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FATIGUE IN TRANSPORT

Introduction

1.1 The transport task in today's 24 hour a day, seven day a week global economy is enormous. Freight and people are being moved on a scale and at a pace never before seen.

1.2 Trucks, planes, ships and trains are carrying greater loads over longer distances. Of itself, this increase in transport activity creates more potential for near misses and accidents. These risks are compounded by the commercial imperative on transport operators to maximise the return on their investment, the demands of customers and by the pressure this places on transport workers to undertake longer hours with fewer rest breaks.

1.3 Human fatigue is now recognised around the world as being the main cause of accidents in the transport industry. It is increasingly being recognised as a safety issue of the highest priority.

> The issue of fatigue in the workplace in all modes of transportation and even beyond transportation is something that is exploding as a priority issue across the industrialised world.[1]

1.4 Fatigue is not just an industrial issue to be negotiated between employers and employees. It is also an occupational health and safety issue, a commercial issue, a public safety issue and, at times, an environmental issue. Individuals and organisations that fail to manage human fatigue

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1 Transcript of evidence, 10 September 1999, Melbourne, p.186 (Prof. David Dinges).

sensibly, risk having or creating accidents with a broad range of damaging and enduring consequences.[2]

1.5 In this chapter we describe what fatigue is; discuss the major causes of fatigue; consider the impact of fatigue in the transport industry; and outline the scope of the problem in Australia.

What is fatigue

Definition

1.6 There is no commonly agreed definition of human fatigue. In sports science, fatigue is seen in purely physical terms.[3] In the context of safety in transportation, wider definitions are used which incorporate both physical and mental factors. Fatigue has been variously defined as:

- the consequence of inadequate restorative sleep,[4]
- the progressive loss of alertness ending in sleep,[5]
- an all encompassing term used to describe a variety of different experiences such as physical discomfort from over working a group of muscles, difficulty concentrating, difficulty appreciating potentially important signals and problems staying awake, and[6]
- a reduction in or loss of physical and/or mental capability as a result of exertion, which may impair all physical abilities, including strength, speed, reaction time, coordination, decision making, or balance.[7]

1.7 The key points taken from the above definitions are that fatigue is the result of inadequate rest over a period of time and that fatigue leads to physical and mental impairment.

1.8 It is commonly understood that there are two different levels or types of fatigue:

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2 The environmental impact of the grounding of the oil tanker *Exxon Valdez* is a case in point. See D. Dinges. 1995, 'An Overview of Sleepiness and Accidents', *Journal of Sleep Research*, Volume 4, Supplement 2, p.8.

3 Information received from Dr Philip Swann, 29 May 2000.

4 Submission No 19, Vol 2, p. 251 (Centre for Sleep Research).

5 Submission No 1, Vol 1, p. 1 (Assoc.Prof. Laurence Hartley).

6 Exhibit 15 *Road Transport Code of Practice* (Dept Transport and Works, NT).

7 Submission No 83, Vol 6, p. 1262 (Dept. Transport and Regional Services).

- acute fatigue is short term and is experienced as a direct consequence of some activity such as strenuous exercise or intense mental concentration.
- chronic fatigue (not to be confused with the medical condition of the same name) is a cumulative state of tiredness and decreased alertness and it is more severe and long term than acute fatigue.[8]

1.9 A common perception equates fatigue with feeling sleepy or tired. In many cases the research uses the terms fatigue and sleepiness interchangeably. However, many researchers differentiate fatigue from "sleepiness" or "tiredness". Tiredness may refer to the ability to initiate sleep while fatigue refers to the ability to maintain job sufficient alertness. By these definitions, it is possible to be fatigued but not tired. For example, the time of day may make it difficult to fall asleep even though a person is fatigued.[9] Further, sleepiness is a subjective state while fatigue involves a loss of objectively measurable performance capability over time.[10]

1.10 The Committee on Flight Time Limitations in the United Kingdom provides a useful differentiation of tiredness from fatigue which underpins how fatigue is understood in this report:

> Tiredness resulting from physical or mental effort is a normal experience. Whilst tiredness may develop into fatigue it differs from it in that a tired person can be quickly aroused to a high level of performance. We have come to consider fatigue as a markedly reduced ability to carry out a task. It is a condition of reduced performance from which there is no certainty that a person can be aroused in an emergency even when considerable stimulus is present.[11]

Circadian rhythms

1.11 Chronic fatigue is directly related to the physiological need for sleep. Being required to function on a roughly 24 hour basis, either through shift work or extended hours of work, comes into conflict with the body's internal 'clock' (often referred to by the physiological term ***circadian pacemaker***). One of the key functions of this internal 'clock' is to determine when people feel the need for sleep and when they feel awake over a 24 hour period (***circadian rhythms***).

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8 Exhibit 3 *The Work Practices of Marine Pilots: A Review* (AMSA).

9 Correspondence, Professor Drew Dawson, received 9 January 2000.

10 Correspondence, Professor David Dinges, received 8 January 2000.

11 Submission No 43, Vol 3, p. 658 (CAOOAA).

1.12 The body's *circadian rhythms* increase and decrease body temperature over a roughly 24 hour period, reaching a low point at approximately 3 am to 5 am with a less severe low point at around 3 pm and 5 pm. These low points induce a strong physiological need for sleep at around these times.[12] Evidence suggests that working through these periods produces a higher relative risk of an accident.[13]

1.13 Importantly, every person operates to a similar wake/sleep pattern. Researchers working with the NASA Fatigue Countermeasures Program observe that;

> Humans are hard-wired with a genetically determined biological need for sleep and with a circadian pacemaker that programs us to sleep at night and to be awake during the day on a 24 hour schedule. Twenty four hour operations challenge these basic physiological principles.[14]

1.14 The body's internal clock can be reset over time if external events change for an extended period, such as when people change time zones for an extended period. However, research shows that it cannot be permanently adjusted to a reversed cycle of work and sleep if external events remain the same, such as occurs in shiftwork.[15]

Sleep debt

1.15 The optimum amount of sleep required by an individual varies, with 8 hours considered the average amount of sleep required by an adult.[16] If an individual continually obtains less than their optimal number of hours of sleep, they build up a **sleep debt (**or **sleep deficit)**.

1.16 A **sleep debt** is 'the difference between a person's minimum sleep requirement needed to maintain appropriate levels of alertness and performance and the actual amount of sleep obtained'.[17] For example, if an individual who requires 8 hours of sleep only obtains 6 hours, they are

12 Rosekind. M, 1999, 'Fatigue in Transportation: Physiological. Performance and Safety Issues', National Transportation Safety Board, *Evaluation of US Department of Transportation Efforts in the 1990s to Address Operator Fatigue*, Safety Report NTSB/SR-99/01, Washington DC, p.71.

13 Exhibit 3, *The Work Practices of Marine Pilots: A Review* (AMSA).

14 Rosekind. M, Gander.P, Gregory.K, Smith.R, Miller.D, Oyung.L, Webbon.L, Johnson.L. 1996, 'Managing fatigue in operational settings 1: Physiological considerations and countermeasures', *Behavioural Medicine*, vol 21, p.157.

15 Submission No 1, Vol 1, p. 2 (Assoc. Prof. Laurence Hartley)

16 Rosekind. M, 1999, 'Fatigue in Transportation: Physiological. Performance and Safety Issues', National Transportation Safety Board, 1999, *Evaluation of U.S. Department of Transportation Efforts in the 1990s to Address Operator Fatigue*, Safety Report NTSB/SR-99/01, Washington DC., p.69

17 Exhibit 3, *The Work Practices of Marine Pilots: A Review* (AMSA).

deprived of 2 hours of sleep. If this occurs over four consecutive nights the sleep loss per night would accumulate into an 8 hour sleep debt that will affect the individual's level of alertness and performance.[18]

1.17 People who are suffering from a sleep debt are at risk of 'nodding off' whilst working. These brief sleep episodes are termed **micro-sleeps** and are usually uncontrolled and spontaneous. Research indicates that operators are not always aware they have fallen asleep and that 'between 2 to 4 minutes of sleep must elapse before more than 50 per cent of people will acknowledge they have fallen asleep'.[19]

1.18 Researchers with the NASA Fatigue Countermeasures Program conclude that 'regardless of training, professionalism, or having the 'right stuff', extreme sleepiness can precipitate uncontrolled and spontaneous sleep'.[20]

Perceiving fatigue

1.19 The physical need for sleep does not always accord with how tired a person feels. There are two ways of understanding how a person perceives their own level of fatigue:

- **physiological,** which is the physical need for sleep, and
- **subjective,** which is how sleepy a person feels. This is not an accurate measure of an individual's physiological need for sleep. It can be affected by factors such as physical activity or a stimulating environment.[21]

1.20 Research indicates that operators are aware they are fatigued because they actively fight sleep in order to complete a journey or a task.[22] Professor Jim Horne, however, argues that 'what many drivers fail to realise is that sleepiness portends sleep, that it can appear more rapidly than they realise, especially if the driver has reached the more profound stage of fighting off sleep (eg. opening the vehicles window, turning up the radio,

18 Rosekind. M, 1999, 'Fatigue in Transportation: Physiological, Performance and Safety Issues', National Transportation Safety Board, *Evaluation of U.S. Department of Transportation Efforts in the 1990s to Address Operator Fatigue*, Safety Report NTSB/SR-99/01, Washington DC, p.70

19 Submission No 1, Vol 1, p. 2 (Assoc. Prof. Laurence Hartley)

20 Rosekind. M, Co. E, Johnson. J, Smith. R, Weldon. K, Miller. D, Gregory. K, Gander. P, Lebacq. L, 1994, 'Alertness Management in Long-Haul Flight Operations', Proceedings of the 39th Annual Corporate Aviation Safety Seminar, St.Louis, at http://olias.arc.nasa.gov/zteam/fcp/pubs/FSF.paper.html, 2/06/1999, p. 7 of 8.

21 Rosekind. M, Gander. P, Gregory. K, Smith. R, Miller. D, Oyung. R, Webbon. L, Johnson. L. 1996, 'Managing Fatigue in Operational Settings 1: Physiological Considerations and Countermeasures', *Behavioural Medicine*, vol 21, p. 159.

22 Submission No 1, Vol 1, p. 2 (Assoc. Prof. Laurence Hartley).

frequent moving around in the driving seat), which must be plainly evident to the driver that he/she is sleepy'. [23]

1.21 There are certain cultural obstacles to getting people to recognise and take appropriate action in regard to fatigue. Most commonly, people are willing to work whilst suffering from fatigue because it is seen as 'professional'. The widely held belief, particularly in the transport industry, that fatigue 'comes with the job' makes it difficult for people to recognise fatigue as a problem and to take appropriate action.[24]

Causes of fatigue

1.22 At its core, fatigue is caused by a lack of restorative sleep.[25]

1.23 The evidence we received suggests that three broad factors can contribute to a lack of restorative sleep: the time of day work takes place, the length of time spent at work and in work related duties (such as driving to and from work), and the amount and quality of rest obtained prior to and after a work period.[26]

1.24 Typically, combinations of these factors contribute to the risk of fatigue. For example, a person operating a vehicle at night, after extended hours on the job and with a lack of quality sleep prior to work, would be facing a significantly higher accident risk that someone exposed to only one of the fatigue factors.

Time of day (circadian factors)

1.25 Research, both in Australia and overseas, has identified the time of day at which work takes place as a key risk factor in fatigue. As described in one research paper, 'the circadian clock is a powerful modulator of human performance and alertness, and in transportation operations, it can be disrupted by night work, time zone changes, and day night shifts'.[27]

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23 Horne.J, Reyner.L, 1999, Sleep Related Vehicle Accidents: Some Guides for Road Safety Policies, paper presented to Fourth International Conference on Fatigue in Transportation, Fremantle, 19–22 March 2000.

24 Dinges.D. 1995, 'An Overview of Sleepiness and Accidents', *Journal of Sleep Research*, vol.4, supplement 2, p. 10.

25 Submission No 19, Vol 2, p. 251 (Centre for Sleep Research).

26 Submission No 83, Vol 6, p. 1270 (Dept. Transport and Regional Services).

27 National Transportation Safety Board. 1999. *Evaluation of U.S. Department of Transportation Efforts in the 1990s to Address Operator Fatigue*, Safety Report NTSB/SR-99/01, Washington DC, p.68.

1.26 There is a substantial body of evidence indicating that accidents are more likely to occur at night, particularly during the period when the circadian cycle is at its lowest point and a person would normally be sleeping. The US Federal Highway Administration and Transport Canada *Driver Fatigue and Alertness Study* concluded that the 'strongest and most consistent factor influencing driver fatigue and alertness in this study was the time of day'.[28] Similar findings are echoed in research conducted on road transport drivers in Australia, where it has been found that 'work during the midnight to dawn period is likely to lead to greater fatigue than day work'.[29]

1.27 Comparable findings are evident in other modes of transport. In the maritime transport sector a study of collisions and groundings found that 67 per cent happened during hours of darkness with 44 per cent occurring during the eight hour period 10 pm to 6 am. Figures for casualties by watch period indicate that casualties are more likely in the period from midnight to 8 am.[30]

1.28 The 1997 Bureau of Air Safety Investigation Air Safety Report, *Human factors in airline maintenance: a study of incident reports*, found a correlation between time of day and the frequency of accidents.

> Human factors were involved in most of the reported incidents, with workers on duty between the hours of 0200 and 0400 having a greater chance of having an incident than workers on duty at other times of the 24-hour clock. The frequency of incidents increased as the shift progressed up to the second last hour, after which the frequency of incidents diminished.[31]

1.29 The report also found that the majority of mistakes were 'rule based mistakes' and that 'absent minded slips' were involved in about one-third of incidents.[32]

1.30 Dr Ann Williamson suggests that night work should be avoided or reduced as much as possible:

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28 Exhibit 30, *Driver Fatigue and Alertness Study* (Transport Canada and US Dept. of Transportation) p.8

29 Submission No 28, Vol 2, p. 364. Similar trends have been identified in the United Kingdom. For example, Horne and Reyner argue that there are clear time of day effects for sleep related vehicle accidents, 'with peaks around 0200–0600 and 1400–1600'. See Horne.J, and Reyner,L, 1999, 'Vehicle accidents related to sleep: a review', *Occupational and Environmental Medicine*, May, vol.56 (5), pp.289-294.

30 Submission No 83, Vol 6, p. 1274-5 (Dept. Transport and Regional Services).

31 Bureau of Air Safety Investigation, 1997, *Human factors in airline maintenance: a study of incident reports*, Department of Transport and Regional Services, Canberra, p.v.

32 Bureau of Air Safety Investigation, 1997, *Human factors in airline maintenance: a study of incident reports*, Department of Transport and Regional Services, Canberra, p.v.

> Night work of any sort is well known to be at higher risk of error and result in poor performance in general. In addition, night work always requires more effort to perform than day work. For these reasons, night work should be avoided where possible. Since the result of errors and poorer performance are more likely to have serious consequences in the transport industry compared to other industries, the increased risk at night cannot be ignored.[33]

1.31 Similarly, a study undertaken in 1998 by the RAAF Institute of Aviation Medicine recommended that shift lengths be adjusted so that day shifts are longer than night shifts. It is argued that shifts of equal length can cause 'periods of acute fatigue and significant performance impairment'. This is due to fatigue accumulation being slower during the day and faster during the night. Further, recovery after a night shift is inefficient because the time of day does not allow for effective sleep.[34]

1.32 Insurance companies also have recognised that the midnight to dawn period poses the highest risk for accidents in road transport. One insurance company questioned by us said that they were applying a 'midnight to dawn excess' on truck operators who wanted to work in that 'high risk zone'.[35]

Hours of work

1.33 It is widely accepted in Australian research literature that long hours of work are a key cause of fatigue in the transport industry.

1.34 Dawson and Fletcher argue that 'the longer a work period, the more fatiguing it is likely to be', noting that the fatigue impact of long hours is compounded by the fact that less time is then available for rest. [36] In a separate written submission, Professor Dawson states that 'when people work for longer than 50 hours per week there is an increasing competition between sleep and other activities of daily living'.[37]

1.35 Studies have also have shown that night shifts longer than 12 hours and day shifts longer than 16 hours are consistently associated with lowered productivity and more accidents across a range of occupational groupings.[38]

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33 Submission No 28.01, Vol 7, p. 1802 (Ann Williamson).

34 Submission No 38, Vol 2, pp.519-20 (Minister for Defence).

35 Transcript of evidence, 13 March 2000, Canberra, p. 811-2 (Mr Dean Croke—MMI Insurance).

36 Fletcher.A, Dawson D, 1997, 'Cabin Safety and Hours of Work: Developing a general risk control model for fatigue', *Journal of the Centre for Sleep Research*, vol. 2, p. 11.

37 Submission No 19, Vol 2, p. 251 (Centre for Sleep Research).

38 Olson.L.G, Ambrogetti.A, 1998, 'Working Harder – Working Dangerously?: Fatigue and performance in hospitals', *Medical Journal of Australia*, vol. 168, issue 12.

1.36 In studies undertaken by Williamson and Feyer on Australian truck drivers, it was found that long hours of work and long periods without sleep caused fatigue. Truck drivers reported 'feeling tired after around 14 hours of work on average'.[39] Hartley cites research indicating that the 'relative risk of crash involvement for drivers who reported a driving time in excess of 8 hours was almost twice that for drivers who had worked fewer hours'.[40]

1.37 Concern about the personal and public safety impact of long hours at work is not limited to the road transport sector. Long hours are also a factor in safety in the marine transport sector. A survey of 2500 seafarers conducted by the International Transport Workers' Federation (ITF) reported that 55 per cent of those surveyed considered that their working hours presented a danger to their health and safety.[41]

1.38 The issue of working hours is discussed in more detail in Chapter 3.

Rest

1.39 The third key cause of fatigue is the amount and quality of rest before work.

1.40 Studies by the US Army Medical Corp indicate that anything less than 8 to 9 hours of sleep per night leads to degraded work performance over time. Moreover, the longer a person suffers from restricted sleep, the longer it takes them to recover even when given optimal conditions for sleep.[42]

1.41 The time of day at which people seek to sleep is also an important factor in fatigue. Research shows that daytime sleep is not as effective as night sleep and is shorter in duration, even if more time for sleep is available. The best and most recuperative sleep is that which starts at around 9 pm. The least amount of sleep is sleep initiated in the afternoon.[43]

1.42 There is also a body of evidence indicating that working at night is related to a reduction in sleep during time off duty, accumulated sleep debt and a

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39 Submission No 28, Vol 2, p. 363 (Dr Ann Williamson and Assoc. Prof Ann–Marie Feyer)

40 Submission No 1, Vol 1, p. 3 (Assoc. Prof. Laurence Hartley). It is worth noting that international research appears not to be conclusive on this point with the US and Canadian *Driver Fatigue and Alertness Study* concluding that 'hours of driving (time-on-task) was not a strong predictor of observed fatigue'. (See Exhibit 30, *Driver Fatigue and Alertness Study*, p.9).

41 International Transport Workers Federation. 'Seafarer fatigue: Wake up to the dangers', London, pp.7–8.

42 Belenky.G, 2000, The Effects of Restricted Sleep on Performance and Submission Nosequent Recovery: Implications for Managing Sleep to Sustain Performance, paper presented to Fourth International Conference on fatigue in Transportation, Fremantle, 19-22 March, 2000. See also Submission No 28, Vol 2, p 364 (Dr Ann Williamson and Assoc. Prof Ann–Marie Feyer).

43 Submission No 1, Vol , p. 3 (Assoc. Prof. Laurence Hartley).

corresponding decline in performance. This is a disturbing finding, as many workers in the transport industry regularly work at night.

1.43 Workers on night shift typically obtain 1 to 3 hours less sleep per day than workers on day shift.[44] In addition, operators who begin work at 3 am average only 5.5 hours sleep during their non work time while those starting at 8 pm only obtain 4 hours of sleep. This is despite the fact that they may have had the opportunity to obtain 8 hours of sleep. A reduction in sleep by as little as 2 hours can result in measurable changes in performance.[45]

1.44 Shift work rosters do, of course, provide for time off-duty to allow for rest and sleep. However, it can be extremely difficult to obtain sufficient rest during daylight hours. Professor Dawson notes that:

> …as the amount of night work increases, so does the amount of sleep that must be attempted at biologically inappropriate times. Sleeping 'out of sync' with the body's biological clock results in reduced duration and quality of sleep. This in turn reduces the restorative value of the sleep obtained.[46]

1.45 Other factors can also influence the effectiveness of rest sought at these times, such as:

- environmental factors (such as higher levels of ambient noise and higher temperatures during the day); and
- the need to fulfil family and personal commitments.

1.46 Workers who are ‘on-call’ during off-duty times can find that their opportunities for rest are disrupted significantly. Evidence indicates, for example, cases where on-call marine pilots have been called up to six times with revised ship arrival times while at home resting. As a consequence they begin their next shift already suffering from the cumulative effects of fatigue.[47]

Additional factors

1.47 Many of the submissions we received argued that not only are the three causes of fatigue (long hours of work, night work and the lack of restorative sleep) ever present in the transport industry, they are exacerbated by other factors common in the industry, such as:

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44 Submission No 19, Vol 2, p. 251 (Centre for Sleep Research).

45 Smiley A, 'Fatigue management: Lessons from research', in L Hartley (ed), 1998, *Managing Fatigue in Transportation*, Elsevier Science Ltd (Pergamon), Oxford, p. 15.

46 Submission No 19, Vol 2, p. 251 (Centre for Sleep Research).

47 Transcript of evidence, 26 July 1999, p 17 (Capt. Robert Hall—Fremantle Pilots).

- insufficient staff numbers;
- poor rostering practices;
- poor work scheduling, particularly poor scheduling of pick-up and delivery times for truck drivers and poor estimating of ship times of arrival for marine pilots;
- inefficient organisation at loading and unloading points resulting in lengthy queuing, particularly for truck drivers;
- methods and rates of pay that induce employees to work longer hours;
- commercial pressures on companies that are passed on to employees;
- regulatory requirements, which compel or allow fatigue inducing practices;
- work related stress;
- repetitive and uninteresting work; and
- environmental factors in the workplace, such as hot, noisy truck cabins or rail compartments.

1.48 Of course, fatigue factors present in the wider community are also present in the transport industry. Age, general levels of fitness and medical conditions, such as sleep disorders, all exist as fatigue factors in the transport industry.

The impact of fatigue

1.49 A transport operator who is fatigued is unable to function at a normal level of alertness and efficiency, possibly leading to slowed reaction times, reduced vigilance, memory lapses, inattention to tasks, complacency, lack of awareness, lack of communication, mood changes, lack of judgement, decline in motivation, and falling asleep.

1.50 As one truck driver described, fatigue presents a very real danger to the operator and to others:

> Your survival capabilities are non-existent. Worst of all you just don't think straight. In other words you're an accident waiting to happen.[48]

1.51 Some other examples presented to us during the inquiry were:

48 Submission No 41, Vol 3, p. 590 (Mr John Bain).

- in road transport, drivers report that fatigue reduces their reaction time and produces poorer steering and gear changing. This increases wear and tear and reduces productivity through the effect on driving speed[49];
- during Operation Desert Storm the United States Air Force observed that cumulative fatigue in C-5 air transport flight crews resulted in the fumbling of radio frequency changes, slowed reaction times, impaired judgement, diminished checklist discipline, decreased aircrew coordination and increased irritability[50]; and
- a study of marine pilotage in the Great Barrier Reef revealed that lowered levels of vigilance can lead to lack of position monitoring, incorrect reading of navigation equipment and pilots failing to check a ship's position at critical times or to communicate information to the crew.[51]

1.52 In some situations, fatigue induced mistakes may be inconsequential, creating minor delays in completing a task (in the case of maintenance work) or rectified by failsafe systems (in the case of aviation or rail operations). In other situations, the risks of damage to equipment, of personal injury and to public safety can be far greater.

1.53 The inquiry into the 1997 Beresfield rail accident found that a lack of 'driver alertness' prior to the accident was a possible contributing factor in the driver missing signals and delaying applying the brakes. The report cited as a significant factor that the drivers suffered from work related fatigue 'of sufficient dimension to impair hand-eye coordination and reaction / response times, and to adversely affect alertness'.[52] Similarly, a key factor in the *Exxon Valdez* accident was the fact that the crewmember at the helm at the time of the accident, who should have been off his shift, failed to turn at the required signal.[53]

1.54 According to Professor David Dinges, these types of accident are indicative of the 'classic kind of fatigue catastrophe we see: good people, supposedly with simple manoeuvres, who are supposed to be watching, and nobody does anything'.[54]

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49 Submission No 28, Vol 2, p. 365 (Dr Ann Williamson and Assoc. Prof Ann–Marie Feyer).

50 Submission No 38, Vol 2, p. 500 (Minister for Defence).

51 Exhibit 3, *The Work Practices of Marine Pilots: A Review* (AMSA).

52 New South Wales Department of Transport, *Independent Inquiry Report, Coal Train Collision, Beresfield NSW, 23 October 1997*, provided by Mr Roger Jowett, National Secretary, Rail, Tram and Bus Union.

53 Transcript of evidence, 10 September 1999, Melbourne, p.201 (Prof. David Dinges).

54 Transcript of evidence, 10 September 1999, Melbourne, p.201 (Prof. David Dinges).

Comparison of fatigue to alcohol

1.55 An important study conducted by the Adelaide Centre for Sleep Research has compared the effects of fatigue against levels of alcohol known to cause impairment. The study indicated that 17 hours of sustained wakefulness leads to a decrease in performance equivalent to a blood alcohol content (BAC) of 0.05 per cent. The decrease in performance after staying awake for 24 hours is equivalent to a BAC of 0.1 per cent.[55]

1.56 A person with a BAC of 0.05 per cent is twice as likely to have an accident as a person with zero BAC, while a person with a BAC of 0.1 per cent is seven times more likely to have an accident.[56] Therefore, a person who has been awake for over 17 hours faces the equivalent risk of having an accident as a person who has been consuming alcohol.[57]

1.57 As noted by Williamson and Feyer 'the[se] results indicate that the consequences of fatigue are at least as important as the consequences of alcohol use in transportation, since they produce similar effects likely to compromise safety after relatively moderate hours without sleep'.[58]

1.58 Anthony Griggs, an experienced pilot, highlighted the similarity in the impact of fatigue and alcohol in the following terms:

> The consequences of fatigue on my capabilities as a pilot has been that I have acted or reacted like I have been consuming alcohol. My response to situations has been delayed, slow and lacking motivation. I have forgotten to undertake simple tasks or checks.[59]

1.59 The comparison of fatigue and alcohol provides a way of measuring the impairment due to fatigue based on what is already known about alcohol. It provides a basis for deciding what level of fatigue may be dangerous and an accessible frame of reference for engendering a broad understanding of the effects of fatigue. Most people are aware of the effects of alcohol on their performance and now have a means of translating that knowledge and experience to their level of fatigue.

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55 Submission No 19, Vol 2, p. 253 (Centre for Sleep Research).

56 Information received from Dr Philip Swann, Vicroads, 30 May 2000.

57 Information received from Dr Philip Swann, Vicroads, 30 May 2000.

58 Submission No 28, Vol 2, p. 365 (Dr Ann Williamson and Assoc. Prof Ann–Marie Feyer).

59 Submission No 2, Vol 1, p. 18 (Mr Anthony Griggs).

The scope of the problem

1.60 Broad ranging research into the key contributors to workplace impairment suggests that fatigue is four times more likely as a cause of impairment than drugs or alcohol.[60]

1.61 While there is agreement amongst experts that fatigue is a significant problem in the transport industry, and is growing along with the scale of the transport task itself, there is some variation in the data available on the subject.

1.62 These variations can be explained by:

- differences in the way that fatigue is defined in each jurisdiction and in each sector of the industry;'[61]
- differences in data collection methodologies; and
- because of the practical difficulties associated with determining whether an operator was suffering from fatigue immediately before an accident.[62]

1.63 Nevertheless, the data that is available allows a broad-brush picture to be established for each sector in the transport industry. It is noteworthy that most Federal and State regulatory agencies caution that the available figures are conservative and that the percentage of fatigue related accidents is probably higher.[63]

Fatigue in road

National statistics

1.64 The Commonwealth Department of Transport and Regional Services observes that available estimates from a range of sources suggest that the 'proportion of serious crashes involving driver fatigue range from about 5 per cent to almost half'.[64] However, 'most experts believe that a figure of the order of 20 to 30 per cent is plausible for fatal road crashes'.[65]

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60 Submission No 19, Vol 2, p. 258 (Centre for Sleep Research).

61 Submission No 83, Vol 6, p. 1318 (Dept. Transport and Regional Services).

62 Moore.B, Brooks.C, 1999, Heavy Vehicle Driver fatigue: A Policy Advisers Perspective, paper presented toFourth International Conference on Fatigue in Transportation, Fremantle, 19–22 March 2000.

63 Submission Nos 1, 83, 88, Vols 1, 6, pp. 4, 1281, 1449

64 Submission No 83, Vol 6, p. 1255 (Dept. Transport and Regional Services).

65 Submission No 83, Vol 6, p. 1255 (Dept. Transport and Regional Services).

1.65 The Federal Office of Road Safety (FORS) database for 1990, 1992, 1994 and 1996 reveals a range of statistics on fatigue related accidents. The estimates are based on all available information in Coroner's reports and police reports:

- fatigue was identified as a contributing factor in seven per cent of accidents in the database;
- 29 crashes in the period studied were identified as involving fatigue of a long distance heavy vehicle driver (0.4% of all fatal crashes) and 467 (6.5% of all crashes) as involving drivers of lighter vehicles; and
- fatigue was identified in 10 per cent of the crashes involving at least one long distance heavy vehicle.[66]

State statistics

1.66 Another perspective on the contribution of fatigue to road transport accidents is provided by State specific data. At this level it becomes more difficult to compare data because of the different regulatory environments in each State and the different approaches taken to data collection. However, an overview of the data does reveal that rural and non-metropolitan areas have a higher incidence of fatigue related accidents than are recorded for metropolitan areas. This is not to imply that rural drivers are more fatigued than city drivers. Rather, it may indicate that city drivers do not have experience on rural roads and with long distance driving, and do not properly plan long trips.

Victoria

1.67 The Work Related Fatalities Prevention Project (a joint project involving the Victorian Workcover Authority, the Victorian State Coroner's Office and the University of Ballarat) analysed work related fatalities cases from the State Coroner's office database, the Workcover compensation database and inspection database for the 1993/94 to 1996/97 financial years. Fatigue was identified in 37 per cent of transport fatalities.[67]

1.68 Vic Roads estimates that fatigue is a factor in 25 per cent of road crashes and in almost one third of rural single vehicle crashes.[68]

66 Submission No 83, Vol 6, p. 1282 (Dept. Transport and Regional Services).

67 Submission No 93, Vol 7, p. 1555 (NOHSC).

68 VicRoads web site, vicroads.vic.gov.au/road_safe/safe_first/fatigue.htm. Downloaded on 22 September 1999.

New South Wales

1.69 Road and Traffic Authority of NSW crash statistics show that for the years 1993 to 1998 fatigued heavy vehicle drivers were involved in 7.8 per cent of all casualty crashes involving heavy trucks. Fatigued drivers of articulated heavy vehicles constitute the majority (5.6%) of this total. The RTA suggest that there has been an upward trend in the number of crashes involving fatigued articulated truck drivers over the six year period.[69]

1.70 In NSW, a driver is assessed as having been fatigued if:

- the vehicles controller was described by police as being asleep or drowsy and / or;
- the vehicle performed a manoeuvre which suggested loss of concentration of the controller due to fatigue.[70]

1.71 Police make their decision about the involvement of fatigue in an accident from drivers involved, witnesses and observations at the scene of the accident. These observations usually involve the lack of avoidance actions such as braking before impact or leaving the road. Police will sometimes make inquiries to determine how long the driver had been on the road and how much rest they had taken prior to the accident.[71]

Queensland

1.72 The Queensland Department of Transport reports that 5.8 per cent of total vehicle crashes were fatigue related in the period from 1992 to 1998. Of the total number of fatal crashes in this period, 12.4 per cent were fatigue related and fatigue related crashes accounted for 9.3 per cent of all accident related hospitalisations.[72] For articulated vehicles, 12 per cent of crashes were fatigue related. As with Victoria, the figures indicate that fatigue related road casualties are higher in rural areas than urban areas.[73]

1.73 The criteria used for identifying a fatigue related road crash in the Queensland Transport data base is:

- Single vehicle crashes in 100km / h or over speed zones during typical fatigue times (2-4pm or 10pm-6am); or

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69 Submission No 105, Vol 7, p. 1705 (NSW Dept. Transport).

70 Roads and Traffic Authority of NSW, 1999. *Road Traffic Accidents in NSW-1997*, ISSN 0155-2546, p.xiv.

71 Correspondence received from Mr Paul Forward, Chief Executive, Roads and Traffic Authority of NSW, 16 March 2000.

72 Submission No 88, Vol 6, p. 1436 (Qld Government).

73 Submission No 88, Vol 6, p. 1449 (Qld Government).

- Where the reporting police officer considered that fatigue was a contributing factor in the crash.[74]

Western Australia

1.74 There is a range of figures available for Western Australia. The West Australian Department of Transport and Main Roads Western Australia estimates that one third of fatal and serious injury crashes are fatigue related. As with other States there is a higher incidence of fatigue related fatal accidents in rural areas.[75] Professor Lawrence Hartley suggests that between 1988 and 1992, around 16 per cent of single vehicle crashes were fatigue related and 16.5 per cent of road train crashes were related to fatigue. These figures are based on a study of the WA Road Injury Database, using evidence from police comments and drivers regarding tiredness and past sleep habits.[76]

1.75 A number of characteristics are used in defining a fatigue related crash:

- where it is recorded by the police, or self reported, as a fatigue related crash in the database
- where the vehicle travelled to the wrong side of a straight road and was involved in ahead on collision or a vehicle ran off a straight road or to the outside curve and the vehicle was not speeding and no other relevant factors are identified in the manoeuvre.[77]

Fatigue in maritime transport

1.76 A study initiated by the Australian Maritime Safety Authority of Australian seafarers revealed that maritime safety is compromised by fatigue, but did not indicate to what extent accidents and injuries on board ship were related to fatigue.[78] By way of comparison, a 1996 United States Coast Guard analysis of 279 incidents showed that fatigue contributed to 16 per cent of shipping accidents and 33 per cent of personal injuries.[79]

1.77 The Department of Transport and Regional Services reports that seven out of forty-six marine accidents involving groundings or collisions

74 Correspondence from Queensland Transport, received 28 February 2000.

75 Submission Nos 75, 78, Vol 5, pp. 1168, 1211.

76 Submission No 1, Vol 1, p. 4 (Assoc. Prof. Laurence Hartley).

77 Submission No 78, Vol 5, p. 1211 (Main Roads Western Australia).

78 Australian Maritime Safety Authority, 1997, *A survey of the health, stress and fatigue of Australian seafarers*, AMSA, Canberra, pp.3, 81.

79 National Transportation Safety Board. 1999, *Evaluation of U.S. Department of Transportation Efforts in the 1990s to Address Operator Fatigue*, Safety Report NTSB/SR-99/01, Washington D.C, p.8.

investigated since January 1994 had fatigue as a causal factor.[80] A number of Marine Incident Investigation Unit (MIIU) reports on marine accidents clearly identify fatigue as a causal factor.[81] Det Norske Veritas, in a report commissioned by the Australian Maritime Safety Authority on marine pilots in the Great Barrier Reef, estimates that 'the proportion of accidents attributable to pilot fatigue would lie in the range 10-25 per cent'.[82]

Fatigue in air transport

1.78 In the period from January 1993 to May 1999 the Bureau of Air Safety Investigation (BASI) database recorded 123 occurrences (0.4% of total reported occurnaces) where fatigue was cited as an "actual or potential" contributing factor.[83] Although this overall figure is small, it is significant that 7 per cent of the occurrences categorised as serious were fatigue related.[84]

1.79 BASI argues that although the number of fatigue related occurrences is small there remains cause for concern for three reasons:

- the absolute number recorded indicates the potential for a serious accident to occur;
- it is likely the BASI database underestimates the prevalence of fatigue as a contributing factor to accidents and incidents; and
- fatigue related occurrences tend to be more serious in nature.[85]

1.80 In a recent BASI study of regional aircraft maintenance personnel, 29 per cent of respondents reported that they were sometimes so tired at the end of a long shift 'that they could not perform their tasks properly."[86] There is no data available on the extent to which fatigue contributes to accidents in this area.

Fatigue in rail

1.81 There is little data available on the number of rail accidents or incidents with fatigue as a contributing factor.

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80 Submission No 83, Vol 6, p. 1286 (Dept. Transport and Regional Services).

81 Marine Incident Investigation Unit, *Incidents at Sea*, Reports 63, 82, 95, 147, Australian Transport Safety Bureau, Canberra.

82 Det Norske Veritas,1999, *Great Barrier Reef Pilotage Fatigue Risk Assessment*, AMSA, Canberra, p,.27.

83 Submission No 83, Vol 6, p. 1278 (Dept. Transport and Regional Services).

84 Submission No 83, Vol 6, p. 1280 (Dept. Transport and Regional Services).

85 Submission No 83, Vol 6, p. 1278 (Dept. Transport and Regional Services).

86 Exhibit 7, *Regional Airline Safety Study*, Bureau of Air Safety Investigation, p.35.

1.82 NSW Freightcorp suggests that the rail sector is relatively safe compared to the road sector, with rail recording one casualty per billion gross tonne kilometres (as opposed to 8 road fatalities per billion gross tonne kilometres in road transport).[87] However, the Public Transport Union argues that 'a number of inquiries into work-related accidents suggests that fatigue is an issue'.[88]

The cost of fatigue related accidents

1.83 Just as the data on fatigue related accidents is variable, so to is the information on the cost to the Australian community of fatigue related transport accidents.

1.84 Professor Dawson estimates that fatigue related accidents and injuries, lost production and indirect subsidies cost the Australian community over A$1 billion per year.[89]

1.85 The Department of Transport and Regional Services has calculated that the annual economic cost of all fatigue related road crashes is about A$850 million, and the cost of fatigue related heavy vehicle crashes is about A$100 million. This estimate is based on mid-range estimates of fatigue involvement in road accidents and 1993 data.[90]

1.86 It is reasonable, however, to assume that both Professor Dawson's and the Department's estimates are conservative.

1.87 A recent study by the Bureau of Transport Economics (BTE), based on a revised and updated methodology, estimates the cost of road transport accidents to be A$15 billion dollars.[91] These latest figures indicate that, using the Department's assumption that approximately 20 per cent of road accidents are fatigue related, the annual cost to the community of fatigue related road accidents alone could be as high as A$3 billion.

1.88 Using the same base data and the Department's estimate that 10 per cent of fatigue related road accidents involve heavy vehicles, it can be further be assumed that fatigue related heavy vehicle road accidents cost the community around A$300 million per year.

1.89 Although reliable fatigue related cost information is not available for the other transport modes, such information would add substantially to the

87 Submission No 79, Vol 5, p. 1218 (FreightCorp).

88 Submission No 63, Vol 4, p. 894 (Australian Rail, Tram and Bus Industry Union—National Office).

89 Submission No 19, Vol 2, p. 254 (Centre for Sleep Research).

90 Submission No 83, Vol 6, p. 1256 (Dept. Transport and Regional Services).

91 Bureau of Transport Economics, 2000, *Road Crash Costs in Australia:*, Report 102, Department of Transport and Regional Services, Canberra, p.xi.

$3 billion figure described above. An indication of the scale of these additional costs can be obtained by noting that the costs would represent a proportion of the following BTE accident cost estimates:

- the cost of civil aviation accidents and incidents in 1996 was $112 million;[92]
- in 1993 rail accidents cost about $69 million; and
- maritime accidents cost $316 million in 1993.[93]

Better data needed

1.90 While there is no doubt that fatigue in transport is a widespread and serious issue, there is doubt about the consistency and comparability of the information that is currently collected and reported about fatigue in the various transport sectors.

1.91 We are also concerned that information about the cost impact of fatigue related accidents is sketchy, presenting only a partial picture of the total cost impact.

1.92 There is an urgent need for definitional inconsistencies to be sorted out, for data collection approaches to be standardised and for consistency to be achieved between the different jurisdictions and different transport modes. As well as being important in their own right, these improvements would help overcome the widely perceived problem of under-reporting of fatigue related accidents.

1.93 The development of sound, broad and comparable data would assist greatly in devising strategies to manage fatigue in the transport industry effectively. This is a task for academics in the field, for industry associations and for State, Territory and Commonwealth Governments. As national consistency is the aim, we believe it would be appropriate for the Commonwealth Government to take a lead by commissioning the Australian Transport Safety Bureau to liaise with all interested parties and develop a nationally and cross-modally consistent approach to data collection and reporting.

1.94 We are aware that the Route 39 Fatigue Management Committee is currently working with the Department of Transport and Regional Services on a common methodology for defining a fatigue crash. The Route 39 Committee believes that 'a single estimation procedure is a necessary prerequisite for monitoring progress in fatigue management on

92 Bureau of Transport Economics, 1998, *Cost of Civil Aviation Accidents and Incidents*, Report 98, Dept. Transport and regional Services, Canberra, p.xi.

93 Submission No 83, Vol 6, p. 1256 (Dept. Transport and Regional Services).

Route 39'.[94] We strongly support this initiative, and consider that the Route 39 initiative should be considered to be a test bed for the adoption of a nationally consistent methodology for defining fatigue crashes.

Recommendation 1

1.95 **The Australian Transport Safety Bureau should:**

- **develop cross-modal national standards for identifying, assessing and recording fatigue related accidents and incidents; and**
- **establish a national database to provide figures on the extent, impact and associated cost of fatigue in all modes of transport on a national level.**

Fatigue and the law

1.96 As knowledge increases about the causes of fatigue and its contribution to accidents, particularly in the road transport area, the courts are taking a broader view in terms of responsibility and liability. A related trend is the introduction of more detailed regulations by State and Commonwealth authorities, particularly in road transport, related to working hours and conditions of drivers. A key aspect of this trend is the 'increasing desire of different legislatures to shift liability for breach of those regulation from individual drivers to their employers and related entities such as operators, contractors and consignors'.[95]

1.97 Although legal approaches to the issue of fatigue are still evolving it is clear that there is a move away from a sole focus on the individual operator to a more inclusive approach that considers the legal responsibility of other players such as managers, executives and company owners.

1.98 Recent cases suggest that there is an increasing willingness by the courts to recognise and apply principles contained in occupational health and safety legislation, such as 'duty of care', to fatigue related transport accidents. In a 1999 landmark Victorian case a transport company was charged with failing to provide and maintain a safe system of working environment, following an accident by one of its drivers in which fatigue

94 Information received from Brian O'Connor, Department of Transport and Regional Services, 17 May 2000.

95 Wilson.R, 1999. Duty of Care Obligations and other Liability for Employers, Consignors and Related Parties in Heavy Vehicle Transportation, paper presented to Fatigue Management in Transport and Logistics, Sydney, 13-14 December 1999.

was a contributing factor. The presiding judge concluded that the company, although it was aware of log book breaches by its drivers and the possibility of excessive hours of work, failed to establish a system which would have enabled it to properly collate and audit driving records to ensure that drivers were not driving excessive hours. The operations manager with the company was charged with failing as an employee to take care for the health and safety of other persons.[96]

Chain of Responsibility

1.99 In the past there has been a legal focus on the operator in regard to apportioning blame and penalties for accidents. While not abrogating the driver of his or her individual responsibility it is now recognised that there is a 'chain of responsibility' in the transport industry. The chain of responsibility links the operator to the manager, company or consignor and the customer and recognises that the 'regulation of fatigue in heavy vehicle operations is outside the control of individual drivers and often lies in the hands of their employers or head contractors'.[97]

1.100 The principle behind the chain of responsibility is that 'any party who has control in a transport operation can be held responsible and may be made legally liable'[98] and it is closely related to the principle of 'duty of care' found in occupational health and safety legislation.[99] In road transport, the 'chain of responsibility' principle has been given legal force by being incorporated into the *National Heavy Vehicle (Driving Hours) Regulations* and has so far been implemented in New South Wales and Queensland.[100]

1.101 We are keen to see the legal fraternity incorporate the latest information on fatigue into their considerations and take a proactive and broad approach to the issue of fatigue. Various occupational health and safety acts and the 'chain of responsibility' provisions in the new national driving hours regulations provide the means for ensuring that decision makers in the industry, not just drivers, are held to account for their actions.

1.102 Wider recognition and strict enforcement of the chain of responsibility is potentially the single most influential factor in seeking to improve the way that fatigue is managed in the transport industry.

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96 Transcript of Proceedings, Sentence, *The Queen v. Pierce Philip Gage and Don Watson Pty Ltd*, County Court, Melbourne, 11 August 1999.

97 Wilson.R, 1999. Duty of Care Obligations and other Liability for Employers, Consignors and Related Parties in Heavy Vehicle Transportation, paper presented to Fatigue Management in Transport and Logistics, Sydney, 13-14 December 1999.

98 Submission No 83, Vol 6, p. 1327 (Dept. Transport and Regional Services).

99 Transcript of evidence, 8 October 1999, Melbourne, p.473 (Mr Stuart Hicks—NRTC).

100 Transcript of evidence, 8 October 1999, Melbourne, p.478.(Mr Barry Moore—NRTC).

1.103 The chain of responsibility recognises that company managers, freight consignors, wholesalers and retailers should all be accountable for the impact of their decisions on fatigue and fatigue related accidents. Not only will the concept allow the fundamental causes of fatigue to be exposed, it will result in considerable moral and financial pressure on decision makers to improve the way that fatigue is managed.

1.104 The costs of defending chain of responsibility litigation; of paying Court awarded penalties and damages; and of meeting increased insurance premiums will compel improvements to fatigue management in a way that encouragement and education alone may not.

Summary

1.105 Despite some problems with data collection and reporting, fatigue is widely recognised as a serious problem warranting concerted action by governments, by transport industry associations, by transport companies and by individual transport workers.

1.106 The costs of badly managed fatigue can be catastrophic: for companies, for individuals and for the community.

1.107 As discussed in the next chapter, some successful measures have been introduced to manage the problem of fatigue in transport. But fatigue management performance has been patchy at best and much more remains to be done before it can be said that sound fatigue management practices are in place throughout the industry.

1.108 Our final chapter, Chapter 3, addresses the question of what more can and should be done to improve the way in which fatigue is managed in the transport industry. We discuss, in particular, the development of national standards and codes of practice to provide guidance on best practice in fatigue management, and the accreditation of operators to ensure compliance.