	272	765
Property damage savings	5,798	2,899	8,154
Additional Financial savings			
Fatality savings	$A55,650,029	$A27,825,014	$A78,257,853
Serious injury savings	$A119,429,677	$A59,714,839	$A167,947,983
Minor injury savings	$A10,685,827	$A5,342,913	$A15,026,944
Property damage savings	$A56,932,827	$A28,466,413	$A80,061,787
Total savings	$A242,698,359	$A121,349,179	$A341,294,567
Total cost	$A166,239,396	$A166,239,396	$A166,239,396
BCR (for added savings/cost)	1.46:1	0.73:1	2.05
BCR for the entire 30 year period in the earlier fitment scenario	2.21:1	1.11:1	3.11
BCR difference	-0.10	-0.05	-0.14

6.3.3 Projection Series C

Table 6.11 presents the estimated savings – and fitment costs, for the three ESC effectiveness values of 32% as the point estimate and the lower and upper effectiveness values of 16% and 45% for the Series C Projection Series.

Using the ESC effectiveness point estimate value of 32%, it was estimated that fitment of ESC under a business-as-usual scenario would result in 541 fewer fatalities over the 30 year period. The fatality savings ranged from 270 (16% effectiveness) to as high as 760 (45% effectiveness). The financial benefits associated with the reduction in fatalities were estimated to be $A579 million, with the range suggesting $A289 million (16% effectiveness) to as high as $A814 million (45% effectiveness).

Table 6.11 also presents estimated reductions in the number of seriously injured, those sustaining minor injuries, and fewer property damage crash savings. The associated financial benefits associated with these reductions are also presented.

In sum, using a 32% ESC effectiveness value the estimated financial saving was $A2.5 billion, with this financial benefit ranging from $A1.262 billion (16% effectiveness) to as high as $A3.551 billion (45% effectiveness).

The fitment cost of ESC over the period – and discounted at 7%, was estimated to be $A1.1 billion assuming a device cost of $A450. The fitment cost is fixed, regardless of the ESC effectiveness value, as the number of vehicles to which the device is fitted is fixed.

The BCR value assuming a 32% ESC effectiveness was 2.29:1, with the BCR being as low as 1.15:1 (given 16% ESC effectiveness) to as high as 3.23:1 (given 45% ESC effectiveness).

Figure 6.6 presents the BCR for the three ESC effectiveness values by ESC fitment cost for Series C. Across the price range there are clear differences with respect to BCRs and the associated 'break-even' point given the ESC effectiveness value assumed.

Table 6.11 Projection Series 'C' benefit under a business-as-usual scenario

	ESC effectiveness		
Benefit	**32%**	**Lower bound 16%**	**Upper bound 45%**
Reductions in injuries (people)			
Fatality savings	541	270	760
Serious injury savings	5,357	2,678	7,533
Minor injury savings	12,980	6,490	18,254
Property damage savings	138,315	69,158	194,506
Financial savings (@ 7% discount rate)			
Fatality savings	$A579,149,613	$A289,574,806	$A814,429,143
Serious injury savings	$A1,242,904,146	$A621,452,073	$A1,747,833,955
Minor injury savings	$A111,207,355	$A55,603,677	$A156,385,342
Property damage savings	$A592,499,686	$A296,249,843	$A833,202,683
Total savings	$A2,525,760,799	$A1,262,880,400	$A3,551,851,124
Cost of fitment (device cost $A450 @ 7% discount rate)			
Total cost	$A1,100,984,827	$A1,100,984,827	$A1,100,984,827
BCR (saving & device cost of $A450 @ 7% discount rate)			
BCR	2.29:1	1.15:1	3.23:1

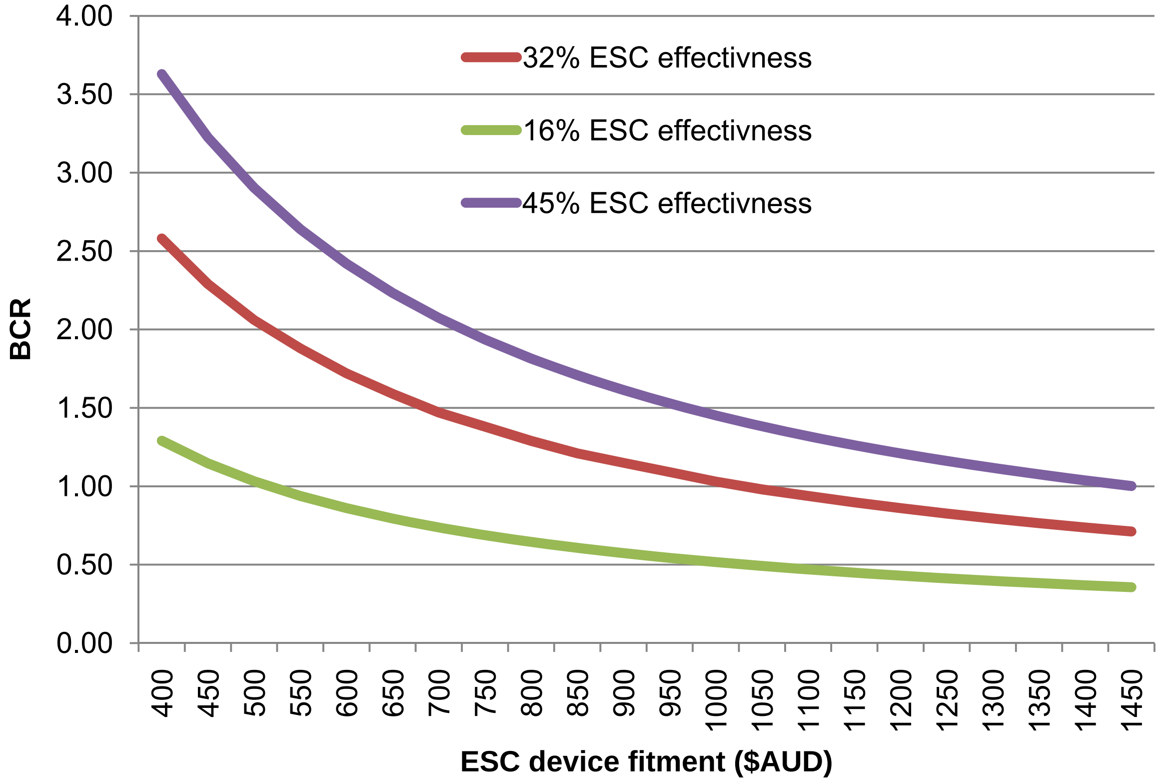


Figure 6.6 BCR value given ESC device fitment cost and ESC effectiveness percent

Table 6.12 presents the additional savings benefits associated with earlier 100% fitment of ESC into the fleet. For this analysis, we assumed that all new light commercial vehicles sold and entering the fleet would have ESC fitted as standard equipment in the year 2013; this is seven years earlier than the business-as-usual scenario.

The additional lives saved by the earlier fitment was estimated to be 22 over the 30 year period, with this seen to range from 11 to 30 depending on the ESC effectiveness value assumed. Reductions in persons seriously injured, those sustaining minor injuries and property damage crashes can also be observed.

The additional financial benefit savings was estimated to be $A232 million, and ranged from $A116 million to as high as $A326 million for a 16% and 45% ESC effectiveness value respectively. The total *additional cost* of fitment associated with the earlier installation of ESC was estimated to be $A159 million. Consequently, the 32% point estimate BCR value for the *additional benefits and costs* was 1.46:1, while the overall BCR across the entire 30 year period was 2.19:1. The BCR values given a 16% effectiveness value and a 45% effectiveness value across the entire implementation period of 30 years was 1.09:1 and 3.08:1 respectively.

Table 6.12 Additional benefits associated with achieving an ESC fitment rate of 100% by 2013, Projection Series C

	ESC effectiveness		
Benefit	**32%**	**Lower bound 16%**	**Upper bound 45%**
Aditional Reductions in injuries (people)			
Fatality savings	22	11	30
Serious injury savings	215	107	302
Minor injury savings	520	260	731
Property damage savings	5,543	2,771	7,794
Additional Financial savings			
Fatality savings	$A53,259,471	$A26,629,736	$A74,896,131
Serious injury savings	$A114,299,338	$A57,149,669	$A160,733,444
Minor injury savings	$A10,226,796	$A5,113,398	$A14,381,432
Property damage savings	$A54,487,164	$A27,243,582	$A76,622,574
Total savings	$A232,272,769	$A116,136,385	$A326,633,582
Total cost	$A159,390,991	$A159,390,992	$A159,390,992
BCR (for added savings/cost)	1.46:1	0.73:1	2.05
BCR for the entire 30 year period in the earlier fitment scenario	2.19:1	1.09:1	3.08
BCR difference	-0.10	-0.06	-0.15

7 DISCUSSION

This report set out to provide the necessary inputs to assist in the determination of whether the mandatory fitment of ESC in the light commercial vehicle Class NA model segment is likely to be of benefit to the Australian society. The question of mandatory fitment has been driven by the reported on-road crash reduction associated with ESC in the passenger car and 4WD segments, as well as discussions locally and internationally following the acceptance of the Global Technical Regulation on ESC (GTR 8).

The completion of a number of tasks was required to derive the necessary inputs so that the savings associated with ESC, both in terms of reductions in fatalities, serious injuries, minor injuries and property-damage only crashes, could be estimated. The financial benefits and cost of fitment were also derived, and hence BCR's were then calculated.

The estimation of the effectiveness of ESC for light commercial vehicles was undertaken on the basis of two parameters: 1. ABS population projections used to estimate future vehicle sales, known as Projection Series A, B and C, and 2. ESC crash-injury reduction effectiveness. This determination entailed the estimation of the future number of light commercial vehicles sold, the future number of registered vehicles and the future number of crashes involving these vehicles.

Using high future population growth (Series A) under a business-as-usual scenario - where it was assumed ESC would be fitted to all commercial vehicles by 2020 and hence nearly all registered vehicles in 2039 would have ESC fitted, the number of fatalities estimated to be saved through the installation of ESC was 700 (range: 350 to 984) across the entire period. In addition, it was estimated there would be 6,934 fewer drivers seriously injured (range: 3,467 to 9,750) while large estimated savings with respect to minor injury crashes and property damage only crashes were found.

In financial terms, the savings to the community was estimated to be $A3.1 billion (range: $A1.575 billion to $A4.429 billion), depending on the ESC effectiveness value used. Using a $A450 ESC fitment cost, BCR values were positive across the percentage effectiveness range with little difference between future population projection series (i.e., Series A, B, C) within each percent effectiveness calculation. While this is the case, the number of actual reductions in injuries saved is highest for Series A, then Series B, then Series C.

The cost saving estimates are expressed in today's dollar values and are based on a business-as-usual scenario for the fitment of ESC, which assumes that ESC will be fitted as standard equipment in all Class NA vehicles by 2020. As 96% of vehicle sold in the 'light commercial' sales figures were certified Class NA vehicles, these benefits could be further reduced. However, it was shown that the proportion of the light commercial fleet certified as Class NA vehicles increased from 89% of 2005 model year vehicles to 96% of 2009 model year vehicles. There were three vehicles not currently certified as Class NA vehicles, these being the Ford F250, the Ford F350 (2x2; 4x4) and the Toyota Land Cruiser PU/CC (refer to Appendix A for details of RCVS status). A decision was taken not to reduce these benefits downwards, although this could be done post-hoc.

The purpose of this report was to provide inputs into any future regulatory impact statement the Australian Government might conduct with respect to the fitment of ESC into the light commercial range. To this end, we examined a faster fitment scenario by assuming 100% fitment at 2013 into all new passenger vehicles (as compared to 100% fitment at 2020 under the business-as-usual scenario. The result of this analysis using the Projection A series was a demonstration that 24 additional lives would be saved using a 32% ESC effectiveness value (16%: 12; 45%: 33), 235 fewer serious injury crashes (16%: 117; 45%: 330), 569 fewer minor injuries (16%: 286; 45%: 800) and 6,064 fewer property damage only crashes (16%: 3032; 45%: 8528); these savings translate to approximately $A253 million at an additional cost of approximately $A173 million (BCR: 1.46:1); with the exception of a 16% effectiveness where the BCR for the *additional benefit* was 0.73:1, the BCRs remained positive for both the additional fitment and the overall 30-year benefit-cost estimation. The additional benefits for Projection Series B and C are lower in accordance with the reduced number of future vehicles although the BCR values were similar.

Each sub-task represents the determination of inputs required for successive steps in the calculation of the ESC benefits, all of which have a range of assumptions and these are stated openly. It remains prudent to bear in mind these assumptions, the veracity of which will be tested in time. Despite this, the final derived ESC benefits reported here are based on the best available evidence at the time of analysis and writing.

It is also the case that the decision to mandate the fitment of ESC into light commercial vehicles, and in particular Class NA vehicles, is entirely the decision of the Australian Government. It is acknowledged that the Australian Government must give consideration to a range of international and national policy objectives, consideration of which are beyond the scope of this report.

As noted above, the estimated benefits rest on the foundation of a series of assumptions. The first key assumption is the projected growth in the number of Class NA vehicle sales. This projected growth was based on established association between past sales figures and the Australian population. Using a simple regression model, the future number of new vehicle sales up to 2039 was determined, and following the Australian Bureau of Statistics Population projections, we were able to derive three projection benefit estimates for ESC. The ABS projections Series A, B and C make specific assumptions concerning fertility patterns, migration and life expectancy. A key assumption underpinning the vehicle growth projections is that past consumer demand and the associated supply side will remain relatively fixed. This does not consider the influence of future economic factors and those relating to a ‘clean environment’ which might have on vehicle availability and buyer purchasing choices.

The analysis makes the assumption that the fitment rate of ESC in Class NA vehicles will approximate the pattern of standard fitment of ESC into new passenger vehicles. Of the current available Class NA models, 4 of 49 are presently fitted with ESC as standard equipment on base model variants. Using a 9.6% annual increase in the number of models sold, all models were estimated to have ESC fitted by 2020 as standard equipment. As we are estimating likely effects 30 years from now, this translates to 20 years of sales at which point all vehicles sold will have ESC fitted. The cumulative fleet age was determined, and vehicles up to 20 years of age represent 98.3% of the fleet. Using this penetration rate – and not 100%, may slightly underestimate the benefits of ESC, as it ignores vehicles presently in the fleet with ESC. A further important consideration when thinking about the timing of the standard fitment of ESC is that the average percentage increase in vehicle models fitted assumes an equivalent relationship of models to sales. That is, that vehicle models are sold in equal volumes, which we know not to be the case. There are clear volume leaders in the market, and the earlier or later fitment of ESC in these particular vehicles would have an influence on the *cumulative savings of ESC across the entire implementation / fitment period,* though this is not the case for the single 30 year point where it is assumed all vehicles will be fitted.

A continued difficulty was the determination of the effectiveness value of ESC for light commercial crashes. The brief literature review highlighted the positive findings of ESC for passenger vehicles and 4WD vehicles, but at the same time noted that there is limited understanding of the effectiveness of ESC for commercial vehicles. Using the Used Car Safety Program Rating (UCSR) database, effectiveness estimates for ESC in vehicle market segments were derived, including for commercial vehicles. Despite using eight years of crash data from five Australian states, it was not possible to determine real-world effectiveness values for crashes where the driver was seriously injured, and non-injury events. This was due to the small number of vehicles in the crash database with ESC fitted. It could be suggested that such estimates could be determined within 3 to 5 years at the current rate of fitment. Thus it was necessary to adopt a conservative approach and use a point estimate of 32% on the basis of overseas literature, and to also conduct a sensitivity analysis using a lower bound of 16% and an upper bound of 45%. The justification for the selection of these values is presented in Section 3.3. It is our view that an effectiveness value of 32% is likely to be conservative, particularly on the basis of ESC effectiveness values specific to 4WD vehicles as it could be anticipated that the benefit of ESC in commercial vehicles should be similar, given the high centre of gravity of both vehicle types and generally similar vehicle dynamics. In addition analysis of crash location and speed zone highlights a higher proportion of light commercial vehicle crashes in high speed rural contexts, precisely locations where it might be anticipated that ESC would have its greatest effect.

Further assumptions included the future composition of the fleet and also the number of future crashes. Given that we had calculated the future number of vehicles sold, it was then necessary to determine the future number of crashes involving light commercial vehicles. For this calculation, it was assumed for that all light commercial vehicles will be classified as Class NA vehicles in the future.

To arrive at the future number of crashes, we first required knowledge of the future size of the total fleet. To determine the total fleet size into the future, we derived a ‘fleet inflation factor’ which was the reciprocal of the proportion of the number of new vehicles divided by the total number of registrations for that year. We then used this inflation factor and the predicted number of new vehicle sales to estimate the total number of vehicles on the register for every year in the future.

Once we estimated the future fleet size, we could then determine the number of crashes by using the proportion of registered vehicles involved in crashes in any one year. We inflated this product so as to include crashes that occur in Tasmania, the NT and the ACT, as these were not included in the crash statistics derived from the Used Car Safety Rating database.

As stated in Section 4.2, where these future crash prediction numbers were reported a number of assumptions were made, and these included: that the general road safety performance, both generally and specific to the vehicle class is constant over time – and does not consider the influence of any future crashworthiness or crash avoidance technology; that the relationship between new vehicle sales and total registrations is constant; that the probability of being involved in a crash is constant, and the crash distribution in the ACT, the NT and Tasmania is similar, on average, for these vehicles to the rest of Australia.

Having derived the total predicted number of crashes we then used all available information to derive the injury reduction benefit by injury severity and their associated cost savings given the stated ESC effectiveness values for the driver only. Any other occupants in the vehicle would add to the benefit estimations presented here.

Moving beyond the benefit calculations and their associated and stated assumptions, a number of other pertinent points can be made. First, the risk of injury and the risk of experiencing a crash is likely to further reduce over time given the historical improvement in vehicle crashworthiness is likely to continue and emergence of crash avoidance technology. These factors are not considered in the benefit calculation reported here. Similarly, other factors that influence crash risk and severity, such as increased congestion, are also not considered in arriving at benefit estimations. Second, the injury severity costs represent the *average* injury costs for persons killed in 2007 inflated to 2010 values using CPI, and it was necessary to use the ratios of road injury crash costs calculated in 1996 (BTE, 2000); the extent to which these costs are accurate for light commercial vehicle crashes now and in the future is unknown given the differential safety levels of these vehicles relative to the passenger car fleet and the cost of medical care. Finally, it was assumed that the effectiveness values for ESC would be a minimum constant standard of performance across all future light commercial and Class NA models and variants, an assumption that can only be tested by the use of a dynamic ESC performance test. On this point, no consideration was given to the potential effect of aftermarket modifications to the vehicle such as those made by ambulance services and aftermarket off-road 4WD modification services.

8 CONCLUSION

The information presented here can be used as the basis for decisions regarding the mandatory fitment of ESC into light commercial Class NA vehicles in Australia. Within the bounds of the stated assumptions and considerations noted above, the full benefit of ESC fitment under a business-as-usual scenario will be reached in 2034, at which point it is assumed that 100% of all registered vehicles will be fitted with ESC. This is based on the estimate that ESC will be fitted as standard equipment on all Class NA and light commercial vehicles by 2020 and accounting for current vehicles fitted with ESC in the fleet. It was demonstrated that a more rapid installation would carry additional savings, both in lives saved, crashes avoided and in financial terms. A critical assumption of this report was that ESC fitment would follow the fitment trend of ESC into the passenger car fleet. Hence, a slower than predicted rate of fitment would mean a more limited benefit to Australian society. As stated, this report provides some of the inputs necessary for the determination of changing the ADR's to mandate the fitment of ESC into Class NA vehicles. Any such decision relies on a range of other considerations, and these are beyond the scope of this report.

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10 APPENDIX A – FULL LIST OF LIGHT COMMERCIAL VEHICLES WITH CLASS NA STATUS AND CERTIFICATION NUMBER

Table A.1 New vehicle sales for light commercial vehicles (light buses, vans) and Class NA ADR designation

Light Commercial	**2005**		**2006**		**2007**		**2008**		**2009**		**RVCS**	
Light Buses	**N**	**%**	**N**	**%**	**N**	**%**	**NA**	**NA**	**N**	**%**	**NA**	**Certification ID**
Ford Transit Bus	420	18.3%	222	8.5%	223	9.0%	207	6.1%	144	6.4%	Yes	22149
Toyota Hiace Bus	1,878	81.7%	2,400	91.5%	2,242	91.0%	3,210	93.9%	2,115	93.6%	Yes	33837
Total Light Buses	**2,298**	**0.2%**	**2,622**	**0.3%**	**2,465**	**0.2%**	**3,417**	**0.3%**	**2,259**	**0.2%**	**2/2**	
Vans	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**		
Citroen Berlingo	477	2.2%	504	2.5%	617	3.0%	335	1.4%	295	1.2%	Yes	30927
Citroen Dispatch					0	0.0%	51	0.2%	87	0.4%	Yes	39382
Ford Econovan Van	512	2.4%	40	0.2%							Yes	13863
Fiat Scudo					0	0.0%	63	0.3%	216	0.9%	Yes	39046
Ford Transit	2,040	9.5%	1,919	9.4%	2,046	10.1%	2,180	9.0%	2,213	9.0%	Yes	22150
Holden Combo	1,122	5.2%	1,034	5.1%	815	4.0%	928	3.8%	740	3.0%	Yes	33565
Kia Pregio	3,592	16.7%	428	2.1%							Yes	29965
Hyundai iLOAD					18	0.1%	2,000	8.2%	3,745	15.3%	Yes	38791
Mercedes-Benz Vito	1,696	7.9%	1,630	8.0%	1,572	7.7%	1,293	5.3%	1,283	5.2%	Yes	31780
Mazda E-Series Van	711	3.3%	301	1.5%							Yes	5544, 11404, 11403
Mercedes-Benz MB Series	43	0.2%	0	0.0%							Yes	13018
Mitsubishi Express	2,529	11.7%	2,318	11.3%	3,387	16.7%	3,169	13.0%	2,275	9.3%	Yes	10442
Peugeot Expert					0	0.0%	47	0.2%	169	0.7%	Yes	39602
Peugeot Partner					0	0.0%	51	0.2%	212	0.9%	Yes	40052
Renault Kangoo	447	2.1%	513	2.5%	449	2.2%	408	1.7%	617	2.5%	Yes	40418 / 32027
Renault Trafic	224	1.0%	282	1.4%	207	1.0%	390	1.6%	167	0.7%	Yes	30678
Suzuki APV	102	0.5%	330	1.6%	449	2.2%	542	2.2%	512	2.1%	Yes	33972
Suzuki Carry Van	47	0.2%									Yes	13883
Toyota Hiace Van	6,050	28.0%	8,465	41.4%	7,672	37.8%	9,493	39.1%	8,923	36.3%	Yes	33837
Volkswagen Caddy	659	3.1%	1,192	5.8%	1,354	6.7%	1,725	7.1%	1,808	7.4%	Yes	32641 (Panel van)
Volkswagen Transporter	1,320	6.1%	1,497	7.3%	1,714	8.4%	1,624	6.7%	1,295	5.3%	Yes	31840
Total Vans	**21,571**	**2.2%**	**20,453**	**2.1%**	**20,300**	**1.9%**	**24,299**	**2.4%**	**24,557**	**2.6%**	**21/21**	

Table A.2 New vehicle sales for light commercial vehicles (PU/CC 4X2) and Class NA ADR designation

	2005		2006		2007		2008		2009		RVCS	
PU/CC 4X2	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**NA**	**Certification ID**
Ford Courier 4X2	3,551	4.3%	4,140	5.7%	131	0.2%					Yes	Multiple
Ford F250 4X2	97	0.1%	134	0.2%	104	0.1%	31	0.0%	4	0.0%	No record in RVCS - Approval Surrendered on 03 October 2000 (10687)	
Ford F350 4X2	55	0.1%	58	0.1%							No record in RVCS	
Ford Falcon Ute	18,384	22.0%	15,858	21.7%	13,758	19.5%	12,600	17.3%	12,180	18.1%	Yes	38450 (Commercial 4)
Ford Ranger 4X2		0.0%	74	0.1%	5,329	7.5%	8,035	11.0%	5,699	8.5%	Yes	36216 / 36157 (Mazda)
Great Wall SA220		0.0%		0.0%					301	0.4%	Yes	39842
Great Wall V240		0.0%		0.0%					641	1.0%	Yes	40934 (V-series)
Holden Colorado 4X2	14,213	17.0%	10,463	14.3%	8,978	12.7%	2,391	3.3%	3,985	5.9%	Yes	39291
Holden Rodeo 4X2	18,877	22.6%	13,377	18.3%	11,511	16.3%	3,957	5.4%	61	0.1%	Yes	29460
Holden Utility 4X2	3,844	4.6%	3,506	4.8%	68	0.1%	13,449	18.5%	12,104	18.0%	Yes	37729 (VE,from 07), 13260 (VU, exp 2003), 24567 (Vy (exp 2005), 32131 (VZ exp 2007)
Isuzu Ute D-Max 4X2		0.0%		0.0%	0	0.0%	90	0.1%	1,011	1.5%	Yes	40095
Mazda BT-50 4X2		0.0%	272	0.4%	5,351	7.6%	4,394	6.0%	5,830	8.7%	Yes	36155
Mazda B-Series 4X2	3,844	4.6%	3,506	4.8%	68						Yes	12080 (Surrendered 2007)
Mitsubishi Triton 4X2	4,213	5.1%	3,344	4.6%	4,678	6.6%	7,213	9.9%	7,625	11.3%	Yes	35555
Nissan Navara 4X2	230	0.3%	333	0.5%	831	1.2%	2,382	3.3%	1,838	2.7%	Yes	34648
Proton Jumbuck	1,225	1.5%	789	1.1%	844	1.2%	672	0.9%	397	0.6%	Yes	28741
Ssangyong Actyon Sports 4X2		0.0%		0.0%	150	0.2%	261	0.4%	357	0.5%	Yes	37191 (Q100 series)
Ssangyong Musso 4X2	435	0.5%	474	0.6%	256	0.4%	7	0.0%	0	0.0%	Yes	32063
Toyota Hilux 4X2	14,410	17.3%	16,723	22.9%	18,617	26.3%	17,330	23.8%	15,360	22.8%	Yes	33886
Total PU/CC 4X2	**83,378**	**8.4%**	**73,051**	**7.6%**	**70,674**	**6.7%**	**72,812**	**7.2%**	**67,393**	**7.2%**	**17 / 19**	

Table A.3 New vehicle sales for light commercial vehicles (PU/CC 4X4) and Class NA ADR designation

	2005		2006		2007		2008		2009		RVCS certification	
PU/CC 4X4	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**NA**	**Certification ID**
Ford Courier 4X4	4,053	6.5%	2,985	4.4%	538	0.7%	16	0.0%			Yes (all surrendered, 2007)	
Ford F250 4X4	1,904	3.0%	643	1.0%	1	0.0%		0.0%			No record in RVCS	
Ford F350 4X4	55	0.1%	7	0.0%	1	0.0%		0.0%			No - NB1 (Ambulance)	
Ford Ranger 4X4	0	0.0%	31	0.0%	6,187	7.5%	7,372	8.8%	8,316	9.7%	Yes	36216
Great Wall V240 4X4							0	0.0%	701	0.8%	Yes	40934
Holden Colorado 4X4					0	0.0%	3,175	3.8%	11,002	12.8%	Yes	39292
Holden Rodeo 4X4	10,369	16.5%	7,983	11.8%	9,428	11.4%	6,260	7.5%	77	0.1%	Yes	29461
Holden Utility 4X4	1,325	2.1%	697	1.0%	9	0.0%	0	0.0%	2	0.0%	Yes	37729
Isuzu Ute D-Max 4X4							183	0.2%	2,555	3.0%	Yes	40096
Land Rover Defender PU/CC	44	0.1%	35	0.1%	30	0.0%	80	0.1%	130	0.2%	Yes	9419
Mazda B-Series 4X4	2,258	3.6%	3,119	4.6%	224	0.3%		0.0%			Yes	12080
Mazda BT-50 4X4	0	0.0%	121	0.2%	5,117	6.2%	5,762	6.9%	5,196	6.1%	Yes	36156
Mitsubishi Triton 4X4	5,860	9.3%	7,283	10.8%	9,764	11.8%	9,370	11.2%	10,557	12.3%	Yes	35555
Nissan Navara 4X4	9,627	15.3%	14,362	21.2%	18,245	22.1%	16,192	19.4%	16,455	19.2%	Yes	34648
Nissan Patrol PU/CC	2,983	4.8%	2,541	3.8%	3,429	4.1%	2,506	3.0%	1,718	2.0%	Yes	12483
Ssangyong Actyon Sports 4X4					199	0.2%	330	0.4%	267	0.3%	Yes	37191 (Q100 series)
Ssangyong Musso 4X4	803	1.3%	484	0.7%	497	0.6%	4	0.0%	1	0.0%	Yes	32063 (P100)
Suzuki Carry 4X4	24	0.0%	0	0.0%				0.0%			Yes	13883
Toyota Hilux 4X4	16,959	27.0%	20,162	29.8%	23,392	28.3%	25,626	30.8%	23,097	26.9%	Yes	33886
Toyota Landcruiser PU/CC	6,464	10.3%	7,186	10.6%	5,630	6.8%	6,432	7.7%	5,739	6.7%	No (NB1 / MC)	NA were: 12686 (2006); 12685 (2007) surrendered
Total PU/CC 4X4	**62,728**	**6.3%**	**67,639**	**7.0%**	**82,691**	**7.9%**	**83,308**	8.2%	**85,813**	**9.2%**	**17/20**	

Table A.4 New vehicle sales for light commercial vehicles (PU/CC 4X4) and Class NA ADR designation

	2005		2006		2007		2008		2009		RVCS certification	
Trucks 2.5-3.5 GVM	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**NA**	**Certification ID**
Ford Transit C/C	509	29.1%	400	26.1%	543	36.3%	454	38.5%	426	41.1%	Yes	22150
Kia K2700	807	46.2%	917	59.9%	718	48.1%	142	12.0%	0	0.0%	Yes	35128
Kia K2900					2	0.1%	317	26.9%	439	42.4%	Yes	38576
Mazda E-Series C/C	261	14.9%	13	0.8%							Yes	5544, 11404
Volkswagen Transporter C/C	170	9.7%	202	13.2%	231	15.5%	267	22.6%	171	16.5%	Yes	31850
Total Trucks 2.5-3.5 GVM	**1,747**	**0.2%**	**1,532**	**0.2%**	**1,494**	**0.1%**	**1,180**	**0.1%**	**1,036**	**0.1%**	**5/5**	
Total light commercial (% all sales)	171,722	17.0%	165,297	16.8%	177,624	16.9%	185,016	18.3%	181,058	19.3%	880,717	92.5% (62/67)
Total NA vehicles (% of light com)	163,147	95%	157,279	95%	171,922	96.8%	178,584	96.5%	175,315	96.5%	846,317	(96.1%)
TOTAL VEHICLE SALES (ALL TYPES)	988,269	100%	962,666	100%	1,049,982	100%	1,012,164	100%	937,328	100%	10,950,409	100%

11 APPENDIX B – 2009 VEHICLE SALES AND ESC FITMENT FOR BASE AND TOP VARIANTS

Table B.1 New vehicle sales for Class NA ADR vehicles, with corresponding ESC fitment status

Rank	FCAI classification	Vehicle Make /Model	Vehicle Sales			RVCS Certification	ESC fitment status for 2009/2010 MY vehicles	
			N	%	Cum. %	NA Cert ID	Base Variant	Top Variant
1	PU/CC 4X4	Toyota Hilux 4X4	23,097	13.2%	13.2%	33886	N/A	N/A
2	PU/CC 4X4	Nissan Navara 4X4	16,455	9.4%	22.6%	34648	N/A	N/A
3	PU/CC 4X2	Toyota Hilux 4X2	15,360	8.8%	31.3%	33886	N/A	N/A
4	PU/CC 4X2	Ford Falcon Ute	12,180	6.9%	38.3%	38450	Option ($A500)	Standard
5	PU/CC 4X2	Holden Utility 4X2	12,104	6.9%	45.2%	37729	Standard	Standard
6	PU/CC 4X4	Holden Colorado 4X4	11,002	6.3%	51.4%	39292	N/A	N/A
7	PU/CC 4X4	Mitsubishi Triton 4X4	10,557	6.0%	57.5%	35555	N/A	Standard
8	Van	Toyota Hiace Van	8,923	5.1%	62.6%	33837	N/A	N/A
9	PU/CC 4X4	Ford Ranger 4X4	8,316	4.7%	67.3%	36216	N/A	N/A
10	PU/CC 4X2	Mitsubishi Triton 4X2	7,625	4.3%	71.7%	35555	N/A	Standard
11	PU/CC 4X2	Mazda BT-50 4X2	5,830	3.3%	75.0%	36155	N/A	N/A
12	PU/CC 4X2	Ford Ranger 4X2	5,699	3.3%	78.2%	36216 / 36157 (Mazda)	N/A	N/A
13	PU/CC 4X4	Mazda BT-50 4X4	5,196	3.0%	81.2%	36156	N/A	N/A
14	PU/CC 4X2	Holden Colorado 4X2	3,985	2.3%	83.5%	39291	N/A	N/A
15	Van	Hyundai iLOAD	3,745	2.1%	85.6%	38791	N/A	Option ($A800)
16	PU/CC 4X4	Isuzu Ute D-Max 4X4	2,555	1.5%	87.1%	40096	N/A	N/A
17	Van	Mitsubishi Express	2,275	1.3%	88.4%	10442	N/A	N/A
18	Van	Ford Transit	2,213	1.3%	89.6%	22150	Option - Safety Pack ($A900)	Standard
19	LB	Toyota Hiace Bus	2,115	1.2%	90.8%	33837	N/A	N/A
20	PU/CC 4X2	Nissan Navara 4X2	1,838	1.0%	91.9%	34648	N/A	N/A
21	Van	Volkswagen Caddy	1,808	1.0%	92.9%	32641 (Panel van)	N/A	Standard
22	PU/CC 4X4	Nissan Patrol PU/CC	1,718	1.0%	93.9%	12483	N/A	N/A
23	Van	Volkswagen Transporter	1,295	0.7%	94.6%	31840	Standard - only T5 Citivan variant (not T5 Van, CrewVan, DualVan)	
24	Van	Mercedes-Benz Vito	1,283	0.7%	95.4%	31780	Standard (all variants)	

Rank	FCAI classification	Vehicle Make /Model	Vehicle Sales			RVCS Certification	ESC fitment status for 2009/2010 MY vehicles	
			N	%	Cum. %	NA Cert ID	Base Variant	Top Variant
25	PU/CC 4X2	Isuzu Ute D-Max 4X2	1,011	0.6%	95.9%	40095	N/A	N/A
26	Van	Holden Combo	740	0.4%	96.4%	33565	N/A (1 variant only)	
27	PU/CC 4X4	Great Wall V240 4X4	701	0.4%	96.8%	40934	N/A	N/A
28	PU/CC 4X2	Great Wall V240	641	0.4%	97.1%	40934 (V-series)	N/A	N/A
29	Van	Renault Kangoo	617	0.4%	97.5%	40418 / 32027	N/A	N/A
30	Van	Suzuki APV	512	0.3%	97.8%	33972	N/A (1 variant only)	
31	Trucks 2.5-3.5 GVM	Kia K2900	439	0.3%	98.0%	38576	N/A	N/A
32	Trucks 2.5-3.5 GVM	Ford Transit C/C	426	0.2%	98.3%	22150	Safety Pack ($A900)	Standard
33	PU/CC 4X2	Proton Jumbuck	397	0.2%	98.5%	28741	N/A	N/A
34	PU/CC 4X2	Ssangyong Actyon Sports 4X2	357	0.2%	98.7%	37191 (Q100 series)	* not in Red Book	
35	PU/CC 4X2	Great Wall SA220	301	0.2%	98.9%	39842	N/A	N/A
36	Van	Citroen Berlingo	295	0.2%	99.0%	30927	N/A	Option ($A450)
37	PU/CC 4X4	Ssangyong Actyon Sports 4X4	267	0.2%	99.2%	37191 (Q100 series)	N/A	Standard
38	Van	Fiat Scudo	216	0.1%	99.3%	39046	N/A (1 variant only)	
39	Van	Peugeot Partner	212	0.1%	99.4%	40052	Option ($A1100)	Option ($A1100)
40	Trucks 2.5-3.5 GVM	Volkswagen Transporter C/C	171	0.1%	99.5%	31850	N/A	N/A
41	Van	Peugeot Expert	169	0.1%	99.6%	39602	Option ($A450)	Option ($A450)
42	Van	Renault Trafic	167	0.1%	99.7%	30678	N/A	N/A
43	LB	Ford Transit Bus	144	0.1%	99.8%	22149	N/A (1 variant only)	
44	PU/CC 4X4	Land Rover Defender PU/CC	130	0.1%	99.9%	9419	N/A	N/A (*Standard SVX Wagon)
45	Van	Citroen Dispatch	87	0.0%	99.9%	39382	Option ($A1100)	Option ($A1100)
46	PU/CC 4X4	Holden Rodeo 4X4	77	0.0%	100.0%	29461	N/A	N/A
47	PU/CC 4X2	Holden Rodeo 4X2	61	0.0%	100.0%	29460	N/A	N/A
48	PU/CC 4X4	Holden Utility 4X4	2	0.0%	100.0%	37729	Standard	Standard
49	PU/CC 4X4	Ssangyong Musso 4X4	1	0.0%	100.0%	32063 (P100)	N/A	N/A

12 APPENDIX C – ACTUAL (2000-09) AND PROJECTED (2010-2039) LIGHT COMMERCIAL VEHICLE SALES

Table C.1 Projected light commercial vehicle sales

Year	Series A	Series B	Series C	Year	Series A	Series B	Series C
2000	108,332	108,332	108,332	2020	308,154.4	285,568.4	264,937.2
2001	108,034	108,034	108,034	2021	320,162.3	294,723.8	271,751.1
2002	124,873	124,873	124,873	2022	332,274.8	303,841.9	278,467.9
2003	146,589	146,589	146,589	2023	344,460.2	312,927.5	285,122.9
2004	163,676	163,676	163,676	2024	356,704.5	321,969.9	291,707.5
2005	171,722	171,722	171,722	2025	368,992.8	330,958.3	298,212.2
2006	165,297	165,297	165,297	2026	381,311.9	339,882.6	304,628.6
2007	177,624	177,624	177,624	2027	393,668.9	348,723.2	310,938.4
2008	185,016	185,016	185,016	2028	406,050.6	357,471.0	317,133.3
2009	181,058	181,058	181,058	2029	418,445.0	366,117.2	323,204.8
2010	195,799.6	193,665.6	191,509.78	2030	430,844.1	374,655.9	329,147.2
2011	206,386.2	202,809.8	199,200.72	2031	443,241.9	383,082.7	334,955.7
2012	217,108.9	211,963.6	206,816.87	2032	455,636.2	391,396.0	340,627.6
2013	227,973.2	221,131.5	214,361.22	2033	468,027.8	399,596.6	346,162.3
2014	238,983.2	230,316.8	221,835.77	2034	480,418.9	407,686.5	351,559.5
2015	250,141.3	239,521.1	229,240.67	2035	492,816.3	415,670.1	356821.2
2016	261,447.2	248,743.9	236,574.43	2036	505,227.5	423,554.7	361,951.2
2017	272,907.5	257,965.4	243,816.65	2037	517,662.2	431,347.3	366,952.9
2018	284,517.3	267,181.1	250,962.29	2038	530,130.2	439,056.8	371,831.6
2019	296,269.3	276,384.9	258,005.13	2039	542,641.3	446,691.4	376,591.3

13 APPENDIX D1 - ESTIMATED NUMBER OF CRASHES BY DRIVER INJURY SEVERITY, SERIES B

Appendix D.1 Estimated number of crashes by driver injury severity, Series B

Year	*Serious injury crashes*	Fatal	Serious	Minor	Property damage only
2010	515	47	467	1,132	12,067
2011	539	49	489	1,186	12,637
2012	563	52	511	1,239	13,208
2013	587	54	534	1,293	13,779
2014	612	56	556	1,347	14,351
2015	636	58	578	1,401	14,925
2016	661	61	600	1,455	15,499
2017	685	63	623	1,508	16,074
2018	710	65	645	1,562	16,648
2019	734	67	667	1,616	17,222
2020	759	70	689	1,670	17,794
2021	783	72	711	1,723	18,364
2022	807	74	733	1,777	18,933
2023	831	76	755	1,830	19,499
2024	855	78	777	1,883	20,062
2025	879	81	799	1,935	20,622
2026	903	83	820	1,987	21,178
2027	926	85	842	2,039	21,729
2028	950	87	863	2,090	22,274
2029	973	89	883	2,141	22,813
2030	995	91	904	2,191	23,345
2031	1,018	93	924	2,240	23,870
2032	1,040	95	944	2,289	24,388
2033	1,062	97	964	2,337	24,899
2034	1,083	99	984	2,384	25,403
2035	1,104	101	1,003	2,431	25,901
2036	1,125	103	1,022	2,477	26,392
2037	1,146	105	1,041	2,522	26,877
2038	1,166	107	1,059	2,567	27,358
2039	1,187	109	1,078	2,612	27,834

14 APPENDIX E1 - ESTIMATED NUMBER OF CRASHES BY DRIVER INJURY SEVERITY, SERIES C

Appendix E.1 Estimated number of crashes by driver injury severity, Series C

Year	*Serious injury crashes*	Fatal	Serious	Minor	Property damage only
2010	509	47	462	1,120	11,933
2011	529	49	481	1,165	12,412
2012	549	50	499	1,209	12,887
2013	570	52	517	1,253	13,357
2014	589	54	535	1,297	13,823
2015	609	56	553	1,341	14,284
2016	629	58	571	1,383	14,741
2017	648	59	588	1,426	15,192
2018	667	61	606	1,468	15,638
2019	685	63	623	1,509	16,076
2020	704	65	639	1,549	16,508
2021	722	66	656	1,589	16,933
2022	740	68	672	1,628	17,351
2023	757	69	688	1,667	17,766
2024	775	71	704	1,706	18,176
2025	792	73	720	1,744	18,582
2026	809	74	735	1,781	18,982
2027	826	76	750	1,818	19,375
2028	843	77	765	1,854	19,761
2029	859	79	780	1,890	20,139
2030	874	80	794	1,925	20,509
2031	890	82	808	1,959	20,871
2032	905	83	822	1,992	21,225
2033	920	84	835	2,024	21,570
2034	934	86	848	2,056	21,906
2035	948	87	861	2,087	22,234
2036	962	88	873	2,117	22,553
2037	975	89	885	2,146	22,865
2038	988	91	897	2,174	23,169
2039	1,001	92	909	2,202	23,466

15 APPENDIX F – FLEET VEHICLE AGE FOR CLASS NA VEHICLES (DERIVED FROM CRASHES)

Table F.1. Percent distribution of vehicle age (derived from crash involvement)

Age of vehicle	Frequency	Percent	Valid Percent	Cumulative Percent
.00	4,827	3.8	3.8	3.8
1	12,860	10.1	10.1	13.9
2	12,301	9.7	9.7	23.6
3	11,375	8.9	9.0	32.6
4	10,457	8.2	8.2	40.8
5	9,159	7.2	7.2	48.0
6	8,150	6.4	6.4	54.4
7	7,523	5.9	5.9	60.3
8	6,827	5.4	5.4	65.7
9	6,054	4.8	4.8	70.5
10	5,449	4.3	4.3	74.8
11	4,954	3.9	3.9	78.7
12	4,609	3.6	3.6	82.3
13	4,063	3.2	3.2	85.5
14	3,489	2.7	2.7	88.2
15	3,001	2.4	2.4	90.6
16	2,776	2.2	2.2	92.8
17	2,489	2.0	2.0	94.7
18	1,994	1.6	1.6	96.3
19	1,496	1.2	1.2	97.5
20	**1,070**	**.8**	**.8**	**98.3**
21	755	.6	.6	98.9
22	645	.5	.5	99.4
23	381	.3	.3	99.7
24	216	.2	.2	99.9
25	90	.1	.1	100
26	42	.0	.0	100
Total	127,052	99.8	100	
Unknown	277	.2		
Total	127,329	100.0		