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NSW Heavy Vehicle Crash Study Final Technical Report

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Abstract

This study was commissioned by the New South Wales Road Safety Bureau and the Federal Office of Road Safety to examine the causes of crashes involving heavy vehicles in New South Wales, Australia in 1988 and 1989 and to suggest countermeasures. **The study included a retrospective** examination of 83 fatal crashes involving heavy vehicles on two New South Wales highways, an analysis of mass data on heavy vehicle crashes in the State from 1982 to 1988, and an analysis of traffic, freight movement and environmental factors.

Keywords

road safety   trucks   driver behaviour   speed   fatigue   drink driving   road environment

RESEARCH REPORT

TO

ROADS AND TRAFFIC AUTHORITY NSW
AND
FEDERAL OFFICE OF ROAD SAFETY

NSW HEAVY VEHICLE CRASH STUDY
FINAL TECHNICAL REPORT
(AUGUST 1990)

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PREFACE

This report is the culmination of a three stranded study into heavy vehicle crashes in NSW. It is the Technical Report on the study. A comprehensive summary of the study is presented in a separate Executive Report.

Readers should note that this study included a retrospective examination of heavy vehicle crashes and that there is therefore some incompleteness regarding the crash data collected. Readers should also note that the countermeasures discussed in this report have not been subjected to any cost-benefit analyses. Care must therefore be used in drawing conclusions from the report. (Please refer to the Executive Report for a more detailed discussion).

Any conclusions or views expressed in this report are therefore those of the authors and not necessarily endorsed by the sponsoring organisations.

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	Sgt Tony McWhirter
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	Const Peter Lane
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Heggies Transport
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Refrigerated Roadways

EXECUTIVE SUMMARY

Briefed by the NSW Road Safety Bureau and the Federal Office of Road Safety, a consortium of consultants (Road User Research Pty Ltd, Monash University Accident Research Centre, Monash University Department of Civil Engineering and R A Pearson and Associates) has conducted a multi-level study of fatal and serious injury crashes involving heavy vehicles (trucks and coaches) in NSW. The study involved (i) detailed investigation of all fatal heavy vehicle crashes occurring on the Hume and Pacific Highways during 1988-1989, (ii) analysis of Road Safety Bureau mass data for all heavy vehicle fatal and hospital admission crashes in NSW. for the period 1982-1988 and (iii) analysis of economic activity, freight movement, traffic and weather data for the period 1982-1988. The overall objectives of the study were to (i) to ascertain the circumstances of, and factors contributing to, fatal crashes involving heavy vehicles in NSW in 1988-1989 and (ii) to provide a basis for the development of countermeasures to improve heavy vehicle safety.

NSW highways, and the Hume and Pacific Highways in particular, provide for a major share of the nation's interstate road freight task. Traffic and freight flows have grown significantly through the 'eighties, with freight flows showing quite large additional fluctuations. There was a large increase in freight flow on the Pacific and Hume Highways in 1988, and this was particularly marked on the Pacific Highway in the latter part of 1988.

The Hume and Pacific Highways are the scene of a significant number of the State's fatal and serious injury truck crashes. However, while the rate of such crashes on the Hume Highway is consistent with state-wide estimates, the rate on the Pacific Highway is up to 3 times higher than the Hume, taking into account relative freight and traffic flows on these highways.

In 1988, there was a state-wide increase in fatal and serious injury truck crashes. This followed a general period of declining crash numbers during the mid-'eighties. The 1988 increase took such crashes to a level above the predicted value based on the 1982-1987 downward trend (ie. 40% above the 95th percentile prediction). The major crash types contributing to the 1988 increase were found to be associated with high speed zones on undivided roads (involving head-on crashes with cars), involved unprotected road users, or involved ran-off-road crashes on curves. These problems were acute on the Pacific Highway but also applied to the Hume Highway. In addition to the effects of increased traffic and freight levels, factors contributing to the fatal truck

crash problem, and probably its increase in 1988, were found to be: night-time travel (and concomitants of poor lighting conditions), the behaviour patterns of road users in cars (including inattention, fatigue and alcohol use), the behaviour of unprotected road users in a road freight environment (involving alcohol and inattention), and the behaviour of truck drivers (involving high speeds and inattention). Major underlying factors in producing a severe truck crash environment in NSW are (a) undivided highways of poor standard (including narrow shoulders, presence of roadside objects, and a high incidence of poor horizontal and vertical road alignment) (b) a high incidence of night-time crashes, often in wet conditions (c) car drivers straying onto the wrong side of the road (presumably due to inattention, fatigue or poor visibility) and (d) relatively high truck speeds throughout NSW (ie. a significant proportion in excess of 120km/h).

Up to 60% of crashes could involve some element of driver fatigue, and up to 40% involve excessive speed by truck or car drivers.

Trucks were found to be responsible in about 45% of multi-vehicle fatal crashes involving trucks and in about 32% of truck-car crashes.

Coach crashes resulted in 67 of 235 heavy vehicle fatalities in 1989, but the small numbers of coach crashes prevented analysis of the trends for the years 1982-89.

The study specifically evaluated all known truck crash countermeasures for their relevance and likely effectiveness in each of the fatal truck crashes studied. The study's technical report contains a prioritized listing of countermeasures in the areas of roads, vehicles, heavy vehicle drivers, car drivers and the road system environment. These are expected to have significant benefits throughout NSW, and extending to other states. Roads countermeasures should be particularly targeted on the Pacific highway.

The most significant countermeasure is clearly the provision of divided highways on major freight routes as this eliminates exposure to head-on crashes and to poor road alignment. Significant benefits are also predicted from (i) road improvements (at blackspots, delineation, road shoulders, culvert protection), (ii) new truck technology (front structural redesign, cab strength), (iii) fitment of speed limiters to trucks, (iv) new enforcement technology (for alcohol and speed limits, and applying to both truck and car drivers), (v) new enforcement strategies (at known blackspots, concentrating on hazardous driving behaviour), (vi) removal of impediments to truck drivers' wearing of seat belts, (vii) truck improvements (removal of bullbars, front and rear under-run protection, elimination of insecure loading practices), (viii) new car technology (crashworthiness in frontal impacts with trucks), (ix) new technology to alert fatigued truck and car drivers, (x) training, education and technology transfer programs for truck drivers (vehicle performance capability and avoidance skills) and for other road users (appropriate behaviour in a road freight environment) and (xi) road freight operator accountability.

The study concludes that a long-range commitment to implementing a wide range of countermeasures is needed if future increases in truck fatal and serious injury crashes are to be prevented.

CONTENTS

1. INTRODUCTION

Heavy vehicle safety became an important issue in the late 1980s. Changes in the heavy vehicle speed limit, media treatment and several serious crashes involving heavy vehicles combined to raise community awareness. There was also increasing evidence that the road transport industry was operating under high pressure, leading to reported abuses of such regulations as speed limits and driving hours.

During late 1988 and early 1989, the Road Safety Bureau of the Roads and Traffic Authority became aware of a growing problem with fatal heavy vehicle crashes in NSW. Fatal crashes involving articulated trucks increased from 59 in 1987 to 120 in 1988. This represented an increase from 30% of Australia-wide fatals to 48%. By comparison NSW represents 31% of Australia's vehicle ownership, 34% of Australia's truck km of travel and 35% of the road freight task (tonne km) (SMVU data).

Fig 1.1 shows the trend of articulated truck fatal crashes over the period 1981-89 and allows comparison of Australia-wide and NSW data. It is apparent that the NSW reducing trend over the period 1984-87 is the most outstanding feature, and this was clearly reversed in 1988. The doubling of fatal crashes in NSW, and a corresponding 25% increase nationally, prompted the Road Safety Bureau and the Federal Office of Road Safety to jointly launch a detailed analysis of fatal and serious injury crashes involving heavy vehicles.

A consortium of consultants from Road User Research Pty Ltd, the Monash University Accident Research Centre, Monash University Department of Civil Engineering and R.A. Pearson and Associates was commissioned on September 27 1989 to undertake a detailed study of heavy vehicle crashes in NSW . The brief is reproduced in Appendix A.

The study aimed to (i) ascertain the circumstances of, and factors contributing to, fatal and serious injury crashes involving heavy vehicles and occurring in 1988 and 1989 and (ii) provide a basis for developing countermeasures to improve heavy vehicle safety.

The study consisted of three strands:

(i) Detailed examination of all available data on fatal and serious injury crashes involving heavy rigid trucks, articulated trucks and long distance coaches in NSW, concentrating on the Hume and Pacific Highways, and covering 1988 and 1989

(ii) Detailed analysis of the NSW mass crash data, covering 1982 through 1988, and determining how 1988 heavy vehicle crashes may have differed from previous years

(iii) Detailed analysis of exposure and economic data, covering travel, tonne-km and weather data for the period 1982 through 1988.

This multi-level approach was structured to gain a specific understanding of the NSW truck crash problem and to provide the basis for the development of countermeasures which could be implemented via NSW Government policy or Federal Government policy.

A number of specific research questions were formulated by RSB:

(i) Given that NSW in 1988 had a large problem with fatal articulated truck crashes, was the problem significantly different from other years?

(ii) Why are the Pacific and Hume Highways apparently a problem?

(iii) Given that fatal articulated truck crashes were higher in 1988 than 1987, why was the total number of articulated truck crashes lower in 1988 than 1987?

(iv) How does the heavy vehicle crash situation in 1989 compare to previous years?

(v) What were the causes and circumstances of heavy vehicle fatal crashes occurring in 1988 and 1989?

(vi) Were heavy vehicles more involved as cause or "key vehicle" in crashes in 1988 than in 1987 or 1989?

(vii) Did economic and travel activity in 1988 differ from that in 1987? If so, how?

(viii) What specific countermeasures are indicated by the outcomes of the study?

Question (i) is addressed in Strand 2 (Section 3) and in Strand 1 (Section 2).

Question (ii) is addressed in all Strands.

Question (iii) is addressed in Strand 2 (Section 3) and in Strand 1 (Section 2).

Question (iv) is addressed in Strand 2 (Section 3).

Question (v) is addressed in Strand 1 (Section 2).

Question (vi) is addressed in Strand 2 (Section 3) and in Strand 1 (Section 2).

Question (vii) is addressed in Strand 3 (Section 4).

Question (viii) is addressed in Strand 1 (Section 2).

In addition, Strand 3 considered economic and travel activity 1982-87 and weather 1982-88.

Consolidated answers to the research questions are given in Section 5.1.

Although tightly structured by the RSB brief, the study did change emphasis as it developed. Visits to crash sites and discussion with local personnel proved a very valuable data source. It was found that serious injury crash data commensurate with data on fatal and serious injury crashes could not be obtained, so it was decided to proceed with the greater detail of fatal crashes rather than accept the lowest common denominator of the serious injury crash data. Therefore Strand 1 only covered fatal, and not serious injury, crashes. The determination of specific countermeasures proved to require interactive analysis and considerable attention was devoted to this aspect of the study.

This report documents the investigations carried out under the three strands (Sections 2, 3 and 4), presents the countermeasure investigation (Section 5), and presents the consolidated study findings (Section 6) and conclusions (Section 7). Supporting material is included in Appendices.

Source: FORS road crash statistics

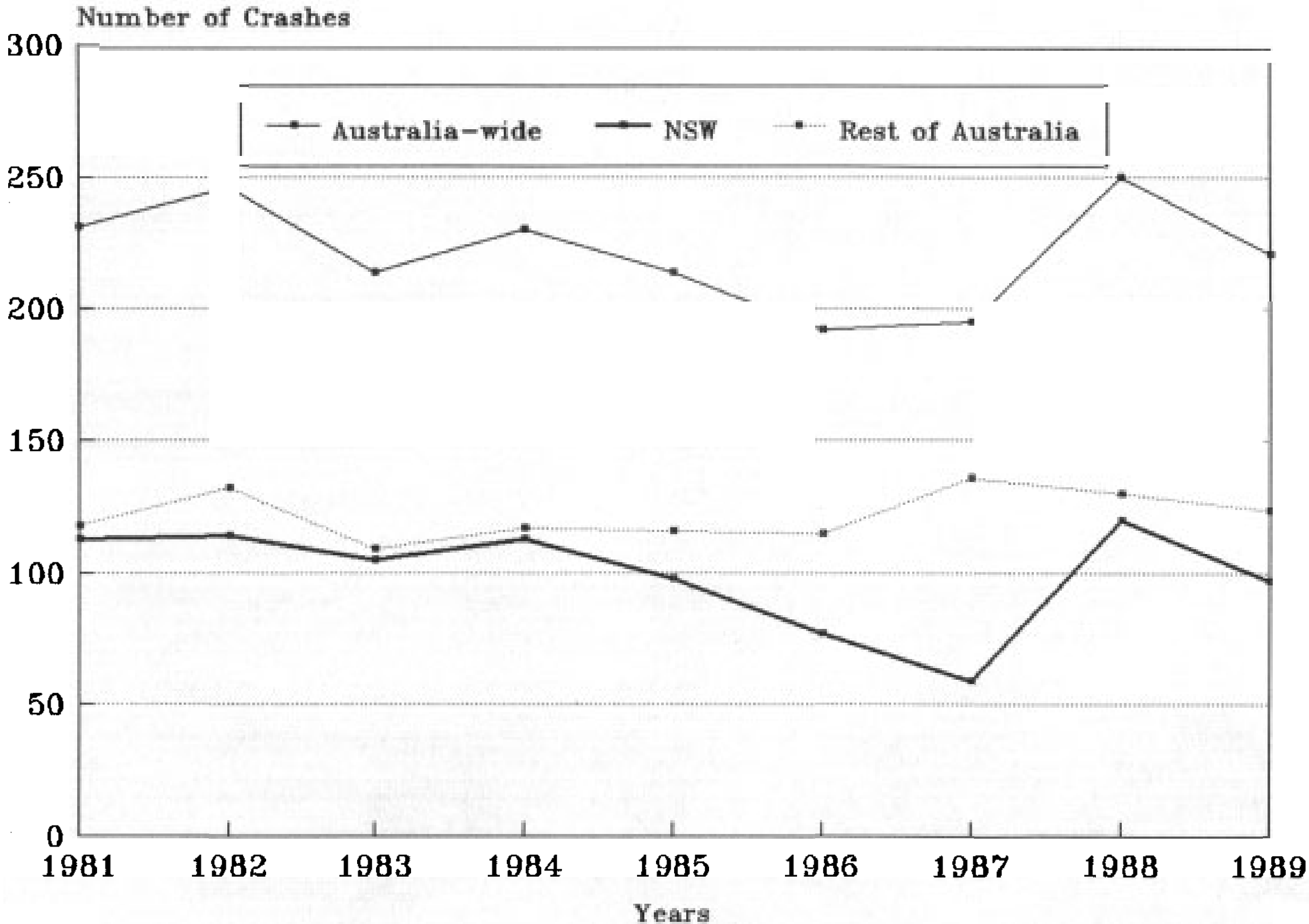


Fig 1.1 Articulated Veh. Fatal Crashes

2. DETAILED CRASH STUDY (STRAND 1)

All available information relevant to the circumstances of, and factors contributing to, heavy vehicle fatal crashes on the Pacific and Hume Highways in 1988 and 1989 was obtained and analyzed. A Level 2 approach was used, involving development of a data base, conferencing to incorporate multi-disciplinary views, and analysis of the data base to address the research questions. By way of example, while the RSB mass data base uses Road User Movement (RUM) Codes, the study developed more specific Crash Descriptors which include information on the responsible vehicle.

The study covered a total of 83 crashes. Of these, 47 were located on the Pacific Highway between Karuah and the Queensland border and 36 were located on the Hume Highway between Campbelltown and the Victorian border. While the Pacific Highway crashes were distributed fairly evenly, the Hume Highway crashes showed a significant clustering between Goulburn and Yass, and, to a lesser extent, in the vicinity of Gundagai.

A key element of the consortium's approach was first hand inspection of crash sites. This was combined with visits to relevant RTA, RSB and Police personnel. Subsequent to these inspections and visits, a number of specific items were followed up by telephone. Fig 2.1 is a diagrammatic representation of the data sources and analytical steps involved in Strand 1. Site inspections involved the use of the RSB mass data base, Police and Accident Investigation Squad reports and local RTA information. The key analytical step was the determination of contributing factors to crashes, and this was supported by Police reports, site inspections, vehicle and driver records and Coroners' reports. The development of countermeasures was supported by the contributing factor analysis, a comprehensive listing of known countermeasures and consideration of possible counter-mechanisms in the circumstances of each individual crash.

SITE INSPECTIONS AND VISITS

Preparation

A survey form was prepared using the database facility of Microsoft Excel. This showed relevant information extracted from the mass data base, plus blanks for supplementary information. Also prepared was a series of maps (at 1:100,000 scale) with the location of each crash

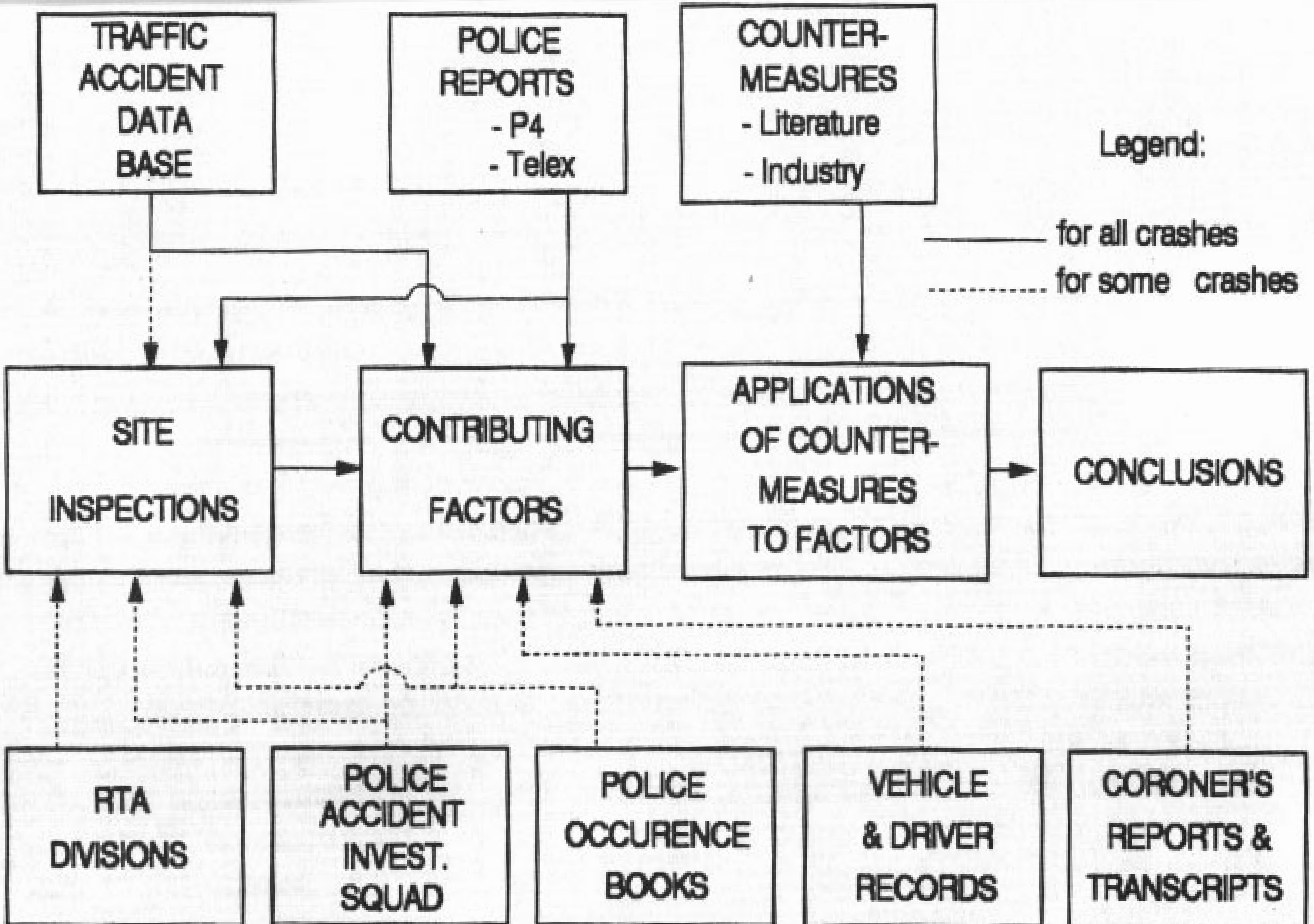


Fig 2.1 Overview of Strand 1 Investigations

marked. It transpired that it was relatively easy to precisely locate the crash site, especially where an AMG reference was given.

Each crash was assigned a Crash Number in Strand 1, consisting of two digits representing the year (eg 88 for 1988) and a further 3 digits, being the last 3 digits in the RSB Accident Number.

Site Inspections

Ken Ogden and Peter Sweatman inspected all known sites of fatal truck crashes on the Hume Highway between Albury and Mittagong. Ken Ogden subsequently inspected all remaining sites on the Hume and all sites on the Pacific.

The researchers photographed the road environment at each crash scene as well as approaching the scene from both directions. The likely crash scenario was discussed and any unusual items additional to the data base were noted, and errors in the data base corrected.

All of the site inspections were carried out using the Police P4 narratives, telexes and/or RSB Accident Description Listings (ADLs), together with the draft survey form referred to above. Most site inspections were carried out in company with an RTA traffic engineer from the local division. This greatly increased the effectiveness of the inspections.

Items added to the survey form as a result of site inspections were:

- Lane width
- Shoulder type and width
- Edge line?
- Barrier Line?
- Raised reflective pavement markers (RRPM's on centre line?
- RRPMs on edge line?
- Check for roadside objects (especially culverts)

Visits

NSW police, from the local station, attend every fatal crash. A form entitled "Fatal Vehicle or Animal Incident Message Form" is completed on the site. This is telexed to Sydney almost immediately (the regulations state that it is to be sent within 2 hours). A copy is retained in the Police station, and copies are lodged with the Police Division, the Accident Investigation Squad (AIS) and, in some cases at least, with the RTA Division as well. Vehicle 1 is always the vehicle driven by the driver held to be responsible (unless a pedestrian).

These telexes are a valuable source of additional information and were studied in detail. In addition to information which is entered on the P4 form, relevant information on these forms includes:

- A narrative description of the crash, based on eye-witness accounts and other evidence, if any (Item 3). These are invaluable in many cases, because they contain contextual information not included on the P4 form (especially in relation to vehicles contributing to the crash, but not actually involved in the crash, specific manoeuvres, etc.).

- An assessment of whether speed was regarded as "normal" or "excessive" (Item 19). There are very few of the latter; the reason given was that speed was very difficult to assess after the event, and that the reference used was normal traffic speed, not the speed limit.

- The person considered responsible (Item 21), and whether police action is proposed (Item 23).

- Whether the vehicle has been retained for mechanical inspection (Item 25)

- Whether the truck was loaded or unloaded (Item 18); this item was not filled in for every case

- Whether the AIS have attended (Item 22, 23). (See below for AIS).

In addition, the form has a space for width of road (Item 8), alignment (Item 7), gradient (Item 7) and traffic flow (Item 7). However, it was found that the first of these (width) was not consistently reported (lane, carriageway, formation width, etc.), while the last (traffic) was unhelpful ("light", "medium", etc.). The other items (alignment and grade) are on the P4 forms. In a few cases, trailer registration was recorded as well as truck registration.

As a result of the telex information, the following items were added to the survey form:

Police station (for follow-up)
AIS attended?
Speed excessive?
Vehicle responsible
Mechanical inspection?

The Police occurrence book was also inspected in several instances. This is held by the local Police station and includes details of every crash, However, the narrative is usually identical to that on the telex, and only occasionally contains extra information.

The AIS only becomes involved if there is likely to be a prosecution. This means that the squad would not usually attend a single vehicle fatal crash, or a multi-vehicle crash where the person considered responsible was killed. Also, information about vehicles which were not the responsible vehicle may be sketchy (e.g. little information may be available about a non-responsible truck in a truck-truck collision).

Points made by police included:

- The courts are 2 years behind, so few 1988 or 1989 cases where charges have been laid have been heard yet.

- Vehicle inspections: the offending vehicle is inspected mechanically. Results may be used to lay charges.

- Not many vehicles are fitted with tachographs, and some that are have not had the card replaced, making interpretation impossible. The AIS have had one case where they sent the card away to be analysed, and in this case the speed supported the stated speed. (It also showed numerous cases of the speed limit being exceeded, but the policy is that the driver will not be booked for speeding on this evidence, because of the sensitivity of the tachograph issue).

- Speed limiters are very rare.

- Information on rest breaks is taken from drivers' log books, which are acknowledged to be unreliable, but no independent source is available.

- Blood alcohol tests are performed on all deceased drivers, and on all drivers hospitalised in NSW. Breath tests are performed on site if the driver is not hospitalised.

- Load information is merely whether the truck is loaded or not; it is very difficult to estimate overloading. The commodity description is not always included.

- Speed estimation is based on witnesses' accounts where available. Police do not reconstruct crashes, because of police policy and opposition from within the courts to such evidence.

- Responsibility (in legal terms) for the crash is usually clear; there are usually marks on the road to indicate the movements of the respective vehicles. In some cases, however, where there are no witnesses, the police do have to rely on the statement of a surviving driver.

- Some crashes are suspected by police to be suicide.

- Information on origin, destination, vehicle loading, etc., is collected from drivers where prosecution is being considered, and if it is thought to have a bearing on the crash.

- Road condition is not usually noted. Road condition is, however, often mentioned as a factor by surviving drivers.

Police and AIS records, in the form of reports on witnesses' statements, experts' reports, police narratives, etc. (as compiled for the purposes of prosecution) were studied in detail, where available. The narrative details were very relevant, especially information not likely to be on the P4. This might include, for example, other vehicle involved, complex manoeuvres not completely captured by RUM code, influence of slow-moving vehicles, conflicts between eye-witness accounts, etc. Also, discussion with AIS members indicates their opinion of some crashes, e.g. suicides, heart attack, driver fell asleep, etc. Specific areas where additional information was obtained (if available) were:

Driving hours
Rest and meal breaks
Mechanical inspection details
Load security

and appropriate categories were added to the survey form. The RTA made available maps showing locations and dates of duplications.

FOLLOW-UP

A number of factors arising from the site inspections and visits were worthy of follow-up activities.

Coroners Reports

Matters relating to cause of death, particularly where heart attack was suspected to be a factor, were checked via coroners' reports, wherever possible.

While some coroners' reports were obtained during the site visits, additional coroners' reports were needed in an attempt to overcome a general lack of knowledge concerning driver factors involved in crashes. The Road Safety Bureau (RSB) undertook to obtain the necessary reports, but this was found to be a time-consuming and expensive exercise as such reports are retained in local jurisdictions. Ten summaries of selected Coroners' reports were obtained from the RSB.

It was noted that, in cases where the police do not require a coronial inquiry (usually where the deceased was held responsible for the crash) it is reasonably common for the deceased's relatives to dispense with an inquiry.

It proved difficult to obtain adequate driver data, particularly related to the use of drugs and alcohol and possible medical factors.

Load Security

One crash was directly caused by loss of load and another was suspected to involve load shift. In the latter case, police anecdotal evidence indicates that other crashes in the past may have involved shifting of similar loads (empty bottles). Preliminary enquiries indicate that loading practices vary significantly from plant to plant.

Tachograph Record

A tachograph record was obtained for a crash where a truck's load rolled onto the cab of an oncoming truck. This occurred in the Cullerin Ranges (Hume Highway) on a particularly winding section. The tachograph shows speed fluctuating rapidly between 58km/h and 89km/h in the 120 seconds period prior to the crash. The crash occurred at 69 km/h on a curve with advisory speed 65 km/h. Considering that this was a high centre-of-gravity vehicle with a possibly unstable load, this speed is probably excessive for the circumstances, and was coded accordingly in the database.

Vehicle Inspections

Most of the AIS vehicle inspections were signed by Const. Johannes (John) Piening of Penrith Police Station. Const. Piening was contacted by telephone and it was ascertained that he and his staff of 5 or 6 carry out mechanical inspections on key crash vehicles throughout NSW for the purposes of prosecution briefs.

His conclusions as to whether any vehicle defects found would have contributed to a crash are based on his opinions taking into account road and weather conditions. On the specific question of truck front brakes rendered ineffective by "backing off" the adjustment, he believed that the front brakes only contribute about 5% of stopping capability and therefore does not rate this defect a contributing factor. He added that he now sees a few such vehicles, but has seen an estimated 10% in the 100 vehicles or so that he has inspected over the past 8 years.

Front Brakes

In two crashes where braking avoidance was directly involved, the AIS vehicle inspection reported that the front brakes had been backed off to the extent that the shoes would not contact the drums. This, and other means of eliminating or reducing front braking, is reported to be common among drivers who believe that front braking threatens steering control.

To estimate the effect of eliminating front brakes, the University of Michigan Transportation Research Institute Simplified Model for Straight Line Braking was run for conditions as similar as possible to Australian trucks. Results showed that front brake elimination reduced deceleration by 14%; with standard brakes operating, the proximity to skidding of the various axles is:

Front axle	27%
Drive axle	51%
Trailer axle	73%

If, rather than reducing front brakes, front braking torque were increased by 100% relative to standard brakes, deceleration is increased by 14% and the proximity to skidding of the various axles becomes:

Front axle	50%
Drive axle	53%
Trailer axle	73%

These results clearly attest to the importance of front brakes to a truck's stopping capability, and the exceedingly low probability of a front wheel lock-up.

2.2 CONFERENCING

In order to focus the range of expertise available in the consortium on the circumstances involved in the crashes, conferencing sessions were held. This involved assembling the police telex, survey form and photographs (and any other information - see section 2.1) for each crash. For part of the conferencing, the Australian Road Research Board (ARRB) Road Geometry data base for the area was also used: on a PC, geometric data (horizontal curvature, crossfall, grade, advisory speed) were available, plus the ability to "drive" the road with a dynamic simulation of the view of the roadway ahead.

Crash Forms

Discussion centred on the contributory factors for each crash. To this end, a truck crash factor form was devised. This covers six categories of factors:

Truck drivers
Car drivers
Trucks
Cars
Road
Environment

and rates the importance of each factor into one of five categories:

Probably not a factor
Suspected
Probably a major factor
Unknown

Driver factors were further categorised (Shinar, McDonald and Treat 1978) into two broad groups: states and behaviours. Driver states are defined as longer-term factors affecting the driver's role in the crash; driver behaviours are defined as specific driver actions, lack of action or occurrences which contributed to the crash. The driver states and behaviours included on the form are as follows:

DRIVER STATES	DRIVER BEHAVIOURS
Alcohol, drugs	Excess speed
Ill health	Slow speed
Inexperience	Asleep
Attitude	Aggressive behaviour
	Inappropriate evasive action
	Overcompensation
	No avoidance
	Inattention
	Close proximity

These factors were also applied to coach drivers, motorcycle riders, cyclists and pedestrians where appropriate.

A typical crash factor form is reproduced in Table 2.1. The factors in the form and their definitions all arose from the circumstances of the crashes studied. The crash factors are defined in Table 2.2.

		TRUCK CRASH FACTORS				
CRASH #:		LOCATION:				DATE:
DESCRIPTOR:		CATEGORY:				
		IMPORTANCE				NATURE
		PNOT	SUS	PYES	UNK	
TRUCK DRIVER STATES						
1	alcohol, drugs					
2	ill health					
3	inexperience					
4	attitude					
TRUCK DRIVER BEHAVIOURS						
5	excess speed					
6	slow speed					
7	asleep					
8	aggressive behaviour					
9	inapprop. evasive action					
10	overcompensation					
11	no avoidance					
12	inattention					
13	close proximity					
CAR DRIVER STATES						
14	alcohol, drugs					
15	ill health					
16	inexperience					
17	attitude					
CAR DRIVER BEHAVIOURS						
18	excess speed					
19	slow speed					
20	asleep					
21	aggressive behaviour					
22	inapprop. evasive action					
23	over compensation					
24	no avoidance					
25	inattention					
26	close proximity					
TRUCKS						
27	load security					
28	brakes					
29	instability					
30	other defects					
CARS						
31	all factors					
ROAD						
32	friction					
33	roughness					
34	roadside objects					
35	delineation					
36	alignment					
37	sight distance					
38	standard					
39	roadworks					
40	shoulder					
ENVIRONMENT						
41	rain					
42	light					
43	object on road					

Table 2.1

TABLE 2.2 DEFINITION OF CRASH FACTORS IN DATABASE

DRIVERS

ALCOHOL, DRUGS: While alcohol is generally well covered by crash investigators with breath tests for surviving drivers and subsequent blood tests for deceased drivers, drugs are very difficult to detect. Drugs are interpreted here to include stimulants and prescribed medication used by long distance driver.

ILL HEALTH: This is interpreted to cover chronic physical or psychological conditions which may impair driving performance or may actually produce erratic driving behaviour (including heart attack and possible suicide).

INEXPERIENCE: This is interpreted by years of holding a license. Lack of experience may affect response to emergencies and judgement in deciding drive all night.

ATTITUDE: This is interpreted as long term attitudes influencing driving behaviour and responses in emergency situations. This includes breaching traffic laws and not wearing seat belts where seat belts would have provided protection.

EXCESS SPEED: This is interpreted as meaning excessive for the circumstances - i.e. speed such as to contribute to loss of control of the vehicle in a particular road and traffic environment. This is difficult to interpret from the available evidence. Police reports rarely cite excessive speed because evidence is lacking. Only a few rare cases have usable tachograph records.

SLOW SPEED: This is interpreted as meaning slow for the circumstances - i.e. speed significantly lower than would be expected by other drivers in a particular road and traffic environment.

ASLEEP: This refers to the driver apparently being asleep in the moments prior to the crash, probably due to fatigue. (The influence of fatigue is difficult to ascertain directly, because it is not apparent to witnesses or investigating officers. This can only be interpreted indirectly, based on apparent hours of driving since sleeping and time since last rest period. Log books are unreliable and tachographs are rarely fitted).

CONT. OVER

TABLE 2.2 (CONT.)

AGGRESSIVE BEHAVIOUR: This refers to driving behaviour which consciously places undue demands on other drivers or the road environment in order to avoid a crash situation (eg. impatient driving).

INAPPROPRIATE EVASIVE ACTION: This refers to braking or steering activity designed to avoid a crash but which has either been unsuccessful or has contributed to a further aspect of the crash.

OVER COMPENSATION: This refers to steering activity, in response to a perceived emergency, causing a crash.

INATTENTION: This is interpreted to cover failure to respond to both normal and unusual traffic situations. This could be contributed to by fatigue or distraction.

CLOSE PROXIMITY: This refers to the situation where vehicles which happen to be closely following a crash vehicle become involved and therefore increase the severity of the crash.

TRUCKS

LOAD SECURITY: This is interpreted as instability in the load, which may lead to destabilisation of the vehicle or loss of the load from the vehicle.

BRAKES: This is interpreted as impaired brake action which may significantly reduce the braking performance of the vehicle. While it is rare for the brakes of crash vehicles to be judged defective by investigating officers, there is evidence of systematic degradation of braking performance by "backing off" the front brakes: some truck drivers consider effective front brakes to be a threat to steering control. It is estimated that "backing off" the front brakes reduces overall braking performance of a tractor-semi-trailer by 10 to 15% and this is considered to be significant. This practice also raises the likelihood of a jacknife instability.

CONT. OVER

TABLE 2.2 (CONT.)

INSTABILITY: Instability refers to a condition where the braking and/or steering demands placed on the vehicle exceed the available thresholds dictated by vehicle design, loading and operation, road condition and environmental factors; such thresholds apply in both the longitudinal and lateral directions. While crashes appear to contain components of the classical tractor-semi-trailer lateral instabilities (i.e. jacknife, rollover, trailer swing), it is often difficult to pinpoint the precise form of instability involved, and the effects of roadside objects and load shift sometimes contribute to the dynamics involved.

OTHER DEFECTS: This covers vehicle or accessory operational deficiencies (including non-fitment of components) not covered in the major mechanical defect categories of brakes, tyres and steering.

FRICTION: This refers to deficiencies in road surface texture which lead to reduced tyre/road friction, especially in the presence of rain or hail. Friction levels may be checked with devices such as SCRIM, but many sites appear to have been resurfaced subsequent to these crashes.

ROUGHNESS: This is interpreted as road surface unevenness of such a level as to reduce vehicle stability, produce a mechanical failure or deficiency or destabilise the load.

ROADSIDE OBJECTS: This covers fixed objects such as trees, poles and barriers, features such as culverts and bridges and immediate roadside topography (i.e. ditches and embankments). These objects could be directly involved in crashes through being impacted by a vehicle, or indirectly involved by their presence influencing a driver's response to an emergency situation.

DELINEATION: This refers to deficiencies in the presence, location, choice and consistency of lines, signs and other devices for delineating the roadway in both day and night conditions. This includes the problem of no lines marked following roadworks.

CONT. OVER

TABLE 2.2 (CONT.)

ALIGNMENT: This is interpreted as features of horizontal and/or vertical alignment which may confuse or mislead the driver or threaten the stability limits of a vehicle. This also includes possible effects of the alignment of the previous stretch of road, which may have loosened a truck's load.

SIGHT DISTANCE: This is interpreted as lack of sight distance for the purposes of overtaking, taking preventative action in relation to oncoming vehicles, responding to unusual situations such as roadworks and poor sight distance at intersections.

STANDARD: This is interpreted as meaning the greatly reduced protection against errant vehicles provided by undivided roads as compared to divided roads, as well as specific instances where the standard of alignment or control of access was poor, or where standards change abruptly.

ROADWORKS: This is interpreted as the influence of roadworks at or near the crash site.

SHOULDER: This covers the vehicle entering the shoulder and losing control plus situations where narrow shoulders prevent vehicles from moving off the roadway to any significant extent, to avoid a crash, plus cases where the truck driver may be reluctant to use the shoulder because he suspects that entering the shoulder would lead to instability of his vehicle.

ENVIRONMENT

RAIN: This is interpreted as a wet road surface leading to reduced tyre/road friction.

LIGHT: This is interpreted as crashes during hours of darkness where lack of illumination was considered to be a factor.

OBJECT ON ROAD: This is interpreted as a stationary or near-stationary object on the roadway.

Truck factor categories of tyres and steering were not included because no such factors were considered to be involved in the crashes investigated. Truck instability is interpreted broadly as meaning the relatively low stability threshold of trucks in general, as compared to cars.

Car factor categories were represented by one catch-all factor, because very few such factors were considered to be involved in the crashes investigated.

Nine road factor categories were included, as shown in Appendix A. Road standard is interpreted broadly as an undivided road as well as specific instances where traffic engineering treatments were not considered to meet acceptable standards.

The environmental factors of rain and light were coded only where these factors were considered to have directly contributed to the crash sequence.

Conference Sessions

A full conference of the consortium members, plus Mr Fred Schnerring of RSB, was used to code crash forms for the crashes selected to be the most controversial, complex or difficult. This was a time-consuming process, with many crashes occupying 30 mins or more.

The more straightforward crashes were coded by Ken Ogden and Peter Sweatman.

It was necessary to use considerable discretion in the coding, due to the post-facto nature of the investigations and reliance on hearsay and judgement.

2.3 DATA BASE

Information from the coded crash factor forms was assembled into a database. For each crash, factors coded PYES (probably a factor) and SUS (suspected to be a factor) were entered into the data base.

Information additional to that described in Section 2.2 was entered, as follows:

CRASH NUMBER
WHICH YEAR?
WHICH HIGHWAY?
UNDIVIDED ROAD?
NUMBER KILLED
VEHICLE CATCH FIRE?
TRUCK RESPONSIBLE?
CRASH DESCRIPTOR
RUM CODE
SINGLE VEHICLE?
ARTIC INVOLVED?
COACH INVOLVED?
TYPE OF LOCATION
WET ROAD?
AT NIGHT?
DRIVER AGE
DRIVING RECORD
DRIVER/VEHICLE CATEGORY

This additional information was obtained from the mass data, with the exception of

UNDIVIDED ROAD - from crash forms
TRUCK RESPONSIBLE? - assigned from crash forms
CRASH DESCRIPTOR - a code of 1-32 describing the vehicle types and manoeuvres involved, assigned from crash forms and disaggregating RUM Codes
WET ROAD? - from crash forms
AT NIGHT? - from crash forms
DRIVER AGE - from State licensing authorities
DRIVING RECORD - from State licensing authorities
DRIVER/VEHICLE CATEGORY - interpreted from registration records

Coding definitions are reproduced in Appendix B.

The database covers 83 crashes ie. all fatal crashes involving heavy vehicles on the Hume and Pacific Highways in NSW in 1988 and 1989.

2.4 ANALYSIS OF DATA BASE

Analysis of the data base was undertaken to address the overall aims of the study. These reduce to the following issues:

(i) Contributory factors and circumstances of 1988/89 crashes

(ii) The role of the heavy vehicle as key vehicle

(iii) Countermeasures

(iv) Why were or are the Hume and Pacific Highways a particular problem?

(v) How did 1989 compare to 1988?

Most crashes were considered to be the result of a chain of events, often involving the complex interaction of a number of factors including the road user, the vehicle, the road system and environmental conditions. In this report, when discussing the percentage of cases in which a specific factor was involved, it should be realized that in almost all cases there are more than one contributory factors. A factor has been included whether it was the one initiating the event or whether its presence contributed to the final outcome.

The database was entered in a Microsoft Excel spreadsheet. The database functions of Excel were then used to analyse the data.

Results for the incidence of all database crash factors, separated by Hume and Pacific Highways and year of occurrence (1988 and 1989) are given in Table 2.3.

				NUMBER OF CRASHES								PERCENTAGE OF CRASHES				
	TOTAL	UNKNOWN	HUME	PACIFIC	HUME 88	HUME 89	PAC 88	PAC 89		TOTAL	HUME	PACIFIC	HUME 88	HUME 89	PAC 88	PAC 89
WHICH HIGHWAY?	83		36	47	20	16	25	22		100.00	43.37	56.63				
NUMBER KILLED	166		58	108	31	27	28	80					1.55	1.69	1.12	3.64
UNDIVIDED ROAD ?	72		29	43						86.75	80.56	91.49				
TRUCK RESPONSIBLE?	41		22	19	12	10	10	9		49.40	61.11	40.43	60.00	62.50	40.00	40.91
CRASH DESCRIPTOR																
21	20		7	12	4	3	8	4		24.10	19.44	25.53	20.00	18.75	32.00	18.18
1	10		3	7	1	2	3	4		12.05	8.33	14.89	5.00	12.50	12.00	18.18
30	6		0	6	0	0	2	4		7.23	0.00	12.77	0.00	0.00	8.00	18.18
RUM CODE																
20	38	5	17	21	9	8	13	8		48.72	47.22	44.68	45.00	50.00	52.00	36.36
SINGLE VEHICLE ?	9		3	6	1	2	2	4		10.84	8.33	12.77	5.00	12.50	8.00	18.18
ARTIC INVOLVED ?	64		32	32	18	14	16	16		77.11	88.89	68.09	90.00	87.50	64.00	72.73
COACH INVOLVED ?	6		2	4						7.23	5.56	8.51				
TYPE OF LOCATION																
12	40	33	16	24						80.00	73.78	84.77				
WET ROAD	24		10	14	6	4	7	7		28.92	27.78	29.79	30.00	25.00	28.00	31.82
AT NIGHT	42		15	27	11	6	13	14		50.60	41.67	57.45	55.00	37.50	52.00	63.64
TRUCK DRIVER STATE																
attitude	8		5	3						9.64	13.89	6.38				
alcohol, drugs	7	27	2	5						12.50	8.23	15.77				
inexperience	2									2.41						
TRUCK DRIVER BEHAVIOUR																
excess speed	23		13	10	6	7	6	4		27.71	36.11	21.28	30.00	43.75	24.00	18.18
inattention	14		9	5	6	3	2	3		16.87	25.00	10.64	30.00	18.75	8.00	13.64
asleep	12		7	5	3	4	3	2		14.46	19.44	10.64	15.00	25.00	12.00	9.09
inapp. evasive action	9		6	3	4	2	1	2		10.84	16.67	6.38	20.00	12.50	4.00	9.09
CAR DRIVER STATE																
alcohol, drugs	8	27	3	5						14.29	12.35	15.77				
inexperience	7		4	3						8.43	11.11	6.00				
attitude	5		1	4						6.02	2.78	8.51				
ill health	5		4	1						6.02	11.11	2.13				
CAR DRIVER BEHAVIOUR																
slow speed	17		6	11	4	2	5	6		20.48	16.67	23.40	20.00	12.50	20.00	27.27
inattention	15		4	11	2	2	6	5		18.07	11.11	23.40	10.00	12.50	24.00	22.73
asleep	9		3	6	2	1	3	3		10.84	8.33	12.77	10.00	6.25	12.00	13.64
excess speed	9		3	6	3	0	4	2		10.84	8.33	12.77	15.00	0.00	16.00	9.09
PEDESTRIAN BEHAVIOUR																
inattention	5		0	5	0	0	2	3		6.02	0.00	10.64	0.00	0.00	8.00	13.64
TRUCK FACTOR																
instability	15		8	7						18.07	22.22	14.89				
ROAD FACTOR																
standard	66		27	39						79.52	75.00	82.98				
alignment	40		16	24						48.19	44.44	51.06				
roadside objects	27		9	17						32.53	25.00	36.17				
shoulder	20		3	17						24.10	8.33	36.17				
delineation	17		9	8						20.48	25.00	17.02				
ENVIRONMENT FACTOR																
light	34		11	23	8	3	13	10		40.96	30.56	48.94	40.00	18.75	52.00	45.45
rain	23		8	15	4	4	8	7		27.71	22.22	31.91	20.00	25.00	32.00	31.82

Table 2.3

Two aspects of these results are of interest:

(i) The relative importance of each factor in the crashes and

(ii) Variations by highway (Hume/Pacific) and year (1988/89).

In Table 2.3, the latter are expressed as percentages of the number of crashes in the database on a particular highway for a particular year. In cases where there is a specific component of "unknowns" (such as alcohol involvement) crash involvement is expressed as a percentage of the total number of crashes minus the number of unknowns.

GENERAL CRASH CHARACTERISTICS

There was some reduction in database fatal crashes in 1989 (38 crashes) compared to 1988 (45 crashes).

There were 31% more database fatal crashes on the Pacific than on the Hume. This ratio was reasonably constant over the two years.

There were 86% more people killed on the Pacific than on the Hume. The number killed per fatal crash was low for the Pacific in 1988 (1.12) and high for the Pacific in 1989 (3.64). The latter figure reflects the two multi-fatal coach crashes.

87% of the database fatal crashes occurred on *undivided roads*. Individual figures for the Hume and Pacific were 81% and 92% respectively.

57% of the data base fatal crashes were *heavy vehicle/car*, 19% were *heavy vehicle/heavy vehicle*, 11% were *single heavy vehicle* and 10% were *heavy vehicle/unprotected road user*.

The *truck was considered responsible* in 49% of the database fatal crashes, and this figure was higher for the Hume (61%) than the Pacific (40%). By definition in the database, truck responsibility in single vehicle crashes is 100%. In multi-vehicle crashes, trucks were considered responsible in 43% of crashes, and this was higher for the Hume (58%) than the Pacific (32%). In truck-car crashes, the truck was considered responsible in 32% of cases; in truck crashes with unprotected road users, the truck was not considered responsible in any case.

According to the analysis of *crash descriptors*, 24% of the database fatal crashes were car (on the wrong side of the road) head-on into truck. This figure was slightly higher for the Pacific (26%) than the Hume (20%); this figure was especially high for the Pacific in 1988 (32%). A further 12% of the database fatal crashes were truck ran off road, and this figure was higher for the Pacific (14%) than the Hume (7%). 60% of truck ran off road crashes occurred at night and *all* of these were on the Pacific. A further 7% of the database fatal crashes were pedestrian into path of truck, and all of these occurred on the Pacific. This figure was especially high for the Pacific in 1989 (18%) and 50% of pedestrian into path of truck crashes occurred at night.

Aggregation of crash descriptors showed that 26% were car-on-wrong-side-of-the-road-head-on (24% truck, 2% coach), 11% were truck-on-wrong-side-of-the-road-head-on (equally divided into truck, coach, car), and 5% were head-on-while-overtaking (4% car, 1% truck).

The *RUM codes* showed that 49% of the known database fatal crashes were code 20 (vehicles from opposing directions - head-on [not overtaking]).

11% of the database fatal crashes were *single vehicle*, and this figure was higher on the Pacific (13%) than the Hume (8%).

An *articulated truck* was involved in 77% of the database fatal crashes, and this figure was higher for the Hume (89%) than the Pacific (68%).

A *coach* was involved in 7% of the database fatal crashes, and this figure was slightly higher for the Pacific (9%) than the Hume (6%).

The *type of location* code showed that 80% of the known database fatal crashes occurred on two-way undivided roads.

29% of the database fatal crashes occurred *in the wet*. Half of these occurred at night, and night time crashes in the wet occurred 3 times more frequently on the Pacific than on the Hume.

51% of the database fatal crashes occurred *at night*, and this figure was somewhat higher (57%) for the Pacific than the Hume (42%).

DRIVER FACTORS

As information on driver states and behaviours is difficult to obtain, these results must represent a lower-bound estimate.

Truck Drivers

With respect to general driver states:

10% of database fatal crashes were considered to involve *truck driver attitude* factors.

13% of known database fatal crashes are known to involve use of *alcohol or drugs*. Almost half of these were single vehicle crashes.

With respect to specific driver actions:

28% of database fatal crashes were considered to involve *excess speed by the truck driver*. This figure was higher for the Hume (36%) than the Pacific (21%). Excess speed at night was involved in 52% of the above crashes.

17% of database fatal crashes were considered to involve *truck driver inattention*.

15% of database fatal crashes were considered to involve the *truck driver falling asleep*. This figure was higher for the Hume (19%) than for the Pacific (11%).

11% of database fatal crashes were considered to involve inappropriate evasive action by the truck driver. This figure was considerably higher for the Hume (17%) than the Pacific (6%).

With respect to general driver characteristics:

The distributions of driver age for (i) truck drivers involved in crashes and (ii) truck drivers considered responsible in crashes are given in Table 2.4.

TABLE 2.4 TRUCK DRIVER AGE DISTRIBUTION

	AGE CATEGORY							
	<20	20-24	25-29	30-34	35-39	40-44	45-49	50-54
drivers in crashes	1	5	13	11	8	4	5	2
drivers responsible	0	3	11	5	2	2	3	0

The distributions of driving record (coded from good=1 through bad=5) for (i) drivers involved in crashes and (ii) drivers responsible for crashes are given in Table 2.5.

TABLE 2.5 DRIVING RECORD DISTRIBUTION

	DRIVING RECORD CATEGORY				
	1	2	3	4	5
drivers in crashes	12	9	7	4	2
drivers responsible	8	5	4	2	0

The distributions of driver/vehicle category, coded as 1=owner, 2=family, 3=employee, for (i) drivers involved in crashes and (ii) drivers responsible for crashes are given in Table 2.6.

TABLE 2.6 DRIVER/VEHICLE CATEGORY DISTRIBUTION

	DRIVER/ VEHICLE CATEGORY		
	1	2	3
drivers in crashes	9	2	26
drivers responsible	3	1	17

For employee drivers responsible for crashes, 53% also involved excess speed, 35% also involved falling asleep, 29% also involved inattention and 24% also involved inappropriate evasive action.

Car Drivers

With respect to general driver states:

Alcohol or drug use by car drivers was known to be a factor in 14% of the known database fatal crashes. This figure was slightly higher on the Pacific (15%) than the Hume (12%).

Inexperience on the part of the car driver was considered to be a factor in 8% of the database fatal crashes. This figure was higher for the Hume (11%) than the Pacific (6%).

With respect to specific driver actions:

20% of the database fatal crashes were considered to involve *slow speed* on the part of the car driver. This figure was slightly higher for the Pacific (23%) than the Hume (17%).

18% of the database fatal crashes were considered to involve *car driver inattention*. This figure was higher on the Pacific (23%) than the Hume (11%).

11% of the database fatal crashes were considered to involve the car driver falling *asleep*. This figure was somewhat higher for the Pacific (13%) than the Hume (8%).

11% of the database fatal crashes were considered to involve *excess speed* on the part of the car driver. This figure was higher on the Pacific (13%) than on the Hume (8%).

Cyclists

Alcohol use by a cyclist was considered to be involved in 2 database fatal crashes.

Inattention on the part of a cyclist was considered to be involved in 2 database fatal crashes.

Pedestrians

Alcohol use by a pedestrian was considered to be involved in 2 database fatal crashes.

Pedestrian attitude was considered to be involved in 2 database fatal crashes.

Inattention on the part of a pedestrian was considered to be a factor in 6% of the database fatal crashes.

All Drivers

Certain of the driver states and behaviours were common to all drivers. These are excess speed, inattention, falling asleep and use of alcohol. In all, 23% of the crashes investigated involved alcohol use by a participant; this represents 34% of those for which alcohol data were available. Similarly, when the incidences of falling asleep and inattention are combined (to obtain an indication of the significance of driver fatigue), and this is done for all participants, up to 60% of crashes could involve some element of fatigue. 39% of crashes were considered to involve excess speed by either a truck driver or a car driver; 8% of multi-vehicle crashes involved *both* excess speed by the truck driver and slow speed by the car driver.

VEHICLE FACTORS

As information on vehicle factors is difficult to obtain, these results must represent a lower-bound estimate.

Truck instability was considered to be a factor in 18% of the database fatal crashes. This figure was higher for the Hume (22%) than the Pacific (15%). Of the 18% of all crashes considered to involve truck instability, 87% also involved poor road alignment, 87% also involved truck excess speed and 73% also involved inappropriate evasive action.

Car factors were considered to be involved in 2 of the database fatal crashes.

ROAD FACTORS

As information on road factors is relatively easy to obtain during site visits, these results are considered to represent a reasonably accurate estimate.

Road standard was considered to be a factor in 80% of the database fatal crashes. This figure was slightly higher for the Pacific (83%) than the Hume (75%).

Road alignment (especially horizontal curvature) was considered to be a factor in 48% of the database fatal crashes. This figure was slightly higher for the Pacific (51%) than the Hume (44%).

Roadside objects were considered to be a factor in 33% of the database fatal crashes. This figure was higher for the Pacific (36%) than the Hume (25%).

The *road shoulder* was considered to be a factor in 24% of database fatal crashes. This figure was extremely high for the Pacific (36%) in relation to the Hume (8%).

Delineation was considered to be a factor in 21% of the database fatal crashes. This figure was higher for the Hume (25%) than the Pacific (17%).

ENVIRONMENTAL FACTORS

Light conditions (at night/in darkness) were considered to be a factor in 41% of the database fatal crashes. This figure was higher for the Pacific (49%) than the Hume (31%). It was especially low (19%) for the Hume in 1989.

Wet conditions were considered to be a factor in 28% of the database fatal crashes. This figure was higher for the Pacific (32%) than for the Hume (22%).

2.5 ROAD GEOMETRY INVESTIGATION

Selected crash sites were examined in depth with respect to their road geometry characteristics. The ARRB Road Geometry Data Acquisition System (RGDAS) was used to (i) produce specific geometric data (horizontal curvature, vertical curvature, crossfall, grade and advisory speed) and (ii) provide the ability to "drive" a particular curve or combination of curves at any desired speed or driver eye height.

ROAD GEOMETRY DATA

Raw data was obtained from RTA NSW. This was derived from RTA NSW RGDAS vehicle surveys carried out in April, 1988, involving one-way surveys of the Hume and Pacific Highways (travelling away from Sydney in both cases). This raw data was processed by ARRB to provide a recognizable map, which was essential to the "manual" location of crash sites. The use of this data for vehicles travelling in both directions required the assumption that the geometry data obtained in one direction was relevant to travel in the opposite direction. While this would be a poor assumption for divided sections of road, most of the sites of interest were on undivided sections, where such an assumption is reasonable.

The above data files were used with the ARRB RGDAS Graphics Programs to examine the alignment data in the vicinity of selected crash locations.

CRASH SITES INVESTIGATED

As described in Section 2.2, road alignment was considered to be a factor contributing to a crash if features of the horizontal and/or vertical alignment were considered to have (i) confused or misled the driver or (ii) threatened the stability limits of his vehicle. However, in some crashes it was also considered possible that the driver had fallen asleep, and that the alignment had "inadvertently" contributed to the vehicle's being on the wrong side of the road. Therefore crash sites investigated for road geometry characteristics were those where (i) alignment was considered to be a factor and (ii) the driver was not considered to have fallen asleep. This resulted in investigation of 6 sites on the Hume Highway and 12 sites on the Pacific Highway. This in itself indicates a relatively high incidence of geometry-related problems on the Pacific Highway.

GEOMETRIC ROAD CHARACTERISTICS INVOLVED IN CRASHES

In each case, the site was located conclusively on the database, with photographs and recollections of the crash sites being used to finally pin-point the required section of road. This was necessary in the absence of any definitive means of cross-referencing the crash locations given on Police forms with the odometer references in the database. This was a time consuming process starting with an electronic map of approximately 20km of road, narrowing down the sections of interest, and adding grade data to assist with identifying the precise location required. Any future research of this nature would greatly benefit from the universal use of a quantitative "ribbon" (rather than qualitative or grid) indentifier for each crash.

As the particular road characteristics of interest depend to some extent on other crash circumstances, each crash site will be considered individually in order as they are encountered travelling away from Sydney.

Distances from Sydney are taken (i) from the intersection with MR 602 at crossroads on the Hume Highway and (ii) from Newcastle on the Pacific Highway. Geometric data are for the direction of travel of the key vehicle and are expressed as horizontal curve radius (m), crossfall (%), calculated advisory speed (km/h) and grade (%, += uphill, -= downhill).

Hume Highway Sites

H1/BREADALBANE/179.7km
(Truck head-on into coach)

Compound curve: 290m radius preceeded by 330m radius within 100m.
Crossfall: 4% (reducing sharply from 8%)
Advisory speed: 85km/h (from 90km/h)
Grade: approx. 1%

Comment: the latter part of this compound curve is more difficult than the first; crossfall reduces suddenly

H2/CULLERIN RANGE/188.9km
(Truck load rolled into path of truck)

Horizontal radius: 130m
Crossfall: 11% reducing to -3% within 50m.
Advisory speed: 69km/h
Grade: -6% changing to 4%.

Comment: tight radius with both grade and crossfall changing abruptly; the vertical sag is approx. 100m beyond the horizontal curve

H3/FARMHOUSE CORNER/211.7km
(Truck jacknifed into path of cars)

Compound curve: 415m radius
Crossfall: 6% reducing to 3% and
increasing to 4%.
Advisory speed: 90km/h
Grade: 2% changing to -2% and then
changing to 1.5% (within 400m)

Comment: both grade and crossfall change rapidly in a compound curve

H4/JERRAWA CREEK/216.7km
(Truck head-on into truck)

Horizontal radius: 355m
Crossfall: 5-6%
Advisory speed: 90km/h
Grade: 4%

Comment: relatively tight radius on 4% grade

H5/MUNDOONANS RANGE/229.8km
(Truck-avoiding oncoming trucks-into rear of car)

Horizontal radius: 450m
Crossfall: 8%
Advisory speed: >100km/h
Grade: -6%

Comment: this is a long downgrade with superimposed "crest" where the crest distances are 94m (car eye height) and 140m (truck eye height); crossfall is high enough to sustain a high advisory speed, but sight distance is very poor

H6/DAISY BED CREEK/326.0km
(Truck jacknifed into path of car)
(Truck jacknifed into path of truck)

Horizontal radius: 500m
Crossfall: 6%
Advisory speed: >100km/h
Grade: zero

Comment: this is a sweeping curve approx. 700m long and is ultimately unforgiving if entered at excessive speed

Pacific Highway Sites

P1/COOLONGOLOOK/117.2km
(Car head-on into truck)

Horizontal radius: 300m
Crossfall: 6%
Advisory speed: 85km/h
Grade: -9% (changes rapidly by 4%)

Comment: tight curve with sudden grade change

P2/JONES ISLAND/176.0km
(Truck-avoiding car-head on into truck)

Horizontal radius: 400m
Advisory speed: 100km/h

Comment: truck came upon stationary car on sweeping curve

P3/ROSS GLEN/199.1km
(Truck ran off road)

Horizontal radius: 250m
Crossfall: 7%
Advisory speed: 85km/h
Grade: 4% changing to -2%

Comment: tight bend with abrupt grade change

P4/ALGOMERA MOUNTAIN/316.4km
(Truck rolled into path of cars)

Horizontal radius: 94m
Crossfall: 8-9%
Advisory speed: 58km/h
Grade: 4%

Comment: extremely tight radius on a grade

P5/WOOLGOOLGA/414.0km
(Truck ran off road)

Horizontal radius: 200m
Crossfall: 4%
Advisory speed: 70km/h
Grade: -6% changing to 1%

Comment: tight radius curve with grade change.

P6/COWPER/492.2km
(Car head-on into truck)

Horizontal radius: 200m
Crossfall: 6%
Advisory speed: 75km/h
Grade: zero

Comment: tight radius curve which appears to have a larger radius

P7/MORORO/530.8km
(Car head-on into truck)

Horizontal radius: 185m
Crossfall: 6%
Advisory speed: 74km/h
Grade: changes by 8%

Comment: tight radius curve with abrupt grade change; curve appears to be of larger radius

P8/TINTENBAR/610.8km
(Truck ran off road)

Horizontal radius: 140m
Crossfall: 5-6%
Advisory speed: 65km/h
Grade: zero

Comment: extremely tight curve

P9/TINTENBAR/612.1km
(Truck rolled into path of car)

Horizontal radius: 200m
Crossfall: 6%
Advisory speed: 77km/h
Grade: 1%

Comment: tight radius curve

P10/MOOBALL/662.0km
(Car head-on into truck)

Horizontal radius: 120m
Crossfall: 8%
Advisory speed: 65km/h
Grade: changes by 3%
Comment: extremely tight radius curve with abrupt grade change

Summary of Road Characteristics

Certain road geometry characteristics appear to threaten the controllability of trucks and cars in various types of crashes, as follows:

(i) Crashes involving cars on the wrong side of the road (4 cases) occurred on tight to very tight curves (120-200m radius) combined with abrupt grade changes.

(ii) Crashes involving trucks rolling over (3 cases) occurred on very tight curves (95-200m radius).

(iii) Crashes involving trucks jacknifing (3 cases) occurred on medium radius compound or extended curves (415-500m radius).

(iv) Crashes involving trucks running off the road (3 cases) occurred on tight radius curves (140-250m radius) combined with abrupt grade changes.

(v) Crashes involving trucks on the wrong side of the road (2 cases) occurred on tight to medium radius curves (290-355m radius)

(vi) Crashes involving trucks avoiding other vehicles (2 cases) occurred on medium radius curves (400-450m radius).

It is concluded that very tight curves (100-200m radius; 60-75km/h advisory speed) run a risk of truck rollovers, tight curves (200-350m radius; 75-90km/h advisory speed) run a risk of trucks being on the wrong side of the road, and medium curves (350-500m radius; 90-100km/h advisory speed) run a risk of trucks jacknifing or losing control while avoiding other vehicles, particularly if they are compound or extended curves. In addition, when very tight or tight curves also involve abrupt grade changes, there is a risk of trucks running off the road, or cars being on the wrong side of the road.

2.6 FINDINGS OF DETAILED CRASH STUDY

CONTRIBUTORY FACTORS AND CIRCUMSTANCES OF 1988/89 CRASHES

Circumstances

The general characteristics of 1988/89 crashes, without considering causative aspects, are:

91% were multi-vehicle.

87% occurred on undivided roads.

77% involved articulated trucks (89% on the Hume)

57% were heavy vehicle/car (19% heavy vehicle/heavy vehicle, 11% single heavy vehicle, 10% heavy vehicle/unprotected road user).

51% occurred at night (57% on the Pacific)

49% were head-on (not overtaking) crashes
24% were cars (on the wrong side of the road) head-on into trucks (32% on the Pacific in 1988)

29% occurred in the wet

12% were truck ran off road

11% were trucks (on the wrong side of the road) head-on.

7% were pedestrian into path of truck (all on the Pacific)

Employee drivers were over-represented as being responsible for crashes and also showed a high incidence of excess speed and evidence of fatigue.

Contributory Factors

Specific factors considered to be part of the causative chain of events in crashes are:

Road standard contributed to 80%

Road alignment contributed to 48%

Light conditions (at night/in darkness) contributed to 41% (49% on the Pacific)

Roadside objects contributed to 33%

Excess truck speed contributed to 28% (36% on the Hume)

Road shoulder contributed to 24% (36% on the Pacific)

Slow car speed contributed to 20%

Truck instability contributed to 18% (22% on the Hume)

Car driver inattention contributed to 18% (23% on the Pacific)

Truck driver inattention contributed to 17% (25% on the Hume)

Truck driver falling asleep contributed to 14% (19% on the Hume)

Car driver alcohol use contributed to 14%

Truck driver alcohol use contributed to 13%

Car driver falling asleep contributed to 11%

Car driver excess speed contributed to 11%

HEAVY VEHICLE AS "KEY VEHICLE"

Heavy vehicles were considered to be responsible in 49% of all cases, (including single-vehicle crashes) and this did not significantly vary between 1988 and 1989. This figure did rise to 61% on the Hume and was reduced to 40% on the Pacific. In truck-car crashes, trucks were responsible in 32% of cases.

PROBLEMS ON THE HUME AND PACIFIC HIGHWAYS

Fatal crashes and persons killed were 31% and 86% higher respectively on the Pacific than the Hume.

Particular problems on the Pacific, in terms of the most frequent contributory factors, are:

- Road standard
- Road alignment
- Night-time crashes
- Car head-on into truck crashes
- Roadside objects
- Rain
- Road shoulder
- Car driver inattention
- Slow car speed
- High truck speed

Crash situations more evident on the Pacific than the Hume are:

Poor road standard

Car head-on into truck crashes

Night-time crashes

Roadside objects

Rain

Car responsible

Car driver inattention

Truck ran off road crashes (single vehicle crashes)

High car speed

Alcohol use by car drivers

Pedestrian into the path of truck crashes.

Truck driver alcohol use

Particular problems on the Hume are:

- Road standard
- Road alignment
- High truck speed
- Light conditions
- Truck instability
- Road shoulder
- Roadside objects
- Rain
- Slow car speed
- Car head-on into truck crashes
- Delineation
- Truck driver inattention

Crash situations more evident on the Hume than the Pacific are:

Articulated trucks

Truck responsible

High truck speed

Truck instability

Truck driver falling asleep

Truck driver inattention

Truck driver inappropriate evasive action

Poor road delineation

CRASH SITUATION IN 1989

The number of fatal crashes reduced slightly (by 16%) and the number of people killed increased dramatically (by 81%), largely due to the two multi-fatal coach crashes. There were less head-on crashes and night-time crashes in 1989 than in 1988.

3. ANALYSIS OF NSW TRUCK CRASHES 1982-88 (STRAND 2)

3.1 INTRODUCTION

While Strand 1 describes 1988-1989 heavy vehicle crashes, Strands 2 and 3 compare these crashes with those occurring in earlier years. Strand 2 focuses on crash numbers and Strand 3 provides the exposure information needed to convert these frequencies to crash risks.

Strand 2 utilised existing RSB mass data systems in order to gain a better understanding of specific aspects of the heavy vehicle crash problem and to examine the interaction of the various factors involved.

Of the specific research questions posed by the RSB, four questions were identified as requiring the analysis of mass crash data. These were

- Given that NSW in 1988 had a large problem with fatal articulated truck crashes, was the problem significantly different from other years?

- Why are the Pacific and Hume Highways apparently a problem?

- Given that fatal articulated truck crashes were higher in 1988 than 1987, why was the total number of articulated truck crashes lower in 1988 than 1987?

- Were heavy vehicles more involved as cause or "key vehicle" in crashes in 1988 than in 1987 or 1989?

3.2 ACQUISITION OF DATA FILES AND TRANSFER TO MONASH UNIVERSITY ACCIDENT RESEARCH CENTRE COMPUTER SYSTEM

The mass crash data for heavy vehicles from 1982 to 1988 were received by the Monash University Accident Research Centre in October 1989. The 21 data files comprised accident, traffic unit and casualty files for each of the seven years. These data files were in the form of two BACKUP files on 11 floppy disks. The files were restored onto the hard disk of the Centre's COMPAQ 386 personal computer.

The mass crash data for the March and June quarters of 1989 were received in March 1990. Preliminary heavy vehicle data for fatal crashes only in the September and December quarters were received in April 1990.

Data security and confidentiality were maintained as required by the RSB. The original floppy disks were locked away immediately after the data was downloaded or returned to the RSB. Access to the computers on which analyses were conducted was restricted to research staff working on the project. Steps were taken to prevent access by unauthorised personnel.

Confidential information relating to controllers of non heavy vehicles was depersonalised for privacy reasons by the RSB. For heavy vehicles, the traffic unit variables Registration Number, Initials of Controller, Surname of Controller, Licence Number, Legal Action, Breath Test Result and Breath Test Analysis were classed as confidential data by the Monash University Accident Research Centre and were stored in a separate data set.

Doubts were expressed by members of the Analysis Unit of the RSB about the accuracy of coding of different types of buses. It was felt that long-distance coaches might not be consistently coded as Traffic Unit Type 18. For this reason, the values of all variables were examined for buses. Seven buses which were originally coded as Traffic Unit Type 19 (Other bus) were amended to Type 18 because the bus was licenced outside NSW and/or the postcode of the controller was outside NSW. Examination of the locations of the crashes also showed it to be likely that these buses were being operated as long distance coaches.

The mass crash data were analysed using SAS (SAS Institute Inc., 1987). Graphs for this section of the report are to be found in pages 102-123 and the corresponding tables may be found in the Appendix C.

3.3 RESEARCH QUESTION (I): WAS THE NUMBER OF FATAL ARTICULATED VEHICLE CRASHES SIGNIFICANTLY DIFFERENT IN 1988 THAN OTHER YEARS?

There were 120 fatal crashes involving articulated vehicles in 1988 compared with 59 such crashes in 1987. This section seeks to determine whether this difference resulted from more crashes in 1988 than would have been expected from previous years or whether there were fewer crashes in 1987 than would have been predicted.

The numbers of fatal and hospital admission injury crashes involving articulated vehicles for the years 1982 to 1988 are shown in Figure 3.1. The numbers of fatal and hospital admission crashes both fell from 1982 to 1987. The puzzling feature of the graph is that there appears to be an increase from 1987 to 1988 in the number of fatal crashes, but not hospital admission crashes, involving articulated vehicles.

Inspection of the quarterly moving totals in Figure 3.2 shows that the increase in fatal articulated vehicle crashes in 1988 was not evident until the September quarter of that year. Clearly the increase was greater in the second half of 1988 than the first. The number of fatal articulated vehicle crashes appears to have decreased in the second half of 1989 but these values remain higher than those observed in 1987.

The predicted number of fatal articulated vehicle crashes in 1988 was calculated from the 1982-1987 figures using linear regression analysis. As shown in the upper panel of Fig 3.3, the observed value of 120 fatal crashes in 1988 was considerably higher than the predicted value of 57. Indeed, the observed value was outside the upper 95% confidence limit for the prediction (dashed line). This comparison shows that there were more crashes in 1988 than predicted from the trend in earlier years.

The actual number of fatal crashes in 1987 was 59 while the predicted value from 1982-1986 data was 77. The actual number was within the 95% confidence limit of 51 to 103, suggesting that there were not significantly fewer crashes in 1987 than were predicted from the numbers in the previous five years.

In contrast to the increase in fatal articulated vehicle crashes, the number of fatal plus hospital admission crashes in 1988 was within the confidence limits of the trend line based on 1982-1987 data (see the lower panel of Fig 3.3).

In summary, the number of fatal articulated vehicle crashes was greater in 1988 than in 1987 and greater than would have been predicted by the 1982-1987 trend. The increase was clearer in the second half of 1988 than the first half. There seems to have been a slight fall in the second half of 1989.

3.4 RESEARCH QUESTION (II): WHY ARE THE HUME AND PACIFIC HIGHWAYS APPARENTLY A PROBLEM?

The question of why the Hume and Pacific Highways are apparently a problem was answered by examining

- the trends for the years 1982 to 1988
- the proportion of the state's heavy vehicle crashes which occurred on these highways
- the characteristics of crashes on the Hume and Pacific Highways.

At the request of the RSB, not all sections of the Hume and Pacific Highways were included. For the Hume Highway analysis was restricted to those crashes which occurred south of Crossroads (Section number>19). The Pacific Highway was divided into northern and southern parts. The northern part corresponded to that portion of the Pacific Highway examined in Strand 1: only those crashes which occurred north of Karuah (Section number>47) were examined. The southern part of the Pacific Highway lies between Karuah and Berowra. Due to extensive roadworks on this length of road between 1982 and 1988 the actual road travelled by most heavy vehicles changed over that period. To account for this, the Pacific Highway South was defined as the combination of Route 10 - Pacific Highway (Section number>20 and <48), Route 26 - Calga-Ourimbah Freeway and Route 6003 - Sydney-Newcastle Freeway (Section number>1).

Heavy vehicle crashes on the Newell and New England Highways were examined to provide a comparison of these routes with the Hume and Pacific Highways.

TRENDS

On both the Hume Highway and the Pacific Highway North the number of fatal crashes and the number of persons killed decreased slightly from 1982 to 1987 and then increased in 1988 (see Fig 3.4). For both routes, more fatal crashes occurred and more people were killed in 1988 than in any year since 1982.

While there were more fatal crashes on the Pacific Highway North than the Hume Highway in 1988, there were more people killed on the Hume than the Pacific Highway North in that year. This reversal suggests that Hume Highway crashes were more severe than Pacific Highway North crashes or involved higher occupancy vehicles in 1988, an issue which will be explored in detail in a later section.

The number of fatal crashes and the number killed increased from 1987 to 1988 on the Pacific Highway South, Newell and New England Highways as well, although the increases were smaller than on the Pacific Highway North and Hume Highways. The worst years in terms of numbers of fatal crashes and persons killed were 1982 for the New England Highway and the Pacific Highway South and 1984 for the Newell Highway.

Hospital admission crashes

Trends in numbers of crashes in which the most severe injury required hospital admission are analysed in this section. These have been called hospital admission crashes in the remainder of the report. This subset was created by specifying those cases in which Degree of accident=2.

Hospital admission crashes were analysed for three reasons:

(i) their severity is such as to require action

(ii) because there are more hospital admission crashes than fatal crashes, the number of hospital admission crashes should show proportionally less random fluctuation from year to year and therefore provide valuable information

(iii) the consistency of reporting is generally better than for crashes in which injuries are not severe enough to require admission to hospital.

There were about twice as many hospital admission crashes as fatal crashes involving heavy vehicles from 1982 to 1988. In contrast, an examination of crashes involving all types of vehicles would probably find about ten times as many hospital admission as fatal crashes. The small ratio of hospital admission to fatal crashes is an indication that crashes involving heavy vehicles are on average more severe than, say, car-only crashes.

Fig 3.5 shows that there were more hospital admission crashes on the Pacific Highway North and Hume Highways than on any of the other three routes. The numbers of crashes varied greatly from year to year with 1986 being perhaps the worst year. The number of hospital admission crashes decreased from 1987 to 1988 on the Pacific Highway North, Pacific Highway South and Hume Highways.

In summary, the trends in fatal and hospital admission crashes differed when analysed by highway. The number of fatal crashes and the number killed increased from 1987 to 1988 on all routes but the number of hospital admission crashes decreased on both parts of the Pacific Highway and the Hume Highway.

PROPORTIONS OF NSW CRASHES

This section examines why the Hume and Pacific Highways are apparently a problem by calculating the proportions of NSW heavy vehicle crashes and fatalities and hospital admissions which occurred on these highways.

<u>Proportions of fatal crashes</u>

The upper panel of Fig 3.6 shows the proportions of NSW fatal heavy vehicle crashes which occurred on the Pacific Highway North, Pacific Highway South, Newell, Hume and New England Highways. In 1988 12% of NSW fatal heavy vehicle crashes occurred on the Pacific Highway North and 10% occurred on the Hume Highway. Thus almost a quarter of the state's fatal heavy vehicle crashes occurred on the Hume Highway and the Pacific Highway North. If one includes the Pacific Highway South, the percentage increases to 27%.

The Hume and Pacific Highways are also a problem when the proportions of NSW heavy vehicle fatalities which resulted from crashes on these routes are examined (see lower panel of Fig 3.6). In 1988 deaths from heavy vehicle crashes on the Pacific Highway North and Hume

Highways accounted for 23.2% of all deaths from heavy vehicle crashes in NSW (27.6% including the Pacific Highway South). This proportion is exceeded only by the 1982 value of 23.4%.

Proportions of hospital admission crashes

In the years 1982 to 1988 between 6% and 12% of NSW hospital admission crashes occurred on the Pacific Highway North and between 5% and 9% occurred on the Hume Highway (see upper panel of Fig 3.7). These percentages are lower than the corresponding values for fatal crashes, suggesting that the Hume and Pacific Highways are a greater problem in terms of fatal crashes than in terms of hospital admission crashes.

While the proportion of NSW fatal crashes on each of the five routes increased from 1987 to 1988, the proportion of hospital admission crashes increased only for the New England and Newell Highways. The proportion of hospital admission crashes dropped from 1987 to 1988 on the Hume Highway and Pacific Highway South and remained constant on the Pacific Highway North.

The trends in the proportions of the state's persons hospitalised in hospital admission crashes (lower panel of Fig 3.7) differed a little from the trends in the proportions of the state's hospital admissions crashes. Firstly, 21% of persons hospitalised as a result of hospital admission crashes occurred on the Pacific Highway North in 1986 from only 12% of the state's hospital admission crashes. Secondly, the proportions of persons hospitalised but not the number of hospital admission crashes, increased slightly on the Pacific Highway North and the Hume Highway from 1987 to 1988.

In summary, the increase in the fatality to hospitalisation ratio in 1988, when compared with 1987 is a strong indication of an increase in the severity of crashes in 1988.

CHARACTERISTICS OF HUME AND PACIFIC HIGHWAY CRASHES

The earlier sections have demonstrated that the Hume and Pacific Highways are a problem in that

a significant proportion of NSW fatal and hospital admission heavy vehicle crashes occurred on these routes and

a significant proportion of persons killed or hospitalised resulted from crashes on these routes.

The characteristics of Hume and Pacific crashes are examined in more detail in this section. The crashes are analysed according to

speed zones
road cross-section
type of vehicles involved
time of day.

A comparison of the effects of classification by speed zones or road cross-section is presented in Appendix C. Classification by speed zone will identify areas in which there are more likely to be pedestrians and cyclists and so is useful in examining crashes according to road users involved. Classification by road cross-section identifies road lengths (undivided road) in which head-on crashes may occur. Thus, classification by speed zones and by road cross-section are both useful.

Speed zones

The purpose of the following analyses is to establish whether the Hume and Pacific Highways are a problem because crashes on these routes occurred at greater average speeds than crashes in the rest of the state. In these analyses the Hume and Pacific Highways are compared with the Newell and New England Highways and the rest of the state.

Because reported estimates of the speeds of vehicles are unreliable and often unobtainable we have examined the distribution of crashes across speed zones instead. The classification was based on the speed limit recorded in the accident section of the mass data file. It is not clear whether the general speed limit was recorded in all cases or whether specific posted truck speed limits were noted (e.g. 80 km/h on some sections of the Hume Highway between Yass and Goulburn).

The percentages of fatal heavy vehicle crashes which occurred in each speed zone during 1982 to 1988 are shown in Fig 3.8. The percentage of crashes which occurred in 60 km/h zones was much higher on the Pacific Highway South than the Pacific Highway North (22% vs. 10%). The percentage was about the same on the Hume Highway (11%) as on the Princes Highway North. No fatal crashes occurred in 60 km/h zones on the Newell Highway but almost a quarter (23%) of crashes on the New England Highway occurred in 60 km/h zones. Crashes in low speed zones were much more common in the rest of the state than on these highways: Almost half of the fatal crashes involving heavy vehicles in the rest of the state (46%) occurred in 60 km/h zones. This difference may have resulted from a greater proportion of the roads in the rest of NSW than on the four highways, being zoned 60 km/h. Unfortunately we do not have details of the relative proportions of each route which was zoned 60 km/h.

The percentage of fatal crashes which occurred in 80 km/h speed zones was between 4% and 12% for the Pacific Highway North, the Newell, the Hume Highway, the New England Highways and the rest of the state. Almost half of the crashes on the Pacific Highway South occurred in 60 or 80 km/h zones, however. The percentage of crashes which occurred in 110 km/h speed zones was about 10% for the Pacific Highway South and the Hume Highway and very low or zero for the other routes. It should be noted that one of the reasons the percentage is low may be that this limit was not in use for the entire seven year period.

The percentages of hospital admission crashes involving heavy vehicles in each speed zone during 1982 to 1988 are shown in Fig 3.9. In general, a larger percentage of hospital admission crashes than fatal crashes occurred in the lower speed zones. Despite this, more hospital admission crashes on the Hume Highway, Pacific Highway North, Newell and New England Highways occurred in 100 km/h zones than in any other speed zones. In contrast, only 18% of hospital admission crashes on the Pacific Highway South and 34% in the rest of NSW occurred in 100 km/h zones.

In the analyses which follow, speed zones are divided into two categories: less than 100 km/h and 100 km/h or greater. These have been termed low and high speed zones. The percentages of fatal crashes and hospital admission crashes according to this classification are shown in Fig 3.10.

The trends for the period 1982-1988 in the percentages of fatal and hospital admission crashes which occurred in high speed zones are shown in Fig 3.11. The proportions of fatal crashes were more variable from year to year than were the proportions of hospital admission crashes. The most variable were the proportions of fatal crashes on the Pacific Highway North and the New England Highway, which were lowest in 1985 and 1986.

In summary, the analyses showed evidence that crashes on the Hume Highway and the Pacific Highway North occurred in higher speed zones, on average, than crashes on the Pacific Highway South or the rest of NSW. This was true for both fatal and hospital admission crashes and did not appear to differ over the seven-year period. The distribution of crashes by speed zones observed for the Pacific Highway North and the Hume Highway was also observed for the Newell and New England Highways.

Road cross-section

Details of the road cross-section where a crash occurred are recorded in the variable Type of Location. For crashes occurring at or within 10 metres of an intersection, the type of intersection is coded. For nonintersection crashes the location is classified as one-way street, two-way undivided street, divided road, single carriageway limited access road, dual carriageway limited access road or other.

Overall, 21.3% of heavy vehicle crashes on the Pacific Highway North, Pacific Highway South, Newell, Hume and New England Highways occurred at intersections. This percentage was lowest for the Hume Highway (15.7%) and was highest for the Pacific Highway South (31.7%).

The proportion of crashes which occurred at intersections was generally greater for less severe crashes: fatal 12.1%, hospital admission 18.4%, hospital treatment 22.5%, non-treated injury 14.8%, towaway 23.8%.

The number of crashes for each type of road cross-section is shown in Table 3.1. For each highway, the majority of crashes occurred in two-way streets. This probably reflects that this type of cross-section comprises a large amount of the routes.

Because of ongoing improvements to highways the amount of each route which is divided carriageway has increased from 1982 to 1988. For this reason, the proportions of fatal and hospital admission crashes which occurred on divided and undivided sections of the Pacific and Hume Highways are presented year by year in Figs 3.12 and 3.13.

TABLE 3 1. TYPES OF LOCATIONS AT WHICH CRASHES OCCURRED (ALL REPORTED CRASHES).

Type of location	Highway				
	Pacific North	Pacific South	Newell	Hume	New England
Intersection	248	317	120	219	182
Two-way street	1148	358	473	836	449
Divided road	41	216	9	281	35
Dual carriageway limited access	0	106	0	52	0
Other	0	4	8	2	0
Total	1437	1001	610	1391	666

There were less than five fatal intersection crashes on either part of the Pacific Highway or the Hume Highway in any year. On the Pacific Highway North and the Hume Highway most fatal crashes occurred on undivided sections of road and the numbers of these crashes generally decreased from 1982 to 1987 and then increased in 1988. The increase in divided road crashes on the Hume Highway is probably a reflection of an increase in duplication of that route. This hypothesis is examined in Table 3.2.

The pattern of distribution of hospital admission crashes by cross-section was similar to that of fatal crashes (see Fig 3.13). There were more hospital admission crashes than fatal crashes at intersections but these numbers did not exceed 10 per year. A noticeable difference was that the number of fatal crashes on undivided roads increased in 1988 on both the Pacific Highway North and the Hume Highway whereas the corresponding number of hospital admission crashes decreased.

In Table 3.2 the number of fatal and hospital admission crashes on divided parts of the Hume Highway are adjusted for the percentage of the route which was divided in that year (as compared with 1982). After the adjustment is made there remains a small increase in the number of fatal crashes. The numbers are too small to draw conclusions, however. The numbers of hospital admission crashes appear to be similar across the seven year period.

TABLE 3.2. NUMBER OF FATAL AND HOSPITAL ADMISSION CRASHES ON DIVIDED PARTS OF THE HUME HIGHWAY ADJUSTED FOR PERCENTAGE OF THE ROUTE WHICH WAS DIVIDED IN THAT YEAR.

Year	% of route divided	Adjusted no. of crashes	
		Fatal	Hospital admission
1982	28.6	1	4
1983	28.6	1	8
1984	28.6	1	8
1985	30.2	1.90	2.84
1986	32.4	1.77	8.83
1987	37.1	3.08	8.48
1988	43.9	3.26	7.82

Types of vehicles involved

> **Note:** In this section the number of crashes is overestimated because more than one type of heavy vehicle was involved in some crashes. For example, a crash involving an articulated vehicle and a rigid truck was counted twice.

Type of heavy vehicle in fatal crashes. The types of heavy vehicles involved in fatal crashes on the Pacific Highway North, Pacific Highway South, Newell, Hume and New England Highways and all of NSW are shown in Table 3.3. Articulated vehicles were involved in more fatal crashes than rigid trucks or long-distance coaches for every route and the state as a whole. The ratio of articulated vehicles to rigid trucks was greatest for the Newell and Hume Highways and least for the Pacific Highway South.

There were 30 fatal crashes involving buses in NSW in 1982-1988. In these 23 buses were coded as long distance coaches (type=18) and 7 buses were coded as 'Other bus' (type=19). No buses were coded as 'Urban Transit Authority bus'.

Two vehicles coded as 'Other bus' were both registered and the drivers licenced outside NSW (872F00358 and 884F00902). The crashes occurred at Halfway Creek on the Pacific Highway (WA registered and Vic licensed) and Breadalbane on the Hume Highway (Queensland registered and licensed). We have recoded these buses as long distance coaches.

TABLE 3.3. TYPES OF HEAVY VEHICLES INVOLVED IN FATAL CRASHES IN NSW IN 1982-1988.

	Articulated	Rigid	Coach
Pacific Highway North	93	32	4
Pacific Highway South	29	23	3
Newell Highway	51	5	2
Hume Highway	89	26	2
New England Highway	37	10	1
All NSW	686	462	25

The involvement of each type of heavy vehicle in fatal crashes for each of the years 1982 to 1988 is shown in Fig 3.14. The numbers of vehicles on the Pacific Highway South were too small to detect trends. For each of the other routes, the numbers of articulated vehicle crashes fell from 1983 to 1987 and increased from 1987 to 1988. There were too few rigid truck and long distance coach crashes to draw conclusions about trends for these vehicles.

As Table 3.4 shows, nine of the crashes involving long distance coaches occurred on the Hume and Pacific Highways, resulting in 15 of the total of 32 fatalities. There were more crashes on the Pacific Highway than the Hume Highway but four fatalities occurred in each of the Hume Highway crashes. The number of fatal crashes is too few to draw conclusions about trends for the period 1982-1988.

<u>Type of heavy vehicle in hospital admission crashes.</u> The types of heavy vehicles involved in hospital admission crashes on the Hume and Pacific Highways and all of NSW are shown in Table 3.5. The ratio of articulated vehicles to rigid trucks appears lower for hospital admission crashes than fatal crashes (compare with Table 3.3). For all of NSW there were more hospital admission crashes involving rigid trucks than articulated trucks although this was not so for the Pacific Highway North, Newell, Hume or New England Highway. The ratio of articulated vehicles to rigid trucks was greatest for the Newell Highway and least for all NSW, as was found in the analysis of fatal crashes.

TABLE 3.4. NUMBER OF FATAL CRASHES INVOLVING LONG DISTANCE COACHES AND NUMBER OF PEOPLE KILLED (IN BOLD TYPE).

	Year							Total
	82	83	84	85	86	87	88	
Pacific Hy Nth	0 **0**	1 **1**	0 **0**	0 **0**	2 **2**	1 **1**	0 **0**	4 **4**
Pacific Hy Sth	1 **1**	0 **0**	0 **0**	1 **1**	1 **1**	0 **0**	0 **0**	3 **3**
Newell Hy	0 **0**	0 **0**	0 **0**	2 **2**	0 **0**	0 **0**	0 **0**	2 **2**
Hume Hy	0 **0**	0 **0**	0 **0**	0 **0**	0 **0**	0 **0**	2 **8**	2 **8**
New England Hy	1 **1**	0 **0**	0 **0**	0 **0**	0 **0**	0 **0**	0 **0**	1 **1**
All NSW	3 **3**	1 **1**	2 **2**	4 **4**	5 **5**	3 **3**	7 **14**	25 **32**

TABLE 3.5. TYPES OF HEAVY VEHICLES INVOLVED IN HOSPITAL ADMISSION CRASHES IN NSW IN 1982-1988.

	Articulated	Rigid	Coach
Pacific Highway North	210	106	14
Pacific Highway South	60	75	3
Newell Highway	100	26	4
Hume Highway	182	80	3
New England Highway	89	52	0
All NSW	1631	2100	57

There were 90 buses involved in hospital admission crashes in NSW during 1982-1988. In the mass data file, 5 were coded as 'Urban Transit Authority bus', 33 were coded as 'Other bus' and 52 were coded as 'Long distance coach'. Closer examination showed that 6 vehicles coded 'Other bus' were interstate registered or the driver held an interstate licence. Five of these vehicles were involved in crashes on the Pacific Highway or Newcastle Freeway at times (and in directions) consistent with overnight travel between Sydney and Brisbane. These five vehicles were recoded 'Long distance coach' for our analysis (Accident numbers 833056273, 883069007, 883077892, 884098119, 884104544).

The involvement of each type of heavy vehicle in hospital admission crashes for each of the years 1982 to 1988 is shown in Fig 3.15. There is no evidence of the pattern observed in fatal crashes: a drop in number of articulated vehicle crashes from 1982 to 1987 followed by an increase in 1988. An increase in hospital admission articulated vehicle crashes from 1987 to 1988 occurred only on the Newell and New England Highways. A decrease was observed on the Pacific Highway North and South.

The number of hospital admission crashes involving long distance coaches and the number injured in these crashes are presented in Table 3.6. The largest numbers of crashes and people hospitalised occurred on the Pacific Highway North. This was largely the result of four crashes in 1986 in which 81 people were hospitalised. The five routes together accounted for about half of the state totals of hospital admission crashes involving long distance coaches and number of people admitted to hospital.

TABLE 3.6. NUMBER OF HOSPITAL ADMISSION CRASHES INVOLVING LONG DISTANCE COACHES AND NUMBER OF PEOPLE INJURED (IN BOLD TYPE).

	Year							Total
	82	83	84	85	86	87	88	
Pacific Hy Nth	1	2	4	1	4	0	2	14
	1	**4**	**32**	**24**	**81**	**0**	**9**	**151**
Pacific Hy Sth	0	0	1	0	0	1	1	3
	0	**0**	**1**	**0**	**0**	**2**	**12**	**15**
Newell Hy	0	1	0	0	2	1	0	4
	0	**30**	**0**	**0**	**28**	**6**	**0**	**64**
Hume Hy	0	0	1	0	0	1	1	3
	0	**0**	**3**	**0**	**0**	**2**	**9**	**14**
New England Hy	0	0	0	0	0	0	0	0
	0	**0**	**0**	**0**	**0**	**0**	**0**	**0**
All NSW	5	9	13	6	9	7	8	57
	5	**75**	**53**	**62**	**115**	**14**	**45**	**369**

<u>Time of day</u>

In these analyses the whole of the Hume and Pacific Highways are included, not merely the sections south of Crossroads and north of Berowra.

Analysing crashes according to the time of day at which they occurred provides an indication of the degree of involvement of reduced night-time visibility and driver fatigue in crashes. Time of day is not a pure measure of fatigue, however, since other factors differ as a function of time of day. These factors include the degree of involvement of alcohol in crashes (McDermott and Hughes, 1983) and traffic density.

The daily patterns of travel of articulated vehicles, rigid trucks and long-distance coaches differ. Rigid trucks often are engaged in shorter trips than other heavy vehicles and are less likely to be travelling at night. Because of these differences in travel patterns, crashes for each type of vehicle were analysed separately.

For the analyses, the day was broken into four time periods: 12 midnight to 6 am, 6 am to 12 noon, 12 noon to 6 pm and 6 pm to midnight. The number of fatal and hospital admission crashes during each time period for 1982 to 1988 is shown in Figure 16. For the state as a whole, the number of articulated vehicle crashes was similar for each time period but the number of rigid truck crashes was less at night. There were more rigid truck crashes than articulated vehicle crashes during daytime (6 am to 6 pm) and the reverse during night-time. There appeared to be fewer long-distance coach crashes between 6 pm and midnight than during the rest of the day.

The patterns for individual highways differed from that of all NSW. For the Pacific Highway North the number of rigid truck crashes was similar across the day but the number of articulated vehicle crashes was greatest at night (particularly between 6 pm and 12 am). The number of long distance coach crashes was greatest between midnight and six am.

The numbers of crashes were smaller for the Pacific Highway and so the trends are less clear. More rigid truck crashes occurred during the day than at night. Articulated vehicle crashes were most common between noon and 6 pm. There were too few long distance coach crashes to identify trends.

For the Newell Highway, there seemed to be fewer rigid truck crashes at night than during the day but the numbers of crashes of articulated vehicles showed no clear pattern. For the Hume Highway, there were more articulated vehicle crashes than rigid truck crashes for every time period. The number of articulated vehicle crashes was greatest between midnight and 6 am and the 6 pm to midnight period also had more crashes than during the day.

There were few clear effects of time of day on crashes on the New England Highway.

In summary, the distribution of fatal and hospital admission crashes by time of day appears to be quite different on the Hume and Pacific Highways than for NSW as a whole: more of the crashes on these routes involved articulated vehicles and most of the articulated vehicle crashes occurred at night-time.

Information about the relative numbers of articulated and rigid trucks travelling during the day and during the night is needed before the relative risk of day and night-time travel can be assessed.

CONCLUSIONS

The analyses in this section have identified a number of ways in which the Hume Highway and the Pacific Highway North are a problem.

In 1988 22% of NSW fatal and 17% of hospital admission heavy vehicle crashes occurred on these routes

In 1988 23% of NSW fatalities and 20% of persons hospitalised in heavy vehicle crashes resulted from crashes on these routes

These routes are also a problem because the downward trend in fatalities from 1982 to 1987 has reversed

The following characteristics of crashes on the Hume and Pacific Highways were identified:

a greater proportion of crashes occurred in higher speed zones on the Hume Highway and Pacific Highway North than on the Pacific Highway South and in the rest of the state. This was found for both fatal and hospital admission crashes. The findings for the Newell and New England Highways were similar to the Hume Highway and the Pacific Highway North

most crashes occurred on undivided sections of road

articulated vehicles were involved in more fatal crashes than rigid trucks or long distance coaches. This was also true for the state as a whole

36% of the state's fatal long-distance coach crashes occurred on the Hume and Pacific Highways

there were more articulated vehicles than rigid trucks involved in hospital admission crashes on the Pacific Highway North and the Hume Highway. The reverse was true for the state as a whole

- the distribution of fatal and hospital admission crashes by time of day appears to be quite different on the Hume and Pacific Highways than for NSW as a whole: more of the crashes on these routes involved articulated vehicles and most of the articulated vehicle crashes occurred at night-time. This is likely to reflect differences in the relative numbers of articulated vehicles and rigid trucks travelling during the day and during the night.

3.5 RESEARCH QUESTION (III): GIVEN THAT FATAL ARTICULATED TRUCK CRASHES WERE HIGHER IN 1988 THAN 1987, WHY WAS THE TOTAL NUMBER OF ARTICULATED TRUCK CRASHES LOWER IN 1988 THAN 1987?

This section examines articulated vehicle crashes in all of NSW. Its aim is to discover why there were more fatal crashes in 1988 than 1987 despite the decrease in the total number of crashes.

If the increased number of fatal crashes reflected a general increase in crash severity, then one might expect

1. the ratio of number of fatal crashes to number of hospital admission crashes to be greater in 1988
2. more persons to be killed per fatal crash in 1988
3. more persons to be injured per hospital admission crash in 1988.

Possible factors underlying the increased number of fatal crashes could be

1. increased crash speed
2. a change in the mix of road users (to more vulnerable) in 1988
3. an increased number of occupants per car in 1988
4. an increased number of vehicles per crash in 1988
5. a change in the types of crashes (as classified by RUM codes) in 1988.

Issue 1 will be considered from the viewpoint of both crash and speed data later in this report.

PROPORTION OF CRASHES WHICH WERE FATAL

While the proportion of all crashes which resulted in a fatality is a simple index of crash severity, the accuracy of this index is affected by the completeness of recording of crashes. The recording of less severe crashes may be incomplete, thus inflating the index. Because the recording of hospital admission crashes is effectively complete, the index of severity used here was the ratio of number of fatal crashes to number of hospital admission crashes.

Table 3.7 shows the ratios of number of fatal articulated vehicle crashes to number of hospital admission crashes for low and high speed zones. In 1987 the ratios were about 0.30 for both low and high speed zones. The ratios were markedly higher in 1988 than 1987, the increase being greater in high than low speed zones..

TABLE 3.7. RATIO OF NUMBER OF FATAL ARTICULATED VEHICLE CRASHES TO NUMBER OF HOSPITAL ADMISSION CRASHES.

	Year	
	1987	1988
Low speed zones (<100 km/h)		
Number of fatal crashes	22	40
Number of hospital admission crashes	71	65
Ratio	0.31	0.62
High speed zones (>=100 km/h)		
Number of fatal crashes	33	80
Number of hospital admission crashes	111	97
Ratio	0.30	0.82

NUMBER KILLED OR INJURED PER CRASH

The number killed per fatal articulated vehicle crash is shown in Table 3.8. The table shows that while there were more fatal crashes and persons killed in 1988 than 1987, the number killed per fatal crash did not increase. Instead, there appeared to be a slight decrease in the number killed per fatal crash in low speed zones.

In addition, Table 3.8 shows that the number killed per fatal crash was greater for crashes in high than low speed zones.

Table 3.9 shows that the number hospitalised per crash was greater in low speed zones in 1987 (1.80) than for any other category (about 1.45). Examination of the data revealed that the value of 1.80 was largely due to one crash in which 25 people were injured. If this crash is removed, the ratio drops to 1.47, similar to the other categories.

TABLE 3.8. NUMBER KILLED PER FATAL ARTICULATED VEHICLE CRASH IN LOW AND HIGH SPEED ZONES.

	Year	
	1987	1988
Low speed zones (<100 km/h)		
Number killed	27	46
Number of fatal crashes	22	40
Number killed per crash	1.23	1.15
High speed zones (>=100 km/h)		
Number killed	44	105
Number of fatal crashes	33	80
Number killed per crash	1.33	1.31

Unlike the mean number killed per fatal crash, the mean number hospitalised in hospital admission crashes did not seem to be higher in the high speed zones.

TABLE 3.9. NUMBER HOSPITALISED PER HOSPITAL ADMISSION CRASH IN LOW AND HIGH SPEED ZONES.

	Year	
	1987	1988
Low speed zones (<100 km/h)		
Number hospitalised	128	93
Number of hospital admission crashes	71	65
Number hospitalised per crash	1.80	1.43
High speed zones (>=100 km/h)		
Number hospitalised	160	141
Number of hospital admission crashes	111	97
Number hospitalised per crash	1.44	1.45

THE MIX OF ROAD USERS

The mix of road users involved in articulated vehicle crashes can be examined in two ways, as the types of vehicles involved in crashes or as the types of road users killed or injured.

Types of vehicles involved in crashes with articulated vehicles

In this section, the types of vehicle involved in crashes with articulated vehicles are divided into those involved in two vehicle crashes and those in crashes involving more than two vehicles.

Two vehicle crashes. The types of vehicles involved in fatal two vehicle crashes with articulated vehicles are shown in Table 3.10. The other vehicle was most commonly a car or an unprotected road user. Crashes with unprotected road users occurred more often in low speed zones.

Very few differences from 1987 to 1988 in the type of other vehicle were found. There was a slight increase from .40 in 1987 to .48 in 1988 in the proportion of low speed zone crashes in which the other vehicle was a car. This proportion did not change from 1987 to 1988 for high speed crashes (about two-thirds in each year).

The proportion of other vehicles which were unprotected road users was just under half in low speed zones in both years. It dropped from .14 in 1987 to .04 in 1988 in high speed zones but these proportions are based on very small numbers.

While there were more hospital admission crashes than fatal crashes involving an articulated vehicle and one other vehicle, Table 3.11 shows that the increase was almost all in car occupants. Proportionally fewer unprotected road users were admitted to hospital than killed in crashes with articulated vehicles.

The proportion of other vehicles which were cars was higher for hospital admission crashes than fatal crashes. The proportion increased slightly from .67 in 1987 to .77 in 1988 in low speed zones but dropped slightly from .75 to .59 in high speed zones.

The proportion of other vehicles which were unprotected road users did not change markedly from 1987 to 1988.

TABLE 3.10. THE OTHER VEHICLE IN TWO VEHICLE FATAL ARTICULATED VEHICLE CRASHES.

	Type of vehicle					
	Bus	Car	Light Truck	Truck	Unprot R U	Other
Speed limit <100 km/h						
1987	0	6	0	2	7	0
1988	0	14	0	1	14	0
Speed limit >=100 km/h						
1987	1	15	2	2	3	0
1988	0	33	9	5	2	0

TABLE 3.11. THE OTHER VEHICLE IN TWO VEHICLE HOSPITAL ADMISSION ARTICULATED VEHICLE CRASHES.

	Type of vehicle					
	Bus	Car	Light Truck	Truck	Unprot R U	Other
Speed limit <100 km/h						
1987	0	28	2	4	8	0
1988	1	34	0	2	7	0
Speed limit >=100 km/h						
1987	0	38	2	6	4	1
1988	1	24	6	7	2	1

Crashes involving more than two vehicles. In Tables 3.12 and 3.13 articulated vehicle crashes in which there were more than two vehicles are divided into those in which there was more than one truck (termed multiple trucks in the table) and crashes in which there was only one truck involved (termed one truck). For example, a crash involving two trucks and a motorcycle would be classed as "multiple trucks" whereas a crash involving one truck and two cars would be classed as "one truck".

Table 3.12 shows that only one truck was involved in most fatal crashes of more than two vehicles. All of the fatal multiple truck crashes occurred in high speed zones. The numbers of crashes involving more than two vehicles increased from 1987 to 1988, particularly in high speed zones. The numbers are too small to allow further comparisons to be made.

TABLE 3.12. NUMBERS OF FATAL ARTICULATED VEHICLE CRASHES INVOLVING MORE THAN TWO VEHICLES DIVIDED INTO MULTIPLE AND ONE TRUCK CRASHES.

	Multiple trucks	One truck
Speed limit <100 km/h		
1987	0	4
1988	0	6
Speed limit >=100 km/h		
1987	1	3
1988	5	11

TABLE 3.13. NUMBERS OF HOSPITAL ADMISSION ARTICULATED VEHICLE CRASHES INVOLVING MORE THAN TWO VEHICLES DIVIDED INTO MULTIPLE AND ONE TRUCK CRASHES.

	Multiple trucks	One truck
Speed limit <100 km/h		
1987	2	9
1988	1	8
Speed limit >=100 km/h		
1987	1	5
1988	0	4

Most many-vehicle hospital admission crashes involved only one truck (see Table 3.13). The number of such crashes did not increase from 1987 to 1988.

Types of road users killed in fatal crashes

The types of road users killed comprised drivers and passengers of cars, light and heavy trucks and buses; motorcycle and bicycle riders and pillion passengers and pedestrians. In Table 3.14 these road users are classified as occupants of cars, buses and light or heavy trucks, and unprotected road users.

In both years car occupants comprised the largest group of road users killed. The number more than doubled from 1987 to 1988. In low speed zone crashes the proportion of road users killed who were car occupants increased from 0.41 in 1987 to 0.52 in 1988. The proportion killed who were car occupants remained constant in high speed zone crashes

The number of heavy truck occupants killed in high speed zones increased markedly from 1987 to 1988. However, the proportion of all road users killed who were heavy truck occupants did not increase from 1987 to 1988.

The proportion of those killed who were unprotected road users remained constant in low speed zones (at about a third) and decreased in high speed zones.

TABLE 3.14. NUMBER OF OCCUPANTS OF CARS, BUSES, AND LIGHT AND HEAVY TRUCKS AND UNPROTECTED ROAD USERS KILLED IN ARTICULATED VEHICLE CRASHES IN 1987 AND 1988.

Type of road user	Year	
	1987	1988
Low speed zone (<100 km/h)		
Car occupant	11	24
Bus occupant	0	0
Light truck occupant	0	0
Heavy truck occupant	7	7
Unprotected road user	9	15
High speed zone (>=100 km/h)		
Car occupant	25	63
Bus occupant	1	4
Light truck occupant	4	10
Heavy truck occupant	10	24
Unprotected road user	4	4

In summary, the only evidence of a change in the mix of road users to more vulnerable is the slight increase from 1987 to 1988 in the proportion of road users killed in low speed zones who were car occupants. The proportion of unprotected road users did not change.

VEHICLE OCCUPANCY

This section addresses the issue of whether an increase in car occupancy contributed to the increased number of fatal crashes involving articulated vehicles in 1988.

Changes in vehicle occupancy have implications for both the number of fatal crashes and the number of fatalities. The latter is the most straightforward relationship: if the number of vehicle occupants is higher, then the maximum number of people which can be killed in a crash is greater. The relationship between vehicle occupancy and the number of fatal crashes is somewhat more subtle. A fatal crash is defined as a crash in which at least one person is killed. The probability that at least one occupant will be killed increases with the number of occupants, thus the probability of a fatal crash increases with the number of vehicle occupants.

An increase in traffic volumes and, perhaps, in occupancy of cars related to trips to EXPO in Brisbane in 1988 has been suggested as a potential contributor to the increase in fatal articulated vehicle crashes on the Pacific Highway in that year. Tables 3.15 and 3.16 present the numbers of occupants per car in fatal and hospital admission car-articulated vehicle crashes on the Pacific Highway North and South and all other highways.

Fatal car-articulated vehicle crashes occurred in both years in high speed zones on the Pacific Highway North only. These data suggest that the levels of car occupancy on that route were similar in 1987 and 1988.

Hospital admission car-articulated vehicle crashes occurred in both 1987 and 1988 in low speed zones on the Pacific Highway South and high speed zones on the Pacific Highway North. The former showed an increase in car occupancy and the latter a decrease.

In summary, because of the absence of car-articulated vehicle crashes on some routes in some years, it was not possible to test the claim of increased occupancies (and thereby fatalities) because of EXPO traffic.

TABLE 3.15. NUMBER OF OCCUPANTS PER CAR IN FATAL CAR-ARTICULATED VEHICLE CRASHES.

	Year	
	1987	1988
Low speed zones (<100 km/h)		
Pacific Highway North	-	1.3
Pacific Highway South	1.5	-
All other highways	1.0	2.1
High speed zones (>=100 km/h)		
Pacific Highway North	1.5	1.6
Pacific Highway South	-	-
All other highways	2.1	1.8

TABLE 3.16. NUMBER OF OCCUPANTS PER CAR IN HOSPITAL ADMISSION CAR-ARTICULATED VEHICLE CRASHES.

	Year	
	1987	1988
Low speed zones (<100 km/h)		
Pacific Highway North	-	2.0
Pacific Highway South	1.4	2.0
All other highways	2.2	1.9
High speed zones (>=100 km/h)		
Pacific Highway North	2.1	1.6
Pacific Highway South	-	2.0
All other highways	2.6	1.7

NUMBER OF VEHICLES INVOLVED IN CRASHES

The number of vehicles involved is another index of crash severity. It is at least intuitively held that the more vehicles are involved, the more serious is the crash. The variable, number of traffic units, analysed in this section includes pedestrians and other non-motorised vehicles.

The mean numbers of traffic units involved in fatal articulated vehicle crashes in 1987 and 1988 were 2.02 and 2.05, respectively. Thus the increased number of fatal articulated vehicle crashes in 1988 cannot be ascribed to an increase in the mean number of vehicles per crash.

The mean numbers of traffic units involved in hospital admission crashes also remained constant at 1.73 in 1987 and 1.74 in 1988.

Number of vehicles involved by speed zone

In both low and high speed zones most articulated vehicle crashes involved two vehicles. Hospital admission crashes in high speed zones were an exception, however. In this category there were more single vehicle crashes than two vehicle crashes.

There were more fatal crashes in 1988 than 1987 for each combination of speed zone and number of vehicles. The largest absolute increase was in two-vehicle crashes in high speed zones, up from 23 in 1987 to 49 in 1988 (see Figure 3.17). As a proportion of all fatal articulated vehicle crashes in high speed zones, however, the contribution of two-vehicle crashes decreased from .70 in 1987 to .61 in 1988.

As Figure 3.18 shows, the number of hospital admission crashes dropped in 1988 for most categories of speed zone and number of vehicles. The only increase was in the number and proportion of two-vehicle crashes in low speed zones, up from 42 (.59 of the total) to 44 (.61 of the total). However, it should be noted that the numbers for previous years were in the 70s and low 80s: 1987 may have been an atypically low year.

Number of vehicles involved by road cross-section

Figure 3.19 shows that most fatal articulated vehicle crashes at intersections involved two vehicles. The proportion of crashes which were single vehicle appeared to be greater on undivided sections of road than divided sections (or intersections).

The proportion of intersection crashes which involved two vehicles was slightly higher in 1988 (.85) than 1987 (.75). In contrast, the proportion of undivided road crashes which involved two vehicles dropped slightly from 1987 (.72) to 1988 (.58). The proportion of divided road crashes which involved two vehicles increased from .62 to .77.

There was a preponderance of two-vehicle crashes among hospital admission crashes at intersections, as was found for fatal crashes.

There were fewer two-vehicle hospital admission crashes at intersections or on undivided stretches of road in 1988 than in 1987 (see Figure 3.20). In addition, there were fewer single vehicle crashes on undivided roads. The only marked increase from 1987 to 1988 was in the number of two-vehicle crashes on divided roads. However, none of these changes from 1987 to 1988 remained when the proportions of crashes were calculated.

RUM CODES

Road user movement (RUM) codes were examined for fatal

and hospital admission articulated vehicle crashes in 1986-1988. The crashes were classified by intersection, divided or undivided carriageway or speed zone (<100 km/h or >=100 km/h).

To simplify presentation, RUM codes were classified into six categories. These are

- vehicle adjacent
  vehicle opposing
  vehicle same direction
  on path
  off path
  other

The "off path" category includes both "on straight" and "on curve". The "other" category includes "pedestrian", "manoeuvring", "overtaking" and "passenger and miscellaneous". More detailed tables are presented in the Appendix.

RUM codes by road cross-section

The RUM codes for fatal articulated vehicle crashes classified by road cross-section are presented in Figure 3.21. Not surprisingly, almost half of the fatal crashes which occurred at intersections were classified as "vehicle adjacent". There were more vehicle adjacent crashes in 1988 than in either of the previous years (10 vs. 6 and 4) but the proportion of crashes of this type remained constant.

The most common coding of fatal crashes which occurred on undivided roads was "vehicle opposing" (91/175 over 3 years). The number of such crashes increased from 17 in 1986 to 26 in 1987 and 48 in 1988. Thus the frequency of this type of crash almost doubled, and contributed 22 of the 61 additional fatal crashes in 1988. The proportion of crashes on undivided roads which were coded "vehicle opposing" was greater in 1987 and 1988 than in 1986 (.60 and .56 versus .37).

In addition, there were eight more "off path, on curve" crashes on undivided roads in 1988 than in 1987 but the proportion of crashes which were of this type did not change.

About half of the fatal crashes on divided roads were coded as "vehicle same direction" (15/31 over 3 years). Because of the small numbers of fatal crashes on divided roads no trends can be discerned.

The most frequent type of hospital admission crash at intersections was "vehicle adjacent", the same pattern as found for fatal crashes (see Figure 3.22). The number of "vehicle adjacent" crashes fell from 26 in 1986 to 15 in 1987 to 11 in 1988. The proportion of intersection crashes of this type fell across the three years, also (.45 to .36 to .31). There were no other marked changes in the types of intersection crashes.

About 37% of hospital admission crashes on undivided roads were classed "off path, on curve" during the three-year period. The numbers and proportions of these crashes remained similar from 1987 (45, .34) to 1988 (46, .42). The largest change was a drop in "vehicle same direction" crashes from 24 in 1987 (.18 of undivided road crashes) to 7 in 1988 (.06). There was a slight increase in "vehicle opposing" crashes, from 24 in 1987 (.18) to 28 in 1988 (.26).

As was found for fatal crashes, there were fewer hospital admission crashes on divided roads than undivided roads or intersections, making the identification of trends difficult. The overall increase from 1987 to 1988 largely consisted of an increase in the number of "vehicle opposing" (2 to 5) and "vehicle same direction" (5 to 8) crashes.

In summary, analysis of RUM codes by road cross-section provided very little evidence of a change in the types of crashes from 1987 to 1988. The proportion of hospital admission crashes at intersections which were classified "vehicle adjacent" fell across the three years. The pattern of RUM codes for hospital admission crashes on undivided roads changed slightly. The proportion of "vehicle same direction" crashes was a little less in 1987 than 1988 while the proportion of "vehicle opposing" crashes increased slightly.

RUM codes by speed zone

The RUM codes for fatal articulated vehicle crashes classified by speed zone are shown in Figure 3.23. In low speed zones the most common RUM coding of fatal crashes was "vehicle opposing" (32/97 over 3 years). The increase from 22 crashes in 1987 to 40 crashes in 1988 was spread rather evenly across RUM codes. The largest increases were for "vehicle adjacent" (from 2 to 6) and "vehicle opposing" (from 9 to 13).

In high speed zones "vehicle opposing" was the most common classification (73/154 over 3 years) of fatal crashes. It was for this class of crash that the increase from 1987 to 1988 was the greatest - the number jumped from 16 to 38. When the proportions of high speed zone crashes are examined, however, the contribution of "vehicle opposing" crashes remained constant across the three years (.46, .48 and .48, respectively).

The number of "off path, on curve" crashes increased from 5 in 1987 to 12 in 1988 but the proportion of crashes which were of this type did not change.

Figure 3.24 shows that hospital admission crashes in low speed zones comprised largely "vehicle adjacent" (42/232 over 3 years), "vehicle opposing" (51/232 over 3 years) and "vehicle same direction" (54/232) crashes. The numbers and proportions of "vehicle adjacent" crashes dropped from 22 (.23) in 1986 to 12 (.17) in 1987 to 8 (.12) in 1988. The number and proportion of "vehicle opposing" crashes were slightly less in 1987 than in 1986 or 1988. The numbers and proportions of "vehicle same direction" crashes decreased across the three years. There was also fewer "off path, on curve" crashes in 1988 than 1987 (16 or .23 in 1987, 10 or .15 in 1988).

"Off path, on curve" was the most common coding of hospital admission crashes in high speed zones (126/353 in 3 years). The number of these crashes increased from 33 in 1987 to 42 in 1988 and the proportion increased from .30 to .43. In contrast, the number of "off path, on straight" crashes dropped from 22 to 10 over the same period. The corresponding proportion fell from .20 to .10.

The pattern of RUM codes did not change from 1987 to 1988 when fatal crashes classified by speed zone were examined. There was some evidence of a change in the pattern of RUM codes of hospital admission crashes in low speed zones. There were relatively fewer "vehicle adjacent", "vehicle same direction" and "off path, on curve" crashes and relatively more "vehicle opposing" crashes in 1988 than 1987. In high speed zones, the proportion of "off path, on curve" hospital admission crashes increased and the proportion of "off path, on straight" crashes decreased.

Vehicle opposing and off path crashes

Vehicle opposing and off path were the groups of RUM codes most frequently coded for fatal and hospital admission articulated vehicle crashes, respectively. Vehicle opposing crashes contributed 29/59 fatal articulated vehicle crashes in 1987 and 51/120 crashes in 1988. In contrast, off path crashes contributed 33/188 hospital admission crashes in 1987 and 39/167 crashes in 1988. This section compares the characteristics of fatal vehicle opposing crashes with all fatal crashes and hospital admission off path crashes with all hospital admission crashes. More detailed results of the analyses may be found in the appendix.

Vehicle opposing crashes. The proportions of fatal crashes coded vehicle opposing in which it was raining were somewhat higher (0.21 in 1987 and 0.33 in 1988) than for all fatal crashes (0.12 in 1987 and 0.24 in 1988). In addition, the results suggest that the proportion of vehicle opposing crashes which occurred in high speed zones was greater than for all crashes.

Vehicle opposing and all fatal articulated vehicle crashes did not differ in the proportion which occurred on curves (about half), the proportion which occurred when it was dark (a little less than half), or the proportions which involved young drivers, elderly drivers, inexperience or alcohol.

Off path crashes. The proportion of hospital admission crashes coded off path in which the road was curved was higher (0.63 in 1987, 0.76 in 1988) than for all hospital admission crashes (0.42 in 1987, 0.55 in 1988). Off path crashes appeared to happen in the dark more often than other hospital admission crashes.

The proportions of hospital admission off path crashes which occurred when it was raining were similar in 1987 (0.19) and 1988 (0.20). This occurred despite a rise in the proportion of all hospital admission crashes which occurred while it was raining (0.12 in 1987 and 0.18 in 1988). The data suggest that a higher proportion of off path crashes occurred in high speed zones than for hospital admission crashes as a whole.

Off path and all hospital admission crashes did not differ in the proportions which involved young drivers, elderly drivers, inexperience or alcohol.

CONCLUSIONS

The aim of this section was to discover why there were more fatal crashes in 1988 than 1987 despite the decrease in the total number of crashes.

The results failed to support the hypothesis that the change reflected a general increase in crash severity. The ratio of number of fatal crashes to number of hospital admission crashes was greater in 1988, as expected, but neither the number of persons killed per fatal crash nor the number of persons hospitalised per hospital admission crash increased in 1988.

Possible factors underlying the increased number of fatal crashes were listed at the beginning of this section as

1. increased truck speeds
2. a change in the mix of road users (to more vulnerable) in 1988
3. an increased number of occupants per car in 1988
4. an increased number of vehicles per crash in 1988
5. a change in the types of crashes (as classified by RUM codes) in 1988

As noted at the beginning of this chapter, Factor 1 is considered in Section 4 of this report.

Examination of the types of vehicles involved in fatal articulated vehicle crashes and of the types of road users killed showed that a change in the mix of road users to more vulnerable did not underlie the increased number of fatal crashes in 1988.

The other vehicle in a two-vehicle fatal articulated vehicle crash was most commonly a car or an unprotected road user. The latter was the case particularly in low speed zones. The proportion of low speed zone crashes in which the other vehicle was a car was slightly higher in 1988 than 1987 but the proportion of unprotected road users did not change in low or high speed zones. In general, the mix of road users in two-vehicle fatal articulated vehicle crashes was similar in 1987 and 1988.

Most fatal articulated vehicle crashes involving more than two vehicles included only one truck. The number of such crashes increased from 1987 to 1988, particularly in high speed zones but remain too small to confidently compare the two years. All of the multiple truck crashes occurred in high speed zones.

Analysis of the types of road users killed showed that car occupants comprised the largest group in both years but the proportion of those killed who were car occupants increased only in crashes in low speed zones. The number, but not the proportion, of heavy truck occupants killed in high speed zones increased from 1987 to 1988.

The absence of car-articulated vehicle crashes on some routes in 1987 or 1988 prevented testing of the claim that increased car occupancies because of EXPO led to the increased number of fatal crashes on the Pacific Highway in 1988.

The number of vehicles involved for both fatal and hospital admission crashes did not appear to change from 1987 to 1988.

Analysis of the number of vehicles involved in fatal crashes by speed zone showed a large increase from 1987 to 1988 in the absolute number of two-vehicle crashes in high speed zones but the proportion of such crashes actually decreased somewhat. The number and proportion of two-vehicle hospital admission crashes in low speed zones increased from 1987 to 1988.

When the number of vehicles was analysed by road cross-section, it was found that the proportion of intersection and divided road crashes which involved two vehicles was slightly higher in 1988 than 1987 but the proportion of crashes on undivided roads which involved two vehicles was lower in 1987 than 1988.

The pattern differed for hospital admission crashes. There the only marked increase from 1987 to 1988 was in the number of two-vehicle crashes on divided roads. This may reflect an increase in the amount of divided road available for travel but this quantity is unlikely to have changed much in one year.

Examination of RUM codes provided some evidence of a change in the type of crashes in 1988. When RUM codes for fatal articulated vehicle crashes were classified by road cross-section the largest increase from 1987 to 1988 was in crashes coded as "vehicle opposing". The frequency of this type of crash almost doubled, contributing 22 of the 61 additional crashes in 1988. However, the proportion of crashes coded as "vehicle opposing" was similar in 1987 and 1988.

The pattern of RUM codes for hospital admission crashes differed from that for fatal crashes. The proportion of intersection crashes which were coded "vehicle adjacent" was lower in 1988 than 1987. On undivided roads, the proportions of crashes which were coded "vehicle same direction" and "vehicle opposing" were lower in 1988 than 1987.

Those fatal articulated vehicle crashes which were coded "vehicle opposing" more often occurred when it was raining or in high speed zones than fatal articulated vehicle crashes as a whole.

There was no evidence of age or inexperience contributing more to off path crashes than to other hospital admission crashes. Rather, these crashes tended to occur more often on curves, in the dark, and in rain (in 1987 but not 1988) than hospital admission crashes as a whole.

In conclusion, the analyses have failed to identify a reason why there were more fatal crashes in 1988 despite the decrease in the total number of crashes. When fatal crashes in 1988 and 1987 were compared, the overall finding was that there were more of most types of crashes, rather than a change in the characteristics of the fatal crashes.

3.6 RESEARCH QUESTION (VI): WERE HEAVY VEHICLES MORE INVOLVED AS CAUSE OR "KEY VEHICLE" IN 1988 THAN IN 1987 OR 1989?

This question will be addressed by reference to the mass data for fatal crashes in 1987, 1988 and 1989 and for hospital admission crashes in 1987 and 1988. Hospital admission data for the whole of 1989 was not available at the time of preparation of this report.

The variables which will be analysed in this section are all contained in the traffic unit section of the mass accident data: Traffic Unit 1, Manoeuvres of the traffic unit, Factors/errors, Legal action and Alcohol group of controller.

The coding of many of these variables has a subjective component and therefore the values of the variables are not as reliable as those of, for example, time of day. Judgements need to be made by Police as to the events which may have occurred during the crash, possibly despite the lack of evidence from a deceased driver or the presentation of conflicting evidence. This affects the accuracy of coding of the variables Traffic Unit 1, Manoeuvres and Factors/errors.

The nature of the legal action proposed or taken against a driver is influenced by Police practices current at the time or in that area. For example, a directive to "crack down" on heavy vehicle drivers might result in a charge being laid, rather than a caution being issued.

Enforcement practices may also affect the coding of the alcohol variables. Changes in these practices may affect the proportion of cases in which a breath test is actually taken.

VEHICLES CODED AS TRAFFIC UNIT 1

A vehicle is coded as Traffic Unit 1 if its actions correspond to those represented by the bold arrow in the Road User Movement (RUM) codes. While there are some exceptions, this vehicle is commonly that considered to be "responsible" or the "key vehicle".

Fatal crashes

Table 17 presents the numbers of rigid trucks, articulated vehicles and long-distance coaches coded as Traffic Unit 1 in fatal crashes in 1987, 1988 and 1989. The numbers of cars involved in fatal crashes with heavy vehicles are included for comparison.

There were more rigid trucks involved in multiple vehicle crashes and more rigid trucks coded as Traffic Unit 1 in 1987 and 1988 than in 1989. The proportions of rigid trucks involved in multiple vehicle crashes which were coded as Traffic Unit 1 were .28 in 1987, .30 in 1988 and .46 in 1989.

There were more articulated vehicles involved in multiple vehicle crashes in 1988 than in 1987 or 1989 and more of these were coded as Traffic Unit 1 in 1988 than 1987 but not 1989. The proportions of articulated vehicles involved in multiple vehicle crashes which were coded as Traffic Unit 1 was about .30 in 1987 and 1988 but increased to .39 in 1989.

The proportions of rigid trucks and, to a lesser extent, articulated vehicles which were coded as Traffic Unit 1 in multi-vehicle crashes seemed to be greater in 1989 than 1988. The numbers of long distance coaches are too small to detect trends.

TABLE 3.17. NUMBERS OF RIGID TRUCKS, ARTICULATED VEHICLES AND BUSES CODED AS TRAFFIC UNIT 1 - FATAL CRASHES. (MV = MULTIPLE VEHICLE)

	Year		
	1987	1988	1989
Rigid trucks			
Number in MV crashes	78	80	41
Number of these coded TU 1	22	24	19
Single vehicle crashes	5	6	4
Rigid trucks coded TU 1	27	30	23
Articulated vehicles			
Number in MV crashes	58	108	93
Number of these coded TU 1	17	33	36
Single vehicle crashes	9	20	14
Articulated vehicles coded TU 1	26	53	50
Long distance coaches			
Number in MV crashes	4	6	10
Number of these coded as TU 1	3	2	4
Single vehicle crashes	0	0	0
LD coaches coded TU 1	3	2	4
Cars			
Number in MV crashes	93	138	102
Number of these coded as TU 1	61	86	57

There were more single vehicle crashes of articulated vehicles in 1988 than in 1987 or 1989. However, as a proportion of fatal crashes, single vehicle crashes were only slightly higher in 1988 (.16 versus .13 and .13, respectively).

The proportion of cars which were coded as TU 1 in crashes with heavy vehicles decreased from .66 to .62 to .56 across the three years. Despite this trend, cars were considerably more often the key vehicle in a fatal crash with a heavy vehicle than were heavy vehicles in all multiple vehicle crashes.

In summary, the proportion of fatal multiple vehicle crashes in which a rigid truck or articulated vehicle was the key vehicle was not greater in 1988 than 1987. Heavy vehicles were more involved as cause or "key vehicle" in 1989 than 1988, however.

Hospital admission crashes

The number of each type of heavy vehicle coded as Traffic Unit 1 in hospital admission crashes did not change noticeably from 1987 to 1988 (see Table 3.18). This contrasts somewhat with the drop in the total number of hospital admission crashes. The proportions coded as Traffic Unit 1 in 1987 and 1988 were .50 and .52 of rigid trucks and .62 and .70 of articulated vehicles.

The proportion of cars which were coded as TU 1 in hospital admission crashes with heavy vehicles decreased slightly from .51 in 1987 to .45 in 1988.

In summary, evidence from rigid trucks, articulated vehicles and cars combines to suggest that heavy vehicles were more involved as cause or "key vehicle" in hospital admission crashes in 1988 than 1987.

MANOEUVRES OF THE TRAFFIC UNIT

This variable describes the manoeuvre immediately prior to involvement in the crash. The coded manoeuvres were grouped in seven categories for analysis. A listing of which codes were assigned to each category is given in Appendix C.

Table 3.19 shows the manoeuvres of rigid trucks which were judged to be key vehicles in fatal crashes in 1987, 1988 and 1989. Most of these trucks were coded as "proceeding along lane". The proportion of such trucks increased from .44 in 1987 to .70 in 1988 before returning to .48 in 1989. In contrast, a smaller proportion of rigid trucks were coded as "incorrect side of road" in 1988 (.13) and 1989 (.17) than in 1987 (.26). The proportion of rigid trucks involved in a turning or reversing manoeuvre was also lowest in 1988 (.13 vs. .30 in both 1987 and 1989).

TABLE 3.18. NUMBERS OF RIGID TRUCKS, ARTICULATED VEHICLES AND BUSES CODED AS TRAFFIC UNIT 1 - HOSPITAL ADMISSION CRASHES. (MV = MULTIPLE VEHICLE)

	Year	
	1987	1988
Rigid trucks		
Number in MV crashes	204	191
Number of these coded as TU 1	80	76
Single vehicle crashes	43	47
Rigid trucks coded as TU 1	123	123
Articulated vehicles		
Number in MV crashes	125	104
Number of these coded as TU 1	49	52
Single vehicle crashes	74	68
Articulated vehicles coded as TU 1	123	120
Long distance coaches		
Number in MV crashes	7	8
Number of these coded as TU 1	4	4
Single vehicle crashes	0	1
Long distance coaches coded as TU 1	4	5
Cars		
Number in MV crashes	285	270
Number of these coded as TU 1	145	122

TABLE 3.19. MANOEUVRES OF RIGID TRUCKS JUDGED TO BE KEY VEHICLES IN FATAL CRASHES.

Manoeuvre	Year		
	1987	1988	1989
Moving along roadway			
Proceeding along lane	12	21	11
Incorrect side of road	7	4	4
Other moving along roadway	0	1	1
Turning or reversing			
Turning right out of own lane	3	1	3
Turning left out of own lane	1	1	0
Other turning	2	1	3
Other reversing	2	1	1
Total	27	30	23

Table 3.20 shows the manoeuvres of articulated vehicles which were judged to be key vehicles in fatal crashes in 1987, 1988 and 1989. The recorded manoeuvres of articulated vehicles appeared to differ from those of rigid trucks: many more articulated vehicles were coded as "incorrect side of road". The increase in fatal crashes from 1987 to 1988 comprised largely an increase from 10 to 29 trucks "proceeding along lane" (.38 to .55). A further increase to 36 trucks "proceeding along lane" (.68) occurred in 1989. However, the proportion of trucks on the "incorrect side of road" fell from .54 to .36 to .24 during the three-year period. These results suggest that the increased numbers of articulated vehicles judged to be key vehicles in fatal crashes in 1988 and 1989 were not accompanied by a proportional increase in dangerous manoeuvres.

The numbers of long-distance coaches cited as key vehicle were so small as to make analysis of trends unhelpful. In each of the years 1987, 1988 and 1989, there was one "Proceeding along lane" for a long-distance coach. There were three recorded instances of "Travelling on the incorrect side of road": one in 1987 and two in 1989. In addition there was a "Veering to right" in 1987, a "Turning right out of own lane" in 1988 and a "Turning left out of own lane" in 1989.

TABLE 3.20. MANOEUVRES OF ARTICULATED VEHICLES JUDGED TO BE KEY VEHICLES IN FATAL CRASHES.

Manoeuvre	Year		
	1987	1988	1989
Moving along roadway			
Proceeding along lane	10	29	34
Incorrect side of road	14	19	12
Other moving along roadway	0	1	2
Turning or reversing			
Turning right out of own lane	1	1	2
Turning left out of own lane	1	2	0
Other turning	0	1	0
Other reversing	0	0	0
Total	26	53	50

The manoeuvres of cars judged to be key vehicles in fatal crashes with heavy vehicles changed across the three-year period (see Table 3.21). The proportion which were judged to be "proceeding along lane" decreased (.33 to .20 to .18) and there was a corresponding increase in the proportion judged to be "incorrect side of road" (.57 to .62 to .70).

TABLE 3.21. MANOEUVRES OF CARS JUDGED TO BE KEY VEHICLES IN FATAL CRASHES.

Manoeuvre	Year		
	1987	1988	1989
Moving along roadway			
Proceeding along lane	20	17	10
Incorrect side of road	35	53	40
Other moving along roadway	0	3	2
Turning or reversing			
Turning right out of own lane	5	11	4
Turning left out of own lane	0	0	0
Other turning	1	2	1
Other reversing	0	0	0
Total	61	86	57

Table 3.22 shows the manoeuvres of rigid trucks judged to be key vehicles in hospital admission crashes. Again, most trucks were "proceeding along lane", although the number and proportion of such cases decreased slightly from 86 in 1987 to 76 in 1988 (.70 to .62). "Incorrect side of road" was the next most frequent manoeuvre", followed by "turning right out of own lane" but the numbers and percentages of such crashes did not change from 1987 to 1988. The number of turning manoeuvres recorded increased from 14 in 1987 to 22 in 1988 (.11 to .18).

TABLE 3.22. MANOEUVRES OF RIGID TRUCKS JUDGED TO BE KEY VEHICLES IN HOSPITAL ADMISSION CRASHES.

Manoeuvre	Year	
	1987	1988
Moving along roadway		
Proceeding along lane	86	76
Incorrect side of road	17	18
Other moving along roadway	2	4
Turning or reversing		
Turning right out of own lane	11	11
Turning left out of own lane	1	6
Other turning	2	5
Other reversing	4	3
Total	123	123

Table 3.23 shows the manoeuvres of articulated vehicles which were judged to be key vehicles in hospital admission crashes in 1987 and 1988. The numbers and proportions were of each type of manoeuvre were similar in 1987 and 1988. Hospital admission crashes followed the same pattern as fatal crashes: there were relatively more articulated vehicles than rigid trucks on the "incorrect side of road".

TABLE 3.23. MANOEUVRES OF ARTICULATED VEHICLES JUDGED TO BE KEY VEHICLES IN HOSPITAL ADMISSION CRASHES.

Manoeuvre	Year	
	1987	1988
Moving along roadway		
Proceeding along lane	87	83
Incorrect side of road	23	22
Other moving along roadway	0	2
Turning or reversing		
Turning right out of own lane	8	10
Turning left out of own lane	4	2
Other turning	1	0
Other reversing	0	1
Total	123	120

The numbers of long-distance coaches were again small. Four long-distance coaches were recorded as key vehicles in hospital admission crashes in 1987 and five in 1988. All were coded as "Proceeding along lane".

As Table 3.24 shows, "proceeding along lane" (about 40%) and "incorrect side of road" (about 30%) were the two classes of manoeuvre which described most cars in hospital admission crashes with heavy vehicles. The numbers and proportions of each type of manoeuvre were similar in 1987 and 1988.

This section has examined in the types of manoeuvres by key vehicles to determine whether heavy vehicles were more involved as cause or key vehicle in 1988 than in 1987 or 1989. This was certainly not so for rigid trucks which were key vehicles in fatal crashes: "incorrect side of road" and turning and reversing manoeuvres made up smaller proportions of the total recorded manoeuvres in 1988 than in 1987 or 1989. There were also relatively fewer articulated vehicle on the wrong side of the road in 1988 (and 1989) than in 1987. Cars were the only type of vehicle which was proportionally more often on the wrong side of the road in fatal heavy vehicle crashes in 1988 than in 1987. The patterns of manoeuvres in hospital admission crashes did not change from 1987 to 1988.

TABLE 3.24. MANOEUVRES OF CARS JUDGED TO BE KEY VEHICLES IN HOSPITAL ADMISSION CRASHES.

Manoeuvre	Year	
	1987	1988
Moving along roadway		
Proceeding along lane	53	53
Incorrect side of road	50	37
Other moving along roadway	7	7
Turning or reversing		
Turning right out of own lane	24	20
Turning left out of own lane	2	1
Other turning	8	4
Other reversing	1	0
Total	145	122

FACTORS/ERRORS

Factors are defined in the Coding Manual as

"any manoeuvres, or conditions of a traffic unit or the environment, which might have contributed to the accident".

The description of these manoeuvres or conditions implies some judgement of the manner in which the traffic system failed; e.g., by the use of terms such as 'distracted', 'swerving to avoid', 'failure' etc., which suggest a primary reason for the accident.

Where more than one factor/error was reported, the one which was considered most relevant to the traffic unit's involvement in the crash was coded. If the traffic unit did not stop after the crash, this took priority in coding.

The Coding Manual allows for more than forty possible factors/errors. For ease of presentation these were grouped into categories of driver disadvantaged, unusual manoeuvre, driver/passenger/pedestrian, stationary vehicle, equipment, loss of control, did not stop after accident and no relevant factors. Table 3.25 shows the factors/errors of rigid trucks, articulated vehicles, long distance coaches and cars coded as key vehicle in fatal crashes.

TABLE 3.25. FACTORS/ERRORS OF TRAFFIC UNITS CODED AS KEY VEHICLE IN FATAL CRASHES.

Factors/errors	Year		
	1987	1988	1989
Rigid truck			
Driver disadvantaged	1	2	2
Unusual manoeuvre	0	0	1
Driver/passenger/pedestrian	0	1	0
Stationary vehicle	0	1	1
Equipment	2	2	0
Loss of Control	2	2	0
Did not stop after accident	0	1	2
No relevant factors	22	21	17
Articulated vehicle			
Driver disadvantaged	0	3	3
Unusual manoeuvre	4	9	10
Driver/passenger/pedestrian	0	2	0
Stationary vehicle	0	0	0
Equipment	2	0	1
Loss of Control	6	11	8
Did not stop after accident	0	1	0
No relevant factors	14	27	28
Long distance coach			
Driver disadvantaged	0	0	1
Unusual manoeuvre	0	1	0
Driver/passenger/pedestrian	0	0	0
Stationary vehicle	0	0	0
Equipment	0	0	0
Loss of Control	0	0	0
Did not stop after accident	0	0	0
No relevant factors	3	1	3
Car			
Driver disadvantaged	1	1	5
Unusual manoeuvre	11	16	16
Driver/passenger/pedestrian	0	0	0
Stationary vehicle	0	0	0
Equipment	1	0	0
Loss of Control	2	8	8
Did not stop after accident	0	0	0
No relevant factors	46	61	28

In each of the three years no relevant factors were recorded for most crashes. This resulted in very small numbers in each category, making comparisons between the years difficult. While there appeared to be more articulated vehicle crashes in which unusual manoeuvres or loss of control was reported in 1988 and 1989 than in 1987 (20 and 18 vs. 10), these factors/errors comprised the same proportion of the total in each year. Of those fatal heavy vehicle crashes in which cars were the key vehicle, the proportions of crashes which involved an unusual manoeuvre or loss of control increased across the three-year period.

Because there were more hospital admission crashes than fatal crashes, it is possible that the comparison of factors involved in these crashes in 1987 and 1988 may be more fruitful (see Table 3.26). Again the most common coding was "No relevant factors". Unusual manoeuvre and loss of control were the next most commonly coded factors/errors for rigid trucks but the numbers and proportions of crashes in which they were identified were similar for 1987 and 1988. For articulated vehicles unusual manoeuvre and loss of control were also frequently coded. There was a small increase in the numbers and proportions of crashes involving loss of control from 19 (.15) in 1987 to 26 (.22) in 1988. For articulated vehicles equipment was identified as a factor in 20 crashes in 1987 (.16) and 12 crashes in 1988 (.10). This factor relates to vehicle defects and overloading or insecure loading.

There were too few fatal and hospital admission crashes involving long distance coaches to allow conclusions about factors/errors to be drawn.

Unusual manoeuvre was the most commonly cited factor/error for cars coded as key vehicles in hospital admission crashes. The unusual manoeuvre category was largely composed of Factor 21 "this unit disobeying traffic control": 21/36 crashes in 1987 and 22/27 crashes in 1988. Overall, the pattern of factors/errors was similar in 1987 and 1988.

In summary, analysis of factors/errors failed to identify any difference which might suggest that heavy vehicles were more involved as cause or "key vehicle" in 1988 than in 1987 other than as an indication of a higher proportion of equipment factors in hospital admission articulated vehicle crashes in 1987 than 1988. This was largely because "No relevant factor" was coded for most crashes. The proportion of unusual manoeuvres and loss of control in fatal heavy vehicle crashes in which a car was the key vehicle increased over the three-year period.

LEGAL ACTION

In interpreting the results of analyses of the legal action variable it must be noted that if more than one charge was brought against a driver, indictment codes take priority, followed by the offence with the lowest code. This results in underestimates of the frequency of charges which are not indictable offences e.g., cross unbroken centre lines (code 21).

TABLE 3.26. FACTORS/ERRORS OF TRAFFIC UNITS CODED AS KEY VEHICLE IN HOSPITAL ADMISSION CRASHES.

Factors/errors	Year	
	1987	1988
Rigid truck		
Driver disadvantaged	6	7
Unusual manoeuvre	20	19
Driver/passenger/pedestrian	0	1
Stationary vehicle	0	2
Equipment	8	7
Loss of Control	16	18
Did not stop after accident	1	1
No relevant factors	72	68
Articulated vehicle		
Driver disadvantaged	6	5
Unusual manoeuvre	19	26
Driver/passenger/pedestrian	1	0
Stationary vehicle	0	0
Equipment	20	12
Loss of Control	24	24
Did not stop after accident	3	4
No relevant factors	50	49
Long distance coach		
Driver disadvantaged	1	0
Unusual manoeuvre	0	1
Driver/passenger/pedestrian	0	0
Stationary vehicle	0	0
Equipment	0	0
Loss of Control	0	1
Did not stop after accident	0	0
No relevant factors	3	3
Car		
Driver disadvantaged	6	4
Unusual manoeuvre	36	27
Driver/passenger/pedestrian	0	0
Stationary vehicle	0	0
Equipment	1	1
Loss of Control	10	8
Did not stop after accident	3	0
No relevant factors	89	82

After examination of the large number of codes possible for legal action, a number of categories were constructed. The code numbers comprising these categories are listed in the Appendix. For example, unsafe turn includes "Not make turn with safety" and "Not make U-turn with safety".

No legal action was taken against about half of the drivers of rigid trucks or articulated vehicles coded as key vehicle in fatal crashes. In some cases, no legal action was possible because the driver was killed in the crash. The number of drivers killed is noted in the tables. The most common legal action recorded as proposed or taken against the driver of a rigid truck (see Table 3.27) or articulated vehicle (Table 3.28) coded as key vehicle in a fatal crash was "culpable driving".

TABLE 3.27. LEGAL ACTIONS PROPOSED OR TAKEN AGAINST DRIVERS OF RIGID TRUCKS CODED AS KEY VEHICLE IN FATAL CRASHES.

Legal action	Year		
	1987	1988	1989
Indictment codes			
Manslaughter	0	0	0
Culpable driving	11	5	4
Negligent act causing grievous bodily harm	0	0	0
Dangerous driving	0	0	0
Failure to stop after accident	0	0	1
Prescribed concentration alcohol	1	1	0
Cancelled driver	0	1	0
Negligent driving	5	3	0
Other driving offences	2	1	1
Unlicensed driver	0	0	0
Insecure loading	0	0	0
Other offence	1	0	0
No legal action	7	17	13
Number of drivers killed	3	3	5
Unknown/not stated	0	2	3
Total	27	29	22

Table 3.27 shows that the proportion of drivers of rigid trucks who were charged with culpable driving fell from .41 in 1987 to .17 in 1988 and .18 in 1989. This was accompanied by an increase from .17 in 1987 to .54 in 1988 and .47 in 1989 in the proportion of surviving drivers for whom there was no legal action.

A different pattern was found for the drivers of articulated vehicles which were key vehicles in fatal crashes (see Table 3.28). The proportions of drivers charged with culpable driving did not change from 1987 to 1988 (.23 to .19) but fell in 1989 (.12). In each year, more than half of the cases of no legal action resulted from the driver being killed. The proportion of surviving drivers for which there was no legal action increased from .29 in 1987 to .34 in 1988 to .47 in 1989.

TABLE 3.28. LEGAL ACTIONS PROPOSED OR TAKEN AGAINST DRIVERS OF ARTICULATED VEHICLES CODED AS KEY VEHICLE IN FATAL CRASHES.

Legal action	Year		
	1987	1988	1989
Indictment codes			
Manslaughter	1	1	0
Culpable driving	6	10	6
Negligent act causing grievous bodily harm	0	0	0
Dangerous driving	0	1	0
Failure to stop after accident	0	0	0
Prescribed concentration alcohol	0	0	1
Cancelled driver	0	1	0
Negligent driving	2	2	3
Other driving offences	0	0	1
Unlicensed driver	0	0	0
Insecure loading	0	0	0
Other offence	0	0	0
No legal action	16	28	34
Number of drivers killed	12	15	20
Unknown/not stated	1	10	5
Total	26	53	50

The legal actions coded for drivers of long-distance coaches recorded as key vehicles in fatal crashes comprised charge each of "culpable driving", "negligent driving" and "not cross lane line with safety" in 1987 and a "cross unbroken centre line" in 1988. In 1989 there was one charge of "culpable driving", no legal action was recorded in two cases and the outcome of another was unknown or not stated.

The legal actions proposed or taken against drivers of cars coded as key vehicle in fatal heavy vehicle crashes are summarised in Table 3.29. Very few legal actions were coded because most car drivers were killed.

TABLE 3.29. LEGAL ACTIONS PROPOSED OR TAKEN AGAINST DRIVERS OF CARS CODED AS KEY VEHICLE IN FATAL CRASHES.

Legal action	Year		
	1987	1988	1989
Indictment codes			
Manslaughter	1	1	0
Culpable driving	5	5	3
Negligent act causing grievous bodily harm	0	0	0
Dangerous driving	0	0	0
Failure to stop after accident	0	0	0
Prescribed concentration alcohol	0	0	1
Cancelled driver	0	0	0
Negligent driving	2	4	1
Other driving offences	0	3	1
Unlicensed driver	0	0	0
Other offence	0	0	0
No legal action	53	60	50
Number of drivers killed	51	57	49
Unknown/not stated	0	13	1
Total	61	86	57

No legal action was proposed or taken against about a third of rigid truck drivers and just under half of articulated truck drivers of key vehicles in hospital admission crashes. "Negligent driving" was the most common legal action coded in hospital admission crashes in which the key vehicle was a rigid truck or an articulated vehicle (see Tables 3.30 and 3.31). There were few differences in the pattern of legal actions from 1987 to 1988: for rigid trucks, the number of "disobey traffic control" dropped from 7 to 3 and the number of "culpable driving" dropped from 8 to 4. For articulated vehicles the number of "other driving offences" fell from 9 in 1987 to 3 in 1988.

TABLE 3.30. LEGAL ACTIONS PROPOSED OR TAKEN AGAINST DRIVERS OF RIGID TRUCKS CODED AS KEY VEHICLE IN HOSPITAL ADMISSION CRASHES.

Legal action	Year	
	1987	1988
Indictment codes		
Manslaughter	0	0
Culpable driving	8	4
Negligent act causing grievous bodily harm	0	0
Dangerous driving	0	2
Failure to stop after accident	1	0
Prescribed concentration alcohol	6	9
Cancelled driver	0	0
Negligent driving	53	53
Other driving offence	12	9
Unlicensed driver	1	0
Insecure loading	0	2
Other offence	0	0
No legal action	42	42
Unknown/not stated	0	0
Total	123	121

The number of legal actions taken against drivers of long-distance coaches coded as key vehicles in hospital admission crashes were too few for a comparison of 1987, 1988 and 1989. The legal actions comprised: a "prescribed concentration of alcohol" in 1987 and a "disobey traffic control" in 1988 and two charges of "negligent driving" in 1987 and and three in 1988.

TABLE 3.31. LEGAL ACTIONS PROPOSED OR TAKEN AGAINST DRIVERS OF ARTICULATED VEHICLES CODED AS KEY VEHICLE IN HOSPITAL ADMISSION CRASHES.

Legal action	Year	
	1987	1988
Indictment codes		
Manslaughter	0	0
Culpable driving	1	2
Negligent act causing grievous bodily harm	1	0
Dangerous driving	2	0
Failure to stop after accident	0	0
Prescribed concentration alcohol	5	4
Cancelled driver	0	0
Negligent driving	54	56
Other driving offences	9	3
Unlicensed driver	0	0
Insecure loading	0	1
Other offence	0	0
No legal action	51	53
Unknown/not stated	0	0
Total	123	119

Legal actions proposed or taken against drivers of cars coded as key vehicles in hospital admission crashes are presented in Table 3.32. The proportion of legal actions which were for prescribed concentration of alcohol was higher for car drivers than for truck drivers. The only differences in the pattern of legal actions between 1987 and 1988 was a slight increase in the proportion of other driving offences (from .21 to .28) and a slight decrease in the proportion of no legal action (from .21 to .11).

TABLE 3.32. LEGAL ACTIONS PROPOSED OR TAKEN AGAINST DRIVERS OF CARS CODED AS KEY VEHICLE IN HOSPITAL ADMISSION CRASHES.

Legal action	Year	
	1987	1988
Indictment codes		
Manslaughter	0	0
Culpable driving	6	5
Negligent act causing grievous bodily harm	0	0
Dangerous driving	2	1
Failure to stop after accident	1	0
Driving under the influence of intoxicating liquor	1	0
Prescribed concentration alcohol	19	18
Cancelled driver	0	0
Negligent driving	56	51
Other driving offences	30	34
Unlicensed driver	0	0
Other offence	0	0
No legal action	30	13
Unknown/not stated	0	0
Total	145	122

In summary, analysis of legal actions proposed or taken failed to identify any pattern of differences which might suggest that heavy vehicles were more involved as cause or "key vehicle" in 1988 than in 1987. Instead, the proportion of drivers of rigid trucks who were charged with culpable driving decreased across the three-year period. There was also an increase in the proportion of surviving drivers for whom there was no legal action. No legal action was often the most frequently coded legal action. In fatal crashes this was often because the driver was killed. The number of legal actions proposed or taken against drivers of key vehicles in hospital admission crashes was too small to allow comparisons of 1987 and 1988 data.

ALCOHOL

There are three alcohol variables recorded in the Traffic Unit section of the mass data system: Breath test result, Breath test analysis and Alcohol group of controller. The first two variables contain information from the Police accident report form only, Alcohol group of controller combines this with information about any blood test carried out at a hospital. Because it is more comprehensive, Alcohol group of controller is the variable analysed in this section.

The alcohol groups of drivers of rigid trucks and articulated vehicles coded as key vehicles in fatal and hospital admission crashes are presented in Tables 3.33 and 3.34. Inspection of these tables shows that a comparison of the involvement of alcohol across the three-year period is difficult because of the small numbers of drivers for which alcohol was detected. In fatal crashes for example, BACs above .05 were recorded for 2/53 drivers of key vehicles in 1987, 4/53 drivers in 1988 and 7/72 drivers in 1989. While the number of articulated vehicles coded as key vehicles in fatal crashes increased from 26 in 1987 to 53 in 1988, the number of drivers with BAC greater than .05 increased only from 0 to 1. In contrast, there were 5 articulated vehicle drivers with BAC greater than .05 in 1989.

TABLE 3.33. ALCOHOL GROUP OF DRIVER OF RIGID TRUCK CODED AS KEY VEHICLE IN FATAL CRASH OR HOSPITAL ADMISSION CRASH.

Degree	Alcohol group of controller							
	Nil	.001-.02	.02-.05	.05-.08	.08-.15	>=.15	Unk	Total
Fatal								
1987	24	0	0	0	1	1	1	27
1988	22	0	0	0	3	0	4	29
1989	18	0	0	0	1	1	2	22
Hospital admission								
1987	104	4	3	0	2	4	6	123
1988	102	1	0	1	7	3	7	121

It should be noted that alcohol group of driver was not known for about a quarter of the drivers of articulated vehicles in fatal crashes. While the usually accepted practice is to report on the basis of "proportion of known cases", the large amount of missing data makes estimates of the contribution of alcohol to such crashes imprecise. Based on the known data the proportion of articulated vehicle drivers in fatal crashes with BAC above .05 was zero in 1987, 2.5% in 1988 and 13.2% in 1989. If none of the missing data were positive this percentage would fall to zero in 1987, 2.0% in 1988 and 10.0% in 1989. But if all of the missing data were positive, the estimates would become 23% in 1987, 26% in 1988 and 34% in 1989. Thus the missing data mean that it is not certain whether there is no alcohol problem in fatal articulated vehicle crashes or whether there is quite a large problem.

TABLE 3.34. ALCOHOL GROUP OF DRIVER OF ARTICULATED VEHICLE CODED AS KEY VEHICLE IN FATAL CRASH OR HOSPITAL ADMISSION CRASH.

Degree	Alcohol group of controller							
	Nil	.001-.02	.02-.05	.05-.08	.08-.15	>=.15	Unk	Total
Fatal								
1987	19	1	0	0	0	0	6	26
1988	37	2	0	0	1	0	13	53
1989	32	0	1	1	3	1	12	50
Hospital admission								
1987	105	1	1	1	2	2	11	123
1988	103	3	2	0	2	2	8	120

Alcohol readings above .05 were recorded for 12/249 drivers of key vehicles in hospital crashes in 1987. The corresponding figure for 1988 was 15/244. Alcohol readings above zero but below .05 were recorded for 9/249 drivers in 1987 and 6/244 in 1988. Small concentrations of alcohol may contribute to crashes by rendering the driver more liable to fall asleep at the wheel.

None of the nine drivers of coaches coded as key vehicles in fatal crashes in 1987, 1988 and 1989 had any measurable alcohol concentration. In hospital admission crashes, one coach driver had an alcohol reading between .08 and .149 in 1987. Alcohol group of controller was missing for one coach driver in each of the two years. The readings were nil for the remaining coach drivers.

None of the above analyses suggest an increase in the role of alcohol in crashes from 1987 to 1988. The possibility remains that an increase in the role of alcohol in <u>car drivers</u> involved in crashes with trucks contributed part of the observed increase in the number of fatal articulated vehicle crashes. The analyses reported in Appendix C refute this claim. They show that the proportion of car drivers with BAC greater than .05% did not increase from 1987 to 1988, it appeared to decrease. The proportion of drivers of cars coded as key vehicle in fatal crashes who had BACs above .05 was .33 in 1987 and .19 in 1988.

CONCLUSIONS

The research question addressed in this section was whether heavy vehicles were more involved as cause or "key factor" in 1988 than in 1987 or 1989. The question was addressed by reference to the mass data for fatal crashes in 1987, 1988 and 1989 and the mass data for hospital admission crashes in 1987 and 1988.

The first indicator of involvement as cause or "key factor" was the proportion of heavy vehicles which were coded as Traffic Unit 1 in multi-vehicle crashes. For both articulated vehicles and rigid trucks in fatal crashes, the proportion coded as Traffic Unit 1 was not highest in 1988, but was highest in 1989. The evidence suggested that heavy vehicles were more involved as cause or "key vehicle" in hospital admission crashes in 1988 than 1987.

The examination of the manoeuvres of heavy vehicles which were judged to be key vehicles showed that most were coded as "Proceeding along lane". In fatal crashes, a smaller proportion of rigid trucks were coded as "incorrect side of road" or as involved in a turning or reversing manoeuvre in 1988 than in 1987 or 1989. The proportion of articulated vehicles coded as Traffic Unit 1 in fatal crashes which were recorded as having been on the wrong side of the road fell during the three-year period. This result suggests that the increased numbers of articulated vehicles judged to be key vehicles in fatal crashes in 1988 and 1989 were not accompanied by a proportional increase in dangerous manoeuvres. In contrast, the proportion of cars coded as "incorrect side of the road" increased during the three-year period.

The pattern of recorded manoeuvres of key vehicles in hospital admission crashes was similar in 1987 and 1988.

The results of the examination of factors/errors were disappointing. Most crashes were coded as "No relevant factors". While the pattern of manoeuvres of heavy vehicles did not appear to be different in 1988, the increase in unusual manoeuvres and loss of control for cars involved in fatal and hospital admission crashes with heavy vehicles from 1987 to 1988 suggests that heavy vehicles were **less** involved as key vehicles in 1988 (at least in crashes involving cars).

Analysis of legal actions proposed or taken failed to identify any pattern of differences which might suggest that heavy vehicles were more involved as cause or "key vehicle" in 1988 than in 1987. Instead, the proportion of drivers of rigid trucks who were charged with culpable driving decreased across the three-year period. There was also an increase in the proportion of surviving drivers for whom there was no legal action. No legal action was often the most frequently coded legal action. In fatal crashes this was often because the driver was killed. The number of legal actions proposed or taken against drivers of key vehicles in hospital admission crashes was too small to allow comparisons of 1987 and 1988 data.

A comparison of the involvement of alcohol across the three-year period is difficult because of the small number of drivers for which alcohol was detected. Alcohol data was not available for about a quarter of the drivers of articulated vehicles in fatal crashes. The contribution of alcohol consumption by drivers of cars coded as key vehicle in fatal crashes with heavy vehicles was less in 1988 than 1987.

3.7 CONCLUSIONS

The aim of Strand 2 was to utilise fully the existing mass data systems to gain a better understanding of specific aspects of the heavy vehicle crash problem and to examine the interaction of the various factors involved. The approach taken was to address each research question separately.

In general, trends in articulated vehicle and rigid truck crashes were identified but the small number of long distance coach crashes prevented fine-grained analysis of coach data. Detailed examination showed that seven long distance coaches were incorrectly coded as "Other bus". For this reason earlier studies may have underestimated the number of long distance coach crashes.

The first research question addressed was:

> Given that NSW in 1988 had a large problem with fatal articulated truck crashes, was the problem significantly different from other years?

Regression analyses showed that the number of fatal articulated vehicle crashes in 1988 was greater than would have been predicted from the 1982-1987 trend. The increase was clearer in the second half of 1988 than the first half. There seems to have been a slight fall in the second half of 1989.

The second research question was:

> Why are the Hume and Pacific Highways apparently a problem?

The analyses in this section have identified a number of ways in which the Hume Highway and the Pacific Highway North are a problem.

- In 1988 22% of NSW fatal and 17% of hospital admission heavy vehicle crashes occurred on these routes

- In 1988 23% of NSW fatalities and 20% of persons hospitalised in heavy vehicle crashes resulted from crashes on these routes

- These routes are also a problem because the downward trend in fatalities from 1982 to 1987 has reversed

The following characteristics of crashes on the Hume and Pacific Highways were identified:

- a greater proportion of crashes occurred in higher speed zones on the Hume Highway and Pacific Highway North than on the Pacific Highway South and in the rest of the state. This was found for both fatal and hospital admission crashes. The findings for the Newell and New England Highways were similar to the Hume Highway and the Pacific Highway North

- most crashes occurred on undivided sections of road

- articulated vehicles were involved in more fatal crashes than rigid trucks or long distance coaches. This was also true for the state as a whole

- 36% of the state's fatal long-distance coach crashes occurred on the Hume and Pacific Highways

- there were more articulated vehicles than rigid trucks involved in hospital admission crashes on the Pacific Highway North and the Hume Highway. The reverse was true for the state as a whole

- the distribution of fatal and hospital admission crashes by time of day appears to be quite different on the Hume and Pacific Highways than for NSW as a whole: more of the crashes on these routes involved articulated vehicles and most of the articulated vehicle crashes occurred at night-time. This is likely to reflect differences in the relative numbers of articulated vehicles and rigid trucks travelling during the day and during the night.

The third research question was why there were more <u>fatal</u> crashes in 1988 than 1987 despite the decrease in the

The results failed to support the hypothesis that the change reflected a general increase in crash severity. The ratio of number of fatal crashes to number of hospital admission crashes was greater in 1988, as expected, but neither the number of persons killed per fatal crash nor the number of persons hospitalised per hospital admission crash increased in 1988.

Possible factors underlying the increased number of fatal crashes were listed at the beginning of this section as

1. increased crash speed

2. a change in the mix of road users (to more vulnerable) in 1988

3. an increased number of occupants per car in 1988

4. an increased number of vehicles per crash in 1988

5. a change in the types of crashes (as classified by RUM codes) in 1988

Factor 1 is addressed in Section 4 of this report.

The analyses failed to detect any of the factors in 2, 3, 4 or 5. When fatal crashes in 1988 and 1987 were compared, the overall finding was that there were more of most types of crashes, rather than a change in the characteristics of the fatal crashes.

The fourth research question was whether heavy vehicles were more involved as cause or "key factor" in 1988 than in 1987 or 1989. The question was addressed by reference to the mass data for fatal crashes in 1987, 1988 and 1989 and the mass data for hospital admission crashes in 1987 and 1988

It was difficult to draw conclusions from variables such as manoeuvres, factors/errors and legal action. It seemed that the Police may have been unwilling to make a judgement about manoeuvres or factors/errors. In addition, the coding procedures designed to record only one factor/error or legal action per crash made it difficult to compare the incidence of various categories. It was in answering this research question that the difficulties in using information collected primarily for legal purposes to address a road safety issue were most evident.

The first indicator of involvement as cause or "key factor" was the proportion of heavy vehicles which were coded as Traffic Unit 1 in multi-vehicle crashes. For both articulated vehicles and rigid trucks in fatal crashes, the proportion coded as Traffic Unit 1 was not highest in 1988, but was highest in 1989. The evidence suggested that heavy vehicles were more involved as cause or "key vehicle" in hospital admission crashes in 1988 than 1987.

The examination of the manoeuvres of heavy vehicles which were judged to be key vehicles showed that most were coded as "proceeding along lane". In fatal crashes, a smaller proportion of rigid trucks were coded as "incorrect side of road" or as involved in a turning or reversing manoeuvre in 1988 than in 1987 or 1989. The increased numbers of articulated vehicles judged to be key vehicles in fatal crashes in 1988 and 1989 were not accompanied by a proportional increase in dangerous manoeuvres. In contrast, the proportion of cars coded as "incorrect side of the road" increased during the three-year period. The pattern of recorded manoeuvres of key vehicles in hospital admission crashes was similar in 1987 and 1988.

The results of the examination of factors/errors were disappointing. Most crashes were coded as "No relevant factors". While the pattern of manoeuvres of heavy vehicles did not appear to be different in 1988, the increase in unusual manoeuvres and loss of control for cars involved in fatal and hospital admission crashes with heavy vehicles from 1987 to 1988 suggests that heavy vehicles were <u>less</u> involved as key vehicles in 1988 (at least in crashes involving cars).

Analysis of legal actions proposed or taken failed to identify any pattern of differences which might suggest that heavy vehicles were more involved as cause or "key vehicle" in 1988 than in 1987. No legal action was often the most frequently coded legal action. In fatal crashes this was often because the driver was killed. The number of legal actions proposed or taken against drivers of key vehicles in hospital admission crashes was too small to allow comparisons of 1987 and 1988 data.

A comparison of the involvement of alcohol across the three-year period is difficult because of the small number of heavy vehicle drivers for which alcohol was detected. Alcohol data was not available for about a quarter of the drivers of articulated vehicles in fatal crashes. The contribution of alcohol consumption by drivers of cars coded as key vehicle in fatal crashes with heavy vehicles was less in 1988 than 1987.

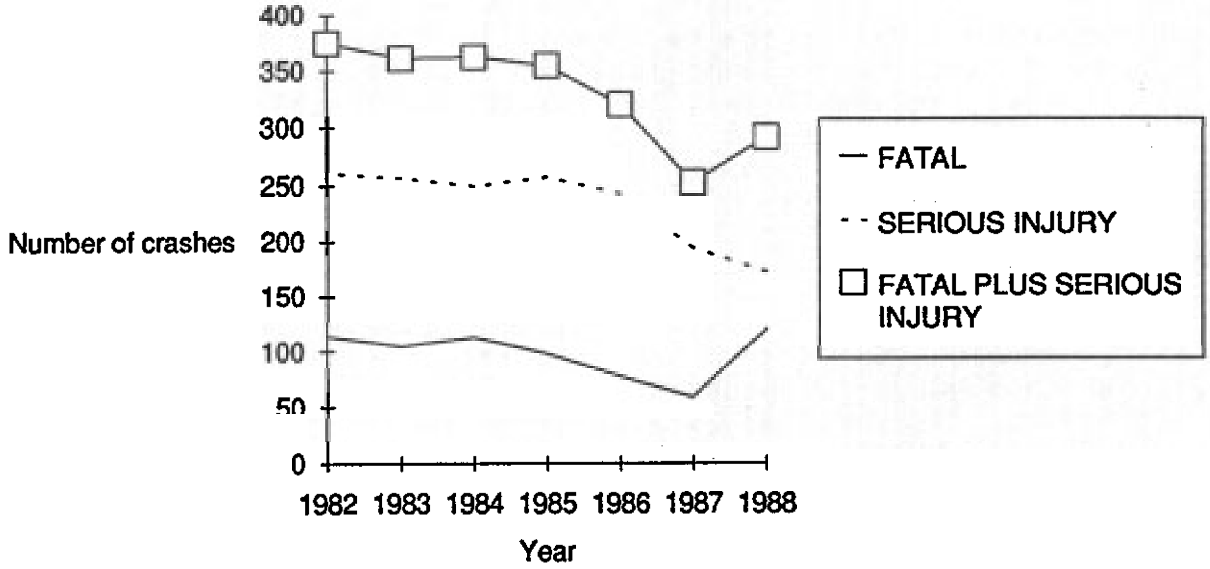


Figure 3.1. The numbers of articulated vehicle crashes which resulted in at least one fatality or hospital admission for the years 1982 to 1988.

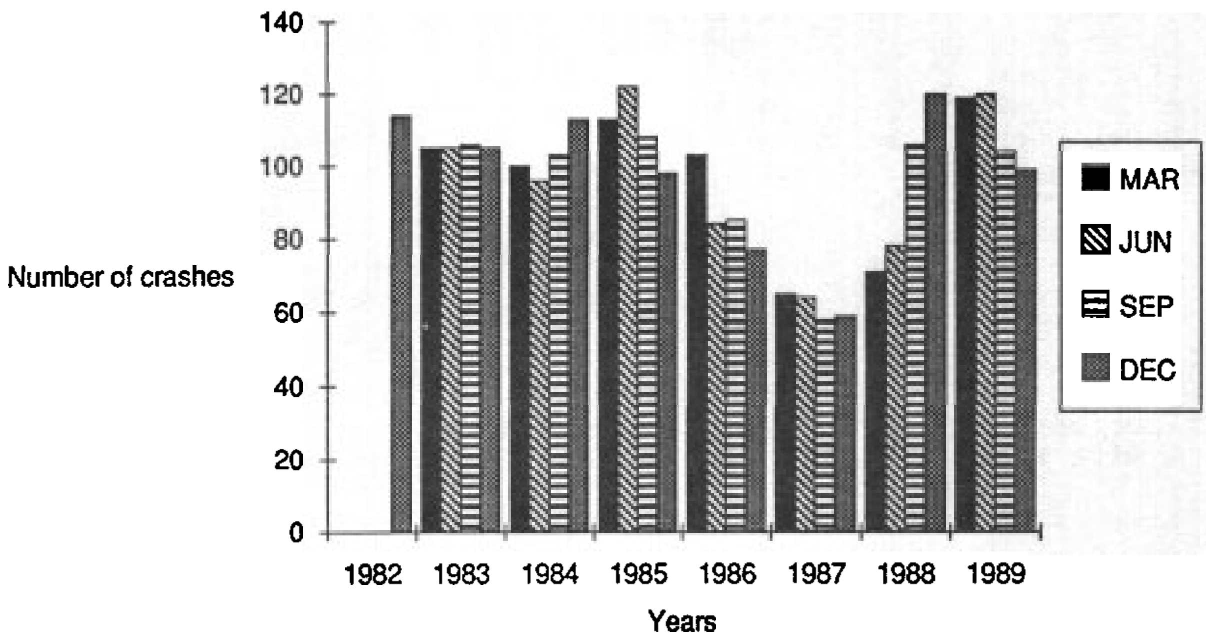
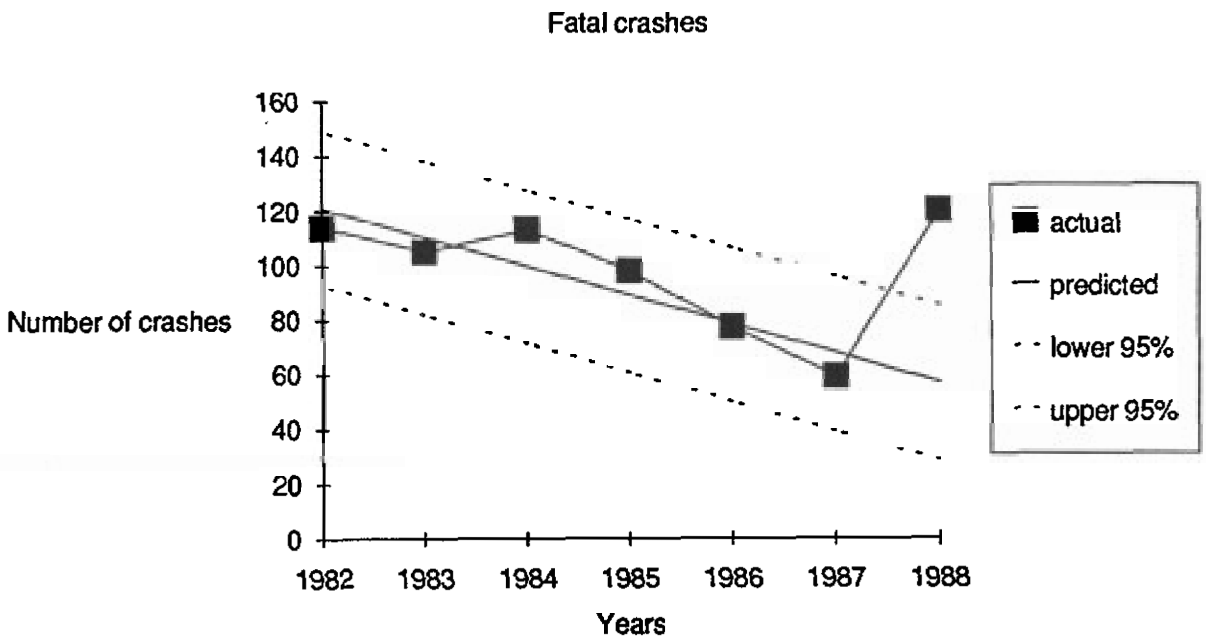


Figure 3.2. Annual numbers of fatal articulated vehicle crashes expressed as a quarterly moving total.



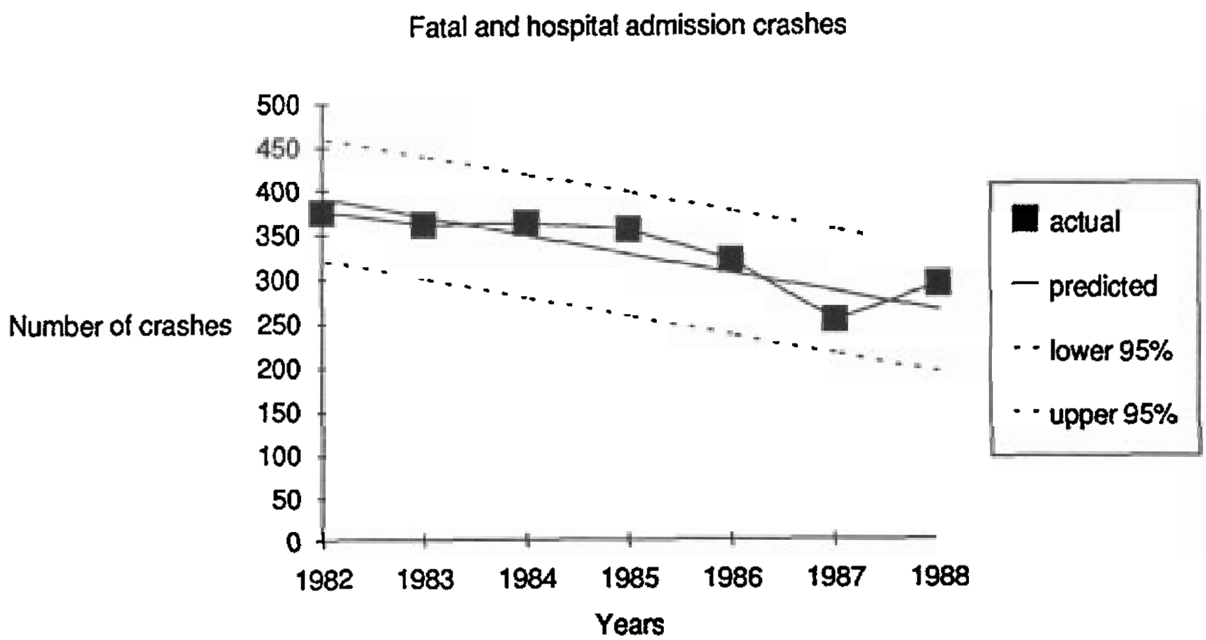
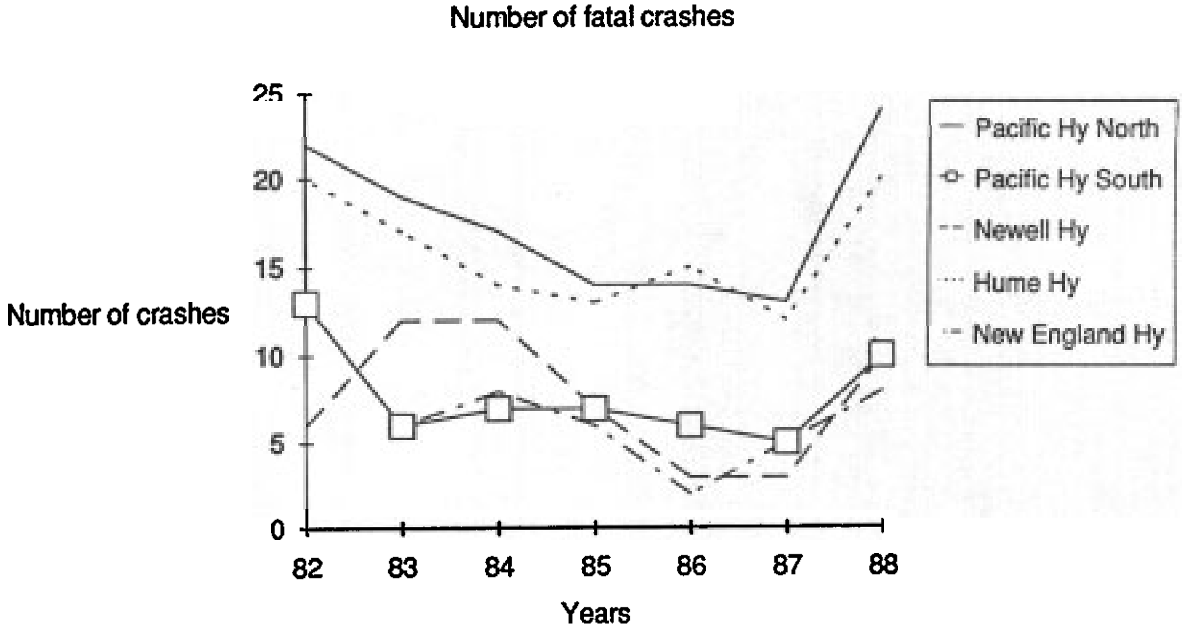


Figure 3.3. The predicted and actual numbers of fatal crashes (upper panel) and fatal and hospital admission crashes (lower panel) involving articulated vehicles for the years 1982 to 1988.



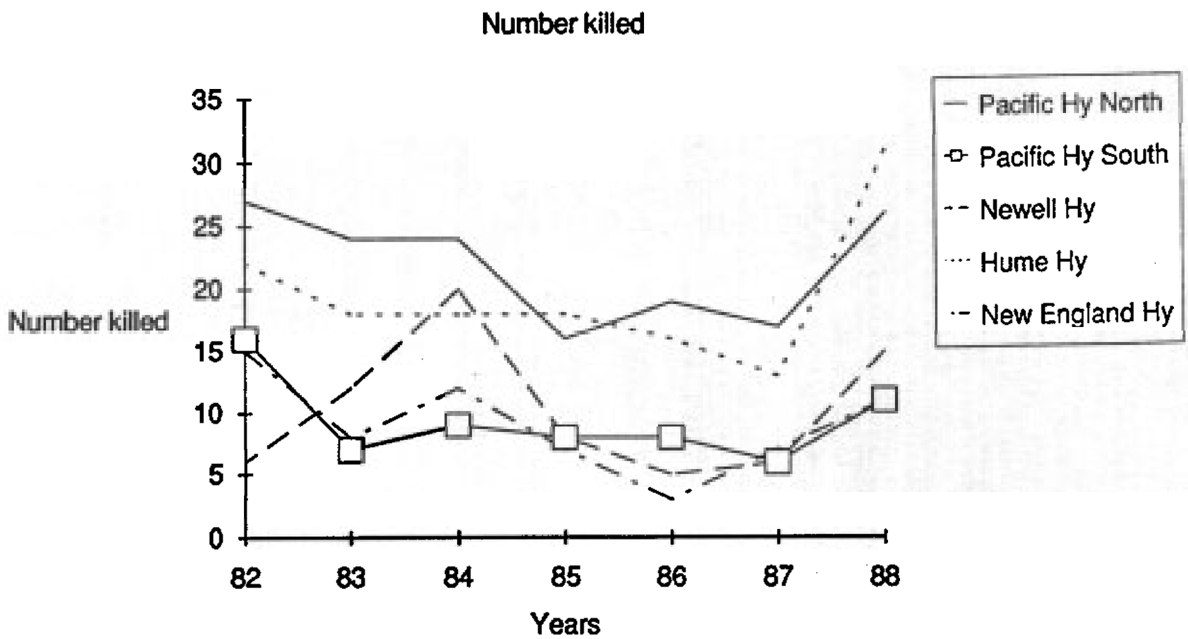


Figure 3.4. The number of fatal heavy vehicle crashes and the number of people killed on the Pacific Highway North, Pacific Highway South, Newell, Hume and New England Highways.

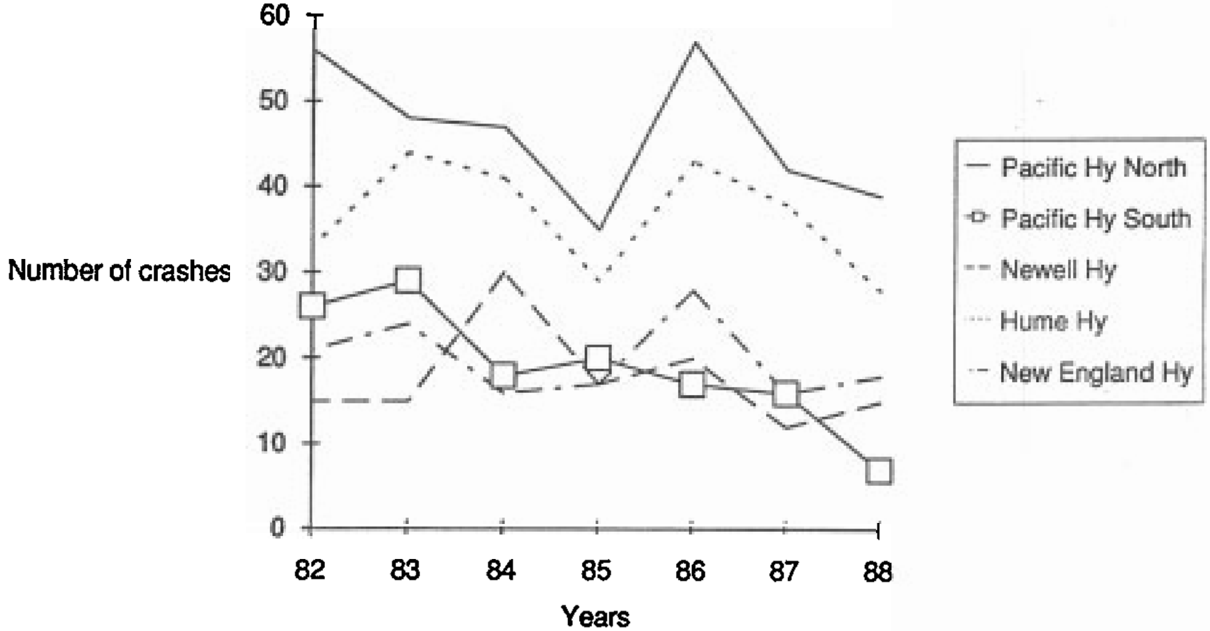
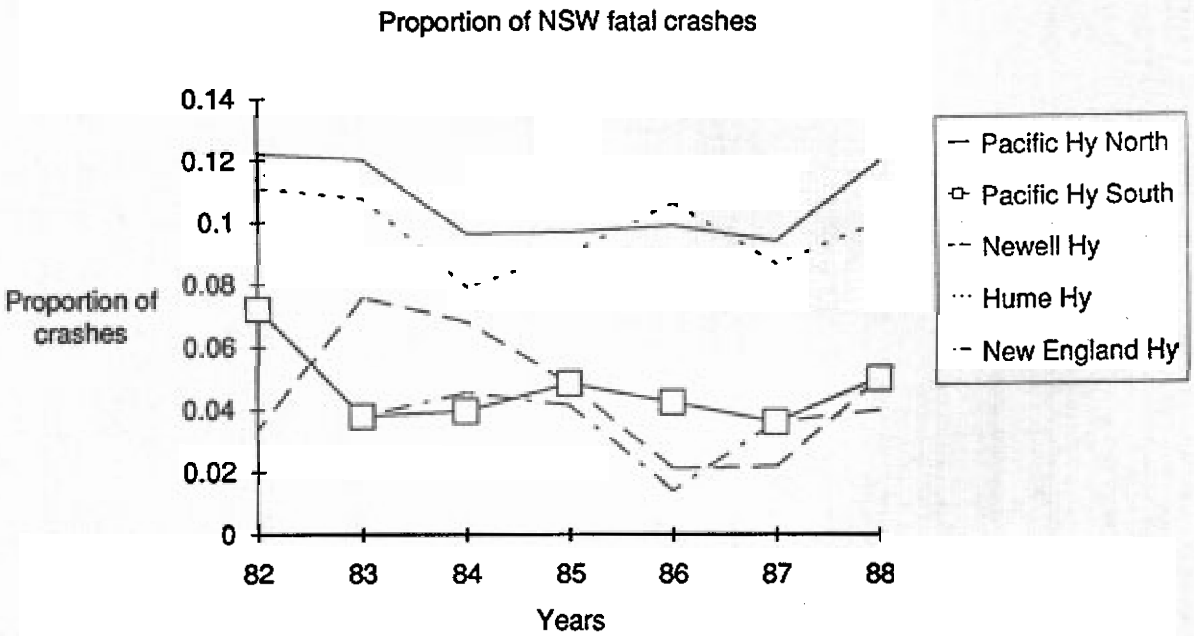


Figure 3.5. The number of crashes in which the most severe injury required hospital admission.



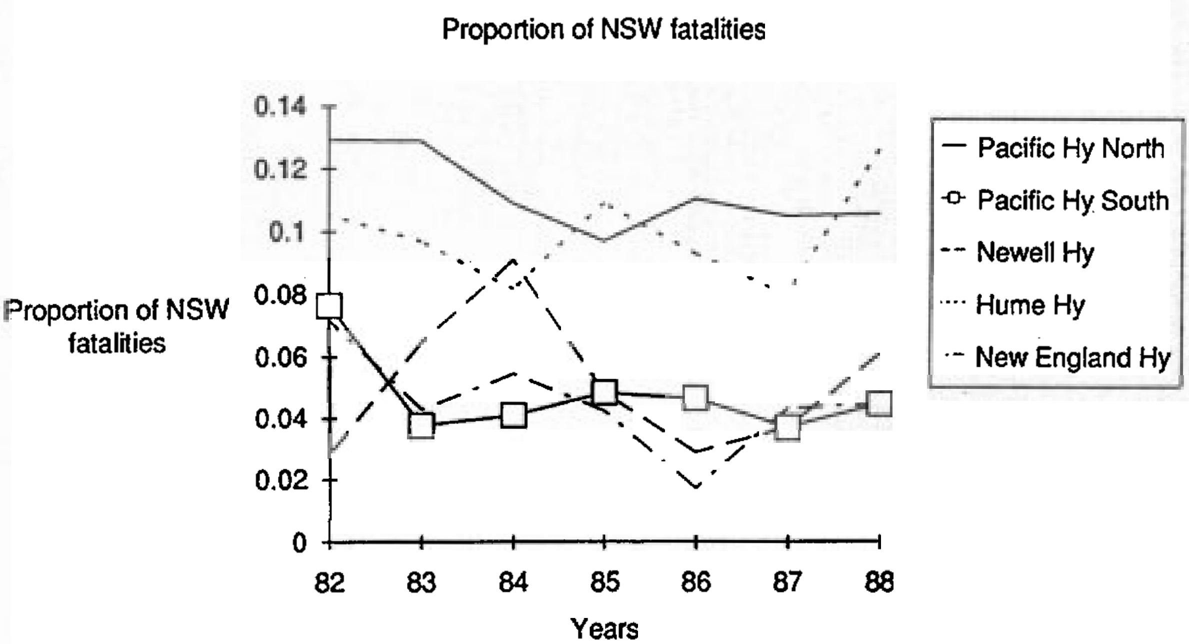


Figure 3.6. The proportions of NSW fatal heavy vehicle crashes and fatalities which occurred on the Pacific Highway North, Pacific Highway South, Newell, Hume and New England Highways in the years 1982 to 1988.

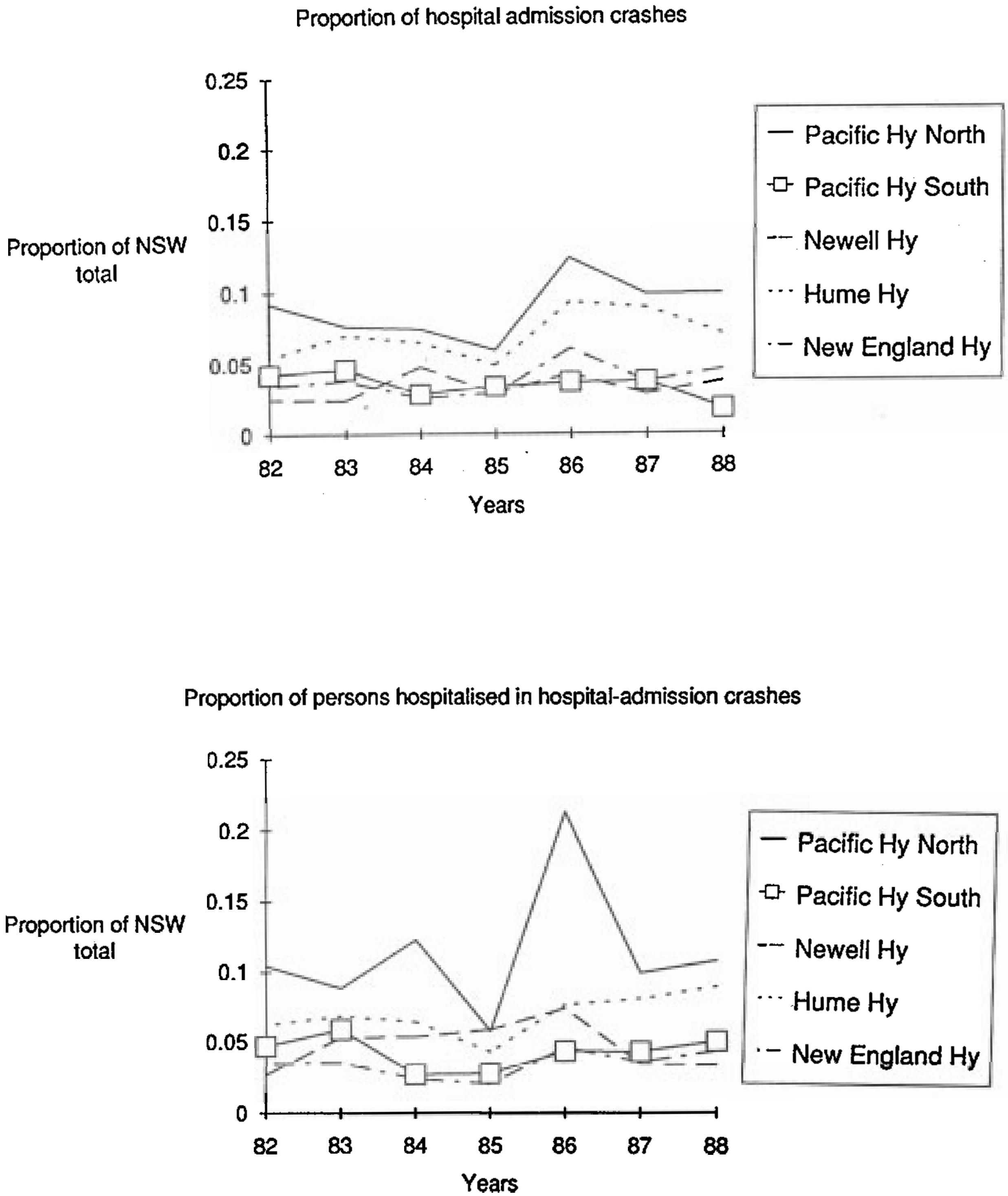


Figure 3.7. Proportion of NSW crashes in which the most severe injury required hospitalisation (upper panel) and proportion of persons hospitalised in such crashes (lower panel) for the Pacific Highway North, Pacific Highway South, Newell, Hume and New England Highways.

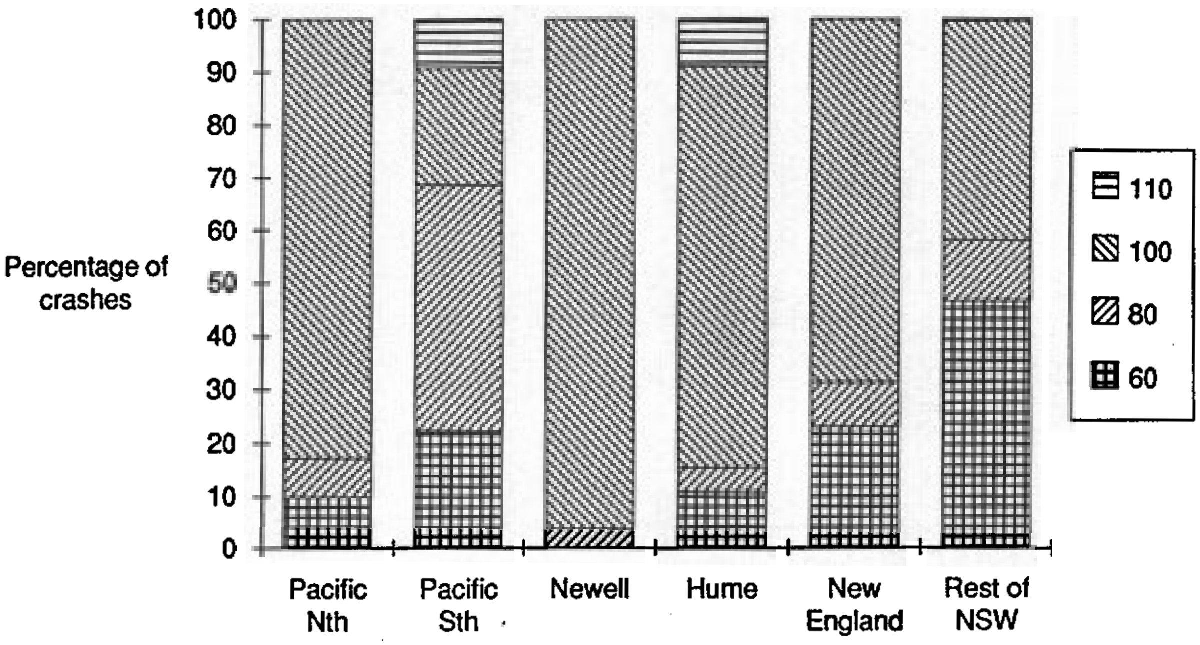


Figure 3.8. The percentages of fatal heavy vehicle crashes which occurred in each speed zone on the Pacific Highway North, Pacific Highway South, Newell, Hume and New England Highways and in the rest of NSW in 1982-1988.

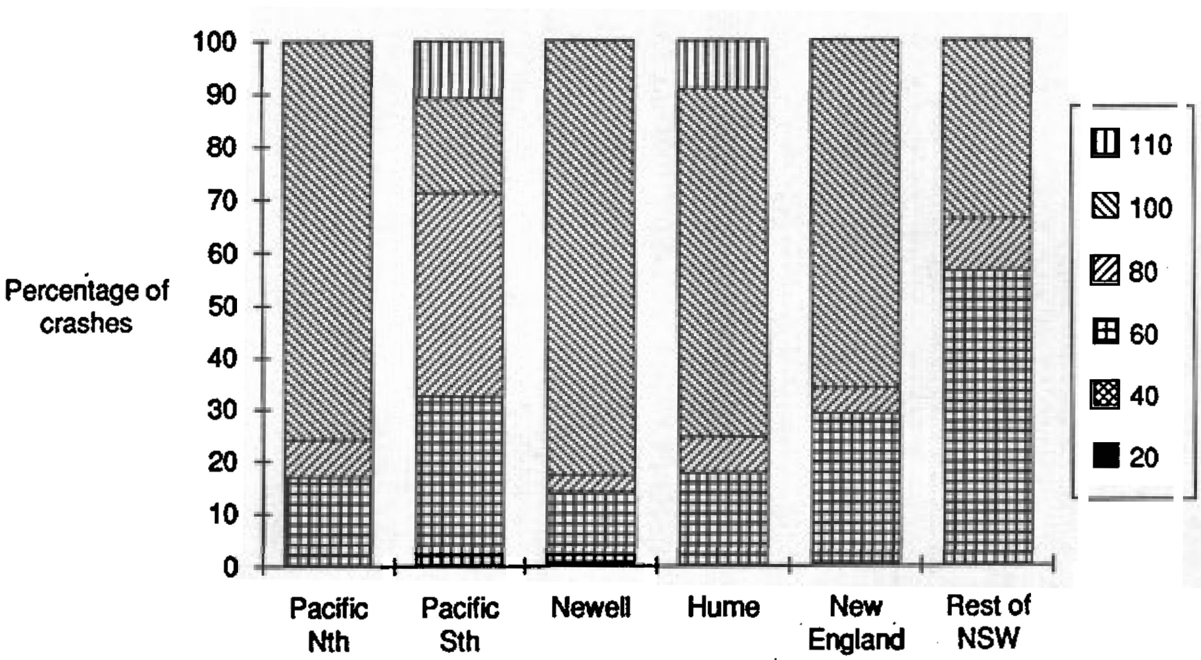


Figure 3.9. The percentage of hospital admission crashes involving heavy vehicles which occurred in each speed zone on the Pacific Highway North, Pacific Highway South, Newell, Hume and New England Highways and the rest of NSW in 1982-1988.

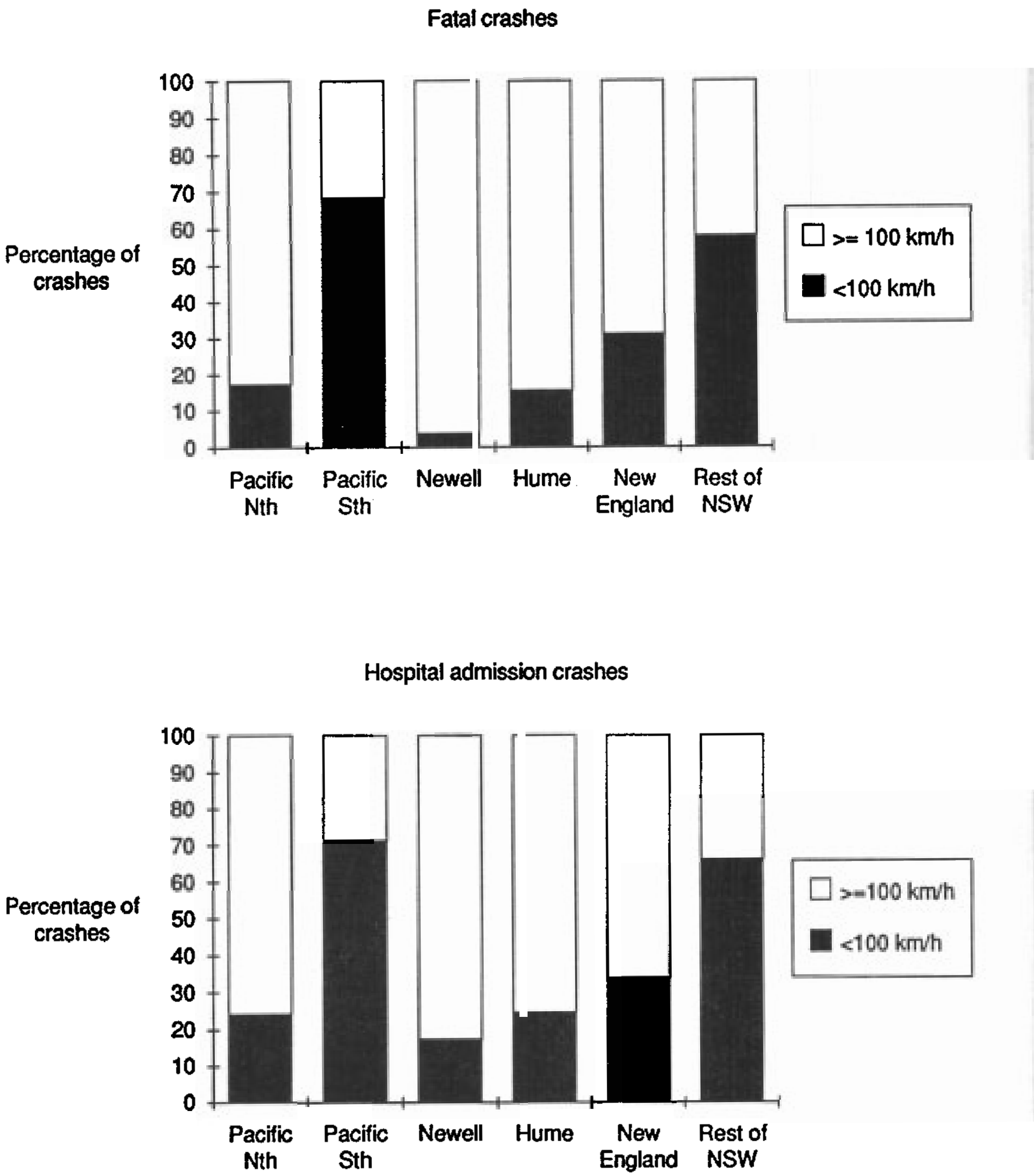
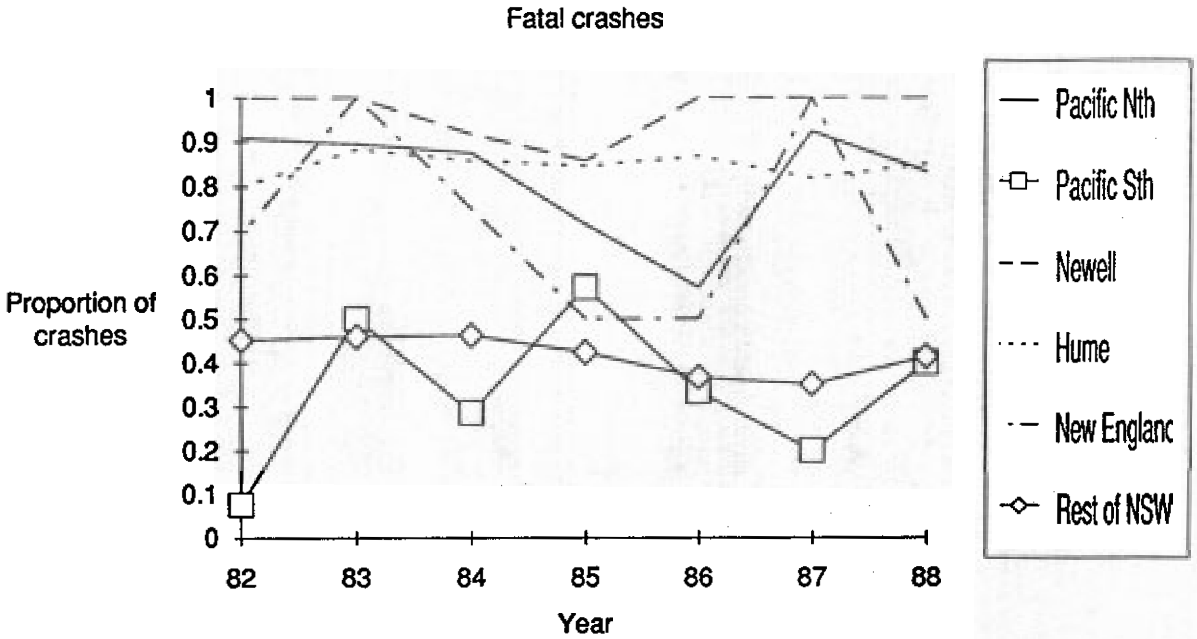


Figure 3.10. The percentages of fatal crashes and hospital admission crashes in less than 100 km/h and 100 km/h or greater speed zones on the Pacific Highway North, Pacific Highway South, Newell, Hume and New England Highways and the rest of NSW in 1982-1988.



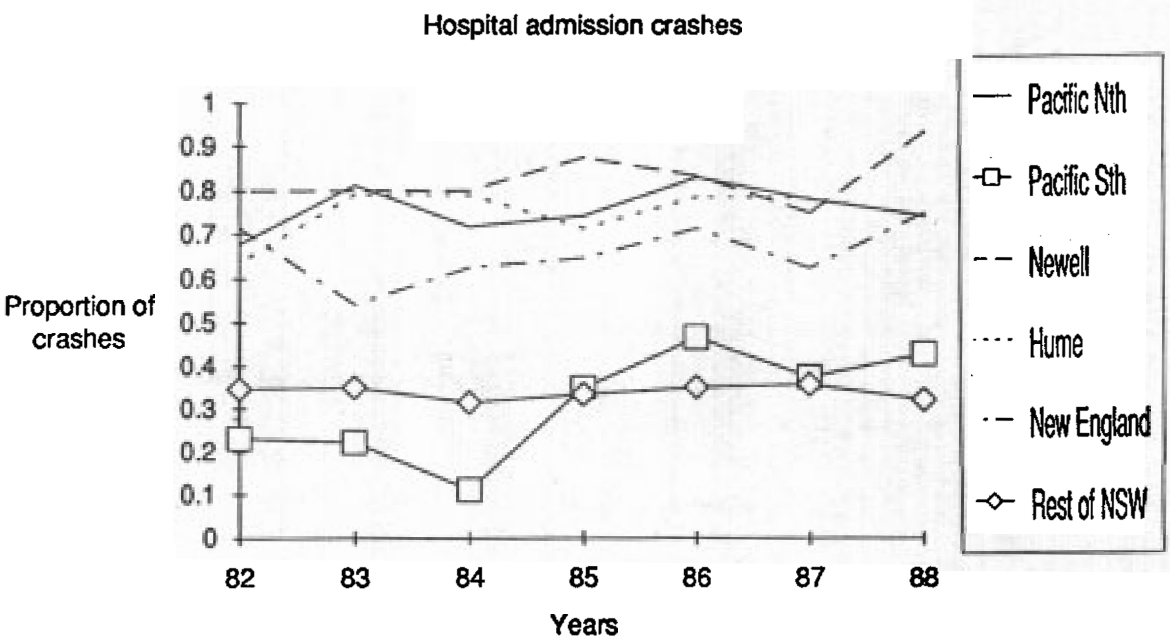


Figure 3.11. Percentages of fatal and hospital admission crashes which occurred in high speed zones on the Pacific Highway North, Pacific Highway South, Newell, Hume and New England Highways and the rest of NSW in 1982-1988.

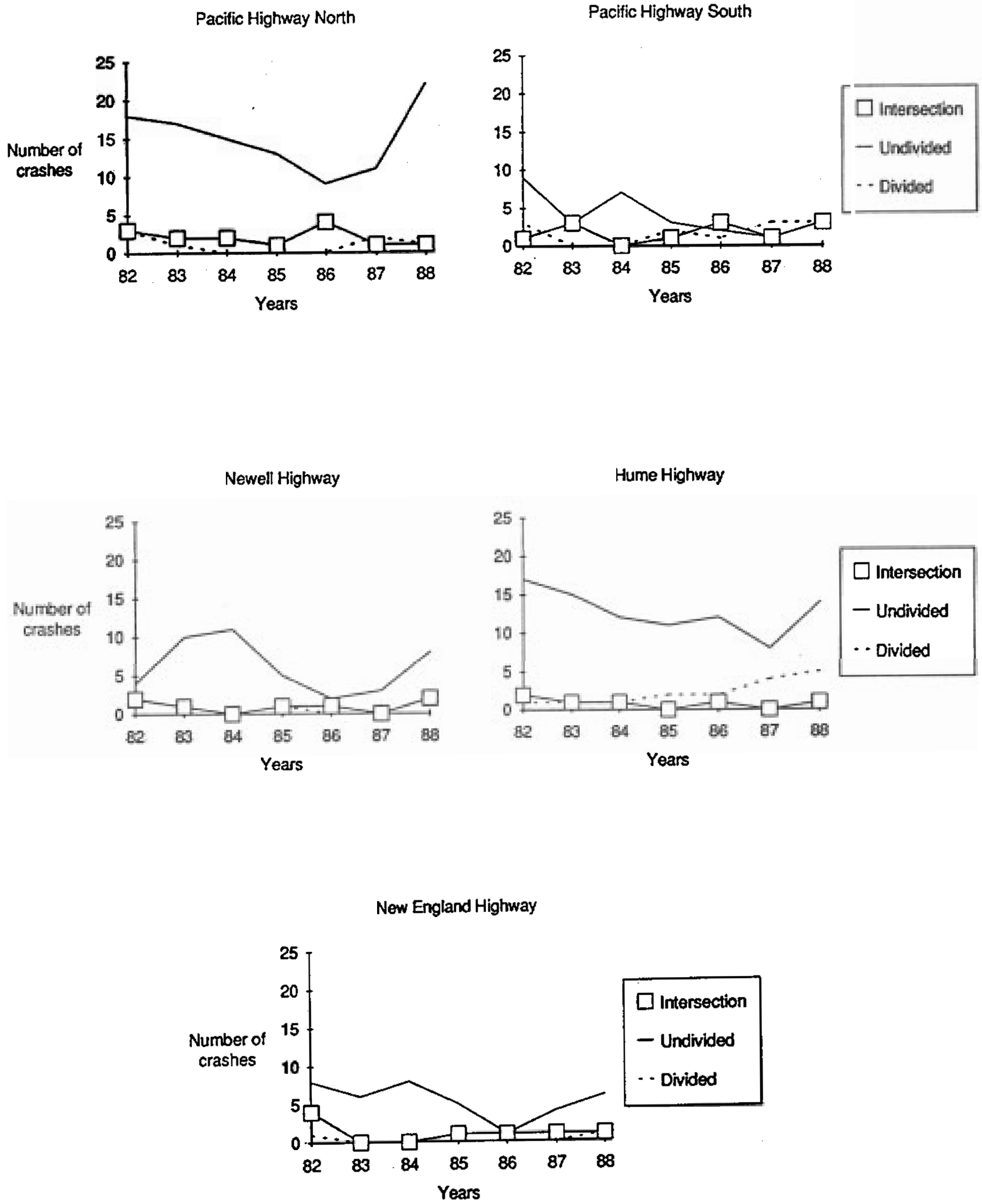


Figure 3.12. Numbers of fatal crashes which occurred on divided and undivided sections of the Pacific Highway North, Pacific Highway South, Newell, Hume and New England Highways in 1982-1988.

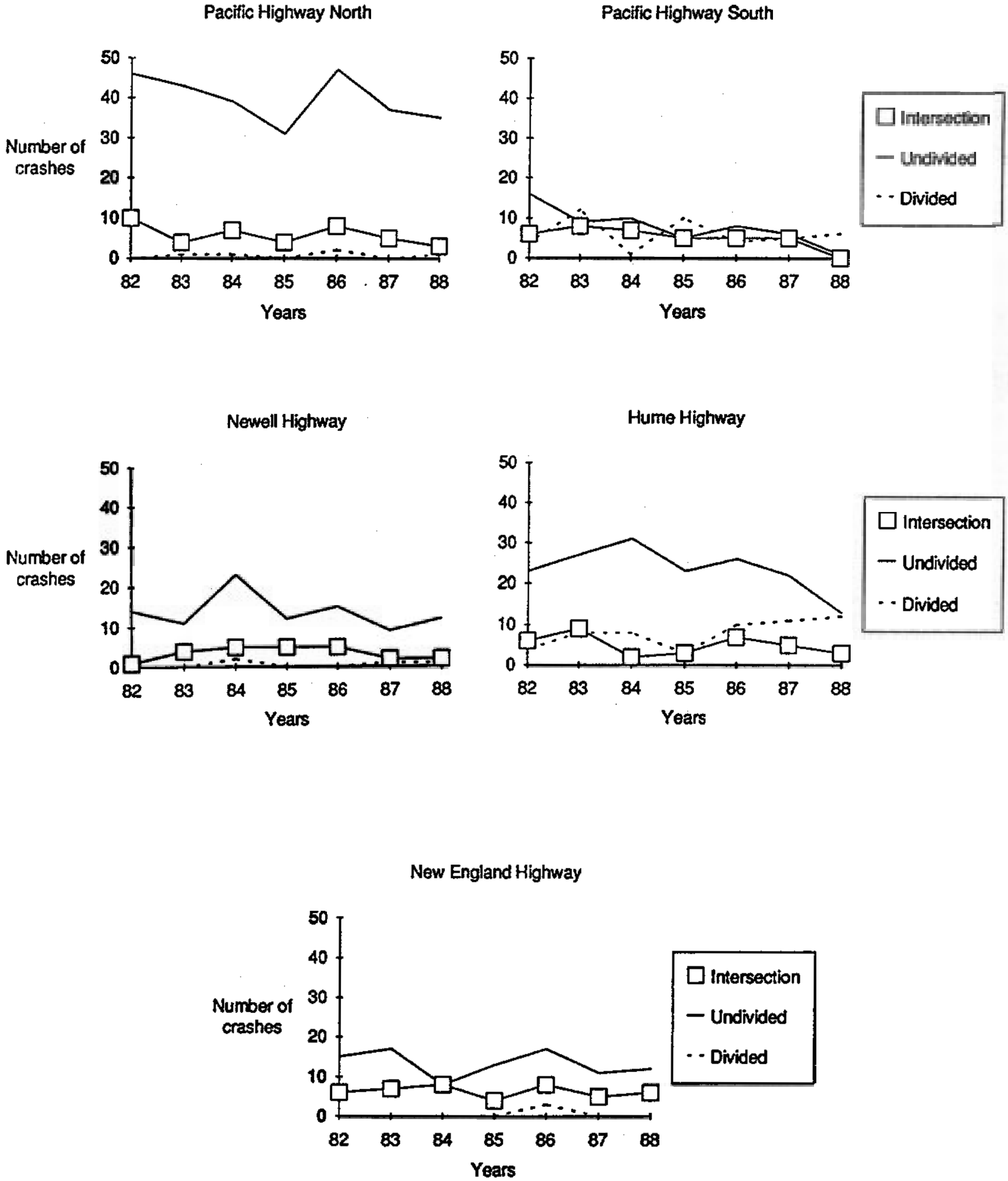


Figure 3.13. Numbers of hospital admission crashes which occurred on divided and undivided sections of the Pacific Highway North, Pacific Highway South, Newell, Hume and New England Highways in 1982-1988.

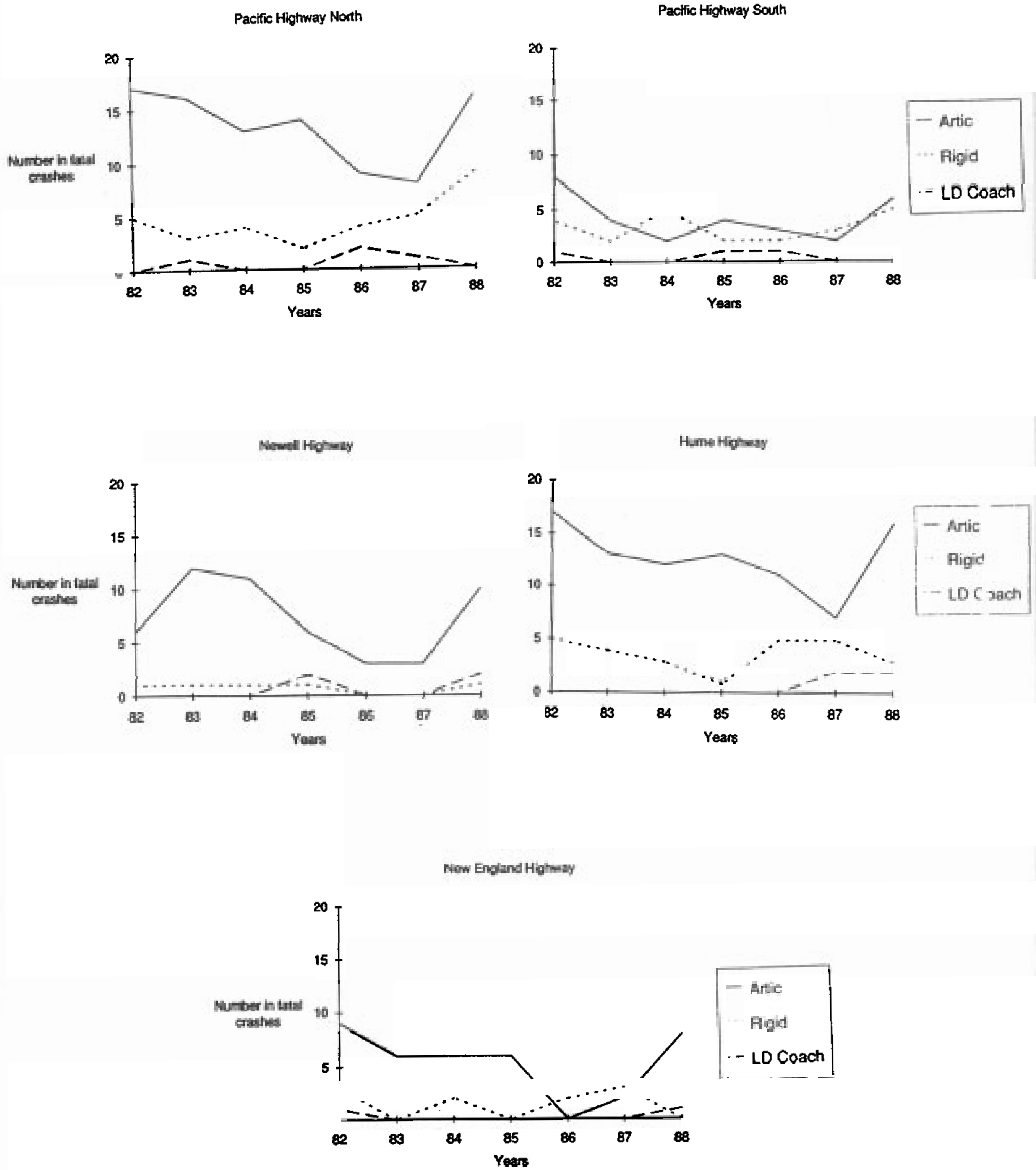


Figure 3.14. The involvement of each type of heavy vehicle in fatal crashes on the Pacific Highway North, Pacific Highway South, Newell, Hume and New England Highways in 1982-1988.

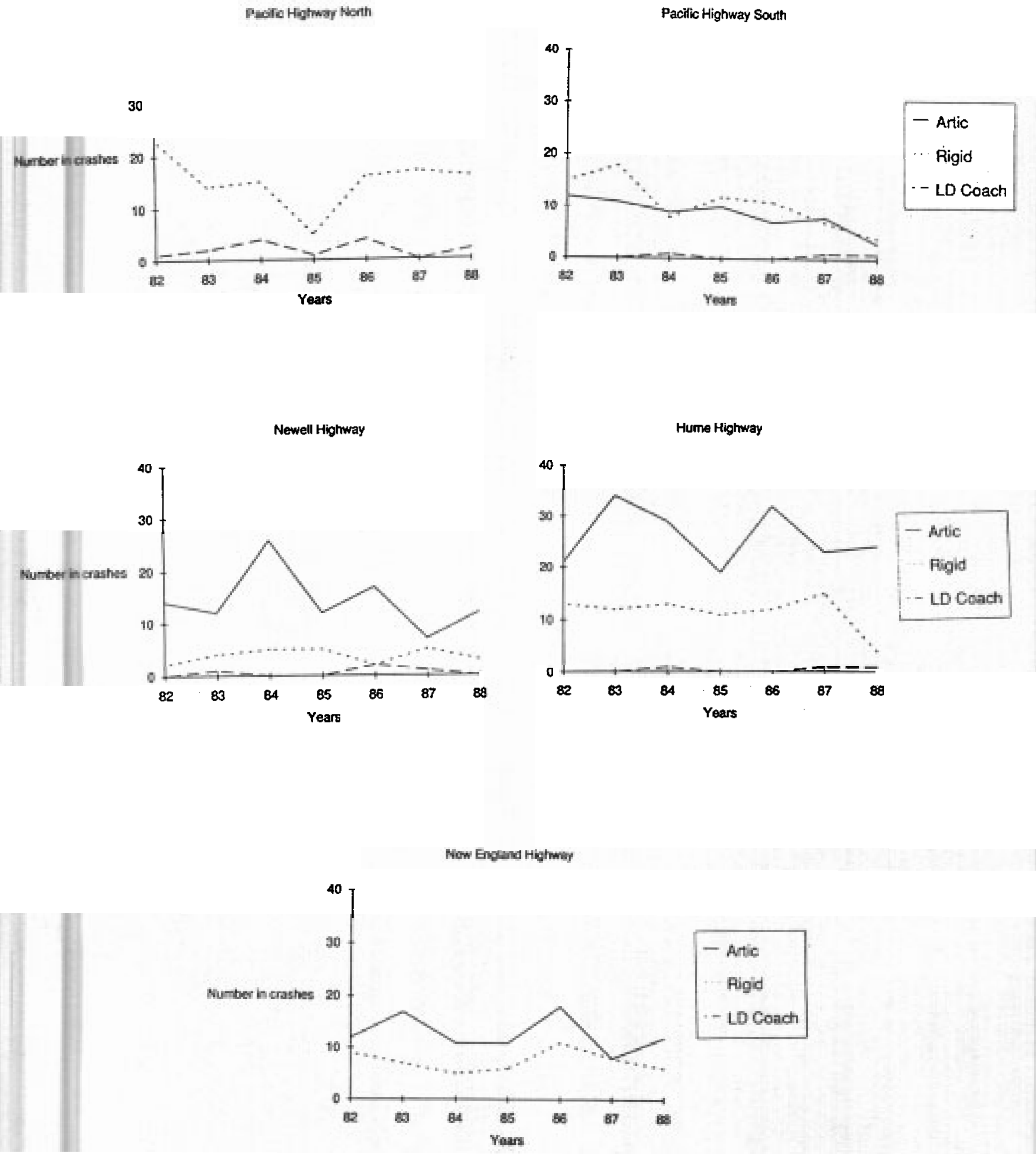


Figure 3.15. The involvement of each type of heavy vehicle in hospital admission crashes on the Pacific Highway North, Pacific Highway South, Newell, Hume and New England Highways in 1982-1988.

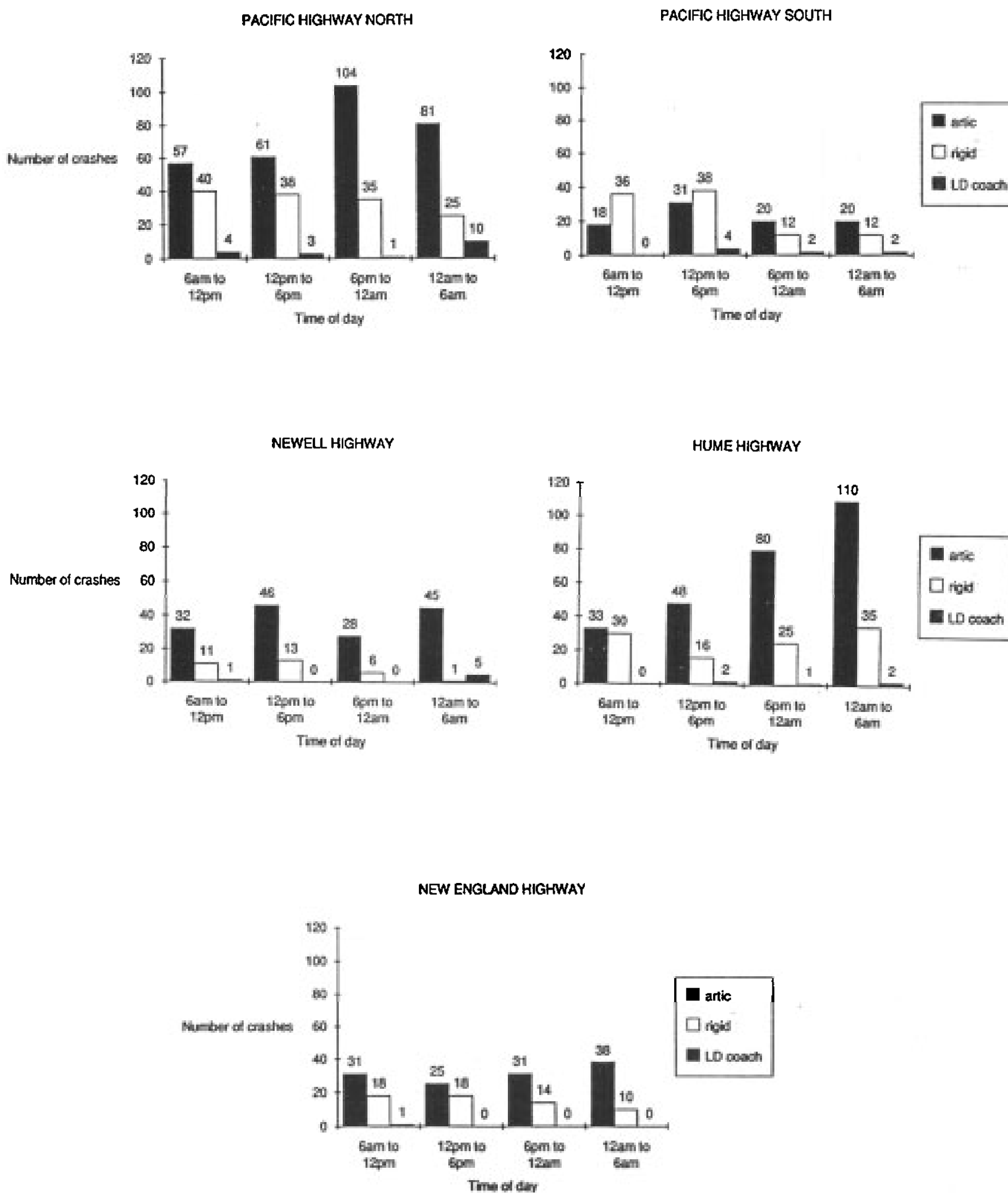
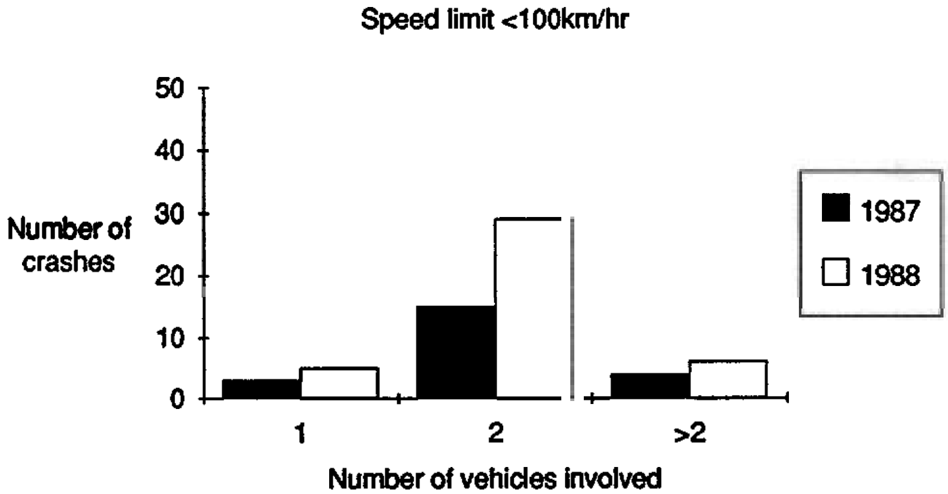


Figure 3.16. Number of fatal and hospital admission crashes (1982-1988) by time of day and type of heavy vehicle for all of NSW, the Pacific Highway North, Pacific Highway South, Newell, Hume and New England Highways.



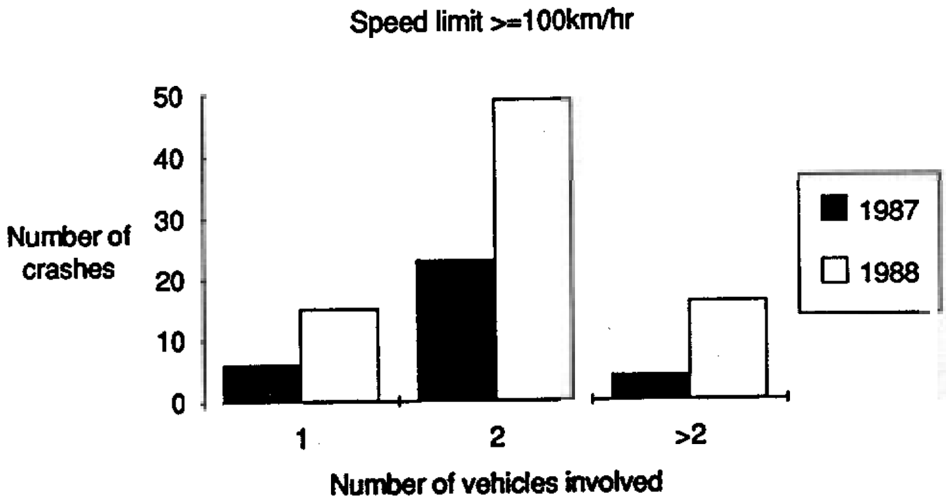
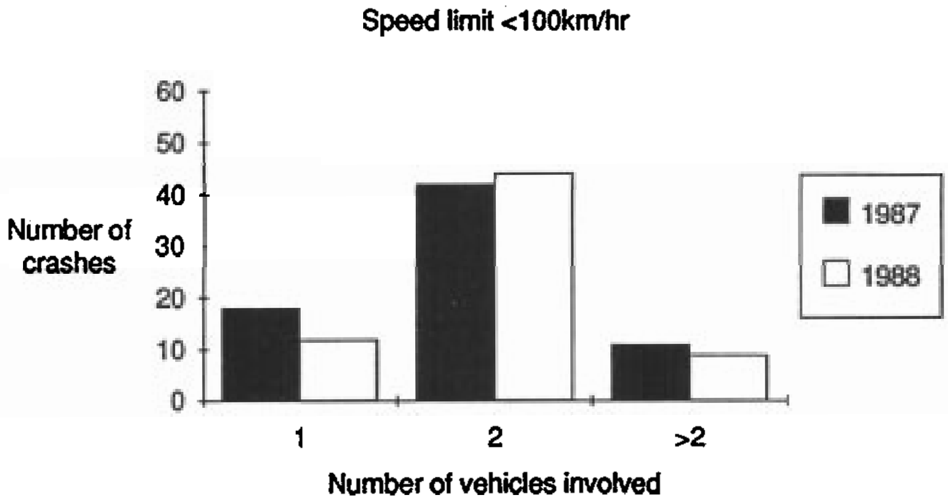


Figure 3.17. Numbers of fatal articulated vehicle crashes involving one, two or more than two vehicles in low and high speed zones in 1987 and 1988.



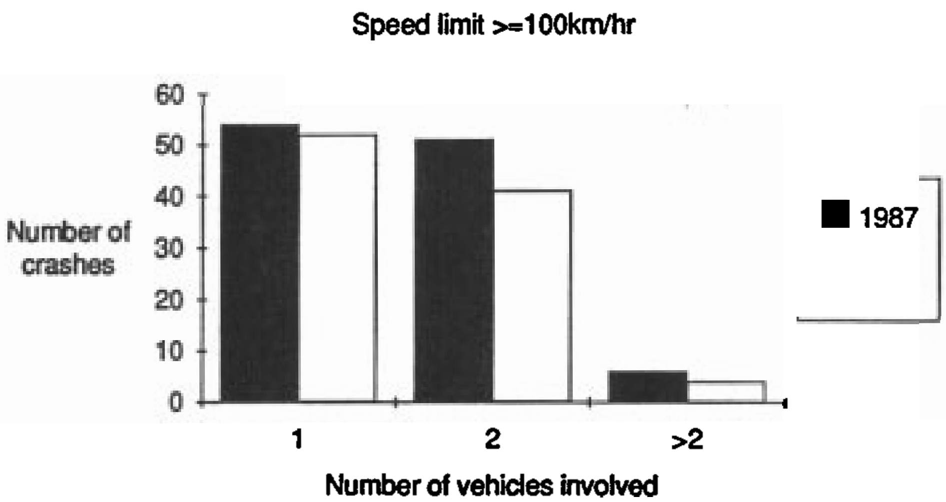


Figure 3.18. Numbers of hospital admission articulated vehicle crashes involving one, two or more than two vehicles in low and high speed zones in 1987 and 1988.

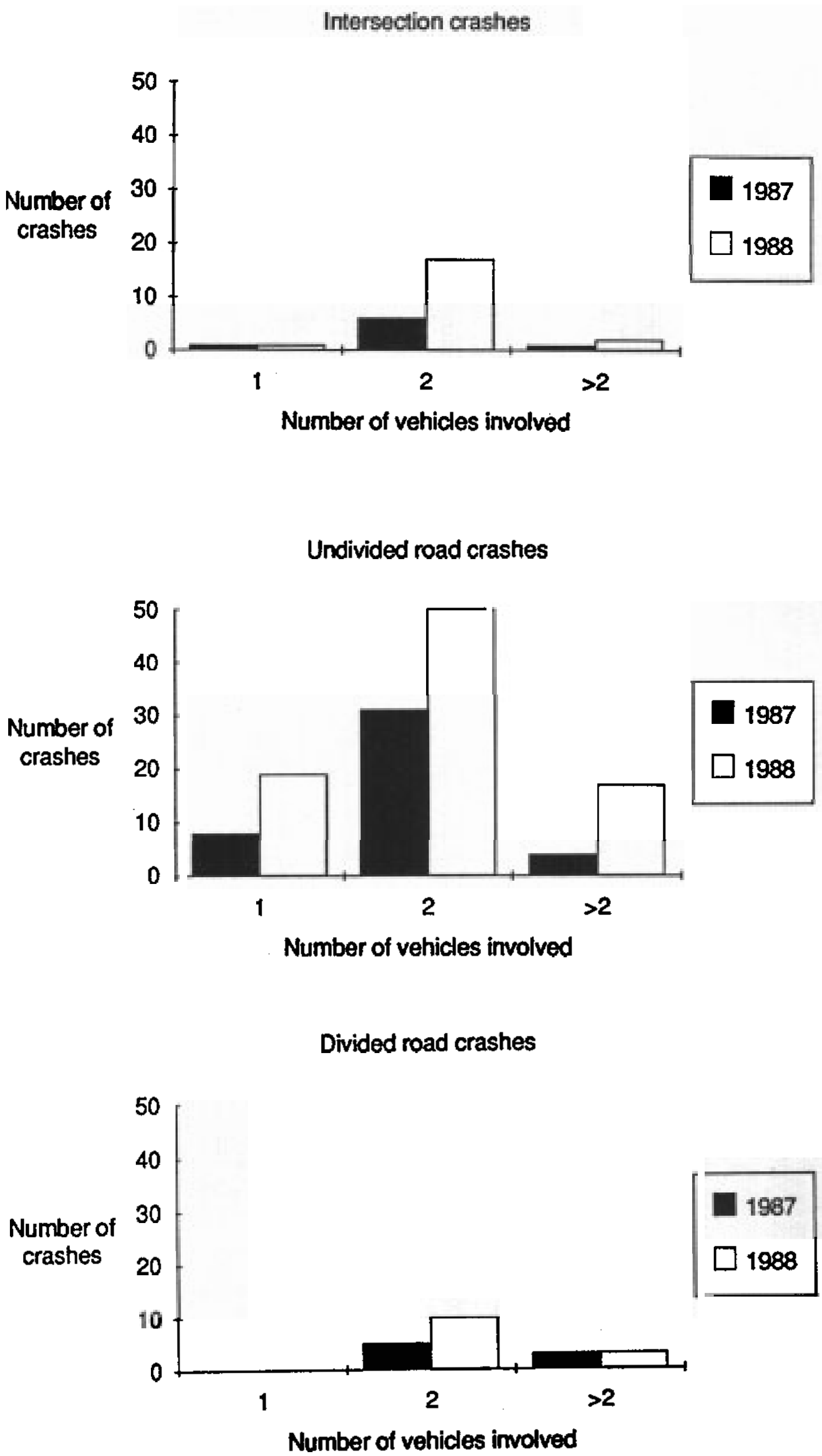


Figure 3.19. Numbers of fatal articulated vehicle crashes in 1987 and 1988 classified by number of vehicles involved and road cross-section.

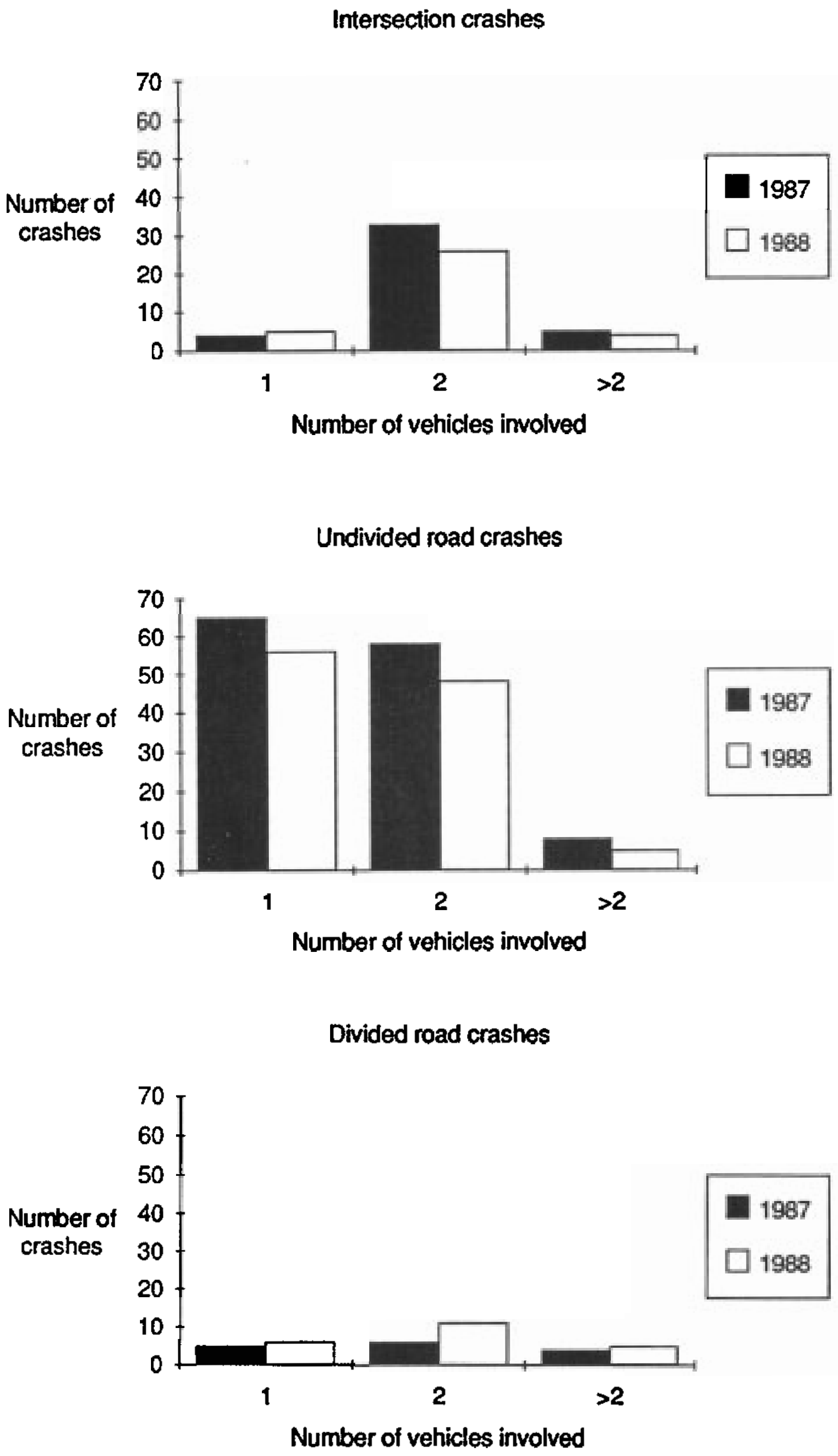


Figure 3.20. Numbers of hospital admission articulated vehicle crashes in 1987 and 1988 classified by number of vehicles involved and road cross-section.

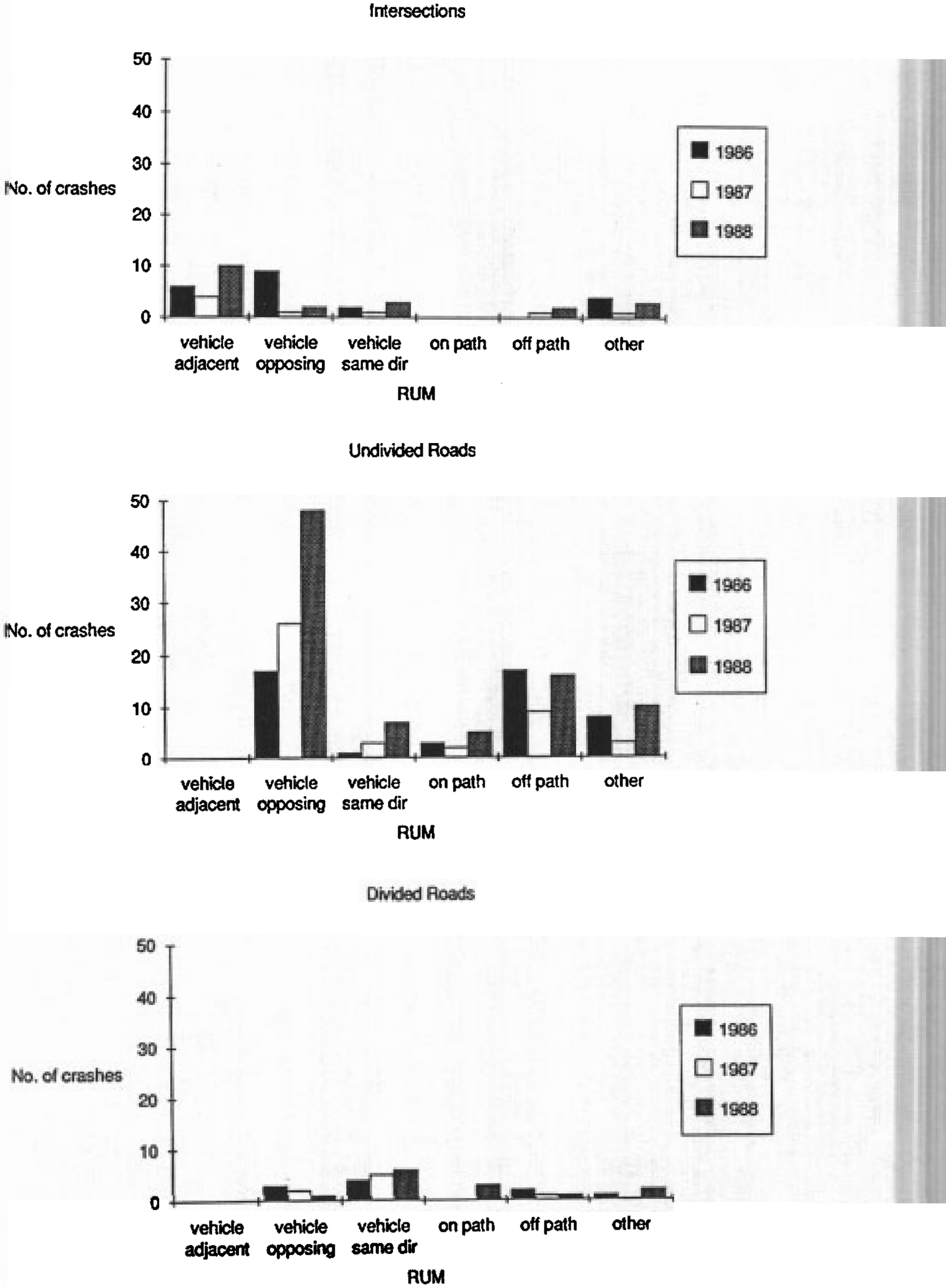


Figure 3.21. Road user movement (RUM) codes for fatal articulated vehicle crashes from 1986 to 1988 classified by road cross-section.

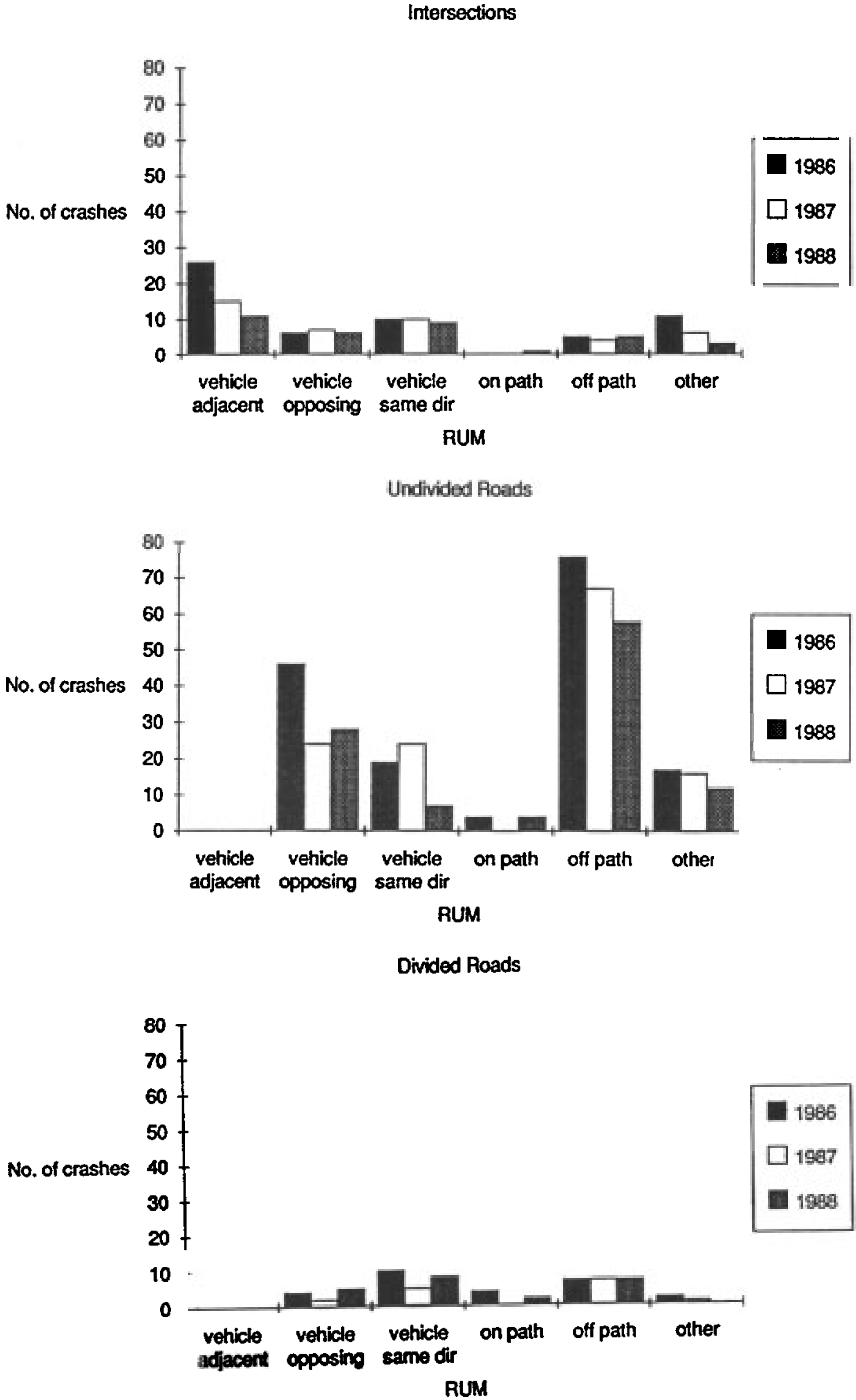
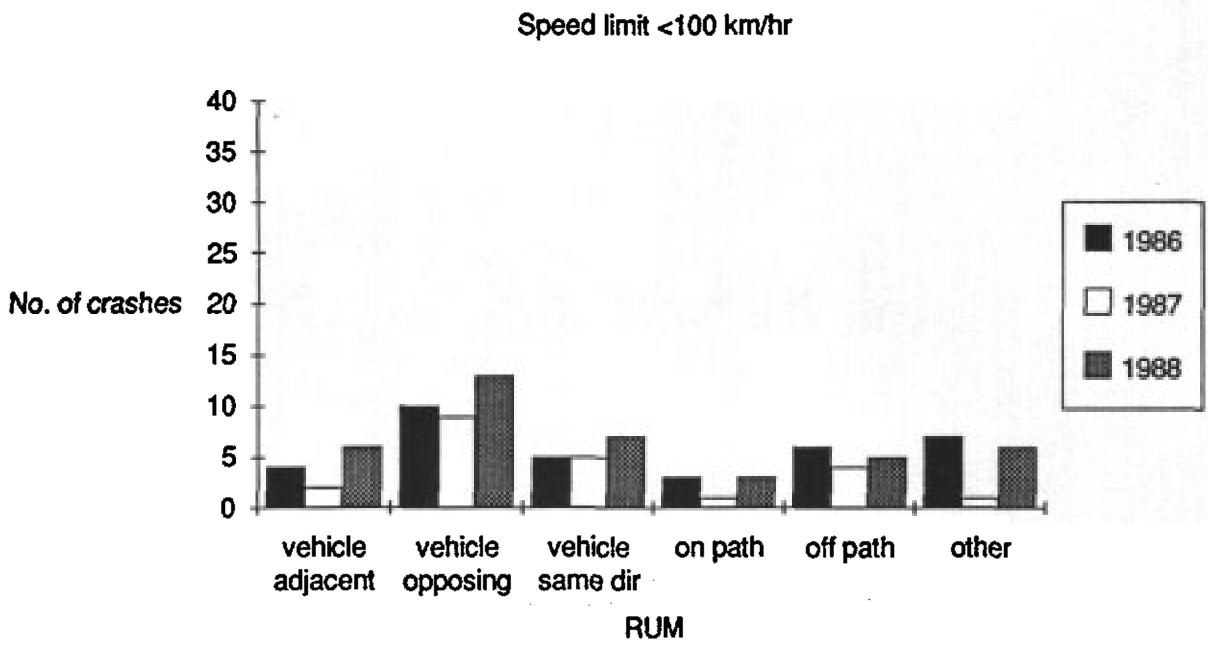


Figure 3.22. Road user movement (RUM) codes for hospital admission articulated vehicle crashes from 1986 to 1988 classified by road cross-section.



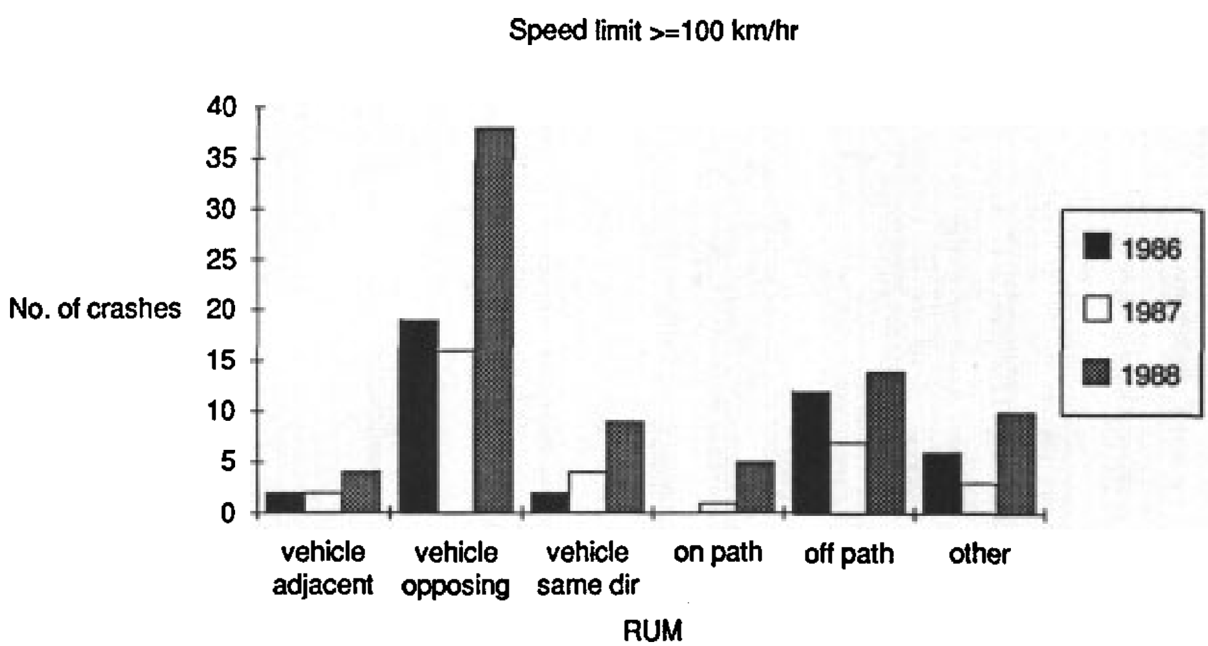


Figure 3.23. Road user movement (RUM) codes for fatal articulated vehicle crashes from 1986 to 1988 classified by speed zone.

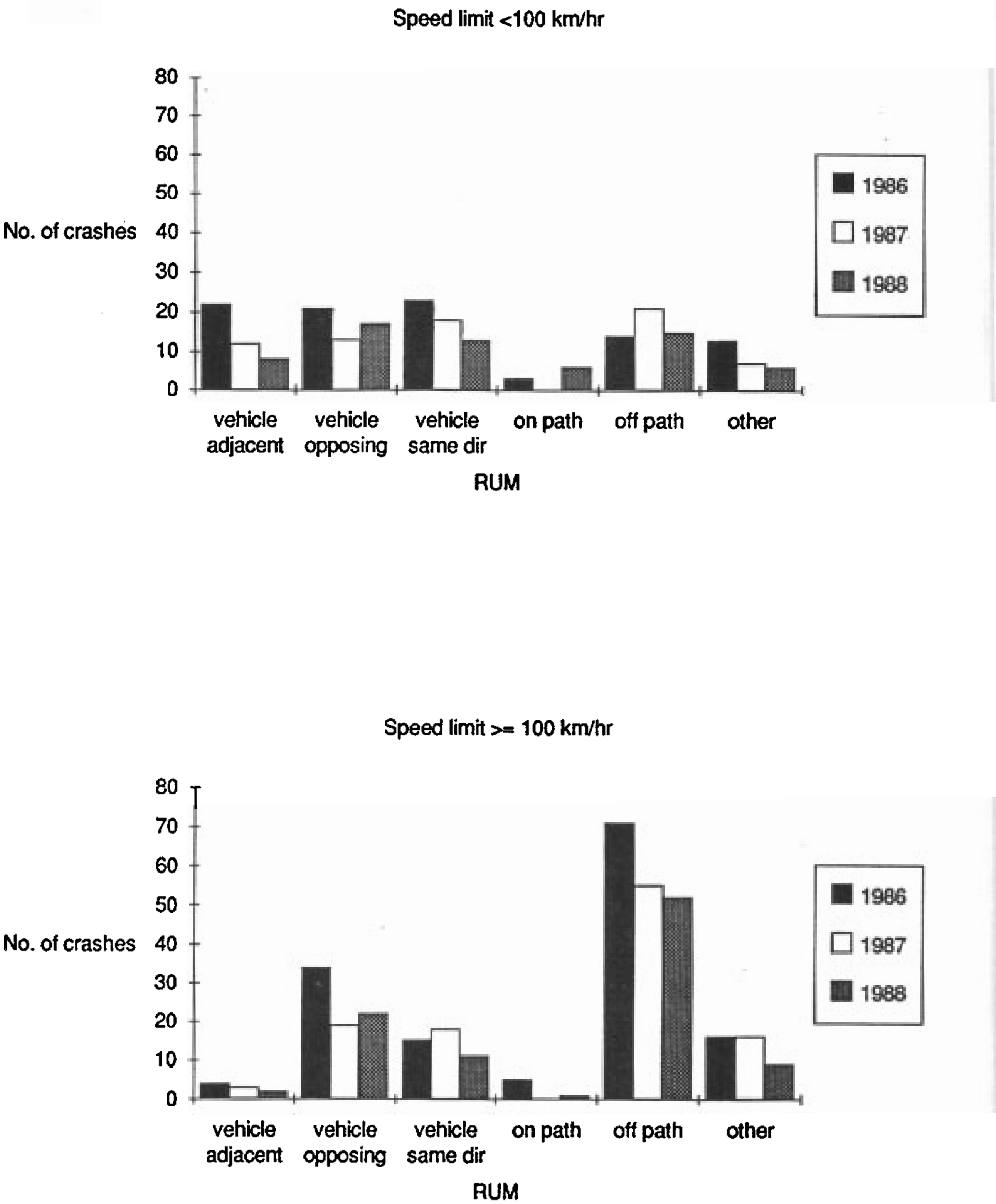


Figure 3.24. Road user movement (RUM) codes for hospital admission articulated vehicle crashes from 1986 to 1988 classified by speed zone.