Submission

by the

Royal Automobile Club of Victoria

to the

Federal inquiry into managing fatigue in transport

Undertaken by the

Parliament of Australia House of Representatives Standing Committee on Communications, Transport & the Arts

EXECUTIVE SUMMARY

The Royal Automobile Club of Victoria (RACV) welcomes the opportunity to make a submission to the Federal Inquiry into Managing Fatigue in Transport. The issues related to driver fatigue in Victoria are of paramount interest to the RACV. In preparing this submission, each of the terms of reference for the Inquiry have been addressed. RACV's submission to the Inquiry discusses the problem of driver fatigue in the context of road transport and road safety.

Driver fatigue is an extremely important road safety issue. Fatigue-related road crashes continue to represent a substantial proportion of the road toll, and fatigue has the potential to impair the driving of all drivers, even if they are not aware it is happening.

RACV believes that the reduction and ultimate prevention of fatigue-related road crashes can be achieved if an integrated, multi-level approach is taken. This should include a broad range of initiatives which encompass the road environment and behavioural issues, as well as innovations in vehicle design and technology that reduce the likelihood of road crash-involvement. Initiatives aimed at achieving greater responsibility on the part of individuals, companies and governments in dealing with fatigue are also important in reducing fatigue-related road crashes.

Road Environment

In instances where crashes occur, roadside hazards may have strong influence on the severity of crashes. The environment immediately adjacent to roads should be a "clear zone", kept free of unprotected collision hazards. Treatment options in this area include: removing the hazard; relocating the hazard to a safer location; installing redirection devices to guard the hazard, and; altering the hazard to reduce impact severity. Initiatives that may assist in this regard include the use of impact-absorbing roadside poles in low-speed, developed areas, and slip-based poles in high-speed, undeveloped areas.

The use of rumble strips and "audible" lines on road edges may also have important road safety benefits, particularly in rural areas. By alerting motorists that vehicle control has become wayward, these countermeasures may increase the likelihood that individual drivers will take rest breaks to alleviate fatigue.

There may be a strong relationship between driver perceptions about the quality and placement of roadside stopping places and the likelihood that drivers will utilise rest area facilities. RACV believes that the provision of adequate roadside stopping places at regular intervals, in terms of both distance and time, should be a major priority on all highways.

Available survey data indicates a range of features are viewed by road users as being essential at all wayside stops and service centres. These include rubbish bins, toilet, shade, sheltered seats and tables, disabled toilets, parking for towed vehicles and a sealed surface. Planned scheduling of rest breaks may also be assisted by an increase in the number of road signs showing travel distances and times to rest areas. Road signs showing information on travel times and distances, and the location of rest area facilities, assist individual drivers to consider the demands of travelling and placement of rest areas when scheduling breaks on a driving journey.

RACV recommendations related to the road environment are outlined below.

- Local and State Governments should conduct regular audits to determine whether roadside countermeasures have been implemented in accordance with "Clear Zone" policy.

- Research should be undertaken to determine whether countermeasure development specified by the "Clear Zone" policy has resulted in crash-rate reductions at high-crash road locations.

- Governments should provide increased funding for use of "audible" road shoulder markings and rumble strips, particularly for high-speed sections of rural roads.

- A coordinated strategy for the placement of rest area facilities needs to be developed at both State and Federal levels.

- State and Federal Governments should ensure that adequate roadside stopping places, in terms of both travel distance and time, are available on all major highways and tourist routes.

- State and Federal Governments should ensure that road signs showing details of travel times and distances to the next rest area are installed and maintained.

- Local and State Governments should conduct regular audits of existing rest area facilities to assess their adequacy in terms of placement, signage and public facilities.

Vehicles

Intelligent Transport Systems (ITS) are a sophisticated group of technologies that, pending technological advances, have considerable potential to change the way in which the problem of driver fatigue is dealt with in the transport system.

The potential for technological devices to reduce fatigue-related road crashes depends specifically on their capacity to *detect* and *overcome* behavioural impairment by fatigue.

Detection of driver fatigue, for all drivers over a range of driving conditions, is problematic as there is still much to be learned about the psychological and physiological basis of fatigue. However, Advanced Vehicle Control Systems (AVCS) may offer a means of overcoming fatigue-related impairment.

Intelligent Cruise Control systems, for example, can provide limited control of longitudinal accelerations of vehicles, and warn drivers of an impending crash. Collision Avoidance Systems represent a step up in technological complexity from Intelligent Cruise Control. Collision Avoidance Systems are capable of longitudinal and lateral control of vehicles, and can take control of vehicles in emergency situations. Intelligent Vehicle Highways are the most highly evolved AVCS, enabling complete systems control of vehicle movement, which greatly reduces opportunity for human error.

Other AVCS applications include Mayday systems, which enable automatic contact between crash-involved vehicles and emergency services in the event of a crash. Automatic crash notification is an important development, as dispatch times for emergency service vehicles may be greatly reduced.

The potential for AVCS to control vehicles both laterally and longitudinally, and the capacity for collision warning and avoidance systems, suggests AVCS may reduce the likelihood of fatigue impaired drivers becoming involved in road crashes. In instances where crashes occur, Mayday systems will facilitate substantially quicker response times by emergency vehicles.

Caution should be exercised to ensure the adoption of new technologies such as AVCS leads to positive road safety outcomes. Little is known, for example, about drivers' responses to in-car warning signals that inform drivers of impairment by fatigue, and there is a very real potential for in-car devices to distract the driver.

Care should also be taken to ensure uptake of AVCS in passenger vehicles does not lead to drivers becoming dependant on in-car systems to warn them of, or respond to, potential crashes. In the event of systems failure, drivers may be incapable of dealing with possible emergencies.

Subsequently, RACV recommendations that relate to vehicle design and technology are:

- The Federal Office of Road Safety and other State road safety agencies should, as a priority, undertake research into the development and trialing of in-vehicle devices that are likely to reduce fatigue related crashes.

- Governments should undertake research and development of "in-car" technological devices that record control indices underlying driving fatigue, so that more accurate estimates of the contribution of driver fatigue to road trauma can be determined.

- In-car fatigue assessment technologies should be promoted as tools that assist drivers to handle their vehicle responsibly and safely, rather than as a form of automated piloting system.

- Research should be undertaken to determine which warning signal stimuli, or combination of stimuli (visual, audio, haptic), designed to prevent driver fatigue are appropriate for low-level and high-level (urgent) warning signals.

Behavioural Issues

A range of educational and promotional campaigns have been developed to improve road users' understanding of the role of fatigue in crashes, and raise awareness about strategies that may alleviate impairment by fatigue.

Operation Coffee Break is an initiative that was developed by Victoria's Community Road Safety Councils, in conjunction with the State Emergency Service, to provide refreshments for drivers during public- and school-holiday periods. By distributing free coffee and 'Kit Kats' at 65 sites throughout Victoria, this initiative provides extra incentive for travellers to pull over and take regular rest breaks during driving journeys.

The Transport Accident Commission's "Powernap" campaign, which features television, radio, press and billboard advertising, was developed to raise public awareness about the causes, identification and consequences of driver fatigue. The campaign encourages people to reflect on the dangers posed by fatigue by providing a range of credible information sources, including:

- a medical professional
- a comparison of different levels of sleep deprivation with appropriate blood alcohol levels
- road crash statistics highlighting the incidence of fatigue-related crashes

A Victorian Community Road Safety Council has implemented a Fatigue Management Program in rural Victoria and New South Wales. The program facilitates the distribution of vouchers for free cups of coffee and discount accommodation to drivers travelling the Hume Freeway between Melbourne and Sydney. Vouchers are distributed by a range of interested parties, including police from both Victoria and New South Wales, Motels in the Best Western accommodation chain, and Tourist Information Centres. Vouchers are also placed at 'Driver Reviver' stops in the region, and local publicity was undertaken to raise driver awareness about the scheme and increase patronage levels.

These campaigns demonstrate how transport and safety stakeholders can form effective partnerships to develop initiatives aimed at reducing fatigue-related road crashes.

Public education campaigns will be prominent in future initiatives that encourage individuals to deal responsibly with driver fatigue. While the specifics of education campaigns may vary, a major priority for these campaigns should be to compel drivers to consider fatigue-related driving risks on a personal level, and challenge biases that may exist in people's perceptions about personal ability to cope with fatigue.

Health professionals may be one source of advice people may consult to address any queries they might have about health-related issues. Information about the identification and relief of fatigue-related behavioural impairment should be readily available through health-care centres and clinics, as well as from a broad range of other information sources that may include service stations, Tourist Information centres and through media sources. Information on the detection and treatment of sleep disorders should also be available through these agencies.

Strip maps are available from motoring clubs for all major highways and high-use roads, and individuals can use this information to plan prospective driving journeys. Strip maps enable rest and sleep breaks to be scheduled prior to a driving journey, rather than during the drive itself when fatigue may impair a driver's ability to make judgements.

Presently, the most coordinated approach to prevention of fatigue-related road crashes has been the formation of legally enforceable occupational guidelines within the commercial transport industry. Commercial drivers are stringently regulated according to scheduling of duty and rest periods, and are subjected to random checks by authorities to ensure work practices are in accordance with Occupational Health and Safety Guidelines.

Workplace scheduling arrangements, even those pertaining to the transport industry, nevertheless cater more strongly to economic considerations than human rest and activity patterns. In order to address these limitations, all workplaces should incorporate fatigue-related educational materials as part of employee induction programs. Employees need to understand that, while companies have a legal obligation to meet Occupational Health and Safety requirements regarding workplace scheduling, fatigue still has potential to undermine the quality and, hence, safety of employee's work.

Road user behaviour and education

- Campaigns should be undertaken by road safety agencies to raise public perceptions about the probability of being involved in a fatigue-related crash and to encourage individuals to take appropriate measures to prevent driver fatigue.

- Public education campaigns should challenge biases that may exist in drivers' perceptions about personal vulnerability to fatigue-related road crashes and emphasise that drivers may not be aware that their driving is impaired by fatigue while they are driving.

- Road safety agencies should ensure that information about the causes, identification and relief of driver fatigue is readily available to all members of the public, and should be available in a range of languages.

- State and Federal Governments should establish associations between road authorities, research organisations and relevant health-professional organisations to ensure community members are provided with accurate, up-to-date advice about steps that can be taken to reduce personal vulnerability to fatigue while driving.

- Research should be undertaken to determine which combination of behavioural, physiological and technological measures provides the most accurate and reliable diagnosis of the presence of fatigue, for all individuals over a range of driving conditions.

- Research should also be undertaken to examine interactions between in-car fatigue warning signal characteristics and human information processing resources to ensure that in-car technologies convey fatigue-related information to drivers as safely and effectively as possible.

- State and Federal Governments should initiate programs to educate employers about issues related to fatigue, and to develop workplace countermeasures to prevent fatigue related injury and death.

TABLE OF CONTENTS

1. INTRODUCTION

1.1 RACV Perspective

The Royal Automobile Club of Victoria (RACV) represents over 1.4 million members. The Public Policy Group within the RACV is responsible for informing members of issues relating to motoring and advocating on behalf of members on a range of motoring and safety issues.

The RACV has been concerned about driver fatigue for many years and is pleased to present this submission to the Federal Inquiry into Managing Fatigue in Transport. This submission will address each of the terms of reference of the Inquiry. RACV's submission to the Inquiry will discuss the problem of driver fatigue in the context of road transport and road safety.

1.2 Terms of Reference

The terms of reference for this Inquiry are:

1. The causes of, and contributing factors to, fatigue;
2. The consequences of fatigue in air, sea, road and rail transport;
3. Initiatives in transport addressing the causes and effects of fatigue;
4. Methods of achieving greater responsibility by individuals, companies, and governments to reduce the problems related to fatigue in transport.

1.3 Report Structure

A discussion of contributory factors to fatigue-related road crashes is included in Section 2.

Section 3 discusses the consequences of driver fatigue.

In Section 4, initiatives addressing contributory factors to, and consequences of, driver fatigue will be outlined. Specific initiatives will be discussed according to whether they are environmental, vehicular, or behavioural in nature.

Section 5 discusses methods that may be employed to achieve greater responsibility on the part of individuals, companies and governments to reduce fatigue-related problems in transport.

2. DETERMINANTS OF DRIVER FATIGUE

This section is an overview of factors that may contribute to the development of fatigue-related driver impairment and road crash occurrence.

In the following section, the interacting roles of psychological, environmental and social factors as determinants of fatigue-related road crashes will be examined. Following this, strategies which may provide a viable means of reducing the contribution of fatigue to crash occurrence will be outlined.

2.1 Driving Demands

2.1.1 Complexity of Driving

Fatigue has been conceptualised largely as a psychological, rather than physiological phenomenon (Bartlely & Chute, 1947; Brown, 1985), and a range of factors are known to effect the experience of fatigue. Potential influences include performance requirements associated with the task at hand, individuals' present and past activity patterns, and subjective factors such as self-evaluations about personal ability to perform a task. Accordingly, fatigue may arise from tasks which are complex, or are *perceived* to be complex, in terms of the mental workload that is placed on a person (Brown, 1994).

2.1.2 Sustained Driving

Research suggests that fatigue may be especially likely to emerge in tasks that require *continued* readiness to cope with occasional or unpredictable demands on attentional, perceptual and decision-making faculties (Brown, 1994).

Generally, driving errors stem not from difficulties controlling the vehicle at any one moment, but from difficulties in maintaining sustained attention and readiness to respond to changeable and often unpredictable inputs (McDonald, 1984). These ongoing task demands may interact with personal factors, such as an individual's self-evaluations of present and past circumstances, to influence the subjective experience of fatigue (Brown, 1994). Accordingly, fatigue may emerge in circumstances where a person is aware of prolonged activity, or when a person perceives they are obliged to continue performing a task beyond the point at which they are confident of maintaining efficient performance.

Thus, while the sheer complexity of the driving task is unlikely to lead to fatigue-related performance decrements, the ongoing demands of attending and responding appropriately to task requirements may induce the subjective experience of fatigue. Depending on the individual's perceived preparedness to cope with ongoing task demands (motivation), fatigue may be particularly likely to emerge when driving long distances, possibly on rural routes (Brown, 1994).

The results of a study into the effects of driving regimes on driver fatigue are consistent with the notion that ongoing task demands of driving may contribute to subjective fatigue. Williamson, Feyer & Friswell (1996) studied the impact of structural features of a 12 hour, 900 km driving journey on 27 professional truck drivers. Three different travel regimes, equated for trip length and start time, were utilised.

A series of direct driving indices (ie. steering control and speed maintenance), measures of physiological arousal, subjective fatigue rating scales, and perceptual, cognitive and motor skills tests were taken. Results indicated that extent of experienced fatigue increased with distance travelled for drivers on all regimes. While some differences existed in the way fatigue developed under each regime, this finding implicates ongoing driving task-demands as a contributory factor in the development of fatigue (Williamson et al, 1996).

2.1.3 Subjective Perceptions and Evaluations

Another factor that may increase the likelihood of fatigue related road trauma is the fact that fatigue effects the capacity for introspection. Individuals who have been performing tasks over a period of time may show considerable performance declines without reporting awareness of reductions in performance level or subjective mood effects, such as drowsiness or loss of concentration (Brown, 1994, 1997).

Thus, when a person is fatigued, his or her ability to monitor subjective mood and performance variables may be impaired. Failure on the part of drivers to notice performance declines while negotiating traffic would be expected to greatly increase the likelihood of crashing. Potential health consequences of driving while impaired by fatigue may be particularly severe on high-speed and lower quality roads which typify many rural roads.

2.2 Driving Patterns / Exposure

Today's lifestyle often involves travel patterns that may susceptibility to fatigue. More specifically, the 'tyranny of distance' faced by all drivers in rural locations may predispose rurally-based drivers to the performance deficits associated with driver fatigue.

Relative to rural areas, amenities and services in metropolitan centres are situated in closer physical proximity and, accordingly, one would expect the "average" individual driving trip in metropolitan centres to be of shorter length, in terms of both distance and time. Figures collected by the Australian Bureau of Statistics seem to support this contention. In a survey of travel patterns to work and shopping destinations, 4.8% of metropolitan respondents reported that they travelled more than 30 kilometres to work. The corresponding figure for rural drivers was 10%. With regard to shopping-related travel, 1% of metropolitan drivers reported that they travelled more than 20 km to shops. The corresponding figure for rural people was 15.1% (Jackson, 1994). Thus, while metropolitan drivers may be inclined to make frequent, shorter journeys in order to utilise amenities and services, this strategy may be impractical for rural drivers.

Given that length of continuous activity periods is one of the strongest causal contributors to fatigue (Brown, 1994; Williamson et al, 1996), location-dependant differences in driving activity patterns may have important implications for susceptibility of drivers to fatigue-related performance declines, and subsequent crash-involvement

2.3 Lifestyle Factors

The length and scheduling of duty periods, rest breaks and sleep periods have considerable potential to effect susceptibility of people to fatigue-related reductions in driver performance (Brown, 1994). Accordingly, scheduling arrangements, whether they relate to work, rest or sleep, should be addressed by initiatives seeking to reduce the incidence of fatigue-related road trauma.

2.3.1 Work Schedules

Research indicates that if work shifts are too long in duration, a person's ability to apply attentional resources to the task at hand will decrease. This phenomenon, known as reactive disinhibition (Brown, 1994), is a tendency for people to respond with decreasing frequency to environmental stimuli that remains unchanged over time. This process represents a loss of motivation to attend to their environment.

The importance of recent work practices in the development of fatigue was highlighted in a survey of drivers who reported having "an accident, near accident, or moved out of their lane *'because of being fatigued or tired' "*. Fell and Black (1997), asked randomly selected telephone respondents about issues including rest before the trip, activities before the trip, trip purpose, intended trip length, time of day, hours of driving and sleep characteristics.

The results indicated behaviours such as working long hours are strongly associated with self-reported crash-involvement. This finding appears particularly important, as hours of work are generally increasing for those in employment within our society[1], and the incidence of fatigue-related accidents occurring as a consequence of temporal arrangements at work may be expected to increase over time (Fell & Black, 1997**;** Lobb, 1998).

The results of Williamson et al's (1996) study into the effects of driving regimes on driver fatigue are also consistent with the notion that recent work patterns may contribute to the development of fatigue. Williamson et al (1996) found that pre-trip fatigue levels were a strong determinant of later fatigue amongst professional truck drivers. The researchers concluded that recent work schedules are likely to have been an important contributor to pre-trip fatigue levels.

2.3.2 Rest Breaks

The timing and length of rest breaks during duty periods, and over the 24 hour cycle, may produce significant variations in the quality of human performance. This is particularly the case for tasks requiring continued alertness and vigilance (Brown, 1994). Accordingly, failure to utilise rest breaks may be expected to undermine driver performance and increase susceptibility to road crash involvement.

[1] A recent analysis by the Australian Centre for Industrial Relations Research & Training reviewed data collected by the Australian Bureau of Statistics over 20 years from 1978. It was found that the amount of time spent on private life among Australian middle class income earners is increasingly being scaled back in favour of work. Many people are working longer hours (at least 50% of Australian workers are working longer than 40 hours per week), taking work home (via mobile phones and information technology), or holding a second job. Lunch breaks and hours spent resting are the areas most strongly effected by this change (sources: The Canberra Times 6/3/93 p3; The Age 18/5/98 p15; The Sunday Mail 28/6/98 p33).

The importance of utilising rest breaks while driving to reduce fatigue is highlighted in a study by Dalziel and Job (1996). This study examined the relationships between work schedules and crash involvement among 42 taxi drivers in metropolitan Sydney over a two year period. Work-related scheduling arrangements, including the number and duration of rest breaks, awareness of falling asleep at the wheel, and job-related attitudinal variables, were measured.

Results indicated that most drivers spend considerable lengths of time on the road each week, and higher average total break times are significantly related to reduced levels of crash-involvement. Reductions in accident involvement in this study are likely to have occurred because longer break durations are more effective in alleviating behavioural impairment due to fatigue (Dalziel & Job, 1996).

2.3.3 Sleep Breaks

The scheduling and duration of sleep breaks is another factor which may potentially influence the quality of driver performance.

While the precise need for sleep is not yet fully understood, sleep is believed to fulfil two broad functions: the first function has been termed "obligatory" sleep, and relates to restitution of physiological damage that occurs during wakefulness; the second is known as "facultative" sleep, and it effects the individual's motivation to perform a task (Horne, 1985 cited in Brown, 1994). Both these functions of sleep are likely to be reduced following periods of sleep deprivation.

Unfortunately, due to the interactive nature of personal characteristics and task demands, there is no minimum "safe" sleep time that can be specified. However, certain types of tasks are particularly susceptible to disinclination to continue responding to tasks demands. Performance deterioration is especially common on complex, but familiar tasks where vigilance must be sustained over long, monotonous periods. Again, this conceptualisation closely reflects the tasks demands associated with controlling a vehicle.

2.3.4 The Role of Sleep Disorders

Sleep disorders are known to effect the quality and duration of sleep and, therefore, may potentially impact on the quality of driver performance. There are many types of sleep disorders, the most common and best understood being the respiratory disorder Obstructive Sleep Apnoea (OSA).

During normal sleep, muscles controlling the tongue and soft palate remain firm to hold the aero-digestive tract open. Relaxation of these muscles can cause the airway to narrow, resulting in snoring and breathing difficulties. Further muscle relaxation may lead to the airway being blocked completely, preventing respiration (Q.D.T., 1993). This phenomenon is referred to as OSA.

OSA is found in around 5% of the population, and effects both males and females. It tends to be more prevalent in males, and is also associated with being overweight (Q.D.T., 1993).

OSA may occur in cyclical fashion hundreds of times during the course of a single night's sleep, leading to sleep deprivation, excessive daytime sleepiness, morning headaches, memory lapses, general lethargy and disorientation, all of which would be expected to impair sufferer's ability to safely handle a motor vehicle.

A study was carried out by the University of Sydney in conjunction with the Road Traffic Authority of New South Wales to examine the self-reported driving behaviours of people with sleep apnoea compared with an aged-matched control group (Q.D.T., 1993). Apnoeics were identified by degree of respiratory disturbance present during sleep.

This study showed that, relative to controls, apnoeics were:

- almost twice as likely to report pulling off the road sometimes or often due to sleepiness;
- 2.5 times more likely to report having had a motor vehicle accident due to sleepiness;
- 7 times more likely to report falling asleep sometimes or often while driving;
- 20 times more likely to report falling asleep sometimes or often at traffic lights (Bearpark & King, 1993).

These figures highlight the potential for sleep-related disorders to impact negatively on driving behaviour.

3. CONSEQUENCES OF FATIGUE IN ROAD TRANSPORT

This section discusses what is known about the consequences of driver fatigue.

3.1 Number of fatigue related crashes

Estimates of the contribution of fatigue to crashes vary widely. This is fundamentally because it is often very difficult to clearly associate driver fatigue with crash outcomes, given that fatigued drivers may have been killed. Estimates of the proportion of fatigue related crashes varies between 7% to 25% (Corfitsen, 1986; Pack, Pack, Rodgman, Cucchiara, Dinges & Schwab, 1995; Victoria Police, 1995).

3.2 Characteristics of fatigue related crashes

Driver fatigue is associated with both rural and urban crashes to some degree. VicRoads (VicRoads; 1999) estimates that:

- fatigue related crashes occur mainly at night and early morning (60%), with a high proportion on weekends
- there are strong associations between fatigue related crashes and journey lengths, as well as driver only trips
- some 30% of single vehicle rural casualty crashes are fatigue related
- approximately 20% of fatal truck crashes are fatigue related.

A study of fatal crash causal variables conducted by the Monash University Accident Research Centre (Haworth and Rechnitzer; 1993) concluded that fatigue crashes were more likely than other crash types to:

- involve fewer vehicles than other types of crashes
- to be off path, on straight crashes
- less often involve pedestrians or vehicles from adjacent directions
- involve low levels of alcohol.

3.3 Future estimates of fatigue related crashes

It is likely that estimates of the contribution of driver fatigue in motor vehicle crashes will change in the future, with the availability of more accurate research.

With the advent of in-vehicle technologies that will possibly allow the “black box” type recording of driver and vehicle information prior to crashes, more accurate information about the causal nature of many factors in crashes will be available. Subsequently, a more accurate depiction of the extent to which fatigue contributes to motor vehicle crashes, and information about the circumstances and particular driver characteristics associated with fatigue crashes will be available. This will enable better targeting of publicity campaigns and enforcement measures to reduce the impact of fatigue on road trauma in Australia.

4. PREVENTION OF FATIGUE-RELATED ROAD TRAUMA

This section is an overview of initiatives addressing contributory factors to, and consequences of, driver fatigue. Specific initiatives will be discussed according to whether they relate to the road environment, vehicles, or behavioural issues.

Background

The processes that lead to fatigue crashes cannot be understood by adopting narrowly-defined theoretical perspectives, nor can the extent of the problem be reduced by employing discrete, narrowly focussed solutions. All potential determinants of road trauma need to be evaluated, and a hierarchy of trauma prevention priorities developed. Therefore, a strategic, broad-level approach will also be required to reduce the contribution of driver fatigue to road trauma.

4.1 Initiatives Addressing the Road Environment

4.1.1 Public Perceptions About, and Utilisation of, Rest Area Facilities

There may be a strong relationship between driver perceptions about the quality of roadside stopping places and likelihood that drivers will utilise rest area facilities. Accordingly, the provision of adequate stopping places at regular intervals, in terms of both distance and time, should be a major priority on all highways.

In 1995, RACV conducted a survey of highway stopping places via a mailback survey in the RACV member magazine, *Royalauto*. Members were asked about the spacing, location and desired features at wayside stops, rest areas and service centres. Some 1,895 members responded to the survey, which suggests drivers are concerned about issues of road safety, driver fatigue, and the use of stopping places for breaks on long road journeys.

Member responses indicated that rest area placement and spacing is presently satisfactory on major highways and high-use routes. Generally, strip maps are available for these roads, and people can use this information to plan prospective driving journeys. Strip maps enable rest and sleep breaks to be scheduled prior to a driving journey, rather than during the drive itself when fatigue may impair a driver's ability to make sound judgements.

4.1.1.1 Development of Coordinated Policy for Rest Area Placement

On minor highways and some popular tourist routes, member responses indicated that rest area placement was somewhat lacking in terms of the number of stops and their placement relative to towns. Respondents felt that a coordinated policy for the placement of rest areas would make it much easier to plan for rest breaks during a driving journey. Present placement of rest areas on minor highways was perceived to be too "random" to be of use to many drivers. Interestingly, a number of members suggested rest area placement should more closely reflect black spot areas with higher rates of fatigue-related crashes.

4.1.1.2 Signage on Rest Area Placement

Survey results indicated also that planned scheduling of rest breaks would be assisted by an increase in the number of road signs showing details of travel distances and times to the next rest area.

4.1.1.3 Amenities and Services at Rest Area Facilities

A range of features were viewed by members as being essential at all wayside stops and service centres. These included rubbish bins, shade, toilets, sheltered seats and tables, disabled toilets, parking for towed vehicles, and a sealed surface. The presence of these features may have a significant impact on driver inclination to utilise available rest area facilities.

4.1.2 Implementation of Roadside Countermeasures

Road toll statistics suggest that a substantial number of vehicles will inevitably leave our roads each year in single vehicle crashes, many of which may be fatigue-related. When this occurs, roadside hazards may have a strong influence on the severity of specific crashes. "Responsible authorities need to recognise this inevitability and design a system which minimises the possibility of severe consequences" (VicRoads, 1998).

A recent evaluation of Victoria's road crash 'black-spot' program was conducted by Monash University Accident Research Centre. This evaluation suggested "typical locations which warrant a more concerted effort being directed towards countermeasure development include...rural (road) lengths with a run-off-the-road problem" (Duarte & Corben, 1998).

4.1.2.1 Maintaining Roadside "Clear Zones"

Keeping roadside "clear zones" free from unprotected and potentially dangerous obstructions may play an important role in reducing fatigue-related trauma. Clear Zones are assigned according to the probability a collision will occur at a particular road site. Estimates of crash risk are derived from traffic volumes and speed restrictions for specific road locations, with higher traffic volumes and speeds generally leading to larger clearance zones at the roadside (VicRoads, 1998).

If an unprotected roadside hazard lies within a clear zone, options available for treatment include:

- removing the hazard
- relocating the hazard to a safer location
- installing redirection devices to guard the hazard
- altering the hazard to reduce impact severity

4.1.2.2 Impact Absorbing Devices

Given that hazards such as trees and poles tend to be most frequently involved in single-vehicle crashes, treatment initiatives have, and should continue, to focus on these obstructions. Valuable treatment initiatives include :

- the development of *impact-absorbing* poles, which are designed to collapse progressively when struck by a vehicle, thereby wrapping around the vehicle and bringing it to a controlled stop. These poles are appropriate for low-speed, developed areas;
- the development of *slip-based* poles, which are designed to separate from their bases when struck by a vehicle, allowing the vehicle to pass over the base and under the falling pole. These poles are appropriate for high-speed, undeveloped areas;
- the removal of mature trees that exceed 100 mm in diameter from clear zones.

4.1.2.3 Tactile Lines and Rumble Strips

The use of "audible" lines and rumble strips on road edges also may have important road safety benefits, particularly in rural areas. If a driver falls asleep at the wheel on a straight road section, a considerable length of time may pass before the vehicle deviates from the direction of the road. If the vehicle and road diverge slowly, audible shoulder markings may awaken the driver in ample time for the performance of evasive manoeuvres.

Likewise, as a driver becomes fatigued over the course of a driving journey, lateral positioning of the vehicle on the roadway may become increasingly wayward. If a fatigued drivers starts to deviate unintentionally onto the road shoulder, the presence of audible lines may increase driver recognition that performance is being undermined by fatigue. By alerting motorists to impairment of personal ability to control a vehicle, audible shoulder markings may increase the likelihood that individual drivers will take rest breaks to alleviate fatigue.

4.2 Initiatives Addressing the Vehicle

Intelligent Transport Systems (ITS) are a sophisticated group of technologies that will greatly change the way in which some problems are solved in the transport system. In this section, implications of ITS for prevention of fatigue-related crashes will be reviewed, in terms of both technological developments in the field of ITS, and issues that need to be addressed before ITS applications can safely be assimilated into passenger vehicles.

4.2.1 ITS Applications - Advanced Vehicle Control Systems (AVCS)

There are many different sorts of ITS applications currently under development, including systems for heavy vehicles, trains, and buses. This review will primarily focus on passenger car applications.

Advanced vehicle control and safety systems comprise a group of technologies varying from Intelligent Cruise Control (ICC), which has almost no automated control, to complete control of the vehicle in the case of Intelligent Vehicle Highways (IVH). Collision Avoidance Systems (CAS) sit somewhere in the middle of these two extremes of technological vehicle control.

4.2.1.1 Intelligent Cruise Control

Intelligent Cruise Control (ICC) systems are one of the more basic ITS applications, and have the following characteristics:

- controls longitudinal accelerations of the vehicle to a limited degree
- provides warning to driver of impending crash in some incident situations
- can not avoid crashes - relies on human control of braking and steering

4.2.1.2 Collision Avoidance Systems

Collision Avoidance Systems (CAS) represent a step up in technological complexity and control from ICC, and have the following characteristics:

- capable of longitudinal and lateral control of vehicle
- capable of taking control of vehicle in emergency situations

CAS operate by scanning the environment around a vehicle with sensors to detect other vehicles or objects on the road. When an object is detected, the system decides whether a crash is likely to occur and will adjust vehicle speed or direction to avoid an incident. Most CAS are non-cooperative. This means that individual vehicles act as individual units, and do not exchange information to help avoid incidents.

4.2.1.3 Intelligent Vehicle Highways

Intelligent Vehicle Highways (IVH) represent a step up in automated control from CAS, and enable complete control of longitudinal and lateral movements of the vehicle. IVH involve the use of dedicated, high-tech highways, and infrastructure such as magnetic nails is used to guide vehicles on the roadway. A range of alternative lateral control systems are also being developed.

IVH are often described as cooperative systems, in that individual vehicles are controlled and interact on a group-by-group basis, as compared with CAS which allows vehicles to be controlled individually. Due to the platooning of individual vehicles into groups, vehicles on IVH can operate safely at high speeds (200km/h) and low headways (1-2m), which allows for greater road capacity, safety (IVH has extremely low opportunity for human error), efficiency, and lower congestion and environmental impacts.

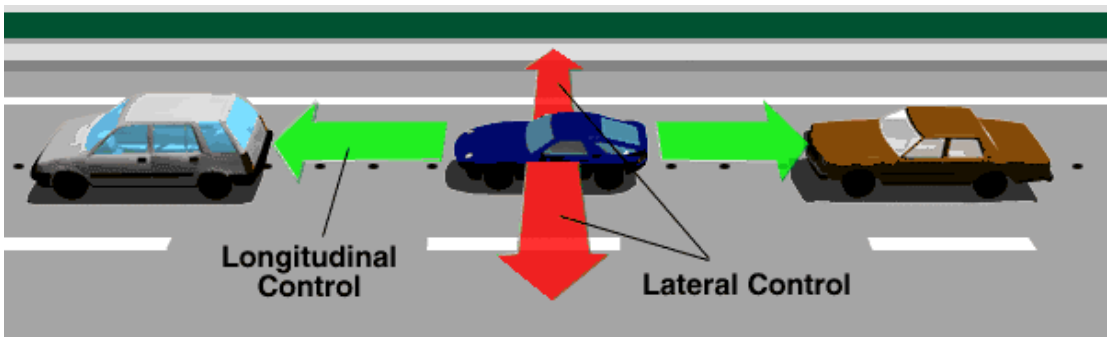

Figure 4.1: Extent of vehicle control possible with AVCS (Berkely, 1999)

4.2.1.4 Mayday Systems

Mayday systems enable automatic contact between a vehicle and control centres and / or emergency services in the event of a crash. This type of AVCS provides for a range of road assistance services, including:

- automatic crash notification, leading to shorter dispatch times for emergency services
- provision of vehicle location information via Global Positioning Systems and communications links to call centres, leading to shorter dispatch times for road assistance vehicles (ie. autoclubs)
- security features, including car recovery and remote vehicle immobilisation, leading to theft reduction benefits
- vehicle location and guidance services
- remote start-up of vehicle engines
- remote door unlocking
- head lights switched off remotely
- windows wound up remotely
- remote monitoring of vehicle battery condition

4.2.1.5 Air Quality Monitors

Reduced levels of oxygen (O_2) and increased levels of carbon dioxide (CO_2) in vehicle cabins also may lead to fatigue-related behavioural impairment in drivers (AAA, 1999).

The Australian Automobile Association (1999) recently suggested that air quality assessment systems may offer a viable means of reducing fatigue-related crashes. For example, systems could monitor the relative levels of O_2 and CO_2 in vehicle cabin air and switch off the engine when concentrations exceed a certain threshold. Alternatively, air quality monitors could directly adjust and maintain the cabin atmosphere at safe levels, with no input from vehicle occupants. Systems of this nature are presently being developed and trialed. More information about these sensors can be found in the AAA submission to this Inquiry.

4.2.2 Potential Road Safety Benefits of AVCS

In Australia, the potential benefits of AVCS have yet to be fully evaluated. In Europe, ERTICO have predicted a 15% survival rate increase from car crashes as a result of AVCS by the year 2017 (Booze, Allen & Hamilton, 1998).

The United States Department of Transport Intelligent Transport System Joint Program Office (DOT, 1996) has predicted that the basic safety benefit of AVCS, in terms of crash reductions in the United States, will be:

Crash Type	**Predicted Reduction in Crashes (%)**
Intersection	30%
Rear End	25%
Roadway Departure	20%
Lane Change	4%
Backing	3%
Opposite Direction	3%
Other	15%

The National Strategy for ITS in Australia (ITSA, 1999) is likely to focus on AVCS in an effort to analyse the potential benefits of such a system, particularly for remote and rural areas. Research will also be required to fully investigate how different drivers react to various AVCS systems.

4.2.3 AVCS and Driver Fatigue

The potential for technological devices to reduce fatigue-related road trauma will depend on their capacity to *detect* and *overcome* performance deficits associated with fatigue.

Detection of driver fatigue, for all drivers over a range of driving conditions, is problematic as there is still much to be learned about the psychological and physiological basis of fatigue. Nevertheless, the potential for AVCS to control vehicles both laterally and longitudinally, and the capacity for collision warning and avoidance systems, suggests AVCS may reduce the likelihood of fatigue-impaired drivers becoming involved in road crashes.

4.2.4 Safe Assimilation of AVCS in Passenger Vehicles

AVCS offers exciting possibilities in terms of reducing fatigue-related crashes. However, caution should be exercised to ensure the adoption of new technologies leads to positive road safety outcomes. There are many complex technical and human factor issues which must be overcome before these systems can be safely implemented.

Little is known, for example, about drivers' responses to in-car warning signals that seek to inform drivers of the presence of fatigue (Haworth & Heffernan, 1989; Brown, 1997). Different types of warning signals are likely to impact on different sensory modalities, and may have significant effects on driver attention. There is a very real potential for in-car devices to distract the driver, in that:

- too many stimuli may be presented to drivers in a given period of time, leading to some information being unintentionally ignored
- drivers may be unable to handle parallel monitoring tasks, such as attending to the dashboard and external environment
- attentional demands placed on drivers by warning systems may create driver stress, leading to improper judgement (Barfield & Dingas, 1998).

Care should also be taken to ensure that uptake of AVCS in passenger vehicles does not lead to drivers becoming dependent on in-car systems to warn them of, or respond to, potential crashes. In the event of system failure, drivers may be incapable of dealing with possible emergencies. Likewise, drivers may drive at higher speeds with closer headways as a result of uptake of AVCS, believing that the system will always get them out of trouble.

Much work remains to be done to develop in-car technologies to a level where they interact effectively and safely with human attentional and information-processing resources. Developments in the fields of information technology and human cognition and information processing may have valuable insights in this regard.

- Research should be undertaken to determine which warning signal stimuli, or combination of stimuli (visual, audio, haptic), designed to prevent driver fatigue are appropriate for low-level and high-level (urgent) warning signals.
- AVCS should be promoted as tools that assist drivers to handle their vehicle responsibly and safely, rather than as a form of automated piloting system, to ensure uptake of this technology leads to positive road safety outcomes.

4.3 Initiatives Addressing Behavioural Issues

A range of educational and promotional campaigns have been developed to improve road users' understanding of the role of fatigue in crashes, and raise awareness about strategies that may alleviate impairment by fatigue. Specific initiatives that have assisted in this regard are described below.

4.3.1 Operation Coffee Break

This initiative has been developed and implemented by Victoria's Community Road Safety Councils, in conjunction with the State Emergency Service, to provide roadside refreshment-stations for drivers during public- and school-holiday periods, which are typically high crash times on Victorian roads.

By distributing free coffee and 'Kit Kats' at 65 sites throughout Victoria, Operation Coffee Break provides an extra incentive for travellers to pull over and take rest breaks during driving journeys.

This event is made possible by up to 1,000 volunteers from SES and Lions, who work extended hours to ensure Operation Coffee Break Sites are staffed throughout holiday periods.

4.3.2 TAC Powernap Campaign

The Transport Accident Commission's (TAC) "Powernap" campaign was developed to illustrate the potential consequences of ignoring the body's sleep signals when driving a motor vehicle.

The Powernap campaign was launched in March 1999 and encourages people to reflect on the dangers that fatigue poses to road users by providing fatigue-related information from a range of credible sources:

- a medical professional from a well-known Victorian hospital discusses the influence of fatigue on reaction times, decision making and driving performance
- behavioural impairment at different levels of sleep deprivation is compared with blood alcohol levels to help drivers understand the dangers posed by fatigue
- road crash statistics are used to highlight the incidence of fatigue-related crashes occurring on Victorian roads

The campaign features television, radio, press and billboard advertising, ensuring that a large proportion of Victorians are exposed to appropriate advice about safely dealing with driver fatigue. The campaign was also timely, as it was aired prior to, and during, the Easter holiday period in Victoria.

4.3.3 Community Road Safety Council Fatigue Management Program

In the 1997/1998 financial year, North Eastern Community Road Safety Council (NECRSC), in conjunction with Goulbourn Valley Community Road Safety Council and the Albury Road Safety Group, developed a fatigue management program to encourage drivers to stop and take breaks during driving journeys.

As part of the program, vouchers for free cups of coffee and discount accommodation were distributed to drivers travelling along the Hume Freeway between Melbourne and Sydney (*see Appendix A for examples of coffee- and accommodation-vouchers*).

Vouchers were distributed by a range of interested parties, including the Traffic Operations Group Police from Victoria, Highway Patrol Police in New South Wales, Best Western Motels, Tourist Information Centres and employees of business and government agencies who travel the Hume Freeway. Vouchers were also placed at 'Driver Reviver' stops throughout the region.

Press releases were sent to media outlets both locally and on a state level prior to, and during the event, to raise driver awareness about the scheme and increase patronage levels.

To evaluate the effectiveness of the fatigue management program, NECRSC kept records for the number of vouchers handed out and the number redeemed. This enabled distribution- and redemption-rates to be compared with previous years. Fatigue-related crash statistics were also monitored against equivalent figures for periods outside implementation dates for the program. Comments from participating drivers were overwhelmingly in favour of the campaign.

The NECRSC Fatigue Management Program is an example of how transport stakeholders can form effective, community based partnerships to develop initiatives aimed at reducing fatigue-related crashes.

5. Fatigue - Methods of achieving greater responsibility

This section discusses initiatives that may be employed to achieve greater responsibility on the part of individuals, companies and governments to reduce fatigue-related problems in transport.

5.1 Individuals

5.1.1 Public Education Campaigns

Initiatives such as TAC's 'Power Nap' campaign and 'Operation Coffee Break' have been effective in, firstly, disseminating information about risk factors associated with fatigue and, secondly, encouraging motorists to alleviate fatigue during driving journeys by utilising regular rest breaks or short naps.

Public education campaigns will be prominent in future initiatives that encourage individuals to deal responsibly with driver fatigue. While the specifics of potential education campaigns may vary, all awareness strategies should specifically target risky behaviours.

A major priority for public information campaigns is to compel drivers to relate to fatigue-related driving risks on a personal level, and challenge biases that may exist in people's perceptions about personal ability to cope with fatigue.

5.1.2 The Role of Health Professionals

If individuals are seeking information about health-related issues, the local doctor may be one of the first sources people look to in order to address any queries they might have. Accordingly, it is important that information on the identification and relief of fatigue-related impairment is readily available through health-care centres and medical clinics. Information on the detection and treatment of sleep disorders should also be available through these agencies.

Presently, given the uncertainty surrounding the phenomenon of fatigue, the emphasis of fatigue-related advice given by health professionals should focus on individuals recognising, firstly, that driving may be seriously undermined by fatigue and, secondly, that the most reliable way of alleviating fatigue is to take regular rest and sleep breaks.

The provision of information on strategies such as engaging in physical activity or taking medication that may alleviate driver fatigue to people who aren't generally well-informed about fatigue-related issues is a potentially dangerous practice. This knowledge may lead to driver overconfidence, and reduce the likelihood that individuals will take precautions to guard against fatigue when planning a driving journey.

5.1.3 Strip Maps

Strip maps are available for major highways and high-use routes, and individuals can use this information to plan prospective driving journeys. Strip maps enable rest and sleep breaks to be scheduled prior to a driving journey, rather than during the drive itself when fatigue may impair a driver's ability to make sound judgements.

Strip maps include information about:

- the location of rest areas or service centres with toilets

- towns with toilets and rest facilities
- travel times in hours on various routes
- SES Operation Coffee Break sites
- SES Operation Coffee Break sites at town locations
- SES Operation Coffee Break sites at rest areas
- fatigue alleviation strategies
- see Appendix B for an example of a strip map developed by RACV

5.1.4 Road Signs showing Travel Times and Distances

Road signs showing information on travel times and travel distances, and the location of rest area facilities, assists individual drivers to consider the demands of travelling and placement of rest areas when scheduling rest breaks on a driving journey.

5.1.5 In-Car Fatigue Assessment Technologies

In-car technological devices that detect possible fatigue-related impairment in "real time" have the potential to warn drivers about impairment due to fatigue and, in some instances, prevent them from continuing driving, therefore reducing fatigue-related crashes.

As the accuracy and reliability of these devices approaches a level where they may be incorporated into passenger vehicles, in-car fatigue assessment technologies should be promoted as tools that assist drivers to act responsibly and safely, rather than as a form of automated piloting system, to ensure the uptake of this technology leads to positive road safety outcomes.

5.2 Companies

5.2.1 Occupational Health & Safety Guidelines and Road Safety

Presently, the most coordinated approach to prevention of fatigue-related crashes has been the formation of legally-enforceable occupational guidelines within the commercial transport industry. Commercial drivers are stringently regulated according to temporal scheduling of duty and rest periods, and are subjected to random checks by authorities to ensure work practices are in accordance with Occupational Health and Safety (OHS) guidelines.

By developing OHS guidelines, in conjunction with improved driver training, police enforcement, and technological vehicle monitors (ie. Safe T Cam), road authorities have created a comprehensive, network approach that has increased driver awareness of health and legal consequences associated with driving while impaired by fatigue. These influences have reduced fatigue-related crashes among commercial vehicles (FORS, 1996) and improved perceptions amongst the general public about the safety of heavy vehicles and their drivers.

5.2.1.2 Limitations of Occupational Health & Safety Guidelines

The development of an industry code of practice within the transport industry has lead to impressive road safety benefits. Nevertheless, it is important to recognise that present OHS guidelines fail to adequately address some of the most important contributory factors underlying fatigue-related crashes.

Workplace scheduling arrangements, even those pertaining to the transport industry, cater more strongly to economic considerations than endogenous biological rhythms underlying human rest and activity patterns. Commercial drivers may, for example, comply with scheduling arrangements relating to professional employment, yet may still accumulate a significant sleep debt over a period of days.

Also, work place hours are generally increasing in Australia and, paradoxically, lunch breaks and hours spent resting are the areas most adversely effected by this change. Viewed in this context, there is a distinct possibility that the contribution of work arrangements to fatigue-related road trauma may increase over time.

5.2.1.3 Increasing Recognition of Fatigue in Occupational Health & Safety Guidelines

In order to address these limitations, all workplaces should incorporate fatigue-related educational materials as part of employee induction programs. Employees need to understand that, while companies have a legal obligation to meet OHS requirements regarding workplace scheduling, fatigue still has potential to undermine the quality and, hence, safety of employee's work.

To this end, the Transport Workers Union launched a road safety program late last year to educate its members about the importance of road safety in general and, more specifically, the dangers posed to road users by driver fatigue. The establishment of a national program to educate transport companies and drivers about fatigue management would represent a particularly positive step in reducing fatigue-related crashes.

In the future, in-car technological systems for monitoring fatigue may be developed to a stage where OHS regulations pertaining to fatigue are self-enforcing, in that technological devices will constrain illegal driving behaviours (E.T.S.C., 1999).

5.3 Government

Government funding for initiatives that encourage individual drivers to act responsibly with regard to driver fatigue will play an important role in reducing fatigue-related road crashes.

5.3.1 Provision of Adequate Roadside Stopping Places

Public perceptions about the adequacy of available rest area facilities may play an important role in determining the likelihood that drivers will utilise roadside stopping places to alleviate fatigue. Priorities in this area include:

- Developing a coordinated strategy for placement of rest area facilities
- Providing adequate roadside stopping places, in terms of both travel distance and time, on all major highways and tourist routes

- Placing rest areas in such a way that motorists in rural areas have the option of selecting appropriate stops at least every 60 minutes
- Placing wayside stops in such a way that motorists in rural areas have the option of taking short stops between rest areas
- Increasing the number of road signs showing details of travel times and distances to the next rest area
- Conducting an audit of existing rest area facilities to assess their adequacy with regard to public perceptions about essential components of rest area facilities

5.3.2 Implementation of Roadside Countermeasures

In instances where road crashes occur, the nature of roadside hazards may play an important role in determining the severity of crashes. Initiatives that may play an important role in reducing extent of experienced trauma include:

- Conducting an audit to determine whether roadside countermeasures have been implemented in accordance with "Clear Zone" policy
- Undertaking research to determine whether countermeasure development specified by the "Clear Zone" policy has resulted in significant crash-rate reductions at high-crash road locations
- Providing increased funding for use of "audible" road shoulder markings and rumble strips, particularly for high-speed sections of rural road

5.3.3 Public Education Campaigns

It is important that fatigue-related driving risks are effectively conveyed to all road users, and Government funds should be allocated for this purpose. Specific issues to be addressed by public education campaigns include:

- Raising public perceptions about the probability of being involved in a fatigue-related crash to encourage individuals to take appropriate measures to prevent driver fatigue
- Challenging biases that may exist in drivers' perceptions about personal vulnerability to fatigue-related road crashes by conveying fatigue-related crash statistics and research findings to the public domain

  By combining empirical research on the relationship between sleep deprivation and driver performance, together with statistics highlighting the incidence of fatigue road crashes, awareness campaigns may demonstrate emphatically that drivers must be conscious of lifestyle issues, such as work, rest and sleep patterns, in order to maintain a high level of safety on our roads.

- Emphasising that considerable deficits may emerge in driving behaviour as a consequence of impairment by fatigue, but drivers may have no conscious awareness that their performance is being undermined

  By emphasising this point, awareness campaigns may directly challenge notions that drivers who regard themselves as being "careful" or "responsible" are not immune from fatigue-related risk factors faced by other road users. Driver fatigue can impair the driving of all people, even if we are not aware it is happening.

  The development of fatigue is not well understood in scientific circles, let alone amongst the general public. The alcohol-crash problem seems to be better understood within the wider community than are fatigue-related driving risks.

Awareness campaigns comparing alcohol and fatigue-related risk factors may provide a useful means of assisting road users to relate personally to the dangers posed by driver fatigue. For example, hours of sleep deprivation could be related to appropriate BAC levels to demonstrate that drivers who don't take precautions to ensure they are properly rested are placing themselves at higher risk of crash-involvement.

5.3.4 Provision of Fatigue Information via Health Professionals

Availability of information on the development, symptoms and consequences of driver fatigue may play an important role in encouraging drivers to give consideration to fatigue before beginning a driving journey. Priorities in this area include:

- Ensuring that information on the causes, identification and relief of driver fatigue is readily available
- Providing for the establishment of formal associations between road authorities, road research organisations and relevant health-professional organisations to ensure community members are provided with accurate, up-to-date advice about steps that can be taken to reduce personal vulnerability to driver fatigue

5.3.5 Research and Development

5.3.5.1 Development of In-Car Technologies

In-car technological devices that assess drivers for fatigue-related impairment in "real time" have the potential to reduce fatigue-related crashes, and Government funds should be allocated for research and development in this area. Specific issues to be addressed by research include:

- Determining which combination of behavioural, physiological and technological measures provides the most accurate and reliable diagnosis of the presence of fatigue, for all individuals over a range of driving conditions
- Examining interactions between in-car fatigue warning signal characteristics and human information processing resources to ensure that in-car technologies convey fatigue-related information to drivers as safely and effectively as possible

5.3.5.2 Assimilation of In-Car Technologies

As the accuracy and reliability of in-car fatigue assessment devices approaches a level where they may be incorporated into passenger vehicles, measures that may help ensure the uptake of in-car technology leads to positive road safety outcomes include:

- Promoting in-car fatigue assessment technologies as tools that assist drivers to handle their vehicle responsibly and safely, rather than as a form of automated piloting system

5.3.5.3 Improved Methods of Road Crash Investigation

The contribution of driver fatigue to road crashes is determined by on-site investigations of road crashes. Advances in methods of road crash investigation may have important consequences for public perceptions about the risk of being in a fatigue-related crash. Priorities in this area include:

- Allocation of funds by Government for research and development of "in-car" technological devices that record control indices underlying driving fatigue

6. SUMMARY OF RECOMMENDATIONS

Outlined below is a summary of RACV recommendations for managing fatigue in road transport, that were discussed in this submission. The recommendations relate to vehicle factors, driver behaviour and education and the road environment.

Vehicle design and technology

- The Federal Office of Road Safety and other State road safety agencies should, as a priority, undertake research into the development and trialing of in-vehicle devices that are likely to reduce fatigue related crashes.
- Governments should undertake research and development of "in-car" technological devices that record control indices underlying driving fatigue, so that more accurate estimates of the contribution of driver fatigue to road trauma can be determined.
- In-car fatigue assessment technologies should be promoted as tools that assist drivers to handle their vehicle responsibly and safely, rather than as a form of automated piloting system.
- Research should be undertaken to determine which warning signal stimuli, or combination of stimuli (visual, audio, haptic), designed to prevent driver fatigue are appropriate for low-level and high-level (urgent) warning signals.

Road user behaviour and education

- Campaigns should be undertaken by road safety agencies to raise public perceptions about the probability of being involved in a fatigue-related crash and to encourage individuals to take appropriate measures to prevent driver fatigue.
- Public education campaigns should challenge biases that may exist in drivers' perceptions about personal vulnerability to fatigue-related road crashes and emphasise that drivers may not be aware that their driving is impaired by fatigue while they are driving.
- Road safety agencies should ensure that information about the causes, identification and relief of driver fatigue is readily available to all members of the public, and should be available in a range of languages.
- State and Federal Governments should establish associations between road authorities, research organisations and relevant health-professional organisations to ensure community members are provided with accurate, up-to-date advice about steps that can be taken to reduce personal vulnerability to fatigue while driving.
- Research should be undertaken to determine which combination of behavioural, physiological and technological measures provides the most accurate and reliable diagnosis of the presence of fatigue, for all individuals over a range of driving conditions.
- Research should also be undertaken to examine interactions between in-car fatigue warning signal characteristics and human information processing resources to ensure that in-car technologies convey fatigue-related information to drivers as safely and effectively as possible.
- State and Federal Governments should initiate programs to educate employers about issues related to fatigue, and to develop workplace countermeasures to prevent fatigue related injury and death.

Road environment

- Local and State Governments should conduct regular audits to determine whether roadside countermeasures have been implemented in accordance with "Clear Zone" policy.
- Research should be undertaken to determine whether countermeasure development specified by the "Clear Zone" policy has resulted in crash-rate reductions at high-crash road locations.
- Governments should provide increased funding for use of "audible" road shoulder markings and rumble strips, particularly for high-speed sections of rural roads.
- A coordinated strategy for the placement of rest area facilities needs to be developed at both State and Federal levels.
- State and Federal Governments should ensure that adequate roadside stopping places, in terms of both travel distance and time, are available on all major highways and tourist routes.
- State and Federal Governments should ensure that road signs showing details of travel times and distances to the next rest area are installed and maintained.
- Local and State Governments should conduct regular audits of existing rest area facilities to assess their adequacy in terms of placement, signage and public facilities.

7. REFERENCES

Automobile Association of Australia. Submission to the House of Representatives Committee Inquiry into Fatigue Management in Transport. June 1999.

Barfield W, Dingas T. (1998). Human Factors in Intelligent Transport Systems. Laurance
Bartley, S.H., & Chute, E. (1947). *Fatigue and impairment in man*. New York: McGraw-Hill.
Berkely (1999). http://www.path.berkeley.edu/~leap/AVCSS/Long_Coll_Avoid/
Booze Allen & Hamilton (1998). Intelligent Transport Solutions. A report prepared for ITS Australia.

Brown, I.D. (1985) Fatigue. In A. Raffle (Ed.), *Medical aspects of fitness to drive* (pp. 79-88). London: Medical Commission on Accident Prevention.

Brown, I.D. (1994). Driver Fatigue. Human Factors, 36(2): 298-314.

Brown, I.D. (1997). Prospects for technological countermeasures against driver fatigue. Accident Analysis and Prevention, 29(4): 525-532.

Corfitsen, M.T. (1986). Fatigue in fatal single vehicle car accidents. *Forensic Science International, 30:3-9.*

Dalziel, J.R., & Job, R.F.S., (1996). Fatigue and taxi drivers: An examination of factors associated with motor vehicle accidents. Department of Psychology, University of Sydney.

DOT, 1996. *ITS at a Glance* Department of Transportations ITS Joint Programs Office, 3rd Quarter, 1996

Duarte, A., & Corben, B. (1998). *Improvements to black spot treatment strategy.* Monash University Accident Research Centre, Report No. 132.

European Transport Safety Council. Police Enforcement Strategies to Reduce Traffic Casualties in Europe. Brussels, Belgium, May 1999.

Fell, D.L., & Black, B. (1997). Driver Fatigue in the City. Accident Analysis & Prevention, 29(4): 463-469.

FORS, (1996). *Road fatalities Australia : 1995 statistical summary*. Statistics and Analysis Unit, Federal Office of Road Safety.

Haworth, N. & Heffernan, C.J. (1989). Information for development of an educational program to reduce fatigue-related truck accidents. Monash University Accident Research Centre, Report No 4, February 1989.

Haworth, N. & Rechnitzer, G., (1993). Description of fatal crashes involving various causal variables. Federal Office of Road Safety, Report No CR119.

ITSA (1999). http://www.itsa.uts.edu.au/
Jackson, S. (1994). *Travel to work, school & shops, Victoria October 1994.* Australian Bureau of Statistics, Catalogue No. 9201.2

McDonald, N. (1984). *Fatigue, safety and the truck driver.* London: Taylor & Francis.

Pack, I.A., Pack, A.M., Rodgman, E., Cucciara, A., Dinges, D.F. & Schwab, C.W. (1995). Characteristics of crashes attributed to the driver having fallen asleep. *Accident Analysis and Prevention, 27(6):769-775.*

Queensland Department of Transport (1993). Falling asleep at the wheel: Proceedings of a seminar on sleep disorders and road safety. Q.D.T Road Safety Division. Report No RUB 93-1, November 1993.

VicRoads, (1998). *Roadside Hazard Management*. Safe Roads No. 106, April 1998.

VicRoads, (1999). Safety First: Road Safety Priorities Program. January - June 1999.

Victoria Police (1995). Single vehicle run off road fatalities (Victoria) - Significant Circumstances Causing Fatalities. Victoria Police Statistical Services Division.

Williamson, A.M., Feyer, A-M. & Friswell, R. (1996). The impact of work practices on fatigue in long-distance truck drivers. *Accident Analysis & Prevention: 28(6): 709-719*.