4WDS – UNSAFE VEHICLES IN A SAFE SYSTEM?

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Prepared: June 2006

1. A BRIEF STATEMENT OF THE ISSUE

Over recent years, four-wheel drive vehicles (4WDs) have accounted for an increasing proportion of new vehicle sales, both in Australia and elsewhere. Particularly because of their mass and design features, 4WDs are often viewed as a safety hazard, at least to other road users.

The purpose of this paper is to assess the safety status of 4WDs.

2. AN EXTENDED ASSESSMENT OF THE ISSUE

4WD vehicles – or Sports Utility Vehicles (SUVs) as they are called in the US and increasingly in Australia - vary in shape, design and mass but have been defined as passenger vehicles not based on a traditional car design, traditionally using the same underbody as pickup trucks[1]. Given recent changes especially in chassis design, a more inclusive definition is “vehicles designed as off road vehicles with four wheel drive capability, high ground clearance and a wagon body type, seating up to nine people. Also includes four by two wagon variants of such vehicles sold in Australia which, if they were four wheel drive, would be eligible for import as off road vehicles”[2]. The special off-road design features usually include 4-wheel drive and various design specifications relating to clearance, suspension and chassis features. However it is difficult to be fully prescriptive as there are acceptable variations across models (for example, the 2-wheel drive Ford Territory) and the overall distinction between off-road passenger vehicles and all-wheel drive passenger vehicles is difficult to maintain consistently.

Figure 1 shows for Australia 1994-2005, the proportion of new passenger vehicle sales accounted for by 4WDs.

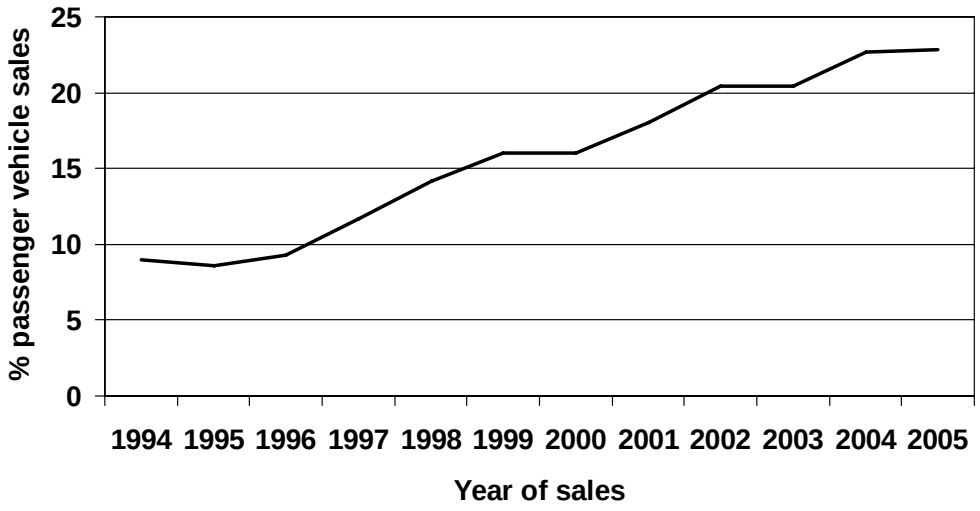

Figure 1: 4WD sales in Australia 1994-2005, as a proportion of all new passenger vehicle sales.

Source: mainly Australian Bureau of Statistics, 9314.0.55.001 - Sales of New Motor Vehicles, Electronic Delivery, April 2006 at website: http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/9314.0.55.001Apr%202006?OpenDocument

Note: Sales data based on original (non-adjusted sales data), with 'all new passenger vehicle sales' consisting of the sum of 'passenger vehicles' and 'sports utility vehicles', as defined by the ABS.

Over the past twelve years, the sale of 4WDs has more than doubled, increasing from 9% of all new passenger vehicles sales in 1994 to 23% in 2005. In terms of absolute numbers, the increase has been greater – from 45 533 vehicles in 1994 to 180 292 vehicles in 2005, representing an almost four-fold increase.

A similar trend is evident in overseas sales. For example, in the US, 4WDs or SUVs accounted for 2% of all new vehicles sold in 1982, 7% by 1991 and 16% by 1997, since when sales have levelled off at around 17%.[3]

This growth has been accompanied by increasing concern about their road safety implications, particularly when used in urban areas. The various expressions of concern are often heated and extend beyond empirical objectivity. As an example:

> … the proliferation of SUVs (4WDs) has created huge problems. Their safe image is an illusion. They roll over too easily, killing and injuring occupants at an alarming rate, and they are dangerous to other road users, inflicting catastrophic damage to cars that they hit and posing a lethal threat to pedestrians. … (Because of design loopholes) the result has been a public policy disaster, with automakers given an enormous and unintended incentive to shift production away from cars and toward inefficient, unsafe, heavily polluting SUVs. (pp xiii-xiv) [3]

The criticism of 4WDs is not limited to the vehicles but extends to their owners:

> … drivers of these technical tyrannosauruses have an increased feeling of their own safety, and to hell with the rest of us. … (They) pull out into traffic flows and accelerate through red lights, secure in the knowledge that other road users will get out of their way. Where are those log trucks when you need them?[4]

From a more empirical basis, a recent survey conducted by Sweeney Research confirmed that there was widespread safety concern about 4WDs[5]. Two-thirds of respondents believed that while 4WDs may be safer for their occupants, they are more dangerous for other road users. More than half of respondents believed that people in cities should be driving smaller, not larger, vehicles.

However, what seems to be a widespread concern about the proliferation of 4WDs, does not necessarily mean that the fears about diminished safety (whether to their occupants or to other road users) are justified.

3. A REVIEW OF THE RESEARCH

3.1 4WDs and safety implications

A Monash University Accident Research Centre (MUARC) team published a report in 1996[6] in response to the growing numbers of 4WDs, cab-chassis utilities and vans coming onto Australian roads, mainly as alternatives to standard passenger cars. An investigation of crash data from police casualty reports in New South Wales 1987-92 produced the following results. Relative to light passenger vehicles and their occupants:

- 4WD vehicles were almost twice as likely to be in casualty crashes on higher speed roads (75+ km/h), probably as a result of greater driving exposure
- 4WD vehicles were at least twice as likely to be involved in roll-over crashes in both low and high speed zones and their occupants were more likely to be seriously injured. Non-use of restraints was considered to be a contributing factor, as was lack of roof integrity
- Considering all crashes, 4WD front seat occupants had three times the likelihood of being killed and almost 1.5 times the likelihood of being seriously injured. However given 4WDs likely greater exposure to high speed roads, this analysis needs to be treated with caution
- Drivers of 4WDs in casualty crashes were more likely to be male and aged 26-55 years.

While the low numbers of 4WDs involved in some of the investigated crash scenarios prevented firm conclusions being drawn, the indications were that 4WD occupants were most at risk of death or serious injury in rollover crashes at any speed and single vehicle crashes at high speed. However there was no consistent evidence that 4WD occupants were at reduced risk of death and serious injury in any of the crash scenarios, including head on crashes.

The Australia Transport Safety Bureau (ATSB) has analysed national fatality data to present a different perspective on 4WD safety[1]. The ATSB has shown that while the number of fatal crashes involving 4WDs has increased substantially in recent years (from 101 in 1990 to 182 in 1999), this increase can be attributed to the growth in vehicle sales and hence, growth in the amount of driving exposure. When fatal crashes per 100 million kilometres per vehicle type for 1998-99 were considered, the following results were obtained:

Vehicle type	**Crash rate per 100m vehicle km**
Motorcycles	15.5
Heavy trucks	2.4
4WDs	1.0
Passenger cars	1.0

It was argued that the finding that 4WDs had no greater fatal crash involvement than standard passenger cars, needed to be qualified by several considerations:

- 4WDs have a propensity to roll over, given their high centre of gravity relative to their wheel base. In 1999, rollovers accounted for 35% of all 4WD fatal on-road crashes, compared to 13% for passenger cars – with one-half of those rollovers occurring in the absence of any prior collision, compared to one-third for passenger cars.
- In multiple-vehicle fatal crashes, 4WDs pose a substantial threat to other crash partners. Again using 1999 fatality data, 74% of deaths from multiple crashes involving 4WDs occurred to other road users. This risk is a direct function particularly of the mass advantage of 4WDs in multiple vehicle crashes, leading the ATSB to conclude that "4WD occupants are safer in the event of front-to-front or front-to-side collisions, but at the cost of the safety of other passenger vehicle occupants" (p 169)[1.] It is also likely that in at least some crash circumstances, 4WDs' greater height contributes to injuries to other road users, given the different impact points.
- 4WD threats to others are not limited to the roadways. The ATSB reported that more than half the incidents involving passenger vehicles causing death to children in driveways between 1996 and 1998 involved large 4WDs – presumably largely because of vision restrictions, especially when reversing.

Another study by the ATSB[7] provided further information about 4WDs' crash patterns. Based on 1998 fatality data:

- It was confirmed that more 4WD fatal crashes occurred on high speed roads (70+ km/h). Despite the widespread criticism of 4WDs as an urban crash risk, there was some evidence that the proportion of crashes occurring on rural roads was increasing (from 57% in 1990 to 68% in 1998). In contrast, passenger car fatal crashes were evenly divided between high speed and low speed roads.
- The most common causal factor attributable to drivers in 4WD fatal crashes was driver impairment, accounting for 54% of all instances. Alcohol was a major associated factor: in cases where the appropriate data were available, it was found that 4WD drivers of all vehicle operators were the most likely to have a blood alcohol concentration (BAC) exceeding 0.05g/100ml. The results were:

Vehicle type	**% of operators with a BAC exceeding 0.05**
4WDs	29
Motorcycles	26
Passenger cars	21
Light trucks	19
Heavy trucks	2

It is stressed that these findings are based upon Australian crash data and may not be fully generaliseable to other countries.

The issue of 4WDs' greater vehicle mass in most instances, is particularly critical to an understanding of their road safety threat. While the research findings confirm that this factor represents a threat to other groups of road users, its impact on the overall road toll is less clear. Recent research from MUARC has centred upon the safety implications of current and impending trends in the makeup of the light vehicle fleet, especially the growing proliferation of 4WDs[8]. The aim of the study was to build a statistical model based upon a Total Safety Index (TSI) – a measurement of the average risk of death or serious injury amongst drivers or unprotected road users in crashes involving the light vehicle fleet.

The general finding was that historical and expected future changes in the composition of the light vehicle fleet had or will have little influence on the TSI. From 1990-2000 the TSI fell by around 1% (that is, a safety improvement) as a result of fleet changes – and it was estimated that over the next decade, the TSI will remain largely unchanged because of this factor. Looking at 4WDs specifically, it was estimated that the removal of small and large vehicles of this type and their replacement by vehicles by various mixes of other vehicles, would result in only marginal safety improvements: for example, if in the safest scenario 4WDs were replaced by large vehicles (the most likely replacement for reasons of functionality), the TSI would fall by only some 2%.

In other words, current and expected trends in 4WD sales are unlikely to have a noticeable impact on overall crash outcomes. The biggest danger lies in 4WDs replacing the more crashworthy, larger vehicles, where in the extreme situation of total replacement, the TSI would increase by almost 9%, representing a substantial worsening of the safety situation. The research suggests that the best safety improvements could be obtained if vehicle owners were encouraged to switch to vehicles with the highest crashworthiness and lowest aggressivity ratings. In this scenario and without altering the current and expected mix of vehicle types, the TSI would fall by around 25%.

The most recent MUARC study[9] has used 1999-2003 crash data from five Australasian jurisdictions, to investigate 4WD crash patterns. It was found that overall, 4WDs accounted for 5% of all crashed vehicles: given that these vehicles make up an estimated 9% of the total vehicle fleet[10], this has substantial safety implications. At the same time however, 4WDs comprised 11% of all vehicles in roll-over crashes, confirming their propensity for this crash scenario. Analyses were also conducted to assess vehicle crashworthiness. Compared to a car driver, a 4WD driver was about 3.4 times as likely to die compared to a car driver when in a rollover crash, and about one-fifth as likely to die when in a head-on crash. As a relating finding, 4WDs also provided relatively poor protection in other single vehicle crashes not involving roll-over, with passenger vans being the worst performed in this context

There were also some mitigating safety factors. It was confirmed the sustained growth of the 4WD fleet has not been associated with a concomitant increase in threat to other car drivers. This may be due to changes in 4WD usage patterns, especially the findings that crash-involved drivers were tending to be both female and older, and that the crashes were increasingly likely to occur in urban areas. These driver groups and locations are associated with lower and less serious crash involvements. In addition, the increased sales of smaller 4WDs may also be having safety benefits.

The extent to which these findings can be applied to New Zealand remains open to question, particularly given the absence of any published research reports based on that country's crash data. However crash statistics for the period 1999-2003 supplied by the New Zealand Ministry of Transport suggest that in both urban and open-road locations, 4WD crashes have around twice the propensity to involve vehicle roll-over relative to standard cars – with most of the 4WD roll-over crashes involving only one vehicle and occurring on open roads.

3.2 4WDs and countermeasures

The research is increasingly suggesting that the burgeoning 4WD fleet does not represent a worsening of the overall road safety situation. However a major qualifier needs to made to this assessment. If may well be that as 4WD vehicles age, they will be sold on and be more affordable to younger drivers. The combination of young drivers' high-risk driving patterns with 4WD vehicles' crash performance could feasibly result in additional crash risk.

Whether or not this latter possibility eventuates, the poor performance of 4WDs in some crash scenarios could be improved through the following steps[9]:

- prospective buyers should attempt to purchase vehicles fitted with ESC (Electronic Stability Control), as a means to reduce the risk of roll-over
- a smaller 4WD with reduced aggressivity towards other vehicles and road users, should generally be purchased in preference to a large vehicle
- young or inexperienced drivers, considered to be more likely to be otherwise involved in roll-over crashes, should be encouraged to drive cars instead of 4WDs.

It also needs to be noted that at least in terms of vehicle crashworthiness, the safety performance of 4WDs of all sizes has shown greater improvement over time than for most other vehicle categories, suggesting that any heightened occupant risk will increasingly diminish[11]. In addition, the basic handling of 4WDs may well improve as a result of the increasing presence of such features as full independent suspension, adjustable ride height and ESC, all of which will further mitigate the propensity for vehicle rollover. One principal means to encourage the continuation of these trends is to monitor and promote the results of further Australian New Car Assessment Program testing.

4. POLITICAL, SOCIAL AND OTHER FACTORS

Historically the purchase of 4WDs has been encouraged by favourable tariff policies[12]. In 1996, the import tariff on 4WDs was 5%, compared to 25%, for other passenger vehicles. However this difference is diminishing (the current levels being 5% and 10%, respectively) and is scheduled to disappear from 1 January 2010.

Again historically, 4WDs have not been subject to the full set of Australian Design Rules which cover other light passenger vehicles. As noted in the1996 MUARC report[6], the main standard governing 4WDs was ADR10/01, which specified maximum steering column impact levels. It was argued that in light of the increasing use of these vehicles as a direct alternative to conventional cars, 4WDs need to provide a similar level of occupant protection. It was further argued that this protection could be best ensured by more comprehensive regulations – with regulations covering frontal crash performance, side impact crashes and roof strength (given 4WD rollover propensities) all specifically recommended. In recent years however, 4WDs have become subject to the same standards as other passenger vehicles in regard to full frontal crashes (ADR 69) and dynamic side impacts (ADR 72) – with different or no standards existing for off-set frontal crashes (ADR 73). There is a continued absence of standards pertaining to roof strength and rollover propensity, for both 4WDs and light passenger vehicles.

5. CONCLUSIONS

On the one hand, 4WDs are an additional crash risk to other road users in multiple-vehicle crash scenarios and to their own occupants in roll-over and perhaps other single-vehicle crashes. On the other hand, they offer additional protection to their occupants in many crash scenarios. The limited available research evidence suggests that 4WDs' proliferation – either actual or predicted – is not responsible for any noticeable net increase in overall crash outcomes.

However this assessment does not address the issue of equity. The main impact of 4WDs on the road toll has been to re-distribute crash risk, with occupants of light vehicles and unprotected road users having been put at additional disadvantage. It is difficult to justify a policy supporting this outcome when alternative vehicles with at least equal occupant protection and reduced aggressivity exist.

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