FATIGUE AND FITNESS FOR DUTY OF NEW ZEALAND TRUCK DRIVERS

PHASE II FINAL REPORT

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FATIGUE AND FITNESS FOR DUTY OF
NEW ZEALAND TRUCK DRIVERS:
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Executive Summary

The House of Representatives inquiry into truck crashes found that despite its importance, truck driver fatigue and fitness for duty are largely unrecognised as problems in New Zealand. The goal of the present research programme was to find out how common driver fatigue is in New Zealand and the degree to which NZ truck drivers suffer from fatigue-related effects on their driving performance. To that end, Phase I of the project was directed at development and demonstration of a roadside driver fatigue and fitness-for-duty survey.

The goal of the second phase of the project was to conduct a thorough assessment of the incidence and extent of truck driver fatigue in New Zealand by testing a sample of 600 truck drivers. This report documents the methodology and results from the Phase II data collection effort. The Phase II data were collected at a variety of North Island sites along long-haul truck routes, including truck stops and depots in Northland, Auckland, Bay of Plenty, Gisborne, Hawkes Bay, Taranaki, Wanganui, and Wellington. The Phase II effort collected data from 506 drivers. Combined with the results of the Phase I effort, at total of 606 drivers completed the fatigue survey. Drivers taking the test a second time and occasional drivers (e.g., farmers moving stock) were removed from the data set prior to analysis, leaving a total sample of 596 truck drivers.

Drivers were sampled across the full range of their duty shift, ranging from 0 to 19 hours driven just prior to testing. The results of the activity inventory showed that a considerable number of New Zealand drivers are operating in excess of the hours of service regulations. One-third of the drivers reported driving more than the maximum of 11 hours out of 24. Some segments of the transport industry were worse than others in this regard. Fully 50% of the logging, stock, and line haul drivers drove beyond the hours of service maximum. Logging, refrigerated, and line haul drivers all reported below average amounts of sleep.

The three fatigue measures in our survey indicated that there are significant levels of fatigue in the New Zealand transport industry. One out of four of the drivers' self-ratings of

fatigue were in the “tired” range, even though many of them were surveyed at the beginning of their shift. Length of previous shift, hours of sleep in the past 24 hours, the hours of driving prior to the survey, and whether it was a night shift, were all significantly correlated with the fatigue self-ratings. The psychomotor test also indicated a very high level of fatigue in the sample. Overall, 24% of the sample failed one or more of the psychomotor performance criteria. In a pattern similar to that observed for the driving hours and sleep data, the logging, stock, and refrigerated freight categories had higher than average failure rates. Further, the psychomotor failure rates parallel CVIU crash rates for the freight categories where these data are available (logging and line haul). Amount of rest and sleep, shift length, and number of driving days per week were all significantly related to psychomotor performance. Six performance measures were found to be robust predictors of driver alertness and showed good correspondence with measures reported elsewhere in the research literature.

The results of the daytime sleepiness inventory showed that the drivers in our sample had somewhat higher levels of daytime sleepiness than do heavy goods vehicle operators in the UK. There was also significant correspondence between the self-rating, psychomotor performance, and daytime sleepiness fatigue measures. Finally, as with results from Western Australia, the drivers in our sample typically felt that fatigue was more of a problem for other drivers than for themselves (although the majority of drivers did indicate that fatigue was “always” dangerous on the road).

The results portray a consistent (albeit disquieting) picture of the incidence and degree of fatigue to be found in the New Zealand Transport industry. It is clear that our current hours of service regulations are not effective in managing the levels of fatigue in the industry (and indeed are not particularly successful in terms of driver compliance either). There do appear to be some segments of the industry where fatigue education and awareness campaigns could be used to good effect, if the findings for the fuel drivers can be taken as an indication (good self-awareness of fatigue, good compliance with hours of service, and excellent performance test results). It is hoped that collection of direct roadside measures of driver performance will enable, for the first time, a better understanding of the extent of the driver fatigue problem in New Zealand.

Acknowledgements

We are particularly grateful for the time and support provided by the drivers that participated in the survey and the support provided by the many managers and organizations that allowed us to use their premises. They all provided their time freely and willingly, very much in the spirit of improving road safety. We were impressed by the level of interest in fatigue that exists within the industry.

We are indebted to the efforts of our data collectors: Rob Emmitt, Ursula Kuhn, Alan Hall, Gary Bastin, Alister McKay and Mark Sullman and would like to thank the Road Safety Trust for making this project possible.

Background

The adverse effect of fatigue on human performance is a well-known experience to most of us. We encounter it to some degree in the course of our everyday lives. Brown (1994) has offered the following definition of driver fatigue: *"...the subjective experience of fatigue involves conflict between the desire to rest and the inclination (or perceived commercial pressure) to continue driving to their planned destination...The main effect of fatigue is a progressive withdrawal of attention from road and traffic demands...the withdrawal of attention will be involuntary and difficult, if not impossible to resist...Individuals so affected have been described as 'driving without attention' (DWA) because they are apparently oblivious to impending collisions*..(pp. 311-312)." The present study adopts the above use of the term driver fatigue, treating the phenomenon as a generalized subjective state resulting from a combination of task demands, environmental factors, arrangement of duty and rest cycles, and factors such as drivers' consumption of alcohol and medications. Of particular importance to the present study are the performance decrements in driving that arise from the psychological state of fatigue.

While it is difficult to quantify the contribution of driver fatigue to crash rates, a number of overseas studies have produced estimates. Vic Roads, the state roading authority in Victoria Australia, has estimated that it is a factor in approximately 25% of all truck-related crashes. Further, it is believed that truck and car drivers are equally responsible for fatigue-related crashes (Vic Roads, 1995). In the United States, it is estimated that each year sleep-related crashes in transportation claim over 15,000 lives and cost more than 12 billion dollars a year in lost productivity and property damage (Caldwell, 2000; Rau, 1996). Other estimates place the incidence of fatigue in commercial driver crashes somewhere between 1% and 56% depending on whether the estimates are from safety researchers, transport regulatory agencies, or coroner's findings (Mitler, Miller, Lipsitz, Walsh & Wylie, 1997). Estimates of the incidence of fatigue-related motor crashes vary widely, primarily because fatigue leaves no direct physical evidence at the scene of a crash and thus must be inferred from the circumstances of the crash and potentially unreliable reports from individuals involved (Summala & Mikkola, 1994). Nonetheless, it is generally acknowledged that fatigue is significantly under-reported in official crash statistics, and is a high-priority safety issue for the transport industry (Moore & Brooks, 2000).

In New Zealand, The 1996 House of Representatives Report of the Transport Committee on the Inquiry into Truck Crashes found that: "*fatigue is likely to be a significant contributing factor in all types of crashes, not just truck crashes. Despite its importance, however, it is largely unrecognised as a problem in New Zealand.*" Similarly, the LTSA statistical statement for motor accidents states that "Driver tired or fell asleep" was a factor in 8.9% of fatal accidents and 3.8% of injury accidents (LTSA, 1995). LTSA Safety Directions 1995/96 states that: *"driver fatigue is an area which has received little attention in New Zealand. The usual methods of investigating crashes probably underestimates the contribution of sleep and fatigue".*

At present the only measure in place in New Zealand with which to assess the incidence and extent of fatigue in NZ drivers is the examination of the driving hours in truck drivers' logbooks. Inasmuch as logbooks are used as the means of compliance checking for hours of service restrictions, and the fact that the recent Truck Crash Inquiry report recognised that the system is widely abused, there is a need to find alternative methods of determining the extent of the driver fatigue problem in New Zealand. Faced with the knowledge that fatigue is a serious problem for the New Zealand transportation system, and the lack of any reliable data on its incidence or impact, the present research programme attempted to identify a reliable means of measuring driver fatigue and then apply it in a large-scale sample of the transport industry.

As alluded to above, direct measures of fatigue simply aren't possible. Thus, researchers have searched for measurable correlates and performance indicators of fatigue, with varying degrees of success. Psychophysiological methods such as EEG recordings, eyelid position and activity (Brookhuis, 1995, 2000; Stern, Boyer, & Schroeder, 1994) have shown promise but are intrusive, difficult to measure outside the laboratory, and suffer from relatively large individual differences. Another approach proposed by some researchers has been to measure accident precursors logically associated with fatigue (Brown, 1994; De Waard & Brookhuis, 1991). Measurement of "eyes-off the road" time and lane-keeping ability possess good logical correspondence to increased crash risk but the lack of an agreed-upon benchmark definition of impairment and practical difficulties in data collection have kept these measures at the level of discussion and demonstration.

Fatigue has well-documented adverse effects on multiple aspects of cognitive and psychomotor performance. As a result, part-task performance tests of cognitive and behavioural impairment associated with fatigue have been among the most successful measures of fatigue to date. These psychomotor tests have included a wide variety of measures including digit-span, memory, vigilance, divided attention, and eye-hand tracking tasks. Of these tests, the vigilance, divided attention, and tracking tasks have enjoyed the greatest acceptance by researchers and industry professionals. At least part of the reason for this acceptance is their clear relationship to the elements of driving. Tracking task performance closely parallels vehicle steering and lane-keeping abilities, while divided attention and vigilance tests correspond to the attentional demands of traffic and road conditions. In a series of studies of driver performance in driving simulators (Stein, Paraseghian, Allen, & Miller, 1992; Stein, 1995), fatigue effects were found to be manifested in reliably measurable changes in drivers' ability to maintain their vehicle in the proper lane, maintain appropriate speed, and their ability to divide their attention. Although the use of part-task performance tests has generally necessitated laboratory measurement, the increasing power and portability of small computers has seen increasing field use of these tests (Charlton & Ashton, 1997).

Finally, various subjective measures of fatigue and sleepiness have been developed. These have ranged from formalised expert observation (by trained driving instructors or traffic safety officers) to self-rating scales and activity inventories completed by drivers. The success of these measures has been mixed. While expert observations of driving behaviour, or of fatigue correlates such as facial symptoms, have issues of inter-observer reliability, they do appear to possess good sensitivity if the criteria for impaired driving can be appropriately defined (Brookhuis, 2000). The implementation of expert observations as a measure, however, is fairly intrusive and typically the knowledge that they are being observed has the effect of arousing drivers and masking their fatigue. Self-report inventories of sleep and fatigue have also met with mixed success. Some researchers have argued that drivers are not good assessors of their own momentary levels of fatigue (Bartlett, 1943 cited in Holding, 1983, Brown, 1994) with individuals tending to overestimate their levels of alertness (Rosekind et al., 1994). Recently, however, a number of researchers have found good correspondence between subjective sleepiness and driving impairment (Baulk, Axelsson, Reynor, & Horne, 1998; Maycock, 1995, 1997; Neville, Bisson, French, Boll, & Storm, 1994). In a recent study of subjective sleepiness it was observed that "major incidents" on a driving simulator (all four wheels out of the land) were preceded by self-awareness of increasing sleepiness as early as 40 minutes prior to the incidents (Horne & Reyner, 2000).

The goal of the present research programme was to find out how common driver fatigue is in New Zealand and the degree to which NZ truck drivers suffer from fatigue-related effects on their driving performance. To that end, the Phase I study was directed at development and demonstration of a roadside driver fatigue and fitness-for-duty survey. Because our traditional method of monitoring and regulating driver fatigue through inspection of driving hours in drivers' log books is, at best, an indirect and somewhat unreliable indicator of driver fatigue, our survey included a variety of fatigue measures: a self-rating of momentary fatigue, a daytime sleepiness survey, and a psychomotor performance test on a driving simulator. The survey also contained a 48-hour activity inventory and several questions about their job and attitudes about fatigue. During Phase I, the roadside survey was trialed on 100 truck drivers in the Waikato District at truck depots, rest stops, and cargo terminals throughout the day and night.

The testing methodology demonstrated in Phase I was successful in terms of the logistics of administering the survey and performance test; the system worked well and was well-received by the transport companies and drivers involved. The findings from the survey data replicated findings reported elsewhere for truck driver fatigue, as well as documenting some attitudes towards fatigue and work activities unique to New Zealand drivers. The data from the activity survey indicated that drivers in our sample were not inhibited from providing answers about their work and rest periods that were in violation of the hours of service regulations. Taken together, the results were encouraging from the standpoint of a successful demonstration of the equipment and procedures employed.

The goal of the second phase of the study was to conduct a thorough assessment of the incidence and extent of truck driver fatigue in New Zealand by testing a sample of 600 truck drivers[1]. This report documents the methodology and results from the Phase II data collection effort. It is hoped that collection of direct roadside measures of driver performance

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[1] This sample size was based on a calculation of power and confidence intervals using performance data from the Phase I data and the data collected as part of the original TOPS validation effort.

will enable, for the first time, a better understanding of the extent of the driver fatigue problem in New Zealand.

The Phase II data were collected at a variety of North Island sites along long-haul truck routes, including truck stops and depots in Northland, Auckland, Bay of Plenty, Gisborne, Hawkes Bay, Taranaki, Wanganui, and Wellington. The methodology employed in Phase II was essentially the same as that used in Phase I. Some of the fatigue questionnaire items were modified slightly to improve the ease of administration and the performance testing software was upgraded. The Phase II effort collected data from 506 drivers, combined with the results of the Phase I effort, a total of 606 drivers completed the fatigue survey. Drivers taking the test a second time and occasional drivers (e.g., farmers moving stock) were removed from the data set prior to analysis, leaving a total sample of truck 596 drivers.

Survey Methodology

The goals of the fatigue and fitness-for-duty survey were to: 1) identify key demographic and work/rest patterns, 2) collect information on drivers' attitudes towards fatigue and propensity towards daytime sleepiness for comparison with other studies of driver fatigue, 3) to obtain self-assessments on drivers' momentary levels of fatigue, and 4) to collect performance data on fatigue-related driving impairment. Phase I of the study was directed at developing the written questionnaire used in the survey, adapting the performance test, and testing the data collection methodology on a sample of 100 drivers. The details of the development work and the results from the 100 drivers sampled were documented in the Phase I report "*Fatigue and Fitness for Duty of New Zealand Truck Drivers Phase I Report: Initial Driver Sample and Concept Demonstration*" (Charlton, Baas, & Ashton, 1998). The characteristics of the survey instrument (written questionnaire and performance test) are summarised below.

Written questionnaire.

In order to minimise the disruptive effects of the testing protocol on the drivers' schedules, it was desirable to make the questionnaire short enough to complete in 10-15 minutes. The questions were selected by reviewing a variety of prior surveys related to fatigue and/or truck driving (described below). The selected questions were then compiled and the resulting draft questionnaire was reviewed by independent researchers in the field. The finished questionnaire, used during data collection in Phase II, is shown at Appendix A.

The demographic portion of the questionnaire contained approximately one dozen questions about the drivers' age, their years of professional driving experience, their type of employment, vehicle type, average workday length, and typical driving distances. The demographic questions were followed by three questions on the degree to which driver fatigue is perceived as a hazard to road safety, for purposes of comparison both to prior studies (Hartley et. al., 1996) and in order to determine any potential relationship between these attitudes and driving schedules and driver performance.

The second page of the survey contained a rating scale intended to capture driver estimates of their own levels of momentary fatigue. The rating scale was adapted from the

USAF School of Aerospace Medicine *Crew Status Survey* which has been employed in studies of operator workload and fatigue in a variety of aviation and command and control systems (Charlton, 1996). The fatigue scale was followed by an activity inventory which inventoried the drivers' time spent driving, sleep periods, timing of meals, physical exercise and freight loading duties, time spent engaged in any desk work, their rest periods, and any partying or drinking over the preceding 48 hours. This activity survey was also adapted from a USAF School of Aerospace Medicine instrument that has been developed to study the activity and rest cycles of aircrews, medical teams, field air traffic controllers, and personnel in other extended-duration duties. (Neville, Bisson, French, Boll, and Storm, 1994)

The last page of the survey contained eight questions on the degree to which the drivers were likely to feel sleepy in various situations. These questions, known collectively as the Epworth Sleepiness Scale, or ESS (Maycock, 1995, 1997), were included to provide another point of comparison with the momentary fatigue ratings and the activity inventory. The sleepiness scale, while not an indicator of a driver's momentary sleepiness or fatigue, is a good indicator of overall sleep debt and has been used in several studies linking the likelihood of daytime sleepiness with accidents by car drivers and heavy goods vehicle drivers.

Performance test.

The performance test was based on driving simulator hardware and software purchased from Systems Technologies Inc. of Hawthorne California. The hardware consisted of a Pentium™ computer equipped with a 34020 TIGA graphics board and 20 inch monitor for displaying the driving scenario; a Metrabyte M5312-4 optical encoder interface card, throttle/brake pedal controller and active steering controller; a sound board and amplified stereo speakers for presenting audio feedback and instructions to the participants; a VGA display card and 14 inch monitor for displaying control information to the experimenter; and a printer. The equipment was configured and installed in a caravan for easy transport and set-up at the data collection sites (See Figure 1).

Figure 1. Fatigue survey caravan.

The software consisted of the commercially available Truck Operator Proficiency System (TOPS) testing software. TOPS is based on a dual-axis sub-critical tracking task (maintaining speed and steering in a controlled but unstable environment, a virtual roadway affected by the appearance of random wind gusts requiring steering correction), and a tertiary or side-task requiring driver monitoring and periodic responses. In the course of its development, TOPS passed through three verification and validation stages (Stein et al., 1992): baseline testing of the device on long-haul truck drivers (to establish driver acceptance, reliability, and ease of use), development of pass/fail criteria for driver performance (based on a discriminant analysis of 40 performance measures taken from three separately sampled sets of long haul truck drivers), and field testing to correlate TOPS performance with actual driving performance and physiological measures of decreased alertness (i.e., EEG, EOG, and EMG).

The TOPS performance index algorithm was defined such that the resulting criterion would have a fatigued driver failure rate of at least 50% (correct detection of fatigued drivers) with non-fatigued failure rate of only 5% (failure by non-fatigued drivers). These criteria were selected to maintain an acceptably low rate of falsely identifying a driver as fatigued, while still detecting the 50% of drivers most adversely impaired by fatigue. Further, since the test was designed for use in selective enforcement stops (testing drivers suspected of being impaired) and not in random testing applications, the operational false positive rate is purportedly much lower than 5% (Stein, 1995). As an aside, it should be noted that different algorithms were obtained for impairment to fatigue versus impairment due to alcohol. The alcohol data showed impairment on similar variables but the magnitude of the effects were different.

Because the testing scenario so closely resembles the operational reality of driving, TOPS has enjoyed very good operator acceptance where it has been employed. As with all fitness for duty tests, when a driver testing paradigm has clear relevance to "real world" driving situations, and the safety implications associated with passing or failing the test are readily apparent, driver acceptance is readily obtained (Miller, 1976). The original TOPS driving scenarios underwent various modifications (i.e., road markings, left-side driving, display of metric rather than English speedometer units) to make them more relevant to New Zealand drivers. The resulting performance test scenario consisted of an eight-minute testing session composed of a straight road scene and 27 to 30 (depending on the driver's speed) divided attention events. As with the original TOPS studies, the divided attention events consisted of symbols presented in the side mirrors to which the driver responded by indicating for a left turn, right turn or pressing the horn button (as appropriate to the type of symbol displayed).

The test scenario was divided into 4 two-minute data collection blocks for analysis purposes. As was the case in the original TOPS studies, data from the first two-minute block was excluded from the analysis. A variety of driver performance data were collected throughout the test scenario. Of chief interest were the performance variables used to calculate a pass/fail score by the TOPS performance index algorithm. Table 1 lists the 20 measures used, the 40 variables used in the algorithm consisted of the mean value and the standard deviation for each measure across the data collection blocks.

Calculation of pass/fail scores was based on five performance index coefficients (linear combinations of the 40 performance variables) such that a driver's performance was transformed according to the five performance indices and compared to established performance criteria for each of the indices. The five indices, although composed of different weightings of the 40 performance variables, can be characterised as focussing on the following five general categories: curvature error variability, divided attention response time variability, throttle activity variability, steering activity variability, and longitudinal speed variability. A driver was required to obtain a passing score on each of the five performance indices in order to receive a passing score for the trial as a whole. The criteria used in the present study were the same as used in the original TOPS studies with the exception of the removal of a sixth performance index and criterion which was used to detect driving impairment associated with blood alcohol levels in the later TOPS validation trials.

Table 1. Performance test measures.
Number of correct divided attention responses
Number of incorrect divided attention responses
Number of divided attention responses with no response
Number of road departures (collisions)
Average time for a divided attention response (seconds)
RMS for a divided attention response
Average lane deviation (feet)
RMS lane deviation
Average steering wheel rate (degrees/sec)
RMS steering wheel rate
Average vehicle heading error (degrees)
RMS vehicle heading error
Average curvature error (1/foot)
RMS curvature error
Average throttle activity (g’s/sec)
RMS throttle activity
Average longitudinal acceleration (g’s)
RMS longitudinal acceleration
Average longitudinal speed (miles/hour)
RMS longitudinal speed

Data collection procedure.

Prior to data collection, transport companies, dispatchers, or depot managers at a data collection site of interest were contacted and the research program was described to them individually. During a typical data collection session the caravan was parked so that it was visible and accessible to drivers as they moved between their vehicles and the dispatchers’ office, break room, or dining room. Individual drivers were approached by one of the experimenters who briefly described the purpose of the study and the time required to participate. In some cases, drivers approached the experimenters after conversing with the dispatcher or other drivers. Drivers expressing a willingness to participate were then shown the informed consent form that, in writing, guaranteed confidentiality of their simulator performance and responses to the survey questions. Drivers were asked to sign a copy of the form and then verbally administered the Driver Fatigue Survey by one of the experimenters. Completion of the survey took an average of 10-15 minutes and was followed by the experimenter showing the driver to the caravan for the driving simulator performance portion of the test. At some high volume locations such as Stag Park Diner, drivers were given the performance test first, as soon as they arrived at the truck stop, and the survey was administered second, as the drivers had their meal inside the diner.

The driving performance test began by seating the drivers in front of the monitor and simulator controls and showing them how to adjust the truck seat so that they were comfortable and could easily reach the hand and foot controls. This was followed by presentation of a two-minute orientation scenario which automatically presented visual and auditory instructions on what to expect, practice in "driving" the simulated vehicle, and practice responding to the divided attention symbols. After completion of the orientation scenario the drivers were given a final opportunity to ask questions and the eight-minute performance test was conducted. At the end of the performance test each driver was informed as to whether or not they passed the test, and in the case of a failure, the nature of the failure (i.e., the component of the test not meeting the criterion) was explained to the driver in some detail. All drivers were then thanked for their participation, provided with a LTSA fact sheet on driver fatigue, and given a complementary chocolate bar. The performance-testing portion of the survey took an average of 12-15 minutes to complete per driver.

In both Phase I and Phase II of the study, drivers were sampled across the full range of a typical duty shift, ranging from 0 to 19 hours driven just prior to testing (an average of 6.03 hours). The distribution of hours of driving immediately prior to participating in the survey is shown in Figure 2.

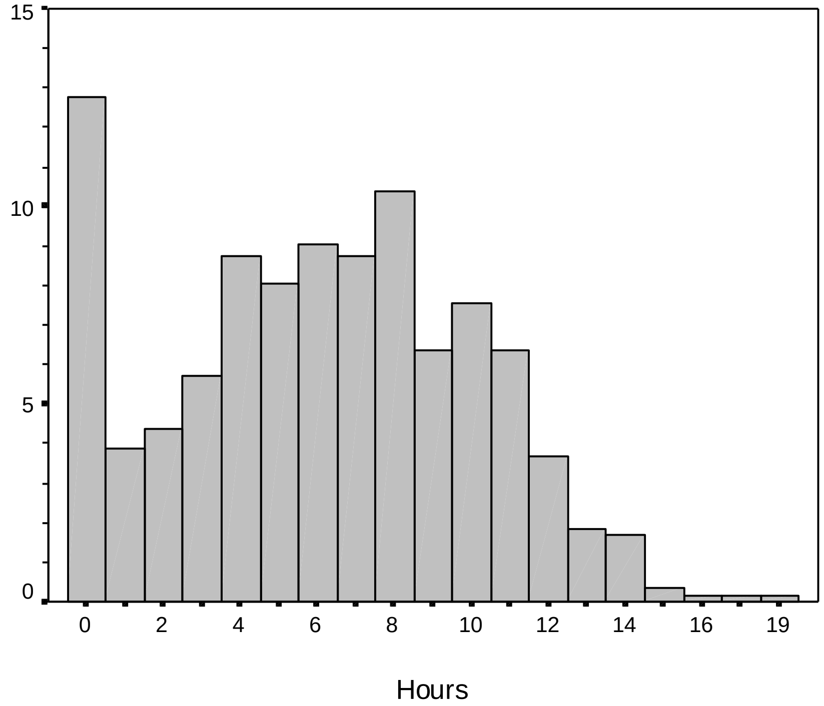

Figure 2. Hours driven prior to survey.

Results

Driver demographics.

The average age of the drivers sampled was 37.05 years (ranging from 18 to 62 years, standard deviation of 9.84). Two of the older drivers declined to give their age. Driving experience averaged 13.43 years (ranging from less than 1 year to 42 years, standard deviation of 9.38 years). All but 6 (1%) of the drivers participating in the survey were male.

As is shown in Figure 3, 74% of the drivers sampled were company employees. The next largest category, owner-drivers subcontracting to one or more transport companies, comprised 17.4% of the sample. Drivers working for owner/drivers and freelancers made up 6.4% and 1.7% of the sample respectively.

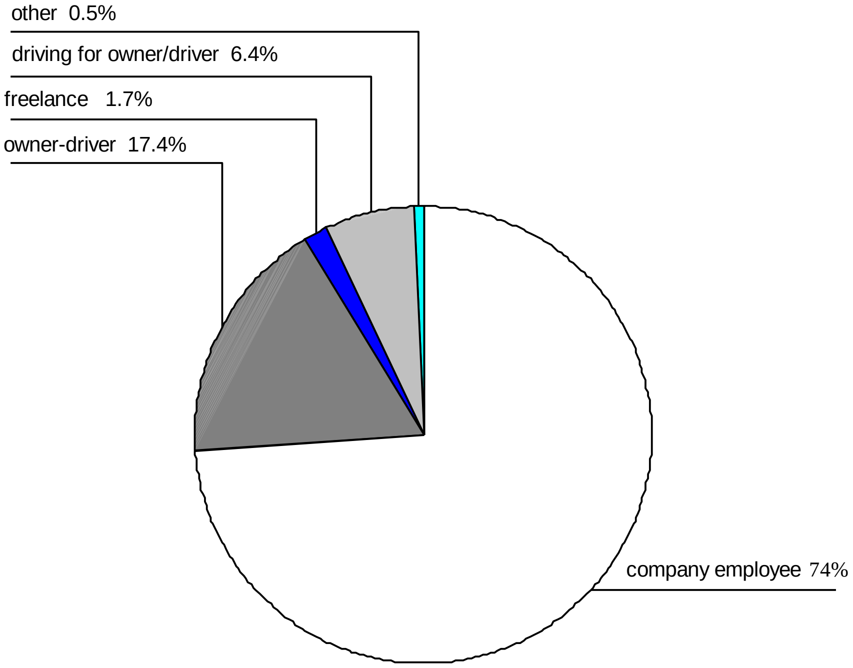

Figure 3. Drivers' employment status.

The number of drivers in each freight category was controlled in proportion to the distribution in the fleet. The number of drivers tested at each location was also controlled to reflect regional differences and the number of rigid versus articulated trucks stopped was in approximate proportion to the fleet composition. Figure 4 shows the percentage of participating drivers in each freight category. As can be seen in the figure, general goods (local and line haul routes) constituted two of the largest freight categories. Review of the individual survey forms showed that drivers indicating the "other" category were typically carrying bulk goods such as fertiliser or grain.

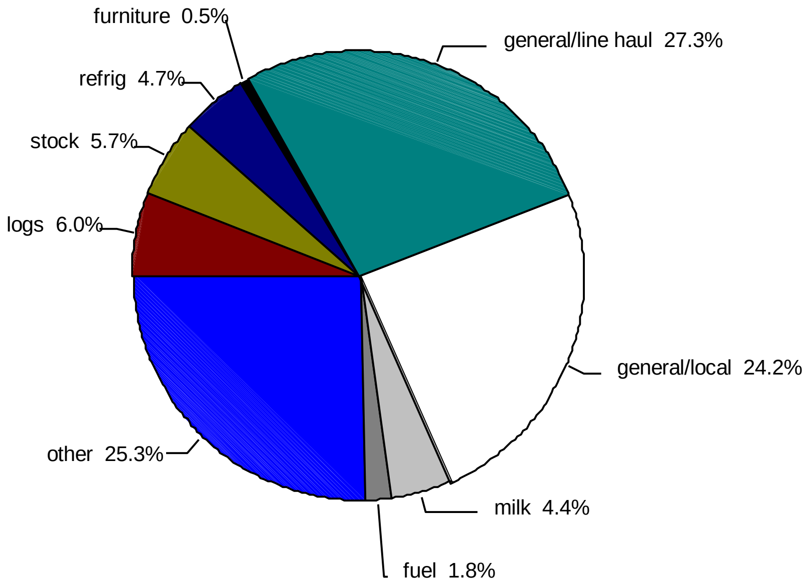

Figure 4. Freight types of participating drivers.

<u>Driver activities and hours of service</u>.

When asked their typical number of days worked per week, the participating drivers reported an average of 5.35 (ranging from .5 to 7 days, std. deviation of .62). The drivers also reported a typical shift length averaging 11.11 hours (ranging from 3 to 16 hours, std. deviation of 2.02 hours). Examining the activity data from the 48 hours prior to the survey, however, shows that the number of hours spent driving in the previous 24 hours ranged from 0 to 23 hours (an average of 8.98 hours, std. deviation of 3.99 hours). This latter statistic is shown in Figure 5, and as can be seen over 30% of the drivers sampled had exceeded their 11 hours of service maximum in the previous 24 hours. The total number of hours of driving in the previous 48 hours ranged from 0 to 45 (an average of 15.895 hours, std. deviation of 7.28 hours).

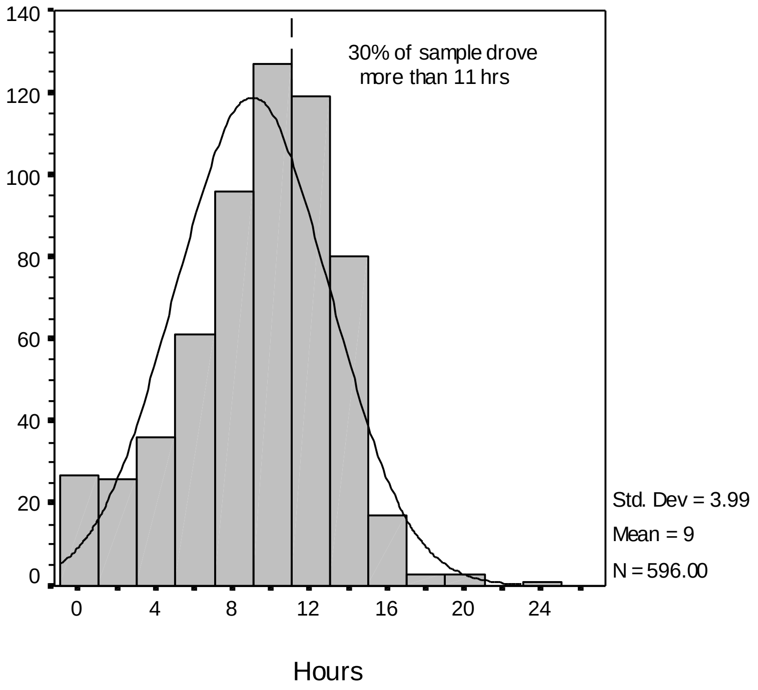

Figure 5. Hours of driving in past 24 hours.

It is worth noting, however, that the hours of driving in the past 24 hours did vary considerably across the different freight categories. Figure 6 shows the median driving hours (dark horizontal lines) the inter-quartile ranges (the shaded boxes represent the 25th to 75th percentiles) and the range of driving hours (the thin "whiskers" extending on either side of the boxes). It can be seen in this figure that 50% of the logs, stock and line haul drivers exceeded 11 hours of driving in the past 24. This was true also of the fuel drivers, but the upper limit of their range was less than 12 hours. In contrast, 25% of the logs, stock, and line-haul drivers exceeded 13 hours of driving in the past 24.

Examining the total number of hours on duty in the previous shift, the average was 10.5 hours (std. deviation of 3.44, ranging from 1 to an astonishing 37 hours), with 8% of the sample reporting shift lengths greater than 14 hours, the maximum allowed under the hours of service regulations. Here again the data show substantial variation across the freight categories as is shown in Figure 7.

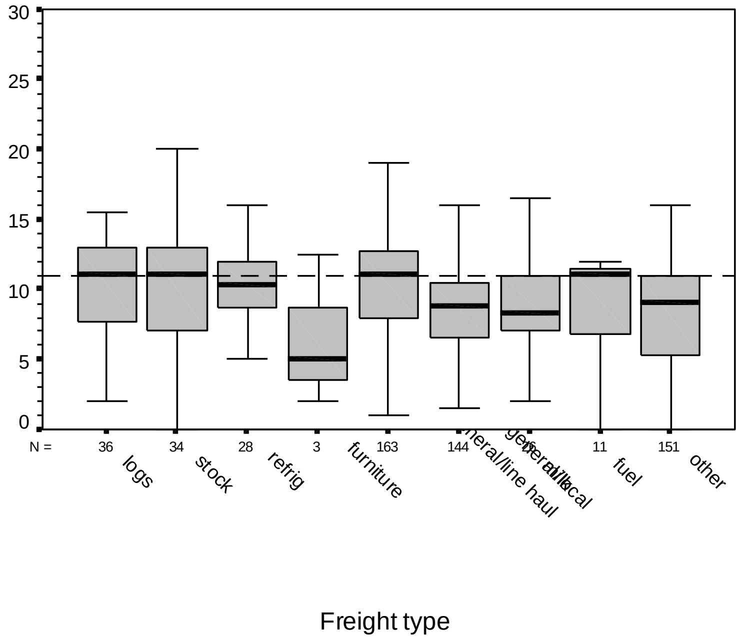

Figure 6. Hours of driving for each freight category. [2]

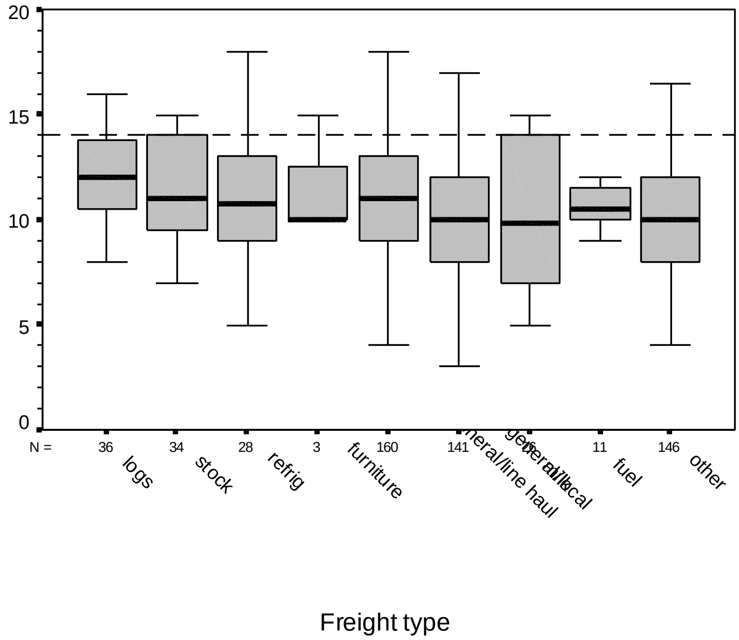

Figure 7. Length of last shift for each freight category. [2]

The average distance driven per shift reported by the drivers was 353.49 kilometers (std. deviation of 202.88 km). The distance driven varied widely across the sample with a

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[2] Outliers, data points further than twice the inter-quartile range from the median, were excluded from this figure.

reported maximum of 900 km. The reported distances for each freight category are shown in Figure 8.

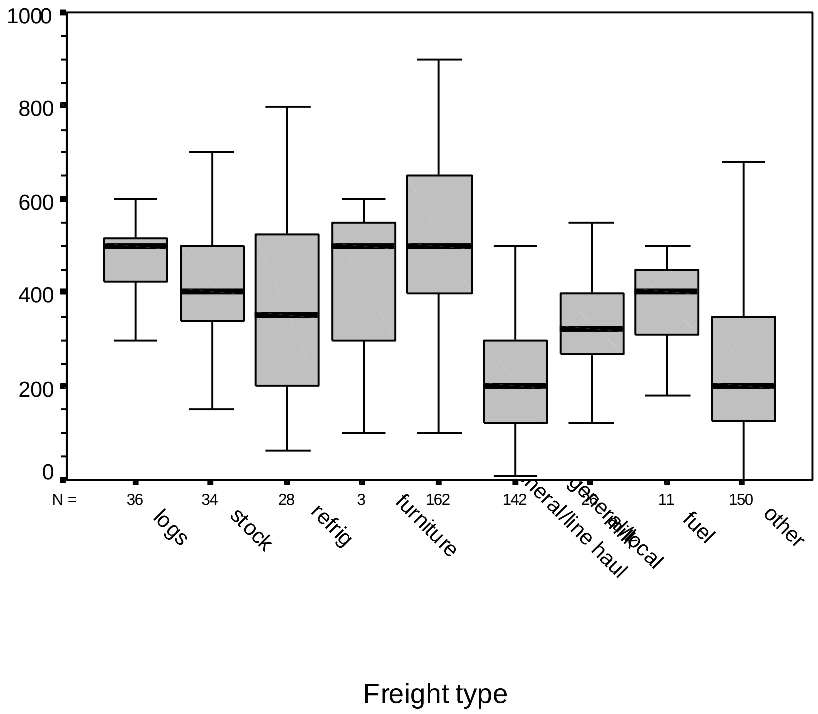

Figure 8. Average distances driven for each freight category.[3]

Moving to the off-duty activities of the drivers, the average amount of sleep reported for the past 24 hours was 7.24 hours (std. deviation of 1.72). Looking at the total length of their last sleep and rest period, the drivers reported an average of 12 hours (std. deviation of 3.62) with 11% of the sample reporting their last rest/sleep period was less than the required 9 hours. The average amounts of rest and sleep reported by the drivers did not appear unreasonable although there were drivers reporting as little of 3 hours of sleep in the past 48 hours. Figure 9 shows the reported amounts of sleep in the past 24 hours for each freight category relative to the overall average. In a complementary pattern to the hours of driving data, the logs and line haul drivers are reporting fewer hours of sleep than other drivers. Drivers of refrigerated freight are also reporting below average amounts of sleep in the past 24 hours.

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[3] Outliers, data points further than twice the inter-quartile range from the median, were excluded from this figure.

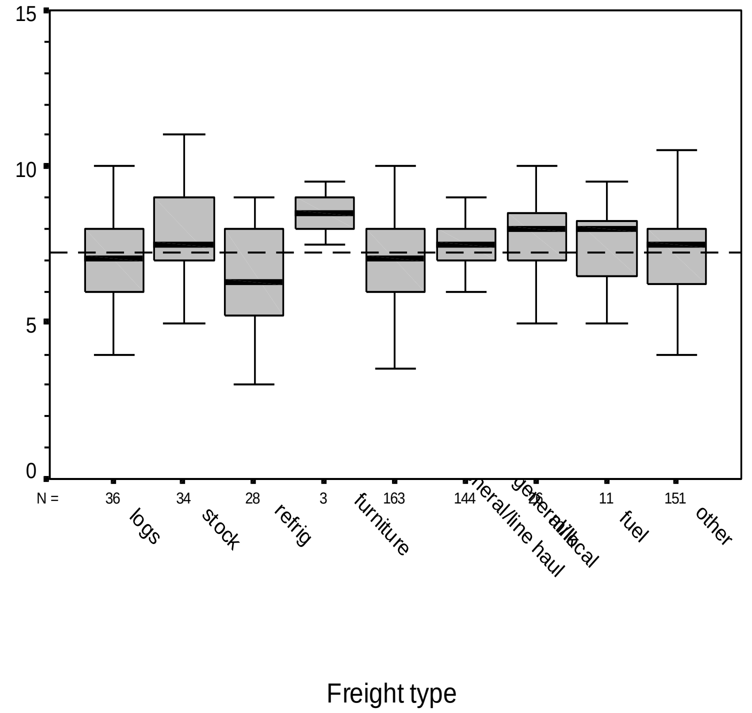

Figure 9. Amount of sleep for each freight category. [4]

The full activity data from the drivers shown in Table 2 contain several other findings of interest. Of note is the relatively low number of meals reported by the drivers (a snack counted as .5 meal). A typical pattern was for the driver to have one very large meal at the end of their shift with a few snacks in the break room or behind the wheel. Some drivers reported substantial hours spent in physical work or desk work, perhaps reflecting a pattern of duty rotation (10% of the sample reported more hours of physical work or desk work than driving over the previous 48 hours). When asked if they drove to a fixed company schedule, 45% of the drivers answered “yes.” Eighty-six percent of the drivers said, however, that they could stop and rest when they wanted to. Finally, 73.4% of the drivers said that they loaded, or helped to load the freight they were transporting that day. From these data it is clear that, for many drivers, a typical duty shift includes much more than just driving.

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[4] Outliers, data points further than twice the inter-quartile range from the median, were excluded from this figure.

Table 2. Driver activity data

	Mean	Std. Deviation	Minimum	Maximum
Hours driving in past 24hrs	8.978	3.993	.00	23.00
Hours driving in past 48hrs	15.895	7.283	.00	45.00
length of last duty shift	10.503	3.439	1.00	37.00
Hours sleeping in past 24hrs	7.241	1.723	.00	16.00
Hours sleeping in past 48hrs	14.688	2.947	3.00	27.00
length of last sleep	7.267	1.782	1.00	17.00
Length of last rest & sleep	12.009	3.619	1.00	32.00
meals in past 24hrs	1.901	0.711	.00	4.00
meals in past 48hrs	3.676	1.268	.00	8.00
Physical work/exercise past 24hrs	1.242	2.300	.00	17.00
Physical work/exercise past 48hrs	2.702	4.217	.00	23.00
desk work in past 24hrs	0.418	1.576	.00	15.00
desk work in past 48hrs	0.810	2.759	.00	27.00
relaxing in past 24hrs	3.940	2.925	.00	17.00
relaxing in past 48hrs	8.746	5.760	.00	28.00
partying in past 24hrs	0.216	0.937	.00	8.00
partying in past 48hrs	0.555	1.844	.00	17.00

Fatigue measures.

There were three principal fatigue measures included in the survey: the CSS self-report fatigue scale, the TOPS performance test, and the ESS daytime sleepiness inventory. The CSS self-ratings of levels of momentary fatigue ranged from 1 "Fully alert" to 7 "Completely exhausted." The median rating across all drivers was a 3, “Somewhat fresh.” There was no substantial difference across freight categories in the median CSS ratings (as shown in Figure 10) with the exception of the fuel drivers whose median rating “A little tired” was one full rating point above the overall median. This may be a reflection of the fatigue awareness campaign provided to drivers in this industry segment.

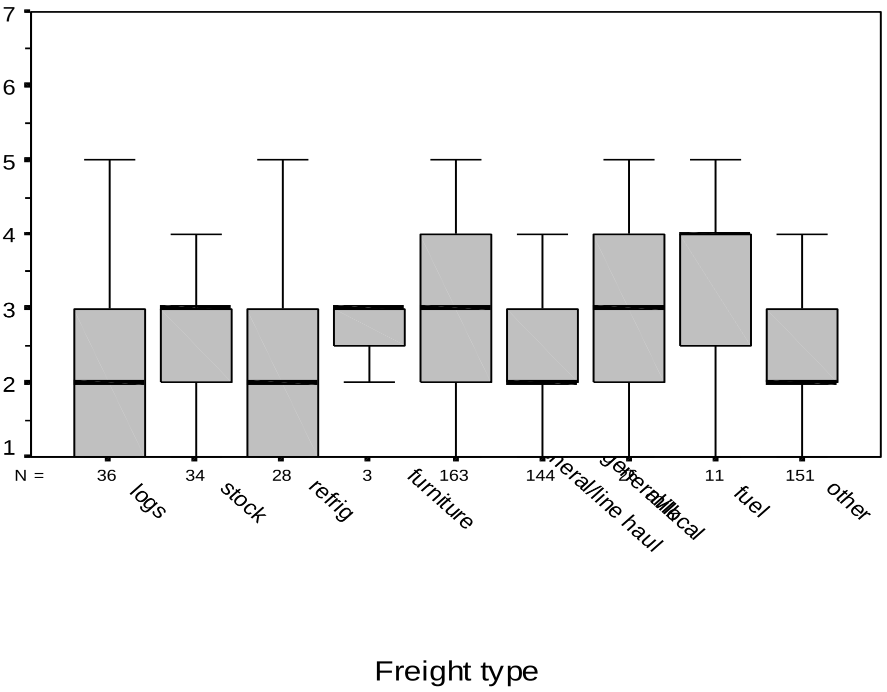

Figure 10. CSS ratings for each freight category. [5]

Drivers' ratings of how great a problem fatigue was for themselves and other drivers showed that most drivers in the sample thought that fatigue was a greater problem for other drivers than for themselves (see Figure 11). When asked if problem was dangerous for drivers, however, 63% of the sample answered "always" with 19% and 16% of the sample answering "often" or "sometimes" respectively. This is essentially the same pattern of results obtained in previous surveys of truck drivers in Western Australia (Hartley, et. al., 1996) where other drivers were seen having a problem with fatigue *always* or *often* by 35.8% of drivers, and *always* or *often* a problem for themselves by only 10% of drivers. In our sample, however, a much lower proportion of drivers rated fatigue as "never" being a problem for themselves (13.8% as opposed to 35.5% in WA). Our sample had roughly the same ratings as the Australian drivers for these ratings of other drivers (8.9% rated as "rarely" or "never" as compared to 8% in WA).

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[5] Outliers, data points further than twice the inter-quartile range from the median, were excluded from this figure.

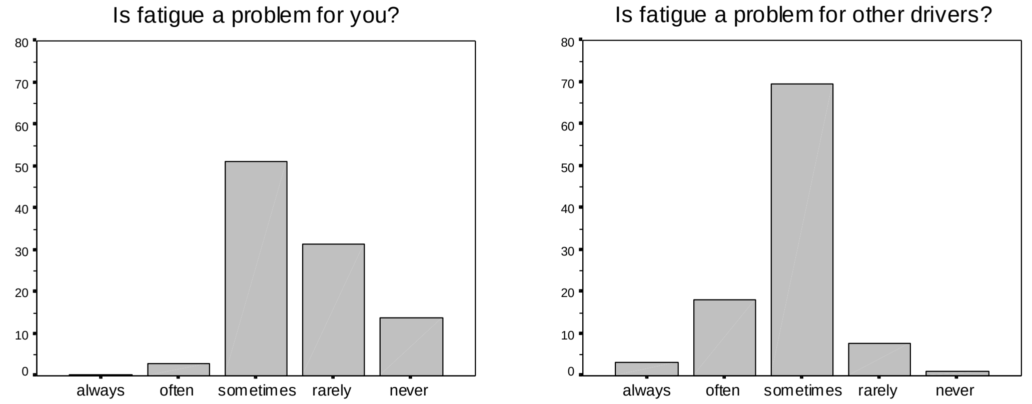

Figure 11. Ratings of fatigue as a problem for drivers

Of the 596 drivers in the sample, 450 met the performance standards associated with the TOPS performance test (a failure rate of 24%). Inspection of the data, however, revealed several areas where the failure rates were particularly high. As shown in Figure 12, some types of freight were associated with higher than average rates of failure. The figure shows that logs, stock, refrigerated, and "other" freight categories were substantially worse than average (the dashed line figure shows the overall failure rate).

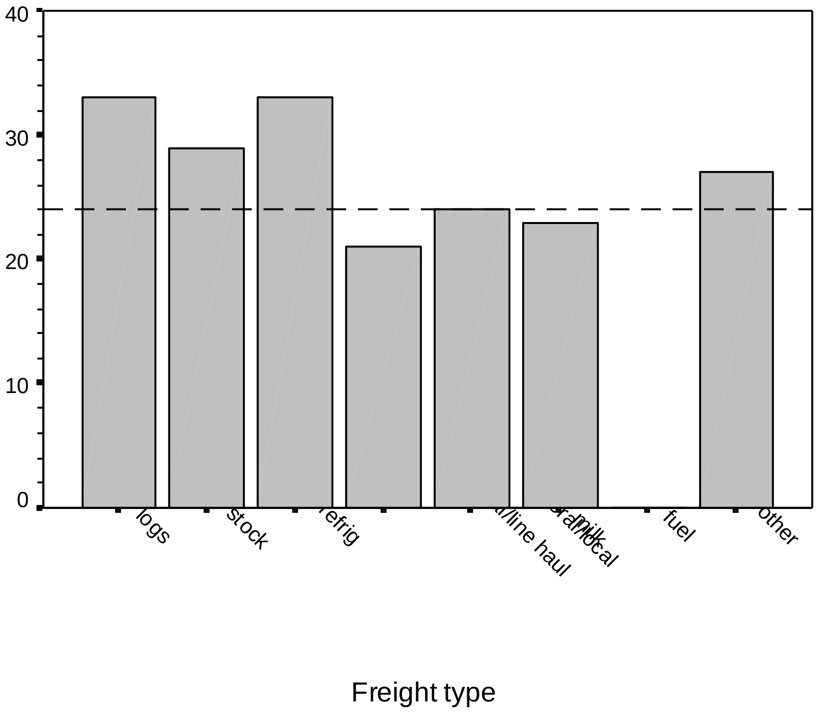

Figure 12. Pass rates for each freight category.

Comparing the failure rates observed for the freight categories to the Police CVIU data for crashes by freight type (per million km) reveals an interesting pattern. Shown in Figure 13 are the normalised crash rates and TOPS failure rates for the two freight categories where CVIU data are available. As can be seen, the TOPS failure rates mirror the crash rates for the logging and line haul segments of the transport industry.

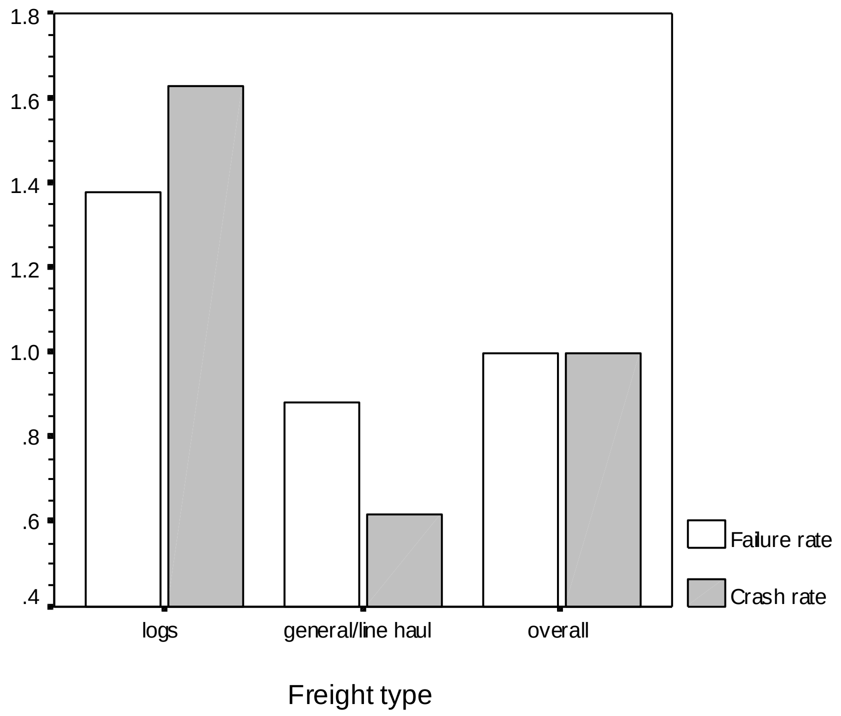

Figure 13. Normalised TOPS failure and crash rates for each freight category. [6]

Three other factors that played significant roles in the pass/fail rates associated with the TOPS performance test were the average distance driven per shift, amount of sleep, and driver age. Of drivers reporting 250 or fewer kilometres per shift, 27% failed the performance test. Similarly, drivers reporting fewer than 10 hours of sleep in the past 48 hours were more likely to fail the test (a 28% failure rate). As mentioned earlier, the average driver age was 37 years. Thirty-four percent of the drivers over the age of 37 failed the performance test as compared to only 17% of drivers aged 37 or younger. Looking at this finding from another perspective, 62% of the drivers who failed the performance test were over 37 years old. The reason for this age effect is not clear. It could be the case that older

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[6] Calculated by dividing individual failure and crash rates by overall rates.

drivers are more susceptible to fatigue than younger drivers, although the CSS fatigue levels were actually higher for the younger drivers (a median of 3 “somewhat fresh” as compared to a median of 2 for the older drivers). Alternatively, the TOPS test could have captured a difference in the driving characteristics of younger and older drivers. A stepwise discriminant analysis predicting driver age from the TOPS performance measures identified several significant predictors of driver age ($\underline{F}_{(6, 558)} = 18.43$, $\underline{p}<.001$). Drivers over the age of 37 displayed generally poorer and more variable driving performance as measured by vehicle heading error, speed, acceleration, and in the accuracy of their responses to the divided attention task. (all important components of the TOPS performance criterion algorithm).

In order to address the question of which duty and lifestyle factors were most closely associated with TOPS failure rates, a discriminant analysis was calculated using the demographic and activity data as predictors. This analysis found two significant predictors: driver age and the length of their last rest and sleep ($\underline{F}_{(2, 562)} = 20.00$, $\underline{p}<.001$). A second discriminant analysis calculated for drivers 37 years and younger produced a different set of predictors; hours on duty on the previous shift, and the amount of desk work in the past 24 hours, years of driving experience, CSS fatigue ratings, and the number of days driving per week, were significant predictors of passing or failing the performance test ($\underline{F}_{(5, 304)} = 4.14$, $\underline{p}<.001$). There were also several duty and lifestyle factors significantly associated with the drivers’ CSS self-ratings of momentary fatigue: hours on duty in the previous shift, hours of sleep in the past 24 hours, hours of driving today, and whether or not they drove a night shift were significant predictors ($\underline{F}_{(5, 572)} = 7.26$, $\underline{p}<.001$).

In order to examine the individual performance components of the TOPS test a discriminant analysis was calculated using the CSS ratings and TOPS scores as classification factors. Drivers indicating a CSS self-rating of less than 3 were classified as “alert” while drivers rating themselves as greater than 4 were classified as “tired.” Of the 327 drivers thus selected, there were 229 alert drivers passing the TOPS test, 68 alert drivers failing, 12 tired drivers failing the TOPS test and 18 tired passing. The analysis yielded significant predictors for both factors ($\underline{F}_{(18, 900)} = 13.09$, $\underline{p}<.001$ for the combined alertness/TOPS factor, $\underline{F}_{(3, 323)} = 10.92$, $\underline{p}<.001$ for alertness, and $\underline{F}_{(8, 587)} = 54.59$, $\underline{p}<.001$ for TOPS score alone[7]).

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[7] This latter statistic is not surprising given the fact that the performance components were themselves the basis of the TOPS score.

Of more interest, however, are the individual performance measures identified by the analysis. For the alertness factor, the performance variables showing the strongest effects were: the response time variability for the divided attention task, the average lane deviation, and the mean steering wheel activity (deg/sec). For the TOPS pass rate factor, the strongest effects were found for: standard deviation of vehicle heading error, standard deviation of acceleration variability, standard deviation of speed variability, standard deviation of speed, average curvature error, average throttle activity, average lane deviation variability, and steering wheel activity variability. Of the 40 variables contained in the TOPS performance indices, these eight measures represent the performance aspects of our sample of New Zealand drivers that “tripped” the TOPS pass/fail criteria. For the combined alertness/TOPS factor the best predictors were: standard deviation of vehicle heading error, collision (all four wheels out of lane) variability, standard deviation of speed variability, standard deviation of speed, response time variability for the divided attention task, and the mean steering wheel activity (deg/sec). It can be argued that, in the present study, these six performance measures were the best psychomotor indicators of driver fatigue.

Shown in Figure 14 are the performance levels for these six measures. As can be seen in the figure, the standard deviation of vehicle heading error is greater for drivers failing the TOPS test, greater for tired than alert drivers, and particularly bad for tired failing drivers. Essentially the same pattern can be seen for the variability of response times to the divided attention task. The collision variability data show that collisions (all 4 wheels outside the lane), when they occur at all, tend to be one-off events committed by alert drivers failing the test. The speed variability data is curious in that the greatest variability was observed for tired drivers passing the TOPS test and the lowest was for alert drivers failing the test. Drivers failing the test showed the reverse pattern, greater variability for alert drivers and lowest variability for tired drivers. The standard deviation of speed was much greater for drivers failing the TOPS test, with a slight tendency for alert failures to be more variable than tired failures whereas tired passers tended to show greater variability than alert passers. Finally steering wheel activity was essentially the same for all drivers except tired failures who had very low rates of steering activity.

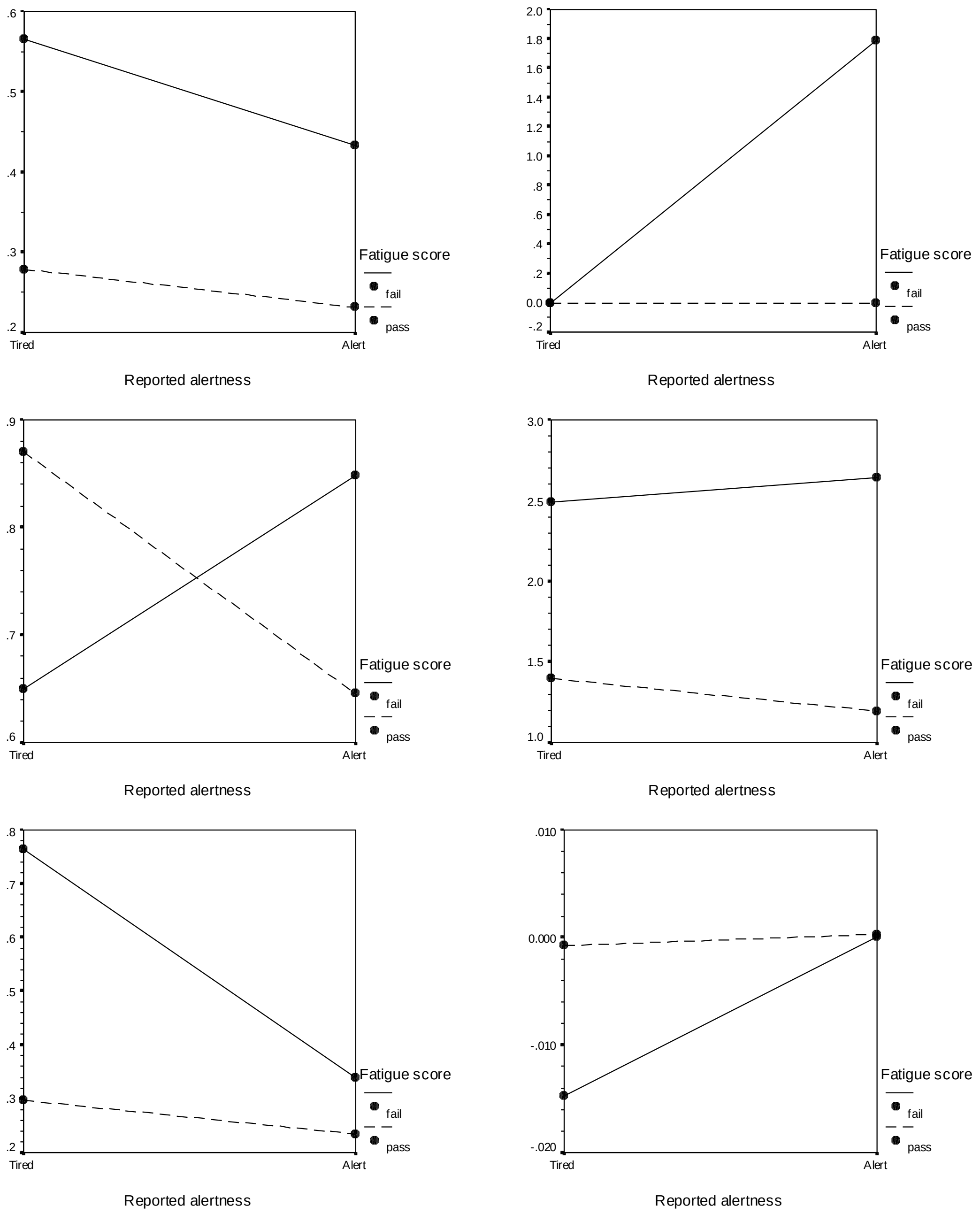

Figure 14. Performance measures predicting fatigue.

Finally, the results from the Epworth Sleepiness Scale are shown in Figure 15. The ESS ratings are essentially the same pattern as was observed in Phase I, the average score in our sample (6.13) being somewhat higher than that observed for heavy goods vehicle operators in the UK. (5.7). There were no appreciable differences across freight categories observed for the drivers in our sample. There was, however good correspondence between the ESS ratings and the CSS ratings. A multiple regression analysis predicting ESS ratings found that CSS ratings, length of last sleep, length of last rest and sleep, and the hours relaxing in the past 48 hours together significantly predicted drivers' ESS ratings ($\underline{F}_{(4,\ 527)}$ = 13.06, $\underline{p}<.001$), with CSS ratings being the strongest predictor of the four.

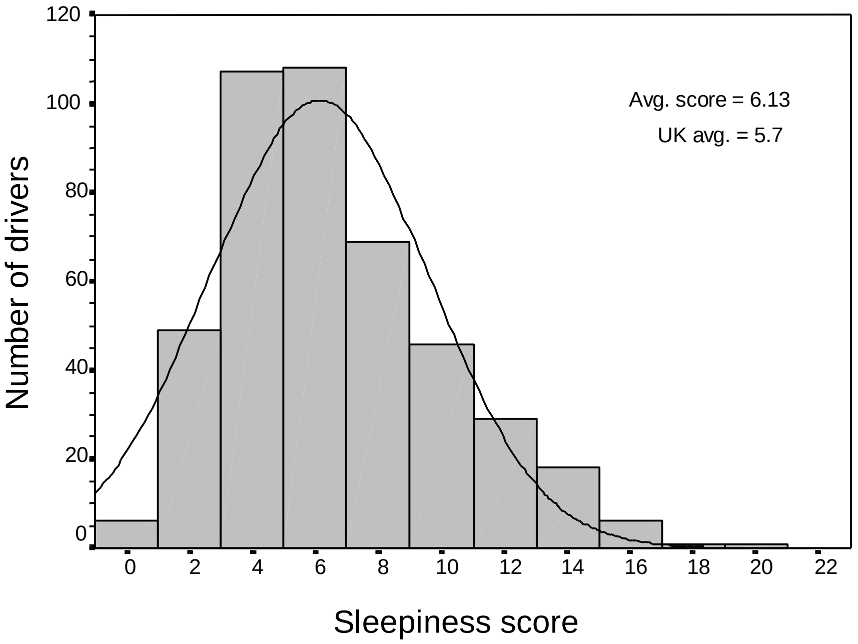

Figure 15. Epworth Sleepiness Scale scores.

Implications

As was observed at the end of Phase I, the results of the activity inventory showed that a considerable number of New Zealand drivers are operating in excess of the hours of service regulations. One-third of the drivers reported driving more than the maximum of 11 hours out of 24. Some segments of the transport industry were worse than others in this regard, fully 50% of the logging, stock, and line haul drivers drove beyond the hours of service maximum. In terms of the amount of sleep the drivers reported, the logging, refrigerated, and line haul drivers were all below the average for the sample. While the drivers' time on duty (shift length) data were not excessive with regard the hours of service regulations it is worth noting that many drivers reported a substantial number of hours of non-driving duties (physical work and desk work).

The three fatigue measures in our survey indicated that there are significant levels of fatigue in the New Zealand transport industry. One out of four of the drivers' CSS self-ratings of fatigue were in the "tired" range, even though many of them were surveyed at the beginning of their shift. Drivers were reporting fatigue across all freight categories, with the interesting finding that the fuel drivers tended to have higher ratings than others, perhaps because of the fatigue awareness campaigns conducted in that industry segment. Length of previous shift, hours of sleep in the past 24 hours, the hours of driving prior to the survey, and whether it was a night shift, were all significantly correlated with the CSS ratings.

The TOPS psychomotor test also indicated a very high level of fatigue in the sample. Overall, 24% of the sample failed one or more of the TOPS performance criteria. In a pattern similar to that observed for the driving hours and sleep data, the logging, stock, and refrigerated freight categories had higher than average failure rates. Further, the TOPS failure rates correspond to CVIU crash rates for the freight categories where these data are available (logging and line haul). Similar to the CSS ratings, amount of rest and sleep, shift length, and number of driving days per week (and in fact CSS ratings themselves) were all significantly related to TOPS performance.[8] Drivers with less than 10 hours sleep in the past 48 hours, drivers on short routes (under 250 km per day), and older drivers also had higher than average failure rates on the TOPS test. It is not clear at this stage how to interpret the age effect in the TOPS results. Drivers older than the mean age of the sample did drive significantly differently than the younger drivers, particularly in terms of their vehicle heading error, speed, and accuracy of their responses to the divided attention task. Further, the older drivers were disproportionately found in the "alert failure" category, drivers who failed the performance test but did not report feeling fatigued. It could be that these older drivers had some difficulty adapting to the testing equipment, a hypothesis supported by the fact that many "alert failures" failed as a result of a "catastrophic" incident such as driving completely off the simulated road.

Another interpretation is to consider the appropriateness of the TOPS criteria for New Zealand drivers. It can be argued that because the original TOPS test criteria were validated with drivers accustomed to straight and level highways (specifically from the western United States), that the TOPS scenarios and criteria are somehow biased against New Zealand drivers (especially those older than 37). While additional validation research would need to be performed to verify that contention, analysis of the drivers' performance on the individual psychomotor measures would seem to argue against any such bias. Six performance measures were found to be robust predictors of driver alertness and showed good correspondence with measures reported elsewhere in the research literature (Brice & Smith, 2000; Dawson & Reid, 1997; Fairclough & Graham, 1999, Williamson, Feyer, Finlay-Brown, & Friswell, 2000). In fact, classification of drivers using discriminant analyses of both activity and performance measures predicted a fatigue rate of 24.02% and a driving failure rate of 27.81%, even higher rates than observed in our sample.

Examining the comments of the drivers participating in the survey, it is apparent that the majority of those who failed knew their performance was bad even before the results of the TOPS test were made known to them. Typically, drivers would volunteer "excuses" or mitigating circumstances to explain why they performed poorly (or in some cases, anticipated their poor performance prior to taking the test). Some example comments from failing drivers included: very tired from delivering concrete tanks all day, drove all day Sunday and was not used to it, had a cold, long hours, long week, sleeping badly because of family problems, a new girlfriend, hospital visit the night before, was visiting Greenlane sleep clinic the night before and the breathing mask kept him awake, worried about his truck parked outside, company is "stuffing up" his work schedule, nervous ever since he rolled his truck

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[8] The latter three predictors were significant only for drivers 37 years and younger.

four years ago. As can be seen from the wide range of comments, failing drivers had a variety of “reasons” for their failure, but did not dispute that their fatigue test performance was poor (nor, presumably is there any reason to suspect that their performance on the road would not be similarly affected).

The results of the ESS daytime sleepiness inventory showed that the drivers in our sample had somewhat higher levels of daytime sleepiness than do heavy goods vehicle operators in the UK. There was also significant correspondence between the ESS, CSS, and TOPS fatigue measures. It is also noteworthy that for particularly “bad” segments of the industry (in terms of hours of driving, and driving performance), there was relatively poorer correlation with self-ratings of fatigue, perhaps indicating that these drivers either weren’t aware of their fatigue or were reluctant to admit it[9]. Finally, as with results from Western Australia, the drivers in our sample typically felt that fatigue was more of a problem for other drivers than for themselves (although the majority of drivers did indicate that fatigue was “always” dangerous on the road).

Taken together, these results portray a consistent (albeit disquieting) picture of the incidence and degree of fatigue to be found in the New Zealand Transport industry. It is clear that our current hours of service regulations are not effective in managing the levels of fatigue in the industry (and indeed are not particularly successful in terms of driver compliance either). There do appear to be some segments of the industry where fatigue education and awareness campaigns could be used to good effect, if the findings for the fuel drivers can be taken as an indication (good self-awareness of fatigue, good compliance with hours of service, and excellent performance test results).

There are some areas of additional research suggested by the results of our study. As was alluded to above, and indeed as has been suggested at the Road Safety Trust fatigue review at the end of Phase I, it might be profitable to establish psychomotor performance criteria using data from New Zealand drivers. This could be undertaken through further statistical analysis of the present data set and (subject to their availability) psychomotor data from other studies of driver fatigue (e.g., Brice & Smith, 2000; Dawson & Reid, 1997; Fairclough & Graham, 1999, Williamson, Feyer, Finlay-Brown, & Friswell, 2000). This

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[9] This pattern was also observed for the older drivers in the sample.

work would allow us to compare the performance of drivers in our sample with the performance deficits observed elsewhere for sleep deprivation and blood-alcohol levels[10].

Additional laboratory work (in concert with, or as an alternative to the above) could involve: 1) tracking a few individuals' psychomotor performance as they are deprived of sleep for up to 48 hours, 2) obtaining psychomotor performance data at various levels of blood alcohol, and 3) developing driving scenarios with more varied terrain and road geometry that are representative of New Zealand roads. The result of the laboratory work would enable us to derive performance criteria that are directly applicable to New Zealand drivers and driving conditions.

A third area of work was one identified by several TAC reviewers at the time of our original proposal, and consists of surveying other sorts of drivers, i.e., drivers of coaches, taxis, courier vans, and non-commercial automobiles. Over the course of this project we have become firmly convinced of the importance of this effort. It became clear to us that the truck drivers we tested were highly skilled drivers, displaying high levels of control in the very difficult unstable critical tracking task embedded in the driving simulation. In spite of their skill, these drivers were unable to escape the involuntary decline in performance that comes with fatigue. Other drivers, commercial and private, may suffer even greater adverse effects of fatigue if we reasonably assume that many of them will not possess the same skill levels as the professional truck drivers.

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[10] For example, it has been reported elsewhere that 24 hours of sustained wakefulness can produce psychomotor decrements equivalent to those found with a BAC of 0.10 percent (Dawson & Reid, 1997). Statistical analyses calibrating the present sample with these sorts of data could further validate conclusions about the extent and degree of fatigue in the NZ transport industry.

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Appendices

Appendix A -- Phase II Fatigue Survey Form

TERNZ Driver Fatigue Study
Information and Consent Form

We are conducting this study of driver fatigue in conjunction with the Road Safety Trust. What we are interested in learning is how common of a problem driver fatigue is in New Zealand and the degree to which NZ truck drivers suffer from fatigue-related effects. Our study of driver fatigue uses the term fatigue to refer to the general feeling of tiredness resulting from a combination of task demands, environmental factors, arrangement of duty and rest cycles, and factors such as consumption of alcohol and medications.

Our fatigue study uses two kinds of fatigue measures: 1) a short survey asking about the hours you have driven, the amount of sleep you have had in the past 48 hours, how sleepiness affects you, and the level of fatigue you feel at the moment, and 2) a short drive on a driving simulator to measure your vehicle control and reaction times. We are looking to measure some drivers at the beginning of their shift, some at the middle of their shift, and some at the end of their shift. **This informed consent form will, in writing, guarantee absolute confidentiality of your simulator performance and responses to the survey questions**. The survey will take approximately 2-3 minutes to fill out and the simulator test will take approximately 8-10 minutes to complete, for a total of approximately 15-20 minutes.

Researcher's Copy

I have received and read an information sheet about this research project. I have had the chance to ask any questions and discuss my participation. I understand that my individual answers and performance will be kept confidential. Any questions have been answered to my satisfaction.

I agree to participate in this research project and I understand that I may withdraw at any time.

Participant's Name: ___________________ Signature: __________________ Date: ______

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Participant's Copy

I have received and read an information sheet about this research project. I have had the chance to ask any questions and discuss my participation. I understand that my individual answers and performance will be kept confidential. Any questions have been answered to my satisfaction.

I agree to participate in this research project and I understand that I may withdraw at any time.

Participant's Name: ___________________ Signature: __________________ Date: ______

Date _________
Time _________
Location _________

Driver Questionnaire

Age ______ Height _________ Weight __________ M/F

How long have you been driving a truck for a living? _______ years

Are you:
_______ a company employee driver
_______ an owner driver subcontracting to a transport co
_______ a free lance owner driver
_______ a driver working for an owner driver
_______ other (specify) _____________________________________

Where are you travelling today?
from __________________ to _________________
from __________________ to _________________
from __________________ to _________________

What type of freight are you carrying?

Logs	Stock	Refrig haulage	Furniture	General goods line haul	General goods local	Milk	Fuel	Other:

What are the RUC vehicle types for your rig OR how many axles does your rig have?

____

Are you driving to a fixed company schedule? *yes/no*

Can you stop and rest when you want? *yes/no*

Did you load the freight you are carrying or help load it? *yes/no*

What is your average workday length? _________ hours

What is your average number of days per week? _________

What is the average distance you drive during each day? ___________

Is tiredness or fatigue a problem for you when you drive?

(*circle the appropriate word)* always often sometimes rarely never

Do you think tiredness or fatigue is a problem for other drivers?

(*circle the appropriate word)* always often sometimes rarely never

Do you think tiredness or fatigue is dangerous on the road?

(*circle the appropriate word)* always often sometimes rarely never

Date _________
Time _________
Location _________

Fatigue Survey

Place an X in the box that best describes how you feel right now.

	Fully alert, wide awake, extremely peppy
	Very lively, responsive, but not at peak
	Okay, somewhat fresh
	A little tired, less than fresh
	Moderately tired, let down
	Extremely tired, difficult to concentrate
	Completely exhausted, unable to function effectively, ready to drop

Activity Survey

Place a mark along the timeline below to show when each activity occurred and for how long

For example: Driving: X-------------X
Sleeping: X----------------X
Meal: H

(A line may be easier to do rather than a number of crosses, as long as it is clear.)

Time of day

	6 am	8	10	12 noon	2	4	6	8	10	12 midnight	2	4	6	8	10	12 noon	2	4	6	8	10	12 midnight	2	4	6 am
Driving																									
Sleeping																									
Meal (H for big meal L for light)																									
Physical work/exercise																									
Desk work/sedentary																									
Relaxing/TV/reading																									
Partying/drinking																									

Date __________
Time __________
Location __________

Sleepiness Survey

How likely are you to doze or fall asleep in the following situations, as opposed to just feeling tired?
*(This refers to your usual way of life in recent times. Even if you have not done some of these things recently,
try to work out how they would have affected you. Tick the box for the most appropriate answer for each situation)*

Situation	Would never doze	Slight chance of dozing	Moderate chance of dozing	High chance of dozing
Sitting and reading				
Watching TV				
Sitting inactive in a public place (theatre or meeting)				
As a passenger in a car for an hour without a break				
Lying down in the afternoon when circumstances permit				
Sitting and talking to someone				
Sitting quietly after a lunch without alcohol				
In a car while stopped for a few minutes in traffic				