Australian Government
Department of Infrastructure and Regional Development

Regulation Impact Statement for the National Heavy Vehicle Braking Strategy Phase I – Antilock Braking Systems

Amendments to:

- Vehicle Standard (Australian Design Rule 35/03—Commercial Vehicle Brake Systems) 2009;
- Vehicle Standard (Australian Design Rule 38/03—Trailer Brake Systems) 2007

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ABSTRACT

The cost of road crashes on the Australian community is significant, estimated to be at least $27 billion per annum. Road crashes relating to heavy commercial vehicles have drawn considerable attention, with growing interest in braking and stability performance through systems such as Antilock Brake Systems (ABS), Electronic Braking Systems (EBS) and Electronic Stability Control (ESC). These technologies are increasingly being mandated in some overseas regulations. In Australia, the braking performance of new heavy commercial vehicles is regulated through national vehicle standards, Australian Design Rules (ADR) 35—Commercial Vehicle Brake Systems and 38—Trailer Brake Systems.

Following a full Australian Government review of ADRs 35 and 38 and a further extensive public consultation process, the National Transport Commission (NTC) and the Department of Infrastructure and Regional Development developed the National Heavy Vehicle Braking Strategy (NHVBS). The NHVBS was intended to chart a path for progressive revision of the heavy commercial vehicle ADRs, with the aim of improving braking safety performance. In 2011, the NHVBS was divided into two parts: Phase I and Phase II. Phase I was listed among the initial actions, and Phase II the future actions, in the National Road Safety Strategy 2011-2020 (NRSS).

This Regulation Impact Statement (RIS) examines the options for improving the braking of heavy vehicles, consistent with the aims of Phase I of the NHVBS. In particular, it looks at ways of increasing the installation of ABS in heavy commercial vehicles. ABS is a technology that prevents wheels from locking when the vehicle is overbraked. For the purposes of this RIS, heavy commercial vehicles are new vehicles greater than 4.5 tonnes Gross Vehicle Mass (GVM) that are represented by the ADR vehicle categories of NB2, NC, MD4, ME, TC and TD.

Within the RIS, four broad options were considered: Option 1—no intervention; Option 2—amend ADRs 35 and 38 to require ABS; Option 3—delete ADRs 35 and 38; and Option 4—adopt a non-regulatory option. The RIS recommends option 2, which through mandating ABS would provide the community with net benefits of $46-73m and save 36-57 lives over a period of 30 years that include 4 years of operation of the regulation before the introduction of Phase II. The benefit-cost ratio was 1.5. It is proposed to come into force from 1 January 2014. A sub-option for trailer manufacturers to fit Load Proportioning (LP) braking systems was also recommended. While practical and expediting the Phase I timetable, this would give less certainty to the magnitude of the benefits. With the further agreement of industry, the proposal was also broadened to include new goods vehicles greater than 3.5 tonnes GVM and less than 4.5 tonnes. These vehicles are represented by the ADR vehicle category of NB1, which also falls within the scope of ADR 35.

This RIS was circulated within the Strategic Vehicle Safety and Environment Group (SVSEG) and Technical Liaison Group (TLG) consultative forums for a period of one month. The intention will be that the final draft text of the amendments to ADRs 35 and 38 be agreed before being submitted to the Federal Minister for Infrastructure and Regional Development, who may then choose to determine an ADR under section 7 of the *Motor Vehicle Standards Act 1989* (C'th).

Industry codes and advisories would also be encouraged as a complement to regulated requirements for compatibility which, due to the nature of the ADRs (single vehicle type approval) are unable to fully deal with combinations (truck and trailer(s) operating together).

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EXECUTIVE SUMMARY

The cost of road crashes on the Australian community is significant, estimated to be at least $27 billion per annum. Road crashes relating to heavy commercial vehicles have drawn considerable attention, with growing interest in braking and stability performance through systems such as Antilock Brake Systems (ABS), Electronic Braking Systems (EBS) and Electronic Stability Control (ESC). These technologies are increasingly being mandated in some overseas regulations.

In Australia, the braking performance of new heavy commercial vehicles is regulated through national vehicle standards, Australian Design Rules (ADR) 35—Commercial Vehicle Brake Systems and ADR 38—Trailer Brake Systems.

In 2002, the then Standing Committee on Transport (SCOT) requested that the National Transport Commission (NTC) review the case for mandating ABS on heavy vehicles. However, the issues were broader than this and so following a full Australian Government review of ADRs 35 and 38 and a further extensive public consultation process, the NTC and the Department of Infrastructure and Regional Development (the Department) developed the National Heavy Vehicle Braking Strategy (NHVBS). The NHVBS was intended to chart a path for progressive revision of the heavy commercial vehicle ADRs, with the aim of improving braking safety performance. In 2011, the NHVBS was divided into two parts: Phase I and Phase II. Phase I was listed among the initial actions, and Phase II the future actions, in the National Road Safety Strategy 2011-2020 (NRSS).

This Regulation Impact Statement (RIS) examines the options for improving the braking of heavy vehicles, consistent with the aims of Phase I of the NHVBS. ABS is a technology that prevents wheels from locking when the vehicle is overbraked. It can provide greater benefits for heavy commercial vehicles when compared with passenger cars because of the relatively poorer braking capabilities of larger vehicles.

Electronic Braking Systems (EBS or in the case of trailers TEBS) integrate ABS technology with other key vehicle control system features to deliver the next generation of braking control. This can include Roll Stability Support (RSS) and Electronic Stability Control (ESC). These systems will be the subject of Phase II of the NHVBS with work expected to commence in 2014. The requirements of Phase II, if implemented, would follow on from Phase I. As the ADRs only apply to new vehicles, in-service vehicles would not be affected.

For the purposes of this RIS, heavy commercial vehicles are new vehicles greater than 4.5 tonnes Gross Vehicle Mass (GVM) that are primarily designed to carry goods (medium and heavy trucks and trailers) or passengers (some light and heavy buses). Under the ADRs, these are represented by the vehicle categories NB2, NC, MD4, ME, TC and TD.

During the 12 months to the end of September 2011, 230 people died from 204 fatal crashes involving heavy trucks or buses. In the past, a wide range of factors have been identified as playing a role in these crashes, including the vehicle, the driver, the road environment and situations such as day/night or rural/metropolitan. For a number of years it has also been recognised that braking and truck instability are significant vehicle factors that relate to crash occurrence. There are currently a number of interventions being considered or being implemented by governments in Australia to take account of the above factors.

The primary objective of this proposal is to reduce the road trauma arising from crashes involving the stability of heavy commercial vehicles under braking, in a way that provides a net benefit to the community and without presenting a technical barrier to vehicle manufacturers wishing to supply Australia with new vehicles meeting a higher level of safety.

In developing the NHVBS to its current state, discussions had been continued within the peak ADRs and vehicle safety consultation groups (the Strategic Vehicle Safety and Environment Group—SVSEG and the Technical Liaison Group—TLG), over the period 2008 to 2011. This allowed the recommendations contained within the original NHVBS report to be further refined. The final form of the proposed changes to the ADRs include the option, for trailers only, of fitting a load proportioning (LP) brake system in lieu of ABS. The detailed text of the proposed amendments to the ADRs is still to be determined in consultation with industry and to assist with this, draft ADRs 35 and 38 were circulated within the peak groups in mid-2012.

Within the RIS, four broad options were considered: Option 1—no intervention; Option 2—amend ADRs 35 and 38 to require ABS; Option 3—delete ADRs 35 and 38; Option 4—adopt a non-regulatory option. Option 2 had two non mutually exclusive variations, 2(a) allow trailer manufacturers to fit a load proportioning (LP) brake system in lieu of ABS, and 2(b) allow manufacturers to meet international standards instead of Australian specific requirements. A number of other minor variations were also considered during the policy development process.

The primary costs under this option would be in fitting the ABS equipment itself. In 2012, industry advised that the average costs for this are as shown in the table below.

Cost of ABS for heavy commercial vehicles

Vehicle Type	System description	Average cost of system
Light duty truck (3.501—8 t GVM)	ABS for a full hydraulic brake system	A$1,000
Medium duty truck (8—18 t GVM)	3-channel ABS on a 2-axle truck with Air-Over-Hydraulic or Full Air system	A$2,500
Heavy duty truck (3-axle and more)	4-channel ABS on 3 and 4-axle trucks with Full Air system	A$3,560
Buses (> 4.5 t GVM)	4-channel ABS	A$3,000
Trailers (>4.5 t GVM)	2 or 3-channel ABS	A$1,500

For the purposes of the RIS, these costs were combined into one overall cost for vehicles over 4.5 tonnes GVM. In each case, the individual costs were weighted by their respective vehicle production numbers per annum. This resulted in an average cost of $2,037.

Benefit-cost analysis was used to help evaluate the value of Option 2. Benefit-cost analysis compares the potential reduction in road trauma with the cost of implementing a particular option. In assigning a monetary value to both, options can be chosen that provide the greatest decrease in road trauma for the resources used.

Calculations were started at the current estimated voluntary compliance rate under the business as usual (BAU) case of 36 per cent of all trucks and trailers above 4.5 tonnes and 90 per cent of buses above 4.5 tonnes. Net benefits were calculated using a discount rate of seven per cent, with sensitivity tests conducted at three per cent and 10 per cent. The table below shows a summary of the net benefits, benefit cost ratios (BCRs) and lives saved calculated for various discount rates and ABS effectiveness values. Following further consultation in June 2013, industry estimated that up to 90 per cent of trucks may be fitted and so the effect of this was noted in the results for the likely case.

The likely case showed that mandating ABS would provide the community with net benefits of $46-73m and save 36-57 lives over a period of 30 years, from 4 years of operation of the regulation, from 2014 until any new requirements under Phase II may come into effect in 2018. The resultant BCR was 1.5. Under Option 2(a), while practical and expediting the Phase I timetable, the net benefits were not able to be determined accurately. These were estimated at a minimum of $46m and 36 lives.

Summary of net benefits, BCRs and lives saved from the regulation of ABS for heavy commercial vehicles over 4 years for option 2

	Net benefits ($m)	BCR	Lives saved
Best case	354	3.0	84
Likely case	73	1.5	57
Worst case	-45	0.7	31

Note:

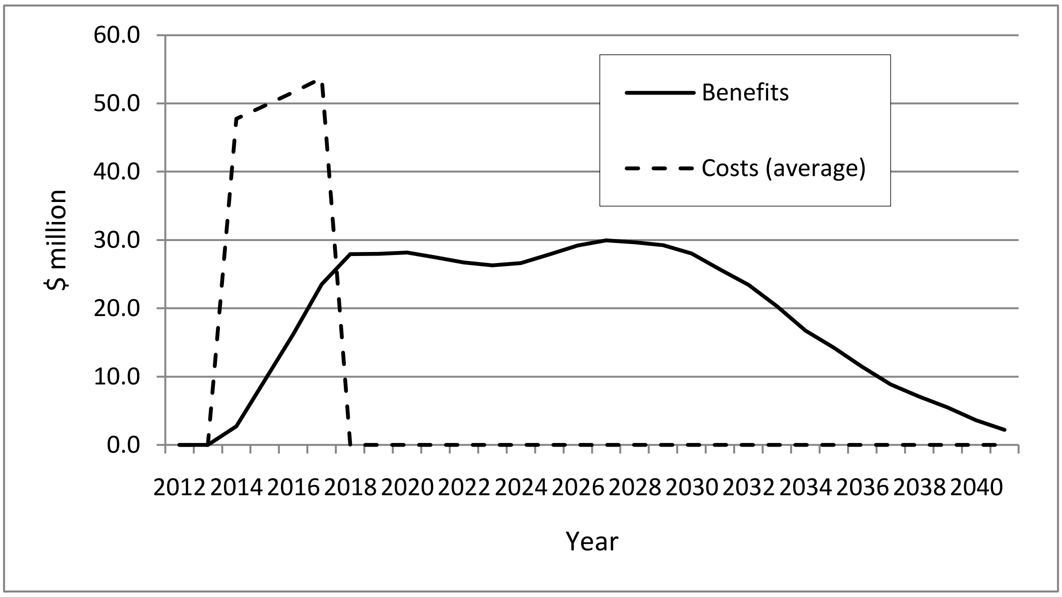
Best case—4-year period; 3 per cent discount rate; 8 per cent effectiveness of ABS

Likely case—4-year period; 7 per cent discount rate; 5.5 per cent effectiveness of ABS. In the case of a 90 per cent voluntary fitment rate for trucks this would become 36 lives saved and a Net benefit of $46m. The BCR would remain the same.

Worst case—4-year period; 10 per cent discount rate; 3 per cent effectiveness of ABS

The benefits and costs over time are shown in the figure below:

Option 2: amend ADRs 35 & 38 to require ABS on heavy commercial vehicles



A sensitivity analysis was carried out to determine the effect on the outcome of some of the less certain inputs to the benefit-cost analysis, the fleet growth prediction and the effectiveness of ABS. In the first case and to be very conservative, the fleet growth prediction was halved from eight to four per cent for all calculations. For the second, the effectiveness was varied between three and eight per cent in line with a variety of existing research. The results indicated that the net benefits would become negative only in the worst case scenario. Although this scenario represents a potential loss, this risk was not considered significant when compared with the likely case of $73m in positive benefit. In all cases ABS does provide a gross benefit in reducing road trauma and so explains the broad support that the Phase I proposed changes have generally received.

Under Option 2(b) it was noted that the international regulation UNECE R 13 was already allowed as an alternative to ADRs 35 and 38. This would continue to be the case and so this option would not affect the result. Manufacturers wishing to supply Australia with new vehicles meeting a higher level of safety would not be subject to any technical barriers.

The NHVBS Phase I details as developed through the SVSEG/TLG process contain a number of other minor proposed changes to ADRs 35 and 38. These were set out in Table 2 in the RIS and are discussed in more detail further below.

i. No need to meet unladen compatibility limits if ABS fitted—this is a relaxation of current ADR requirement as it allows ABS in lieu of unladen compatibility. This aligns with R 13. The unladen state is a relatively low risk vehicle configuration for braking, provided ABS protects the wheels from locking.

ii. ABS off switch for off-road or road train—this was an early recommendation but industry had subsequently indicated that systems are now capable of handling unsealed road conditions that some road trains may operate on. However, it had been agreed that genuine off-road design vehicles should be able to switch off ABS when conditions dictate and this aligns with R 13. This was discussed further with industry; in particular about whether road train trucks that are not of off-road design—but are used in off-road areas—should be allowed concessions to the ABS requirements. Following a further round of consultation in June 2013 it was then determined that the fitting of an ABS off switch would be permitted for all vehicles.

iii. Provision of electrical ABS connector, where a tow coupling is fitted—refer paragraph 5.3.4.

iv. Split-mu (independent braking control left to right) on axles other than steerable axles—R 13 requires demonstration of 'split-mu' ABS performance for some vehicle categories (heavy trucks and buses and heavy semi-trailers). This is being discussed further with industry as split-mu systems are not currently a requirement in ADRs 35 and 38.

v. No release times for circuits controlled by ABS modulation valves—currently the only release times required are at the coupling head of Road Trains (since ADR 35/03) and so this does not appear to be an issue any more.

vi. Certification of EBS compatibility performance—refer paragraph 5.3.4 regarding EBS generally. This is being discussed further with industry but is a certification matter and as such is not part of this RIS.

vii. Where EBS is fitted, ABS/EBS power voltage to match CAN voltage—refer paragraph 5.3.4.

viii. A tolerance on the LP valve unladen compatibility requirements to allow for particular combinations (does not apply to electronic LP operation)—refer paragraph 5.3.4 regarding LP generally. This is an industry proposal to relax the existing limits of LP in order to better match particular vehicles when using them in combination.

<u>Load proportioning (LP)</u>

During development of the NHVBS, some of the trailer industry flagged a need for a transition to the electronic systems that are part of Phase I of the NHVBS in terms of ABS, and part of Phase II in terms of EBS/ESC. It was therefore proposed to allow, for trailers only, mechanical or pneumatic LP systems for Phase I in lieu of ABS.

LP was considered under Option 2(a). Discussions with industry regarding the details of LP are ongoing.

Compatibility

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

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

The Australian Road Transport Suppliers Association (ARTSA) has worked with the Australian Trucking Association (ATA) and with some state and territory governments in continuing to develop a Brake Code of Practice. The code deals with (amongst other things) issues of compatibility. The ATA have also produced an Australian Air Brake Code of Practice and more recently an Advisory Procedure for Heavy Vehicle Combinations and the use of Electronic Braking Systems.

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

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

Electronic Braking Systems

EBS (or for trailers TEBS) overlay conventional pneumatically controlled brake systems and instead control brake actuation through electrical signals (the pneumatic control is used as a backup). An important feature of EBS is the ability to allow communication between elements of the braking system on all vehicles in a combination (i.e. truck and trailer(s)) via a communications network that operates on set protocols (a Controller Area Network (CAN) bus) system. When EBS is fitted, ABS is always incorporated, as it provides the emergency braking component of the electronic control of the braking system.

EBS is not mandated in R 13 but, if fitted, must not affect the safe operation of other mandated systems. It must also have safe operation and warn the driver under fault conditions. These same requirements are proposed to be adopted by the ADRs. In addition, and in alignment with R 13, where a tow coupling is fitted to a vehicle, an ABS connector will have to be provided and where a CAN connection is provided, it must be compatible with the ABS power voltage. These requirements will ensure that all prime movers and other trucks and buses with trailer connections will not only have ABS themselves, but will provide power for an ABS system if they are connected to a trailer with ABS fitted. Similarly, where a trailer has an EBS (TEBS) system fitted, the voltage of the communications network between truck and trailer will also be compatible.

The above proposals (i)-(viii), and those relating to LP, compatibility and EBS, are second order matters in relation to the more fundamental question of mandating ABS and so have not been analysed further for the purposes of this RIS. However, they relate directly to the original report and NTC response to the NHVBS and have been discussed with industry on an ongoing basis.

Similarly, Electronic Stability Control (ESC) is the subject of Phase II of the NHVBS and is not considered further in this analysis.

Draft ADRs 35/04 and 38/04 have been developed which reflect the above proposed changes. A tabulated form of the proposed changes is at Appendix 5—Proposed Changes to the Current ADR Versions. The ADR amendments are proposed to come into force from 1 January 2014. A transition date in order to phase in new models first has not at this stage been sought by industry.

The consultation process for the proposed amendments to ADRs 35 and 38 has been ongoing in nature. It has followed on from a full review of these ADRs starting in 2006 (with amendments coming into force in 2009) and with one of the outcomes being the NHVBS. The NHVBS has then fed into the NRSS. A detailed public consultation process was carried out initially in the development of the NHVBS and this was subsequently supported through the public comment process for the NRSS.

In terms of details of the proposed amendments, the NHVBS report was released publicly via the NTC and was used as a basis for continuing to develop the recommended requirements through the standards development forums, the TLG and SVSEG, where they were discussed within the forums as well as within member's organisations a number of times. This resulted in the proposed changes set down in Table 2 being developed.

This approach was reconfirmed by SVSEG in April 2011 and, furthermore, strong support was given for an accelerated process to be undertaken. It was agreed that a simplified RIS would be acceptable and that this need only to be circulated within the SVSEG/TLG forum.

This RIS was subsequently circulated within the SVSEG and TLG forums for a period of one month, with the intention that the final draft text of the amendments to ADRs 35 and 38 be agreed before being submitted to the Federal Minister for Infrastructure and Regional Development for consideration and signature.

Option 2, including the variation under 2(a), is the most effective solution in terms of achieving the objective established earlier. Under this option ADR 35/03 and ADR 38/03 would mandate ABS for heavy commercial vehicles (trucks, trailers and buses) but with LP braking systems a sub-option for heavy trailers. With the further agreement of industry, the proposal was also broadened to include new goods vehicles greater than 3.5 tonnes GVM and less than 4.5 tonnes. These vehicles are represented by the ADR vehicle category of NB1 (large vans and small trucks), which also falls within the scope of ADR 35.

The ADRs would also accommodate the latest revision of R 13 within its alternative standards provisions. The ADR amendments are proposed to come into force from 1 January 2014. A transition date in order to phase in new models first has not yet been sought by industry, however may become a necessity in view of the approaching date.

Option 1—taking no action. Based on the most recent industry estimates of voluntary ABS installation (90% of trucks), this option is achieving the objective to reduce the road trauma arising from crashes involving the stability of heavy commercial vehicles under braking to a large extent. However, industry wide installation is unlikely to be achieved in the medium term.

Option 2—adopting the proposed amendments, would reduce road trauma. It would also provide a net benefit to the wider community without presenting a technical barrier to vehicle manufacturers wishing to supply Australia with new vehicles meeting a higher level of safety and it. The impact analysis shows that, due to the mature nature of the technology, there is effectively a small positive net benefit to the community for each additional heavy vehicle fitted with ABS even as the voluntary rate approaches 100%. It is therefore expected to achieve a higher net benefit than the status quo or the non-regulatory options. It is the recommended option.

Option 3—deleting ADRs 35 and 38, and Option 4—non-regulatory options, were options that had been considered and rejected at the last full review. They had previously been rejected as not being appropriate for such a high impact, high risk area of public safety. These options are unlikely to achieve 100% ABS uptake, and therefore unlikely to achieve a net benefit higher than option 2.

ADRs 35 and 38 will be scheduled for a full review on an ongoing basis and in accordance with the Australian Government's Business Review Agenda. The timing for review is to be determined. In the interim, consideration of full stability systems (ESC) under Phase II of the NHVBS will begin at the completion of Phase I. This is scheduled within the NRSS for 2014+ and it is expected that this work will begin at the start of 2014.

Industry codes and advisories must also be encouraged as a complement to regulated requirements for compatibility which, due to the nature of the ADRs (single vehicle type approval) are unable to fully deal with combinations (truck and trailer(s) operating together).

1 INTRODUCTION

The cost of road crashes on the Australian community is significant, estimated to be at least $27 billion per annum (DIT 2012). This cost is broadly borne by the general public, business and government. There is also a personal dimension for those affected that is difficult to quantify.

Road crashes relating to heavy commercial vehicles have drawn considerable attention from policy makers, road safety practitioners and the general public. These vehicles have unique operating characteristics that can increase the crash severity, such as high gross mass, long vehicle length and relatively long stopping distances.

There has been a growing interest from governments and the community to require the latest safety technology to be fitted to heavy commercial vehicles. There is particular interest in braking and stability performance, with distinct systems such as Antilock Brake Systems (ABS), Electronic Braking Systems (EBS) and Electronic Stability Control (ESC) coming under scrutiny. These technologies are increasingly being mandated in some overseas regulations.

Braking systems are heavily regulated throughout the world. In Australia, the braking performance of new heavy commercial vehicles is regulated through national vehicle standards, Australian Design Rules (ADR) 35—Commercial Vehicle Brake Systems and ADR 38—Trailer Brake Systems

Following a public consultation process after the last Australian Government review of ADRs 35 and 38, the National Transport Commission (NTC) and the Department of Infrastructure and Regional Development (the Department) developed the National Heavy Vehicle Braking Strategy (NHVBS). The NHVBS was intended to chart a path of progressive revision of the heavy commercial vehicle ADRs, with the aim of improving braking safety performance and in doing so increase alignment with international regulation. In 2011, the NHVBS was divided into two parts: Phase I and Phase II, and was subsequently adopted into the National Road Safety Strategy (2011-20) (NRSS).

This Regulation Impact Statement (RIS) examined the case for amending ADRs 35 and 38 in line with Phase I of the NHVBS. This would see an increased alignment of these ADRs with the latest version of the international heavy vehicle braking standard United Nations Economic Commission for Europe (UNECE) Regulation 13—Uniform Provisions Concerning the Approval of Vehicles of Categories M, N and O with Regard to Braking (R 13). The focus of Phase I is the adoption of ABS systems.

If implemented, Phase II would follow Phase I. The focus of Phase II is the adoption of ESC systems, which would result in even greater alignment with UNECE R13. ADRs only apply to new vehicles and so a change from Phase I requirements to Phase II requirements would not be applied to those vehicles already in service.

For the purposes of this RIS, heavy commercial vehicles are new vehicles greater than 4.5 tonnes Gross Vehicle Mass (GVM) that are primarily designed to carry goods (medium and heavy trucks and trailers) or passengers (some light and heavy buses). Under the ADRs, these are represented by the vehicle categories NB2, NC, MD4, ME, TC and TD.

2 BACKGROUND

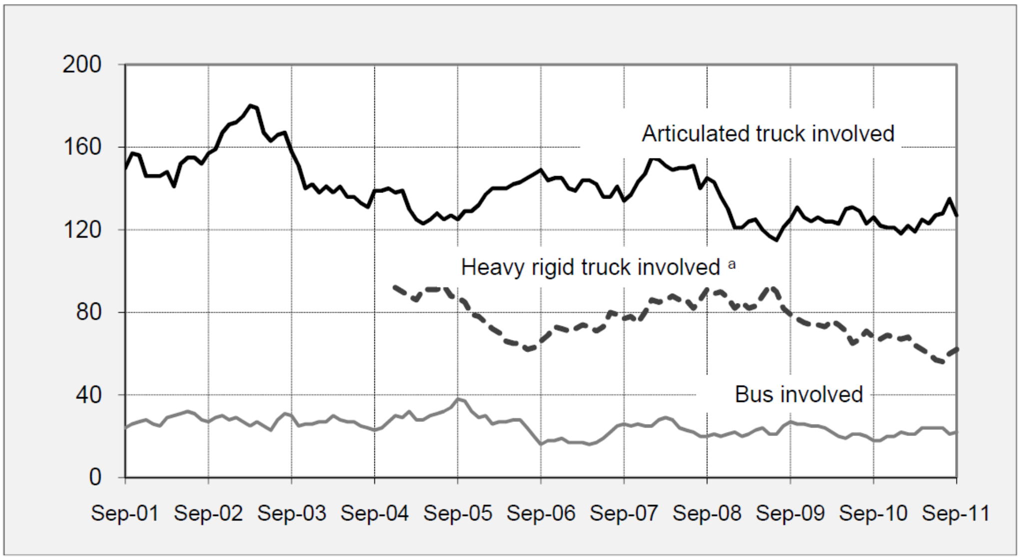
2.1 The Problem

Heavy commercial vehicles represent 2.9 per cent of all registered vehicles in Australia (ABS 2012) and account for 7 per cent of total kilometres driven on public roads (ABS 2011).

Appendix 1—Heavy Commercial Vehicle Categories describes in more detail the various categories of heavy commercial vehicles as listed in the ADRs while Appendix 2—Common Types of Medium and Heavy Trucks illustrates the common types of medium and heavy trucks that are operating on Australian roads.

Heavy commercial vehicles are involved in some 20 per cent of fatal crashes and cost the Australian community $3 billion annually (BTE 2000). During the 12 months to the end of September 2011, 230 people died from 204 fatal crashes involving heavy trucks or buses (BITRE, 2011).

Figure 1 Fatal heavy vehicle crashes Australia, July-September 2011 (BITRE, 2011)



Fatal crashes involving articulated trucks have decreased by an average of 3.8 per cent per year over the three years to September 2011. Fatal crashes involving heavy rigid trucks have decreased by an average of 12.2 per cent per year over the same period (BITRE, 2011). However, this is a very gradual trend and it cannot be guaranteed that this will continue into the future, given an expected doubling of the freight transport task by 2020 (Truck Industry Council, 2004 & Gargett, 2012).

Internationally, the freight transport task has grown significantly in recent decades in most member countries of the International Transport Forum (ITF), growing faster than passenger transport. Further, because of its flexibility and timeliness, road transport is expected to account for much of the growth in freight transport for the foreseeable future (Working Group of the Joint Transport Research Centre on Heavy Vehicles: Regulatory, Operational and Productivity Improvements, 2010).

It is inevitable that this increase in freight task creates some challenging operational conditions for the industry, including economic pressure to have longer in-service operational times, shorter loading times and lengthened maintenance intervals. These conditions have the potential to lead to some kind of failure, either human or vehicle related.

In the past, a wide range of factors have been identified as playing a role in these crashes, including vehicle, driver, road environment and situations such as day/night or rural/metropolitan. There are currently a number of interventions being considered or being implemented by governments in Australia to take account of these factors and these include:

- The introduction of a single national set of laws for heavy vehicles over 4.5 tonnes and a single National Heavy Vehicle Regulator to administer the laws. This is part of the Council of Australian Governments (COAG) broader Seamless National Economy initiative.

- Implementation of Australia's new NRSS. The strategy has several initiatives targeting the safety performance of the heavy vehicle industry, including: measures to increase the prosecution of heavy vehicle speeding offences, including the development of new regulatory tools and more effective use of registration sanctions for non-operational speed-limiters;

- Consideration of mandating improved braking systems for heavy vehicles and trailers; investigating options to improve the safety of restricted-access heavy vehicle operations; reviewing licensing arrangements for heavy vehicle drivers; and piloting electronic work diaries.

- The introduction of more rest opportunities for heavy vehicle drivers under the Australian Government's Heavy Vehicle Safety and Productivity Program (HVSPP).

In the past, surveys conducted by states and territory transport agencies have shown that tyres and brakes are two dominant components on heavy commercial vehicles that contribute to mechanical defects that can in turn lead to crashes. This suggests that even primary safety systems such as brakes on heavy commercial vehicles are not immune to economic pressures.

For a number of years it has been recognised that braking and truck instability are significant vehicle factors that relate to crash occurrence (Sweatman et al, 1995). These factors can be exacerbated by the use of incompatible vehicle combinations and the challenging operational conditions described above.

2.2 The National Heavy Vehicle Braking Strategy

The Australian Government provides protection for new vehicle consumers and operators through the Motor Vehicle Standards Act 1989 (C'th) (MVSA). The MVSA provides mandatory vehicle safety, emission and anti-theft standards which apply when new vehicles are supplied to the Australian market. These are national standards and are known as the ADRs.

Braking systems are regulated throughout the world. In Australia, the braking performance of heavy commercial vehicles has been regulated through the ADRs since 1975, with the introduction of ADR 35 – Commercial Vehicle Braking Systems. At the time of its introduction there was perceived urgent need to improve heavy vehicle braking of new vehicles in the fleet (National Transport Commission & Federal Office of Road Safety, 1994). In 1984, ADR 38 – Trailer Brake Systems was also implemented and work began on improving ADR 35 to better balance the braking compatibility between towing vehicle (truck) and towed vehicle (trailer). When ADR 38 was introduced, there followed a vigorous debate regarding the compatibility of ADR 35 and ADR 38 braking systems when in a combination vehicle. This issue of compatibility between truck and trailer continues to be the major focus of heavy vehicle braking performance by regulatory authorities and features in most heavy vehicle braking regulations.

During the mid-nineties, ADRs 35 and 38 were reviewed and amended to better harmonise with international regulations, specifically R 13 requirements, as was the policy of the Australian Government at the time. There was a further review of ADRs 35 and 38 in 2006, by which time the policy of harmonising with UNECE regulations had become a fundamental obligation of Australia's membership of the World Trade Organisation (WTO) Agreement on technical barriers to trade and of the Council of Australian Governments (COAG) principles and guidelines for assessing regulatory proposals. The WTO and COAG principles and guidelines stipulate the use of international standards where they exist, unless there are compelling reasons not to (COAG 2004). The WTO has identified the UNECE regulations as the peak international regulations for vehicle safety and so Australia has gradually been harmonising the ADRs with these regulations.

In 2002, the Standing Committee on Transport (SCOT) requested that the NTC review the case for mandating ABS on heavy vehicles. This ran in parallel with the ADR review of the heavy vehicle braking ADRs 35 and 38 in 2006, ADRs 35/02 and 38/03 being published in 2007. These came into force in 2009.

As the issues were seen as broader than just ABS, the NTC, in conjunction with the Department, initiated a project to develop the more comprehensive NHVBS.

This began with an extensive consultation process. Two public meetings were held in Melbourne in late 2005 involving discussions with representatives of transport industry groups, to discuss the general situation with heavy vehicle braking regulation and on-road performance. A discussion paper was released in January 2006 that identified six strategic objectives. Written and verbal comments were invited by April 2006. Three workshops were held to describe the proposals and to receive feedback. These were held in Melbourne, Brisbane and Perth and led to a further meeting of around twenty industry and road agency representatives in June 2006. The consultation process involved detailed discussions with about 200 representatives and written comments were received from about 40 correspondents. Section 5.6 summarises the views put forward at that stage. In very broad terms there was support for mandating ABS for heavy vehicles but other means of ensuring brake compatibility were preferred for trailers, such as load proportioning (LP) brake systems.

Following this process, a report was published containing a number of strategic objectives to be implemented (refer to Appendix 3—Extract from the Executive Summary of the National Heavy Vehicle Braking Strategy Report). In particular, Strategic Objective 4 recommended that the ADRs for heavy vehicle braking be amended to mandate ABS, with an allowance for LP systems for trailers. The NTC responded to a final report on the NHVBS with a December 2008 information paper. An extract of this is provided at Appendix 4—The NTC Response to the National Heavy Vehicle Braking Strategy Report. The Department then issued a proposed way ahead in June 2009 at the Technical Liaison Group (TLG) meeting 32.

This proposal was subsequently adopted into the NRSS in May 2011 in two parts; Phase I and Phase II. At the Strategic Vehicle Safety and Environment Group (SVSEG) meeting 4 in September 2011, it was then agreed to prioritise them for completion as Phase I in 2012 and Phase II in 2014+ (i.e. nominally 2014 but to be determined when the NRSS is reviewed in 2013).

Both Phases would see an increased alignment of these ADRs with the latest version of the international heavy vehicle braking standard United Nations Economic Commission for Europe (UNECE) Regulation 13—Uniform Provisions Concerning the Approval of Vehicles of Categories M, N and O with Regard to Braking (R 13). The focus of Phase I is the adoption of ABS systems and the focus of Phase II is the adoption of ESC systems.

If and when implemented, Phase II would follow Phase I, that is, new vehicles would need to comply with Phase I requirements under ADRs 35 and 38 until these changed under any Phase II requirements. Existing vehicles in service would not be affected by such a change. Phase II requirements would also be compatible with Phase I ie a vehicle model that meets Phase II requirements early would also meet Phase I requirements.

In parallel with the development of this RIS, draft ADRs 35/04 and 38/04 were circulated to all TLG members in July 2012. These drafts are in line with the NHVBS recommendations as set down in the NRSS. A tabulated form showing the proposed changes to the current ADR versions and incorporating comments from the TLG meeting in August 2012 can be found at Appendix 5—Proposed Changes to the Current ADR Versions.

In April 2011, strong support was given at SVSEG for an accelerated process to be undertaken. It was agreed that a simplified RIS should be developed and also that final consultation need only be through the membership of the SVSEG and TLG forums.

2.3 Objective

The primary objective of this proposal is to reduce the road trauma arising from crashes involving the stability of heavy commercial vehicles under braking, in a way that provides a net benefit to the community and without presenting a technical barrier to vehicle manufacturers wishing to supply Australia with new vehicles meeting a higher level of safety.

Where intervention involves the use of regulation where the decision maker is the Australian Government's Cabinet, the Prime Minister, minister, statutory authority, board or other regulator, Australian Government RIS requirements apply. This is the case for this RIS. The requirements are set out in the Best Practice Regulation Handbook (Australian Government, 2010).

3 OPTIONS

3.1 Option 1: Take no action

Under this option, the proposal as set out in the NRSS relating to Phase I of the NHVBS would not be implemented, and so vehicles would continue to only have to comply with the current ADR 35/03 and ADR 38/03 requirements.

3.2 Option 2: Amend ADRs 35 & 38 to require Antilock Braking Systems (ABS) on new heavy commercial vehicles

Under this option, new heavy commercial vehicles would be required to be fitted with ABS. This would align with Strategic Objective 4 of the NHVBS report. The report had recommended that the ADRs for heavy vehicle braking be amended to mandate ABS.

ABS is a safety technology that prevents wheels from locking when the vehicle is overbraked. It helps to maintain directional stability and control during braking, and may reduce stopping distances on some road surfaces, especially where wet.

There were two variations to this proposal that were also considered as part of Option 2:

Option 2(a) – as for Option 2 but allowing trailer manufacturers to fit Load Proportioning (LP) brake systems instead of ABS. This was introduced in part due to concerns from some parts of the trailer industry about the cost and robustness of more sophisticated systems such as ABS, when operating in hostile environments.

Option 2(b) – as for Option 2 but in all cases allow or mandate the technical requirements of relevant international regulations for ABS or LP, rather than develop Australian specific requirements. ADRs 35 and 38 currently contain Australian specific requirements (although both also allow for the international regulation UNECE R 13 as an alternative).

3.3 Option 3: Delete ADRs 35 & 38

Under this option, vehicles would no longer be required to comply with ADR 35/03 or 38/03 requirements.

The ADRs are subject to a review every ten years as resources permit, to ensure that they remain relevant, cost effective and do not become a barrier to the importation of safer vehicles and vehicle components. As discussed above, ADRs 35/03 and 38/03 were reviewed in 2006 with amendments coming into force in 2009, and the issue of whether to retain or delete the ADR was considered and rejected.

It was argued at the time that in deleting the ADRs, there would be high risks created from the imprecise control of heavy vehicles, with a potential to inflict fatal and serious injuries to road users. It would be expected that state and territory governments would step in and regulate on a state by state basis, leading to inconsistencies across Australia. Such a move could increase the cost of compliance to industry and governments, all of which would eventually have to be recovered from road users through higher taxes, levies, charges and insurance premiums (DOTARS 2006).

These arguments are still highly applicable today, and so this option has not been considered further in the RIS.

3.4 Option 4: Non-regulatory option

Under this option, non-regulatory options such as suasion (publicity, social pressure etc.), pure market approaches (property rights) and economic approaches (taxes, charges, fees, or subsidies) would be considered that would have the same effect as the proposal for this amendment. As with Option 3, non-regulatory options were considered and rejected as part of the last full review of ADRs 35/03 and 38/03.

In this case the focus of the analysis was on the provision of information that could influence operators to voluntarily invest in safe braking systems. It was argued that the information currently contained within regulation is too technically complex to inform the average operator/purchaser and that any information program or Code of Practice would only be voluntary, would not cover all the operators in the industry (if run through the peak representative bodies) and would moreover lack the force of law to force offenders to comply. This would not be an appropriate response to such a high impact, high risk area of public safety (DOTARS 2006).

Therefore, this option has not been considered any further in this RIS.

4 ANALYSIS

4.1 Option 1: Take no action (the status quo)

This option would involve maintaining ADRs 35/03 and 38/03 in their current form.

By not changing the ADR provisions, vehicles supplied to Australia may not meet the latest internationally agreed levels of safety performance including for braking systems. Therefore, there would be no reduction in road trauma arising from crashes involving the stability of heavy commercial vehicles under braking.

ABS is not a new or emerging technology. It has been used around the world in various automotive forms for over thirty years. It has been mandated for heavy vehicles in Europe and the US for 15-20 years, which is where the majority of Australia's heavy trucks get their basic design influences from. Similarly, the international regulation for heavy vehicle braking, UNECE R13, has mandated ABS in line with Europe for a number of years. Yet ABS is still supplied in Australia at reasonably low levels (this is discussed later when analysing benefits against the different options).

One major reason that these influences have not carried across to the Australian fleet is the nature of construction of heavy commercial vehicles. Compared to light passenger vehicles (cars and Sports Utility Vehicles etc), heavy vehicles tend to be built to order, with engines, drivetrains, suspensions, brakes, axles and safety systems such as ABS individually specified by the purchaser. Purchasers and operators will be seeking the maximum in productivity for the money spent. This means that the designs or regulations of other countries will have a lesser effect on what is built in Australia. In the case of trailers, they are almost exclusively designed and built in Australia and so there is even less influence on the local product.

Because of this, it was argued that the status quo would change only slowly without any intervention.

4.2 Option 2: Amend ADRs 35 & 38 to require ABS on heavy commercial vehicles

This option would involve mandating the fitment of ABS to heavy commercial vehicles. Under the ADRs these are new vehicles greater than 4.5 tonnes GVM that are primarily designed to carry goods (medium and heavy trucks and trailers) or passengers (some light and heavy buses). These are represented by the vehicle categories NB2, NC, MD4, ME, TC and TD.

As discussed earlier, the NHVBS was a product of the last ADR review in 2006. In itself the NHVBS involved significant consultation, prior to it being adopted into the 2011-2020 NRSS under items 16(b) and 16(c) of the Safe Vehicles section. These items are listed in Table 1.

Table 1—The NHVBS as incorporated into the NRSS

NRSS action no.	ADR title	Description	Notes	Specific timing for Departmental work
16(b)	35/03—Commercial Vehicle Brakes	Implement Heavy Vehicle Braking Strategy (HVBS) Phase I—ABS	Relates to ABS to prevent wheel lock up under braking of heavy trucks. Also includes electrical connection compatibility. Requirements exist under R 13.	2012
16(c)	35/03—Commercial Vehicle Brakes	Implement Heavy Vehicle Braking Strategy (HVBS) Phase II—ESC	Relates to lateral directional control of the vehicle through the braking system of heavy trucks. Requirements exist under R 13.	2014+
16(b)	38/03—Trailer Brakes	Implement Heavy Vehicle Braking Strategy (HVBS) Phase I—ABS or LP	Relates to ABS to prevent wheel lock up under braking or Load Proportioning (LP) brake systems to balance braking of heavy trailers. Also includes electrical connection compatibility. Part requirements exist under R 13.	2012
16(c)	38/03—Trailer Brakes	Implement Heavy Vehicle Braking Strategy (HVBS) Phase II—ESC	Relates to lateral directional control of the vehicle through the braking system of heavy trailers. Requirements exist under R 13.	2014+

Further work was carried out within the peak bodies set up to consult regarding vehicle safety and the ADRs over the period 2008 to 2011 in order to refine the recommendations contained within the NHVBS. This involved discussions with TLG and SVSEG. The role of these groups is discussed further in section 5.5. The final form of the proposed changes is as shown in Table 1 above in conjunction with associated changes as shown in Table 2 below.

As part of item 16(b) for ADR 38/03, the option of fitment of a load proportioning (LP) brake system to trailers in lieu of ABS was incorporated into the draft requirements. Like ABS, LP brake systems are also a safety technology that prevents wheels from locking when the vehicle would otherwise be overbraked. Unlike ABS, it does not require electrical power from the truck. At the same time it is less sophisticated in operation. This option has been included as a variation to Option 2, ie **Option 2(a).**

A further variation is in the technical requirements themselves. While the finer details would be worked through by the consultation groups rather than within a RIS, the basic question of adopting or otherwise international standards for the requirements was also considered as a variation to Option2, ie **Option 2(b).**

Options 2, 2(a) and 2(b) are not mutually exclusive and so were able to be considered separately.

Table 2—The NHVBS Phase I details as developed through the SVSEG/TLG process

Description	Status	Source/comments
No need to meet unladen compatibility limits if ABS fitted	Relaxation	UNECE (refer paragraph 5.3.1.1)
ABS off switch for off-road or road train	Relaxation	UNECE + NTC/Departmental report (refer paragraph 5.3.1.2)
Provision of electrical ABS connector, where a tow coupling is fitted	Increase (minimal)	UNECE + NTC/ Departmental report (refer paragraph 5.3.1.3)
Split mu on axles other than steerable	To be resolved	UNECE requires split mu but this may not be picked up in Phase I—to be discussed further. (refer paragraph 5.3.1.4)
No release times for circuits controlled by ABS modulation valves	Relaxation	The only release times currently required are at the coupling heads of road trains (these would not be controlled by ABS anyway) (refer paragraph 5.3.1.5)
Certification of EBS compatibility performance	Increase	UNECE + industry discussion (refer paragraph 5.3.1.6)
Where EBS fitted, ABS/EBS power voltage to match CAN voltage	Increase (minimal)	UNECE + industry proposal (refer paragraph 5.3.1.7)
References to Road Friendly Suspension (RFS) in Table 2 of ADR 35 and Table 1 of ADR 38 to become informative only, as they do not relate to requirements for a standard vehicle	Relaxation	Industry proposal (refer paragraph 5.3.1.8)
A tolerance on the LP valve unladen compatibility requirements to allow for particular combinations (does not apply to electronic LP operation)	Relaxation	Industry proposal (refer paragraph 5.3.1.9)

Note: paragraph references are to where these source/comments are discussed later in the RIS

These requirements are shown in greater detail against the current ADRs 35 and 38 and also against the corresponding international standard for heavy vehicle braking R 13 in Appendix 5—Proposed Changes to the Current ADR Versions. As ABS and LP are the most significant changes being proposed within Phase I of the NHVBS, this RIS will focus on this aspect of the NHVBS.

4.2.1 Antilock Brake Systems (Option 2)

ABS prevent wheels from locking when the vehicle is overbraked. With ABS operating, the braking distance is often shorter than with locked wheels (Bosch, 2007).

ABS can provide greater benefits for heavy commercial vehicles when compared to passenger cars because of the relatively poorer braking capabilities of larger vehicles. On dry roads, large vehicles take much farther to stop — 47 per cent farther in some tests conducted in the United States (US) (Insurance Institute for Highway Safety & Highway Loss Data Institute, 2012).

The purpose of ABS is to help maintain directional stability and control during braking, and possibly reduce stopping distances on some road surfaces, especially on wet roads. ABS can reduce crashes involving jack-knife, loss-of-control, run-off-road, lane departure, or skidding, or where trucks with conventional brakes are unable to stop in time to avoid hitting something frontally. On the other hand, ABS is unlikely to affect crashes where the truck is standing still, moving too slowly for ABS activation, or proceeding straight ahead when another vehicle unexpectedly hits it in the side or rear (Hart, 2008).

ABS comprises wheel speed sensors, electronic control unit, and electro-pneumatic pressure control valves. The Antilock system monitors the wheel slip on the sensed wheels and manages (modulates) the brake air pressure applied to the controlled wheels to prevent the wheel slip reaching the lock-up level (ARTSA, 2011). Depending on the complexity of the system there may be differing numbers of sensors and modulators. This will determine whether wheels are sensed and/or modulated individually or as a group. Appendix 6—Types of Antilock Brake Systems outlines the various levels of complexity.

ABS systems for trucks may have an off-road mode which is selectable by the driver. In this mode the antilock controller is more tolerant of developing wheel lock-up and will let the wheels fully lock before releasing. This is done to achieve shorter stopping distances on loose surfaces (ARTSA, 2011).

Electronic Braking Systems (EBS or in the case of trailers TEBS) integrates antilock technology with other key vehicle control system features to deliver the next generation of braking control. This can include Roll Stability Support (RSS) and Electronic Stability Control (ESC) (Pearson et al, 2011). ESC is the subject of Phase II of the NHVBS.

4.2.2 Regulation of ABS

Australian ABS experience dates from 1986 (first B-Double installation). Trial ABS installations on triple road train occurred in 1993 (with a special 24V power supply scheme) (ARTSA, 2011).

ABS is currently mandated in Australian Design Rule (ADR) 64 - Heavy Goods Vehicles Designed for Use in Road Trains & B-Doubles, for all new B-double prime-movers. State and territory road regulations also require ABS to be fitted to B-double trailers that are tanker bodied and that carry dangerous goods.

Anti-lock brakes are mandated on new motor trucks and heavy trailers in the European Union, USA, Japan and Canada. Countries that have or are harmonizing their brake rules to UNECE Regulation 13, such as China, India and South Africa, have or are in the process of mandating ABS as a consequence (ARTSA, 2011).

The European Union ABS requirement is in European Union (EU) Directive 71/320/EC as subsequently amended. ABS has been mandated from 1991. Most Central European countries have harmonised their brake rules with UNECE Regulation 13 since 2003, and hence have mandated ABS. It is also mandated on heavy trucks in Japan and South Korea (ARTSA, 2011).

The adoption of more stringent stopping distance requirements into the US Federal Motor Vehicle Safety Standard (FMVSS) 121 in 1975 promoted the development for ABS, mainly for drive wheel skid protection. Early US systems proved to be unreliable and consequently ABS developed a poor reputation in North America. However, this is no longer the case and ABS has been mandated on heavy trucks and trailers in the USA and Canada from 1998. Details of systems and regulatory requirements in Australia can be found in Appendix 6—Types of Antilock Brake Systems.

The detailed form of the above amendments would be determined in consultation with industry and it was stated earlier that draft ADRs have previously been circulated within the peak consultative groups. The principle used would be that the amendments would be modelled as closely as possible on the recommendations coming through the NHVBS Report as adopted by the NRSS. Any mandated requirements would also align as much as possible with corresponding requirements within the international standard R 13, so that a vehicle meeting this standard would not be restricted from entering the Australian market.

4.2.3 Load proportioning (LP) systems for trailers (Option 2(a))

Trailers are almost exclusively manufactured in Australia and so less tied to either R 13 or the US counterpart (FMVSS 121) designs. During development of the NHVBS and as reported in Table 1, some of the trailer industry flagged a need for a transition to the electronic systems that are part of Phase I of the NHVBS in terms of ABS, and part of Phase II in terms of EBS/ESC.

It was therefore proposed to allow mechanical or pneumatic LP systems for Phase I in lieu of ABS. LP modifies the braking signal of a vehicle, depending on the mass being carried, in order to provide for more consistent decelerations under braking regardless of the mass being carried. LP may be mechanical, pneumatic or electronically operated and may also be referred to as "Load Sensing Brakes (LSB)". It may use a Load Sensing Valve (LSV) to detect the deflection of a mechanical suspension under load or pressure in air suspension, or it may be electronic in which case it could calculate the axle load from the deceleration of the vehicle, the slip of the wheel, or the known load state of other axles on the vehicle. LP is almost exclusively static in operation, in other words it does not take into account mass transfer effects during braking.

LP is identified as a "Variable Proportioning Brake System" within ADRs 35/03 and 38/03. It is not mandated, although there are mandatory technical requirements for where it is fitted. These requirements were brought in from 2009. It is not stated within the ADRs how the load must be sensed.

LP has been common in Europe but less so in Australia. In Europe, it has been increasingly incorporated into EBS instead. This has been aided by the fact that European heavy vehicle combinations are not as custom-made as those of the US (Esber et al, 2007) or Australia.

LP is an effective technology provided it is set up correctly for the combination of vehicle being operated. Besides a lower cost, it has the distinct advantage over ABS of being able to operate without electrical power, for example when a trailer with LP is connected to a prime-mover that does not have ABS (and so cannot also power the trailer). Its main drawback is that it gives a pre-set response to braking related only to the loading condition of the trailer. Therefore it does not take into account any locking of wheels in the combination during a braking event. This makes it more sensitive to being used in the right combination types as well as in the optimal position within a multi-combination vehicle.

4.2.4 Adopting international regulations for ABS or LP (Option 2(b))

As discussed earlier, ADRs 35 and 38 currently set Australian developed requirements but also allow the international regulation UNECE R 13 as an alternative for manufacturers to comply with. Whether the ADRs should move over to international regulations exclusively, or no longer allow international regulations as an alternative, was considered during the initial consultation period for the NHVBS. The NHVBS Report, part of which is shown at Appendix 3—Extract from the Executive Summary of the National Heavy Vehicle Braking Strategy Report, shows Strategic Objective 5 as being to "…. harmonise requirements with ECE Regulation 13 where sensible".

The Australian Government has a long standing policy of harmonising with international regulations where possible and this is outlined in Section 2.2 above. In the case of ADRs 35 and 38, Option 2 as a whole could continue to allow UNECE R 13 as an alternative. As UNECE R 13 already mandates ABS, the act of updating the ADRs to mandate ABS would, in practical terms, involve revising the Australian developed requirements to "catch up" with the R 13 requirements that are already listed as an alternative standard.

4.2.5 Conclusion for Option 2

Option 2 would meet the objective. Both ABS and LP improve braking stability and so their mandating would be expected to reduce road trauma under Option 2 or the variation Option 2(a). Option 2(b) would continue to allow for international regulations as an alternative and so would not present a technical barrier to vehicle manufacturers wishing to supply Australia with new vehicles meeting a higher level of safety.

5 IMPACTS

5.1 Cost to business/consumers

The new vehicle certification system administered by the Department imposes costs on industry. Before a new vehicle can be issued an identification plate (allowing it to be supplied to the market) test evidence must be provided to show that the vehicle meets all relevant ADRs. This evidence consists primarily of summaries of tests performed on various components or the whole vehicle.

Option 1: take no action would preserve the status quo and not impose any additional cost on vehicle manufacturers.

Option 2: amend ADRs 35 and 38 to require ABS on heavy commercial vehicles, would make little change to the certification cost for the majority of manufacturers. The certification costs are the costs for a manufacturer to perform any tests or checks required of the ADRs and submit the required documentation for approval by the Australian Government.

For the majority, the expansion of the ADR requirements to include ABS will have already been carried out for other international markets. For manufacturers who do not already certify vehicles for other markets, there may be some increase in certification costs. However, this would also be negligible as the testing would be carried out as part of the existing ADR 35 and 38 certification process. Therefore, these costs have not been included in the analysis. Note that these costs are not the costs for fitting the ABS equipment itself to the vehicle.

The primary costs under this option would be in fitting the ABS equipment itself. In 2012, industry advised that the average costs for this are as shown in Table 3 below.

Table 3 Cost of ABS for heavy commercial vehicles

Vehicle Type	System description	Average cost of system
Light duty truck (3.501—8 t GVM)	ABS for a full hydraulic brake system	A$1,000
Medium duty truck (8—18 t GVM)	3-channel ABS on a 2-axle truck with Air-Over-Hydraulic or Full Air system	A$2,500
Heavy duty truck (3-axle and more)	4-channel ABS on 3 and 4-axle trucks with Full Air system	A$3,560
Buses (> 4.5 t GVM)	4-channel ABS	A$3,000
Trailers (>4.5 t GVM)	2 or 3-channel ABS	A$1,500

Source: Truck Industry Council, Bus Industry Confederation, various heavy trailer and systems suppliers and manufacturers, 2012

For the purposes of this RIS, these costs were combined into one overall cost for vehicles over 4.5 tonnes GVM. In each case, the individual costs were weighted by their respective vehicle production numbers per annum as set out in Table 4 below.

Table 4 Average number of heavy commercial vehicles produced for Australia (2009-2011)

Vehicle type	Number per annum
Light duty truck (3.501—8 t GVM)	12.913
Medium duty truck (8—18 t GVM)	6.830
Heavy duty truck (3-axle and more)	9,000
Buses (> 4.5 t GVM)	4,000
Trailers (>4.5 t GVM)	13,663

Source: Truck Industry Council, Australian Bureau of Statistics and the Department of Infrastructure and Regional Development

The overall average cost of ABS is calculated as follows:

$$= \left[\frac{(\$1000 \times 12913) + (\$2500 \times 6830) + (\$3560 \times 9000) + (\$3000 \times 4000) + (\$1500 \times 13663)}{12913 + 6830 + 9000 + 13663}\right]$$

= \$2,037

Option 2(a) - Load proportioning (LP) systems; costs for trailers were estimated at around half the cost of an ABS system. Although Load Sensing Valve(s) and associated pipework would be in the order of a few hundred dollars, the setup and certification costs would be higher than for ABS as LP. This is because LP systems would require more tailored testing or engineering calculations for each trailer model certified.

Option 2(b) - Adopting international regulations for ABS or LP; costs would be the lowest if Australian developed but with international regulations allowed as an alternative. This is the case with the current ADRs 35 and 38 and it has been assumed that this would continue to be the case. Therefore, the costs would not be affected by this variation to Option 2.

5.2 Benefits

Option 2: amend ADRs 35 and 38 to require ABS on heavy commercial vehicles, would reduce the road trauma resulting from loss of directional stability and control during the braking of heavy commercial vehicles.

Benefit-cost analysis was used to evaluate the value of Option 2 with regards to mandating ABS. Benefit-cost analysis compares the potential reduction in road trauma to the cost of implementing a particular option. In assigning a monetary value to both, options can be chosen that provide the greatest decrease in road trauma for the resources consumed.

Benefit-cost analysis was not used to evaluate Option 2(a) - Load proportioning (LP) systems costs for trailers. It is recognised in engineering terms that LP systems used correctly will result in improved braking stability of a heavy commercial vehicle or combination. Hart (2012) reported a test of a single combination vehicle in Australia that was subjected to the "braking in a curve test" from US Federal Motor Vehicle Safety Standard (FMVSS) 121. The test demonstrated that when limited to non-electronic systems only (ie not ABS or similar), LP fitted to a trailer in combination with a typical ADR compliant prime mover performed the best. This means that when compared to the regulated performance of an existing ADR 35 and 38 compliant truck and trailer, fitting an LP system to the trailer gives an improvement in stability under braking.

However, there are no comprehensive studies available that cover the general case of LP systems and the fact is that LP technology is less advanced than dynamically active systems such as ABS or ESC. Because of this, it was not considered worthwhile to pursue LP as a primary option. Instead, it was concluded that allowing LP systems in lieu of ABS would still result in some sort of improvement to current performance, at a cost less than for ABS. It was therefore proposed that under Option 2 this choice be left to the trailer manufacturer to make - either way providing net benefits to the community. To summarise, variation (a) to Option 2 was not analysed by Benefit-cost analysis, although it was recognised that when correctly used LP would provide road safety benefits. Within Option 2, LP would be offered as an alternative to ABS for trailers. The impact on business and the community would be positive in this instance, and it would expedite the Phase I timetable. When considering the final results of the Benefit-cost model, the contribution to net benefits of trailers is about 37 per cent, (being the proportion of the heavy commercial fleet that are trailers). As a conservative scenario, the net benefits could be reduced by this amount. This assumes that LP provides benefits that are equal to, but no better than, than the cost of fitment.

Similarly, Benefit-cost analysis was not used to evaluate Option 2(b) - Adopting international regulations for ABS or LP. As discussed in section 5.1 above, it had already been assumed that international regulations would continue to be allowed as an alternative to any Australian developed requirements. Therefore, this variation would not affect the final result.

Benefit-cost model

A benefit-cost analysis model was developed to analyse the scenario of Option 2. With this option, the costs of the proposal are incurred in the first four years only, the anticipated length of time Phase I would be in force before being followed by Phase II. The benefits are derived over a much longer period, the length of time vehicles newly registered while Phase I is in force are driving on the road (ie the life of a typical vehicle).

The model used was the Net Present Value (NPV) model. With this model the flow of benefits and costs are reduced to one specific moment in time. The time period that the benefits are assumed to be generated over is the life of the vehicle(s). Benefit-Cost Ratios (BCRs) are also calculated to show whether the returns (benefits) outweigh the resources outlaid (cost) and indicate what this difference is.

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

The analysis model that was used had the capacity to calculate over a 30-year period of analysis. Option 2 was given a starting point of 2014. By then running the analysis model such that the regulation option remained in force for 4 years (as mentioned above, only 4 years was chosen as after 4 years from 2014, Phase II of the NHVBS, if it leads to further ADR amendments, would be expected to come into force around 2018). There then followed a 26 year period for close to the full set of benefits to be realised over the life of a cohort of vehicles. It was necessary to run the analysis over such a long period because in the general case, road safety benefits from improving the performance of vehicles are realised gradually as the fleet is first replaced and then the vehicles age and crash over a crash period of about 26 years for each vehicle

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

In general, 26 years is considered the most accurate period over which to calculate the benefits. This is because historical crash data has shown that nearly all crashes involve vehicles that are 26 years old or less (Fildes et al, 2002). However, to be conservative, a shorter period of 13 years was adopted for the final cohort of vehicles assumed to be coming through in 2029.

The benefits were calculated using established monetary values representing fatalities, serious injuries and minor injuries. It was assumed that these injuries would remain proportional to the expanding human population and vehicular population in Australia over the coming years; however the assumed fleet growth rate was halved to be conservative. These values represented an average cost of crashes.

In accordance with the Best Practice Regulation Handbook published by the Office of Best Practice Regulation (OBPR), the net benefits were calculated using a discount rate of 7 per cent, with sensitivity tests conducted at 3 per cent and 10 per cent. Table 5 shows a summary of the net benefits, BCRs and lives saved calculated for various discount rates and ABS effectiveness values.

A detailed explanation of the method can be found in Appendix 8—Benefit-Cost Analysis—Methodology and Appendix 9—Assumptions.

<u>Voluntary fitment rates</u>

Where ABS is already being fitted to vehicles on a voluntary basis, neither the costs nor the benefits are included in the analysis as they become part of the Business as Usual (BAU) case. Currently, ADR 64—Heavy Goods Vehicles Designed for Use in Road Trains and B-Doubles, requires B-Double prime movers to be fitted with ABS (clause 64.5.2). In addition, various state and territory legislation requires B-Double tanker type trailers that carry dangerous goods to be fitted with ABS as well. It has been estimated that 20 per cent of all prime movers sold are designed for B-Double duty and so these would have ABS (Pearson et al, 2011). Conservatively, if this was extended to all B-Double trailers as well (with two trailers per B-Double), this would represent around 10 per cent of all trucks and trailers above 4.5 tonnes GVM (or ATM in the case of trailers).

However, other industry sources estimate that upwards of 30 per cent of trucks and 20 per cent of trailers are being fitted with ABS. Combined, these would represent around 26 per cent of all trucks and trailers above 4.5 tonnes. As this value was higher than the B-Double estimation, it was used in preference. Further, given that the 26 per cent itself was only an estimate, for the analysis the rate was increased to 36 per cent in order to be as conservative as possible. This was then used as the current voluntary fitment rate of ABS for trucks and trailers. Following the final consultation period in June 2013, industry estimated that for trucks the figure could be as high as 90 per cent voluntary fitment.

As the 90 per cent was an alternative, but uncertain, voluntary fitment rate, the existing analysis was maintained and the 90 per cent figure was used to recalculate the benefits as a further possibility. When combined with the trailer fitment rate, the combined truck and trailer voluntary fitment rate would increase from 36 to 60 per cent and so reduce the net benefits accordingly. As the primary cost of ABS is in the equipment and installation per vehicle, rather than in overheads (design, testing etc) the benefit-cost ratio would not be affected by a change to the voluntary fitment rates).

Regarding buses, the majority of buses above 4.5 tonnes are required to have ABS where they are subject to local government contract arrangements. For the purposes of the analysis this was set to 90 per cent voluntary fitment rate. In the case of buses, the majority of the benefit of a regulatory intervention would be to transfer local contract arrangements into national standards. This would provide increases in administrative efficiency as the requirements for each bus model would be handled only once and on a national basis.

Therefore, calculations were started at the current estimated voluntary compliance rate of 36 per cent of all trucks and trailers above 4.5 tonnes and 90 per cent of buses above 4.5 tonnes. Detailed results are shown in Table 10 to Table 17 of Appendix 10—Benefit-Cost Analysis—Details of Results. Note 2 was added to set out the changes to the benefits in the case of a 90 per cent fitment rate for trucks.

Table 5 Summary of net benefits, BCRs and lives saved from the regulation of ABS for heavy commercial vehicles over 4 years for option 2

	Net benefits ($m)	BCR	Lives saved
Best case	354	3.0	84
Likely case	73	1.5	57
Worst case	-45	0.7	31

Note 1:
Best case—4-year period; 3 per cent discount rate; 8 per cent effectiveness of ABS
Likely case—4-year period; 7 per cent discount rate; 5.5 per cent effectiveness of ABS
Worst case—4-year period; 10 per cent discount rate; 3 per cent effectiveness of ABS

Note 2: In the case of a 90 per cent voluntary fitment rate for trucks, this would translate to 60 per cent for truck/trailer combinations and so a reduction of 37 per cent in gross benefits. The figures would then be for the Likely case 36 lives saved and a Net benefit of $46m. The BCR would remain the same.

Figure 2 Option 2: amend ADRs 35 & 38 to require ABS on heavy commercial vehicles

Table 5 shows that fitting ABS to heavy commercial vehicles would, in the likely case, result in net benefits of $73m as a result of a 4-year period of implementing the amendments to ADRs 35 and 38. There would be 57 lives saved over the subsequent 26 years and the BCR would be positive, indicating that in monetary terms the community would receive more benefits that it costs to implement the option.

The graph results display the distribution of the benefits and costs over time. The costs are a step function as mandatory requirements come in end 2013/start 2014. These then slowly increase in line with an increasing fleet size and finally after 4 years the regulation is likely replaced, in line with Phase II of the NHVBS. The benefits begin flowing as new vehicles are fitted with ABS and peak sometime after the regulation is removed.

As discussed in section 5.2 above, if as per Option 2(a) all trailers were fitted with LP systems instead of ABS, a very approximate reduction of 37 per cent of net benefits could be estimated – an accurate figure would not be possible given that effectiveness of LP was not able to be quantified. In this scenario, the net benefits would reduce from $73m to $46m while the lives saved would be 36 instead of 57. As also discussed, one way to deal with this possibility is to simply acknowledge that LP systems used correctly will improve braking stability and provide gross benefits to the community. It then becomes an industry choice whether to fit ABS with its demonstrated net benefits or accept the cost – whatever it may be, to provide LP with its gross benefits.

In other words, the community would benefit to some degree, but there is no guarantee that this would outweigh the resulting cost to industry – however this would remain industry's choice.

Sensitivity Analysis

A sensitivity analysis was carried out to determine the effect on the outcome of some of the less certain inputs to the benefit-cost analysis.

The cost of ABS was as provided by industry and so considered reasonably accurate. As noted above, the discount rate was varied from between three per cent up to 10 per cent. The voluntary fitment rates under the BAU case were also considered to be extremely conservative (having been increased significantly from their current value), especially as heavy commercial vehicles are much less likely to adopt ABS than passenger cars etc. However as noted earlier, and following a further round of consultation in June 2013, industry estimated that for trucks the figure could be as high as 90 per cent voluntary fitment. Although the net benefits were not recalculated in full for this scenario, it was subsequently noted in the results that this could reduce the net benefits for the Likely case to 36 lives saved and a Net benefit of $46m. The BCR would remain the same.

The two other variables likely to change are the fleet growth prediction and the effectiveness of ABS. In the first case and to be very conservative, the prediction was halved from eight to four per cent for all calculations. For the second, the effectiveness was varied between three and eight per cent. The results indicated that the net benefits would become negative only in the worst case scenario. Although this scenario represents a potential loss, this risk was not considered significant when compared with the likely case of $73m in positive benefit.

The results are shown at Appendix 10—Benefit-Cost Analysis—Details of Results.

The analysis for the likely case assigns a 5.5 per cent effectiveness to ABS technology as well as a seven per cent discount rate.

The range of effectiveness of ABS for heavy commercial vehicles was potentially quite broad according to the available research. The available Australian research was extremely relevant to the Australian context, but was somewhat out of date. On the other hand, the US research was current but less relevant in the Australian context. The likely case was set at 5.5 per cent, which is a value halfway between the two. Details of effectiveness can be found at Appendix 11—Effectiveness of Antilock Braking System Technology for Heavy Vehicles. The best case and worst case show that net benefits could reach $354m or drop to negative (-45m) but it is argued that in all cases ABS does have a gross benefit in reducing road trauma and that industry is willing to support improved braking performance as a result.

The current voluntary compliance rate (fitting of ABS) was discussed earlier and while a further increase in the estimated voluntary rate would reduce the net benefits, they could never be negative for the likely case, nor could the BCR change.

5.3 Technical considerations

Part of the objective of the proposal is to ensure that any new or amended ADR requirements do not present a technical barrier to vehicle manufacturers wishing to supply Australia with new vehicles meeting a higher level of safety.

It had been discussed earlier that ADRs 35 and 38 have previously been reviewed and amended to better harmonise with international regulations, specifically R 13. R 13 is listed as an alternative standard for both ADRs 35 and 38, with minor additional requirements only needed for those vehicles used in road train operation and in the operation of the parking brake system, in order to deal with uniquely Australian vehicle configurations and operation. Further alignment of ADRs 35 and 38 with the latest version of R 13 is being considered under this RIS, with the focus on mandating the fitment of ABS.

The heavy commercial vehicle market in Australia is dominated by European and US designs, particularly with respect to rigid trucks, prime movers and buses. In the past the balance was heavily weighted towards US designs, but this is no longer the case. European design vehicles are fully compatible with R 13 and so it would be relatively straightforward to adopt particular UNECE requirements for these vehicles.

While it would be less straightforward for US design vehicles, ABS has already been mandated there for a number of years. More recently, the National Highway Traffic Safety Administration (NHTSA) in the US acknowledged the use of sophisticated electronic braking systems under R 13 and commissioned research into the use of these systems in the US (Esber et al, 2007). Such systems are the subject of Phase II of the NHVBS, but nonetheless this indicates the recognition of regulatory authorities in the US that UNECE R13 compatible technology will be making its way into the US market in the future.

In short, specifying international requirements in the ADRs, as taken from R 13, would minimise the impact to Australian manufacturers and suppliers.

5.3.1 Details of the proposed changes

The NHVBS Phase I details as developed through the SVSEG/TLG process contain a number of other minor proposed changes to ADRs 35 and 38. These were set out in Table 2 earlier in the RIS and are discussed in more detail further below.

5.3.1.1 No need to meet unladen compatibility limits if ABS fitted—this is a relaxation of current ADR requirement as it allows ABS in lieu of unladen compatibility. This aligns with R 13. The unladen state is a relatively low risk vehicle configuration for braking, provided ABS protects the wheels from locking.

5.3.1.2 ABS off switch for off-road or road train—this was an early recommendation but industry had subsequently indicated that systems are now capable of handling unsealed road conditions that some road trains may operate on. However, it had been agreed that genuine off-road design vehicles should be able to switch off ABS when conditions dictate and this aligns with the R 13. This was discussed further with industry; in particular about whether road train trucks that are not of off-road design—but are used in off-road areas—should be allowed concessions to the ABS requirements. Following a further round of consultation in June 2013 it was recognised that many types of vehicle may need to operate off-road or on poor on-road conditions. To alleviate any concerns that operators may have, the fitting of an ABS off switch would be permitted for all vehicles.

5.3.1.3 Provision of electrical ABS connector, where a tow coupling is fitted—refer paragraph 5.3.4.

5.3.1.4 Split-mu on axles other than steerable [axles]—R 13 requires demonstration of 'split-mu' ABS performance for some vehicle categories (heavy trucks and buses and heavy semi-trailers). This means that the ABS must be able to control left and right sides of the vehicle independently, to cater for different road surfaces such as the shoulder of a road or a patch of ice that only contacts one side of a vehicle's tyres. This is being discussed further with industry as split-mu systems provide greater performance but at higher cost and they are not currently a requirement in ADRs 35 and 38 (there are other requirements for where ABS is fitted).

5.3.1.5 No release times for circuits controlled by ABS modulation valves—currently the only release times required are at the coupling head of Road Trains (since ADR 35/03) and so this does not appear to be an issue any more.

5.3.1.6 Certification of EBS compatibility performance—refer paragraph 5.3.4 regarding EBS generally. Certification is related to how compliance to standards is shown rather than standards setting. This is being discussed further with industry but is a certification matter and as such is not part of this RIS.

5.3.1.7 Where EBS fitted, ABS/EBS power voltage to match CAN voltage—refer paragraph 5.3.4.

5.3.1.8 References to RFS in Table 2 of ADR 35 and Table 1 of ADR 38 to become informative only, as they do not relate to requirements for a standard vehicle—this is a correction and does not affect stringency. Mass limits for RFS vehicle suspension/braking systems are beyond those for a standard vehicle and so should not be listed in the ADR other than in an information capacity.

5.3.1.9 A tolerance on the LP valve unladen compatibility requirements to allow for particular combinations (does not apply to electronic LP operation)—refer paragraph 5.3.4 regarding LP generally. This is an industry proposal to relax the existing limits of LP in order to better match particular vehicles when using them in combination.

5.3.2 Load proportioning (LP) systems

As discussed in section 4.2.3 above, Option 2(a), a variation on Option 2, allowed for LP systems to be fitted in lieu of ABS for trailers only. The technical requirements for LP would be as per the current ADRs 35 and 38, subject to further discussions with industry. The international regulation UNECE R 13 would be accepted as an alternative.

5.3.3 Compatibility

When braking as a combination of a towing vehicle and a towed vehicle, trucks need to provide trailer braking systems with the right signal (normally by the use of differing air pressures) to ensure that the trailer(s) contribute a similar amount of braking effort. This compatibility of truck and trailer is specified in ADRs 35 and 38. It consists of a set of bands or "tramlines" that dictate the deceleration of the truck in terms of the output signal of the truck to the trailer in the case of ADR 35/03 (Figure 1 and 2), and the deceleration of the trailer in terms of the input signal coming from the truck in the case of ADR 38/03 (Figure 1 and 2). However, as these requirements contain tolerance bands and as they have been updated from time to time through revisions of the ADRs, consideration must always be given to in-service compatibility when slightly different designs are used together, or, more importantly, when new trucks and trailers are matched with older trucks and trailers.

Some of these issues of compatibility have been identified by the Australian Road Transport Suppliers Association (ARTSA) (Hart, 2011).

- A wide range of [differing technical] characteristics, reflecting source country practices and philosophies.
- Significant differences in threshold pressures [before brakes begin to operate].
- Adoption of EBS and ESC on European trucks. These assume that a European design trailer is being towed.
- [Differing performance of] trailers that comply with R 13 compared to the ADRs as written.
- Mixing of adaptive braked trucks with non-adaptive trailers.
- [Electrical power and signal sources such as] 12V/24V.

The ARTSA has worked with the Australian Trucking Association (ATA) and with some state and territory governments in continuing to develop a Brake Code of Practice. The code deals with (amongst other things) issues of compatibility (ARTSA, 2011). The ATA have also produced an Australian Air Brake Code of Practice (Australian Trucking Association, 2000) and more recently an Advisory Procedure for Heavy Vehicle Combinations and the use of Electronic Braking Systems (Australian Trucking Association, 2012).

While ADRs 35 and 38 can and do specify primary compatibility levels, in practice only the careful matching of truck and trailer(s) can ensure optimum braking performance. To this end, industry codes and advisories play a vital role in the matching of vehicles with different levels of braking technology fitted, including when new and old vehicles are combined in-service. A good example of the task at hand is given in Appendix 12—Compatibility, which shows the level of compatibility of various current heavy vehicle braking technologies that exist in the fleet today, technologies which are proposed under Phase I of the NHVBS (Byrnes, 2009).

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

5.3.4 Electronic Braking Systems

EBS (or for trailers TEBS) overlay conventional pneumatically controlled brake systems and instead control brake actuation through electrical signals (the pneumatic control is used as a backup). Also more generally known as Electronically controlled Braking systems (ELB), these systems provide optimum braking in terms of faster response times and better distribution of braking forces (Bosch, 2007).

An important feature of EBS is the ability to allow communication between elements of the braking system on all vehicles in a combination (i.e. truck and trailer(s)) via a communications network that operates on set protocols (a Controller Area Network (CAN) bus) system.

When EBS is fitted, ABS is always incorporated, as it provides the emergency braking component of the electronic control of the braking system.

EBS is not mandated in R 13 but if fitted, it must not affect the safe operation of other mandated systems. It must also have safe operation and warn the driver under fault conditions. These same requirements are proposed to be adopted by the ADRs. In addition, and in alignment with R 13, where a tow coupling is fitted to a vehicle, an ABS connector will have to be provided and where a CAN connection is provided, it must be compatible with the ABS power voltage. These requirements will ensure that all prime movers and other trucks and buses with trailer connections will not only have ABS themselves, but will provide power for an ABS system if they are connected to a trailer with ABS fitted. Similarly, where a trailer has an EBS (TEBS) system fitted, the voltage of the communications network between truck and trailer will also be compatible.

The above proposals, including those relating to LP, Compatibility and EBS, are second order matters in relation to the more fundamental question of mandating ABS and so have not been analysed further for the purposes of this RIS. However, they are directly related to the original report and NTC response to the NHVBS (refer Section 2.2) and have been discussed with industry on an ongoing basis.

A further refinement of EBS is Electronic Stability Control (ESC, ESP (Program) or Vehicle Stability Control (VSC). ESC detects gross vehicle dynamics, such as rate of cornering (lateral acceleration and yaw rate), steering angle, centre of gravity location, and provides corrective braking to stabilise a vehicle that is at risk of going out of control. ESC is the subject of Phase II of the NHVBS and is not considered further in this analysis.

5.4 Draft ADRs

Draft ADRs 35/04 and 38/04 were developed that detail the above agreed requirements. A tabulated form of the proposed changes is at Appendix 5—Proposed Changes to the Current ADR Versions.

The ADR amendments are proposed to come into force from 1 January 2014. A transition date in order to phase in new models first has not at this point been sought by industry.

5.5 General Consultation Arrangements

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

The Department undertakes public consultation on significant proposals. Under Part 2, section 8 of the MVSA the Minister may consult with state and territory agencies responsible for road safety, organizations and persons involved in the road vehicle industry and organisations representing road vehicle users before determining a design rule.

Depending on the nature of the proposed changes, consultation could involve the TLG, SVSEG, Transport and Infrastructure Senior Officials' Committee (TISOC) and the Standing Council on Transport and Infrastructure (SCOTI).

- TLG consists of technical representatives of government (Australian and state/territory), the manufacturing and operational arms of the industry (including organisations such as the Federal Chamber of Automotive Industries (FCAI) and the ATA) and of representative organisations of consumers and road users (particularly through the Australian Automobile Association (AAA)).

- SVSEG consists of senior representatives of government (Australian and state/territory), the manufacturing and operational arms of the industry and of representative organisations of consumers and road users (at a higher level within each organisation as represented in TLG).

- TISOC consists of state and territory transport and/or infrastructure Chief Executive Officers (CEO) (or equivalents), the CEO of the NTC, New Zealand and the Australian Local Government Association.

- SCOTI consists of the Australian, state/territory and New Zealand Ministers with responsibility for transport and infrastructure issues.

Up until 2010, the TLG was the principal consultative forum for advising on ADR proposals. The TLG has since been reconstituted under the higher level SVSEG forum, although its role in ADR development continues in a similar way to before. Membership of the TLG is shown at Appendix 13—Membership of the Technical Liaison Group (TLG).

5.6 Specific Consultation for this RIS

As outlined in Section 2.2, the consultation process for the proposed amendments to ADRs 35 and 38 has been ongoing in nature. It has followed on from a full review of these ADRs starting 2006 (with amendments coming into force in 2009) with one of the outcomes being the NHVBS. The NHVBS then fed into the NRSS. A detailed public consultation process was carried out initially in the forming of the NHVBS and this was subsequently supported through the public comment process for the NRSS.

The original proposal (relating to ABS) that was taken to the public consultation process was under Strategic Objective 3 of the January 2006 discussion paper; that is to " …require wheel lock-up protection (ABS function) on new [commercial] motor vehicles and all single and B-double trailers that carry dangerous goods". The proposal for ABS on motor vehicles drew support for and against, but with many regarding it as "inevitable". There was modest support at best for ABS on trailers, mainly from ABS and axle suppliers, arguing that it would protect against "trailer swing" arising from wheel lock up when unladen. Operators were generally against it, citing reliability problems (Hart 2008). This helped shape the final proposal, which was to require trailers to at least meet compatibility limits (achievable through the use of load proportioning (LP) systems).

In terms of details of the proposed amendments, the NHVBS report was released publicly via the NTC and was used as a basis for continuing to develop the recommended requirements through the standards development forums, the TLG and SVSEG, where they were discussed within the forums as well as within member's organisations a number of times. With further penetration into the trailer market in the subsequent years and perhaps resulting changes in the perception of robustness of electronic systems, the fitting of ABS to trailers again became the more favoured option by some, at least in terms of ABS and LP being proposed as alternatives. This resulted in the proposed changes as set down in Table 2 being developed and taken through the National Road Safety Strategy 2011-20 process in 2011.

This approach was reconfirmed by SVSEG in April 2011 and furthermore; strong support was given for an accelerated process to be undertaken. It was agreed that a simplified RIS would be acceptable and that this need only to be circulated within the SVSEG/TLG forum.

As SVSEG members agreed that further consultation through the public comment process was not necessary, and state and territory members represented the views of their jurisdictions, there is also no need for further consultation through TISOC or SCOTI.

This RIS was therefore circulated within the SVSEG and TLG forums in June 2013 for a period of one month, with the intention that the final draft text of the amendments to ADRs 35 and 38 be agreed before being submitted to the Federal Minister for Infrastructure and Regional Development for signature. All responses were collated and considered and revisions to the proposal were made where necessary. A discussion of the points raised by respondents and the Department's response to those points has been included in Appendix 15—SVSEG and TLG forum comment, along with the Department's analysis. The analysis includes reference to any revisions made to the proposal.

There was broad agreement from most parties that responded although (due to its great diversity) this included some views from industry that the proposal would not go far enough as well as views that it would be going too far. Reasons for support included that the improvement in braking and overall safety were worth pursuing, and that the preferred option was a reasonable way to achieve this. While agreeing broadly with the proposal many stakeholders thought that it went too far in places. In particular, the ABS off switch component drew some criticism. As previously noted the proposal has been altered in response to this feedback. Some stakeholders, including WA and the CVIAA stated their preference for a move directly to Phase II. However, a stepped approach (Phase I, Phase II) for this issue has been agreed and endorsed a number of times.

State and territories generally supported the proposal throughout its development within the consultative groups. However, only Western Australia made a formal submission. This urged the government to look at moving to Phase II straight away, while at the same time expressing some local manufacturer's concerns with the current proposal relating to the proposed "ABS off switch", the use of load proportioning on mechanical suspensions, and the general concern of mixed braking technology within combinations. These latter two points were also raised by the CVIAA with concerns about mechanical suspensions and more generally ABS reliability in harsh conditions also included as part of the ALRTA submission.

A number of responses included additional technical proposals not directly related to the question of ABS and load proportioning such as Dangerous Goods plated trailers, auxiliary brakes, road train release times and brake lamp activation. These had to be set aside as topics for Phase II unless they were minor, had previously been discussed within the groups or there was reasonable agreement on them. Proposals agreed to were:

- A relaxation on the fitment of an off switch. This had come through a few of the comments;
- A relaxation to the load sensing requirements. This reflected previous work within the TLG;
- A relaxation for trailers of unusual design. This had previously been raised at TLG;
- A minor increase in stringency to mandate automatic wear compensation devices (slack-adjusters). This would contribute to optimal ABS performance;

- Plugs and wiring to be provided where a trailer tows another trailer. This would provide for ABS/EBS trailers being connected into a combination in the future. The feature would be a very good for "future-proofing" and had been discussed amongst and promoted by industry; and

- Consideration of relaxations of load proportioning requirements for mechanical suspensions and/or trailers of high unladen mass. This would be mostly applicable to the approximately 10 per cent of trailers that are used in remote areas or otherwise harsh conditions.

In terms of the scope of the proposed ADR changes and with the further agreement of the vehicle manufacturers as represented by the peak industry body the Truck Industry Council, the proposal was also broadened to include new goods vehicles greater than 3.5 tonnes GVM and less than 4.5 tonnes. These vehicles are represented by the ADR vehicle category of NB1, which also falls within the scope of ADR 35. They consist of the larger vans and smaller two axle trucks used mainly for local transportation duties, or with specialist bodies built on to them such as for motor homes. They make up around 20 per cent of the vehicles considered under this RIS.

For consistency, the scope of the requirements in the draft ADRs had already mirrored that for NB1 within the international braking standard UNECE R13, with ABS being required. While within Australia crash data was not able to be identified just for these types of vehicles and so benefits have not been included with the analysis, the benefits would be expected to be consistent with the heavy vehicle case.

6 CONCLUSIONS AND RECOMMENDATIONS

Option 2, including the variation (sub-option) under 2(a), is the most effective solution in terms of achieving the objective established earlier. Under this option and in line with the National Heavy Vehicle Braking Strategy (NHVBS) Phase I requirements and the National Road Safety Strategy 2011-20 (NRSS), ADR 35/03 and ADR 38/03 would be amended to mandate ABS for heavy commercial vehicles (trucks, trailers and buses) but with Load Proportioning (LP) braking systems an option for heavy trailers. Medium trucks of the NB1 category would also be included. The ADRs would become ADR 35/04 and ADR 38/04 respectively and as part of this would also accommodate the latest revision of R 13 within its alternative standards provisions. The ADR amendments are proposed to come into force from 1 January 2014.

Option 1—taking no action. Based on the most recent industry estimates of voluntary ABS installation (90% of trucks), this option is achieving the objective to reduce the road trauma arising from crashes involving the stability of heavy commercial vehicles under braking to a large extent. However, industry wide installation is unlikely to be achieved in the medium term.

Options 3 and 4, to delete ADRs 35 and 38 and possibly use non-regulatory mechanisms instead, were also rejected. These options were rejected at the last full review of these ADRs in 2006 and so would only be considered as part of the next full review. They had previously been rejected as not being appropriate for such a high impact, high risk area of public safety.

Option 2, adopting the proposed amendments to mandate ABS for heavy commercial vehicles, including medium trucks and allowing LP for heavy trailers, would reduce road trauma. It would provide a net benefit to the wider community without presenting a technical barrier to vehicle manufacturers wishing to supply Australia with new vehicles meeting a higher level of safety and it. This is because the international regulations UNECE R 13 would be acceptable as alternative standard to comply with. Option 2 (including variations (a) for LP and (b) for allowing international standards) is the recommended option.

The focus of Phase II is the adoption of ESC systems. If implemented further into the future, Phase II would follow Phase I, that is, new vehicles would need to comply with Phase I requirements under ADRs 35 and 38 until these changed under Phase II requirements. Existing vehicles in service would not be affected by such a change. Phase II requirements would also be compatible with Phase I ie a vehicle model that meets Phase II requirements early would also meet Phase I requirements.

Industry codes and advisories would be encouraged as a complement to regulated requirements for compatibility which, due to the nature of the ADRs (single vehicle type approval) are unable to fully deal with combinations (truck and trailer(s) operating together).

7 IMPLEMENTATION AND REVIEW

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

As Australian Government regulations, ADRs are subject to review every ten years as resources permit. This ensures that they remain relevant, cost effective and do not become a barrier to the importation of safer vehicles and vehicle components. ADRs 35 and 38 will be scheduled for a full review on an ongoing basis and in accordance with the Australian Government's Business Review Agenda. The timing for review is to be determined. In the interim, consideration of full stability systems under Phase II of the NHVBS will begin at the completion of Phase I. This is scheduled within the NRSS for 2014+ and it is anticipated that this work will begin at the start of 2014.

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APPENDIX 1—HEAVY COMMERCIAL VEHICLE CATEGORIES

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

The categories listed below are those relevant to vehicles greater than 4.5 tonnes GVM.

OMNIBUSES

A passenger vehicle having more than 9 seating positions, including that of the driver.
An omnibus comprising 2 or more non-separable but articulated units shall be considered as a single vehicle.

LIGHT OMNIBUS (MD)

An omnibus with a '*GVM*' not exceeding 5.0 tonnes.

Sub-category
MD4 – over 4.5 tonnes, up to 5 tonnes '*GVM*'

HEAVY OMNIBUS (ME)

An omnibus with a '*GVM*' exceeding 5.0 tonnes.

GOODS VEHICLES

A motor vehicle constructed primarily for the carriage of goods and having at least 4 wheels; or 3 wheels and a '*Gross Vehicle Mass*' exceeding 1.0 tonne.
A vehicle constructed for both the carriage of persons and the carriage of goods shall be considered to be primarily for the carriage of goods if the number of seating positions times 68 kg is less than 50 per cent of the difference between the '*GVM*' and the '*Unladen Mass*'.
The equipment and installations carried on certain special-purpose vehicles not designed for the carriage of passengers (crane vehicles, workshop vehicles, publicity vehicles, etc.) are regarded as being equivalent to goods for the purposes of this definition.
A goods vehicle comprising 2 or more non-separable but articulated units shall be considered as a single vehicle.

MEDIUM GOODS VEHICLES (NB)

A goods vehicle with a '*GVM*' exceeding 3.5 tonnes but not exceeding 12.0 tonnes.

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

HEAVY GOODS VEHICLE (NC)

A goods vehicle with a '*GVM*' exceeding 12.0 tonnes.

TRAILERS

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

MEDIUM TRAILER (TC)

A trailer with a '*GVM*' exceeding 3.5 tonnes but not exceeding 10 tonnes

HEAVY TRAILER (TD)

A trailer with a '*GVM*' exceeding 3.5 tonnes but not exceeding 10 tonnes

APPENDIX 2—COMMON TYPES OF MEDIUM AND HEAVY TRUCKS

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

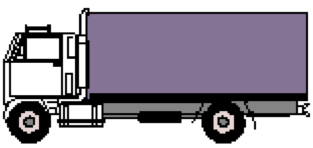
The various types of heavy commercial vehicles operating in Australia are detailed below. In summary, there are five main operating classes of heavy commercial vehicles. These are:

- Rigid commercial vehicles
- Rigid commercial vehicles with trailers
- Semi-trailers
- B-Doubles
- Road trains

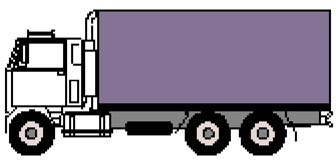
A B-Double combination consists of a prime mover towing two semi-trailers. The first trailer includes a turntable, which links to the second trailer, rather than using a dolly to link the trailers as in road train configurations. A road train comprises of a prime mover hauling two or more trailers and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

RIGID HEAVY COMMERCIAL VEHICLES

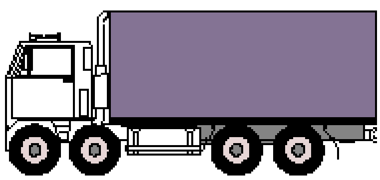
1. TWO AXLE



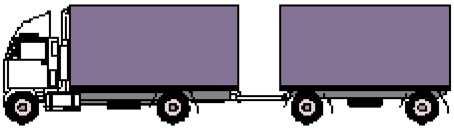
2. THREE AXLE



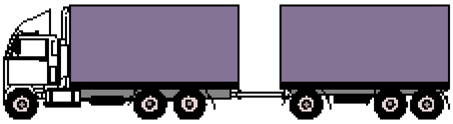
3. FOUR AXLE TWIN-STEER



4. TWO AXLE WITH TWO AXLE DOG TRAILER

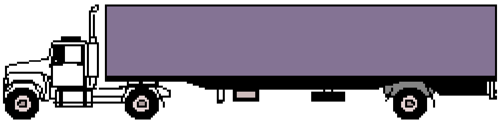


5. THREE AXLE WITH THREE AXLE DOG TRAILER

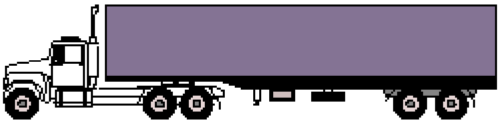


<u>ARTICULATED HEAVY COMMERCIAL VEHICLES</u>

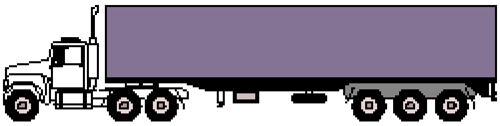
6. THREE AXLE SEMI-TRAILER



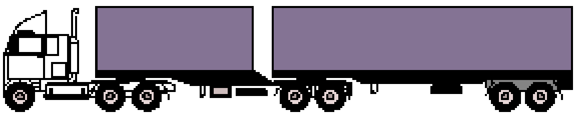
7. FIVE AXLE SEMI-TRAILER



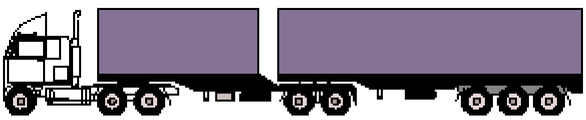
8. SIX AXLE SEMI-TRAILER



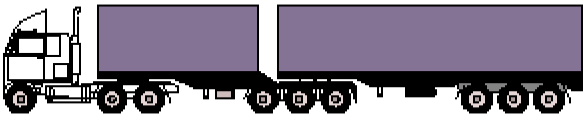
9. SEVEN AXLE B-DOUBLE



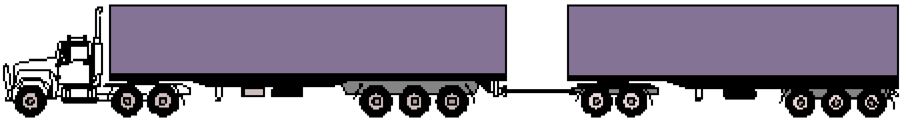
10. EIGHT AXLE B-DOUBLE



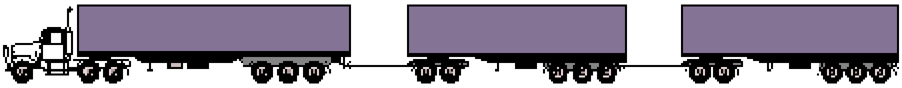
11. NINE AXLE B-DOUBLE



12. DOUBLE ROAD TRAIN



13. TRIPLE ROAD TRAIN



(National Transport Commission, 2010)

APPENDIX 3—EXTRACT FROM THE EXECUTIVE SUMMARY OF THE NATIONAL HEAVY VEHICLE BRAKING STRATEGY REPORT

1 EXECUTIVE SUMMARY

The purpose of the National Heavy Vehicle Braking Strategy project is to provide a plan for the development of brake rules and codes of practice into the foreseeable future. This purpose underpins the objective to improve the safety of heavy vehicles on Australian roads.

It is proposed that the scope of the strategy cover all motor vehicles with a gross vehicle mass of greater than 3.5t and all trailers with an aggregate trailer mass of greater than 3.5t. This scope is broader than the existing heavy vehicle categories, which apply to vehicles with a gross rating of greater than 4.5t. The justification for this change of scope is that vehicles in the 3.5t to 4.5t range share similar brake system characteristics and performance issues to those in the immediately heavier category and it is appropriate to apply the same approach.

Reform Imperatives

The imperative to review and reform heavy vehicle brake regulation arises because:

- Brake technologies generally and in particular electronic brake controls are advancing rapidly. A review of potential benefits and challenges associated with new technologies is advisable. The potential exists for new and dangerous incompatibilities to occur on combination vehicles. On the other hand, new brake technologies can result in performance improvements if safeguards are in place.

- The range of possible configurations and combinations of technologies is making it increasingly difficult to achieve acceptable brake balance on combination vehicles. This is a challenge to road safety improvement.

- National stopping distance standards should be reviewed as technological advances allow substantial improvements in performance to be specified. Performance standards can now be set based on road safety considerations rather than performance limitations.

- A request from the Standing Committee on Transport (SCOT) to the NTC to review the case for mandating antilock braking systems (ABS) on heavy vehicles should be responded to.

- The Federal Government policy of harmonizing with the United Nations Economic Commission for Europe (UN ECE) Regulations if practical should be assessed in the braking context.

- ‘Due diligence’ and ‘chain of responsibility’ obligations exist for vehicle operators. There is a need to assess the likely brake performance of vehicles at the specification stage.

- There are no effective controls over the technical standards of safety-relevant replacement brake parts, which leaves operators uncertain about the legality of some current brake replacement practices.

- Operators, mechanics and sometimes drivers often modify the brake set-up and control adjustments on combination vehicles. There is little control over this despite there being ADR compliance implications. The recently available capability to make significant brake balance adjustments using electronic service tools underscores the need for procedures and controls to be developed.

Heavy Vehicle Braking and Road Trauma

It is an essential safety requirement that a vehicle be able to stop in an adequately short distance without loosing directional control. Compared to light vehicles, heavy vehicles face the challenge of variable loads, variable vehicles in combination, a greater number of instability modes and higher wear rates.

The Australian statistics for fatal crashes involving a heavy vehicle provide little useful information about the contribution of poor directional instability during heavy braking to crashes. A loss of control event may be exacerbated by poor brake balance even when the vehicle has adequate brake capacity. Examples can be cited where short-duration sideslips have occurred that have resulted in heavy vehicles moving to the wrong side of the road with fatal consequences. In one major case the initiating event was probably the sudden automatic application of a powerful engine brake.

Furthermore, there is no publicly available assessment of the role of poor brake performance in truck-involved crashes on suburban freeways, which are challenging environments for truck stopping performance. Despite this, brake engineers understand that most heavy vehicles have poor brake balance under some loading conditions and may be difficult to control in emergency situations.

There is some overseas evidence that sub-standard brake performance is a factor in 20 - 25% of truck crashes (National Highway Transport Safety Authority – USA - crash data project; 2006, Ref[29]). It is plausible that a similar influence level exists in Australian crash statistics.

The Victoria Police major crash investigation unit recently reviewed its records on heavy-vehicle involved crashes and found that poor brake adjustment and maintenance was a causal or significant factor in about 6% of the crashes that it had investigated (Nov. 2006). This statistic does not account for the effect of poor directional control during braking due to design as a factor in crashes because it was not assessed.

The cost of heavy vehicle crashes can be estimated using Bureau of Transport Economics (BTE) total road trauma crash cost estimates (BTE Report 102, Ref[2]) and by applying South Australian crash data (CASR Report CSR009, Ref[1]) that estimates the split up of crashes involving heavy vehicles.

In 1996 dollar values the BTE estimated the total cost of road crashes to be about $15B. Based on the South Australia crash assessments, crashes involving heavy vehicles (4% of the total) cost about $600M pa, or about $750M in current value. This estimate is certainly conservative because it does not account for disruption to the road network arising from road crashes involving heavy vehicles.

The annual number of road deaths in crashes involving articulated vehicles has remained static over recent years. This represents an improving outcome given increasing numbers of trucks and kilometres travelled. However, there remains great potential for improvement.

Assuming that poor brake condition is a factor in 6% of heavy vehicle crashes and that poor stopping performance due to poor brake balance is a factor in a further 6% of crashes, the quantum of crash costs that could be reduced by improved performance is about $AUD 80M per annum (12% x $AUD 750M pa).

If the goal is set of reducing the brake-related crash causation factors by half then a potential saving of about $AUD 40M per annum (continuing) can be set.

Key Factors in Improved Heavy Vehicle Road Safety

To achieve improved road safety:

- The brake balance of combination vehicles must be improved. Poor brake balance results in premature wheel lock-up and likely consequential degraded stopping distance performance and / or loss of directional control.
- Higher national stopping and control performance standards should be specified.
- Antilock brakes should be mandated in the short-term on some heavy vehicle types to provide protection against wheel lock-up (in particular skidding on drive axles).
- Electronic brake control systems should be promoted subject to revised technical performance requirements. In the longer term Electronically Controlled Braking Systems (ECBS) and Vehicle Stability Systems should be mandated (as is pending in Europe) on a new generation of (combination) heavy vehicles.
- Replacement brake parts should meet standards to ensure that performance comparable with the relevant new, certified vehicle be achieved.
- Guidelines about brake adjustments and modifications should be developed for brake mechanics and technicians to ensure that the changes they often make are always beneficial.

The Brake Balance Challenge

Balanced braking exists when each axle group on a vehicle provides retardation forces that are approximately in proportion to the weight carried by the axle. The measure of brake balance is the friction utilization (u = retardation force / weight) of each axle group and the extent to which the values differ between axle groups.

As a rotating wheel is braked it delivers forward retardation force at the expense of sideways stabilising force. An optimum braking situation exists without the wheel locking-up. The aim of all good brake system design is to keep all the wheels rotating up to high deceleration levels.

Brake balance varies with load level and with different vehicle combinations. Most vehicle engineers who participated in the consultation phase of this project agreed that lightly laden truck brake balance is often sub-standard, particularly on combination vehicles. Dual-wheel tyre slid marks are commonly seen on suburban freeways and as these are precursors to loss of control events, it can be expected that failure-to-stop in time or jack-knife events will be relatively common.

Combination vehicles are routinely coupled together without regard for the brake incompatibilities that could exist. The Australian Design Rules cannot effectively regulate such incompatibilities because the range of possibilities is too great and because the rules are focused on laden performance. Whilst the existing compatibility requirements that do exist should not be dispensed with, a new approach is needed to identify the characteristics of unacceptable combination vehicles.

Because of the wide range of vehicle brake characteristics in the Australian marketplace and because new technologies may not be installed on all parts of a combination vehicle, it is sensible to adopt a performance-based approach. That is to specify an overarching deceleration level that vehicles should meet in any loading condition without exhibiting gross wheel lock-up (and thereby maintaining direction control during heavy braking).

Existing and Proposed Stopping Performance Standards

The national stopping-distance performance levels (which are expressed as average test deceleration levels from 100km/h, 60km/h and / or 35 km/h) are stated in the Australian Design Rules (35 & 38) and in the Australian Vehicle Standards Rules. A review of these standards is timely because higher standards might be justifiable due to technological improvements and because there is a need to refine the standards so that they are consistent for different vehicle types.

It is proposed that in-time both new and in-service heavy vehicles be capable of meeting the following overarching performance objective:

> *Vehicles not exhibit gross wheel lock-up behaviour in any loading condition when they are braked from 60 km/h on a dry sealed pavement to achieve the assessment deceleration level on a high-friction level roadway.*
>
> *The proposed assessment deceleration levels are:*

PBS* Access Level	Typical vehicle configuration	Average Deceleration from 60 km/h
New and in-service single vehicles. (Access level 1)	Rigid trucks and buses	0.40g ($3.9\ m/s^2$ with an implied stopping distance of 35.4m)
1	Semi-trailers	0.35g ($3.4\ m/s^2$ with an implied stopping distance of 40.5m)
2	B-double combinations	0.30g ($2.9\ m/s^2$ with an implied stopping distance of 47.2m)
3	Road-Train A-doubles and B-triples	0.25g ($2.5\ m/s^2$ with an implied stopping distance of 57m)
4	Road Train A-triples	0.2g ($1.96\ m/s^2$ with an implied stopping distance of 70.8m)

4	Road Train A-triples	0.2g (1.96 m/s^2 with an implied stopping distance of 70.8m)

Table 1 Proposed *assessment deceleration levels for the overarching performance objective*. g = 9.81 m/s^2

*PBS is Performance Based Standards. This proposed standard is identical to the PBS braking element *Directional Stability Under Braking.*

Gross wheel lock-up behaviour can be defined *as sustained wheel lock-up during heavy braking on half or more of the axles in any one-axle group*. For example, wheel lock-up would be unacceptable on any axles in a single- or tandem-group but lock-up on one axle in a tri- or quad-axle group would be acceptable.

The overarching performance objective identifies the minimum average deceleration levels that a heavy vehicle should be able to achieve. For comparison the current national deceleration standards are 0.38g from 100km/h for single motor vehicles and 0.28g from 35km/h for combinations. The ultimate potential average deceleration of a heavy vehicle on a dry sealed road with balanced brakes is at least 0.7g.

A vehicle that meets the overarching performance objective will achieve relative short stopping distances without loosing directional control because gross wheel lock-up behaviour is not exhibited. Higher ultimate average deceleration levels than those stated in the Table 1 can be anticipated because the objective does not preclude high control pressures being used that lock-up the wheels. The objective seeks to achieve a satisfactory balance between short stopping performance and directional control during heavy braking.

The overarching performance objective stated above has been adopted in the Performance-Based Standards Element *Directional Control Under Braking.* This objective is recommended (in-time) for all heavy vehicles because its achievement will improve vehicle control during braking (by minimising wheel lock-up) whilst requiring that reasonably short stopping distances be achieved.

The high-level performance objective could prove compliance by either test or computation. Alternatively it should be acceptable to rely upon electronic brake control technology to meet the performance objective using technologies that meet ADR standards.

Compliance with the Australian Design Rules is not inconsistent with achievement of the overarching performance objective. The proposal certainly will require changes to the Australian Vehicle Standards Rules.

Amendment to the Australian Vehicle Standards Rules

In the longer term the over-aching performance objective should be adopted in the Australian Vehicle Standards Rules. In the meantime a *Brake Balance Brake Code of Practice* should be developed to provide vehicle operators with guidance about how the overarching performance objective can be met.

Experience of the overarching performance objective will occur with Performance Based Standards (PBS) vehicles. Note that the PBS braking element requires that vehicles comply to both the overarching performance objective and with the existing Australian design braking rules.

The deceleration levels that are specified in the overarching performance objective are higher than, and from a different starting speed (60km/h) than in the existing AVSRs. These constitute a significant improvement in stopping distance performance.

Code of Practice Approach to Improving Brake Balance

The strategy proposes that a voluntary *Brake Balance Code of Practice* be developed by industry that gives guidance to operators about achievement of acceptable brake balance on heavy vehicles and identifies particular combinations of brake technologies that could have poor brake performance.

Public domain access to a computational (software) tool that calculates a brake balance '*figure of merit*' should form part of the *Brake Balance Code of Practice*. The tool should provide an estimate of the likely performance of an individual (combination) vehicle against the overarching performance objective. The 'figure of merit' should provide an indication of the likely performance level against the overarching performance objective.

Australian fleet operators regularly reconfigure combination vehicles. It would be an onerous task to study the brake balance of each possible combination of equipment in a large fleet. It is possible however, to identify the characteristics of vehicles that are likely to have poor brake balance when coupled together. The *Brake Balance Code of Practice* should do this and thereby provide guidance to operators about the combinations to be avoided.

Recent changes to ADRs 35 & 38 allow load-proportioning brakes to be used on one part but not all parts of a combination vehicle. There is a risk that a semi-trailer combination will be susceptible to jack-knife if the semi-trailer has load-proportioning brakes and the prime-mover does not. The *Brake Balance Code of Practice* should specifically provide assessment criteria for this situation.

To facilitate computation of the brake balance on a heavy vehicle, suppliers should be required to declare the brake torque and control system characteristics of new heavy vehicles. That is, the foundation brakes should be certifiable sub-assemblies. This approach exists at present for trailer brake systems without controversy.

The *Brake Balance Code of Practice* approach is needed to support the adoption of the proposed overarching performance objective.

Electronic Brake Controls Including ABS

New technologies that apply electronic control of brakes have now matured into reliable commercial options for single, semi-trailer and B-double vehicles. These are:

- Antilock Brake System (ABS), which limits the friction utilization to pre-slip levels during braking.
- Traction Control (TC), which applies the drive-wheel brakes to prevent wheel slip during traction.
- Electronically Controlled Brake Systems (ECBS), which adjusts the brake balance on a vehicle in response to performance measures.

- Vehicle Stability Systems (VSS), which applies individual brakes to improve directional stability.

Additionally, collision avoidance and lane guidance technologies may become commercially available in the future. Regenerative braking systems are currently being introduced that can apply substantial retardation to the drive wheels.

Australia has baulked at mandating antilock brakes (ABS) on heavy vehicles because of concerns about reliability and cost. There is a respectable argument that mandated ABS provides a protection against the consequence of poor brake balance; which is loss of directional control during heavy braking. Australia's major trading partners (Europe, USA and China) have mandated ABS on heavy vehicles including trailers.

Whilst new electronic technologies can improve brake performance, there are potential problems. If the brake balance on a vehicle is poor, antilock brakes may increase stopping distances because wheels that have a propensity to lock-up will be routinely modulated (ie the brake is released and then reapplied). The new technologies work best when the brake balance is reasonably good. In particular antilock brakes may greatly increase stopping distance on gravel roads. Most antilock systems have a second level of control that can be temporarily activated by the driver when driving on a loose surface. This feature should be mandated when antilock brakes are used in Australia.

The case for mandating antilock brakes on trailers is not as strong as on motor vehicles. The greatest benefits come from protection against wheel lock-up on drive axles of motor vehicles. A significant problem is that trailer antilock will not function unless provision is made on the motor vehicle to provide the necessary electrical connections.

Antilock brakes are currently mandated on dangerous-goods hauling B-double trailers as well as B-double prime-movers. It could be that 20% of antilock brake systems on applicable semi-trailers do not function, due mainly to sensor mal-adjustment and wheel bearing slackness. The dangerous-goods haulage sector of the Australian transport industry is accustomed to maintaining antilock brake systems and probably experiences a greater level of reliability.

Manufacturers of electronically controlled braking systems are encouraged to improve the adjustment performance of wheel speed sensors; which are currently vulnerable to bearing slop and rough-road vibrations. Wheel speed sensors should be ideally located radially and not laterally.

Unreliability with wheel-speed sensor adjustment is a threat to the achievement of the full potential of electronically- controlled brake systems. It is likely that 25% of heavy vehicles on Australian roads that have antilock brakes have some wheel sensors out of adjustment with the consequence that the system does not work on some of the wheels.

On balance antilock brakes should be mandated on new heavy motor vehicles, but not on heavy trailers. This requirement should apply to new motor vehicles within a two-year time frame. Prime-movers or rigid motor vehicles that are certified for road-train use should be exempt from this requirement.

Electronically Controlled Braking Systems (ECBS) could improve brake balance performance as well as providing antilock brake protection. When used, it is highly desirable that ECBS is on all parts of a combination vehicle. Note that current ECBS systems are usually installed in conjunction with load proportioning brakes.

ECBS in conjunction with vehicle stability systems (VSS) are to be mandated on new heavy vehicles in Europe within a few years. If correctly maintained, these systems should provide greatly improved heavy vehicle braking, directional stability and roll stability. The performance improvements will be lost if new vehicle parts are coupled with old (without electronic technologies) parts.

Governments should find ways to encourage use of the new technologies on all parts of a heavy combination vehicle.

Currently antilock brakes are mandated on B-double prime-movers and on D-double trailers with placarded dangerous goods loads. It is inconsistent that single and semi-trailer vehicles do not also need to have antilock brakes. Despite the recommendation not to mandated antilock brakes in the short-term generally for Australian trailers, there is a good case for requiring all dangerous goods carrying vehicles other than road trails to have antilock brakes. The justification is that the costs of dealing with a crash involving such vehicles are particularly high.

There is also a case for requiring new B-double and B-triple vehicles that haul dangerous goods to have an electronically controlled brake system (ECBS). This requirement would give Australia an extensive experience of the benefits and problems with ECBS. Many dangerous goods B-doubles are currently being specified with ECBS.

Amendments to the Australian Design Rules are needed to set appropriate performance levels, compatibility requirements and warning features for electronic brake control technologies.

Amendments to the Australian Design Rules

Recent amendments to the brake ADRs (35 and 38) allow vehicles that comply with UN ECE Regulation 13 to be acceptable in Australia without modification. Furthermore, a previous limitation on the use of load-proportioning brakes on trailers has been removed. These changes effectively widen the range of vehicle characteristics that can be put into combination.

There is a risk that unwise combinations of prime-movers without, and trailers with load-proportioning brakes will be unsafe when unladen. A *Brake Balance Code of Practice* could help by identifying unsatisfactory combinations of technologies.

Amendments to the braking ADRs should be made to modernise the rules and address particular safety concerns. These are:

- Restriction on the automatic application of powerful auxiliary retarders is needed.
- Automatic brake adjustment is necessary when antilock brakes are installed.
- Axillary brake operation should cause the stop lamps to illuminate when decelerations exceeding 0.1g are possible.
- Trailer hand controls should be spring-to-off.
- Electronic brake control system requirements should be specified (as per ECE Regulation 13).

- Slow charging of road train pneumatic systems, which is a current problem, should to be addressed in the rules.
- Brake timing release limits should not apply when antilock brakes are installed.
- Specify brake burnishing procedures for ADR 35 and 38 tests.
- The brake compatibility limits in ADRs 35 & 38 should be aligned with those in the UN ECE regulation 13.

The restriction on the automatic application of auxiliary brakes is of particular urgency. Retarder technology (including the likely use of add-on hybrid retarders) now provides retardation levels that can lock drive-wheels under adverse conditions. Some vehicles have two types of auxiliary brakes with compounded performance. An immediate road safety benefit will result if powerful auxiliary brakes can only apply under deliberate driver control. A serious heavy-vehicle crash on Australia Day 2001 that resulted in five deaths was probably the result of a powerful retarder applying automatically and momentarily locking up drive wheels on a poor road surface.

Some but not all of the above-mentioned items are in UN ECE Regulation 13. The Australian government has adopted a policy of harmonising the Australian rules with the UN ECE rules wherever practical. Adoption of Regulation 13 as the national brake rule would cause considerable disruption in the short term. The requirements are unfamiliar and complex and the test requirements are more onerous than in the existing Australian brake rules.

On balance the Australian brake rules should be aligned with UN ECE Regulation 13 but with some substantial Australian variations. The ECE R13 provisions could be incorporated into a new Australian rule that applies to both motor vehicles and trailers.

The justification for making this major change is that ECE Regulation 13 is an influential international rule that has promoted world-leading brake system performance on European trucks. The rule has kept pace with electronic brake technologies and has provisions that Australia should adopt if it is to get the full safety benefits from new electronic brake controls. It contains provisions aimed at improving brake balance performance, which should be beneficial in Australia.

The Australian Government's policy of requiring a regulatory impact assessment of changes to design rules that introduce new requirements provides a fairly high hurdle for brake rule reform. Revolutionary technological changes are occurring that need to be accounted for in vehicle standards rules if full benefits are to be achieved. Estimates of costs can be reliably made. Estimates of benefits are often subjective. Because proposals to harmonize Australia's rules with the UN ECE model rules are treated favorably in the Regulation Impact Statement process, the only way to achieve substantial change to the ADR brake rules might be to base the changes on harmonization with UN ECE Regulation13 Version 11.

UN ECE Regulation 13 should be incorporated as the technical appendix of a new Australian brake rule that applies to both motor vehicles and trailers. The main part of the rule would have Australian variations and provisions. (A similar approach has been used for the lighting rule ADR 13/00).

Because ECE R13 is now an unrestricted alternative standard in ADRs 35/02 & 38/03, the maintenance of separate compatibility and tests standards in the ADRs is not required. Furthermore, the effort needed to continue to develop Australian-only brake rules is substantial and unsustainable. Recent changes to ADRs 35 and 38 have taken ~5 years to achieve. This highlights the effort needed to maintain Australian-only brake rules into the future.

The Australian provisions in the new rule should facilitate the certification of heavy trailers by the sub-assembly approach and require foundation brakes to be certified as a sub-assembly. Exception from some requirements (such as mandated antilock brakes) for road-train category trucks and trailers should be made.

A two-stage approach is recommended with amendments to the existing brake rules being implemented over a two-year period and the introduction of a new brake rule based on UN ECE Regulation 13 over a five-year timeframe. The early alignment of Australia's stopping performance and compatibility standards with ECE Regulation 13 will make it easier to introduce the new Australian brake rule in the longer term because partial alignment will have already occurred.

UN ECE R13 Version 11 has been recently released. Electronic stability control encompassing ECBS and ESS is to be mandated on new vehicles, apparently from 2010. The new Australian brake rule should be based on Version 11. This could create 'generational change' with braking on Australian heavy vehicles.

A carrot and stick approach will be necessary to ensure that when a new generation vehicle is used, it is combination with other new generation vehicles. It is impractical to expect that all vehicle parts on Australian roads, irrespective of age and technology level will have acceptable brake compatibility when they are coupled together.

There is a case for requiring all new vehicles in the interim period before the new brake rule applies to meet unladen compatibility requirements (unless they have antilock brakes). This would require load-proportioning brakes to be fitted when antilock brakes are not fitted. However, the risk that detrimental incompatibilities between old and new vehicles in combination could occur precludes such a recommendation being made.

Road-train vehicles should be manufactured to comply with the new Australian brake rule. However, the in-service rules should exempt these vehicles from requiring the systems to be functional when used in remote areas. Further work is needed to determine whether substantial safety benefits can come from electronic brake technologies on remote sealed roads.

The net effect for trailers of the recommendations in this project are then that antilock brakes be not mandated on new trailers but that ECBS (which incorporates the antilock function) and VSS be mandated on trailers in about five years time.

It is imperative that Australia adopts the performance standards for electronically controlled brake systems that are in UN ECE Regulation 13. This is necessary to protect against sub-standard systems being used here. The existing technical standards in ADRs 35, 38 and 64 are not adequate.

The recommendation to develop a new design rule based on ECE R13 Version 11 signifies the author's conviction that electronically controlled brake technology will define the future performance of heavy vehicle braking and that this technology will be referenced to the ECE R13 performance limits. Therefore it is essential that the Australian brake rule be consistent with ECE R13, V11.

Consultation with Interested Parties

The recommendations in this report are the result of an extensive consultation process. Two meetings were held in Melbourne in late 2005 involving discussions with representatives of transport industry groups, to discuss the general situation with heavy vehicle braking regulation and on-road performance. A discussion paper was released in January 2006 that identified six strategic objectives. Written and verbal comments were invited by April 13th 2006.

Three workshops were held to describe the proposals and to receive feedback. These were held in Melbourne, Brisbane and Perth during February-March. In response to some comments that better consultation was needed between industry and road agencies about reform proposals in general, a meeting of about twenty industry and road agency representatives was held in Melbourne in early June 2006. The consultation process involved detailed discussions with about 200 representatives and written comments were received from about 40 correspondents.

As a result of the consultations ten strategic objectives are recommended in this report. There are thirty-eight action items supporting these and in total forty-three recommendations are made. The recommended strategic objectives for the national heavy vehicle braking strategy are:

Strategic Objective 1

Introduce consistent national minimum stopping distance and brake balance performance standards applicable (in time) to all heavy vehicles. Align these with UN ECE Regulation 13 where applicable. These standards should support the achievement of a 'overarching performance objective' for all new and in-service heavy vehicles (containing a new part).

The purpose of this objective is to improve Australia's national heavy vehicle brake stopping distance performance standards.

The necessary actions are:

- Amend the deceleration and compatibility standards in ADRs 35 and 38 to align with those in ECE Regulation 13 Version 6.
- Amend the Australian Vehicle Standards Rules to specify compliance with the *overarching performance objective*. This should apply to in-service vehicles that contain a new part manufactured after a specified date.

Strategic Objective 2

Require foundation brakes to be certified so that torque performance, fade performance and set-up information is tested and is on the public record.

The purpose of this objective is to prove foundation brake performance and to provide information in the public domain that will facilitate computation of vehicle braking performance. In turn this will support the development of a *Brake Balance Code of Practice*. Because the foundation brakes are the fundamental braking unit, specific performance standards should be applied.

The necessary actions are:

- Introduce fade performance limits for foundation brakes into ADRs 35 and 38.
- Require suppliers to certify the foundation brakes.
- Specify that certification can be via inertia dynamometer tests.
- The foundation brake torque v application pressure performance to be publicly available.

Strategic Objective 3

Improve unladen brake compatibility on new and in-service combination vehicles.

Achievement of the overarching performance objective will require acceptable unladen brake compatibility. A *Brake Balance Code of Practice* is needed to provide the guidance and assessment tools to achieve this objective.

The necessary actions are:

- An industry-developed *Brake Balance Code of Practice* to be developed.
- The *Code* to provide guidance for operators about likely good, acceptable and poor combinations of brake technologies.
- The *Code* to include a '*figure of merit*' for combination braking performance. A suitable *figure of merit* is the achievable stopping distance when a maximum average friction utilization of 0.7 occurs in any one axle group.
- A ' brake calculator' that computes the *figure of merit* to be made publicly available (on the Internet).

Strategic Objective 4

Require wheel lock-up protection (antilock or ABS function) on new motor vehicles and improve ABS performance standards.

This objective is necessary to improve heavy vehicle directional stability under heavy braking. It will help bring Australian requirements into line with our major trading partners.

Vehicles with antilock brakes should be required to meet the overarching performance objective. It is envisaged that systems that comply with UN ECE Regulation 13 will be satisfactory.

The necessary actions are:

- Amend ADR 35 to mandate antilock brakes on motor vehicles (other than Road Train vehicles).

- Require motor vehicles that have antilock brakes and a tow coupling to also have a trailer electrical connector for trailer antilock brakes.
- Require antilock systems to have a split-mu capability. (That is, to control the wheels on each side independently).
- Encourage suppliers of electronically controlled brake equipment to improve the adjustment reliability of wheel speed sensors.

Strategic Objective 5

Update the Australian Design Rules to require modern brake features on new vehicles and to harmonize requirements with ECE Regulation 13 where sensible.

This objective addresses some particular safety concerns that have arisen because of major changes in brake technology and the capacity of modern brake systems. It also bases a new Australian brake rule (for vehicles over 3.5t) on UN ECE Regulation 13.

The necessary actions are:

- Amend ADRs 35 and 38 appropriately to mandate the requirements listed previously.
- Introduce a new Australian brake rule applicable in five years that is based on UN ECE Regulation 13 Version 11.
- Introduce incentives to promote the coupling of combination vehicles with only new-generation parts.
- Amend the AVSRs to not require working electronic brake control technology on road-trains when they are in remote areas.

APPENDIX 4—THE NTC RESPONSE TO THE NATIONAL HEAVY VEHICLE BRAKING STRATEGY REPORT

Purpose

The purpose of the National Heavy Vehicle Braking Strategy is to provide a plan for the development of brake rules and codes of practice into the foreseeable future. It underpins the NTC's broader strategic objectives with regard to safety and technology, specifically:

- To make progress towards the National Heavy Vehicle Safety Strategy target.
- To bring the Australian heavy vehicle crash rate as close as possible to world's best practice[1].
- For regulation to keep pace with and take advantage of technology.

Background

The need to review and reform heavy vehicle brake regulation arises because of the following reasons:

1. A request from Standing Committee on Transport (SCOT) to the NTC to review the case for mandating antilock braking systems (ABS)
2. The agenda to harmonize the ADR with The United Nations Economic Commission for Europe (UN ECE) Regulations
3. Inconsistencies between ADR, AVSR and PBS braking standards.
4. New technologies and the potential to improve stopping distance standard and stability standards.
5. Existing incompatibilities between trucks and trailers in combination

Discussion/Issues

The NTC commissioned Dr. Peter Hart to develop a discussion paper and undertake a consultation process to develop the National Heavy Vehicle Braking Strategy. A discussion paper with six strategic objectives was produced and an extensive consultation process was then undertaken.

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[1] Currently world best practice is 1.7 fatalities per 100 million truck km travelled and the Australian rate is 2.5 fatalities per 100 million truck km travelled.

Dr. Hart's investigation included an assessment of the crash record. Evidently the accident record doesn't contain enough information to establish a direct link between accidents and brake performance. Although international evidence suggests poor brake performance is a factor in 20-25% of crashes, currently there is no faithful economic case which provides the imperative to move forward with reform. However, it is clear that Australia lags behind Europe, Japan, China and America in mandating anti-lock braking systems and because of the large mix of equipment there is a greater chance of poor compatibility between trucks and trailers.

The economic benefits of anti-lock braking systems include anticipated reduction in crash costs and improved tyre wear rates. The economic costs include installation costs (which have reduced over recent years), enforcement and workshop maintenance costs.

Dr. Hart's final report includes ten strategic objectives, thirty eight action items and forty three recommendations.

Recommendation

To proceed in delivering on the recommendations contained in the Hart report, the following activities should be undertaken.

1. Amendments to the ADR Braking Standards, aligning with ECE R13 where sensible
2. Specification of higher national stopping distances and control performance standards.
3. Development of an Industry Brake Balance Code of Practice
4. Review alternative strategies, including mandatory regulations, to increase the uptake of electronically controlled braking systems.

The scope of these activities will ensure that the main findings of the Hart Report are addressed. Further details are contained in Appendix A.

To implement these recommendations the follow actions are required:

1. The Department of Infrastructure, Transport, Regional Development and Local Government must undertake to amend the ADR Braking Standards, aligning with ECE where sensible. Priority actions, namely amendments concerning mandating ABS on new motor vehicles, should be undertaken in 2008. Other amendments should be reviewed and implemented before 2010.
2. The NTC will need to develop a proposal for a project to define higher national stopping distance and control performance standards. This proposal will need to be approved for inclusion on the NTC's 2008/09 work program.

3. The NTC will need to develop a proposal for a project to oversee and partially fund the development of an industry Brake Code of Practice. This will need to be approved by for inclusion in the NTC's 2008/09 work program.

4. The NTC to develop a proposal for a project to review alternative strategies, including mandatory regulation, to increase the uptake of electronically controlled braking systems. This will need to be approved for inclusion in the NTC's 2008/09 work program.

To better understand the implications of poor brake balance crash data collection needs to be improved. This is a significant issue that needs to be addressed by Jurisdictions and Police in conjunction with the Australian Transport Safety Bureau. It will require that a nationally consistent minimum set of relevant crash data be recorded.

Appendix A

The National Heavy Vehicle Brake Rule

A key element presented in the Hart report is the idea of a national heavy vehicle brake rule, which would in time replace the existing brake rules. During the consultation after the discussion paper, support for the performance based approach was 'near universal'. Now, a project is needed to set and review national stopping-distance and control performance standards.

Dr. Hart proposes that the current format of the PBS braking standard is appropriate for overarching performance standard, but recognises that further work needs to be done to arrive upon the correct PBS Levels. Currently the PBS requirements are not setting minimum stopping distances – rather they are ensuring directional control and the implication is that shorter stopping distances are possible.

PBS provides a regulatory framework for implementing national performance standard that recognises the uniqueness of Australian heavy vehicle combinations and road networks. It has the advantage of being applicable to new and in-service vehicles and also provides a means by which compliance can be shown using computer simulation and physical testing.

A national heavy vehicle brake rule would require additional, prescriptive requirements like those contained in the ADR and ECE brake regulations.

The development of this overarching performance standard will be a consultative process which draws upon technical expertise from the vehicle manufacturing industry, largely through the process of developing an Industry Brake Code of Practice. It will also be draw upon details contained in the ADR and ECE brake regulations.

It is worth noting that the ECE braking standard goes to some lengths to optimize the brake performance by maximizing the friction utilization during braking. It does this by accounting for dynamic load shift which occurs during braking. ADR's don't do this. However, the ECE rule is based around a European semi-trailer, and it has not clear that the methodology would translate to b-doubles, b-triples, road trains and SMART Heavy (PBS) vehicles.

ADR Amendments

The Department of Infrastructure, Transport, Regional Development and Local Government have begun the process of working through each applicable recommendation in the Hart report. Generally any ADR amendments will require a regulatory impact statement (RIS). However, there was a procedural provision that would allow amendments to be fast tracked if they were consistent with harmonization with ECE regulations.

The Hart report proposes that a number of specific changes be made to the ADR's. They fall into seven categories.

1. Mandating antilock braking systems on new motor vehicles

a. Mandating ABS on new motor vehicles

b. Vehicles fitted with antilock braking systems should be exempt from unladen brake compatibility limits (requirement 1).

c. Road train components to be exempt from requiring antilock braking system (requirement 9) or unladen brake compatibility requirements.

d. Require unladen brake compatibility limits.

e. Allow a mechanism to disengage the antilock braking system when operating on gravel roads

f. Antilock braking systems to have split-mu capability

g. Steerable trailer axles with antilock braking systems are not required to have split-mu capability

h. Vehicles that are fitted with a tow coupling should provide an electrical ABS connector.

i. Mandate automatic brake adjustment on vehicles fitted with ABS

j. No release times to apply to air that passes through an ABS modulation valve

k. ADR 35 and 38 to be able to achieve national stopping distance requirements irrespective of the ABS system being activated

2. Foundation brake certification

l. SARN reports to show;

i. Actuator size

ii. Lever length (if applicable)

iii. Brake dimensions

iv. Disc or drum brakes used

v. Average torque values

vi. Manufacturers nominal lining friction rating

vii. Manufacturers nominal lining friction rating

m. Historical SARN data available

n. SARN number for foundation brakes to be available for each vehicle

o. Inertia dynamometer be an acceptable method of certifying foundation brakes, and that FMVSS 121, ECE R13 and EU 86/12/EC test reports be acceptable in Australia

p. ADR 35 and ADR 38 to specify a burnishing procedure

3. ECE R13 as an alternative standard

q. Require certification based on ECE approval to declare test weights at which compatibility test was done.

r. Develop summary of evidence form that is tailored to ECE regulation 13

4. Trailer brake controls – 'spring to off'

s. ADR 35 to require that when trailer brake controls are fitted they are 'spring to off'

5. Auxiliary braking systems

t. ABS to have veto control over the auxiliary brakes (retarder)

u. Stop lamps to illuminate when an auxiliary brake is active that could cause a 0.1g deceleration

6. Intelligent braking systems

v. Adoption of section in ADRs 35 & 38 that specifically to concerns the performance, control and warning features and interfaces of intelligent braking systems

7. Road Train Pneumatic Systems

w. ADR 64 to specify a maximum pneumatic resistance under specified conditions for the charging path on road train vehicles that have a rear tow coupling

The recommendations that relate to Mandating ABS on new motor vehicles should be considered with the highest priority. Also, the requirements for antilock braking systems to have veto power over the auxiliary braking should be considered in the context of mandatory antilock braking systems.

The requirement for foundation brake certification is discussed in the context of requiring data publicly available for the purposes of computer simulation. This proposal will be referred to the PBS policy steering committee in the broader context of making vehicle component data on the public record for the purposes of computer simulation.

Industry Brake Code of Practice

Dr. Hart's report proposes that the existing Air Brake Code of Practice be extended to:

1. Provide guidance on the procedures to be applied to correct poor brake balance on combination vehicles.

2. Include the definition of a figure of merit for brake balance and proposed minimum values for the figure of merit.

A number of other recommendations offered in the Hart report may be undertaken by the industry within the scope of a code of practice, these include:

3. A replacement part code of practice

4. Roller brake testing procedures

5. Brake Technician Accreditation

6. Guidance for modifications undertaken via VSB 6.0

7. Information for drivers on brake performance

It is proposed that a Code of Practice be developed by industry which should provide a practical perspective on how acceptable braking performance may be achieved and improved upon. It is expected that this work will be at least partly government funded. The terms of reference for the code of practice will include an overriding imperative to ensure public safety and focus on delivering world's best practice.

Dr. Hart has also suggested that it would be desirable to be able to simulate braking performance using computer software. This would be beneficial to engineers because:

- It would make it easier to assess the likely performance of vehicle combinations
- Provide a means of assessment with performance based standards
- And a means to assess the suitability of modifications undertaken in accordance with VSB 6.0.

In addition it has been recommended that foundation brake data should be made available on the public record to enable performance to be simulated. Whilst this is a desirable outcome, currently PBS standards are determined using computer simulation and information is not required to be on the public record. In practice equipment suppliers make this information available because it is demanded by customers. There is merit in having physical characteristics on the public record to aid assessors. However, manufacturers do have issues with making certain technical data available because it is considered to be commercially sensitive. Nevertheless, the proposal should be referred to the PBS policy steering committee within a broader context of making vehicle technical information available on the public record for the purposes of simulating performance.

Mandatory electronic braking systems with vehicle stability function

Dr. Hart has recognised that brake technologies, in particular electronic brake controls are advancing rapidly, and offer the safety benefits by improving brake balance and active intervention to correct unsafe dynamic modes. The ECE brake regulations have gone some way in characterising these systems and are due to phase in their mandatory application within the next few years. Given the safety benefits of these systems it is appropriate to review the alternative strategies, including mandatory regulation, that might be employed to increase the uptake of these systems.

APPENDIX 5—PROPOSED CHANGES TO THE CURRENT ADR VERSIONS

Table 6 Phase I—ADR 35/04 Commercial Vehicle Braking Systems

Amendment no. and title	Description	UNECE/ADR category	Draft ADR clause	Notes	R 13 paragraph
Table 1 Antilock Braking System (ABS)	Require trucks and buses (>3.5t).to have ABS fitted. Must be fitted if not over 4 axles.	M2, M3, N2, N3 (MD3, MD4, ME, NB, NC)	4.1.5.1, 8.4	May meet ADR 35/.. Appendix 1 or UNECE R13.	5.2.1.22 and Annex 13
Table 2 (a) Allow ABS as an alternative to meeting unloaded limits where variable proportioning is fitted.	If vehicle is equipped to tow an airbraked trailer, distribution and compatibility requirements in both unladen and laden condition must be met if ABS is not fitted; at least laden compatibility requirements if ABS. Compatibility requirements to be met for any additional electrical control of the braking signal.	All	4.1.9.2, 4.1.9.3, 4.1.9.5	Relaxation of current ADR requirement as it allows ABS in lieu of unladen compatibility. Aligns with R 13. Compatibility requirements for the electrical control of the braking signal raised by industry at TLG 35.	Annex 10, paragraph 1.1, 1.2 and Annex 13, paragraph 1.1
Table 2 (c) Electrical ABS connector	Trucks and buses fitted with a tow coupling must provide an electrical ABS connector. Where EBS (electric control transmission) is fitted, the CAN signal is to be compatible with the supply voltage.	M2, M3, N2, N3 (MD3, MD4, ME, NB, NC)	Appendix 1, clauses 1.3.1-1.3.3, Appendix 1 Annex 1, clauses 1-1.1.1	Allow for 1997 version of ISO/DIN 7638	5.1.3.6, 5.2.1.23, 5.2.2.18
Table 2(b) Deactivation	On/off switch optional if off-road design (must reset on ignition cycle and must have warning).	N2, N3 (NB, NC)	4.1.5.2		Annex 13, paragraph 4.5
Table 2(e) No release times for circuits controlled by ABS modulation valves			Nil	Currently the only release times required are at the coupling head of Road Trains (since the amendment of ADR 35/02)	Nil
Table 2(d) Split mu capability for ABS on other than steerable axles			Possibly nil for Phase I. To be discussed with industry.	Cat 1 type requires split mu performance in R 13. No current requirement in ADR.	Annex 13, paragraph 5.3.5 (no distinction given to steerable axles)
Table 2 (h) Remove RFS from being applicable to a standard vehicle		All	Table 2	RFS can still be kept in the ADR for information. Raised by industry at TLG	Nil
Add unladen requirements where a vehicle has a Rated Towing Capacity of > 4.5 t and variable proportioning is fitted.	Where unloaded limits are required to be reported on the basis of a vehicle's rated towing capacity rather than being equipped to tow a trailer, this must include the unladen condition where variable proportioning is fitted.	All	4.1.10.2, 7.13.2	Extension of existing requirement	Nil

Table 7 Phase I— ADR 38/04 Trailer Brake Systems

Amendment no. and title	Description	UNECE/ADR category	Draft ADR clause	Notes	R 13 paragraph
Table 1 Antilock Braking System (ABS)	Require trailers (>3.5t) to have variable proportioning or ABS fitted.	O3, O4 (TC, TD)	4.5 (new text) 6.7, 22.1, 22.3	May meet ADR 38/.. Appendix 1 or UNECE R13	5.2.2.13 and Annex 13
Table 2 (a) Allow ABS as an alternative to meeting unloaded limits where variable proportioning is fitted.	Distribution and compatibility requirements in both unladen and laden condition must be met if ABS is not fitted; at least laden compatibility requirements if ABS. Compatibility requirements to be met for any additional electrical control of the braking signal.	O3, O4 (TC, TD)	6.5.2, 6.5.3, 6.5.4	Relaxation of current ADR requirement as it allows ABS in lieu of unladen compatibility. Aligns with R 13	Annex 10, paragraphs 1.1, 1.2 and Annex 13, paragraph 1.1
Table 1 Relax the requirement for trailers to meet unloaded limits if variable proportioning is fitted.			Figure 2, Note 2	Requested by industry at TLG 31. Limiting to other than electronic LP	Nil
Table 2 (c) Electrical ABS connector	For trailers fitted with an electrical ABS connector, any CAN signal received is to be compatible with the supply voltage.	O3, O4 (TC, TD)	Appendix 1, clauses 3.1-3.5	Allow for 1997 and 2003 version of ISO/DIN 7638	5.1.3.6, 5.2.2.17, 5.2.2.18
Table 2(e) No release times for circuits controlled by ABS modulation valves			Nil	Currently the only release times required are at the rear service couplings of Road Train trailers (since the amendment of ADR 38/03)	Nil
Table 2(d) Split mu capability for ABS on other than steerable axles			Possibly nil for Phase I. To be discussed with industry.	Cat A type for > 10t (O4) requires split mu performance in R 13. No current requirement in ADR.	Annex 13, paragraph 6.3.2 (no distinction given to steerable axles)
Table 2 (h) Remove Road Friendly Suspension (RFS) from being applicable to a standard vehicle		All	Table 1	RFS can still be kept in the ADR for information. Raised by industry at TLG	Nil
Remove transitional arrangements only relevant in moving from ADR 38/02 to 38/03		All	22.3	Relates to certification of trailers without variable proportioning brake systems under ADR 38/03. Now superseded	Nil

APPENDIX 6—TYPES OF ANTILOCK BRAKE SYSTEMS

Antilock brake systems (ABS) may be grouped according to how wheel braking is controlled. The basic types are (Bosch, 2007):

Individual control (IR)

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

Select-low control (SL)

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

Select-smart control (SSM)

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

Individual control modified (IRM)

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

ARTSA (2011) outlines the systems in terms of the numbers of wheel speed Sensors (S) and Modulators (M) used and their fitment to Australian vehicles.

Trucks

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

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

This configuration is often used on air-over-hydraulic (AOH) brake systems that are common on light-medium commercial vehicles. Only one AOH booster is required for the steer axle ABS.

4S/4M—Four sensed wheel ends and four modulators. The usual scheme on Australian motive trucks whether they have singe-axle or multi-axle groups. Each rear modulator controls one or two wheels on each side of both rear axles.

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

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

6S/6M—A fully controlled and modulated system for three-axle vehicles.

Trailers

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

2S/1M systems are widely used on North American trailers (which tend to have bogie axles, both of which are controlled) and occasionally used in Australia. When used in Australia, 2S/1M ABS is applied to steerable dolly trailer axles.

2S/2M systems are commonly used on dual-axle and tri-axle axle groups. Occasionally used on dolly trailers. They are also commonly used on European tri-axle semi-trailers and Australian semi-trailers with a bi-axle rear group.

4S/2M systems are commonly used on semi-trailers. The front and the rear axles in the rear group are sensed independently.

4S/3M—the usual 'dog' trailer configuration. Rarely used on dual-axle or tri-axle semi-trailers.

6S/3M - is available although seldom used and 4S/4M - is not currently used on Australian trailers.

Technical Standards

When fitted to new heavy vehicles in Australia, ABS must comply with the design and performance requirements in ADRs 35/03 and 38/03.

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

ADRs 35/03 and 38/03 allow R 13 as an alternative standard, and this includes UN ABS requirements. While the basic test is similar to the ADRs, there is the addition of an adhesion utilisation tests, and heavy vehicles must have a Category 1 (in the case of trucks) and Category A (in the case of trailers systems. These systems are split-µ meaning that they control left side braking and right side braking individually.

APPENDIX 7—HEAVY VEHICLE CRASHES IN AUSTRALIA

Table 8 Fatalities from crashes involving heavy commercial vehicles, Australia: 1989-2011

	State/ territory	Year																							10-year average
		89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	
Articulated vehicles	NSW	143	94	78	84	69	67	63	56	71	71	64	84	60	86	63	64	52	69	59	53	47	51	51	62
	VIC	68	68	40	32	50	38	38	39	27	32	39	40	45	49	41	37	32	31	48	23	20	36	23	35
	QLD	60	37	26	38	42	41	55	42	35	33	38	40	33	28	35	13	35	37	41	46	40	29	39	35
	SA	31	26	22	14	18	15	19	25	18	24	21	19	18	13	13	13	17	10	7	10	11	7	13	13
	WA	20	17	12	10	21	16	14	26	14	13	23	13	14	14	17	18	13	14	20	10	15	13	12	14
	TAS	9	13	4	1	3	1	5	2	4	2	2	6	5	3	1	4	5	7	5	6	11	3	2	5
	NT	3	8	1	2	1	1	4	2	2	2	3	6	0	7	1	2	1	2	2	3	2	1	2	2
	ACT	1	0	0	0	0	0	1	2	0	2	1	0	3	0	0	0	0	0	0	0	2	1	0	1
	Australia	**335**	**263**	**183**	**181**	**204**	**179**	**199**	**194**	**171**	**179**	**191**	**208**	**178**	**200**	**171**	**151**	**155**	**170**	**182**	**151**	**148**	**141**	**142**	**166**
Rigid vehicles	NSW	0	0	0	0	0	0	0	0	0	0	0	0	0	41	23	38	28	30	29	12	24	24	17	22
	VIC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21	30	33	15	26	25	19	24	11	17
	QLD	0	0	0	0	0	0	0	0	0	0	0	0	0	19	18	22	13	16	11	24	13	15	13	14
	SA	0	0	0	0	0	0	0	0	0	0	0	0	0	11	8	7	3	5	5	10	2	2	6	5
	WA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	7	9	10	18	18	12	9	8
	TAS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	2	3	1	2	1	5	2	2
	NT	0	0	0	0	0	0	0	0	0	0	0	0	0	3	2	0	1	1	2	2	1	0	4	1
	ACT	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	1	1	1	0	0	1	0	1
	Australia	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**75**	**74**	**108**	**88**	**80**	**85**	**93**	**78**	**83**	**62**	**69**
Buses	NSW	84	16	7	20	15	8	9	18	14	15	13	13	12	16	15	15	21	7	11	5	9	9	11	12
	VIC	5	6	6	4	15	7	3	5	1	2	2	3	7	6	3	6	5	3	4	4	9	2	5	5
	QLD	9	15	13	4	8	19	6	9	3	10	12	6	4	7	4	6	9	5	7	9	10	4	8	7
	SA	2	5	3	3	2	0	2	0	0	0	2	1	2	5	3	2	1	1	1	1	2	3	0	2
	WA	1	3	1	2	6	3	2	3	5	0	1	0	0	2	2	0	2	1	2	3	0	0	1	1
	TAS	0	0	1	5	1	1	1	1	2	1	1	1	5	0	1	0	0	1	0	0	1	1	0	1
	NT	0	1	0	0	1	1	0	0	1	1	0	0	0	0	1	0	0	1	0	0	0	1	0	0
	ACT	3	0	1	1	1	1	0	2	1	0	1	0	2	0	0	1	0	0	0	0	0	1	0	0
	Australia	**104**	**46**	**32**	**39**	**49**	**40**	**23**	**38**	**27**	**29**	**32**	**24**	**32**	**36**	**29**	**30**	**38**	**19**	**25**	**22**	**31**	**21**	**25**	**28**
																								Total average	**263**

Source: Australian Road Deaths Database

Table 9 Ratio between injury types: 2012

	Victoria (5 year)	Victoria (1 year)	Percentage	Australia (extrapolated from Table 8)
Fatal	216	43	6	199
Serious injury	1,586	317	43	1,459
Other injury	1,908	382	51	1,755
Total	3,710			3,413

Source: VicRoads CrashStats database

APPENDIX 8—BENEFIT-COST ANALYSIS—METHODOLOGY

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

1. The trend in new vehicle sales data for heavy trucks, trailers and buses was established for the years 2003 to 2011. Registration data for this period showed a large rise in vehicle sales of around eight per cent per year. However, to avoid any chance that it is a temporary trend, the annual growth rate in new vehicle sales was halved to four per cent instead.

2. The voluntary fitment rates of ABS in trucks, trailers and buses were established for the BAU case, starting at a current rate of 36 per cent of all trucks and trailers above 4.5 tonnes and 90 per cent of buses above 4.5 tonnes. The fitment rate was then established for the mandatory option as 100 per cent.

3. The likelihood of a registered vehicle having a crash where an occupant is injured (including fatally) was established for each year of a vehicle's life using the method described in Fildes (2002). The method includes historical data of crash rates over 26 years.

4. The difference between the BAU and the option was calculated, resulting in the net number of vehicles fitted with ABS in a particular year that would be attributable to the option.

5. For each year, the net number of vehicles fitted with ABS for the option was multiplied by the likelihood of an injury crash per registration in that first year. This was then added to the likelihoods of older vehicles crashing during that year. The likelihood of an injury crash per registration was calculated by taking a ten-year average of heavy vehicle fatalities and adding serious injuries and minor (other) injuries. The number of serious injuries and other injuries was calculated by reference to Vicroads crash statistics. These showed that in Victoria, for 216 fatalities relating to heavy commercial vehicles over a five year period, there were also 1,586 serious injuries and 1,908 other injuries. These ratios were extrapolated nationally to give an injury crash rate of (199 +1459+1755) / 492,071 registered heavy commercial vehicles. This equated to 0.00694 injuries per registered vehicle. Refer Appendix 7—Heavy Vehicle Crashes in Australia for details.

6. The net number of vehicles from Step 4 was multiplied by the number of expected crashes for that year as determined in Step 5. The result was then multiplied by the overall effectiveness of ABS (as determined in Appendix 11—Effectiveness of Antilock Braking System Technology for Heavy Vehicles), the outcome being the number of crashes that could be influenced by ABS due to the intervention option.

7. The crashes in Step 6 were multiplied by the value of an average casualty crash. This gave the savings associated with the reduction in the number and severity of crashes, which in turn became the benefits for the option. Research undertaken by the Bureau of Transport Economics (2000) in Australia found that the cost in 1996 dollars of a road crash was $1.65 million for a fatal crash, $407,990 for a serious injury crash, and $13,776 for a minor injury crash. The costs for a serious injury crash and a minor injury crash were updated to 2012 dollars, using an annual inflation rate of 2.6 per cent (Reserve Bank of Australia, 2012), to $615,187 and $20,772 respectively. The cost of a fatality was then modified to reflect willingness to pay terms. This was done using a base cost of $3.587m (Abelson, 2007), with added other costs from the Bureau of Transport Economics (2000) to a value of $922, 551, to reach a final value for a fatal crash of $4.51m (in 2008 dollars). This value was updated to 2012 dollars, using an inflation rate of 2.6 per cent (Reserve Bank of Australia, 2012), to $5m. The values for fatal, serious injury and minor injury crashes were proportioned using the ratio between injuries calculated in Step 5:

8. All calculated values were discounted and summed, allowing calculations of net benefits, total costs, BCRs and number of lives and serious injuries saved. A discount rate of seven per cent was assumed, this being in line with similar studies. However, discount rates of three per cent and ten per cent were used as part of a sensitivity check.

APPENDIX 9—ASSUMPTIONS

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

1. The potential benefits were based on the identified cost of a fatality, serious injury and minor injury for a heavy commercial vehicle crash in Australia. The ratio between fatalities, serious injuries and minor injuries could not be obtained at a national level. Therefore, this ratio was determined from statistics for heavy commercial vehicle crashes in Victoria, sourced from the Victorian CrashStats database. It was assumed that the ratio calculated from the Victorian statistics is representative of the national case.

2. The effectiveness of ABS was based on a number of studies that ranged in results. The final value was taken approximately midway between the low value of recent, but less relevant, US based research and the high value of older, but highly relevant, Australian research.

3. A discount rate of seven per cent was assumed, this being in line with similar studies. However, a rate of ten per cent was used as part of the sensitivity checks. The expected crash life of a vehicle was set at 26 years as per the historical data used for the calculations. Refer Appendix 8—Benefit-Cost Analysis—Methodology. This may affect the final values slightly.

4. A historically based fleet profile was used to adjust the contribution that each vehicle fitted with ABS would provide towards the total benefit. This contribution was based on both the proportion of vehicles in the fleet of any particular age, and the tendency for vehicles of a particular age to be involved in road crashes. It was assumed that this profile, which was based on light vehicles, could represent the heavy commercial vehicle fleet now and into the future. Refer Appendix 8—Benefit-Cost Analysis—Methodology. This may affect how rapidly the benefits would be realised and so change their final values slightly.

5. It was assumed that the rate of fatalities and injuries would remain constant for the foreseeable future. However, the predicted trend of vehicle numbers and crash rates increasing by around eight per cent was halved to four per cent in the analysis, in the interests of being conservative. A large increase in the current voluntary fitment rate was also brought in in order to be even more conservative.

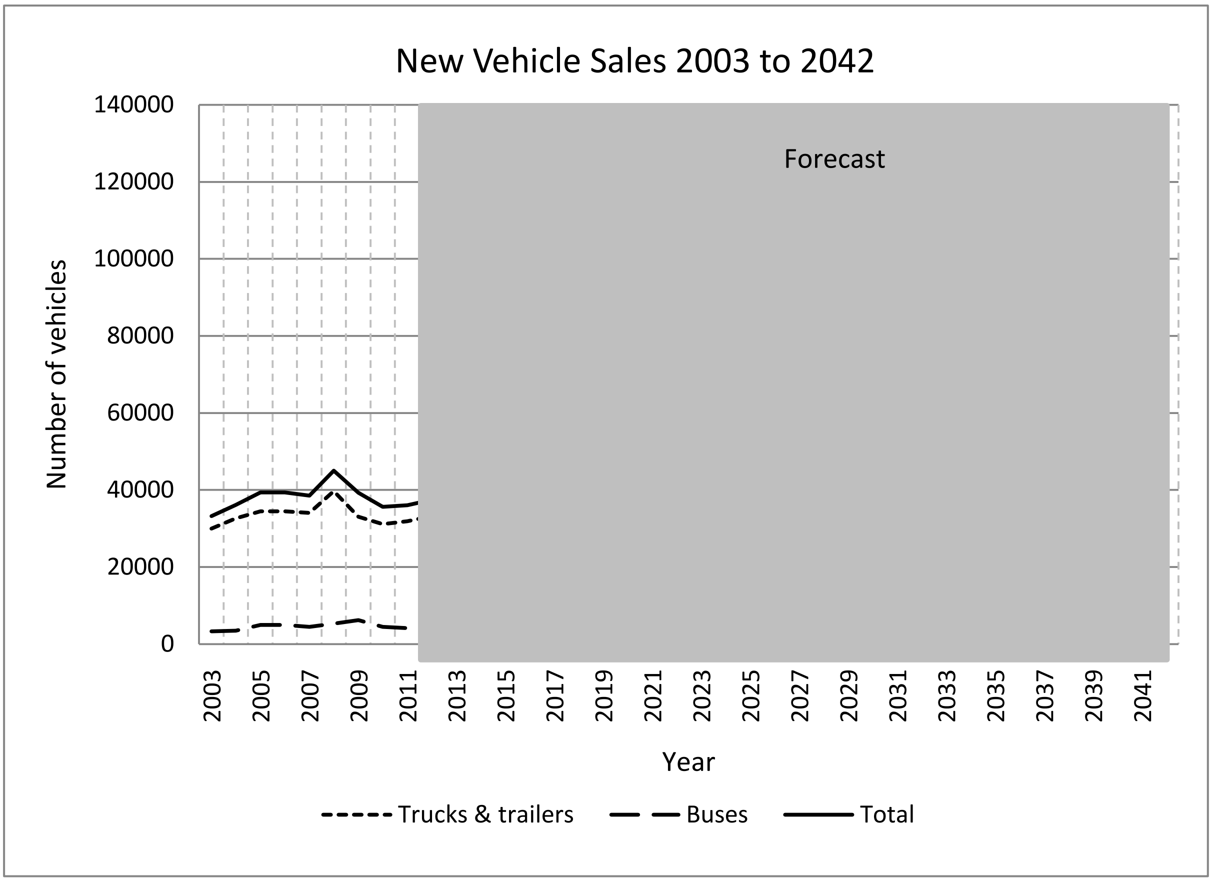
APPENDIX 10—BENEFIT-COST ANALYSIS—DETAILS OF RESULTS

1. Establish the trend in new vehicle sales data for heavy trucks, trailers and buses for the years 2003 to 2011. Extrapolate to 2042 by assuming an annual growth rate in new vehicle sales of 4 per cent.

Table 10 New heavy commercial vehicle sales 2003-2042 (ABS, 2012 & the Department of Infrastructure and Transport, 2011)

Year	Trucks and trailers	Buses
2003	29947	3296
2004	32654	3445
2005	34446	4934
2006	34446	4934
2007	34056	4448
2008	39686	5346
2009	33032	6249
2010	31141	4486
2011	31918	4107
2012	33195	4271
2013	34523	4442
2014	35903	4620
2015	37340	4805
2016	38833	4997
2017	40387	5197
2018	42002	5405
2019	43682	5621
2020	45429	5846
2021	47247	6079
2022	49136	6323
2023	51102	6575
2024	53146	6838
2025	55272	7112
2026	57483	7396
2027	59782	7692
2028	62173	8000
2029	64660	8320
2030	67247	8653
2031	69936	8999
2032	72734	9359
2033	75643	9733
2034	78669	10123
2035	81816	10528
2036	85088	10949
2037	88492	11387
2038	92032	11842
2039	95713	12316
2040	99541	12808
2041	103523	13321
2042	107664	13853

Table 11 New vehicle sales from 2003 to 2042



2. Establish the fitment rate of ABS for the BAU case. Establish the fitment rate for the option.

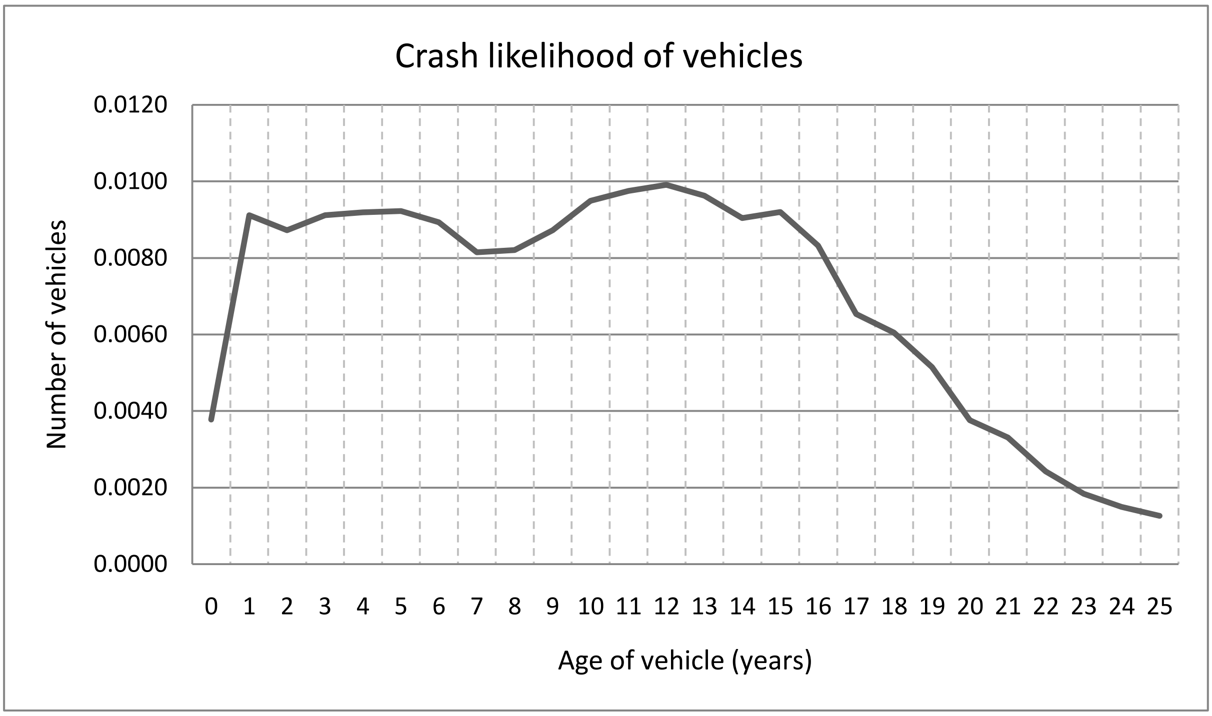
Table 12 Establishing the fitment rate

	Trucks and trailers		**Buses**		**Total**	
	BAU	Option	BAU	Option	BAU	Option
2012	0.360	0.360	0.900	0.900	0.422	0.422
2013	0.360	0.360	0.900	0.900	0.422	0.422
2014	0.360	1.000	0.900	1.000	0.422	1.000
2015	0.360	1.000	0.900	1.000	0.422	1.000
2016	0.360	1.000	0.900	1.000	0.422	1.000
2017	0.360	1.000	0.900	1.000	0.422	1.000
2018	-	-	-	-	-	-
2019	-	-	-	-	-	-
2020	-	-	-	-	-	-
2021	-	-	-	-	-	-
2022	-	-	-	-	-	-
2023	-	-	-	-	-	-
2024	-	-	-	-	-	-
2025	-	-	-	-	-	-
2026	-	-	-	-	-	-
2027	-	-	-	-	-	-
2028	-	-	-	-	-	-
2029	-	-	-	-	-	-
2030	-	-	-	-	-	-
2031	-	-	-	-	-	-
2032	-	-	-	-	-	-
2033	-	-	-	-	-	-
2034	-	-	-	-	-	-
2035	-	-	-	-	-	-
2036	-	-	-	-	-	-
2037	-	-	-	-	-	-
2038	-	-	-	-	-	-
2039	-	-	-	-	-	-
2040	-	-	-	-	-	-
2041	-	-	-	-	-	-
2042	-	-	-	-	-	-

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

Table 13 Establishing the likelihood of a registered vehicle crashing where an occupant is injured

Age of vehicle	Crashes	Annual registrations	Likelihood of casualty crash
1	1087	760523	0.0038
2	2556	740998	0.0091
3	2572	778997	0.0087
4	2412	698916	0.0091
5	2194	630869	0.0092
6	2142	613261	0.0092
7	1990	588550	0.0089
8	1637	530947	0.0081
9	1635	526303	0.0082
10	1591	482099	0.0087
11	2038	567202	0.0095
12	2008	544296	0.0097
13	1790	477461	0.0099
14	1510	414467	0.0096
15	1636	478197	0.0090
16	2176	625061	0.0092
17	1827	579925	0.0083
18	1297	524515	0.0065
19	1330	580654	0.0061
20	1082	555753	0.0051
21	804	565653	0.0038
22	667	532710	0.0033
23	489	532473	0.0024
24	360	517449	0.0018
25	314	556300	0.0015
26	263	551011	0.0013



4. Calculate the net difference in the number of vehicles fitted with ABS between the BAU and the option.

5. For each year under the option, multiply the net number of vehicles fitted with ABS by the likelihood of an injury crash per registration in that first year. Add this to the likelihoods of all older vehicles crashing during that year.

6. For each year under the option, multiply the result from step 5 by the overall effectiveness of ABS.

7. Multiply the result from step 6 by the costs associated with the average casualty crash. This gives the benefits.

Table 14 Option 2—amend ADRs 35 and 38 on heavy commercial vehicles (regulation)—trucks and trailers

Year	Likelihood of crash per vehicle	Option minus BAU	Year																															Total vehicles
			0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
1	0.0038	0		0																														0
2	0.0091	22978		0	87																													87
3	0.0087	23897		0	209	90																												300
4	0.0091	24853		0	200	218	94																											512
5	0.0092	25847		0	210	208	227	98																										742
6	0.0092	0		0	211	218	217	236	0																									881
7	0.0089	0		0	212	220	227	225	0	0																								884
8	0.0081	0		0	205	221	228	236	0	0	0																							890
9	0.0082	0		0	187	214	229	238	0	0	0	0																						868
10	0.0087	0		0	189	195	222	239	0	0	0	0	0																					844
11	0.0095	0		0	200	196	202	231	0	0	0	0	0	0																				830
12	0.0097	0		0	218	208	204	211	0	0	0	0	0	0	0																			841
13	0.0099	0		0	224	227	217	212	0	0	0	0	0	0	0	0																		880
14	0.0096	0		0	228	233	236	225	0	0	0	0	0	0	0	0	0																	922
15	0.0090	0		0	221	237	242	245	0	0	0	0	0	0	0	0	0	0																946
16	0.0092	0		0	208	230	246	252	0	0	0	0	0	0	0	0	0	0	0															936
17	0.0083	0		0	211	216	239	256	0	0	0	0	0	0	0	0	0	0	0	0														923
18	0.0065	0		0	191	220	225	249	0	0	0	0	0	0	0	0	0	0	0	0	0													885
19	0.0061	0		0	150	199	229	234	0	0	0	0	0	0	0	0	0	0	0	0	0	0												811
20	0.0051	0		0	139	156	207	238	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											740
21	0.0038	0		0	118	145	162	215	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0										640
22	0.0033	0		0	86	123	150	169	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0									529
23	0.0024	0		0	76	90	128	156	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0								450
24	0.0018	0		0	56	79	93	133	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							361
25	0.0015	0		0	42	58	82	97	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0						280
26	0.0013	0		0	34	44	60	86	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0					224
27	0.0000	0			29	36	46	63	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				173
28	0.0000	0				30	37	48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			115
29	0.0000	0					31	39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		70
30	0.0000	0						33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	33

Table 15 Option 2—amend ADRs 35 and 38 on heavy commercial vehicles (regulation)—buses

Year	Likelihood of crash per vehicle	Option minus BAU	Year																															Total vehicles
			0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
1	0.0038	0		0																														0
2	0.0091	462		0	2																													2
3	0.0087	480		0	4	2																												6
4	0.0091	500		0	4	4	2																											10
5	0.0092	520		0	4	4	5	2																										15
6	0.0092	0		0	4	4	4	5	0																									18
7	0.0089	0		0	4	4	5	5	0	0																								18
8	0.0081	0		0	4	4	5	5	0	0	0																							18
9	0.0082	0		0	4	4	5	5	0	0	0	0																						17
10	0.0087	0		0	4	4	4	5	0	0	0	0	0																					17
11	0.0095	0		0	4	4	4	5	0	0	0	0	0	0																				17
12	0.0097	0		0	4	4	4	4	0	0	0	0	0	0	0																			17
13	0.0099	0		0	5	5	4	4	0	0	0	0	0	0	0	0																		18
14	0.0096	0		0	5	5	5	5	0	0	0	0	0	0	0	0	0																	19
15	0.0090	0		0	4	5	5	5	0	0	0	0	0	0	0	0	0	0																19
16	0.0092	0		0	4	5	5	5	0	0	0	0	0	0	0	0	0	0	0															19
17	0.0083	0		0	4	4	5	5	0	0	0	0	0	0	0	0	0	0	0	0														19
18	0.0065	0		0	4	4	5	5	0	0	0	0	0	0	0	0	0	0	0	0	0													18
19	0.0061	0		0	3	4	5	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0												16
20	0.0051	0		0	3	3	4	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											15
21	0.0038	0		0	2	3	3	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0										13
22	0.0033	0		0	2	2	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0									11
23	0.0024	0		0	2	2	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0								9
24	0.0018	0		0	1	2	2	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							7
25	0.0015	0		0	1	1	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0						6
26	0.0013	0		0	1	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0					5
27	0.0000	0			1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				3
28	0.0000	0				1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			2
29	0.0000	0					1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		1
30	0.0000	0						1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

Table 16 Option 2—amend ADRs 35 and 38 to require ABS on heavy commercial vehicles (regulation)

		Vehicle sales			Option's expected fitment rate			BAU expected (voluntary) fitment rate			Option minus BAU			Net vehicle crashes influenced			Value of net vehicle crashes influenced		
	Year	Trucks and trailers	Buses	Total	Trucks and trailers	Buses	Total	Trucks and trailers	Buses	Total	Trucks and trailers	Buses	Total	Trucks and trailers	Buses	Total	Trucks and trailers	Buses	Total
0	2012	33,195	4,271	37,466	11,950	3,844	15,794	11,950	3,844	15,794	-	-	-	-	-	-	-	-	-
1	2013	34,523	4,442	38,965	12,428	3,998	16,426	12,428	3,998	16,426	-	-	-	-	-	-	-	-	-
2	2014	35,903	4,620	40,523	35,903	4,620	40,523	12,925	4,158	17,083	22,978	462	23,440	5	0	5	2,694,835	54,180	2,749,015
3	2015	37,340	4,805	42,144	37,340	4,805	42,144	13,442	4,324	17,766	23,897	480	24,378	16	0	17	9,306,303	187,105	9,493,409
4	2016	38,833	4,997	43,830	38,833	4,997	43,830	13,980	4,497	18,477	24,853	500	25,353	28	1	29	15,903,710	319,748	16,223,458
5	2017	40,387	5,197	45,583	40,387	5,197	45,583	14,539	4,677	19,216	25,847	520	26,367	41	1	42	23,046,657	463,358	23,510,015
6	2018	-	-	-	-	-	-	-	-	-	-	-	-	48	1	49	27,373,056	550,342	27,923,398
7	2019	-	-	-	-	-	-	-	-	-	-	-	-	49	1	50	27,445,105	551,790	27,996,895
8	2020	-	-	-	-	-	-	-	-	-	-	-	-	49	1	50	27,635,424	555,617	28,191,041
9	2021	-	-	-	-	-	-	-	-	-	-	-	-	48	1	49	26,941,971	541,675	27,483,646
10	2022	-	-	-	-	-	-	-	-	-	-	-	-	46	1	47	26,206,052	526,879	26,732,931
11	2023	-	-	-	-	-	-	-	-	-	-	-	-	46	1	47	25,772,455	518,161	26,290,616
12	2024	-	-	-	-	-	-	-	-	-	-	-	-	46	1	47	26,119,993	525,149	26,645,141
13	2025	-	-	-	-	-	-	-	-	-	-	-	-	48	1	49	27,319,957	549,274	27,869,231
14	2026	-	-	-	-	-	-	-	-	-	-	-	-	51	1	52	28,629,098	575,595	29,204,693
15	2027	-	-	-	-	-	-	-	-	-	-	-	-	52	1	53	29,364,219	590,375	29,954,594
16	2028	-	-	-	-	-	-	-	-	-	-	-	-	51	1	53	29,063,976	584,338	29,648,314
17	2029	-	-	-	-	-	-	-	-	-	-	-	-	51	1	52	28,653,041	576,076	29,229,117
18	2030	-	-	-	-	-	-	-	-	-	-	-	-	49	1	50	27,469,898	552,289	28,022,187
19	2031	-	-	-	-	-	-	-	-	-	-	-	-	45	1	46	25,195,045	506,552	25,701,597
20	2032	-	-	-	-	-	-	-	-	-	-	-	-	41	1	42	22,975,370	461,925	23,437,295
21	2033	-	-	-	-	-	-	-	-	-	-	-	-	35	1	36	19,886,532	399,823	20,286,356
22	2034	-	-	-	-	-	-	-	-	-	-	-	-	29	1	30	16,413,024	329,988	16,743,012
23	2035	-	-	-	-	-	-	-	-	-	-	-	-	25	0	25	13,976,103	280,993	14,257,096
24	2036	-	-	-	-	-	-	-	-	-	-	-	-	20	0	20	11,214,439	225,469	11,439,908
25	2037	-	-	-	-	-	-	-	-	-	-	-	-	15	0	16	8,680,449	174,522	8,854,971
26	2038	-	-	-	-	-	-	-	-	-	-	-	-	12	0	13	6,956,776	139,868	7,096,644
27	2039	-	-	-	-	-	-	-	-	-	-	-	-	10	0	10	5,373,237	108,030	5,481,267
28	2040	-	-	-	-	-	-	-	-	-	-	-	-	6	0	6	3,562,539	71,626	3,634,165
29	2041	-	-	-	-	-	-	-	-	-	-	-	-	4	0	4	2,170,482	43,638	2,214,121
30	2042	-	-	-	-	-	-	-	-	-	-	-	-	2	0	2	1,012,303	20,353	1,032,656
														NPV 30 years			**$217,832,858**	**$4,379,581**	**$222,212,439**

8. Calculate the implementation costs for the option. Sum and discount all the calculated values for each year using a discount rate of seven per cent. Calculate the net benefits, total costs, benefit-cost ratios and number of lives saved.

Table 17 Option 2—amend ADRs 35 and 38 to require ABS on heavy commercial vehicles (regulation)

Year		Net fitment costs	Net benefits	Lives saved
0	2012	-	-	-
1	2013	-	-	-
2	2014	47,744,424	-44,995,408	0.3
3	2015	49,654,201	-40,160,792	1.0
4	2016	51,640,369	-35,416,910	1.7
5	2017	53,705,983	-30,195,968	2.4
6	2018	-	27,923,398	2.9
7	2019	-	27,996,895	2.9
8	2020	-	28,191,041	2.9
9	2021	-	27,483,646	2.8
10	2022	-	26,732,931	2.8
11	2023	-	26,290,616	2.7
12	2024	-	26,645,141	2.7
13	2025	-	27,869,231	2.9
14	2026	-	29,204,693	3.0
15	2027	-	29,954,594	3.1
16	2028	-	29,648,314	3.1
17	2029	-	29,229,117	3.0
18	2030	-	28,022,187	2.9
19	2031	-	25,701,597	2.7
20	2032	-	23,437,295	2.4
21	2033	-	20,286,356	2.1
22	2034	-	16,743,012	1.7
23	2035	-	14,257,096	1.5
24	2036	-	11,439,908	1.2
25	2037	-	8,854,971	0.9
26	2038	-	7,096,644	0.7
27	2039	-	5,481,267	0.6
28	2040	-	3,634,165	0.4
29	2041	-	2,214,121	0.2
30	2042	-	1,032,656	0.1
		$149,460,057*	**$72,752,382***	**57**
		Benefit-Cost Ratio (BCR) = 1.5		

***Discounted totals shown.**

Summary and Sensitivities

	Net benefit	Cost to business	Cost to government	BCR	Lives saved
Best case	$353,950,624	$177,333,376	-	3.0	84
Likely case	**$72,752,382**	**$149,460,057**	**-**	**1.5**	**57**
Worst case	-$45,012,408	$132,165,813	-	0.7	31

Note:
Best case—4-year period; 3 per cent discount rate; 8 per cent effectiveness of ABS
Likely case—4-year period; 7 per cent discount rate; 5.5 per cent effectiveness of ABS
Worst case—4-year period; 10 per cent discount rate; 3 per cent effectiveness of ABS

APPENDIX 11—EFFECTIVENESS OF ANTILOCK BRAKING SYSTEM TECHNOLOGY FOR HEAVY VEHICLES

Multiple studies from around the world have demonstrated the effectiveness of ABS in helping to reduce heavy vehicle crashes.

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

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

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

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

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

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

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

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

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

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

Summary

A summary of the effectiveness rates is given below. It can be seen that although the rates contain a wide variation, there is a consistently demonstrable benefit of fitment of ABS to heavy vehicles in the order of no less than 1 per cent to no more than 10 per cent.

The Stage 2 results were the most accurate in the Australian context at the time that they were compiled. There have been no later studies in Australia since then, however it is noted that the US, having mandated ABS based on similar effectiveness rates of five to nine per cent, have recently used statistical methods to show that in practice in the US the effectiveness, at least for articulated vehicles, is around 30-60 per cent of this figure.

For this latest analysis a range of effectiveness will be used, ranging from three per cent to eight per cent. This most closely follows the Australian Stage 2 results and contains the US results.

Table 18 Effectiveness of ABS for heavy vehicles

Study	Vehicle type	Crash Type	Effectiveness (%)
Billing, Lam & Vespa (1995)	B-train double tankers	Braking efficiency	Substantially improved
Otte et al (1984) (from 19)	Commercial vehicles	Occupant personal injuries	8.7
		Preventable or reducible	
		Other preventable	7.2
		Other reducible	3.6
Klusmeyer et al (1992) (from 3			7
NHTSA (1995)	Articulated	Preventable	8.86
(from	Rigid	Preventable	5.83
NHTSA (2010)	Prime-mover	Preventable police reported crashes	3
		Preventable fatal	2
NRTC Stage 1 (1994)	Prime-mover	Preventable fatal	8.3
		Reducible to injury	2.3
	Rigid over 12t	Preventable fatal	5
		Reducible to injury	8
	Bus over 5t	Preventable fatal	6
		Reducible to injury	7
	All vehicles	Preventable fatal	7
		Reducible to injury	3
	Prime-mover	Preventable	6.1
	Rigid over 12t	Preventable	1.4
	Bus over 5t	Preventable	7.4
NRTC Stage 2 (1996)	Prime-mover	Preventable fatal	5.3
		Reducible to injury	3
	Rigid over 12t	Preventable fatal	8.3
		Reducible to injury	2.8
	Bus over 5t	Preventable fatal	1
		Reducible to injury	2
	All vehicles	Preventable fatal	6.2
		Reducible to injury	2.9
	Prime-mover	Preventable	6.4
	Rigid over 12t	Preventable	8.3
	Bus over 5t	Preventable	2.8
Robinson & Duffin (1993)			10

Source: see text

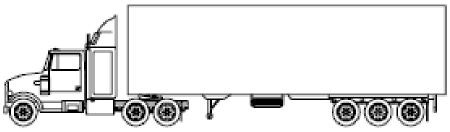
APPENDIX 12—COMPATIBILITY

The following chart demonstrates the complex nature of compatibility. It outlines the various current heavy vehicle braking technologies that exist in the fleet today, technologies which are proposed under Phase I of the NHVBS (Byrnes, 2009).

- Given that the second example in the chart is evaluated as "no better than combinations in service now" (i.e. no safety detriment), comment will centre on the third and sixth examples.

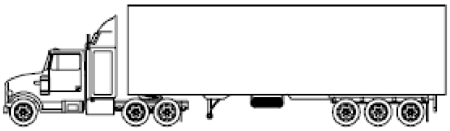
- Third example—the issue raised is the limit adjustment allowed under ADRs 35 and 38 to balance this combination. There is a change being considered under the current proposal to widen the tolerance of this band to allow for particular combinations and this should correct any problem.

- Sixth example—the issue raised is truck overbraking. However, it should be acknowledged that the ABS on the truck will prevent truck wheel lock and so safety will not be comprised. This is an approved combination under the Performance Based Standards (PBS) run by the state and territory governments.

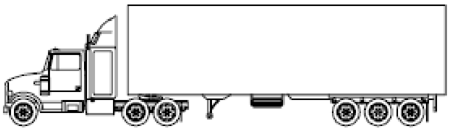


✗ **MOST COMBINATIONS IN SERVICE NOW.**
No load proportioned braking (LPB) on either towing vehicle or trailer means both are overbraked when empty. Trailer tends to be more overbraked due to higher laden/empty axle load ratio so is more likely to lock wheels and become unstable. Brake force and thus brake wear distribution between towing vehicle and trailer remains fixed.

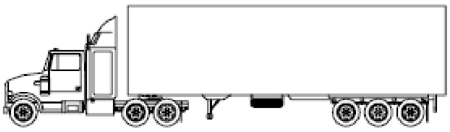
POSSIBLE OUTCOMES ENFORCED BY 2011 NHVBS PROPOSAL...



✗ NHVBS outcome for old towing vehicles with new ABS trailers.
No better than most combinations in service now. No LPB on either means both are overbraked when empty, and ABS on trailer is not powered (because towing vehicle without ABS has no trailer ABS connector) so essentially same as most combinations now. Brake force same laden and empty so wear balance unaltered.

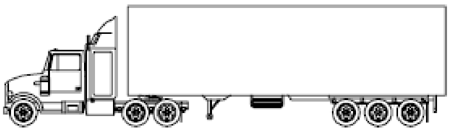


✗ NHVBS outcome for old towing vehicles with new LPB trailers.
Worse than most combinations in service now. LPB on trailer only (if set for trailer axle load ratio) means towing vehicle is severely overbraked relative to trailer when empty, causing chronic wheel lock instability and high drive axle brake wear. (trailer LPB can be set higher to balance with non-LPB towing vehicle, but this is not enforced by ADR and compromises balance with LPB towing vehicles).

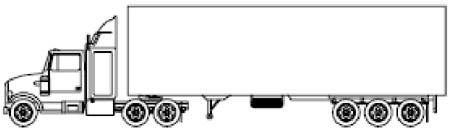


✓ NHVBS outcome for new US towing vehicles with old trailers.
Somewhat better than most combinations in service now. No LPB on either means both are overbraked when empty, but ABS prevents wheel lock instability of towing vehicle, and trailer no worse than now (will lock wheels when empty, under heavy braking, and/or on slippery roads). Brake force same laden and empty so wear balance unaltered.

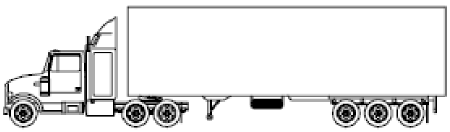
✓ NHVBS outcome for new US towing vehicles with new ABS trailers.
Better than most combinations in service now. No LPB on either means both are overbraked when empty, but ABS on both prevents any wheel lock instability. Brake force same laden and empty so wear balance unaltered.



✗ NHVBS outcome for new US towing vehicles with new LPB trailers.
Potentially worse than most combinations in service now. LPB on trailer only (if set for trailer axle load ratio) means towing vehicle is severely overbraked relative to trailer when empty, but ABS prevents drive wheel lock instability. Trailer brake force reduced so empty wheel lock less likely but still possible under heavy braking and/or on slippery roads. Drive axle brake wear likely increased. (trailer LPB can be set higher to balance with non-LPB towing vehicle, but this is not enforced by ADR and compromises balance with LPB towing vehicles).



✓ NHVBS outcome for new Euro towing vehicles with new ABS trailers.
Better than most combinations in service now. LPB only on towing vehicle means trailer overbraked when empty, but ABS on both prevents any wheel lock instability. Trailer brake wear likely increased.



✓ NHVBS outcome for new Euro towing vehicles with new LPB trailers.
Better than most combinations in service now. ABS on towing vehicle prevents wheel lock instability but trailer wheel lock still possible under heavy braking and/or on slippery roads. LPB on both balances wear.

APPENDIX 13—MEMBERSHIP OF THE TECHNICAL LIAISON GROUP (TLG)

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

APPENDIX 14—ACRONYMS

AAA	Australian Automobile Association
ABS	Antilock Braking System
ADR	Australian Design Rule
AOH	Air-Over-Hydraulic
ATA	Australian Trucking Association
ARTSA	Australian Road Transport Suppliers Association
ATC	Automatic Traction Control
BAU	Business as Usual
BCR	Benefit-Cost Ratio
BTE	Bureau of Transport Economics
CAN	Controller Area Network
COAG	Council of Australian Governments
DIT	Department of Infrastructure and Transport
EBS	Electronic Braking Systems
ELB	Electronically controlled Braking systems
ESC	Electronic Stability Control
FCAI	Federal Chamber of Automotive Industries
FMVSS	Federal Motor Vehicle Safety Standard
GVM	Gross Vehicle Mass
HVSPP	Heavy Vehicle Safety & Productivity Program
IR	Individual Control
IRM	Individual Control Modified
ITF	International Transport Forum
LP	Load Proportioning
MVSA	Motor Vehicle Standards Act 1989
NHVBS	National Heavy Vehicle Braking Strategy
NHTSA	National Highway Traffic Safety Administration
NRSS	National Road Safety Strategy 2011-2020
NPV	Net Present Value
NTC	National Transport Commission
OBPR	Office of Best Practice Regulation
RFS	Road Friendly Suspension
RIS	Regulation Impact Statement
SCOT	Standing Committee on Transport
SCOTI	Standing Council on Transport and Infrastructure
SL	Select-low Control
SSM	Select-smart Control
SVSEG	Strategic Vehicle Safety and Environment Group

TEBS	Trailer Electronic Braking Systems
TISOC	Transport and Infrastructure Senior Officials' Committee
TLG	Technical Liaison Group
UNECE	United Nations Economic Commission for Europe
WTO	World Trade Organisation

APPENDIX 15—SVSEG AND TLG FORUM COMMENT

The following is a list of the parties that responded to the invitation for comment through the Strategic Vehicle Safety and Environment Group (SVSEG) and the Technical Liaison Group (TLG) forums in May 2013.

Note: The terms Load proportioning (LP) systems, Variable Proportioning Brake Systems and Load Sensing brake systems (LS/ LSB) are used interchangeably.

Organisation	Comments	Discussed further on page	Departmental response
Australian Automobile Association (AAA)	Supports the recommendation under Phase I of the NHVBS to introduce mandatory Antilock Braking Systems for heavy vehicles with load proportioning braking systems as an option for heavy trailers. The compulsory introduction of safety technologies on heavy vehicles will assist in addressing community concerns surrounding the safety of heavy vehicles and address some of the technological inequity between light and heavy vehicles. Also urges the Commonwealth to also consider the introduction of Advanced Emergency Braking Systems as part of Phase II of the NHVBS	-	Noted
Australian Road Transport Suppliers Association Inc (ARTSA)	ARTSA strongly supports brake rule development of ADRs 35 & 38. ARTSA accepts that Option 2 in the RIS is the only practical short-term path for brake rule development. ARTSA recommends that Stage I of the NHVBS be implemented immediately and that Stage II be implemented two years after Stage I. By publicising an adoption date for Phase II, this will promote the early adoption of more advanced technology such as ESC. A detailed response is:	-	Noted

	1. The combination of ABS and LSB is a preferable option for new trailers because it is likely to have the shortest stopping distance under all load conditions. This is a half-step to Stage II.	-	1. Not agreed. This is not in line with the National Heavy Vehicle Braking Strategy (NHVBS) and it is not in line with the National Road Safety Strategy (NRSS). This would be an increase in stringency when compared to the current proposal.
	2. There is a risk that some multi-combination vehicles will have poor brake compatibility as a result of adverse mixtures of brake technologies. This risk will arise whether the brake rule development goes ahead or not, but is more likely to happen after the adoption of ADR38/04. The National Code of Practice concerning intermixing of brake control technologies, that is under development, should provide reliable guidance for the full range of technologies that could be mixed.	35	2. Agreed. Industry is encouraged to finalise the work on the code as soon as possible.
	3. The proposed inclusion of an ABS off switch limits the use of an ‘off-road mode’ switch to defined off- road vehicles. This clause should be dropped. Many Australian motive trucks run on poor quality roads with loose surfaces. It should not be concluded that standard trucks will not encounter loose surface roads.	33	3. Agreed. The revised ADR 35 will reflect that the ABS off switch may be fitted to any vehicle. This would be a reduction in stringency when compared to the current proposal.
	4. Vehicle certification testing should include Items 3 & 10 of Table 1 of ADR 35/03 for new models but just Appendix one for existing models. Foundation Brake Sub-Assembly tests should not include ABS as a relevant factor.	-	4. Agreed. The revised ADR 35 certification arrangements are likely to reflect this, although certification is not part of this RIS. This would be a reduction in stringency when compared to the current certification arrangements.
	5. ABS should be able to veto any auxiliary (or endurance brakes) and these brakes should only be able to be operated by a deliberate braking control action by the driver.	-	5. Not Agreed. This would be an increase in stringency when compared to the current proposal. May be considered under Phase II.
	6. Dangerous Goods plated trailers should have to have a roll-stability control function. This requirement could be applied additionally.	-	6. Not agreed. Dangerous Goods requirements are a matter for state and territory road authorities and so are not able to be addressed through this proposal. This would be an increase in stringency when compared to the current proposal.

	7. ABS systems should have split Mu characteristics, for non-steerable axles.	-	7. Not agreed. The current ABS technical requirements do not require this feature and it was proposed to continue to allow for this. This would be an increase in stringency when compared to the current proposal.
	8. An alternative certification level should be provided in ADR 35 so that a Load Sensing Brake System can be set to comply with Figure 2 or the LSB can be set to 65 % in the lightly-laden-test-mass condition. The later condition has been proven to be a good 'average' setting for B-type combination vehicles.	95, 108 and paragraph 5.3.1.9	8. Agreed. The revised ADR 38 will reflect this and it had already been highlighted with reference to widening the tolerance band in Figure 2. This would be the same or a reduction in stringency when compared to the current proposal.
	9. A number of other detailed comments were provided but not elaborated on.	-	9. These may be considered under Phase II should more detail become available in the future.
Commercial Vehicle Industry Association of Australia (CVIAA)	CVIAA Seeks a change in direction for ADR 38 to narrow down the opportunities for the assembly of potentially unsafe vehicle combinations:	-	See responses below.
	1. Believes that the current implementation process [for multi-combination trailers] contains too many unknowns and so recommends abandoning Phase I of the NHVBS and moving directly to Phase II with full stability control, following further research.	16	1. Not agreed. A stepped approach (Phase I, Phase II) has been agreed and endorsed a number of times through the National Heavy Vehicle Braking Strategy (NHVBS) process and remains in line with the National Road Safety Strategy 2011-2020 (NRSS) as well as more recently at the SVSEG level. It is necessary because the transport industry currently operates at widely diverse levels of braking sophistication, with some practical aspects of the most sophisticated systems (such as EBS) still being resolved from both from a user (and regulatory perspective elsewhere). Phase I represents well established technologies and an opportunity to transition electronic braking systems such as ABS, EBS and ESC into the broader fleet. There are a number of operators within the heavy vehicle industry who have been successfully using the equipment and combinations that would result from implementation of the proposal. This is supported by feedback from other heavy

			vehicle peak representative bodies (ATA, ARTSA) that are of the view that any remaining concerns could be managed through the industry code of practice being developed. Notwithstanding this, the Minister may consider additional relaxations to the current proposal in the form of: i. Exemption from the requirements due to tare mass (design) – Where the tare mass (or axle group load) of a trailer is above a certain nominated mass, LP systems if fitted would have a minimal effect and so both ABS and LP could be made exempt for trailers. Preliminary estimates by the ATA are that this would be the case for most stock crates. The exemption could also be put in terms of trailers having to meet the unladen compatibility figure in ADR 38 without specifying having to fit LP to achieve this performance level. ii. Exemption from the requirements due to the region of use – Where there are specific cases of concern over the reliability/durability of ABS as well as the performance of LP systems due to harsh operating conditions in regional and remote operations, operators of trailers could be allowed to seek agreement (under specified conditions of use) from their state or territory government to not fit ABS or LP. This would be facilitated (but could not be guaranteed as the power to exempt lies with state and territory registration authorities) by the Australian Government through the Manufacturer's Identification (Compliance) Plate approval. iii. Exemption from the requirements due to suspension type (design) - Where there are specific cases of concern about the reliability/durability of ABS as well as the performance of LP systems, utilising mechanical suspensions (typically steel leaf suspensions) in remote or regional operations, both ABS and LP could be made exempt for trailers fitted with this type of suspension. This exemption could be extended to the general case of these types of suspensions fitted to all

			trailers. iv. Exemption from the requirements due to trailer type and/or axle group configuration (design) - Where there are concerns about the operation of ABS and LP systems with road train dolly converter trailer design or trailers with more than four axles in an axle group, both ABS and LP could be made exempt for these types of trailers.
	2. Unable to support the fitting of Variable Proportioning Brake Systems where used in multi-combination vehicles and so prefers to mandate ABS only. Variable Proportioning Brake Systems are not suitable for steel (mechanical) suspensions or hydraulic suspensions with adjustable ride heights or with other trailers with CAN controlled systems. Mandating only ABS would remove these concerns.	-	2. Not agreed. The Variable Proportioning Brake Systems requirements have been adopted from long standing international requirements that apply equally to mechanical or air systems. The technology is well established. Manufacturers/operators would be free to fit ABS instead of load proportioning if they had a particular concern about their chosen vehicle configuration. Mandating only ABS would be an increase in stringency when compared to the current proposal. (However, the Minister may consider additional relaxations to the current proposal as listed directly above.)
	3. The required axle numbers to have ABS sensors should be the number of axles in the axle group divided by two and then rounded up. This will allow for future axle combinations.	-	3. Agreed. This could be introduced as a further statement in the ADR as currently the axle combinations listed do follow this pattern. This would make the current proposal more flexible for the future and would not affect its stringency.
	4. A preference is to mandate ABS systems with split Mu characteristics, for non-steerable axles. Few systems are currently available without it and this trend should be maintained.	-	4. Not agreed. The current ABS technical requirements do not require this feature and the general view more recently within the TLG forum has been to continue to allow for these requirements. This would be an increase in stringency when compared to the current proposal.
	5. Low loaders equipped with rows of eight suspensions, goose neck low loader dollies, self propelled modular transporters and other types of load platforms should be exempt from the ABS and Variable Proportioning Brake	-	5. Agreed. The proposal will be modified to accommodate these. This would be a reduction in stringency when compared to the current proposal.

	System requirements.		
Truck Industry Council (TIC)	TIC supports the two-phase approach in adoption of the National Heavy Vehicle Braking Strategy, and also its fastest possible introduction. Accordingly, TIC supports Option 2 – amend ADRs 35 and 38 to require ABS. While TIC is sympathetic to the complexity and compromise that may evolve from a two-phase NHVBS, members believe that setting the minimum standard at ABS as soon as is practical will ensure that a minimum safety level is met for new heavy vehicles on the road. The following specific comments are offered:	-	See responses below.
	1. Applicability – The ABS cost table and the coverage of the draft ADR 35 includes vehicle category NB1 (over 3.5 tonnes and up to 4.5 tonnes) yet the RIS excludes vehicles under 4.5 tonnes early on in the text.	40	1. Agreed. The NHVBS is primarily aimed at vehicles over 4.5 tonnes, but ADRs 35 and 38 cover all masses of vehicles and the issue of ABS also has relevance to lighter categories. For consistency, the scope of the requirements in the draft ADRs mirror that of the international braking standard UNECE R13 and industry has generally been supportive of this. The RIS has been amended to note this. This does not affect the stringency of the current proposal as the draft ADRs circulated to industry are unchanged.
	2. Costs of implementing the ADR – The RIS assumes that the current ABS fitment rate to trucks and trailers is 36 per cent. The TIC instead estimates this for trucks as 90 per cent.	29, 32	2. Agreed. However, the estimate in the RIS was for trucks and trailers rather than trucks alone and so this is a combined figure. As there are only approximate estimates available for all types of vehicles, the benefit-cost analysis has been left as is but with the effect of a 90 per cent voluntary rate on the net benefits reported as a further possibility. This allows the overall effect of the TIC market analysis to be recognised but does not affect the stringency of the proposal.
	3. ABS off switch for off-road or road train – Supported but not if it was extended to a full exemption from ABS for off-road unless the scope of off-road were narrowed to as	-	3. Not Agreed. A full exemption will be given, as noted against other feedback above. Doing so will be a reduction in stringency

	provided by TIC (in its submission).		when compared to the current proposal.
	4. Applicability and Implementation Timing – 1 January 2014 acceptable for new model vehicles if the ADRs are finalised before the end of June 2013. A one year lead time will then be needed for all new vehicles (June 2015).	-	4. Agreed in principle. The ADRs are expected to be finalised by the end of July 2013 and to provide for adequate lead time, the Minister may elect to accept an introduction date beyond January 2014 for all new vehicles (and for new models of vehicles). This may be different for different categories of vehicles. This would be a reduction in stringency when compared to the current proposal.
	5. Road Train Release Times – For prime movers registered as road trains with ABS fitted, release time requirements should be removed. Note that larger combinations such as B-Triples do not need to meet this requirement.	-	5. Agreed in principle. Control of release times is a unique Australian requirement that is applied to road trains only. They are not required on other combinations and there has been no discernible impact of this. However, as release times are a current requirement under the ADRs and their relaxation has not been part of the current proposal, they will need to be considered as part of Phase II of the NHVBS.
	6. Alternative standards – Request that the current alternative version of the UN R13 standard is permitted. The proposal updates this to the latest version.	-	6. Agreed. As a short lead time is being proposed, and as the current proposal is primarily about ABS and LP rather than any general update to braking requirements, the Australian Government's general policy of updating references to alternative standards will be set aside in this instance. This would be a reduction in stringency when compared to the current proposal.
	7. The contents of the proposed Appendix 1, Annex 1 in the proposed ADR 35, could be incorporated directly into Appendix 1.	-	7. Not Agreed. Under clause 4.1.5 of the proposed ADR 35, Appendix 1 requirements apply to any vehicle with ABS. However, Annex 1 requirements apply only to the nominated categories. There is no change in stringency when compared to the current proposal in not adopting this.
	8. Brake Lamp Activation when driveline retarders in operation – A statement is needed identifying when the brake lamps are to activate due to the operation of an	-	8. Not Agreed. This is an industry request designed to give clarity to manufacturers and as such will be adopted if possible for Phase II. However, to date there has been little discussion on the

	auxiliary driveline brake system.		topic. This would be an increase in stringency.
	9. ABS or Load proportioning system - As all new heavy trucks would be fitted with ABS under the proposal; all heavy trailers should be as well.	-	9. Not agreed. The long standing schedule within the NHVBS and the NRSS allows for load proportioning systems instead of ABS for heavy trailers. This would be an increase in stringency when compared to the current proposal.
	10. Electrical connector – All new heavy trailers should be fitted with multi-voltage or voltage independent electrical systems and ABS connector.	-	10. May be agreed. The trailer industry has proposed providing wiring to transmit ABS and EBS signals but the question of multi- voltage is to be resolved. See the trailer industry comments below. This would be an increase in stringency when compared to the current proposal.
Australian Trucking Association (ATA)	The proposed ADR amendments are a sound way to enhance baseline braking capabilities in the trucking industry of tomorrow. The ATA is supportive of the general thrust of these changes as they take steps to improve safety that are both sensible and affordable. Anti-lock Brake Systems (ABS), Load Sensing brake systems (LS) and electronic brake systems (EBS) are all currently deployed throughout the trucking industry and the industry is managing resulting complexities. It should be noted the ADRs can only address *single* vehicles, the safe operation of combinations of ADR-compliant vehicles relies upon industry competence and attention to potential inter-operability issues. Industry also has a number of publications to assist stakeholders with this. The proposed ADR changes make a sensible move towards the desired ultimate outcome and will ensure the productivity that flows directly from trailer interchange is not lost.	-	Noted.

	There are some specific comments that address areas where further supportive comments is warranted and some suggested addition policies for consideration outlined in this report aimed at making transition to Phase 2 easier for transport operators. [These are:]:		
	1. Auto-slack adjustment must be mandated where ABS or EBS is used, and Anti-lock sensors should be applied as appropriate to the axle group type.	-	1. Agreed. Correct adjustment of the foundation brakes is essential for good ABS performance and the technology is readily available at a modest cost. Although this would be an increase in stringency when compared to the current proposal, it is a request by industry.
	2. Mandating 24 volt ABS/EBS power and “CanBus” signal on tow vehicles rated at more than 50 tonnes GCM.	-	2. May be agreed. The proposal currently mandates 12 or 24 volt ABS power if a vehicle is fitted with a tow coupling and a CanBus signal of the same voltage if the vehicle is fitted with EBS. A choice of voltage was a feature of the changes to ADRs 35 and 38 at their last review in 2006. However this is an industry proposal. This would be an increase in stringency when compared to the current proposal.
	3. All trailers able to tow another trailer being required to provide plugs and wiring that would support transmission of ABS/EBS power and “CanBus” signal at 24 volts, regardless if conventional SL foundation brakes are use or multi-volt ABS or EBS is fitted.	-	3. Agreed. The proposal does not currently include this but would be a low cost means of facilitating power being available to (and thus full functionality of) ABS equipped trailers, no matter where they are positioned in a multi-combination. Although this would be an increase in stringency when compared to the current proposal, it is a modest request by industry.
	4. Changing the LS setting outlined in the ADR to that outlined in Attachment 3, and related amendments in attachment 4.	95	4. Agreed in principle. This is based on a previous proposal for a minor amendment to ADRs 35 and 38 that was overtaken by the current proposal. The current proposal adds Note 2 to Figure 2 of ADR 38 to allow a + 20 per cent tolerance for matching of particular combinations. This is now proposed to be increased and as such the ATA analysis will need to be verified. This tolerance would not be available for electronic LS as its

			functioning relies on it being connected to a similarly electronically controlled tow vehicle. This would be a reduction in stringency when compared to the current proposal.
	5. ADR amendments need to encompass the fact that powered trailers are in use, and can be expected to become more common over time. Similarly, smart dollies with computer-controlled steer axles are in use and need to be accommodated. Special purpose trailers that are part of heavy load carrying combinations normally controlled by OSOM permits, should be excluded from the scope of ABS and LS provisions of the ADR.	-	5. May be agreed. While some special purpose trailers have been accommodated, the Minister may consider additional relaxations to the current proposal for trailers such as dolly converters and/or for other unusual axle configurations. This would be a reduction in stringency when compared to the current proposal.
Australian Livestock and Rural Transporter's Association (ALRTA)	The ALRTA generally supports incremental safety improvements and considers that advances in minimum braking standards are inevitable and worth pursuing. However, it is unable to support the current proposal while the full implications for its unique sector remain uncertain. In preparing the RIS there was an inherent obligation on the Federal Government to clearly articulate whether the previously documented concerns about mandating ABS for road trains and heavy trailers (as outlined at Appendix 3 and Appendix 4 of the RIS) have been comprehensively resolved. These are: • Cost, reliability and performance of ABS in remote operating environments; and • The practical implications of compatibility issues likely to arise when operating 'smart' and 'dumb' trailers in combination. The 2008 recommendation of the NHVBS report appears to be a reasonable position in the absence of new information comprehensively addressing the concerns above; which	-	The approach (Phase I, Phase II) has been agreed and endorsed a number of times through the National Heavy Vehicle Braking Strategy (NHVBS) process and remains in line with the National Road Safety Strategy 2011-2020 (NRSS) as well as more recently at the SVSEG level. Phase I represents well established technologies that have been in use around the world for at least thirty years and as such provide an opportunity to transition electronic braking systems such as ABS, EBS and ESC into the broader fleet. There are a number of operators within the heavy vehicle industry who have been successfully using the equipment and combinations, that would result from implementation of the proposal, both generally as well as in remote and regional areas. This is supported by feedback from other heavy vehicle peak representative bodies (ATA, ARTSA) and so it is considered that the reliability and performance of the systems has been proven in-service and additional trials are not necessary. Notwithstanding this, it has been noted earlier that the Minister may consider additional relaxations to the current proposal that are specifically targeted at any concerns over remote and regional use of trailers. These are:

	was "on balance antilock brakes should be mandated on new heavy vehicle motor vehicles but not on heavy trailers" and that "prime-movers or rigid motor vehicles that are certified for road train use should be exempted from this requirement". It is wholly insufficient for the RIS to simply rely on unsubstantiated assurances from manufacturers. Further, it is clear that the period between the development of the original and currently proposed ADR modifications has not been used to generate reliable and objective data to inform the current decision when the previous concerns were well known and documented in previous reports. While mindful of the delays that have already occurred, the ALRTA asserts that a robust trial of ABS technology in multi-combination vehicles (including probable combinations of 'smart' and 'dumb' trailers) must be undertaken in challenging rural and remote operating environments if industry and government are to fully understand the implications of the current proposal. In this regard, the ALRTA is prepared to work with government and manufacturers to assist in progressing appropriate trial arrangements. In the meantime, there are several options for dealing with the matter. The current requirement for ABS on prime movers intended for use as B-Doubles and for vehicles carrying dangerous goods demonstrates that, while somewhat rigid, there is scope within ADRs and related instruments to either exempt or subject vehicles to certain requirements on the basis of their use. Therefore, the range of options might include: 1. Delaying blanket ADR changes until trial data can be produced for remote environments;		i. Exemption from the requirements due to tare mass. ii. Exemption from the requirements due to the region of use. iii. Exemption from the requirements due to suspension type. iv. Exemption from the requirements due to trailer type and/or axle group configuration.

	2. Proceed with limited application of the proposal in urban settings with provision to effectively exclude trailers and vehicles certified for use in regional and remote areas until such time as a case for their inclusion can be demonstrated; or 3. Abandon the current ABS proposal and immediately commence trials to examine the case for mandating EBS in phase II of the braking strategy.		
Department of Transport, Western Australia, Main Roads WA, Office of Road Safety, WA.	1. As a comment on the overall strategy, the need for a "stepped approach" is questioned, particularly if EBS is the final goal of Stage 2. As the technology for EBS is already available at a reasonable price, it seems likely that the long term cost to industry would be substantially reduced by simply introducing a phased requirement for EBS in the first instance. As an added benefit, a single step process would be likely to reduce the difficulties the transport industry will face in the future in dealing with mismatched multi-combination vehicles as discussed in point 6 below.	-	1. Not agreed. Refer Departmental response to CVIAA point 1. There would be no increase in long term cost as Phase I requirements could be met through Phase II technologies if the manufacturer/operator so chooses. It is also the Department's view is that a stepped approach is the only way to reduce any concerns about mismatching of multi-combination vehicles. Also see responses 6.and 10 below.
	2. The proposal contains a provision to allow a deactivation switch for the ABS on vehicle "of off-road design". It is questioned: a. how an "off-road" vehicle is defined for this purpose, as the definition of off-road under the ADR is unclear, with the definition referenced under the ADR referring to an "off-road passenger vehicle"; and b. how the proposed ABS requirement can have effect for "off-road" vehicles, as the Motor Vehicle Standards Act 1989 only empowers the setting of standards for "Road Vehicles"	-	2. Against comment a. The use of "off-road" has been adopted from the United Nations braking regulation R13 that is currently listed as an alternative to ADR 35. This definition includes heavy commercial vehicles within its scope. Against comment b. The requirements would cover off-road designs that are used on-road. There are many types of certified vehicles where this applies such as four-wheel-drive Sports Utility Vehicles in the case of light passenger or commercial vehicles. As an example in regulation, ADR 84 includes similar provisions for heavy commercial vehicles. However, also see response 3. directly below.

	as defined in that Act.		
	3. It appears that the proposed allowance for a deactivation switch on off-road vehicles is intended to address the concern that in some circumstances ABS has been found to reduce braking performance on gravel or other non-bitumen surfaces. If this is the case, then consideration should be given to extending the provision to all vehicles covered by the ADRs in question, as it is possible that any of these vehicles could be operated on a non-bitumen surface.	-	3. Agreed. As noted in other feedback above, the revised ADR 35 will reflect that the ABS off switch may be fitted to any vehicle. This would be a reduction in stringency when compared to the current proposal.
	4. On the other hand, if it is decided to only allow a deactivation switch on vehicles which are designed to spend a significant amount of their time off road, then consideration could be given to linking the operation of an ABS disabling function to the engagement of "all wheel drive" on the motor vehicle.	-	4. Not agreed. See response 3. above
	5. The proposal offers the option of load proportioning braking on trailers as an alternative to ABS. However, there is a safety concern that load proportioning may not work well on mechanical suspensions, as it is necessary to use mechanical displacement transducers. Unfortunately, mechanical transducers have in some instances proven to be an unsatisfactory means of measuring the loading on an axle group for the purpose of controlling braking performance. Therefore, there is concern that braking performance may be reduced as a result of complying with the proposed provisions, by fitting load proportioning braking to a trailer with steel suspension. It is strongly suggested that this issue be investigated prior to the finalisation of the proposal.	-	5. Not agreed. However, exemptions may be considered. Refer response above to CVIAA feedback 1.(iii).
	6. Given the high degree of interchangeability in many West Australian transport operations, there is concern about	-	6. Agreed. However, these issues exist now between old and new vehicles and will continue to exist for any future change in

	compatibility issues between older vehicles, without ABS or load proportioning, and newer vehicles that comply with the proposed provisions. The small amount of literature currently available indicates a complex situation even for single trailer combinations, so it is likely that the issues are even more complex for multi trailer combinations. Consequently, the provision of further guidance on compatibility issues and their effect on braking performance will be a crucial element of the implementation package.		available technologies or regulation. The ATA, ARTSA, CVIAA and TIC are collaborating on guidance material to resolve any concerns operators may have with interchangeability. See above response to ARTSA feedback on page 101.
	7. Currently it appears that the process for the certification of trailers should not be seriously affected by the adoption of the proposed ADRs. Could you confirm that no significant changes to the process, such as additional testing requirements, are likely.	-	7. Agreed. Since 2009 under ADR 35/03, load proportioning systems and ABS "where fitted" have already had to be certified through the ADRs for new vehicles. Test requirements similar to these would be applied.
	8. In relation to the Regulatory impact Statement (RIS) analysis, it is noted that benefits are calculated using the number of heavy vehicle-related fatalities as a basis. Has allowance been made for the fact not all of the associated incidents are related to heavy vehicle braking performance? If this allowance has not been made, then the benefits associated with the implementation of the proposal will be overestimated in the analysis.	-	8. Yes, allowance has been given. The Australian research discussed in Appendix 11 only utilised those crashes that related to heavy vehicle braking in calculating an effectiveness that could then be applied to all crashes. The US research was a statistical analysis of crashes where braking would be considered a factor. This was moderated to obtain an overall effectiveness for all crashes.
	9. It is understood that the statistics used for the RIS relied heavily on Victorian, rather than Australia wide, data. In view of the many differences between conditions in West Australia and those in Victoria, the applicability of the conclusions to the West Australian heavy vehicle fleet is brought into question. This issue might be resolved by a consideration of variations in the underlying assumptions in WA (and other jurisdictions) and the inclusion of a sensitivity analysis in the RIS.	-	9. The data used was the best available as it was detailed and represented one of the larger states and so would reasonably represent all of Australia. The wide range of effectiveness applied in effect became a sensitivity analysis. In any event, the ADRs are national standards and as such it would not be possible to apply regional variations based on slight state to state differences in operating or crash profiles.

	10. The increasing complexity of braking technology is resulting in a requirement for higher levels of expertise to install, diagnose and repair braking systems, as well as a requirement for more sophisticated testing equipment. There is concern about the "preparedness" of the heavy vehicle manufacturing and repair industries for the increases in brake system complexity that will occur as a result of this proposal, as well as the longer term strategy to progress to EBS. It is questioned whether there are any proposed measures to address this issue as part of the implementation plan.	-	10. The current proposal provides this through the stepped approach of the two phases of the NHVBS and the facilitation of industry provided guidance on mixing different brake technologies. Technologies in both the heavy and light vehicle sector have changed markedly over the past twenty years. Both sectors have shown themselves more than capable of adapting to the increase in sophistication of modern vehicle systems. The industry peak bodies such as The ATA, ARTSA, CVIAA and TIC all provide a wealth of expertise and guidance material for any aspect of braking from workshop procedures to configuring vehicles for EBS.