ROAD SAFETY IMPACT OF FITTING SEAT BELTS TO SCHOOL BUSES

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1 A BRIEF STATEMENT OF THE ISSUE

The road safety benefits of fitting and using seat belts in private vehicles are well established. For many members of the public (and particularly concerned parents), it seems contradictory that children are allowed to travel in school buses, unrestrained.

2 AN ASSESSMENT OF THE ROAD SAFETY ISSUE

In many countries including the US, a school bus is a specific type of vehicle with its own construction standards and patterns of use. In Australia, however, there is no exact definition, with many children carried to school in route service or transit buses used for carrying other types of passengers (Henderson & Paine 1994). For the purposes of this report and in accordance with Australian Design Rule (ADR) 68/00, 'school bus' refers only to vehicles over 3.5 tonnes and used primarily, if not exclusively, for transporting students to and from school (Austroads 2002a).

There are two broad options for fitting seat belts to school buses:

- two-point seat belts which offer a lap belt only
- three-point seat belts which offer both a lap belt and a shoulder harness.

The latter option is strongly preferred, to the point that there is now widespread agreement that 2-point seat belts do not have a meaningful safety role (Henderson & Paine 1994; National Highway Traffic Safety Administration 2002) and can increase rather than prevent injuries.

In Australasia, school buses over 3.5 tonnes are usually not fitted with seat belts and were not designed to have seat belts fitted. Retrospective fitting of seat belts to these buses is usually not possible for a number of reasons (School transportation news on the web):

- In the event of a crash, it is unlikely that the seats and flooring of many early model buses could withstand the additional loads exerted if seat belts were fitted.
- In some buses, it may be possible to strengthen the underfloor structure to allow at least two-point seat belt anchorages to be installed, albeit at considerable expense and with dubious safety outcomes.
- The optimum distance between seats equipped with seat belts needs to be approximately 85 centimetres. If seats are spaced closer, as is the case in many older buses, the possibility and severity of head, neck and spinal injuries are increased.

If seat belts on school buses were deemed mandatory in Australia, this could be achieved in some cases by retrofitting and in other cases through new vehicle purchases. In 2002 the total cost of fitting seat belts to the current school bus fleet using both these options was put at $697.4 million (Austroads 2002b). Higher estimates published in 2004 substantially increased the costs between $1 billion and $2.5 billion in NSW alone (Saffron 2004). Based on the 1990-1997 road toll and the Bureau of Transport Economics (2000) crash costings, the annual cost of deaths and serious injuries to on-board school bus passengers at a national level can be calculated to be $4.3 million.

3 CURRENT PRACTICES IN AUSTRALASIAN JURISDICTIONS

Seat belt provisions in school buses in Australia are determined by the ADRs, with ADR 68/00 defining the key provisions (Austroads 2002a). In summary, the rule requires that buses over 3.5 tonnes which seat more than 17 people and which have seat back heights exceeding one metre, require three-point seat belts to be fitted – provided that these buses were manufactured on or after 1 July 1995. ADR 68/00 also specifies some additional requirements for seat belt fitment, including strength of seats, seat anchorages and other occupant protection provisions. However, very few of the buses used to transport children to and from school in Australia are directly affected by ADR 68/00 (Austroads 2002a). In many instances, the seat backs are less than one metre, in other instances the buses are general route service vehicles and hence exempted from the requirements, in other instances the buses were manufactured before 1 July 1995.

In most instances, seat belts in school buses are not mandatory in Australasian jurisdictions. As an exception to this however, on 6 November 2005 the West Australian Government announced a commitment to introducing seatbelts on all school buses in that jurisdiction. All new school buses now require seatbelts and all existing Government funded school buses need to be either retrofitted with seatbelts where economically viable, or need to be replaced.

In New Zealand mini-buses designed to seat up to nine people (including the driver) must be fitted with seatbelts for every seat. Elsewhere, ADR 4/01 requires light omnibuses up to 3.5 tonnes and up to twelve seats to have seat belts fitted if the vehicles were manufactured on or after 1 July 1991. If seatbelts are fitted to a mini-bus, whether or not the law requires them, the belts must be worn at all times when the vehicle is operated. However, most vehicles used as school buses are heavy vehicles and are not required to be fitted with seatbelts.

4 A REVIEW OF THE RESEARCH

The possible benefits of fitting seat belts to school buses, rest on the following issues:

- size of the road safety problem posed by school bus passengers
- road safety benefits arising from widespread fitting of seat belts
- benefits arising from other possible improvements in bus occupant safety.

4.1 Size of the road safety problem posed by school bus passengers

The crash epidemiology relating to school bus travel suggests that mandatory installation of seat belts is likely to have a very minor impact on the road toll.

Looking at school-aged children 5-18 years and the Australian road toll over the period 1993 to 2002, 9 children were killed and 1,262 were injured as bus passengers. These numbers represent 4% of all deaths and injuries of children killed or injured during school travel times for the period. Six of these fatalities occurred in NSW, where detailed analysis revealed that a seat belt may have prevented only one of the six fatalities (Saffron 2004).

School bus travel is riskier than these very low passenger casualty levels might suggest. However, almost all of the risk is associated with alighting from the bus, as distinct from travelling in it. A detailed analysis of fatal crash records for the years 1992, 1994, 1996, 1997 and 1998 reveals that a total of 28 children aged 5-17 years were killed during bus travel to and from school (Austroads 2002a). The deaths occurred thus:

- as a pedestrian crossing the road:

—	to board the bus	1
—	after alighting from the bus	22

- as a bus passenger:

—	alighting	2
—	within the bus/collision with another vehicle	2
—	other	1
	TOTAL	**28**

In the same period 5 children were killed during school bus travel in NZ. Of these children, four were killed after alighting from the bus and one was within the bus at the time (note that these figures relate to dedicated school buses only).

The picture that emerges from crash data both in Australasia (Austroads 2002a) and from overseas (National Highway Traffic Safety Administration 2002) is consistent. The relatively small dangers associated with school bus travel in most cases occur only after the child has completed the bus trip and is alighting from the bus, usually on the way home.

As a general mode of travel to and from school, school buses represent the safest available option. An Australian study (Austroads 2002a) has estimated that, relative to school bus travel, a child's risk of death or injury is:

- 7 times greater, if travelling by private car
- 31 times greater, if walking
- 228 times greater, if cycling.

Any requirements imposed on school bus fleet owners that result in a reduced capacity to carry students, thereby forcing children into other travel modes, is therefore likely to have road safety disbenefits (National Highway Traffic Safety Administration 2002).

4.2 Road safety benefits of seat belts in school buses

Notwithstanding the low death and injury rates directly associated with travelling as a passenger on a school bus, the possibility remains that fitment of seat belts may still have some safety benefits. The US National Transportation Safety Board (NTSB 1987) has undertaken a series of studies in an attempt to answer this issue. Its recommendations included:

- In large school buses, the use of lap belts would be likely to save only two of the thirteen deaths investigated and would have no net impact on injury levels, except to risk a possible increase. It therefore decided against lap seat belt requirements for large school buses, arguing that the crashworthiness of these vehicles rendered them an exceptionally safe form of transportation.

- In smaller (van-type) school buses in crashes, lap belted occupants were not at advantage relative to unrestrained occupants. However, the injury patterns sustained by front seat passengers suggested that three-point seat belts offering both a lap belt and a shoulder harness, could prevent some head and facial injuries by enabling greater torso restraint.

In both types of bus, it appeared that seating position rather than restraint status was the main determinant of injury outcome.

A more recent review relating to the safety benefits of seatbelts in buses and other heavy vehicles found no evidence relating to this issue (Elvik & Vaa 2004). It also found that in light of the very small numbers of bus passengers injured in road crashes each year, 'even if seat belts could eliminate all injuries to bus passengers, the measure would not be cost effective' (p. 694). The estimated benefit/cost ratio based on the situation in Norway was 0.02.

4.3 Other possible improvements in bus occupant safety

There may be a limited scope for seat belts that incorporate both lap and shoulder harnesses to reduce by a very small measure what is already a very small road safety issue. However, opinion is very much against seat belts on large school buses as a cost-effective countermeasure, particularly if considered against other competing options:

- An early review of school bus safety in New South Wales while recommending against the fitment of seat belts to large buses, urged that priority be given to aspects of compartmentalisation plus pedestrian safety around buses (Henderson & Paine 1994).
- The US Transportation Research Board ranked nine possible school bus safety countermeasures in terms of value per dollar spent (Transportation Research Board 1989), with higher seat backs and pupil education programs emerging as the best-value options. The two options considered to be of least value were seat belts (lap belts only) and school monitors.

In its 2002 report to Congress the National Highway Traffic Safety Administration (NHTSA) attributed the impressive record of school bus travel to requirements for compartmentalisation on large school buses and to three-point seat belts plus compartmentalisation on smaller van-type buses. Compartmentalisation centres upon strong, closely spaced seats with energy-absorbing seat backs that serve as protective envelopes around passengers, usually supplemented by improved body construction and stringent fuel system integrity requirements.

While compartmentalisation is generally regarded as the most effective countermeasure for frontal impact crashes, it offers less adequate protection for side-impact and roll-over crashes. One Canadian study illustrated this with their investigation of a severe roll-over school bus crash. The study showed that compartmentalisation failed to contain passengers in this crash and to protect passengers along the sides of the compartment. The authors suggested that extra padding along the sides of the compartment over window headers and on panelling between windows would be helpful in minimising direct impact trauma (Lapner, Nguyen, & Letts 2003). However, side impact and roll-over crashes are relatively rare: in Australia during the 1990s, side-impact and roll-over events accounted for only 15% of all fatal crashes involving buses, whereas frontals accounted for 62% of crashes (Australian Transport Safety Bureau 2001).

At least in regard to large buses, compartmentalisation and seat belts are regarded as mutually exclusive options (School transportation news on the web:). To give two illustrations from the US:

- Compartmentalisation requires seat backs to bend at relatively low force levels, (somewhere around 1000 pounds), thereby absorbing some of the crash forces. In contradistinction, three-point seat belts require anchorage hardware able to withstand 5000 pound forces.

- Compartmentalisation requires seat spacing at around 60 centimetres whereas seat belts require seat spacing of around 85 centimetres if incidental injuries are to be avoided.

The extent to which this mutual exclusivity applies to Australian vehicles and standards, needs further research.

NHTSA's 2002 report to Congress included the results of a series of sled tests comparing two-point and three-point seat belts with compartmentalisation. The tests simulated a 30 mph (approximately 50 km/h) frontal crash into a rigid barrier using dummies representing a 6-year-old child, a 12-year-old child and a large high school student. Key results included:

- Compartmentalisation was effective in minimising the risk of head, chest and leg injuries but produced high neck injury measures in half of the tests.
- Two-point belts kept dummies in their seats but produced the highest neck injury measures.
- Three-point seat belts provided the best form of occupant protection in regard to head and neck injuries, but only if worn properly. Improper wearing and any non-use produced a range of undesirable outcomes.

The report stopped short of recommending the fitment of three-point seat belts to large buses, arguing that other considerations - increased capital costs, reduced seating capacities, transfer to other less safe travel modes and the dangers of incorrect wearing - were insufficiently researched.

A further study by Transport Canada investigated the relative safety offered to children of different ages by compartmentalisation and by child restraints in school buses. The results showed that children whose mass is 18 kg and under, or until they reach approximately 4½ years of age, would benefit from being restrained in child restraints appropriate to their height and weight while travelling in a school bus. The study also found that older children are well protected by school bus compartmentalisation (Transport Canada 2004).

5 POLITICAL, SOCIAL AND OTHER FACTORS

Proponents of widespread fitting of seat belts to school buses frequently advance the following arguments:

- The life-saving and injury-reducing potential of safety belts in a moving vehicle cannot be denied. Seat belts in buses will keep children in their seats and thereby prevent them being thrown about within the vehicle or ejected from the vehicle.
- Teaching children to buckle up in motor vehicles is a sound strategy to reduce crash fatalities and injuries. Use of seat belts in school buses will reinforce the educational messages aimed at school-age youngsters and have a carryover effect.
- Proper use of seat belts will improve student behaviour on the bus, reduce driver distraction, and may thereby translate into accidents avoided.

The common counter-argument to these claims is that school buses consistently have a near-to-excellent safety record when their occupants are on-board. The money required for either retrofitting seat belts or new vehicle purchases could be more effectively spent in other more problematic areas of school travel (especially pedestrian movements after alighting).

Other issues against the widespread fitting of seat belts to school buses include the likely opposition from bus fleet owners, many of whom may not be able to bear the initial costs incurred as a result of either retrofitting seat belts or purchasing a new vehicle. Widespread fitting would also be likely to result in reduced passenger capacity per bus, due to the likely ban on standing passengers and to the requirement of only two passengers per seat.

Nor does providing seat belts ensure that they will be used: ensuring compliance may well prove to be a major disciplinary problem that could distract driver attention at critical times. A recent study evaluated a seat belt trial on school buses in Queensland. Evaluation was based on the bus drivers' reports of seat belt use and an automatic monitoring system (AMS). Although bus drivers' reports indicated seat belt use levels ranging from 0 to 100%, there were major discrepancies between the drivers' estimates and the AMS results, with drivers' overestimating use rates by up to 100%. The study concluded that introducing seat belts on school buses would be a complex undertaking, with the need to clarify the responsibilities of the different stakeholders in achieving an acceptable level of compliance (Coutts et al. 2003).

In addition, in Australia unlike other countries such as the US, many students travel to and from school by bus in general route service vehicles. A decision to make three-point seat belts mandatory in dedicated school buses but not other buses, would be difficult to defend: a decision to make three-point seat belts mandatory in all buses, could not be justified in terms of likely road safety benefits.

6 CONCLUSIONS

In the final analysis, and putting aside the considerable technical and financial issues, the telling argument against requiring seat belts on large school buses rests upon the intrinsic safety of their passengers: in other words, the number of children injured as passengers in school bus crashes each year represents a minute proportion of the total road toll. However, while the weight of opinion supports school bus safety countermeasures other than seat belts, there is widespread agreement that three-point seat belts need to remain mandatory for the smaller van-type buses.

REFERENCES

Australian Transport Safety Bureau 2001, *Australian bus safety*, ATSB, Canberra.

Austroads 2002a, *Review of the school bus safety action plan - final report*, report AP-R207, Austroads, Sydney.

Austroads 2002b, *Investigation of internal bus safety measures*, report AP-R213, Austroads, Sydney.

Bureau of Transport Economics 2000, *Road crash costs in Australia*, report 102, BTE, Canberra.

Coutts, M, Newman, S, Roper, P, & Styles, T 2003, 'Evaluation of the seat belt trial in Queensland: final report', RC2462-4, ARRB Transport Research, Vermont South, (unpublished)..

Elvik, R & Vaa, T (eds) 2004, *The handbook of road safety measures*, Elsevier, Oxford, UK, pp 636-640.

Henderson M & Paine M 1994, *School bus seat belts their fitment, effectiveness and cost. Report to the Bus Safety Advisory Committee*, NSW Department of Transport, Sydney.

Lapner, PC, Nguyen, D, & Letts, M 2003, 'Analysis of a school bus collision: mechanism of injury in the unrestrained child', *Canadian Journal of Surgery*, vol.46, no.4, pp.269-272.

National Highway Traffic Safety Administration 2002, *School bus safety: crashworthiness research. Report to Congress,* viewed 20 June 2006, http://www-nrd.nhtsa.dot.gov/departments/nrd-11/SchoolBus/SBReportFINAL.pdf.

National Transportation Safety Board 1987, *Safety study - crashworthiness of large post-standard school buses*, report ss-87/01, NTSB, Washington, D.C.

Saffron, D 2004, *Deliberations of the NSW School Bus Safety Working Group: seat belts on school buses, Report to the NSW School Bus Safety Working Group*, Sydney.

School transportation news: occupant restraint, viewed 20 June 2006, http://www.schooltransportation.com/stn/occupantrestraint/index.htm

Transport Canada 2004, *School bus restraints for small children in Canada*, report 14325E, Montreal, Quebec.

Transportation Research Board 1989, *Improving school bus safety*, special report 222, TRB, Washington, DC.