Introduction

The NRMA plans to review its guidelines for *insuring* vehicles with non-standard road wheels. A fundamental requirement for all vehicles is that they be acceptable to the NSW Roads and Traffic Authority (RTA) for the purpose of registration and therefore they must meet the RTA published requirements for modified vehicles (Vehicle Standards Information No.9 issued October 1994). For many years, however, the NRMA has applied more stringent requirements to vehicles fitted with wide wheels. For example, front-wheel-drive vehicles are not permitted to have rims more than half an inch wider than the manufacturer's standard. In contrast the RTA permits wheels up to 26mm wider than the widest rim recommended by the vehicle manufacturer (generally listed on the vehicle's tyre and rim placard). The difference between the NRMA insurance guidelines and the published RTA standards has led to difficulties because "street legal" vehicles have been refused insurance.

If it is demonstrated that a vehicle with "legal" wide wheels carries an increased, but not unacceptable, risk of being involved in an accident then there is potential for the vehicle to be insured with a higher premium. This is not currently NRMA policy but should be taken into consideration in the investigation of wide-wheel issues.

This report sets out the results of an investigation by Vehicle Design and Research Pty Limited (VDR) into the issue.

Vehicle Modifications and Accident Risk

In 1994 VDR undertook an investigation for the National Road Transport Commission concerning the contribution of defects to crashes (Paine, 1994). Subject to concern that vehicle factors tend to be under-reported in accidents, the findings were that defects were primary causal factors in about 4% of reported accidents and either casual or contributory in between 13% and 24% of reported accidents. No studies on the effects of vehicle modifications were found during the literature search for that project, which covered local and overseas databases.

The NSW Roads and Traffic Authority is about to carry out a major study of vehicle factors in accidents. This will include examination of vehicle modifications and it should, for the first time, give researchers an indication of the contribution of modifications to crashes. RTA Inspectors have recently received training in the inspection of crash-involved vehicles for the purpose of this project which is not expected to be completed until mid-1996.

VDR also carried out a project for Austroads (the organisation of Australian road authorities such as the RTA) to produce guidelines for the use by enforcement officers in the assessment of accident risk posed by vehicle defects. The principles developed as part of that project also apply to modifications such as the fitting of wide wheels. These principles are summarised below.

Effects of Defects/Modifications

Vehicle defects and/or modifications can have the following effects, which might contribute to a crash.

a) They impair the driver's view of the road. Examples are a scored windscreen, inoperative wipers in wet weather, missing mirrors, inoperative headlamps and excessively tinted window film.

b) They impair the visibility of the vehicle by other road-users or they prevent the driver from indicating his or her intentions (conspicuity). Examples are inoperative lights, lights of the wrong colour and inoperative horn.

c) They impair the driver's control of the vehicle (control of direction and/or speed). Examples are steering, tyre and brake defects or unsafe modifications, overweight vehicles and insecure driver's seat.

d) They result in intrusion into other users' road space or undue danger to other road users. Examples are oversize vehicles, insecure loads, oil leaks and sharp projections.

e) They impair the built-in occupant protection afforded by the vehicle in the event of a crash (crash protection). Examples are missing or broken seat belts, insecure seats, unsafe replacement seats and weakened body structure (through corrosion or major structural modification).

f) They increase the risk of further injury after a crash has occurred (post-crash). Examples are fuel leaks with a risk of fire and inoperative emergency exits.

Circumstances where a defect or modification contributes to a crash

It will be rare to encounter a vehicle with a defect or modification which immediately prevents the driver from having proper control. It is therefore necessary to assess the likely circumstances under which a defect might contribute to a crash. The following circumstances might be encountered:

1. Immediate. Examples: no brakes; no steering (unlikely); inoperative power steering; no lights at night; no wipers in the rain; hazardous projection of load

2. Imminent - defects which not have an effect until the component is subjected to higher than normal demands, when a catastrophic failure might occur. Examples: a cracked or overloaded suspension component which breaks completely under heavy braking or cornering; worn brake linings or contaminated brake fluid leading to brake fade on a long descent; structural rust resulting in collapse of the occupant space in a severe crash; bald tyres which result in skidding in the wet; missing/broken wheel studs; insecure load; imbalanced front brakes.

3. Delayed - defects which do not have an effect until they degrade (wear) further to the point where a catastrophic failure might occur. Examples: a brake cam going over-centre due to wear in several components; semi-trailer king-pin/jaw wear; worn seat-belt webbing. Note that these types of defects will usually also be affected by abnormal demands (category 2). The difference is that further wear is necessary before there is any risk of failure.

4. Gradual -defects which degrade gradually resulting in a progressive reduction in the performance of a safety system. The effects might not be evident until abnormal demands are placed on the vehicle safety systems. Examples: contamination of brake linings; worn brake linings; out-of-balance rear brakes; wear/looseness in steering system; windscreen damage affecting driver's vision. The difference between this category and category 3 is that degradation of performance is gradual and catastrophic failure is unlikely.

Most types of modifications which degrade safety probably fall into the "Imminent" category - the vehicle appears to operate satisfactorily under normal driving conditions but the effects of the modification become evident under extreme conditions such as hard braking and/or cornering, rough roads, night-time or wet roads or the effects might only be apparent during a crash.

Suspension Modifications

With most suspension modifications the owner believes that the handling of the vehicle is being enhanced. Improved handling is associated with improved ability to avoid accidents - all other things being equal, a vehicle with better handling is less likely to be involved in an accident. There is however, a limit to this process. Most drivers would have difficulty driving a car which has been prepared for the racetrack because the driver controls and handling are too sensitive. Another general problem with suspension modifications is that, while handling under most driving conditions might be improved, handling and stability under some adverse conditions might be much worse. Wide wheels and tyres are a case in point. Wide tyres generally have better roadholding ability, under normal conditions, than standard tyres. However, on a very wet road surface wide tyres can greatly increase the chance of aquaplaning (Gillespie, 1992). These and other issues are covered in more detail below.

Technical effects of wide wheels and tyres

There are several technical effects resulting from the fitting of wide wheels and tyres in place of standard equipment. In order to discuss these effects it is necessary to describe some technical terms (refer to figure 1 overleaf).

"Rim" is the portion of a road wheel which retains the tyre

"Rim width" is the transverse distance between the *inside surfaces* of the rim. For steel wheels this can be approximated to the distance between outside surfaces but in the case of alloy wheels the thickness of the rim flange needs to be considered.

"Rim diameter" is the diameter of the rim where the tyre bead sits

"Section width" is the transverse distance across the outer surface of the side-walls of a tyre. (does not include protective ribs & decorations on the side-wall)

"Section height" - half the difference between the tyre outside diameter and the rim diameter (i.e radial distance from tyre bead to outer edge of tread)

"Aspect ratio" is section height divided by section width (typically around 0.7 for normal tyres and 0.6 or lower for low-aspect-ratio tyres.

"King-pin axis" is the near-vertical axis about which the road wheels turn when the steering wheel is turned.

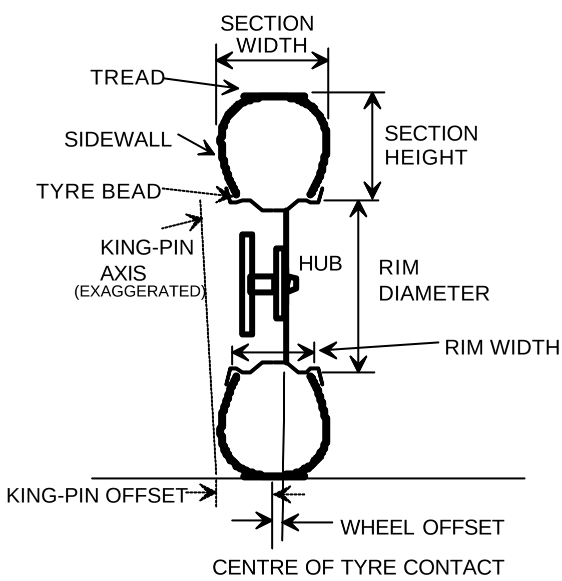
"Centre of tyre contact" is a point vertically below the spin-axis (axle) of the road wheel and in the transverse centre of the tyre (i.e centre of its section width - this is generally the same as the centre of the tyre tread)

"Wheel track" is the transverse distance between the centres of tyre contact on tyres which are on the same axle.

"King-pin offset" is the transverse distance from the point where the king-pin axis intersects the ground to the centre of tyre contact.

"Wheel offset" is the transverse distance from the centre of tyre contact to the face of the wheel which contacts the hub assembly of the axle. A change in wheel offset can be measured as a change in wheel track (half the change in track, assuming the replacement wheels are identical to one another). Also, a change in wheel offset generally leads to a change in king-pin offset.

TYRE & RIM TERMINOLOGY FIGURE 1



Effects of a change in wheel offset

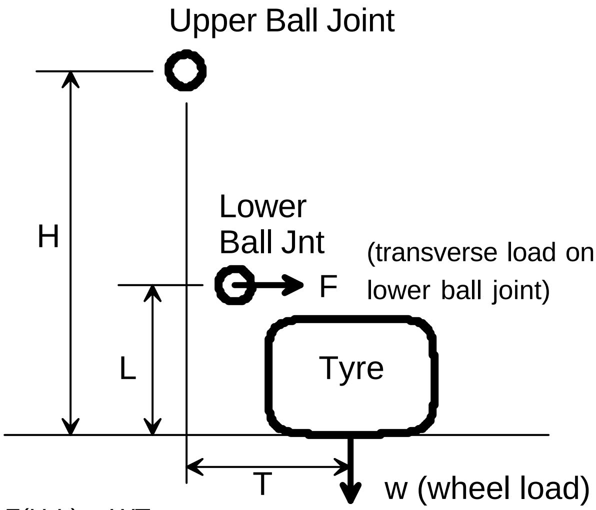
In modern vehicles there is usually very little clearance inwards, between the tyre/wheel and suspension/steering components. Therefore, in most cases, the only practical way to accommodate a large increase in tyre/rim width is to go outwards and this is achieved by changing the wheel offset. There are two main consequences of a change to wheel offset: increased loads are placed on suspension components and there is increased 'kick-back" through the steering system.

Suspension loads

Increased loads are placed on suspension components because the centre of tyre contact is further from the suspension pivot points and therefore the lever-arm effect on these components is increased. For the geometry of a typical car front suspension an increase in wheel offset from 6mm to 12mm (i.e 1" increase in rim width) will result in an increase in the static transverse load on the lower ball joint of about 8% (see Figure 2). Similar increases could be expected for wheel bearings.

Such an increase in loads on ball joints and related suspension components should be well within the factor of safety inherent in all production vehicle designs. The resulting factor of safety is reduced but a component failure due to overloading is still highly unlikely. The ball joints and wheel bearings might need to be replaced earlier than with standard road wheels but this is a maintenance issue rather than a safety issue.

FIGURE 2
Effect of Increased Wheel Offset on Suspension Loads



F(H-L) = WT

Change in transverse force on lower ball joint

$\triangle F\% = \triangle T / T\%$

For typical car T = 160mm therefore a 12mm increase

gives $\triangle F\% = 12/160 = 7.5\%$

Steering loads

Increased forces are placed on steering components because of the increase in king-pin offset. The lever-arm effect about the king-pin axis is increased and forces generated by the tyre under cornering, braking and, with front-wheel drive, acceleration have a larger feed-back into the steering system. In particular the effects of uneven tyre forces, such as the tyre on one side hitting a bump or braking on an uneven surface, are exaggerated by an increase in king-pin offset.

It used to be popular to have a king-pin offset between 6mm and 12mm (Irving, 1950). This was primarily intended to provide a degree of pre-loading in the steering system to reduce vagueness due to inevitable slack in some components. Modern cars have much less slack in the steering system. Practical tests on some popular vehicle models indicate that it is usual to have king-pin offsets less than 6mm[1]. At least one manufacturer (Mercedes) has produced models with "negative offset" (the king-pin axis intersects the ground outboard of the centre of tyre contact on the basis that it improves response to bumps).

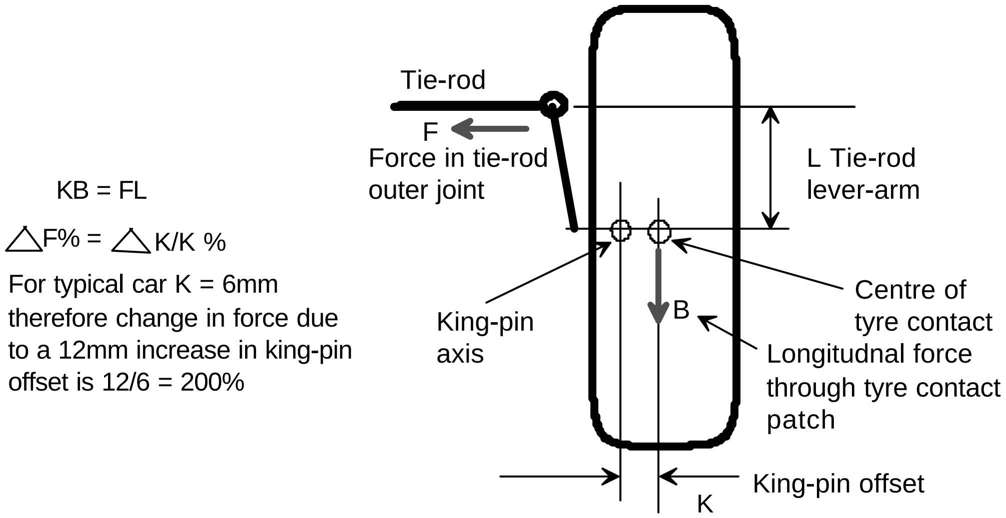
To gauge the effect of increased wheel offset assume that a typical modern car has a king-pin offset of 6mm. Referring to Figure 3, a 12mm increase in wheel offset will result in a 200% increase in force transmitted through the outer tie-rod ball joint due to longitudinal braking/traction forces generated at the tyre contact patch.

Note that the above calculation is very sensitive to the original king-pin offset provided by the vehicle manufacturer. As this offset approaches zero the calculation becomes meaningless.

Figure 3

Effect of increased king-pin offset on loads through steering system

Plan view of road wheel



Although the calculated percentage increase is relatively large the actual forces should be well within the capacity of the components concerned. For example, a tyre carrying a typical

[1] The test is very simple and consists of parking the vehicle on a relatievly smooth hard surface, rolling one of the front wheels onto a sheet of paper, turning the steering wheel so that the road wheel turns about 15^{0}, and returning the road wheels to the straight ahead position. The tyre tread leaves an imprint on the paper with radial marks corresponding to rotation about the king-pin axis. The author found that the smooth, grubby surface of service station driveways made an ideal test location. Note that the paper must stick to the tyre and not the road surface therefore a smooth road surface is required.

mass of 300kg can generate a peak braking force of about 3000N and the lever-arm ratios with a king-pin offset of 18mm (6mm standard plus 12mm due to wide wheels) would result in a load of 350N at the outer tie-rod ball joint (half the weight of a typical adult).

The increased load will, however, manifest itself as a stronger kick-back effect through the steering system if the braking forces (or traction forces with driven front wheels) are unequal across an axle. One result of steering system kick-back is a slightly increased risk of loss of control due to driver momentarily loosing grip of the steering wheel. This is less likely to occur with power steering which tends to isolate the driver from kick-back effects.

A more subtle effect of a change in king-pin offset is the tendency for the vehicle to veer to one side - particularly to try to steer out of a corner (understeer). Gillespie (1992) notes that there are several factors which influence this effect and some of these cancel one another to provide the desired steering characteristics. This is generally more important with driven front wheels because of the extra (drive) forces imposed on the tyres.

Effects of wider tyres

Wide tyres generally have a higher cornering stiffness than standard tyres. This means that for a given amount of turn of the steering wheel the wider tyre will tend to turn the vehicle through a greater angle than a standard tyre. On the racetrack this is seen as an advantage but it means that, for normal driving, the steering system is more sensitive and is less forgiving of excessive driver actions.

The load capacity of a wide tyre is generally higher than that of a standard tyre. Therefore, when carrying the same load, the wider tyre is operating at a lower proportion of its maximum capacity. Data presented by Gillespie (1992) indicate that there is a 1% rise in co-efficient of friction when the vertical load on a tyre decreases from 70% to 60% of rated load capacity of the tyre. This in turn means that the tyre can develop slightly higher friction forces (better "grip"). As an example, consider standard and wide profile tyres for a Holden Commodore or Ford Falcon:

Tyre Size	Min rim width	Max rim width	Load rating	% of load rating for 390kg load
P185/75 R14	4.5"	6"	580kg	67%
P215/65 HR14	5.5"	7"	650kg	60%

The slight improvement in tyre-road friction with wider tyres also holds for wet roads *up to a point.* However, when the amount of water on the road is sufficient and the speed of the vehicle is high enough, a layer of water builds up between the tyre and the road which can, in extreme cases, cause complete loss of tyre-road friction - a condition known as aquaplaning or hydroplaning. Under identical circumstances a wider tyre is more likely to hydroplane than a standard tyre, simply because more water must be displaced to achieve tyre-road contact.

Hydrodynamics theory *for boats* (Ducane, 1962) indicates that, for the same vertical load, the speed at which hydroplaning occurs is roughly proportional to the inverse of the *width* of the planing surface. Assuming similar conditions apply with a hydroplaning tyre then an 8" wide tyre would commence to hydroplane at a speed which is 75% of the hydroplaning speed for the 6" tyre (i.e. 6/8). Although much research has been conducted on the hydroplaning of tyres, particularly in the aviation industry, no references could be located which presented experimental results to test the application of boating hydrodynamics theory to hydroplaning road tyres therefore the results should be treated as indicative only.

The risk of hydroplaning can be reduced by clever tread design (e.g Allbert, 1968) but this is unlikely to fully compensate for the underlying hydrodynamic effects.

Accident risk from wide wheels and tyres

To summarise the points of the previous section, wide wheels and tyres have the following advantages and disadvantages:

Advantages

1. slightly better tyre-road friction ("grip") on dry and moderately wet road surfaces due to higher load capacity.
2. better response to steering wheel movement due to higher cornering stiffness of the tyre.

Disadvantages

1. increased risk of hydroplaning on very wet roads
2. slightly increased loads on front suspension components resulting from increased wheel offset
3. increased "kick-back" effect through steering system due to increased king-pin offset
4. greater tendency to veer from path due to increased king-pin offset.
5. less tolerance to excessive steering actions by the driver (due to higher cornering stiffness of tyre).

It is evident that the second advantage (improved handling) is probably negated by disadvantages 3, 4 and 5. The key differences are the propensity for hydroplaning with wide tyres on very wet roads, compared with the slightly improved grip of these tyres at other times.

Improved tyre "grip" - effect on accident risk

In the absence of hydroplaning, Gillespie's data for typical US passenger cars indicates that the frequency of wheel lock-ups under braking on wet surfaces will decrease by about 4% for a 1% improvement in "braking efficiency" (number of "events" per year per vehicle reduces from 2.10 to 1.98). Braking efficiency is directly proportional to tyre-road friction therefore the improvement in this friction due to use of wider tyres (calculated previously for a wider tyre operating at a lower proportion of its load capacity than a standard tyre) can be expected to result in a similar reduction in wheel lockups on wet roads. Of course, not all of these lock-ups events can be expected to result in an accident but, assuming the proportions are maintained, accidents involving wheel lock-up on wet roads (without aquaplaning) can be expected to be *reduced* with better performing wide wheels and tyres by a similar amount, *assuming that drivers do not negate the improved performance of wide tyres by taking increased risks.*

NSW road accidents involving "skidding"

The NSW Roads and Traffic Authority has provided a summary of "skidding" accidents over a three year period. These are accidents where the attending police officer reported that the principal vehicle (a passenger car or derivative) skidded before impact. The results are summarised in the following table. Appendix A contains more details.

Year	**Total Accidents**	**Total (%) "skidding"**	**Total (%) "skidding" on dry road**	**Total (%) "skidding" on wet road**
1994	42,525	1,317 (3.1%)	582 (1.4%)	735 (1.7%)
1993	42,115	1,338 (3.2%)	541 (1.3%)	797 (1.9%)
1992	41,980	1,455 (3.5%)	550 (1.3%)	905 (2.2%)
Total	126,620	4,110 (3.2%)	1,673 (1.3%)	2,437 (1.9%)

An unknown, but small, number of the "wet road" accidents would have involved hydroplaning.

A similar analysis by Sabey (1973) of skidding accidents in the UK found 11.8% of all dry road accidents and 27.8% of wet road accidents involved skidding. The corresponding ratios for NSW for the years 1992-4 were 1.7% and 9.2% respectively. Sabey points out that the UK figures are likely to be an underestimate and that only about half of the wet-road accidents involving skidding were attributed to reduced tyre/road friction - most of the remainder were attributed to impaired visibility. In the case of the NSW figures it is more likely that skidding, and therefore tyre/road friction, was a factor in the accident.

Overseas studies on the benefits of anti-lock braking systems (ABS) can provide a means of comparison of the NSW analysis for "wet road skidding" because anti-lock braking systems have the most benefit under these conditions (low tyre-road friction due to wet road surface). An early USA study (Treat, 1974) suggested that about 5% of all passenger car accidents could be avoided by the use of ABS. This study was done well before ABS became common on passenger cars. It was based on detailed analysis of motor vehicle accidents and predicting the cases where ABS would probably have prevented the accident. Subsequent studies (IIHS, 1995) have suggested that the actual benefits of ABS in preventing accidents are negligible. ABS equipped cars were found to have the same number of accidents (per vehicles insured) as non-ABS vehicles. The lack of actual benefits due to ABS has been attributed, in part, to increased risk taking by the drivers of these vehicles. As mentioned previously, the same problem might negate the benefits of wide wheels and tyres.

In any case, the *best* improvement that can be expected from the improved grip of wide wheels and tyres is of the order of 0.13% of all car accidents involving the selected vehicles (based on a 4% reduction in NSW "skidding" accidents, which comprised 3.2% of all passenger car accidents). The actual improvement, if any, is likely to be considerably lower than this estimate due to the factors described above.

It is concluded that the slightly improved grip of wide wheels and tyres, compared with standard wheels and tyres, will be of negligible benefit in avoiding accidents.

Propensity for aquaplaning - effect on accident risk

As indicated previously, for the same vertical load and road conditions, the onset of hydroplaning for wide wheels and tyres is likely to occur at a speed which is inversely proportional to the increase in tyre tread width. Continuing the example of a wheel/tyre combination which is one inch wider than standard, and assuming the standard rim is 6" wide, the onset of hydroplaning for the 7" wide wheel/tyre will be at a speed which is approximately 87% of that for the standard combination. As a rough approximation, assuming that vehicles with wide wheels have the same speed distribution as vehicles with standard wheels, the number of times that the vehicle with wide wheels encounters conditions where hydroplaning occurs will be about 13% more than for vehicles with standard wheels.

The number of road accidents in NSW involving hydroplaning cannot be determined from accident statistics. Various overseas authors have described the occurrence of true hydroplaning as "very infrequent" (Allbert, 1968) and "not a major cause of *skidding* accidents" (Sabey 1973). One problem is that expert investigators need to attend the accident scene very promptly in order to establish whether conditions were conducive to hydroplaning. On the other hand, caution needs to be exercised with police reports of "hydroplaning" because the effects of low friction due to a mixture of oil and water on the road surface can be mistaken for hydroplaning.

For the purpose of gauging the magnitude of the problem of hydroplaning in NSW, and in the absence of any reliable estimates of the number of accidents involving hydroplaning , assume that one quarter of all the "wet road skidding accidents" in NSW involved hydroplaning. On this basis, which is likely to be an over-estimate, 0.5% of all passenger car accidents involved hydroplaning. A 13% increase in "hydroplaning" accidents due to the effects of wide wheels/tyres would therefore result in an overall increase of 0.07% in all accidents involving cars fitted with wide wheels/tyres (assuming their "exposure" to accidents is the same as the whole passenger car population).

RTA Requirements

The NSW Roads and Traffic Authority has published its requirements for non-standard wheels and tyres in Vehicle Standards Information sheet 9 *Guidelines for alternative wheels and tyres* (see Appendix B). In brief, the NSW requirements are:

- wheel track must not be increased by more than 25mm beyond the maximum specified by the vehicle manufacturer.
- rim width not more than 26mm wider than the widest optional rim recommended by the vehicle manufacturer (usually displayed on the tyre and rim placard) - may be exceeded with engineering report (see below)
- rim width not less than narrowest optional rim.
- outside tyre diameter not more than 15mm larger than largest option nor less than 15mm smaller than smallest option - may be exceeded with engineering report (see below).

- wheels and tyres must be contained within the body work when steering is straight ahead.
- wheels and tyres must not foul any part of the suspension or body under all operating conditions [note: in practice this can be very difficult to check because it can take substantial forces to move the suspension into its extreme positions; RTA officers generally look for signs of rubbing]

Requirements also cover wheel nuts, tyre ratings, mixing tyre types and retreads.

The rim width and tyre outside diameter limits may be exceeded if an engineering certificate is obtained by the vehicle owner. In these cases the RTA has specified further limits including that the certified rim width increases must not exceed those specified for the RTA based on vehicle tare weight. In effect a vehicle with a tare weight not more than 800kg is restricted to the usual 26mm limit, as are front-wheel-drive vehicles.

Meeting with RTA Officers

The section of the RTA document which deals with engineering certificates includes the use of the phrase "except where the original manufacturer provides to the contrary". Clarification was sought from the Manager, Vehicle Standards, Mr Bruce Dowdell about the meaning of this phrase. The nature of the current project and any possible changes to NSW or national requirements were also discussed.

Mr Dowdell stated that the above phrase was only intended to apply more stringent requirements than those set out in the document. Subsequent discussions with Mr Montano from the RTA Vehicle Standards revealed that this only applied to modifications covered by engineering certificates. It does not apply to rim widths up to 26mm wider than the widest option, even in the case of front wheels on front-wheel-drive vehicles. For example, if a vehicle manufacturer issued a letter or service bulletin which stated that its front-wheel-drive vehicles should not be fitted with any rim which is wider than the widest optional rim then the RTA would *not* apply this manufacturer's limit, provided the rim width was within the general 26mm limit for minor modifications. Note that the RTA document effectively prohibits the issue of engineering certificates for front wheels which are more than 26mm wider than the widest optional rim. Mr Montano said that the wording of the document would be amended to clarify this matter.

Moves are currently underway to develop a national code for light vehicle modifications under the co-ordination of the Federal Office of Road Safety. Mr Dowdell stated that the national code will be based mainly on the NSW requirements and that these are unlikely to change.

Discussion and Recommendations

Accident Risk

There is an absence of research information which provides a reliable indication of the effects of fitting wide wheels and tyres on risk of involvement in an accident. Indirect methods have therefore been employed to gain an indication of the possible effects. These indirect methods suggest that the effects are negligible and, in any case, tend to cancel one another out:

- wide wheels and tyres generally provide improve "grip" under all road conditions except where there is a heavy build up of water on the road (hydroplaning conditions). The best improvement that could be expected is an 0.13% *reduction* in the overall number of accidents for vehicles fitted with wheels/tyres 1" wider than standard due to improved grip.
- wide wheels and tyres have a higher propensity to hydroplane. However, the conditions for hydroplaning are very rarely encountered and a conservative estimate is an 0.07% *increase* in the overall number of accidents for vehicles fitted with wheels/tyres 1" wider than standard due to increased propensity for hydroplaning.

These estimates assume that all other factors, including risk-taking by drivers, are the same. It has been suggested that persons who fit wider wheels and tyres to their vehicles are more likely to be at risk by pushing their vehicles closer to handling limits. If this is the case then the wide wheels and tyres are an *indicator* of increased risk rather the *cause* of increased risk..

Modification Limits

The current limits for rim widths set out in the NRMA Motor Vehicle Insurance Manual are generally more stringent than those prescribed by the RTA. For example the RTA permits front-wheel-drive vehicles to have rim widths up to 26mm wider than the *widest option* provided by the manufacturer but the NRMA only allows a $^{1}/_{2}$" (12.5mm) increase beyond the *standard* rim. From an administrative and customer relations viewpoint there are advantages in moving into line with the RTA requirements, particularly since they are likely to be adopted at a national level.

In effect there are two levels to the RTA requirements: "minor changes" such as rim-width increases up to 26mm can be performed without the need for an engineering certificate. Beyond these limits an engineering certificate is required. The vast majority of persons seeking insurance for vehicles with wide wheels and tyres would satisfy the RTA's minor changes category. In view of the negligible effect on accident risk due to these wide wheels and tyres it is considered that they should not be refused insurance and that there is no direct case for applying a higher insurance category.

The cases for which the RTA requires an engineering certificate are more extreme. For example an engineer may certify a large vehicle (tare over 1200kg) with a wheel rim which is up to 51mm wider than standard. To a degree the RTA is relying on the engineer to assume responsibility for the safe design and performance of the vehicle. This relates more to catastrophic failures rather than subtle effects which might increase the risk of an accident. In the circumstances, it is considered that cases where the RTA requires an engineering certificate should be regarded as a higher insurance risk. *All other factors being equal*, the increased risk of an accident due to the fitting of wide wheels and tyres within the limits prescribed by the RTA for engineering certificates should still be well under 1% and therefore it is unlikely to provide grounds for refusing insurance.

Recommendations

On the basis of investigations described in this report the following recommendations are made:

1. The NRMA should accept for insurance vehicles which meet the RTA guidelines for wheel/tyre modifications not requiring an engineering certificate
2. The NRMA could accept for insurance vehicles which require an engineering certificate due to wheel/tyre modifications but consideration should be given to increasing the category of insurance for these vehicles.

In accepting these vehicles for insurance, other factors which affect insurance risk should be closely monitored because these recommendations are made on the basis that factors such as risk-taking by drivers are the same for vehicles with and without wide wheels/tyres or are otherwise accounted for in determining insurance risk.

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Mike Adams - accident statistics

Bruce Dowdell & Jorge Montano - vehicle standards

References

Allbert B.J. 1968 *Tires and Hydroplaning,* SAE Paper 680140, Automotive Engineering Congress, January 1968.

Blamer G.G. & Gallaway R.M. 1983 *Hydroplaning - how to reduce it,* Public Roads Vol.47 No.1, June 1983.

Ducane P. 1962 *The following sea - broaching & surging* Trans Royal Institute of Naval Architects, Vol 104 April 1962.

Gillespie T. 1992, *Fundamentals of vehicle dynamics*, Society of Automotive Engineers, Warrendale.

I.I.H.S. 1995 *Antilock brakes aren't reducing crashes or crash costs,* Status Report Vol.30 No.2, Insurance Institute for Highway Safety, Arlington USA, February 1995.

Irving J.S. 1950, *Automobile Engineering - steering gear, shafts and universals,* New Era Publishing Co., London (undated, circa 1950).

NRMA 1991 *Review of Vehicle Defects, Accidents & Safety Inspection Systems,* NRMA Chief Engineer's Department , Discussion paper, Sydney (undated).

NRMA 1995, Motor Vehicle Insurance Manual (extract).

Paine M.P. 1994 *Contribution of Vehicle Defects to Crashes: Literature & Research Review,* Vehicle Design and Research Pty Limited, Report G174 prepared for National Road Transport Commission, Melbourne, June 1994.

Paine M.P. 1995 *National Guidelines for Assessment of Defective Vehicles,* Vehicle Design and Research Pty Limited, Report G187 prepared for Austroads, Sydney, June 1995.

Roads & Traffic Authority of NSW 1994, Guidelines for alternative wheels and tyres, Vehicle Standards Information Sheet 9, October 1994.

S.W.O.V. 1973 *Skidding Accidents,* Institute for Road Safety Research (SWOV), Voorburg, Netherlands.

Sabey B. 1973 *Accidents: Their cost and relation to surface characteristics,* Symposium on Safety and the concrete road surface - design, specification and construction, Cement & Concrete Association, Birmingham November 1973.

Sandberg U. 1976 *Tire Dimensions; Properties of Wide and Low versus Narrow and High Tires*, VTI Rapport NR108A, National Roads &Traffic Research Institute, Sweden.

Staughton G.C. & Williams T. 1970 *Tyre performance in wet surface conditions,* RRL Report LR355, Road Research Laboratory, Crowthorne UK.

Treat J.R. & Stansifer R.L. 1977 *Vehicular Problems as Accidents causes - an Overview of Available Information,* SAE Paper 770117, International Automotive Engineering Congress & Exposition, February 1977.

Treat J.R. 1974 *Tri-level Study of the Causes of Traffic Accidents Vol.II: Potential Benefits of Radar Warning, Radar Actuated, and Anti-lock Braking Systems in Preventing Accidents and Reducing Their Severity*. Indiana University Institute for Research in Public Safety, December 1974.

Appendix A

NSW Accident Statistics

These are based on Police reports. They cover accidents where the "key" vehicle was a passenger car or derivative and skidding was noted in the Police description of the accident.

	Degree of accident				
Conditions	**Fatal**	**Serious Injury**	**Other Injury**	**Non-casualty**	**Total**
1994					
Skidding on wet road	6	49	167	513	735
Skidding on dry road	8	66	153	355	582
All accidents	383	3730	11257	27155	42525
1993					
Skidding on wet road	5	55	181	556	797
Skidding on dry road	6	65	146	324	541
All accidents	356	3806	11003	26950	42115
1992					
Skidding on wet road	5	76	194	630	905
Skidding on dry road	6	63	150	331	550
All accidents	419	3714	10829	27018	41980

Appendix B

RTA Vehicle Standards Information No. 9

Guidelines for Alternative Wheels and Tyres