THE PARLIAMENT OF THE COMMONWEALTH OF AUSTRALIA

# TYRE SAFETY

REPORT OF THE HOUSE OF REPRESENTATIVES
STANDING COMMITTEE ON ROAD SAFETY
JUNE 1980

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* Mr Mutton replaced Mr F.R. Hinkley as Clerk to the Committee on 7 January 1980.

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## MAJOR CONCLUSIONS AND RECOMMENDATIONS

### MAJOR CONCLUSIONS

The Committee concludes that:

- specifications in Australian Design Rule 23 to limit dimensional variations in tyres are adequate. (para. 37).

- at best, only marginal benefits for road safety, and even for consumers generally, would result from the introduction of a uniform tyre quality grading system along the lines of the United States system. (para. 73).

- radial ply tyres, especially steel-belted radials, almost certainly achieve higher standards of performance in most respects than other types of tyre construction. (para. 96).

- shallow tread depth significantly detracts from tyre and, therefore, vehicle performance in wet conditions and significantly increases risk of accident at a depth of less than 3mm, and especially less than 1.5mm. (para. 112).

- inflation pressure is an important operational factor in determining tyre performance. It may even be an operating factor of the same order of importance as tread depth. (para. 120).

- there is not always adequate warning of tyre failure to permit drivers to avoid danger. (para. 141).

- shortcomings in tyre design and manufacture contributed towards a significant rate of separation failure in steel-belted radials in the early years of production in Australia but the magnitude of the problem was not as great as that of the Firestone '500' steel-belted radial in the United States. The Australian tyre manufacturers responded to the design and manufacturing problems when they became evident and major reductions in separation failures have occurred over the last three years. The majority of the design and manufacturing problems appear to have been overcome and improvements are continuing to be made. Non-uniformity was not found to be a contributory factor in tyre failure. (para. 149).

- some driving conditions in Australia clearly placed unexpectedly high demands on tyres. It is equally clear that, despite their access to overseas technology and expertise, Australian manufacturers had to undergo a learning phase in manufacturing processes. Market forces and perhaps public pressure have ensured that improvements have been made progressively. (para. 150).

- one Australian tyre manufacturer acted irresponsibly in not recalling tyres produced in the initial stages of its steel-belted radial production which, the manufacturer knew, were failing at an unacceptably high rate and were thus placing many people at risk. (para. 157).

- on the evidence available, steel-belted radials are no more susceptible to failure due to underinflation than textile radial or bias ply tyres. (para. 172).

- the incidence of underinflation of tyres in relation to vehicle manufacturers' tyre pressure recommendations is serious a cause for concern. The available evidence does not however help to establish the incidence of underinflation in relation to the recommendations of the Tyre and Rim Association which are the appropriate basis for assessing the margin of safety in tyres. (para. 178).

- while the Australian tyre manufacturers have attempted to educate the public on the importance of tyre inflation pressures their approach has not been sufficiently broadly based and generally has not been sufficiently aggressive. (para. 185).

- a strong case has been made for the need to educate the public on the maintenance of tyres, especially on the importance of correct inflation pressures. (para. 185).

- the limited available evidence suggests that tyres are a causative factor in only a relatively small proportion of accidents in Australia, although they may be more significant in rural than urban crashes, especially of motorcycles. However, the available data are so inadequate that these conclusions can only be regarded as tentative. The suspicion lingers that tyres may play a more important role in accidents than existing data generally suggest. (para. 225).

## RECOMMENDATIONS

The Committee recommends that:

- the Office of Road Safety follow closely the current review of United States Motor Vehicle Safety Standard No. 109. (para. 23).

- Australian Design Rule 23 be amended to raise its high speed performance requirements to those specified in ECE Regulation 30. (para. 28).

- the Office of Road Safety investigate the need to provide for testing of tyres under conditions of side force. (para. 32).

- the Australian Transport Advisory Council amend Draft Regulations to permit substitution of tyres of equivalent performance and load carrying capacity for those nominated on vehicle placards. (para. 35).

- the Australian Transport Advisory Council amend Australian Design Rule 23 to require that tyre manufacturers mark their tyres with the date of manufacture in a form easily understood by the consumer. (para. 43).

- the Office of Road Safety review current overseas research on testing of safety rims to determine whether and, if so, how rims can be required by regulation to retain deflated tyres under side force. (para. 46).

- the spare tyre be included in the vehicle certification process and, further, that temporary spare tyres be considered for adoption in Australian Design Rules only if it is established that they meet adequate safety requirements and that their sensitivity to misuse is within acceptable limits. (para. 52).

- replacement tyres be required by regulatory action under the Trade Practices Act to comply with standards set down in Australian Design Rules and that enforcement be at the point of sale. (para. 57).

- the Office of Road Safety investigate the costs and benefits of establishing an independent tyre testing facility or utilising existing overseas testing facilities. (para. 81).

- the Office of Road Safety review the significance of tyre tread depth in the causation of motor vehicle accidents as a basis for review of legal minimum tyre tread depths. (para. 113).

- the Minister for Transport raise with Australian Transport Advisory Council Ministers the urgent necessity of adopting a minimum legal tyre tread depth of at least 1.5mm in all States and Territories. (para. 113).

- the Publicity Advisory Committee on Education in Road Safety (PACERS) investigate effective means of making available to motorcycle riders information on the matching of tyres, rims and machines and on motorcycle tyre performance. (para. 123).

- effective visual inspection of tyres be carried out regularly by tyre outlets and by service stations. (para. 143).

- the Office of Road Safety investigate the known techniques for designing tyres to improve the warning of separation with a view to possible amendment of Australian Design Rules. (para. 143).

- within two years, the Office of Road Safety again investigate the incidence of premature tyre failure. (para. 152).

- the Office of Road Safety confer with interested parties in order to obtain their agreement to include in all education material for the general public only the vehicle manufacturers' tyre pressure recommendations. (para. 169).

- the Office of Road Safety determine the degree of tolerance of steel and textile radial and bias ply tyres to persistent underinflation with a view to determining conclusively whether the tolerance is adequate and to amending Australian Design Rule 23 to incorporate more suitable testing for tyres operating under abuse of incorrect inflation. (para. 174).

- the Office of Road Safety undertake a survey of in-service tyre inflation pressures to determine the incidence of underinflation, in relation to the recommendations of the Tyre and Rim Association, with a view to determining ultimately whether tyre designs and manufacturing standards take sufficient account of 'normal' levels of consumer abuse. (para. 179).

- the Publicity Advisory Committee on Education in Road Safety (PACERS) assist tyre manufacturers and importers in developing a model for a broad-based campaign to educate the public on the importance of tyre maintenance, especially of correct tyre pressures. (para. 189).

- the burden of responsibility for funding and implementing the campaign lie with tyre manufacturers and importers, and the Department of Transport monitor the campaign with a view to advising the Government on the need for regulatory action should the efforts voluntarily undertaken be inadequate. (para. 189).

- the Department of Business and Consumer Affairs consult with its State and Territory counterparts with a view to the initiation of regulatory action at those levels to require that service stations and tyre dealers keep accurate tyre pressure gauges and that gauges be checked regularly by authorities responsible for weights and measures. (para. 193).

- facilities for checking the accuracy of personal tyre pressure gauges be made available in Departments of Weights and Measures, or their equivalents, and on the premises of the Australian pressure gauge manufacturers and that availability of the service at those points should be made known to consumers at the point of sale. (para. 196).

- the Australian Transport Advisory Council introduce into the Australian Design Rules a requirement that all new passenger cars and similar vehicles be fitted with monitoring and warning devices which will acquaint the drivers of these vehicles with a hazardous loss of inflation pressure in any tyre, including the spare tyre. (para. 199).

- the Australian Transport Advisory Council amend Draft Regulations to provide that it should be unlawful for a vehicle to be operated with tyre pressures below those recommended by the vehicle manufacturer for normal operating conditions. (para. 202).

- Australian Standard specification AS 1973-1976 (Retreaded Pneumatic Passenger Car Tyres) be amended to provide for specific maximum speed marking, that the specification be adopted as a mandatory standard under the Trade Practices Act, and that it be enforced at point of sale. (para. 207).

- the Office of Road Safety investigate flat ledge rims to determine whether they can safely retain tubeless tyres. (para. 212).

- future in-depth accident studies continue to attempt to determine the role of tyres in accident causation. (para. 226).

- the Department of Employment and Youth Affairs hold discussions with State and Territory technical education authorities and representatives of the tyre retailing and retreading industries with a view to implementation of training courses for employees in those industries. (para. 230).

- the Government introduce legislation to empower the Minister for Business and Consumer Affairs to require the recall of defective or unsafe products, such as tyres, and that the legislation place the onus on manufacturers to inform the Minister of any production batches in which an unacceptable proportion of products is found to be defective or unsafe. (para. 240).

## ABBREVIATIONS

| | | |
|---|---|---|
| * | ACSVD | Advisory Committee on Safety in Vehicle Design |
| * | ACVP | Advisory Committee on Vehicle Performance |
| | ADR | Australian Design Rule |
| ** | ATAC | Australian Transport Advisory Council |
| | km/h | kilometres per hour |
| | kPa | kilopascals |
| | mph | miles per hour |
| | NRMA | National Roads and Motorists' Association |
| | Office of Road Safety | Office of Road Safety, Department of Transport |
| * | PACERS | Publicity Advisory Committee on Education in Road Safety |
| | psi | pounds per square inch |
| | RACV | Royal Automobile Club of Victoria |
| | RoSTA | Road Safety and Traffic Authority (Victoria) |
| | SAA | Standards Association of Australia |
| | Territories | Australian Capital Territory and the Northern Territory |

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* Each of these committees is a subsidiary committee of the Australian Transport Advisory Council.

** The Australian Transport Advisory Council is a co-ordinating and advisory committee at Ministerial level. It provides a forum at which federal and State governments attempt to maintain uniformity of approach towards transport administrative procedures and policy.

## INTRODUCTION

This inquiry grew out of the Committee's concern at controversy regarding the safety of steel-belted radial tyres for passenger cars. The controversy developed in Australia in late 1978 following publication of a United States congressional sub-committee report on the safety of 'Firestone 500' steel-belted radial tyres.[1]

The congressional sub-committee concluded that these tyres presented an unquestionable risk of continuing accidents, injuries and deaths to the motoring public and directly attributed thirty-four deaths to failure of this one brand and design of tyre. Between 1972 and 1978 Firestone replaced some 4.1m tyres, representing 17.5% of production in that period.[2]

Although 'Firestone 500' tyres had not been imported into Australia the Committee was concerned at increasing public attention given to failures of steel-belted radial tyres here. It therefore decided in May 1979 to conduct an inquiry to determine whether such tyres pose a threat to public safety in Australia.

The evidence submitted to the Committee concentrated largely on this issue but the inquiry was broader. It covered: tyres used on passenger cars, motorcycles, trucks and buses; various tyre constructions, notably radial, bias ply and retreaded tyres; tyre performance characteristics; the reasons for and effects of various forms of tyre disablement and failure; the involvement of tyre failure in accidents; and the scope for corrective action.

Details of the manner in which the inquiry was conducted are at Appendix I.

The Committee records its appreciation of the assistance provided by the many individuals and organisations who lodged submissions and who gave oral evidence at hearings and to those companies which invited the Committee to inspect their operations. The Committee is especially indebted to its three specialist advisers: Mr Lloyd Austin (retired, formerly a senior technical manager with an Australian tyre manufacturer), Mr Michael Rice (Principal Engineer, Department of Transport), and Dr Peter Sweatman (Senior Research Scientist, Australian Road Research Board).

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1 United States of America. House of Representatives, The Safety of Firestone '500' Steel-Belted Radial Tyres, Report by the Sub-committee on Oversight and Investigations of the Committee on Interstate and Foreign Commerce, August 1978.

2 United States Congressional Sub-committee Report, p. 18.

# CHAPTER 1

# TYRES

## The Tyre Market

### - Manufacturers

1. There are four tyre manufacturers in Australia: Dunlop, Goodyear, Olympic and Uniroyal. All but Olympic are financially affiliated with overseas tyre companies.[3] Olympic is wholly Australian but has technical agreements with overseas companies. The market is also supplied by many imported brands.

### - Passenger Car Tyres[4]

2. Passenger car tyres account for 84% of the total tyre market (by quantity). The market comprises the original equipment (OE) sector (tyres supplied to vehicle manufacturers for new cars), and the replacement sector. Replacement sales constituted about 78% of car tyre sales in the three years ending 1977-78.

3. There has been a strong trend from bias ply to radial tyres over the last twenty years, and to steel-belted radials in recent years. The original equipment radial tyre market increased by over 50% from 1975-76 (1.19m tyres) to 1977-78. In the same period radials' share of the replacement market increased by 19%. This trend is continuing. Sales of steel-belted radials manufactured in Australia are estimated to have increased from 1.46m tyres in 1975-76 to 3.93m in 1978-79 when locally manufactured tyres captured 76.5% of the market for steel-belted radial passenger car tyres. Sales of Australian-made textile radials declined by almost 30% in that period to 1.36m tyres as a result of market acceptance of steel-belted radials. For further details see Appendix 2.

4. Passenger car tyres are retailed mainly through chains of outlets owned by some tyre manufacturers, a multiplicity of independently owned tyre retailers, service stations and some stores handling general merchandise where technical advice may not always be available.

- Motorcycle Tyres

5. All motorcycle tyres are imported, mainly from Japan but also from Europe and the United States. They are usually of bias ply construction. Tyres are available in a wide range of tread patterns designed for front and/or rear wheel fitment and are classified for highway use, off-the-road, rallying or racing. Tubeless tyres have been introduced recently, increasing quite rapidly, a trend which will probably continue.[5]

- Truck and Bus Tyres

6. All four Australian manufacturers produce truck and bus tyres. In 1977-78 they enjoyed about 60% of the total truck and bus tyre market. There is a trend towards steel radials which are already produced by three local manufacturers and will soon be produced by the fourth. The steel-belted radial market is still generally dominated by imports (Appendix 2).

- Re-conditioned Tyres

7. About 300 retread factories in Australia produce over four million retreaded tyres per year. The relative importance of retreads for passenger cars has been diminishing for some years. Approximately one-third of retreads produced in Australia are manufactured by subsidiaries of the tyre manufacturing companies and the remainder by independently financed commercial operations.[6]

8. For economic reasons retreaded and regrooved tyres are more significant in commercial use, such as on commercial vehicles, taxi fleets, trucks and buses than in the passenger car tyre market. Truck operators expect at least one retreading for each new tyre and often retain their own tyre carcasses for retreading.

## Types of Tyres

### - Tyre Construction

9. The component parts of a tyre are described in Figure 1. The major components are the tread, carcass, beads and belts.

10. Road tyres in general use are either bias ply (cross ply) or radial ply, each of which may be tubed or tubeless. Much of the evidence concentrated on the differences between these types of construction. The following descriptions are generally applicable to passenger car, motorcycle and truck tyres.

11. Bias ply or cross ply tyres (Figure 2) have a carcass with two or more plies in which the cords cross the tread centre line at an angle between $30^{o}$ and $40^{o}$. The tyre has no belt but may have one or two breakers. Radial ply tyres (Figure 3) have a carcass with one or more plies with cords at or near $90^{o}$ to the tread centreline and extending to the beads, on which is fitted a belt made with two or more plies. Bias-belted tyres were a compromise between bias and radial ply tyres and are no longer produced by Australian manufacturers. They had a carcass with two or more plies at a given angle around $30^{o}$ to $40^{o}$ to the centre line, on which was fitted a belt generally made with two plies at $30^{o}$ to $35^{o}$.

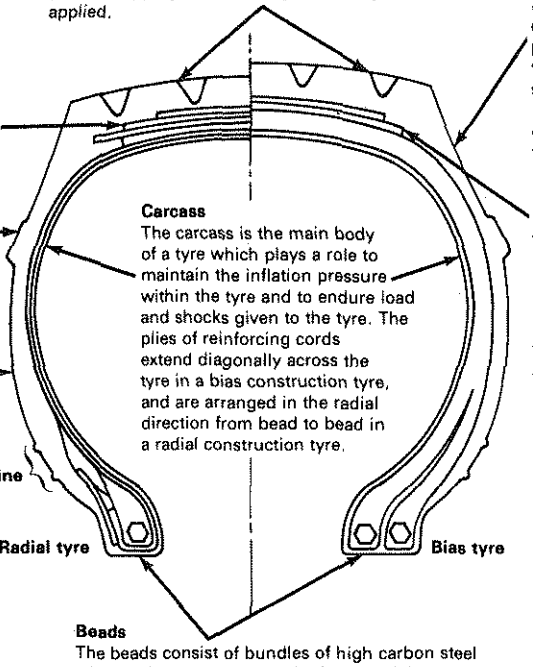
12. Tubed tyres require an inner tube to contain the inflation medium, usually air. Tubeless tyres incorporate an inner liner, usually a butyl type rubber compound, as an integral part of the tyre's construction and the tyre in conjunction with the rim contains the air.

## FIGURE 1 TYRE STRUCTURE

**Tread**
The tread is the outer cover of a tyre that bears on a road and serves to protect the carcass from *damage as well as to resist wear and cuts. Tread* patterns which differ according to the specific application are provided on its surface to perform such functions as to provide sufficient traction on a wet road surface by discharging water or to prevent slipping when driving or braking force is *applied.*

**Belts**
*Belts are reinforcing tyre cord* materials placed between the tread and the carcass in the circumferential direction in a radial or bias construction tyre and function to tighten the carcass firmly so as to enhance the lateral stiffness of the tread.

**Shoulders**
The shoulders are sometimes *referred to as "buttresses" and* consist of thick rubber. Their primary function is to protect the carcass from damage. The shoulders are designed to have void areas, just as the grooves in the tread, to facilitate dissipation of heat.




**Carcass**
The carcass is the main body of a tyre which plays a role to maintain the inflation pressure within the tyre and to endure load and shocks given to the tyre. The plies of reinforcing cords extend diagonally across the tyre in a bias construction tyre, and are arranged in the radial direction from bead to bead in a radial construction tyre.

**Breakers**
*The breakers in a bias ply tyre* are placed between the tread and the carcass to absorb shocks to the carcass and to prevent separation of the tread from the carcass. (Note: There are some types of bias ply tyres for passenger cars which do not incorporate breakers.)

**Sidewalls**
The sidewalls are the portions of a tyre contour which do not directly contact the ground *when a vehicle runs and serve* to protect the carcass. Of all the components of a tyre, the sidewalls are the parts which are subjected to the most severe flexture. For this reason, they are sometimes referred to as 'flex areas'. Information such as the name of a manufacturer, etc. are shown on these parts.

**Beads**
The beads consist of bundles of high carbon steel wires and serve to support both ends of the carcass cords, to anchor the plies and to hold the tyre assembly on the rim. Normally, the beads are designed with a certain interference provided against the diameter of the rim so that the beads may fit on the rim wheel closely when the tyre is inflated.

**Source:** Submission by Bridgestone Tyre Co. Ltd.

- Tread Patterns

13. There are many tread patterns designed for the varying types of vehicle operation. The variations affect particular tyre performance characteristics in general use and may also cater for special conditions such as usage in mud and snow or off the road.

- Reconditioned Tyres

14. Worn tyres assessed as being free of structural defects may be used again after retreading, that is, after moulding a new tread onto the worn tyre carcass. Retreaded tyres are usually less expensive than new tyres but generally have a shorter life.[7] They may provide cost savings to users, especially of commercial vehicles. The retreading process consumes only 20% to 25% of the petroleum contained in a new tyre and therefore offers benefits in resource conservation. The need for future tyre developments to improve the retreadability of tyres, as a resource conservation measure, was raised by some tyre manufacturers. Retreads also reduce the serious waste management problems of tyre carcass disposal.

15. There are at least five variations in the process of tyre retreading. The 'hot capping' process holds more than 80% of the total Australian retread market, and about 95% of the passenger car market.[8] The bulk of the remainder of the market is taken by pre-cured tread processes, involving pressure chambers (with lower temperatures) or diaphragms, which are used predominantly for truck and bus tyres.

16. Retreading extends the in-service life of tyre carcasses. Because carcasses deteriorate through even normal usage they have a limited life. A vital part of the retreading process is therefore the inspection and selection of carcasses to ensure that only carcasses free of structural defects are accepted for retreading. Ultra-sonic systems for detecting damage have been developed, but no commercially acceptable system currently exists.[9]

**FIGURE 2 BIAS PLY TYRE**

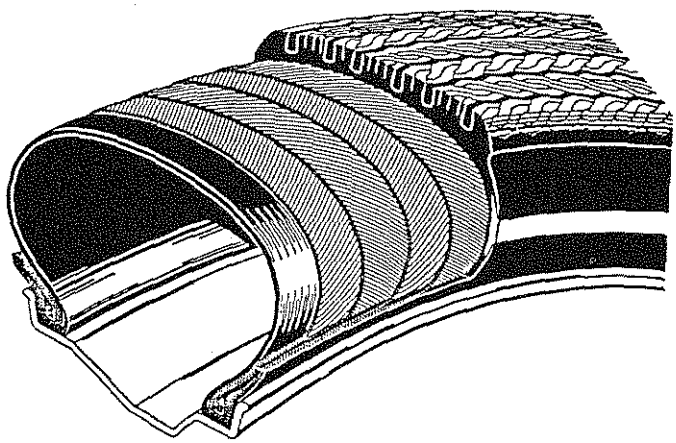
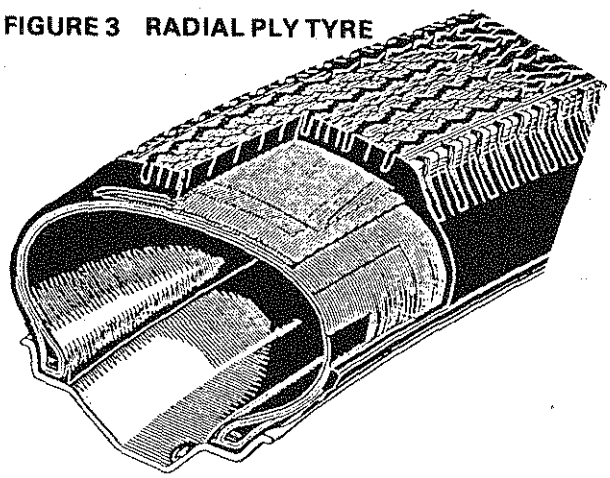


**FIGURE 3 RADIAL PLY TYRE**



*Source:* Submission by Australian Tyre Manufacturers' Association.

17. Regrooving of tyres is illegal except when the tyre is especially constructed for this purpose. Tyres designed for use on slower suburban buses are marked 'regroovable' or 'PT', public transport. These tyres have additional rubber under the tread pattern to permit regrooving without damage to the carcass.

## The Manufacturing Process

18. A detailed description of the processes involved in the manufacture of new tyres is not essential to an understanding of this report or of the issues raised in the inquiry. Some aspects of these processes nevertheless warrant comment:

- manufacture of radial tyres is more complex and requires closer tolerances on specification requirements than does manufacture of bias ply tyres;[10]

- assembly of the component parts into an integral whole, 'tyre building', is a highly skilled and essentially manual operation the equipment used by different manufacturers making varying demands on these manual skills;

- the 'building' operation for bias ply and radial ply tyres differs significantly;

- temperature and humidity must be strictly controlled when steel corded material for belts is being prepared to ensure satisfactory adhesion between the rubber carcass compound and the steel cord in the final tyre;[11]

- steel belts in radial tyres are inspected on a sampling basis on a television screen using an X-ray sensor.

3 Dunlop has recently made a take-over offer for the shares of Olmpic. The matter has not yet been resolved (as at 13 June 1980).

4 Unless otherwise indicated tyre market statistics up to 1977-78 are extracted from: Tyres, Tyre Cases etc., Industries Assistance Commission Report, Canberra 1979. Statistics for 1978-79 are at Appendix 2.

5 For example, evidence pp. 1844-5.

6 Evidence, p. 1116.

7 One retread company claimed its process, which has a significant share of the truck and bus tyre markets, produces a retreaded tyre with wear and performance characteristics equal to, or even superior to , those of the original tyre. Evidence, p. 266.

8 Evidence, p. 247-8.

9 Evidence, p. 287.

10 Evidence, pp. 1059 and 1881.

11 Evidence, p. 1051.

## CHAPTER 2

## TYRE STANDARDS

### Design Rules for New Passenger Car Tyres

#### - Existing Design Rules

19. Tyres fitted to new passenger cars and similar vehicles are required to comply with Australian Design Rule 23 (ADR 23) - 'New Pneumatic Passenger Car Tyres' and with ADR 24 - 'Tyre Selection'. ADR 23 has been applied to new vehicles manufactured since 1 January 1974 and ADR 24 since 1 January 1973.

20. The compliance of new vehicles with the applicable Design Rules is certified by the Australian Motor Vehicle Certification Board. The certification process requires the submission of detailed test reports and descriptive information which demonstrate compliance of the tyres and the vehicle with each relevant Design Rule. Normally ADR 23 testing is carried out by the tyre manufacturers. ADR 24 is an 'application' rule which does not involve testing of the tyre.

21. ADR 23 specifies tyre performance standards of strength, tyre endurance, high speed performance and resistance to bead unseating. In addition, physical dimensions of each tyre size together with its pressure/load relationship are detailed and permitted tyre size/rim size combinations are listed. Tests are prescribed to establish compliance with these requirements. (For further detail see Appendix 3).

22. ADR 23 is largely based on the United States Federal Motor Vehicle Safety Standard No 109 (FMVSS 109). This standard is currently under review by United States authorities.

23. **It is strongly recommended that:**

- **the Office of Road Safety follow closely the current review of United States Motor Vehicle Safety Standard No 109.**

24. The Standards Association of Australia Specification D31 - 1973, which is not mandatory, contains specifications and specified minimum values identical with those of ADR 23. A draft revision is being prepared by the Association.

25. ADR 24 covers the selection of tyres and rims for each vehicle and ensures that the tyre size and rim size are compatible and that the tyre has adequate load carrying capacity and speed capability. The Rule also requires that a placard be permanently fixed to the vehicle. The information on the placard specifies the recommended tyre/rim fitments, required maximum tyre load capacity and speed performance rating, and minimum tyre inflation pressure for given vehicle operating conditions for each tyre size and rim size fitted as standard or optional original equipment to the vehicle. (For further details see Appendix 3.) ADR 24 has some similarities to the United States Federal Motor Vehicle Safety Standard No. 110 (FMVSS110).

- <u>High Speed Performance Test</u>

26. ADR 23 requires high speed testing on a test wheel at speeds of 75, 80 and 85 mph (about 121, 129 and 137 km/h) under prescribed loading conditions. Local manufacturers voluntarily test their tyres to higher standards. The Committee agrees that the test needs to be upgraded. This upgraded test would also provide some guide to a tyre's temperature resistance (see p. 23).

27. The European test set down in ECE Regulation 30 requires that the tyre undergo endurance testing up to within 10 km/h of the prescribed maximum speed for which the tyre is to be rated[12]. Incorporation of this more demanding test, which was recommended by the Australian Tyre Manufacturers Association (ATMA), would produce no significant difficulties for overseas tyre manufacturers wanting to export to Australia.

28. It is recommended that:

. **Australian Design Rule 23 be amended to raise its high speed performance requirements to those specified in ECE Regulation 30.**

29. The Advisory Committee on Safety in Vehicle Design (ACSVD) has such a proposal under consideration.

- Test Under Conditions of Abuse

30. Tyre endurance is diminished, sometimes to the point of catastrophic failure, by in-service abuse. The major forms of abuse are failure to maintain correct inflation pressures and overloading. The adequacy of ADR 23 as a test of endurance under conditions of abuse may need to be investigated. This is discussed in Chapter 4.

- Side Forces

31. Dr P. Sweatman of the Australian Road Research Board indicated that ADR 23 requires only tests with forces acting vertically. No tests include side forces of the kind produced by cornering. He suggested such tests should be adopted [13]. Not enough evidence was put to the Committee to enable it to determine conclusively the need for such testing. The proposal nevertheless warrants attention.

32. It is therefore recommended that:

. the Office of Road Safety investigate the need to provide for testing of tyres under conditions of side force.

- Tyre Sizes and Dimensions

33. ADR 24 requires that the vehicle placard state the rim profiles nominated for the vehicle together with the corresponding recommended tyre size designations. Some States require that all vehicles, not only new ones, which carry an ADR 24 placard conform with the tyre and rim specifications recorded on it. However, since 1973 when the rule became operational some nominated tyre sizes have become obsolete and are no longer readily available. Motorists who fit tyres not shown on the placard could face difficulties with traffic authorities and insurance companies. Some motorists could not legally fit steel-belted radials to their cars.

34. Tyre manufacturers proposed that the Design Rules permit tyres of equal performance and load carrying capacity to be substituted for tyres nominated on vehicle placards. Under existing circumstances manufacturers are morally obliged to produce obsolete tyre sizes for which there is little demand. It is of course inappropriate for regulations to require fitment of tyres which are not only of obsolete size but also of obsolete design.

35. It is therefore recommended that:

. the Australian Transport Advisory Council amend Draft Regulations to permit substitution of tyres of equivalent performance and load carrying capacity for those nominated on vehicle placards.

36. Some witnesses expressed concern that variations exist in the dimensions, especially the overall diameter, of tyres produced to the same nominal size by different manufacturers. ADR 23 places no specific upper limitation on the overall diameter of tyres. However, by requiring that section width not exceed that nominated in ADR 23 tables by more than 7% and prescribing that the size factor must not be less than that designated in the tables, a minimum limit is indirectly imposed [14].

37. The Department of Transport advised the Committee that complaints on dimensional variation brought to its attention concerned variations of about the magnitude permitted by existing standards. The complaints therefore relate to standards rather than non-compliance. The Department summarised its position as follows:

> 'If rigid dimensional tolerances were imposed, considerable restriction would be placed on the engineer's choice of materials and internal construction configuration for the tyres he designs. Additionally, the design and development task would become considerably more difficult and expensive. There are no indications that the variability permitted between different tyre designs of the same nominal size creates significant problems for the designers or operators of passenger cars. Consequently, it is difficult to justify the imposition of more restrictive dimensional tolerances in tyre safety standards.' [15]

None of the evidence submitted provides any ground for questioning the validity of this view. It is therefore concluded that specifications in ADR 23 to limit dimensional variations in tyres are adequate.

- Non-uniformity

38. Several witnesses called for design rules to specify limits to non-uniformity of tyres. It was alleged that non-uniformity represents both a safety hazard and a source of discomfort. These issues are discussed in Chapter 4.

- Date of Manufacture

39. Most, if not all, tyre manufacturers mark each tyre with a code indicating date of manufacture of the tyre. This code is intended only for the manufacturer's own use and is not made known either to tyre dealers or consumers. Some witnesses suggested that the date of manufacture or a readily understood date code should be stamped on tyres for public information.

40. Tyre components are degraded over time, even when in storage, by oxidation and the effects of ozone and other aggressive elements in the environment. These effects may be significant if tyres are inappropriately stored for extended periods, especially in the sun, as is sometimes the case at service stations for example. The Australian Tyre Manufacturers Association stated that some early steel-belted radial tyres were adversely affected after a shelf life of two or more years [16].

41. Two retreading organisations suggested that date markings, especially of truck tyres, would assist in selection of tyres for retreading [17].

42. While the benefits to consumers of date marking would seem limited the problems caused to local manufacturers in changing secret codes already used to date markings for consumer information would be slight. It is significant that ECE Regulation 30 and United States standards already require that the date of manufacture be marked on the tyre.

43. It is recommended that:

(1) the Australian Transport Advisory Council amend Australian Design Rule 23 to require that tyre manufacturers mark their tyres with the date of manufacture in a form easily understood by the consumer.

## Safety Rims for Passenger Cars

44. Rims fitted to new passenger cars and similar vehicles are required to comply with Australian Design Rule 20 (ADR 20), 'Safety Rims'. This Design Rule is intended to ensure that wheel rims fitted to the specified vehicle categories will retain a deflated tyre in the event of a rapid loss of inflation pressure. Essentially the Design Rule requires that, subsequent to its rapid deflation, the tyre must be retained on its rim when the vehicle is brought to a halt from 60 mph (96.6 km/h) or 80% of the maximum speed of the vehicle, whichever is the lower. In bringing the vehicle to a halt, under a specified minimum deceleration, the driver must attempt to maintain the vehicle on a straight course.

45. It was suggested in evidence that a driver would frequently not be aware that a tyre, especially a steel-belted radial, had deflated until he attempted to manoeuvre by overtaking or cornering. This evidence cast doubt on the adequacy of the ADR 20 test which requires that the deflated tyre be retained on the rim while the vehicle is brought to rest in a straight line. The Department of Transport indicated that it had been guided by overseas practices and that the test is identical to that required by United States authorities. There are difficulties in defining all the requirements for the retention of tyres on rims [18].

46. It is recommended that:

- the Office of Road Safety review current overseas research on testing of safety rims to determine whether and, if so, how rims can be required by regulation to retain deflated tyres under side force.

47. Tyres are now being developed overseas which can be deflated without risk of being dislodged from the rim whether in a straight line or not.[19] Other tyres are being designed so that they can be driven in safety at limited speed even when completely deflated, for about 80km. The goal is to dispense with the need for a spare tyre. Considerable advances are expected in the next decade.

Temporary Spare Tyres

48. Since the 1978 model year some United States vehicle manufacturers have been producing vehicles which are provided with so-called temporary spare tyres. Several million would now be in service. There are various types. They may be of conventional dimensions, fold away construction, or of small section inflated to high pressure. All are of light construction. These tyres, some of which are fitted to special rims, save space and weight and are claimed to contribute to improvement in fuel economy. They have a limited tread life of about 3000 to 4000 kilometres, sometimes even less. American safety standard FMVSS109 has been amended to permit the use of these tyres. This matter is also under consideration in Europe.

49. Australian Design Rules make no reference to temporary spare tyres. The Australian Motor Vehicle Certification Board has advised vehicle manufacturers that it will not consider the spare tyre of a vehicle in the certification process. Vehicle manufacturers may therefore use temporary spare tyres if they wish. The Committee notes that the ACSVD is currently considering the question of temporary spare tyres.

50. These tyres present potential difficulties for Australian motorists. Fears were expressed about the limited range capabilities of these tyres in some parts of Australia. In addition, the tyres may adversely affect vehicle braking and handling characteristics [20]. No detailed evidence on the magnitude of these effects, particularly under conditions of abuse such as underinflation, was presented. Professor Joubert suggested that until such effects are tested temporary spare tyres should not be permitted in Australia [21].

51. Temporary spare tyres are open to abuse of excessive speed, load or underinflation of a potentially hazardous kind. The United States Department of Transportation has issued a warning on the potential hazards of misusing the high pressure type of temporary tyre [22]. The warning stressed that they are for temporary use only, must not be used continuously at speeds over 80 km/h and the tread life expectancy is only about 1600 to 4000 kilometres. Motorists were also warned against using this type of temporary spare tyre on full-sized rims because such a mismatch could result in tyre and rim separation.

52. It is recommended that:

- the spare tyre be included in the vehicle certification process and, further, that temporary spare tyres be considered for adoption in Australian Design Rules only if it is established that they meet adequate safety requirements and that their sensitivity to misuse is within acceptable limits.

## Replacement Passenger Car Tyres

53. A fundamental limitation of Australian Design Rules is that they apply only to new vehicles. They have no direct relevance for tyres sold as replacements for those originally

fitted. Manufacturers who produce tyres for fitment to new vehicles, and this includes all Australian manufacturers, do not make different tyres for the original equipment and replacement markets. Consequently the tyres they sell on the replacement market meet Australian Design Rule requirements. While the great majority of imported tyres on the replacement market would comply with similar overseas standards there is nothing to prevent the importation of the minority which do not. This is an anomaly which may affect about 20% of the Australian tyre market. The Committee is especially concerned because of suggestions by several witnesses that certain imported tyres are, or have been, of poor quality.

54. Lack of regulation on the selection and fitment of replacement tyres as opposed to performance and endurance is also a concern. Draft Regulation 120 requires, inter alia, that replacement equipment is to be manufactured and fitted to the vehicle so that continuing compliance with prescribed Design Rules is not compromised [23]. Modifications which would affect the status of a vehicle's compliance with the Australian Design Rules may be introduced only where such modifications are options provided by the vehicle manufacturer or where the modifications have been approved by the vehicle manufacturer or where the modifications have been approved by an administering authority. Sub-section (2)(r) of this regulation refers, in this context, specifically to ADRs 23 and 24. Because this draft regulation has not been adopted, or has only been partly adopted, in some States and Territories replacement tyres often do not conform with the requirements of Australian Design Rules in relation to selection and fitment. Evidence, including evidence from the States, overwhelmingly supported the need for replacement tyres to be governed by the same regulations as original equipment tyres.

55. Concern was expressed that even in those States where replacement tyres must comply with part or all of the Design Rules' requirements enforcement is neither systematic nor

uniform^24. Tyres may be checked during annual inspections for registration or randomly by traffic policemen. Several witnesses proposed that mandatory standards for replacement tyres be enforced at the point of sale under consumer protection legislation in order to ensure an adequate level of enforcement. This was suggested not only by consumer affairs authorities but also by two State motor traffic authorities ^25.

56. It was asserted that lack of independent tyre testing facilities in Australia may be a basic impediment to enforcement of mandatory tyre standards at the point of sale under the Trade Practices Act. Though it has been a limitation the lack of such a facility has not prevented the application of Australian Design Rules to original equipment tyres. The Committee nevertheless considers that an independent tyre testing facility would be desirable. (See also pp. 25-6).

57. It is recommended that:

- **replacement tyres be required by regulatory action under the Trade Practices Act to comply with standards set down in Australian Design Rules and that enforcement be at the point of sale.**

Draft Regulations

58. The Draft Regulations include requirements for tyres fitted to vehicles in service. No State or Territory has adopted all of these Draft Regulations in legislation but some are enforced at State level.

59. Several Draft Regulations on tyres attracted no attention during the inquiry. The Committee records no comment on these. A summary of all current Draft Regulations relating to

tyres is at Appendix 4. Other Draft Regulations are discussed elsewhere in the report. These concern: compliance with ADRs 23 and 24 (pp. 17-19), minimum tread depth (pp. 34-6), retreaded tyres (pp. 65-7) and mixing of different tyre constructions (pp. 31-2).

## Retreaded Passenger Car Tyres

60. The Standards Association of Austalia has published a non-mandatory standard specification on Retreaded Passenger Car Tyres. This specification, which has been taken up in Draft Regulations, is discussed in Chapter 4.

## Tyre Industry and Vehicle Industry Standards

61. The tyre industry, through the Tyre and Rim Association of Australia, has its own long established standards for tyre and rim sizes and dimensions and design criteria in terms of load and inflation pressure specifications for each tyre size. These standards, which form the basis on which tyres are designed, are drawn on heavily in Australian Design Rules.

62. In addition to ensuring that mandatory standards are met, each manufacturer establishes internal standards in line with normal commercial practice. They are also required to meet vehicle manufacturers' requirements for original equipment for particular vehicles. These requirements may be more stringent than those of the tyre manufacturer. Although specific tyres are not manufactured to be sold in the original equipment or replacement market some are unacceptable as original equipment. By specifying their own standards vehicle manufacturers attempt to ensure acceptable compatibility, in service, between the tyres and the vehicle concerned.

63. *Differences in tyre and vehicle manufacturers' standards* on non-uniformity were frequently alluded to during the inquiry. Some witnesses were concerned that the often less stringent limitations set by tyre manufacturers represent both a safety and comfort problem. The safety issue is dealt with in Chapter 4. The second is outside the Committee's terms of reference. The Committee simply notes that excessive non-uniformity can reduce comfort through vibration and that this has become more evident with certain types of car suspensions.

64. Some tyres suffer such a degree of non-uniformity that they are either scrapped or sold for use on trailers, caravans or some agricultural equipment [26]. These are stamped 'T' or 'TUO' meaning 'Trailer Use Only'. TUO tyres have been fitted to passenger cars, sometimes after the marking has been removed. The practice of removing the marking to deceive consumers was brought to the attention of authorities. The Department of Business and Consumer Affairs stated that the practice was stopped [27]. However, the practice of using TUO tyres on cars has not stopped.

65. Tyre manufacturers insisted that the use of TUO tyres on cars does not pose a safety hazard though this would produce an uncomfortable ride, particularly in recent model cars [28]. (See also pp. 48-9 on the safety implications of non-uniformity). The marking therefore is intended as a direction to retailers and as guidance for consumers. Consumers would be better assisted if a clearer marking were provided such as 'For Trailer Use Only'. 'TUO' could easily be misrepresented to mean for 'Taxi Use Only', which some consumers might consider an acceptable standard. The marking should be required to be indented into the tyre to minimise chances of removal. As these matters are outside the Committee's terms of reference no recommendation is recorded.

66. 'Blemish' (or 'job') tyres are identical to normal tyres except for visual defects, for example in the lettering. Because of these minor defects they cannot be sold at normal prices. They are, however, as safe as a normal tyre.

## Uniform Tyre Quality Grading

67. The United States has instituted a system of uniform quality grading of passenger car tyres which was introduced in stages from April 1979 to April 1980. The system provides for such gradings to be determined for treadwear, traction and temperature resistance. (The importance and significance of the latter is discussed in Chapter 4.) Ultimately, the grades will be moulded on each tyre's sidewall. Introduction of a system of this kind was supported by some witnesses and is under consideration by the Commonwealth/State Consumer Products Advisory Committee.

68. In the United States system the treadwear grading is determined by comparing the rate of treadwear of the test tyre with that of a standard monitoring tyre of equivalent construction. Both tyres are tested simultaneously on the prescribed test course on a section of public road. The gradings are numerical. For example, a tyre with a treadwear rating of 150 may, if correctly maintained and used, be expected to last 50% longer on the test course than one with a grading of 100. Doubt was cast on the value of these gradings since under normal usage, which involves a variety of road conditions and of usages, the comparisons quantified in the gradings would not necessarily hold. The rate of treadwear is of course a predominantly economic issue rather than a safety one.

69. Traction gradings are determined at a Government-owned test track facility consisting of wet skid pads. The test tyre and a standard calibration tyre are tested simultaneously on a skid trailer. The gradings are established by a comparison of the

locked wheel traction co-efficients of the two tyres. The gradings are 'A', 'B' or 'C', an 'A' grading signifying the best braking performance on wet roads. These gradings also attracted scepticism. Dr Sweatman indicated that problems with accuracy and repeatability of measurements, and possible changes of tyre gradings on different surfaces, have led to poor discrimination between tyres in the gradings ^29. All but three of some fifty different types of tyres of all constructions received the same rating ^30. Other evidence from Professor Joubert and Dr Sweatman suggested that the tests were unsatisfactory because the test surfaces are at 'safe' levels of skid resistance and slippery surfaces are not used because of the unreliability of traction measurement ^31.

70. Temperature resistance gradings are based on tests of tyres on standard testing machines. The tests are conducted at test wheel speeds ranging from 75 to 115 mph (about 120 to 195 km/h) for thirty minute periods. Tyres which fail to complete the test at a speed of 100 mph (about 170 km/h) are graded 'C'. Those which complete this stage successfully are graded 'B' and those which complete the 115 mph (about 195 km/h) stage are graded 'A'. Grades A and B indicate a higher level of high speed performance than is required by the United States equivalent of ADR 23. The United States National Highway and Traffic Safety Authority state that a tyre graded 'A' will perform safely and reliably when run continuously at the United States speed limit of 55 mph (88.7 km/h) in very hot weather ^32.

71. A major factor in the establishment of the United States system was the confusion resulting from the production by each manufacturer of tyres at a multiplicity of quality levels, as many as seven, in each tyre size ^33. In Australia there are relatively few sizes in which more than one tyre is made. The difference is in speed rating and load capacity which are already marked on the tyre. The tyre manufacturers suggested that gradings scored for treadwear and wet traction would be the same

for all Australian tyres in any one size and speed rating [34]. While there are differences in tyre characteristics between Australian brands the evidence does not suggest they would be such as to justify a system with so few gradings for each characteristic as are contained in the United States system.

72. The only detailed assessment of cost, submitted by the Australian Tyre Manufacturers Association, suggested that the system would add up to $5 to the retail price of a tyre [35]. Even if this estimate were exaggerated there is no doubt that the costs would be high.

73. It is therefore concluded that, at best, only marginal benefits for road safety, and even for consumers generally, would result from the introduction of a uniform tyre quality grading system along the lines of the United States system. Adoption of such a system is not therefore recommended.

Motorcycles, Trucks and Buses

74. There are no Australian Design Rules on motorcycle, truck or bus tyres. The Standards Association of Australia has, however, published a non-mandatory specification, AS 2230 - 'New Pneumatic Highway Tyres other than Passenger Car Tyres'. The standard establishes performance and marking requirements for tyres other than passenger car tyres for use in multi-purpose passenger vehicles, trucks, buses, heavy trailers and semi-trailers, and motorcycles on highways. It is based on US Federal Motor Vehicle Safety Standard No.119, 'New Pneumatic Tyres for Vehicles other than Passenger Cars'.

75. The Government has informed the Committee, in response to its report on Motorcycle and Bicycle Safety, that there is no evidence of a major problem in Australia with respect to motorcycle tyres and rims. Attention was drawn to a current

review of the influence of tyres, wheels and rims on motorcycle stability and handling. The Government sees this review as a necessary preliminary to consideration of the need for additional regulation.

76. Because the Committee received insufficient evidence on motorcycle (and moped) tyre standards it is not prepared to recommend any change to the status quo. It is simply suggested that those undertaking the review mentioned above take note of the evidence submitted to this inquiry, particularly by Dr M. Wigan of the Australian Road Research Board. Dr Wigan agreed that there is no evidence that a major problem of motorcycle tyre safety exists in Australia. He pressed for the extension, or completion, of the coverage of the Australian Standard on tyres as an advisory standard only. He also suggested the need for similar standards on wheels.

77. In its report on Heavy Vehicle Safety the Committee recommended that a program of research be implemented with a view to the *drafting of an Australian Design Rule on heavy vehicle* tyres. The Government accepted this recommendation in broad principle but indicated that the Advisory Committee on Safety in Vehicle Design (ACSVD) had advised that research programs are very expensive and that before it could recommend a research program on heavy vehicle tyres, an analysis of truck accident data is needed to identify the problem areas. The ACSVD is continuing to monitor truck accident data. The Committee is satisfied with the Government's undertaking but would emphasise the need to ensure that this long-term project is not allowed to be neglected or ignored.

## Independent Tyre Testing Facilities

78. In Australia only the tyre manufacturers have tyre testing facilities and even these, in most cases, do not have a complete capacity for measuring dynamic tyre performance

characteristics. Professor Joubert submitted a proposal for an elaborate tyre testing facility with laboratory equipment [36]. Supporters of the proposal cited the shortcomings of the manufacturers' local facilities and the inadequacies of publicly available data on tyre characteristics, especially of truck and motorcycle tyres.

79. An independent tyre testing facility is worthy of consideration although it might not necessarily be as elaborate as that proposed by Professor Joubert. Its primary function might be to monitor compliance with Australian Design Rules and the standards proposed in this report for tyres, especially imports, in the replacement market. The present system whereby manufacturers of original equipment tyres simply submit test results, which cannot be checked at independent facilities, is inadequate. This inadequacy would be even more significant if imported tyres on the replacement market were to be regulated. An independent facility could be used in further assessment of the adequacy of design rule standards and tests and in the development of new ones, if necessary. Research of the kind proposed at pages 56-7 could be conducted. An independent testing facility would also be useful in the field of consumer protection.

80. An alternative to the establishment of an independent tyre testing facility in Australia might be the utilisation of existing overseas facilities. This alternative warrants investigation.

81. It is therefore recommended that:

- the Office of Road Safety investigate the costs and benefits of establishing an independent tyre testing facility or utilising existing overseas testing facilities.

12 Economic Commission for Europe (ECE) Regulations are contained in a United Nations Agreement concerning adoption of uniform conditions of approval and reciprocal recognition of approval for motor vehicles, equipment and parts. The only signatories to the agreement are European countries.

13 Evidence, pp. 626-7, 631.

14 Evidence, p. 1202.

15 Evidence, p. 1203.

16 Evidence, p. 1090.

17 Evidence, pp. 278-9, 926.

18 Evidence, p. 1368.

19 Evidence, p. 1771.

20 Evidence, p. 630.

21 Evidence, p. 763.

22 Evidence, p. 424.

23 Draft Regulations are a code intended for adoption in State and Territory legislation to control in-service requirements for motor vehicles. Individual States may choose not to adopt them.

24 Evidence, p. 410.

25 Evidence, pp. 410, 419, 560, 564.

26 Not all manufacturers produce TUO type tyres. See for example evidence, pp. 1466-7.

27 Evidence, p. 433.

28 Evidence, pp. 1613-4, 1784.

29 Evidence, p. 607.

30 Evidence, p. 619-20.

31 Tyre Performance Characteristics: Review and Recommendations for Research, P.F. Sweatman and P.N. Joubert, Vehicle Research Group, University of Melbourne, May 1976, p. 458.

32 Evidence, p. 1196.

33 Evidence, p. 1123.

34,35 Evidence, p. 1124.

36 Evidence, p. 760.

## CHAPTER 3

## *TYRE PERFORMANCE*

### Tyre Functions and Design Compromises

82. Tyres are a major factor in motor vehicle safety. They must support the weight of the vehicle and transmit steering, braking and acceleration forces. They are a critical link in the chain of components between the driver and the road. If the tyre fails, the link fails and steering and braking are partially or totally lost. If the failure is sudden or unexpected the driver may suddenly lose control of the vehicle and the result may be injury or death.

83. Because tyres are a commercial product sold in a competitive market they must not only perform their functions safely and effectively but they must also achieve this at an acceptable monetary cost and with acceptable comfort for consumers. The economic considerations add to a multiplicity of compromises necessarily built into the design of tyres. Compromises are unavoidable. Some desirable performance characteristics such as treadwear and skid resistance cannot both be maximised simultaneously because the tread compounds which achieve these objectives tend to be different. Improvement in one characteristic is usually gained at the expense of the other.

84. Tyre performance is influenced by many highly complex factors. It would not be appropriate, or even feasible, to deal with the detailed engineering complexities here. Evidence concentrated almost entirely on a limited range of factors affecting tyre performance, notably the design factors of tyre construction type and tread design and compounds, the in-service factors of tread depth and tyre inflation pressures and the associated factor of consumer neglect.

## Design Development and Testing

85. The complexity of tyre technology is such that Australian tyre manufacturers must draw on overseas research and development. Resources of Australian affiliates of overseas tyre manufacturers are concentrated on providing overseas research and development centres with information about Australian needs and conditions as a basis for designs appropriate to Australia.

86. The local manufacturers evaluate tyres under local conditions mainly by field testing of wear and structural integrity, especially resistance to high ambient temperatures. Such tests are undertaken with special test vehicles, company fleet vehicles and taxis and sometimes with professional drivers on racing tracks. Tyres are also tested for compliance with Australian Design Rule requirements and to meet vehicle manufacturers' specifications.

87. One Australian tyre manufacturer is not a direct affiliate of any overseas company and is therefore more reliant on its own design, development and testing resources. Nevertheless, it includes in its development the adaptation of basic overseas technology to Australian requirements.

88. An important input into development and evaluation of tyre designs and manufacturing processes is information collected by manufacturers from claims by consumers for replacement of allegedly unsatisfactory and defective tyres.

89. No detailed evidence was submitted to the Committee on the extent to which the designs of tyres imported into Australia take account of local conditions, especially of high ambient temperatures. One overseas manufacturer which exports to Australia indicated that service conditions in Australia are considerably more severe than in most other parts of the world. Claims for defective tyres in Australia are four times higher than the manufacturer's worldwide return rate [37].

## Construction Types

### - Relative Merits

90. Most evidence on tyre performance related to the relative merits of steel-belted radial, textile radial and bias ply tyres. The almost universal claim from a wide range of sources was that steel-belted radials perform best in most respects and are the most economical. Little objective evidence was adduced to substantiate the former claim but well-informed witnesses, including vehicle manufacturers and operators of large vehicle fleets, insisted that the superior performance is obvious to the driver. These assertions would seem to be supported by market trends.

91. The issue of the relative proneness to failure of the different tyre construction types is discussed in Chapter 4.

92. The burden of evidence suggests the following to be the major advantages of radial ply construction over bias ply:

- lower cost per kilometre due to significantly better treadwear and improved fuel economy;
- superior handling;
- generation of less heat (a major factor in tyre wear);
- better braking performance;
- better wet adhesion for cornering and braking;
- better resistance to impact fractures and punctures (because of greater crown thickness);
- greater potential for design improvements.

93. Bias ply tyres were claimed to provide a quieter and more comfortable ride, particularly at lower speeds. The relative comfort of radial tyres has improved, however, in cars with suspensions designed for radial tyres. The initial cost of bias ply tyres is lower than that of radials.

94. Textile radials and steel-belted radials were said to have similar properties except that the mileage of the former is significantly less - somewhere between that of steel-belted radials and bias ply tyres. The advantages of radials in general were often claimed to be more pronounced in steel-belted radials. Little objective evidence was adduced to support these claims but one witness perhaps summed up the position by saying:

> 'If steel-belted tyres are inferior to textile tyres, then it means the whole tyre industry is heading at 100 miles an hour in the wrong direction'. [38]

95. A characteristic of radial tyre design which could be interpreted as a disadvantage is that it disguises underinflation. This is discussed in detail at p. 59. The safety implications, disclosed there and at pp. 51-2, are significant.

96. It is concluded that radial ply tyres, especially steel-belted radials, almost certainly achieve higher standards of performance in most respects than other types of tyre construction.

- Mixed Tyre Constructions

97. Certain combinations of tyre construction types can produce potentially dangerous handling characteristics. Indeed it is illegal in most States for tyres of differing forms of construction to be fitted on opposite sides of the front or rear axles of a vehicle. Although Australian Design Rules do not permit intermixing of construction types, Draft Regulations do permit the following combinations of construction in service:

| Form of carcass construction on front wheels | Form of carcass construction on rear wheels |
|---|---|
| Bias ply | Belted bias |
| Bias ply | Radial ply |
| Belted bias | Radial ply [39] |

These configurations may reduce the response of the vehicle to steering control. However, the effects are less dramatic than other combinations, such as radials on the front axle and bias ply on the rear, which produce instability through oversteer [40]. The Advisory Committee on Vehicle Performance (ACVP) recently sought information on the matter as a basis for possible amendment of the relevant Draft Regulations. No change in the Draft Regulations was made.

98. The Melbourne study of collisions with utility poles found so few examples of intermixing that no conclusion could be drawn on the role of intermixing of tyre constructions in crashes. (Some 4% of a random sample involved a mixture on the same axle and 6% on different axles [41].) Another Australian study has found still less instances of mixture on the same axle[42].

## Tread Design and Compounds

99. Tread pattern design and the rubber compounds used in the tread significantly affect performance, especially as regards treadwear, handling, skid resistance and speed. In Australia tyres must cope with higher ambient temperatures, conditions which promote high tyre operating temperatures, and a wide variety of road surfaces. Design and compounds developed and used overseas therefore need to be modified for Australian conditions.

100. Improved wet skid resistance through modified tread compounds can be achieved only at the expense of increased treadwear and heat build up because of the fundamental differences in tread compounds required to maximise these characteristics. These are important characteristics from an economic and safety point of view respectively. They are therefore impediments to improvement in wet skid resistance. The Committee was told however that some manufacturers are placing some emphasis on wet skid resistance, even at the expense of treadwear [43].

101. Tread pattern design also affects wet skid resistance, by permitting water to drain through the tread grooves from the tyre's point of contact with the road. Radial ply construction provides greater scope for improving the drainage capacity of the tread pattern than does bias ply construction [44].

102. In extreme conditions wet surfaces may cause a tyre to lose all contact with the road. This is called aquaplaning or hydraplaning. It is a hazardous but rare phenomenon which results from the inability of the tyre to drain large quantities of water from the tyre's road contact area. Ultimately the water takes the full load of the vehicle and separates it from the road surface. High speed increases the risk of aquaplaning because of the shorter time the tyre is permitted to clear the water. The drainage capacity of the tread pattern design is critical in determining the speed at which aquaplaning will be initiated [45]. Underinflation and, for obvious reasons, low tread depth are also important determinants.

103. The Committee received no evidence to suggest that the compromises necessarily made by tyre manufacturers in rubber tread compounds and in the design of tread patterns are such as to represent a road safety hazard for passenger cars.

## Tread Depth

### - Wet Skid Resistance and Aquaplaning

104. Tread depth is an important operational determinant of tyre performance. Shallow tread depth adversely affects wet skid resistance because of the reduced size of the grooves through which water is drained from the area of contact between the tyre and the road. Similarly shallow tread depth lowers the speed at which aquaplaning occurs. Bald tyres, of course, provide no means of water drainage.

105. Braking is adversely affected by shallow tread depth, especially when it is less than 2mm. Expert evidence suggests that braking effectiveness at high speed on a smooth road surface would increase progressively, with tread depths between 2mm and 9mm, probably to the total extent of 30 % to 40 % ^46.

### - Tyre Disablement

106. An American study has discovered that the risk of tyre disablement increases sharply below tread depth of 1.5mm. Bald tyres were found to be forty-five times more susceptible to disablement than new tyres. The study nevertheless concluded that tyre disablements contributed to no more than 2.42% and possibly as few as 0.9% of all accidents ^47.

### - User Attitudes

107. Two Melbourne studies suggest that the incidence of shallow tread depth is high. A Victorian survey found that 27% of vehicles had tread depth of less than 1.5mm and 17% had tyres with tread depths less than the Victorian legal minimum ^48. The utility poles collision survey found 10% of cars with front tyre tread depths of less than 3mm and 18% with similarly shallow rear tyre tread depths ^49. The Victorian study's finding that a high

proportion of vehicles have tyres with illegally shallow tread depths suggests a need for stricter enforcement of the relevant laws, at least in Victoria. The Committee received no evidence on these matters in relation to other States or Territories.

- Relative Accident Risk

108. The relationship of tread depth and relative risk of accident has been studied several times. There is a strong body of evidence that the likelihood of a skidding accident increases sharply at shallow tread depth.

109. The evidence of the sharp increase in risk of accident which occurs with tread depth below 1.5mm is such that Draft Regulations specify it as the minimum legal tread depth ^50. The Committee is concerned that some States have lower statutory minimum tread depths and is convinced that a limit of at least 1.5mm is an important safety measure.

110. It was suggested to the Committee that the minimum may need to be raised as high as 2mm or even 3mm ^51. The Melbourne study of utility pole collisions found that tread depths over 3mm are associated with virtually no change in accident risk and are very close to the average accident risk ^52. Below 3mm, however, risk rises sharply, especially on wet roads. With tread depth of 0.5mm risk of accident on wet roads was found to increase by a factor of fifteen against that of tyres with a tread depth of 5mm or more. For diagrammatic comparison of relative risk versus average front and rear tyre tread depths for wet and dry roads see Appendix 5. A United States study found a less dramatic increase in risk at tread depths between 1.5mm and 3mm ^53.

111. The utility pole study also found that shallow tread depth increases risk of accident on dry roads, though to a lesser extent. This was a surprising result as traction should improve. It was concluded that other safety-related factors may be

correlated with tread depth ^54. Overdue vehicle maintenance and general driver attitudes are possibly influential. Similar findings were recorded in a study in the United States. The latter study was not controlled for age of driver and it has been suggested that this factor may have influenced the findings ^55. The study, which covered 2717 accidents, also found that the likelihood of accidents on wet and dry roads is inversely related to tyre tread depth.

- Conclusions and Recommendations

112. It is concluded that shallow tread depth significantly detracts from tyre and, therefore, vehicle performance in wet conditions and significantly increases risk of accident at a depth of less than 3mm, and especially less than 1.5mm. The Committee is not prepared, however, to recommend without further study that the minimum tread depth provided for in Draft Regulations be raised. Such a measure would impose significant additional direct costs on motorists.

113. It is therefore recommended that:

- the Office of Road Safety review the significance of tyre tread depth in the causation of motor vehicle accidents as a basis for review of legal minimum tyre tread depths, and

- the Minister for Transport raise with Australian Transport Advisory Council Ministers the urgent necessity of adopting a minimum legal tyre tread depth of at least 1.5mm in all States and Territories.

## Tyre Inflation Pressures

### - Handling

114. Handling is adversely affected by underinflation of tyres all round and is favourably affected by overinflation though comfort and resistance to impact fracture are reduced at high pressures [56]. Evidence suggested that a tyre running with pressure in the range of 70 to 100 kPa (about 10 to 15 psi) has markedly different handling characteristics than a tyre with recommended pressure, and that with tyres at less than 70 kPa the average driver could have considerable difficulty in controlling a vehicle [57].

115. Differing pressures, front and rear, which alter the front-rear pressure balance recommended by the vehicle manufacturer may create understeer or oversteer and consequent loss of stability, especially if rear tyres are underinflated and front tyres overinflated [58].

116. The study of utility pole collisions in Melbourne made important findings on the relative risk of accident associated with the adverse handling characteristics resulting from incorrect tyre inflation pressures [59]. An important measurement used was the 'pressure margin' between the measured pressure on each vehicle and the pressure recommended by the vehicle manufacturer. Relative risk of accident was found to reduce as the average pressure margin (i.e. on all four tyres) was raised to between 35 and 50 kPa (about 5 and 7 psi). A levelling off of risk then occurred. On the other hand accident risk increased with general underinflation of tyres. A car with tyres underinflated by 70 kPa (10 psi) all round was found to be five times more likely to be involved in an accident than one with pressures down by 35 kPa (5 psi).

117. The incidence of underinflation in the general vehicle population was found to be high. Some 35% of accident-involved vehicles and 23% of randomly selected vehicles had tyres underinflated relative to the vehicle manufacturers' recommendations. This finding is supported by other evidence.

118. The study also found that accident involvement increases when the balance of tyre pressures between front and rear tyres differs substantially from that recommended by the manufacturer. Some 33% of accident-involved vehicles had front-rear pressure margins associated with greater than average accident risk. Imbalance of more than 35 kPa (5 psi) was found in 14% of the vehicles. The study concluded:

> 'A substantial proportion of accident-involved vehicles have handling characteristics that have been dangerously degraded through use of improper inflation pressures. Efforts should be made to educate drivers and garage attendants on the importance of maintaining tyre pressures at the levels recommended by the vehicle manufacturer.'

The evidence supporting this conclusion is persuasive.

- Skid Resistance and Aquaplaning

119. Underinflation of tyres tends to diminish skid resistance and, in particular, to reduce sharply the speed at which aquaplaning is initiated. In the latter phenomenon underinflation is the main factor apart from the water depth. Research indicates, for example, that aquaplaning in deep water will be initiated at about 80km/h when tyre pressures are at 175 kPa (25 psi). However, if the tyres are at 70 kPa (10 psi) the speed at which aquaplaning is initiated is about 50 km/h [60]. The Committee was informed that braking performance is adversely affected by underinflation but no evidence was presented on the magnitude of this effect [61].

- Conclusions

120. The Committee concludes that inflation pressure is an important operational factor in determining tyre performance. It may even be an operating factor of the same order of importance as tread depth. Incorrect inflation pressures are also strongly associated with tyre failure. This is discussed in Chapter 4 where the Committee records recommendations relating to tyre inflation pressures.

## Motorcycle Tyres

121. Motorcycle tyre performance characteristics have received relatively little attention from researchers, partly because of lack of access to tyre testing equipment. However, evidence taken during the current inquiry and during the Committee's recent inquiry into Motorcycle and Bicycle Safety suggests that market forces have produced a marked and continuing improvement in performance, notably in adhesion both in the wet and dry ^62. This improvement has occurred without Government regulation.

122. Witnesses stressed that the matching of tyres and rims to particular machines could significantly affect performance. Adequate information is not readily available to riders who wish to replace their tyres, especially if they want to change the size of the rims (with a view to improving performance) ^73. The Committee received no convincing evidence on how such information could most effectively be made available.

123. **It is recommended that:**

- **the Publicity Advisory Committee on Education in Road Safety (PACERS) investigate effective means of making available to motorcycle riders information on the matching of tyres, rims and machines and on motorcycle tyre performance.**

## Truck Tyres

124. Researchers have directed relatively little attention to truck tyres as compared with passenger car tyres [64]. The Committee drew attention to this in its report on Heavy Vehicle Safety [65]. In that report it was recommended that a program of research be implemented with a view to the drafting of an Australian Design Rule on heavy vehicle tyres. In response to the Committee's recommendation the Minister for Transport noted the high cost involved and indicated an analysis of truck accident data is needed to identify problem areas before a research program on heavy vehicle tyres can be recommended. The recommendation was nevertheless accepted in principle.

125. During the current inquiry the Committee was told that truck tyres perform poorly in wet skid resistance and in other respects. Preventing heat build up and promoting good tread life are major factors in truck tyre design and may impede development of tyres with good skid resistance. It was suggested that truck tyres with good wet skid resistance are not available. Wet skid resistance is affected by load, growing worse with higher loads. One means of improving this performance characteristic is to use larger tyres than are called for by the Tyre and Rim Association's load pressure tables.[66]

126. While this expert evidence on truck tyre performance, notably on wet skid resistance, was supported by the Australian Institute of Petroleum whose members are major users of trucks, it was rejected by the Commercial Vehicle Industry Association of Australia. This Association claimed that its members are satisfied with the economic and safety compromises currently made in truck tyre design [67].

127. The Committee confirms its earlier recommendations on truck tyre research and the need for regulation, through Australian Design Rules, to require minimum truck tyre performance standards.

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37 Evidence, p. 1878.

38 Evidence, p. 509.

39 Draft Regulation 802.

40 Evidence, p. 623.

41 Evidence, p. 770. See also Collisions with Utility Poles, p. 209.

42 Report of the Road Accident Research Unit, p. 91.

43 Evidence, pp. 1391, 1595.

44,45 Evidence, p. 606.

46 Evidence, p. 619.

47 The study was conducted by Baker and McIllwraith (1969) on accidents on the Illinois Tollway. These results were recorded in A Review of Vehicle Design to Reduce Accidents, E.R. Hoffman, AGPS, Canberra 1973, pp. 11-12.

48 Report of the Road Accident Research Unit, p. 64.

49 Evidence, p. 768.

50 See, for example, Hoffman, pp. 12-13.

51 Evidence, pp. 618, 774.

52 Evidence, p. 767.

53 Study by the Highway Safety Foundation. Results reported in Collisions with Utility Poles, p. 200.

54 Collisions with Utility Poles, p. 197.

55 Hoffman, p. 12.

56 For example, evidence, p. 624.

57 Evidence, p. 1545.

58 Evidence, pp. 623, 769-70.

59 Evidence, pp. 768-770, Collisions with Utility Poles, pp. 196-209, 349-50.

60 Evidence, p. 615.

61 Evidence, p. 607.

62 Evidence, pp. 641, 1853, 1856. See also Motorcycle and Bicycle Safety, Report from the House of Representatives Safety Committee on Road Safety, 1978, p. 43.

63 Evidence, p. 1852.

64 Evidence, p. 613.

65 Heavy Vehicle Safety, Report of the House of Representatives Standing Committee on Road Safety, 1973.

66 Evidence, pp. 620-2.

67 Evidence, pp. 1012, 1014, 1016.

## CHAPTER 4

## TYRE FAILURES

### Types of Failure

- Introduction

128. No tyre can have an indefinite life since tyre components are subject to fatigue through natural causes, which can be accentuated by consumer abuse. This Committee's primary concern lies with premature, and particularly catastrophic, failures. Tyre failure is broadly defined as a loss of mechanical integrity resulting in the inability of the tyre to perform satisfactorily all or any of its functions [68].

129. Tyres fail in a multiplicity of ways and for a multiplicity of reasons. Of all the modes of failure, evidence concentrated almost exclusively on:

- separation of the tyre's component parts (notably the tread or steel belts);
- carcass break-up; and
- impact fractures and punctures [69].

- Carcass Break-up

130. Carcass break-up results from fatigue of the carcass cords. This produces a circumferential break, usually below the shoulder. The process is often initiated by excessive loads and underinflation which cause stress and heat build up, or by the

ingress of moisture, or by manufacturing defects. The failure can be so severe that the tyre splits into three pieces and hazardous loss of control can result.

- Separation

131. Separation failures are usually identified by a bulge or bubble and failure to recognise this, in extreme cases, may lead to the tread tearing completely and suddenly from the carcass. Part or all of the belt may also separate. This type of failure, which has been mainly confined to steel-belted radial car tyres, was the subject of much of the evidence submitted during the inquiry. The processes whereby separation takes place were not a subject of disagreement. Rather, disagreement centred on the factors which set these processes in train.

132. The main cause of tread separation is rubber compound fatigue cracking which starts from the belt edges. This cracking is aggravated by the strong centrifugal forces acting on the belts. Fatigue occurs in all tyres and is irreversible, but it normally progresses slowly so that the tyre has at least one tread life before the fatigue affects performance. However the following factors may accelerate the process and result in a premature failure:

- heat degradation;
- very high temperature at the moment of failure;
- rubber compounds with poor resistance to heat degradation or low strength at high temperature;
- design factors causing excessive stress and fatigue between the belt layers.

133. Tread separation may also result from ingress of moisture which produces rust in the steel belt which in turn results in greatly weakened adhesion between rubber and steel cords. Sand and grit may also enter the tyre and reduce this

adhesion. Moisture may reach the belts during manufacture, or through cuts in the tyre or through inadequate repairs to punctured tyres.

134. Separation occurs in textile belted radials, but is less likely to lead to complete separation in these tyres.[70] Separation also occurs in bias ply and reconditioned tyres.

- Impact Fractures and Punctures

135. Impact fractures are caused by running the tread into or over an object with a relatively sharp edge or corner, eg. a house brick, or by pinching the tyre wall between the rim and kerb. Punctures and cuts result from less severe impact or from penetration, e.g. by nails. Punctures and fractures may occur through the tread or sidewalls.

## Effects of Tyre Failure

136. The major factor in tyre failure likely to create a hazardous situation is instability, usually produced by sudden loss of air pressure. Such failures were termed 'catastrophic'. Most failures, however, result in slow loss of pressure which becomes apparent to the driver when handling is affected or when the tyre finally becomes 'flat'.

- Impact Fractures and Punctures

137. Impact fractures or punctures which produce sudden loss of air pressure result in hazardous loss of control. The effects of impact fractures and punctures in tubed tyres are generally more severe than in tubeless tyres. Because of their differing construction tubed tyres are more prone to sudden loss of air pressure.

- Separation and Carcass Break-up

138. Evidence consistently indicated that, like most failures, separation and carcass break-up are progressive and can be observed in their initial stages. Stress was therefore placed on routine checking of tyres [71].

139. A warning of separation is normally given to the driver by obvious vibration caused by a bulge or bubble in the tyre. If the tread actually separates severe, irregular noise results. If only the tread separates and tyre pressure is retained handling is probably not greatly affected [72]. Generally the driver has time to stop his car before a dangerous situation develops. However, if the belt separates with the tread the tyre cannot generate sufficient force to permit proper control over the vehicle. This is particularly hazardous if it occurs in a tyre on the back axle. The car becomes extremely unstable and may roll over. It was submitted that even an experienced driver would have difficulty in controlling a vehicle at high speed if such a failure occurred [73]. Separation may also generate sufficient internal friction to destroy the carcass and thereby produce a 'blow-out' and serious loss of cornering power. The tyre can also be dislodged from the rim.

140. The on-set of carcass break-up can be disguised in steel-belted radials because of the rigidity of the belt and the inherent stability of the tyre. This is especially so at high speeds. If the driver does not detect the progressive loss of cornering power failure will appear to be sudden. As already indicated such failures can result in serious damage to the tyre, including sudden loss of air pressure.

141. It is concluded that there is not always adequate warning of tyre failure to permit drivers to avoid danger.

142. Although techniques for designing tyres to improve the warning of separation are apparently already known, no substantial evidence was submitted to the Committee.[74] The most effective means of guarding against sudden failure is regular visual inspection of tyres. Such inspections are likely to become less frequent with the trend towards longer periods between services in modern cars and the advent of self-service petrol stations.

143. It is recommended that:

- effective visual inspection of tyres be carried out regularly by tyre outlets and by service stations, and

- the Office of Road Safety investigate the known techniques for designing tyres to improve the warning of separation with a view to possible amendment of Australian Design Rules.

Design and Manufacturing Defects

144. Design and manufacturing defects clearly presented difficulties in the early years of production of steel-belted radial tyres in Australia. The design of certain types of steel-belted radials was especially inadequate for Australian service conditions in hot country areas. Statistics and other evidence supplied by the Australian tyre manufacturers, and evidence by the Department of Transport and a broad cross-section of large fleet operators leave no doubt that these problems existed. Only one local manufacturer seems to have avoided a significant problem of tyre failure through tread and belt separation in those early stages. The others experienced the problem to varying degrees and their responses to the design and manufacturing aspects and to the protection of consumers differed.

145. Responses to the design and manufacturing problems included changes in rubber compounds, introduction of nylon overlays to combat the centrifugal force generated by the steel belt and improvements in the manufacturing processes. These modifications, adopted mainly in 1977, have resulted in a marked reduction in adjustments for separations.

146. The Committee notes that statistics from two manufacturers for the last three years show claims for separation in bias ply tyres to be slightly greater than similar claims for radial tyres.

147. Some witnesses alleged that a high rate of failures, notably tread separations, in steel-belted radial car tyres had resulted from non-uniformity of the tyres which was not kept within acceptable limits by tyre manufacturers. These allegations were made forcefully but no reliable objective evidence was produced to sustain them. It was generally held to be self-evident that the non-uniformities would result in excessive heat build up through added friction and ultimately failure through heat degradation.[75] Laboratory tests viewed by the Committee demonstrated that non-uniformities do not in fact result in heat build up.[76] The assumption on which the allegations were based would therefore seem to be false. (These tests are described and the results recorded at Appendix 6). The Department of Transport also indicated that it is unaware of any evidence indicating that non-uniformity is a safety factor.[77]

148. Non-uniformity is a comfort rather than safety-related factor. It was submitted that vibration of the car would be unbearable on tyres in which non-uniformity could pose a safety problem.[78] The adverse effects of non-uniformity on comfort and the desire of tyre and vehicle manufacturers to minimise it were amply demonstrated but as this comfort factor is unrelated to this inquiry the Committee records no findings or recommendations.

149. On the evidence available it is concluded that shortcomings in tyre design and manufacture contributed towards a significant rate of separation failure in steel-belted radials in the early years of production in Australia but that the magnitude of the problem was not as great as that of the 'Firestone 500' steel-belted radial in the United States (see p. ixx). The Australian tyre manufacturers responded to the design and manufacturing problems when they became evident and major reductions in separation failures have occurred over the last three years. The majority of the design and manufacturing problems appear to have been overcome and improvements are continuing to be made. Non-uniformity was not found to be a contributory factor in tyre failure.

150. Some driving conditions in Australia clearly placed unexpectedly high demands on tyres. It is equally clear that, despite their access to overseas technology and expertise, Australian manufacturers had to undergo a learning phase in manufacturing processes. Market forces and perhaps public pressure have ensured that improvements have been made progressively.

151. Although the available evidence leaves the Committee confident that the problems associated with steel-belted radial tyres have been largely overcome this cannot be regarded as a certainty. As experience has shown already tyre problems take some time to become evident. It would be prudent therefore to review the situation in about two years' time. The Committee will, within twelve months, obtain from local manufacturers up-dated statistics on claim rates.

152. It is recommended that:

- within two years, the Office of Road Safety again investigate the incidence of premature tyre failure.

153. There is nothing to suggest that imported tyres have been free of the problems associated with those locally produced. Indeed, several witnesses asserted that imported tyres represent a more significant problem in terms of design and manufacturing defects. It is possible that some imported brands of tyre may not possess design compromises suitable to the Australian climate and road conditions. Evidence was inadequate to enable the Committee to draw firm conclusions about the adequacy of design and manufacture of the many brands of imported tyres. It nevertheless needs to be said that some brands of imported tyres have clearly performed well in Australian conditions. (The need for imported tyres to meet adequate performance and endurance standards is discussed in Chapter 2).

154. The Committee notes claims by the Australian manufacturers, to some extent supported by independent evidence, that they have followed liberal adjustment policies. However, this may be changing. One manufacturer, for example, reduced adjustments by 35% in 1979 by subjecting claims to more thorough investigation. This figure is consistent with evidence provided by another manufacturer. It is doubtful whether manufacturers were motivated only by goodwill and by a sense of responsibility towards consumers. Liberal adjustment policies might well have been intended to minimise public controversy.

155. Statistical data on claim rates for tyre failures were submitted by the local tyre manufacturers. The statistics provided by one manufacturer showed a high claim rate in its initial period of steel-belted radial tyre production. The rate was so high (though still less than that of the 'Firestone 500' in the United States) that the Committee believes the manufacturer should have taken some action to protect purchasers of the tyres produced in that period. At the least those purchasers should have been warned of the high failure rate and advised of appropriate precautions, either by letter or, if that were not possible, by notices in the press. A more appropriate

response would have been to recall the tyres concerned either totally or from areas where the failure rate was high (as one other local manufacturer did). No such action was taken. It was not sufficient for the manufacturer to pursue a liberal policy of replacing tyres after they had failed. Given the relatively high risk of failure of its tyres the manufacturer should have recalled the tyres as soon as the magnitude of the problem was evident so that its customers were no longer at risk.

156. The Committee is convinced that under any system of mandatory recall of unsafe products this manufacturer would have been required to recall the steel-belted radial tyres produced in this initial production stage. (The desirability of a mandatory recall system is discussed in Chapter 6.)

157. It is concluded that one Australian tyre manufacturer acted irresponsibly in not recalling tyres produced in the initial stages of its steel-belted radial production which, the manufacturer knew, were failing at an unacceptably high rate and were thus placing many people at risk.

**Tyre Pressures**

158. Clearly, despite improvements in the design and manufacture of steel-belted radial tyres, separation failures will continue to occur. Constant perfection is impossible in any mass produced item. Secondly, failures will inevitably occur because of consumer abuse. The level, causes and effects of consumer abuse of steel-belted radial tyres in particular were central issues in this inquiry.

159. Underinflation increases the running temperature of tyres through additional flexing of the tyre. Since additional pressure is required when normal load and/or speed is increased a tyre inflated to normal operating pressure will be underinflated in these conditions and any less pressure will further aggravate

the problem of heat build up. High ambient temperatures such as are encountered in many areas of Australia add to these effects. The excessive running temperatures so caused can promote separations and the eventual break-down of the tread to carcass adhesion through accelerated degradation of the rubber.

160. Laboratory tests performed in the Committee's presence demonstrated that gross underinflation causes a sharp increase in temperature build up at all speeds for steel and textile radial tyres. There was only a mild effect on temperature build up at speeds up to 100 km/h if the inflation pressure was allowed to fall several pounds per square inch below the recommended minimum. Steel-belted radials showed no more susceptibility than textile radials to a small loss of inflation pressure. (Appendix 7). The Committee was told that previous tests had shown these results to be typical of all brands of passenger and radial tyres[79].

161. The proposition that underinflation is a major cause of tyre failures was not seriously challenged during the inquiry though not all witnesses agreed on its importance relative to defects in design, manufacturing processes and manufacturing standards. Evidence on inflation pressures concentrated on the following questions:

- what is the margin of safety in inflation pressures, and are steel-belted radial tyres unacceptably sensitive to underinflation; and

- have consumers been adequately informed of the importance of maintaining correct inflation pressures.

## The Margin of Safety in Tyre Inflation Pressures

162. One would expect users of tyres to be able to find out easily the correct tyre inflation pressure for any given tyre on any given vehicle in any given situation. However, they probably cannot. The Committee was told that even tyre dealers' advice to customers on inflation pressures ranges 'from dangerous to highly conservative'.[80]

163. Since 1974 a placard has been fixed to every new vehicle showing recommended tyre pressures. These pressures must not be less than the pressures prescribed in the tables of Australian Design Rule 23 for the tyre when at normal load. These are identical to the load/inflation tables produced by the Tyre and Rim Association of Australia, an industry organisation. The Association therefore, in effect, specifies minimum pressures which vehicle manufacturers may recommend. Vehicle manufacturers frequently recommend pressures above these minima in order to improve handling. Clearly they are not permitted to recommend lower pressures, as some witnesses alleged.

164. Individual tyre manufacturers produce tables of recommended pressures which sometimes differ from either of the pressure recommendations already mentioned. Uniroyal recommends tyre pressures 14 to 28 kPa (2 to 4 psi) above the vehicle manufacturers' recommended pressures. It does so in an attempt to minimise the effects of consumer ignorance and apathy. These recommendations are particularly aimed at minimising the problem of motorists' not adjusting tyre pressures for above normal speeds and loads and not making allowance for measuring pressures when the tyres are cold[81]. Uniroyal stressed, however, that its tables show recommended operating pressures whereas vehicle placards show recommended minimum pressures. Uniroyal also stated that it had no experience of any vehicle manufacturer recommending inflation pressures which are too low[82]. This is significant in that some witnesses who alleged such recommendations referred to Uniroyal's tables as evidence[83].

165. In addition to these three sources of often differing recommendations is to be added the individual tyre dealer who in some instances recommends a pressure he considers appropriate on the basis of experience.

166. The consumer may therefore be presented with four different recommended inflation pressures for the same tyre, on the same vehicle, operating under the same conditions of load and speed. (His likely confusion will be aggravated if either of the last two variables is other than 'normal'). All of these recommendations would come to him from people he would expect to be well-informed. Since these recommendations can vary by as much as 56 kPa (8 psi), a driver whose tyre pressures are in the centre of the range may be told in one quarter that they are underinflated by 28 kPa (4 psi) and in another that they are overinflated by 28 kPa. So what does the term 'underinflated' really mean?

167. The minimum recommendations of the Tyre and Rim Association do not necessarily provide for optimum vehicle safety, performance or comfort - they are determined primarily on the basis of capacity to carry a given load. As pressures increase handling improves but ride becomes harder and, less comfortable. Beyond an optimum point tyre tread wears unevenly and with extreme overinflation, susceptibility to punctures and impact damage increases. The vehicle manufacturers' recommendation necessarily represents a compromise between comfort and handling favouring one or the other according to the manufacturer's priorities. However, it must be emphasised, in light of allegations made to the Committee, that vehicle manufacturers cannot legally recommend tyre pressures lower than those recommended by the Tyre and Rim Association. One local car manufacturer stated that its tendency in recent years has been to give higher priority to handling than to comfort.

168. The confusion created for motorists by the multiplicity of recommended tyre inflation pressures needs to be overcome. The vehicle manufacturers' recommendations are the most suitable for motorists to follow as they take into account vehicle as well as tyre characteristics.

169. It is recommended that:

- the Office of Road Safety confer with interested parties in order to obtain their agreement to include in all education material for the general public only the vehicle manufacturers' tyre pressure recommendations.

170. Nevertheless since the Tyre and Rim Association's recommended pressures represent the minimum for safe operation of the tyre and vehicle the Committee concludes that underinflation, for the purpose of determining a tyre's safety limits, should be assessed in relation to them. It may be presumed that the tyre industry, in agreeing to the load/inflation characteristics for each tyre size designation, has acted in the expectation that compliance with the calculated characteristics would ensure adequate tyre durability in normal service. While the industry concedes that it would prefer motorists to operate with pressures higher than the Association's minimum recommendations it nevertheless states that these minimum levels provide adequate tyre life, handling and comfort[84].

171. Tyre manufacturers submitted details and results of tests which, it was claimed, prove not only that steel-belted radial tyres have an adequate margin of safety but that the margin is greater than for tyres of bias ply construction. Tyres of the three main types of construction were subjected to the ADR 23 endurance tests. The results of one series of tests were as follows:[85]

| | ADR 23 Endurance Test | | | |
|---|---|---|---|---|
| Inflation pressure psi | 24 | 20 | 16 | 12 |
| Steel radial | Pass | Pass | Pass | Fail |
| Textile radial | " | " | " | " |
| Bias | " | " | Fail | " |

These results represent testing under conditions required by ADR 23 but do not imply that such pressure reductions can necessarily be used on roads. They do show, however, that steel-belted radials are no more suspectible to failure through underinflation than textile radials or bias ply tyres. They are probably even less susceptible. The figures are not useful as indications of the tyres' margin of safety.

172. On the evidence available it is concluded that steel-belted radials are no more susceptible to failure due to underinflation than textile radial or bias ply tyres.

173. Evidence indicated that infrequent underinflation is unlikely to result in early 'catastrophic' failure, unless underinflation is gross. However persistent underinflation may establish the preconditions for premature failure. No objective and conclusive evidence was presented to the Committee on the margin of safety involved. While the evidence taken as a whole suggests that this margin is acceptable, this cannot be stated with confidence. It is essential information.

174. **It is therefore recommended that:**

- **the Office of Road Safety determine the degree of tolerance of steel and textile radial and bias ply tyres to persistent underinflation with a view to determining conclusively**

**whether the tolerance is adequate and to amending Australian Design Rule 23 to incorporate more suitable testing for tyres operating under abuse of incorrect inflation.**

175. In making this recommendation the Committee fully acknowledges that no product can be designed and manufactured to withstand any level of abuse and that consumers must act responsibly. However, where possible, safety related products such as tyres must have some tolerance of consumer abuse.

## Consumer Abuse

### - Magnitude of the Problem

176. Evidence of motorists' failure to maintain correct inflation pressures was presented from several sources. A survey by the RACV showed that some 75% of a sample of 155 cars had one or more tyres inflated below the car manufacturers' recommendations and some 7% had tyres more than 56 kPa (8 psi) below that level[86]. A survey by Dunlop in 1979 indicated that 31.6% of tyres from a sample of 378 were underinflated, 9% of them by more than 8 psi in relation to the vehicle manufacturers' recommended cold pressures (though the tyres were warm and could have had a pressure build up of 14 to 28 kPa)[87]. It cannot be said categorically however that pressures even 56 kPa below the latter are unsafe as far as risk of failure is concerned. Nevertheless variations of that magnitude would usually constitute gross underinflation and would certainly have an adverse effect on tyre performance (see pp. 37-9).

177. The RACV was alarmed by the results of its survey and concluded that 'many motorists seem totally unconcerned or even aware that correct tyre pressures are vital to the handling, braking and occupant safety of every car'.[88]

178. The Committee concludes that the incidence of under-inflation of tyres in relation to vehicle manufacturers' tyre pressure recommendations is a serious cause for concern. The available evidence does not however help to establish the incidence of underinflation in relation to the recommendations of the Tyre and Rim Association which, it has already been said, are the appropriate basis for assessing the margin of safety in tyres.

179. It is therefore recommended that:

- the Office of Road Safety undertake a survey of in-service tyre inflation pressures to determine the incidence of underinflation, in relation to the recommendations of the Tyre and Rim Association, with a view to determining ultimately whether tyre designs and manufacturing standards take sufficient account of 'normal' levels of consumer abuse.

- Education of Motorists

180. The failure of motorists to maintain tyre pressures at appropriate levels may be the result of apathy, ignorance, and/or limited access to, or inaccuracies in, pressure gauges. No evidence was presented on the relative importance of these factors but all play a part and are often inter-related.

181. Witnesses emphasised the need for public education on tyre maintenance, and on tyre pressures in particular. Many motorists are unaware of the importance of tyre pressures in the handling of vehicles and their relevance to personal risk and tyre failure. It is also likely that many motorists do not know the correct pressures, or range of pressures, for their vehicle and even more are unaware of the appropriate inflation pressures when unusually high speeds or loads are involved.

182. The problem has been aggravated by the rapid move to the use of radial tyres. Motorists may often be unaware that radials are underinflated because, unlike bias ply tyres, they do not look underinflated until pressures are extremely low. Even tyres with pressures of 110 and 165 kPa (16 and 24 psi) look almost identical when placed side by side.[89] It was also suggested that radials permit better handling when underinflated than do other construction types. Therefore, handling characteristics often do not provide a clear warning to the average driver until tyres are grossly underinflated or difficult manoeuvres are required.[90] Finally, modern tubeless tyres tend to lose pressure more slowly so that some motorists may have lost the habit of checking their tyres. The frequency of checking has probably been further reduced by the introduction of self-service petrol stations and the less frequent servicing periods required by the modern car.

183. The tyre manufacturers claimed to have made strenuous efforts to educate consumers and produced a multiplicity of booklets, charts and stickers to support their claim. However they indicated that they had had only limited success and called for a major public education campaign. This lack of success is confirmed by evidence of tyre dealers and the surveys of tyre pressures referred to above.[91]

184. As the tyre manufacturers themselves pointed out, most tyres are now sold as original equipment or through independent tyre retailers so that tyre manufacturers have limited direct contact with users of tyres at the point of sale.[92] This suggests that the manufacturers' concentration of public education at the point of sale could never have had more than a limited effect. They have not taken such a narrow view when advertising, another form of public education, the relative merits of their own brands of tyres. In that case they attempt to reach all potential users through the mass media.

185. It is concluded that while the Australian tyre manufacturers have attempted to educate the public on the importance of tyre inflation pressures their approach has not been sufficiently broadly based and generally has not been sufficiently aggressive. It is further concluded that a strong case has been made for the need to educate the public on the maintenance of tyres, especially on the importance of correct inflation pressures.

186. The burden of this task should lie with tyre manufacturers who, as producers of goods with significant potential to cause harm through abuse, have a special responsibility to warn consumers as to what constitutes abuse and the possible consequences of such abuse. Tyre importers should share the burden.

187. The essential feature of a public education campaign must be an attempt to reach all motorists directly. Education at point of sale is worthwhile but its limitations are such that it can only be regarded as part of a broader-based campaign. Clearly the campaign needs to concentrate on the mass media. It may include information on tyre safety alone, comments or warnings in normal brand advertising, and active encouragement of well-informed feature reporting in the popular press and electronic media as well as the specialist press.

188. The resources of the public and private sectors should be pooled in the development, as opposed to implementation, of the campaign to maximise the prospects of success. This would be best achieved through the Publicity Advisory Committee on Education in Road Safety (PACERS). The Committee was informed that PACERS is already collecting printed material produced by tyre manufacturers and distributors in relation to tyre maintenance and safety checks. PACERS is considering the possibility of a publication by the Office of Road Safety for distribution on a national basis through State road safety organisations.

189. It is recommended that:

- the Publicity Advisory Committee on Education in Road Safety (PACERS) assist tyre manufacturers and importers in developing a model for a broad-based campaign to educate the public on the importance of tyre maintenance, especially of correct tyre pressures, and

- the burden of responsibility for funding and implementing the campaign lie with tyre manufacturers and importers and that the Department of Transport monitor the campaign with a view to advising the Government on the need for regulatory action should the efforts voluntarily undertaken be inadequate.

- Pressure Gauges

190. Witnesses informed the Committee that pressure gauges at service stations, and even at tyre dealers' premises, are often inaccurate.[93] This evidence was supported by a survey conducted by the NRMA of thirty-four tyre pressure gauges in Sydney service stations.[94] Six were inaccurate by at least 28 kPa (4 psi), two gave readings 70 kPa (10 psi) below the correct level and one gave readings 40 kPa (6 psi) above it. The survey concluded that motorists should buy their own tyre gauge and keep it in the glovebox.

191. The importance of tyre inflation pressure, both for handling and tyre endurance, has already been demonstrated. Clearly motorists must have access to accurate pressure gauges in order to maintain correct pressures. Because it is to service stations that they turn for this facility, and reasonably so, it follows that gauges in service stations should be accurate. Too

often this is not the case. Evidence suggested that the inaccuracy of gauges results principally from abuse by motorists and lack of maintenance by service station operators.[95] Wall gauges are expensive but for obvious reasons would substantially reduce the difficulty of keeping gauges accurate. A gauge is available to permit service station operators to check the accuracy of their own gauges or of their customers'.[96]

192. The present situation with regard to tyre pressure gauges is most alarming. It is concluded that action must be taken to ensure that service stations and tyre dealers make pressure gauges available to their customers and that these gauges be kept accurate within a reasonable margin, probably plus or minus 14 kPa (2 psi). Because of the significant public safety factor involved in the need for accurate measurement of tyre pressures there can be no doubt that it is at least as important that tyre pressure gauges be accurate as it is that shop scales or petrol pumps be accurate, as is presently required by State laws. For constitutional reasons regulation of this kind could only be undertaken at State and Territory level.

193. It is therefore recommended that:

- **the Department of Business and Consumer Affairs consult with its State and Territory counterparts with a view to the initiation of regulatory action at those levels to require that service stations and tyre dealers keep accurate tyre pressure gauges and that gauges be checked regularly by authorities responsible for weights and measures.**

194. No direct charge should be made on customers for the use of tyre pressure gauges. This could prove a disincentive to some motorists. Rather, the cost of providing the service should continue to be recouped indirectly, probably through the price of petrol. The additional costs resulting from implementation of the Committee's recommendation would be very small indeed.

195. Owners of personal pressure gauges find it difficult to have their accuracy properly checked. Such people are usually keenly aware of the need for tyre safety, and in particular of the desirability of checking tyres when cold, but their diligence goes unrewarded if their gauge is inaccurate. Sales of personal pressure gauges have fallen in recent years and many of the facilities once made available for checking them have been closed down because of lack of demand.[97]

196. It is recommended that:

- facilities for checking the accuracy of personal tyre pressure gauges be made available in Departments of Weights and Measures, or their equivalents, and on the premises of the Australian pressure gauge manufacturers and that the availability of the service at those points should be made known to consumers at the point of sale.

- Warning Devices

197. Research and development is being conducted in many quarters on devices to warn drivers automatically of incorrect tyre pressure. The Committee is aware of only one being marketed commercially. This device relies on electro-magnetic signalling and provides for an illuminated display to be mounted in the driving compartment. The display enables the identification of any underinflated tyre. An audible warning is also given. Automatic compensation is provided for increased tyre temperatures resulting from operation of the vehicle or from variation in ambient conditions. It is understood that the device is first to be offered as an optional extra on certain Alfa Romeo models.[98]

198. The Committee considers warning devices hold some promise of improved tyre safety. The Office of Road Safety shares this view.[99]

199. It is therefore recommended that:

- the Australian Transport Advisory Council introduce into the Australian Design Rules a requirement that all new passenger cars and similar vehicles be fitted with monitoring and warning devices which will acquaint the drivers of these vehicles with a hazardous loss of inflation pressure in any tyre, including the spare tyre.

- Statutory Tyre Pressure Requirements

200. Tyre pressures are of such importance to safety, both in terms of performance and risk of tyre failure, that motorists should be required to maintain their tyres at appropriate pressures. Clearly, at present, reliance cannot be placed on service station pressure gauges and owners of personal gauges face difficulties in having them tested for accuracy. However, if the Committee's recommendation on regulation to ensure the accuracy of pressure gauges is implemented this impediment would be removed.

201. The variety of 'correct' tyre pressures for different conditions, notably speed and load, would create further difficulty for regulations aimed at deterring underinflation. Nevertheless, a minimum inflation pressure could be established. This minimum would be the vehicle manufacturer's recommended pressure for normal operating conditions.

202. It is therefore recommended that:

- the Australian Transport Advisory Council (ATAC) amend Draft Regulations to provide that it should be unlawful for a vehicle to be operated with tyre pressures below those recommended by the vehicle manufacturer for normal operating conditions.

Reconditioned Tyres

203. Expert witnesses suggested that the wear undergone by the carcass of a tyre which has outworn one tread life must make it more susceptible to failure than a new tyre.[100] This argument is persuasive and is supported by United Kingdom research. A study of tyre failures found that if the relative risk of failure of an original treaded tubeless tyre were taken as one, that of a retreaded tubeless tyre was 2.6 and a retreaded tyre with tube was 4.8. Specifically, tread separation and blow-outs were found to be much more frequent for retreads. Similar results were found in a motorway study.[101] A significant finding of the latter study was that retreaded tyres on commercial vehicles were twice as liable to punctures and about four times as liable to burst as tyres with original tread.[102]

204. The Standards Association of Australia has published a non-mandatory standard specification on retreaded passenger car tyres.[103] The specification sets out minimum requirements for the retreading of passenger car tyres, and defines the performance, and dimensional and physical requirements for the tyres. The specification includes requirements for retread materials, limits of damage, processing, marking, and final inspection. The standard was prepared at the request of the Advisory Committee on Vehicle Performance (ACVP) and the SAA Consumer Standards Advisory Committee. The objective of the

former in seeking the standard was to provide for in-service implementation of ADRs 23 and 24 in respect of retreaded tyres. Although the specification is not mandatory it has been taken up in Draft Regulation 804 which states that, after 1 January 1980, passenger cars may not be fitted with retreaded tyres unless they have been processed and marked in accordance with the provisions of the SAA specification. Not all States and Territories have adopted the Draft Regulation into legislation so that in some parts of Australia compliance with the standard is not required.

205. Because of the inevitably used condition of the carcass, retreaded tyres are especially at risk if subjected to excessive heat build up created by high speed, underinflation or overloading. Any other structural weaknesses resulting from poor processing or inadequate inspection of carcasses would also be subjected to stress. The Standards Association specification sets down a maximum speed limit of 120 km/h for retreaded bias ply and bias belted tyres and 135 km/h for radials. However it only requires that the tyres be marked 'Speed Limited'. The ACVP consider this adequate because the speed capability of tyres meeting the standard is in excess of the legal speed limit.[104] The Committee rejects this as a valid reason for not requiring specific maximum speed markings. The ACVP has not applied the same argument to tyres with original tread. The criterion used there is that the performance speed rating of any tyre fitted to a vehicle must not be less than the maximum speed of the vehicle and the speed rating must be marked on the tyre. The Committee is convinced of the need for an explicit speed limit marking on retreaded tyres because of their susceptibility to failure at significantly lesser speeds than tyres with original tread.

206. On a more general level the Committee is concerned that in some States retreaded tyres are less subject to regulation than new tyres. This is unacceptable. Mandatory standards are needed and the appropriate basis for them is the Standards Association of Australia specification, amended to cover marking

for maximum speeds. These standards should be enforced at the point of sale. This approach places appropriate responsibility on manufacturers and retailers and can be effectively enforced.

207. It is therefore recommended that:

- **Australian Standard specification AS 1973-1976 (Retreaded Pneumatic Passenger Car Tyres) be amended to provide for specific maximum speed marking, that the specification be adopted as a mandatory standard under the Trade Practices Act, and that it be enforced at point of sale.**

## Tubed and Tubeless Tyres

208. Tubeless tyres are less susceptible to puncture and to sudden deflation.[105] The latter phenomenon is of course more hazardous than a slow puncture. Whereas a penetrating object larger than, say, a nail may cause a split rather than a small hole in a tubed tyre, the same object is likely to enter and be gripped by the liner of a tubeless tyre resulting in only slow deflation.[106] The rate of punctures for tubed tyres was shown in a British study in 1969 to be about four times that of a tubeless tyre.[107] Impact fracture, for example as a result of running over a brick, can have more serious consequences in tubed tyres. The damaged inner plies may chafe the tube until it fails catastrophically. In tubeless tyres the same damage tends to work through the liner and finally results in slow deflation.[108]

209. Users of retreaded tubeless tyres are advised to use tubes if there is any doubt as to the integrity of the tyres' liner or beads. (This is required by Draft Regulations).

210. Although the additional risk of failure, especially of punctures, in tubed tyres is well-documented the Committee received no evidence to indicate that risk of accident is significantly increased. A recent Melbourne study concluded:

> 'The results do not suggest that the tube status of a tyre is a significant factor in vehicle safety'.[109]

211. Professor Joubert raised a separate issue relevant to the safety of tubeless tyres. He expressed concern about flat ledge safety rims which have no hump or raised bead. He was aware of instances where inflated tyres had not been retained by such rims though he was not in a position to generalise about them. He suggested there is a need to test flat ledge rims to determine whether they can in fact maintain the required side force to retain tubeless tyres.[110]

212. **It is recommended that:**

- **the Office of Road Safety investigate flat ledge rims to determine whether they can safely retain tubeless tyres.**

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68 Evidence, p. 1078.

69 Detailed descriptions of these and other modes of failure are at pp. 1078-1087 of the evidence.

70 Evidence, p. 1087.

71 For example, evidence pp. 122-3, 1162.

72 Evidence p. 1165.

73 Evidence, p. 1166.

74 Evidence, p. 1353.

75 For example, evidence, p. 133.

76 Evidence, pp. 1444, 1446 and 1454.

77 Evidence, pp. 1367-8.

78 Evidence, p. 1604.

79 Evidence, p. 1444.
80 Evidence, p. 1542.
81 Evidence, p. 1601.
82 Evidence, pp. 1615-6.
83 For example, evidence, pp. 10, 512.
84 Evidence, pp. 1136, 1753.
85 Evidence, p. 1121.
86 Evidence, p. 578.
87 Evidence, p. 1888.
88 Evidence, p. 578.
89 Evidence, pp. 1073, 1539.
90 Evidence, p. 1131.
91 For example, evidence, pp. 82, 222-4.
92 Evidence, p. 1100.
93 For example, evidence, pp. 595, 1138, 1514.
94 Exhibit No 45.
95 For example, evidence, pp. 576, 586.
96 Evidence, pp. 591-4.
97 Evidence, pp. 584, 590.
98 Evidence, pp. 1945-6.
99 Evidence, p. 1356.
100 Evidence, pp. 760, 1538.
101 Hoffman, p. 10. The studies were conducted by Farr (1969) and Starks (1966) respectively.
102 Review of Truck and Bus Design in Relation to Road Safety, P.N. Joubert, Department of Transport, 1973, p. 55.
103 AS 1973-1976, 'Retreaded Pneumatic Passenger Car Tyres'.
104 This was stated in the Government response to the Committee's report on Passenger Motor Vehicle Safety.
105 Evidence, p. 632.
106 Evidence, p. 1154. Sweatman and Joubert p. 399.
107 Hoffman, p. 10. See also Sweatman and Joubert, p. 399.
108 Evidence, p. 1154.
109 Report of the Road Accident Research Unit, p. 54.
110 Evidence, p. 764.

## CHAPTER 5

## THE ROLE OF TYRES IN ACCIDENTS

### Passenger Cars

213. Data on the role of tyres in accidents in Australia and overseas are limited and inconsistent. A basic problem is the difficulty of determining whether a tyre has deflated before or during an accident and the lack of the required expertise on the part of those who normally report on accidents.

214. The Adelaide In-Depth Accident Study conducted by a team of specialists found that not one of the 304 accidents attended was caused by tyre failure.[111] The following table shows other tyre-related defects noted:

| | Total accidents for which defects were reported | Accidents where defects may have been a contributory factor |
|---|---|---|
| Fitting of tyres and rims not in accordance with ADR 24 | 14 | 1 |
| Inadequate tread depth | 111 | 7 |
| Tyre mismatch | 16 | 2 |

A recent study in Melbourne reported similar findings. Having noted that vehicle defects most frequently involve tyres and brakes the report concluded:

> '...the contribution of vehicle defects to the cause, or severity, of crashes in the [fatal and accident] samples

was quite small (about 1%) considering the high proportion of vehicles which would have failed current roadworthiness requirements.'[112]

215. The Melbourne study of utility pole collisions established that tread depth and incorrect inflation pressures raise significantly the relative risk of accidents.

216. Each of these studies involved metropolitan crashes. Tyres may be more important in rural accidents. No full-scale study of rural accidents has been conducted in Australia. However, a pilot study of eighty-one casualty accidents occurring within 160km of Brisbane in 1969-70 concluded that two accidents resulted from blowouts, one loss-of-control accident was probably caused by a flat tyre and two other accidents involved vehicles with bald tyres.[113]

217. Some overseas studies have reached conclusions similar to those of the Australian studies but some have shown a much more significant role for tyres. A 1962 study on the London-Birmingham motorway found tyre failure to be the cause of 13% of car accidents.[114] A study on the British MI motorway in 1963 found 10.2% of multiple vehicle crashes and 32.4% of single vehicle accidents were caused by tyre failure. On the other hand, a 1969 study on the Illinois Tollway showed tyre disablement contributed to no more than 2.4%, and possibly as few as 0.9%, of all accidents.[115]

Motorcycles

218. Very little data exist on the role of tyres in motorcycle accidents.

219. NSW statistics show that from 1976 to 1978 motorcycle accidents involving tyre failure fell from 0.8% to 0.6% of all motorcycle accidents. The Adelaide In-Depth Accident Study found

only one case of a motorcycle defect of any kind to be relevant to the cause of the accident and noted that some 90% of the motorcycles had two 'good' or 'as new' tyre treads.[116]

220. A 1979 urban Los Angles study of almost 1000 motorcycle accidents found that 5% of such accidents had a contributory front tyre element and 7.2% had a contributory rear tyre element.[117]

221. A study on the London-Birmingham motorway in 1962 found nine out of eighteen, that is 50%, of motorcycle accidents involved tyre failure. Dr M. Wigan suggested that this finding was significant because the most common forms of motorcycle accidents, collisions involving failure to observe right of way, are virtually absent on the motorway. He considered tyre failure is therefore likely to be important in single vehicle accidents in rural Australia where similar conditions and speeds apply.[118]

Trucks and Buses

222. Little substantive evidence was received on the role of tyre failure in trucks but some witnesses suggested it is probably small.[119] Attention was drawn to NSW statistics for 1977 showing three fatal truck accidents involving tyre failure and none involving smooth tyres. These represented 0.36% of fatal accidents (0.2% in 1976). Tyre failure was shown to be even less significant in accidents involving injury.[120] The weaknesses in such official statistics have already been discussed. The Committee notes however that evidence from fleet operators was consistent with the NSW statistics.

223. Data on the involvement of buses are also very limited. The Bus Proprietors Association (NSW) quoted NSW accident statistics to support its view that the rate of accidents involving buses and coaches is so low as to obviate the need for

additional regulation on tyres.[121] Again, the statistics can be regarded only as a general guide in the absence of detailed investigation. Account needs to be taken, for example, of kilometres travelled.

224. The Department of Transport has explored the possibility of investigating the extent to which tyres contribute to accidents involving commercial vehicles but has encountered delays in implementing such a study. This project must not be allowed to be delayed any longer.

## Conclusions and Recommendation

225. The limited available evidence suggests that tyres are a causative factor in only a relatively small proportion of accidents in Australia, although they may be more significant in rural than urban crashes, especially of motorcycles. However, the available data are so inadequate that these conclusions can only be regarded as tentative. The suspicion lingers that tyres may play a more important role in accidents than existing data generally suggest.

226. It is therefore recommended that:

- **future in-depth accident studies continue to attempt to determine the role of tyres in accident causation.**

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111 Evidence, p. 1181 .

112 Report of the Road Accident Research Unit, p. 78.

113 Evidence, p. 1181.

114 Sweatman and Joubert, p. 397.

115 Hoffman, p. 11.

116,117,118 Evidence p. 1814.

119 Evidence, pp. 611, 1472.

120 Evidence, p. 1006. See also evidence, pp. 1010 and 1019.

121 Evidence, pp. 979-986.

## CHAPTER 6

## REGULATION OF THE TYRE INDUSTRY

### Licensing and Training

227. Several witnesses, mainly tyre dealers or their associations, submitted that tyre dealers or retreaders should be licensed. This proposal was usually linked with a recommendation that training courses be established for personnel employed by them. It was generally suggested that licensed outlets should have trained personnel, adequate equipment, and be subject to licence disqualification for unlawful practices such as fitting tyres other than in accordance with traffic regulations.

228. The objective of the last proposal concerning unlawful practices would be substantially covered by the Committee's recommendations that Australian Design Rules be made applicable to replacement tyres and that these requirements be enforced at point of sale, and that standards for retreaded tyres also be adopted and be similarly enforced.

229. There are few formal training courses for personnel employed in the tyre retailing and retreading industries. Indeed, only one was mentioned in evidence. (It was run by the Victorian Automobile Chamber of Commerce.) The Committee received sufficient evidence on incorrect repairs, incorrect selection and fitment of tyres, and ignorance of relevant government regulations, to be convinced that the present lack of training courses is unacceptable. Whether there should be separate courses in tyre retailing and retreading, and whether such courses should be at apprenticeship or some lower level are questions which should be resolved in discussions between the tyre retailing and retreading industries and technical education authorities.

230. It is recommended that:

- the Department of Employment and Youth Affairs hold discussions with State and Territory technical education authorities and representatives of the tyre retailing and retreading industries with a view to implementation of training courses for employees in those industries.

231. The Committee has reservations about the licensing of tyre retailers and retreaders at this time. However, the need for such regulation should be kept under review. Much would depend upon the response to the availability of training courses and upon the effectiveness of point of sale control of tyre standards and regulations.

## Recalls

232. Australia has no uniform product recall legislation or other mandatory notification procedures governing defective or unsafe products. The Department of Business and Consumer Affairs and State and Territory consumer affairs authorities are currently examining the implications and desirability of such legislation.

233. Recall of original equipment tyres is covered by the vehicle manufacturing industry's voluntary recall code which was developed by the vehicle industry and endorsed by ATAC. The code has been drafted to encompass components such as tyres which have been supplied for original equipment use. The code also imposes an obligation on component manufacturers to undertake recalls in the replacement markets on the advice of the vehicle manufacturer. It is not clear that component manufacturers would always expect this obligation, since they were not involved in

the drafting of the code. It should be noted that one local manufacturer indicated that it had undertaken a recall in 1972 in accordance with procedures set down in the code.[122]

234. The Committee was informed that the United States mandatory recall system requires extensive records, resulting in high administrative costs to retailers [123]. Each tyre sale has to be registered so that a recall notice can be sent to the consumer concerned. The benefits of the legislation have nevertheless been demonstrated by the recent compulsory recall of some 13 million tyres by Firestone, and two million tyres by Uniroyal. The Firestone tyres were alleged to have had defects which resulted in some instances in accidents, injuries and even deaths.

235. Few tyre recalls have been undertaken in Australia. The recall in 1972, which took place before steel-belted radial production commenced, involved national advertisements asking owners of tyres with a specified period of manufacture code to return them to the manufacturer's dealers. New vehicle dealers' records were also used. Only about 40% of the tyres were returned[124].

236. Another local manufacturer, when it discovered problems with its steel-belted radials some three years ago in western New South Wales and Queensland, withdrew them from sale in those areas and informed people in those areas that suitable adjustments would be made on returned tyres. The tyres withdrawn were sold in metropolitan areas where, it was claimed, no problems were experienced. The company's representative was unable to specify the proportion of tyres returned during the recall but stated that it was far from 100%.

237. Two of the four manufacturers have never undertaken a recall. One indicated that its recall procedure would be to place press advertisements and withdraw tyres from dealers.

238. Despite the limited recalls undertaken evidence suggests significant rates of failure are at times experienced with batches of tyres [125]. It is not enough simply to adopt liberal adjustment policies on tyres in such batches after they have failed. They should be recalled as a safety measure before damage can be done. As indicated in Chapter 4 the Committee is convinced that one local tyre manufacturer would have been required, under a mandatory recall system, to recall tyres produced during the initial stages of its steel-belted radial production.

239. Existing arrangements have basic flaws. The Government presently has no power to order the recall of defective or unsafe goods already purchased (though the Minister for Business and Consumer Affairs may ban the sale of such products). The voluntary recall procedures are ineffective and leave much to chance. There is no onus on the manufacturer to inform government authorities or consumers at large of known or likely defects in their products. This is important because of the secrecy manufacturers attach to claim rates for defective products - they are usually the first, and sometimes the only ones, to know the magnitude of defect problems.

240. It is recommended that:

- **the Government introduce legislation to empower the Minister for Business and Consumer Affairs to require the recall of defective or unsafe products, such as tyres, and that the legislation place the onus on manufacturers to inform the Minister of any production batches in which an unacceptable proportion of products is found to be defective or unsafe.**

R.C. Katter
Chairman

June 1980

122 Evidence, p. 1424.

123 Evidence, pp. 692, 1372.

124 Evidence, p. 1427.

125 For example evidence, pp. 307, 325-8, 1801.

APPENDIX I

## CONDUCT OF THE INQUIRY

### Terms of Reference

The House of Representatives Standing Committee on Road Safety was appointed by resolution of the House of Representatives on 2 March 1978 to inquire into and report on:

(a) the main causes of the present high level of the road toll in Australia;

(b) the most effective means of achieving greater road safety in Australia;

(c) the particular aspects of the problem to which those concerned with road safety could most advantageously direct their efforts; and

(d) the economic cost to the community of road accidents in Australia in terms of -

(i) material damage;

(ii) loss of man hours and earning capacity; and

(iii) cost of treatment of accident victims.

These terms of reference are identical with those of the Standing Committee on Road Safety established in the Twenty-ninth and Thirtieth Parliaments and with the terms of reference of the Select Committees on Road Safety in the Twenty-seventh and Twenty-eighth Parliaments.

## Tyre Safety Inquiry

The Committee publicly announced its inquiry into Tyre Safety on 8 May 1979. This announcement included an invitation to interested individuals and organisations to make submissions. In addition manufacturers, importers, retailers, retreaders, Commonwealth and State road safety and regulatory authorities, research bodies, clubs and associations, and numerous other organisations were approached directly and invited to make submissions.

One hundred and nine submissions were received and sixty-seven witnesses appeared before the Committee. A list of witnesses is at Appendix 8.

Commencing on 2 October 1979 eight public hearings were held at which some 2,000 pages of evidence and many exhibits were taken. A list of exhibits is at Appendix 9. Published evidence is available for inspection at the House of Representatives Committee Office and the National Library of Australia in Canberra.

A number of inspections were undertaken during the Inquiry. On 3 October 1979 in Brisbane the Committee inspected the operations of Bandag Manufacturing Pty Ltd and Fletchers' Tyre Service. The Committee inspected the tyre production and related facilities of Goodyear, Olympic and Dunlop, on 30 October 1979 in Melbourne and those of Uniroyal in Salisbury, South Australia, on 5 December 1979.

APPENDIX 2

Tyres - Comparison of Industry Sales With Imports (Units)

Twelve Months - July '78 to June '79

| Item | Passenger | | | Light Truck | | | Other Truck | |
|---|---|---|---|---|---|---|---|---|
| | Textile Radial | Steel Radial | Bias | Textile Radial | Steel Radial | Bias | Radial | Bias |
| Imports by Manufacturers | 16,790 | 122,646 | 27,180 | - | 1,763 | 14,504 | 7,587 | 5,117 |
| Other Imports | 336,367 | 1,095,846 | 219,502 | 25,961 | 65,053 | 29,897 | 152,134 | 64,470 |
| Total Imports | 353,157 | 1,218,492 | 246,682 | 25,961 | 66,816 | 44,401 | 159,721 | 69,587 |
| Industry Replacement Sales | 1,067,614 | 2,386,696 | 1,318,415 | - | 28,990 | 345,591 | 94,463 | 337,927 |
| % Dutiable Imports to Replacement Market | 24.8 | 34.8 | 16.0 | 98.2 | 70.7 | 11.8 | 64.5 | 17.2 |
| Industry Sales (OE & Replacement) | 1,355,015 | 4,048,197 | 1,434,725 | - | 67,335 | 392,374 | 96,923 | 428,264 |
| Total Market | 1,691,382 | 5,144,043 | 1,654,227 | 25,961 | 132,388 | 422,271 | 249,057 | 492,734 |
| % Dutiable Imports to Total Market | 20.6 | 23.5 | 14.9 | 98.2 | 50.2 | 10.5 | 63.9 | 14.0 |

* Source: Submission by Australian Tyre Manufacturers' Association, Evidence, p. 1035.

APPENDIX 3

## REQUIREMENTS OF AUSTRALIAN DESIGN RULES 23 AND 24*

### AUSTRALIAN DESIGN RULE 23
(New Pneumatic Passenger Car Tyres)

. Performance

- Resistance to bead unseating (applicable to tubeless tyre). The bead must not separate from a rim when controlled side force is applied to the fully inflated tyre under specified test conditions.

- Tyre Strength. A minimum strength level is specified for resistance of the tyre to penetration by a cylindrical plunger with a hemispherical end. The test is performed on the tread area at five equally-spaced points on the periphery of the tyre.

- Tyre Endurance. Minimum endurance times are specified for tyres when tested on a large diameter flat-faced steel roller at a surface speed of 50 mph (about 80 km/h). The test is performed under controlled conditions and under a range of load conditions varying from the normal to the maximum rated load of the tyre.

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* The requirements listed are only summaries of the very detailed provisions of the Design Rules.

- High Speed Performance. The Rule specifies a minimum performance time without failure when the tyre is tested on a large flat faced steel roller at speeds up to 85 mph (about 137 km/h) for specified periods under load/inflation conditions.

. General Requirements

- *Physical Dimensions. The Rule prescribes tolerances* on section width and requires that the sum of the section width and the outer diameter of the tyre ('size factor') be no lower than a figure tabulated in the ADR for each tyre size designated.

- Labelling Requirements. Requirements are specified in the Rule which have the effect of ensuring that the following data are clearly and permanently moulded into the tyre wall:

  . tyre size designation;

  . performance rating (denoting maximum speed of vehicles for which the tyre is rated);

  . the maximum load specified for the tyre;

  . the identification of the manufacturer by name or brand name and an approved code mark;

  . the words 'tubeless', 'radial', 'belted bias' or 'bias belted' where applicable.

- The permissible loadings recommended by the tyre manufacturer for the various inflation pressures must comply with the data tabulated in ADR 23 unless otherwise approved.

- The tread of a tyre must incorporate four equally spaced treadwear indicators each of which must provide a visual indication when the tread has been worn to a depth of 0.063 inch (1.6mm).

**AUSTRALIAN DESIGN RULE 24**
(Tyre Selection)

. Placard

- A durable placard must be permanently affixed to the glove compartment door or in an equally accessible location. The placard must provide the vehicle owner with the following information:

  . the rim profiles nominated for the vehicle together with the corresponding tyre size designations recommended for the vehicle;

  . the maximum load and recommended pressures for normal operation for each tyre size for which the vehicle is approved;

  . recommended variations in tyre inflation pressures for loads other than normal, and for consistent operation at high speed.

. Choice of Tyres and Rims

- The Rule specifies the following requirements regarding the choice of tyres and rims:

  . all tyres fitted to a vehicle must be of the same type of carcass construction;

- the rims fitted to the vehicle must have bead seat and flange dimensions as specified in one of the national or industry standards nominated in the Rule;

- the maximum vehicle load on any tyre must not exceed the maximum load rating of the tyre;

- the normal vehicle load on any tyre must not exceed the test load specified for the ADR 23 high speed test for that tyre;

- the performance (speed) rating of any tyre fitted to a vehicle must not be less than the maximum speed of the vehicle;

- the inflation pressures shown on the vehicle placard must not be less than the pressure prescribed in the tables of ADR 23 for the tyre when at normal vehicle load.

APPENDIX 4

## DRAFT REGULATIONS ON TYRES*

Draft Regulation 120 requires that equipment (including tyres) fitted to a vehicle shall be maintained in good repair and that replacement equipment shall be manufactured and fitted to the vehicle so that continuing compliance with prescribed Design Rules is not compromised. Modifications which would affect the status of a vehicle's compliance with the Australian Design Rules may be introduced only where such modifications are options provided by the vehicle manufacturer or where the modifications have been approved by the vehicle manufacturer or where the modifications have been approved by an administering authority. Sub-section (2)(r) of this Regulation refers, in this context, specifically to ADRs 23 and 24.

Draft Regulation 801 relating to truck tyres requires that, unless otherwise approved by an appropriate authority, no vehicle shall be equipped with radial tyres inflated to a pressure of more than 825 kPa, or any other type of tyre inflated to a pressure of more than 700 kPa.

Draft Regulation No. 802 specifies a number of requirements relating to pneumatic tyres. These include the following:

(i) Each tyre must be free of visible defects which are potentially hazardous.

(ii) Each tyre must have a tread depth of not less than 1.5 mm.

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* Source: Submission by Department of Transport, evidence, pp. 1185-7.

(iii) Each tyre and rim must be of a size and capacity adequate to carry the maximum wheel load which may be imposed on that tyre by the vehicle.

(iv) No tyre may be fitted with cleats or similar devices.

(v) No tyre which has been recut or regrooved may be fitted to a vehicle, unless the tyre has been so constructed that it incorporates an extra depth of rubber between the carcass and the original tread of the tyre. This extra depth of rubber must have been provided with the intention of accommodating re-cutting or re-grooving and the tyre must be indelibly labelled that it has been constructed in this manner.

(vi) The sum of the mass carrying capacities recommended for all the tyres and rims with which the vehicle is equipped shall be not less than the Manufacturer's Recommended Maximum Gross Vehicle Weight for the vehicle.

(vii) Under certain circumstances, vehicles may be operated such that the loads on the tyres exceed the recommended load capacities in those tyres. Those relaxations are principally intended to be applicable to commercial vehicles.

(viii) Tyres of differing forms of carcass construction may not be fitted on opposite sides of the front or rear axles of a vehicle.

(ix) In the case of two axle vehicles with single wheels, mixtures of carcass constructions may be used only if fitted to the vehicle in the manner tabulated below:

| Form of carcass construction on front wheels | Form of carcass construction on rear wheels |
|---|---|
| Cross (Bias) Ply | Belted Bias |
| Cross (Bias) Ply | Radial Ply |
| Belted Bias | Radial Ply |

These last requirements of Draft Regulation No. 802 were recently reviewed, since it has been suggested that they do not adequately reflect the current views of tyre specialists regarding those combinations of tyre constructions which are acceptable. The Regulation was not amended.

Draft Regulation No. 803 requires that all passenger cars equipped with passenger car tyres comply with ADRs 23 and 24. Additionally in the case of passenger car derivatives and multi-purpose passenger cars not equipped with passenger car tyres, compliance with ADR 24 is required.

*Draft Regulation No. 804 specifies that, after 1 January* 1980, passenger cars may not be fitted with tyres which have been retreaded unless they have been processed and marked in accordance with the provisions of Australian Standard AS 1973 - 'Retreaded Pneumatic Passenger Car Tyres'.

Draft Regulation Nos. 1401 and 1402A specify, inter alia, maximum tyre loads for motor vehicles, trailers and combinations thereof.

Draft Regulation No. 1404 provides for the use of wide profile tyres to replace dual tyres. Wide profile tyres are defined as tyres having section widths not less than 450 mm. The requirements of this Regulation override any corresponding requirements of Regulation No. 802.

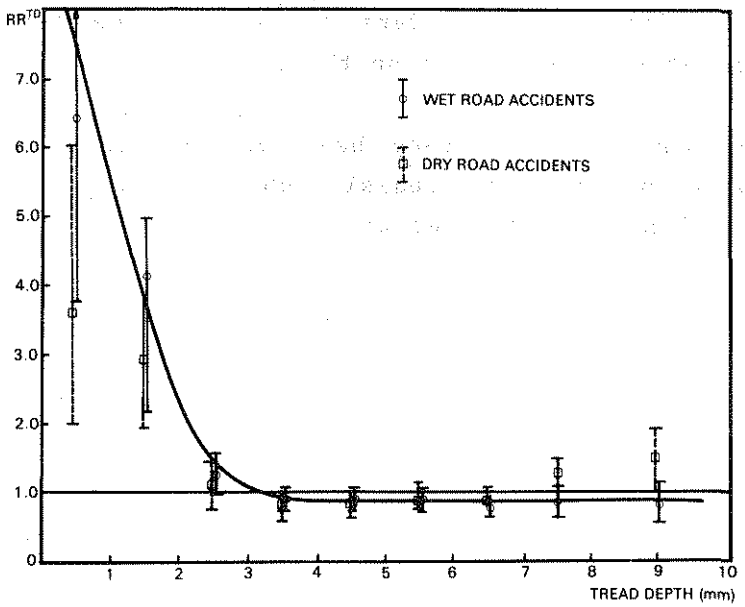
Draft Regulation No. 6011 specifies requirements for tyres fitted to trailers. Those requirements relate to the permissible load/inflation characteristics of trailer tyres and require the display, on a data plate, of the tyre and rim combinations which may be used on the trailer.

No State or Territory has yet adopted all the above Draft Regulations into its legislation. However, a number of these Regulations are enforced at the State level in one way or another.

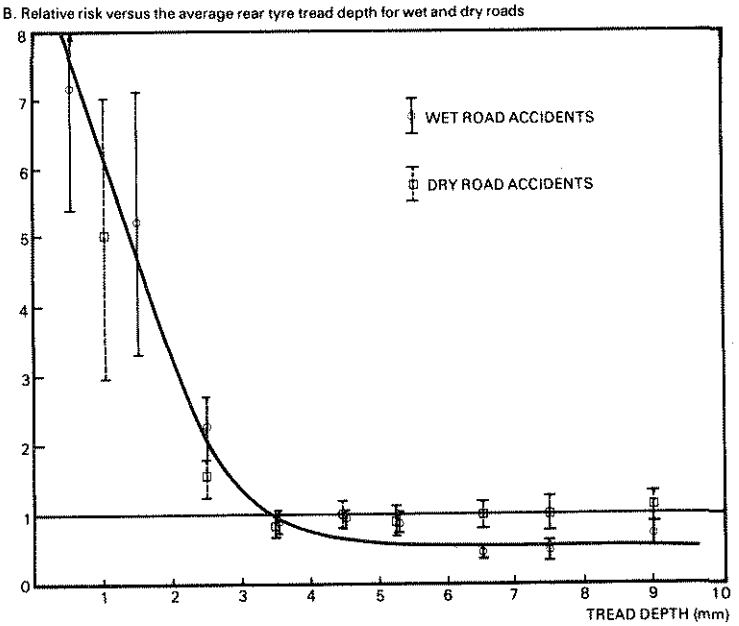
## APPENDIX 5

### TYRE TREAD DEPTH AND RELATIVE RISK OF AN ACCIDENT*

A. Relative risk versus the average front tyre tread depth for wet and dry roads.




B. Relative risk versus the average rear tyre tread depth for wet and dry roads




*Source: Fox, Good and Joubert, Collisions with Utility Poles, Department of Transport, February 1979, pp. 198-9. Exhibit No. 13.

Source: Fox, Good and Joubert, Collisions with Utility Poles, Department of Transport, February 1979, pp. 198-9. Exhibit No. 13.

APPENDIX 6

## EFFECT OF RADIAL RUN-OUT ON TEMPERATURE BUILD UP IN STEEL-BELTED PASSENGER CAR RADIAL TYRES*

It was demonstrated on a test wheel dynamometer to the Standing Committee, that addition of balance weights to cause gross unbalance to a rolling radial tyre, has a negligible effect on temperature build up.

Subsequently, three steel-belted passenger radials with low, average and above-average radial run-out, were run at 100 km/h on the test wheel dynamometer in an ambient temperature of 37°C.

The temperature build up was measured at different points around the tyres including that in the vicinity of the run-out.

The results are listed below and the general conclusions are:

(i) There is no correlation between run-out and tyre temperature.

(ii) The tyre with higher than average run-out showed the lowest temperature build up.

(iii) The tyre run-out when on the rim does not necessarily relate to the true tyre run-out which is measured on a true running rim.

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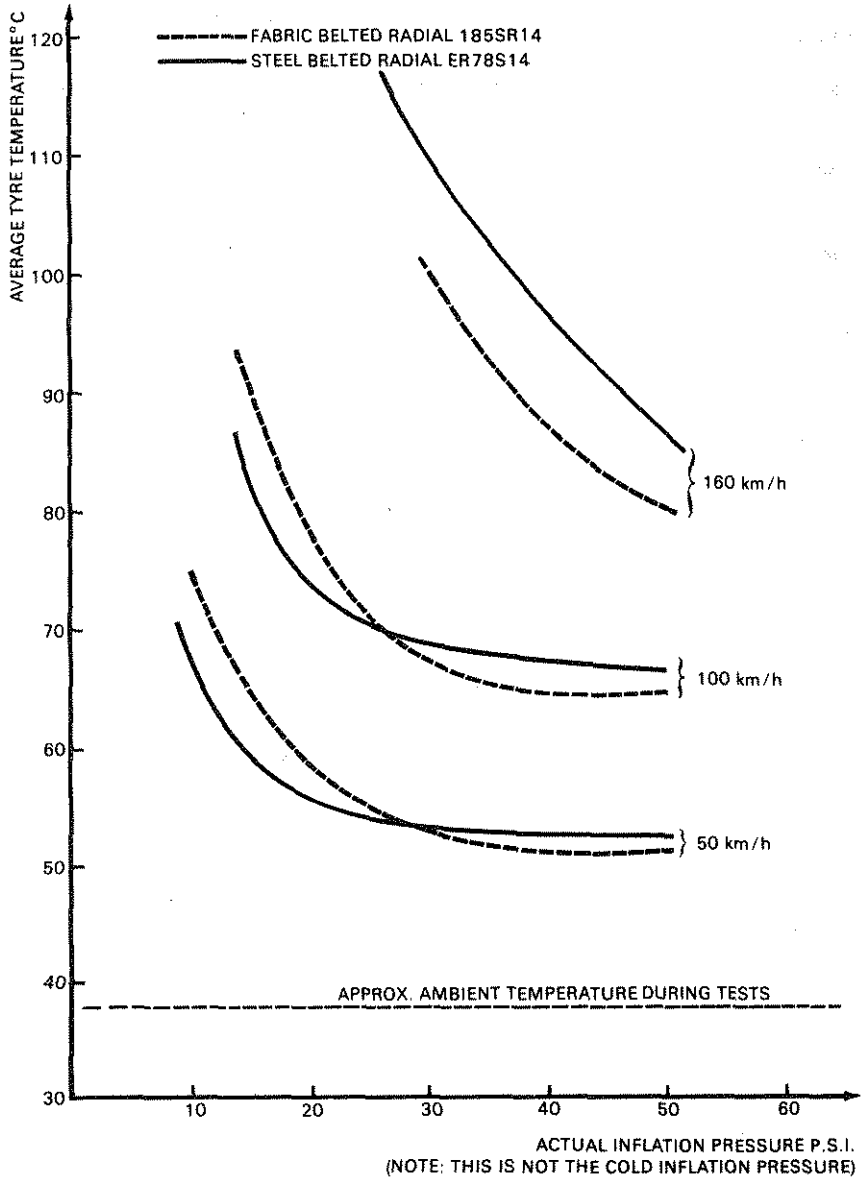
* Source: Evidence, pp. 1444, 1446.

| | | | Tyre Temperature (°C) | |
|---|---|---|---|---|
| | Actual Runout | Run | Shoulder | Centre |
| TYRE 1 | Average | 1 | 65-69 | 60-61 |
| | | 2 | 65-68 | 56-60 |
| TYRE 2 | Lower Than Average | 1 | 61-68 | 55-59 |
| | | 2 | 64-67 | 55-59 |
| TYRE 3 | Higher Than Average | 1 | 61-63 | 51-56 |
| | | 2 | 60-68 | 51-57 |

## APPENDIX 7

### TYRE INFLATION PRESSURE AND TEMPERATURE BUILD UP –RADIAL CAR TYRES

*The following graph shows average tyre temperature against inflation pressure at various speeds and loaded to equivalent maximum 24 p.s.i. load.*




*Source: Evidence, p. 1445 (Olympic).*

Source: Evidence, p. 1445 (Olympic).

APPENDIX 8

## LIST OF WITNESSES*

| | |
|---|---|
| ANDERSON, MR R.J. | Factory Manager, Jax Tyres Pty Ltd, Girraween, New South Wales. |
| AUSTIN MLA, MR B.D. | Parliament House, Brisbane. |
| BURTON, MR W.P.H. | Acting Deputy Mechanical Engineer, Department of Main Roads, Sydney. |
| BUTLER, MR K.A. | Engineer, RVB Limited, Spotswood, Melbourne. |
| BUTLER, MR K.W. | Managing Director, RVB Limited, Spotswood, Melbourne. |
| BYRON, MR H.R. | Director, Operations and General Works, Department of Housing and Construction, Canberra. |
| CASEY, MR T.P. | Materials Engineer, Australian Mineral Development Laboratories, Frewville, South Australia. |
| CIOCCARELLI, MR V.P. | Executive Member, Police Association of New South Wales, Sydney. |
| COLEBATCH, Dr P.R. | Representative, Australian Consumers' Association, Chippendale, New South Wales. |
| COXON, MR C.G. | Managing Engineer, Chassis Engineering, Chrysler Australia Limited, Clovelly Park, South Australia. |
| CREMEN, MR K.J. | Secretary, Australian Tyre Manufacturers Association, Canberra. |
| CROTHERS, MR N.G. | Representative, Australian Consumers' Association, Chippendale, New South Wales. |
| CULSHAW, MR G.V. | General Manager, Tyre Division, Uniroyal Pty Ltd, Salisbury, South Australia. |

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* Only the names of witnesses who gave oral evidence at hearings are included in this list. Some of the submissions not examined at hearings were dealt with as exhibits (Appendix 9), while others were simply made public.

| | |
|---|---|
| DAVIES, MR R.W.B. | First Assistant Secretary, Transport and Storage Division, Department of Administrative Services, Canberra. |
| DEWEY, MR G. | Immediate Past President, Bus Proprietors Association (NSW), North Parramatta, New South Wales. |
| EDWARDS, MR N.S. | Technical and Development Manager, Dunlop Australia Limited, Port Melbourne, Victoria. |
| EDWARDS, MR R.A. | Chairman, Queensland Tyre Dealers Association, Milton, Queensland. |
| EGAN, MR K.P. | President of the Australian Tyre Dealers Association, Melbourne. |
| FENTON-SMITH, MR R.E. | Chairman, Australian Tyre Manufacturers Association, Canberra, Australian Capital Territory and General Manager, Corporate Affairs, Dunlop Australia Limited, Port Melbourne, Victoria. |
| FLETCHER, MR E.R. | Proprietor, Fletcher's Tyre Service, Yeronga, Queensland. |
| GARTSHORE, MR I.W. | Past President and Vice Chairman, Queensland Tyre Dealers Association, Milton, Queensland. |
| GERAGHTY, MR J.J. | Managing Director, Straight Talk Tyre People Pty Ltd, Revesby, New South Wales. |
| GILLHAM, MR T.W. | Member of Transport Committee, Australian Institute of Petroleum, Melbourne. |
| GLANVILLE, MR P.R. | Bureau Solicitor, West Australian Bureau of Consumer Affairs, Perth. |
| GLEDHILL, MR R.E. | Chairman, Technical Committee, Bus Proprietors Association (NSW), North Parramatta, New South Wales. |
| GOOD, DR M.C. | Senior Lecturer in Mechanical Engineering, University of Melbourne, Victoria. |
| GOULD, MR C.J. | Managing Director, Brisbane Tyre Service Pty Ltd, Red Hill, Queensland. |
| GRICE, MR J.S. | Chairman, Industry Technical Sub-committee, Australian Tyre Manufacturers Association, Canberra. |

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|---|---|
| HARRISON, MR N.P. | Member of Transport Committee, Australian Institute of Petroleum, Melbourne. |
| HOWLETT, MR D.R. | National Sales Manager, Bandag Manufacturing Pty Ltd, Wacol, Queensland. |
| HUTTON, MR G.A.J. | Assistant Secretary (Operations), Transport and Storage Division, Department of Administrative Services, Canberra. |
| JACKSON, MR G.H.D. | Director (Technical), Transport and Storage Division, Department of Administrative Services, Canberra. |
| JANE, MR R.F. | Managing Director, Bob Jane Corporation Pty Ltd, Carlton, Victoria. |
| JOHNSON, MR C.R. | Assistant Director, Standards Association of Australia, North Sydney, New South Wales. |
| JOHNSON, MR G.W. | Assistant Secretary, Trade Practices Operations Branch, Department of Business and Consumer Affairs, Canberra. |
| JORDAN, MR M.J. | Research and Administration Manager, The Olympic Tyre and Rubber Co. Pty Ltd, West Footscray, Victoria. |
| JOUBERT, Professor P.N. | Professor of Mechanical Engineering, University of Melbourne, Victoria. |
| KERR, MR A.G. | First Assistant Secretary, Trade Practices and Consumer Affairs Division, Department of Business and Consumer Affairs, Canberra. |
| KEEFE, Senator J.B. | Cape Pallarenda, Queensland. |
| LACHOWICZ, MR A. | Chief Executive Officer, Consumer Affairs Bureau, Melbourne. |
| LEE, MR D.G.F. | Development Manager, Bandag Manufacturing Pty Ltd, Wacol, Queensland. |
| LUDLAM, MR B. | Mechanical Design Engineer, Chrysler Australia Limited, Clovelly Park, South Australia. |
| McDONALD, MR B. | Senior Technical Officer, Standards Association of Australia, North Sydney. |

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| McGRATH, MR R.J. | Committee Member, Federation of Austraian Motor Cyclists, Victorian Branch. |
| MANSFIELD, MR D.G. | Assistant Secretary, Plant and Workshops, Department of Housing and Construction, Canberra. |
| MOORE, MR M.R. | Factory Manager, Straight Talk Tyre People Pty Ltd, Revesby, New South Wales. |
| MULLER, MR J.J.F. | Managing Director, Mullers Tyre Distributors Pty Ltd, Townsville, Queensland. |
| MURPHY, MR K.A. | Engineer/Secretary, Standards Association of Australia, North Sydney, New South Wales. |
| OLLE, MR G.D. | President, Federation of Australian Motor Cyclists, Victorian Branch. |
| OSBORNE, MR B.N. | Committee Member, Motorcycle Riders Association, Melbourne. |
| PAGE, MR R.W. | General Secretary, Police Association of New South Wales, Sydney. |
| PERMEZEL, MR J.H.W. | Director, Vehicle Structures Safety Branch, Commonwealth Department of Transport, Melbourne. |
| RANDERSON, MR A.R. | General Manager, Bandag Manufacturing Pty Ltd. Wacol, Queensland. |
| READ, MR G.J. | Committee Member, Federation of Australian Motor Cyclists, Victorian Branch. |
| SCHUBERT, MR J.E. | Manager, Tyre Marketing, Goodyear Tyre and Rubber Co., Sydney. |
| SCICLUNA, MR A.C. | Committee Member, Motorcycle Riders Association, Melbourne. |
| SHATTOCK, MR C.J. | Chassis Engineer, General Motors-Holden's Ltd, Port Melbourne, Victoria. |
| SIM, MR B.V. | Motorcycle Riders Association (Queensland), Paddington, Queensland. |
| SWEATMAN, DR P.F. | Senior Research Scientist, Australian Road Research Board, Vermont South, Victoria. |

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| TINGLE, MR J. | Lane Cove, New South Wales. |
| TURLEY, MR I.F. | Executive Adviser, seconded to the Australian Tyre Dealers Association, Melbourne. |
| WELLS, MR B.R. | Engineer Executive, Australian Automobile Association, Canberra. |
| WHITROD, MR I.R. | Factory Manager, Tyre Division, Uniroyal Pty Ltd, Salisbury, South Australia. |
| WIGAN, DR M.R. | Chief Scientist (Transport), Australian Road Research Board, Vermont, Victoria. |
| WILLIAMS, MR I.M. | Manager, Automotive Engineering, Goodyear Tyre and Rubber Co., Sydney. |
| WILLIAMS, MR M. | General Manager, (Transport), Blue Metal Industries Limited, Wentworthville, New South Wales. |
| WOODWARD, MR H.K. | Executive Director, The Commercial Vehicle Industry Association of Australia, Bankstown, New South Wales. |
| YEEND, MR F.E. | Director, Office of Road Safety, Commonwealth Department of Transport, Melbourne. |

## EXHIBITS

| * Exhibit No. | Description |
|---|---|
| 1 | Mullers Tyre Distributors Pty Ltd. Document entitled: Uniroyal. Recommended Tyre Pressure for Radial Tyres. |
| 2 | Fletcher's Tyre Service. Attachments to submission:<br>. Correspondence with Standards Association of Australia.<br>. Tuckey, 'Wheels', June Volume 51, No. 1.<br>. Delivery Advice by the Olympic Tyre & Rubber Co. Pty Ltd.<br>. Newspaper clipping.<br>. Pamphlets: The Truth about Tyre Truing, Repco; How Good Are Steels? Dunlop. |
| 3 | Mr B.L. Austin. Attachments to submission:<br>. photographs of damaged tyres.<br>. receipt from the Olympic Tyre and Rubber Co Pty Ltd. for "Ford Validated" tyres.<br>. submission by Fletcher's Tyre Service. |
| 4 | Mr B.L. Austin. Correspondence tabled by Mr Austin. |
| 5 | Brisbane Tyre Service Pty Ltd. Clippings from Tyres & Accessories, June 1979:<br>. 'City and Guilds Examination For Retreaders'.<br>. 'Tyre Industry Under Fire in Australia'.<br>. 'There's No Need For You To Be As Ignorant As These . . . . . '. |

* Exhibits marked with an asterisk are confidential.

6 Department of Business and Consumer Affairs. Attachments to submission:

- New Pneumatic Passenger Car Tyres.
- New Pneumatic Highway Tyres (Other than Passenger Car Tyres).
- Retreaded Pneumatic Passenger Car Tyres.
- Queensland Traffic Regulations.
- Extract from Consumer Reports, April 1979.
- Federal Motor Vehicle Safety Standards under the National Traffic Motor Vehicle Safety Act 1966.
- Canadian Regulations.

7 Bob Jane Corporation Pty Ltd. Attachments to Corporation's submissions:

- Newspaper and magazine clippings, pamphlets and news release concerning tyre safety.
- Extracts from following publications:
  - The Physics of Tyre Traction - Theory and Experiment
  - The Performance and Failure of Car Tyres
- Choice report on tests completed in 1978.
- Transcript of radio interview.
- Extract from report received from Kleber, France.
- Letter from Kleber (Australia) Pty Ltd to Mr R. Jane.
- Graphs contained in document entitled: Summary of Kleber Check on Inflation.

8 Department of Business and Consumer Affairs. Documents entitled:

- Forewarnings of Fatal Flaws, Time, 25 June 1979.

- Firestone 500's Not The Only Problem Says Repair Shop Owner, Consumer Union News Digest, 1 March 1979.

9 R.V.B. Limited. Document entitled: Tyre Pressure Gauges.

10 Australian Automobile Chamber of Commerce. Paragraphs 2.2 and 2.6 and the Appendix to the Chamber's submission.

11 Australian Tyre Dealers Association. Document entitled VACC Training Within Industry: Tyre Serviceman Training Course.

12 General Motors - Holden's Limited. Photographs illustrating GM-H tyre testing activities.

13 Professore P.N. Joubert. The following reports:

- Tyre Safety Performance Characteristics: Review And Recommendations For Research, P.F. Sweatman and P.N. Joubert, Vehicle Research Group, University of Melbourne, May 1976 (Report VR 1).

- Collisions With Utility Poles, J.C. Fox, M.C. Good, P.N. Joubert, Department of Mechanical Engineering, University of Melbourne, (Report CR 1) February 1979.

- Collisions With Utility Poles Summary Report, J.C. Fox, M.C. Good, P.N. Joubert, Department of Mechanical Engineering, University of Melbourne (Report CR 2) February 1979.

14 Bridgestone Tire Co. Ltd. Submission, dated 20 July 1979.

15 Yokohama Rubber Co. Ltd. Japan. Document entitled: 1975 Safety Standards For Automobile Tires (Quality Standards Edition), Japan Automobile Tire Manufacturers' Association, Inc.

16 NSW Department of Public Works. Photographs of failed tyres.

17 Lismore Tyre Company. Photographs of failed tyres.

| | | |
|---|---|---|
| | 18 | Police Association of New South Wales. Document entitled. Report on an investigation of the high speed hazards of steel belted radial tires on police patrol cars. Jared J. Collard. U.S. National Bureau of Standards. June 1977. |
| | 19 | Mr J. Tingle. Attachment to submission and correspondence tabled by Mr Tingle. |
| | 20 | Standards Association of Australia. Copies of Australian Standards 1973-1976, 2230-1979 and D31-1973 and the following documents:<br>. The Australian Standards Mark, what it is, what it means, the advantages it offers.<br>. Standards Assocation of Australia, What it is and What it does.<br>. Standards Association of Australia, its status and activities. |
| | 21 | Commercial Vehicle Industry Association of Australia. Document entitled: Tire Stocks: Protecting a major investment. |
| | 22 | Australian Tyre Manufacturers' Association. The following documents:<br>. Tyre Care and Safety - Australian Tyre Manufacturers Association Booklet 1975.<br>. Building a Tyre - Dunlop (UK) Education Section.<br>. Safety Rules In Tyre Care - Australian Tyre Manufacturers Assocation Wall Chart, 1979.<br>. An Invitation to Become a Member of the Tyre and Rim Association of Australia. |
| | 23 | Dunlop Automotive and Industrial Group. Various documents for public education on tyres. |
| * | 24 | Dunlop Automotive and Industrial Group. Pages of submission containing confidential information. |

* Exhibits marked with an asterisk are confidential.

25 Bureau of Consumer Affairs, Western Australia. Document entitled: The Big Firestone 500 Recall - What Was Wrong With The Firestone Radial Tire, And What You Can Do If You Were Among The Stung.

26 Uniroyal Pty Ltd. Submission dated 27 November 1979 and sections of the submission dated 17 September 1979, entitled 'Tyre Engineering and Design' and 'Tyre Safety'.

27 Uniroyal Pty Ltd. Various documents for public education on tyres.

28 Brisbane Tyre Service. Correspondence concerning tyre fitters' training.

29 Bandag Manufacturing Pty Ltd. Correspondence concerning common age code branding, USA tyre grade labelling, and US motor vehicle safety standard on retreading.

30 Australian Automobile Association. Correspondence containing results of tyre pressure surveys in various States.

31 Australian Automobile Chamber of Commerce. Correspondence concerning training on tyre fitment.

32 Australian Consumers' Association. Correspondence concerning the adequacy of Australian Design Rules 20 and 23, and complaints received on steel-belted radials.

33 A Brief Study of Steel-Belted Radial Passenger Car Tyre Failures for New South Wales Department of Motor Transport Traffic Accident Research Unit. Report prepared by Layton Tyre Management, dated November 1979.

34 National Roads and Motorists' Association (NRMA). Correspondence concerning a tyre inflation pressure survey.

*35 Dunlop Automotive and Industrial Group. Correspondence containing tyre claims statistics.

*36 Correspondence from Goodyear Tyre and Rubber Co. (Australia) Limited concerning:

- production statistics and claim rates;
- non-uniformity limits;
- improvements to Goodyear tyres;
- tests on non-uniformity, underinflation, and high speed, and their effect on tyre endurance.

*37 Olympic Tyre and Rubber Co. Pty Ltd. Correspondence concerning production levels, claim rates and limits on non-uniformity.

*38 Chrysler (Australia). Correspondence concerning specifications for radial force variations.

*39 Uniroyal Pty Ltd. Correspondence concerning:

- tests on non-uniformity and underinflation and their effects on tyre endurance;
- adjustment rates;
- improvements to Uniroyal tyres.

*40 Kleber, Branche Pneumatiques, France. Submission.

*41 Sumitomo Rubber Industries, Ltd. Claim rate statistics.

42 Steel-Belted Radial Ply Passenger Car Tyres: An Enquiry into Alleged Failures, Report by Traffic Accident Research Unit, dated November 1979.

43 Report on Enquiries Made Concerning the Safety of Steel-Belted Radial Tyres, Department of Transport, dated January 1980.

*44 Dunlop Automotive and Industrial Group. Correspondence concerning claim rate statistics.

45 National Roads and Motorists' Association (NRMA). Report on a survey of the accuracy of tyre pressure gauges at Sydney service stations.

46 Department of Transport. Correspondence concerning measures taken by tyre manufacturers to reduce the sensitivity of their products to underinflation.

*47 Olympic Tyre and Rubber Co. Pty Ltd. Claim rate statistics.

*48 Uniroyal Pty Ltd. Claim rate statistics.

*49 Goodyear Tyre and Rubber Co. (Australia) Limited. Claim rate statistics.