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Development of a North-American Fatigue Management Program for Commercial Motor Carriers

Phase II (Pilot Study)

Development of Educational Material and Testing of Tools and Procedures to Be Used in Phase III Fatigue Management Program

Prepared for:

Transportation Development Centre

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16. Abstract

This Pilot Study was designed specifically for the motor carrier industry to evaluate a comprehensive fatigue management program (FMP) comprising customized educational modules, operational tools, and step-wise clinical sleep disorder screening and treatment. The study, carried out in an actual operational environment, involved pre- and post-FMP data collection, measuring a variety of sleep- and fatigue-related factors, both subjectively and objectively. Data was collected from commercial motor carriers in Alberta, Quebec, and Texas.

The results indicated that drivers exhibited patterns of less sleep and greater levels of fatigue than the general public. Drivers suffering from sleep apnea were identified and treated, and increased their observed sleep time by 73 percent (3.9 hours of sleep to 6.8 hours), highlighting the important role of medical diagnosis and treatment in reducing fatigue. Drivers experienced 44 percent fewer lapses in vigilance following FMP intervention.

Recommendations include having experienced and knowledgeable fatigue management trainers deliver the educational modules; modifying the order in which the modules are delivered; and emphasizing communications between the research team and the participating motor carriers to ensure the success of the FMP.

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16. Résumé

La présente étude pilote, conçue expressément pour le secteur du transport routier, visait à évaluer un programme complet de gestion de la fatigue (PGF), constitué de modules de formation personnalisés pour des publics cibles, d'outils opérationnels et d'un processus de dépistage et de traitement des troubles du sommeil. L'étude a été menée en service réel. Elle a comporté la collecte de données avant et après le PGF, et la mesure d'un éventail de facteurs reliés au sommeil et à la fatigue, de manière subjective et objective. Des transporteurs routiers de l'Alberta, du Québec et du Texas ont participé à l'étude.

Les résultats ont indiqué que les conducteurs avaient tendance à moins dormir et à être plus fatigués que la population générale. Les conducteurs chez qui une apnée du sommeil a été dépistée ont reçu un traitement, après quoi leur temps de sommeil observé a augmenté de 73 % (passant de 3,9 heures à 6,8 heures), ce qui fait ressortir l'importance des diagnostics et traitements médicaux pour réduire la fatigue. Les conducteurs ont connu 44 % moins de baisses de vigilance après l'intervention du PGF.

Finalement, il a été recommandé de recourir à des formateurs d'expérience et qualifiés en gestion de la fatigue pour dispenser les modules de formation; de modifier l'ordre dans lequel les modules sont donnés; et de mettre l'accent sur les communications entre l'équipe de recherche et les transporteurs participants pour garantir le succès du PGF.

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- Alberta Infrastructure and Transportation
- Alberta Workers’ Compensation Board

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- Association du camionnage du Québec
- Commission de la santé et de la sécurité du travail
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EXECUTIVE SUMMARY

Background

The Development of a North-American Fatigue Management Program for Commercial Motor Carriers was originally undertaken as an Alberta project focused on developing a comprehensive Fatigue Management Program (FMP) for implementation within the Alberta commercial motor carrier (CMC) industry. The project design evolved over a period of four years to become a comprehensive, multi-jurisdictional (Alberta, Quebec, and Texas) project that included educational, clinical and operational components designed to reduce commercial motor vehicle driver fatigue and increase safety. Phase I developed the concept of a comprehensive FMP for the CMC industry through consultation with the industry and a review of existing literature and educational modules; and beta tested potential field assessment tools to use during later phases of the project. Phase II, reported here, refined those components and tools, added a clinical component, and pilot-tested the FMP during implementation in three jurisdictions: Alberta, Quebec, and Texas.

To date, no organization or group has objectively tested an integrated, interventional FMP for any industry or application. The present pilot study helps to fill that void. It provides the first objective pilot study of a comprehensive FMP implementation involving all of the components recognized as necessary for a successful FMP:

- a corporate change process
- risk-based modifications to scheduling according to fatigue management guidelines
- fatigue management training
- sleep apnea screening and treatment

The approach is intended to demonstrate the value and success of providing a process for companies and their employees to share the responsibility of managing the risk of fatigue. The approach also fits well within the corporate environment, using consultation methods that guide companies and their employees through the FMP process, and providing support throughout. This allows companies to operate as usual while changes are planned and implemented in stages. The pilot study also developed and tested many tools that can be used for planning, implementing and evaluating an FMP. Furthermore, all stakeholders in the company are involved in the education, planning, implementation, and evaluation of the FMP. The next step (Phase III) is a full-scale field implementation and assessment of the refined FMP, resulting from the integration of improvements recommended by this study.

Brief Chronology of the FMP Development

A partnership between Alberta Infrastructure and Transportation and the Alberta Workers', Compensation Board with "in kind" support from the Alberta Trucking Safety Association (now called Alberta Trucking Association) led to a contract with the Canadian Sleep Institute to develop a comprehensive and integrated FMP for commercial motor carriers and drivers. The funding and support partnership was subsequently expanded to include the Transportation Development Centre of Transport Canada, the Société de l'assurance automobile du Quebec, the Commission de la santé et de la sécurité du travail, the Quebec Trucking Association and, eventually, the U.S., through the Federal Motor Carrier Safety Administration and the American Transportation Research Institute. The Phase II implementation was conducted using three

research teams located in three jurisdictions. A separate contract was signed by the Société de l'assurance automobile du Québec and the Douglas Hospital Research Centre in Montreal to cover the Quebec portion of Phase II. The Texas portion of the project was the last to be carried out and was funded by the Federal Motor Carrier Safety Administration and managed by the Transportation Development Centre of Transport Canada.

Key Issues for Phase II

The Phase II implementation was conducted in a naturalistic operational environment under the prevailing hours-of-service rules for Alberta, Quebec, and Texas. The approach minimized interference with day-to-day operations but did strive to effect positive change in the process and outcomes of these operations. However, the approach was responsive to the needs of the company and the drivers, allowing for contingencies that improved co-operation and resulted in a high level of company involvement. Effective data collection tools were developed and validated. The study required the collection of subjective and objective data from both the companies and their drivers. The study also included a process for screening, assessment, and treatment of sleep disorders as part of the toolkit to improve sleep and reduce fatigue. As far as the authors are aware, this is the first FMP to include a medical (sleep disorder) screening, assessment, and treatment component in a commercial motor vehicle (CMV) project in a naturalistic field study. The success of the component was due to the fact that once a driver was identified as having a potential risk of moderate or severe obstructive sleep apnea (OSA), the driver was admitted into a sleep centre for a sleep lab study and treatment was offered immediately following the diagnosis. Since the drivers in the study complied with treatment, doctors did not have to report their condition to authorities. Other sleep disorders were also identified if present, and the appropriate treatment or counselling provided.

Phase II Objectives

Phase II, the "Pilot Phase" of the project, was guided by seven formal objectives:

- To develop various tools and measures of individual fatigue and alertness, using both subjective (questionnaire) and objective (vigilance and actigraphy) measures to be used in a field operational setting with drivers on revenue-generating routes.
- To develop core and supplementary fatigue management (FM) educational modules.
- To tailor FM education modules to dispatchers' and managers' specific needs.
- To develop an FM education module for families (Family Forum) to help them understand and support the drivers' management of fatigue.
- To develop interventional measures, such as sleep disorder screening, assessment, and treatment, as well as guidelines for dispatchers on biocompatible scheduling.
- To develop dispatch or scheduling tools.

- To pilot test and assess the feasibility and utility of the educational material, interventional measures, and assessment methodology in an operational environment, and refine those aspects for Phase III.

Phase II Pilot Study Methodology

The process for conducting the research commenced in Alberta with recruitment of an initial sample of 73 volunteer drivers who completed a baseline questionnaire, from which 29 drivers were selected according to specific eligibility criteria to participate as field participants. In Quebec and Texas, eight drivers were ultimately recruited to participate in each jurisdiction. A pre-FMP and post-FMP approach to provide a baseline to post-intervention comparison was tested for the Alberta and Quebec jurisdictions. Round #1 (pre-FMP) data collection was conducted with the recruited drivers using various subjective instruments to measure sleepiness, fatigue, sleep duration and quality, and objective activity data (actigraphy to obtain objective sleep) and vigilance performance (Performance Vigilance Test – PVT). The same data were collected at the end of the FMP test period in Alberta and Quebec. The pre-post data collection process will be a fundamental element of the Phase III field operational test, which will determine whether the FMP interventions reduce fatigue, increase drivers' sleep duration, and improve specific driver and company performance parameters.

The educational modules were developed and piloted with a sample of drivers from three trucking companies and one bus company from Alberta. Two trucking companies from Quebec, and one trucking firm in Texas were also involved in the pilot study, using the same protocol developed by the Alberta research team. Educational materials and data collection tools were translated to French for the Quebec pilot. The educational process began with a Core Module that provided drivers with an introduction to sleep and fatigue within the context of the CMC industry. A series of three driver-focused supplementary modules was also developed to provide a more in-depth discussion of issues related to "Trip Planning", "Wellness and Lifestyle" and "Sleep and Sleep Disorders". The participants reported that the modules were useful, interesting and informative. Minor editorial changes were made as a result of their feedback, and a knowledge-based competency evaluation process was subsequently piloted in Texas. In addition to the education modules for drivers, a module focused on sleep and fatigue from the perspective of company managers and dispatchers was created as a means of providing tools that would assist them in managing drivers and driver fatigue more effectively. Finally, because families are also considered to be an integral component of the fatigue management equation, a module dealing with family-related issues in the context of driver fatigue and recovery was also developed and piloted.

Results of the Pilot Study

Data Collection Tools

A number of modifications were made to the subjective logs based on feedback from the participants in the Alberta and Quebec pilot studies. The modified tools that were subsequently used in the Texas pilot yielded higher-quality data than those in the Alberta and Quebec pilots. However, further enhancements to these tools were also proposed as a result of the Texas experience.

Sleep

Sleep information is a major component of pre-post comparisons of FMP effectiveness, and some preliminary insights into FMP effectiveness can be gained from the Phase II pilot results. The pilot study results indicated that, as expected, drivers exhibited patterns of less sleep and greater levels of fatigue than the general public. These initial indications were consistent with the findings of other researchers. A majority of the drivers reported that they required at least seven hours of sleep per night, while objective data across all three jurisdictions showed they received an average of 5.30 hours per night during on-duty and off-duty days combined. During on-duty days, drivers received an average sleep time of only 5.09 hours. Sleep time for all Alberta drivers increased following the FMP intervention in Round #2 by 20.9 percent for combined on-duty and off-duty sleep, while on-duty sleep for the Alberta drivers increased by 13.4 percent.

Fatigue

Fatigue was measured objectively through use of the PVT in which vigilance is used as a surrogate for fatigue. The reaction time data did not show clear trends for improvement, but this may be a result of the small sample size. In contrast, when considering lapses experienced at the beginning of their shift, Alberta drivers across the sample went from an average of 1 lapse in Round #1 to 0.4 in Round #2. These measures suggest a potential reduction in driver fatigue of between 38 percent and 50 percent pre- and post-FMP intervention.

FMP Educational Modules

The overall Phase II experience indicated that some changes in the FMP educational modules would be required for the purposes of field implementation. The initial plan was for a "train-the-trainer" approach. The Alberta pilot study identified inconsistencies among company trainers in terms of their subject matter knowledge and ability to transfer this knowledge to the drivers. It was concluded that further utilization of the package would necessitate standardized delivery by individuals who have greater subject matter knowledge, as well as training delivery experience. As a result, project staff delivered all of the educational modules in the Texas pilot, a strategy that demonstrated great success based on the evaluations provided by the participants (i.e., company managers, dispatchers and drivers). This formal feedback showed these modules to be highly valuable and useful, that the trainers were knowledgeable, that the training materials were effective, that the modules were of the proper duration, that the content was relevant to the participant's job, and that participants planned to use the strategies learned to reduce their fatigue. Future FMP implementations must consider more stringent requirements for trainers involved in the educational delivery.

Based on experience from the Phase II studies in Alberta and Quebec, in order to maximize the impact of the educational modules on driver behaviour, it was clear that the order of delivery required modification. As a result, the *FMP for Managers and Dispatchers* and *Family Forum* modules were delivered in close proximity to the *Core Module* for drivers during the Texas pilot. The order of the supplementary modules was also changed to have the *Trip Planning* module first, followed in succession by the *Wellness and Lifestyle* and *Sleep and Sleep Disorders* modules. It was also noted that for behaviour change associated with the FMP to become embedded in the company, the modules will require an interactive style of delivery to better utilize the drivers' own experiences as part of the learning process.

Sleep Apnea Screening and Treatment

Sleep apnea screening and treatment was an important addition to the Phase II pilot, and a total of 35 drivers completed this process. The process proved to be highly feasible and, with the support of company executives and managers, and the help of driver supervisors, the execution was smooth and efficient. The staged approach to screening, assessment, and treatment of sleep disorders, and the equipment used to implement it demonstrated that valid, reliable results can be obtained within an operational CMC work environment.

Of the 35 drivers, 25 (or 71 percent) were found to have some degree of sleep apnea, with 14 (56 percent) rated as mild, 7 (28 percent) rated as moderate, and another 4 (16 percent) rated as severe. A total of 10 drivers (29 percent) had a condition serious enough to warrant medical intervention. Where appropriate, drivers were provided with treatment either through a Continuous Positive Airway Pressure (CPAP) device (this was the case for five of the drivers) or a dental device (for the remaining five drivers). All drivers were provided additional individual counselling with respect to sleep hygiene and improved sleep management. Those drivers who received treatment for sleep apnea via CPAP showed a substantial increase (73 percent) in objectively measured sleep time following the FMP intervention, increasing from 3.9 hours per night to 6.8 hours per night.

Although the above numbers appear to be suggesting a higher prevalence of sleep apnea in our limited sample than has been reported in the much larger study by Pack et al. (2002) (60 percent in this study vs. 28 percent in the Pack et al. study, with most of the differences occurring in the detection of mild sleep apnea), it is important to note that in this study, our sample of drivers was notably older in terms of mean age than the subjects in the Pack sample. This higher prevalence may also be a reflection of selection bias on the part of individuals who suspected they might have a condition they wished to have evaluated, and therefore volunteered at the initial stage of recruitment.

Communications

Communications between the research team and the participating carriers should be of prime focus. The Alberta and Quebec pilot studies highlighted the need to strengthen ties and establish a more collaborative relationship with the participating carriers' management teams. As a result, well before the Texas pilot began, a significant amount of time and energy was invested as a means of establishing a strong partnership with the participating company. This was perhaps the most critical success factor for the Texas pilot, as local management were highly visible in their support for this project, and also assisted throughout the duration of the study to accomplish all study-related tasks in an efficient and effective manner. This highlights the value of working closely with participant companies to optimize the processes for data collection, educational delivery, and sleep apnea screening, but more importantly, to assist with changes in company practices.

The overall Phase II experience showed that it is necessary to enhance the communication among all stakeholders, including management, dispatchers, drivers, researchers, Operations Committee members (participating company staff responsible for managing and organizing FMP components, the contractors, and government scientists involved in the FMP implementation) and the Steering Committee (representatives of the FMP stakeholders, including government, drivers' organizations, and company associations). In particular, it was agreed that additional

efforts would need to be made in future phases of this research to ensure that company participants were kept informed as to the progress of the study through a series of newsletters and personal contact with the investigators. Finally, it is apparent that communication with the drivers will need to be consistent and ongoing to ensure that they retain a high level of understanding of the project and the importance of their continued full participation in the process.

Since the purpose of Phase II was to develop and refine the FMP along with its relevant content and procedures, there was no intention to use the data collected to support the efficacy of the proposed FMP. Nevertheless, the differences between the pre- and post-FMP data demonstrated that drivers experienced improvements in terms of increased sleep per night, reduced levels of objectively assessed fatigue, and effective assessment and treatment of sleep apnea. These findings provide preliminary support for the view that the proposed FMP will be effective when assessed systematically in Phase III.

In summary, the pilot phase achieved its objectives, and the available results (taking into consideration their limitations) suggest that there is significant value to be gained by proceeding to scientific and operational evaluation of the North-American Fatigue Management Program for Commercial Motor Carriers.

Conclusions and Recommendations

The pilot study generated the following main conclusions:

i. Assessment and refinement of the educational modules were achieved, and a final educational module is now available in its amended form for Phase III, although the results suggest that interactive, expert supervised sessions be provided for an enhanced training experience.

ii. The feasibility of various tools and measures to assess individual fatigue and alertness in a field operational setting with drivers on revenue-generating routes was successfully demonstrated.

iii. Testing and implementation of a step-wise sleep disorder screening, assessment, and treatment process was successfully achieved with positive results.

iv. The continuous improvement of the protocol and the FMP process through ongoing consultation and feedback during the Phase II pilot study led to many changes and enhancements from the perspective of stakeholder preference.

v. The preliminary results of the pilot study data analysis are consistent with some trends and findings previously noted in other studies related to commercial drivers, and emphasize the need for further research in areas such as:

   - systematic assessment of fatigue risk and its impact on the health and safety of drivers and the public
   - research and development for effective approaches and guidelines for biocompatible scheduling of drivers under a representative range of scenarios
   - development of tools and data collection procedures for corporate outcome parameters beyond data collection with individual drivers as a benefit of a comprehensive FMP

- research on the effectiveness of self-assessment tools for measuring fatigue and adherence to good fatigue management practices
- research and development of computer-based tools for fatigue management education, self-assessment, and FMP evaluation and assessment

Specific Preliminary Pilot Data Supporting the Need for Evaluable Fatigue Management Approaches

Although the objective of the pilot study was to develop a feasible FMP process and materials and to test evaluation tools to be used for an operational field test, the following preliminary results provide some information regarding the potential for success in Phase III:

- As expected and demonstrated in other studies, the CMV drivers in this pilot study clearly identified that they obtain significantly less sleep than what they require for optimal alertness.
- Fatigue was identified by the group as a significant occupational hazard, with family members also identifying the need for effective fatigue management as a way of addressing the issue.
- Subjective reporting of sleep time obtained was consistently overestimated by from 10 to 34 percent, depending on the jurisdiction.
- Mean sleep time actually obtained during on-duty days barely exceeded 5 hours on average.
- In spite of reports regarding utilization of recovery time to catch up with sleep, the pilot study demonstrated that sleep time during off-duty days was still less than 6 hours on average.
- Cumulative sleep debt plays a major role in increasing levels of fatigue.
- The FMP intervention may have been instrumental in reducing both subjective and objective levels of fatigue and increasing sleep duration.
- The preliminary data show that those individuals identified with sleep apnea have greatly benefited from the nature of the intervention, as determined by measures of both subjective indices of fatigue and objective changes in total sleep duration.
- When drivers treated for sleep apnea were included in the sample, the changes were substantial, with about a 50 percent drop in PVT lapses and a 48-minute increase in on-duty sleep duration.
- A screening, assessment, and treatment process was effectively implemented within company operational constraints and with no negative impact on the individual driver's livelihood and driving privileges.

Lessons Learned from the Phase II Pilot Study

Through a process of continual consultation and feedback, the research team was able to improve the protocol and the FMP process, including:

- Necessity of continuous quality improvement in educational materials
- Verification that early training on the FMP process, information, and resulting benefits increases the effectiveness of the program
- Verification that educational trainers must be well-trained and knowledgeable of both the subject area and the FMP process
- Recognition of the need for a project manager who is sensitive to the FMP process and is wholly involved in the planning, implementation, analysis, and reporting
- Recognition that strong, clear communications between the researchers and the company's management and drivers throughout the process strengthens commitment to and participation in the FMP process and research protocols
- Verification that constant consistent communications with and support for the company management and drivers improves the quality of data collected and effectiveness of the FMP process including improved participation and involvement
- Necessity of refinement and quality improvement in data collection tools
- Verification that a step-wise approach to sleep screening, assessment, and treatment increases the thoroughness of the screening and reduces the overall costs
- Verification that providing treatment to those identified with moderate to severe levels of OSA is a feasible approach that reduces the risk of legal and economic hardships for the drivers
- Verification that if drivers are well informed of the procedures and their importance, and of the benefits of the sleep disorder screening, assessment, and treatment, more complete participation results
- Verification that providing compensation to drivers for their time to attend sleep study sessions and initial screening leads to improved participation
- Recognition that the use of scheduling guidelines combined with fatigue risk management tools will strengthen a company's ability to effectively manage biocompatible schedules

Summary Recommendations

i. On the basis of the findings, Development of a North-American Fatigue Management Program for Commercial Motor Carriers should proceed to Phase III and undergo scientific evaluation to determine the efficacy of the Program and its components.

ii. The Phase III research should be conducted based on generally accepted empirical and clinical standards and procedures for data collection and analysis in a field-operational environment.

iii. To the extent possible, researchers should reinforce with participating companies that the FMP is a change management process requiring the active, visible support of company management. Moreover, companies should be made aware of the shared responsibility of the FMP and to avoid a solely operator-focused approach.

iv. To the extent possible, researchers should ensure drivers are fully informed and understand the commitment that is being made when they consent to participate in the FMP research process.

v. A staged sleep disorder screening, assessment, and treatment process should be included as an integral part of the FMP, along with the other major FMP components (education, corporate change, and FMP evaluation).

vi. Companies should be encouraged to develop policies that facilitate sleep disorder screening, assessment, and treatment, should ensure that drivers' visits to the sleep lab are accommodated, and should provide a mechanism to support necessary follow up visits.

vii. Researchers should follow a continuous communications approach focused on the drivers and all levels of company management in order to enhance ongoing project support and retention of study participants. There is a need for substantial time and effort to be expended on communication with the participating companies' managers and executives in terms of two areas:

- providing them with education relative to the FMP in an early phase of the project; and
- eliciting the ongoing and visible support of the FMP within their companies.

viii. Training in Phase III should be conducted by experienced trainers who are well versed in FMP educational content.

ix. The educational modules should have additional exercises, be more practical, and allow time to discuss issues.

x. Additional tools should be created to assess scheduling guidelines and impact of training.

xi. Additional tools should be designed to help drivers in assessing their level of fatigue.

xii. Additional tools should be developed to collect data for corporate outcome parameters beyond data collection with individual drivers as a benefit of a comprehensive FMP.

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GLOSSARY

AHI	Apnea/Hypopnea Index
AMTA	Alberta Motor Transport Association
BMI	Body Mass Index
BAC	Blood Alcohol Concentration
CMC	Commercial Motor Carrier
CMV	Commercial Motor Vehicle
CPAP	Continuous Positive Airway Pressure
EMG	Electromyogram
ESS	Epworth Sleepiness Scale
FMP	Fatigue Management Program
FRMP	Fatigue Risk Management Program
FMCSA	Federal Motor Carrier Safety Administration
ICH	International Conference on Harmonization of Technical Requirements for Registration of Pharmaceuticals for Human Use
MAP	Multivariable Apnea Prediction
NASA TLX	NASA Task Load Index
OSA	Obstructive Sleep Apnea
PSG	Polysomnogram
PVT	Psychomotor Vigilance Test
RDI	Respiratory Disturbance Index
SAQLI	Sleep Apnea Quality of Life Index
SD	Standard Deviation
SF-12	Short Form – 12 Health
SSS	Stanford Sleepiness Scale
USCG	U.S. Coast Guard

1 INTRODUCTION

Fatigue and fatigue-related impairment in human performance has been cited as a cause of major catastrophes for the past 15 to 20 years (e.g. Mitler et al., 1988; Dinges, 1995). In commercial motor carrier (CMC) operations, fatigue has been cited for some time as a major cause of accidents with 31 percent of fatal-to-driver accidents being the result of fatigue (NTSB, 1990). However, it is likely that such estimates may be the lower limit of the contribution of fatigue to fatal accidents and incidents, since fatigue is thought to be under-reported and under-recognized as a cause of accidents, incidents, and lost productivity. More recently at a Canadian conference on fatigue in all modes of transportation, fatigue was recognized as a major contributing factor to accidents and incidents (e.g. Hendersen, 1999). Such concern has led the Canadian and U.S. governments to reconsider their Hours-of-Service Regulations in recent years, with those regulations being under review and proposed revisions currently under implementation in both countries. In Australia, surveys of CMC drivers and their companies revealed that fatigue was a problem for the industry, and scheduling, loading/unloading, waiting, and working conditions were significant contributors to fatigue (Feyer et al., 2001). Similar findings were found by Crum et al. (2002) and Morrow and Crum (2004) in their U.S. surveys.

Consistent with the recognition by regulators that fatigue has a major impact on the CMC industry, in late 1999 the Canadian Sleep Institute was contracted by the Alberta Trucking Industry Safety Association, now the Alberta Motor Transport Association (AMTA) to undertake a study titled "Fatigue Management Program Recommended Practice" to develop and pilot field test an integrated fatigue management program (FMP) for commercial motor vehicle (CMV) drivers. Overall management of the study was subsequently undertaken by a Steering Committee with representatives from AMTA, Alberta Transportation, Transport Canada, and the U.S. Federal Motor Carrier Safety Administration (FMCSA).

Phase I of the project (beta testing) began in 2000 with a series of focus groups to assist in the project design. Subsequently, subjective and objective tools were identified for use in data collection, and a beta test with six drivers was undertaken. The research protocol for Phase II of the study (pilot test) was finalized in March of 2001 and field data collection began. The protocol was adapted for pilot testing in Quebec in late 2001 through agreement between the Société de l'assurance automobile du Québec and the Douglas Hospital Research Centre. Subsequently, in the spring of 2002 the original protocol was amended to provide for the implementation of sleep disorder screening and treatment as part of the overall project.

The balance of the project implementation took place between 2002 and 2004, with the Alberta portion being completed in March of 2003 and the Quebec portion completed in the spring of 2004. The U.S. portion of the study was subsequently conducted over a six-month period between July 2004 and January 2005 with the assistance of a commercial motor carrier based out of Houston, Texas.

It should be noted that the Alberta and Quebec portions of Phase II involved both a pre- and post-FMP assessment to determine the preliminary effectiveness of the FMP. The pilot study tested the procedures and tools used to do this assessment. The Texas portion of Phase II, however, did not include post-FMP data collection, since enough data had been collected during the Alberta and Quebec pilot studies to effectively modify the procedures and tools for

Phase III (Field Operational Test of the FMP). Notwithstanding this, the Texas study did provide valuable information on the feasibility of implementing a comprehensive FMP in the Texas jurisdiction, as well as the opportunity to compare these results with the other two jurisdictions.

This report presents some relevant background for the project, a brief description of the work performed during Phases I and II, the results of the Phase II pilot study, a detailed discussion of the Phase II findings and conclusions, and a summary of recommendations.

2 BACKGROUND

2.1 Project Rationale

With over 8.5 million large trucks and 820,000 buses currently operating in North America (FMCSA, 2005), the positive impact of an effective FMP on highway safety and motor carrier performance could be substantial. The goal of an active FMP is to reduce fatigue-related incidents, which should ultimately decrease the cost to drivers, companies, workers' compensation agencies, and insurance carriers. Drivers trained in the area of fatigue and alertness management could save the industry well in excess of the costs of such a program when all factors (lower premiums, fewer incidents, reduced turnover through increased driver satisfaction) are considered. Companies that recognize the risk of fatigue and take measures to manage the risk will be able to improve the scheduling of drivers through improved practices, help drivers to achieve their best performance, and reap the benefits of increased efficiencies and improved safety.

Traffic collisions in North America involving large trucks result in an average of 5,500 fatalities and 143,000 injuries per year (Transport Canada, 2001; FMCSA, 2003). Even from a regional Canadian perspective the costs of fatigue are apparent. According to Alberta traffic safety studies comparing truck drivers with drivers of other vehicles, improper actions by truck drivers (including running off the road and being left of the centre lane) led to more frequent incidents resulting in human casualties (Alberta Infrastructure, 1997). Such actions by drivers are consistent with the effects of driver fatigue.

For economic (KPMG, 1995), as well as a combination of other reasons, driver fatigue has become an important issue for the industry, regulatory agencies, insurance carriers and the public at large. Public awareness and perception in this area have been increasingly focusing on pushing for improved safety practices. With this in mind, evaluating the innovative FMP proposed here is an important step toward the development of empirically based solutions to fatigue management for the CMC industry.

2.2 Literature Review

Fatigue has long been acknowledged but only recently appreciated as a key safety issue in all transportation modes – road, rail, air, and marine (e.g. Hendersen, 1999; NASA/NTSB, 1995). Specifically, fatigue in the truck and bus sectors is now receiving increased attention from researchers, industry and regulators around the world, as demonstrated by the recent conference on Fatigue and Transportation held in Fremantle, Australia, in March 2003, and in Seattle in September 2005 (International conference on Fatigue Management in Transportation Operations www.engr.washington.edu/epp/fmto). Most of the attention is focused on the limitations of traditional regulatory methods alone to adequately address the safety impact of fatigue on commercial drivers, and on new approaches to fatigue management. Furthermore, FMPs are considered to be an important part of commercial motor carrier safety management systems according to the U.S. Department of Transportation (Knipling et al., 2003).

The issue of fatigue risk is further fuelled by the estimates in North America that as many as 30 to 40 percent of all heavy truck accidents are fatigue-related (NTSB, 1995). Additional research has identified fatigue as a contributing factor in 15 percent of all fatal and injury accidents involving large trucks (FMCSA, 2000). When these figures are considered alongside the cost of road accidents, the implications for trucking/bussing carriers, workers' compensation agencies and insurance companies are significant. In particular, the average cost per crash involving large trucks (related figures for buses in brackets) is estimated at $3.4 million for fatal crashes ($3.3 million), $217,000 for injury crashes ($131,000) and $11,000 for property damage crashes ($11,000) (FMCSA, 2001b).

As mentioned earlier, the 1990 study by the National Transportation Safety Board identified fatigue as the most frequently cited (31 percent) probable causal factor in fatal-to-the-driver heavy truck accidents. However, as the majority of accident scene investigations cannot conclusively identify fatigue as a causative factor, this figure is also believed to underestimate the true incidence of fatigue-related accidents. A number of studies (e.g. Mitler et al., 1988; Wylie et al., 1996; Williamson et al., 2001) have also identified the critical factors in predicting fatigue-related accidents as time of day, duration of the most recent sleep period, amount of sleep in the preceding 24 hours, and fragmented sleep patterns.

As well, a recent study into the role of motor carrier scheduling practices on driver fatigue identified several factors found to affect fatigue and safety (Crum et al., 2002). These factors included the extent to which drivers were able to drive at regular times (i.e. the same hours), and experience adequate rest and recovery time. The study also recommended that "carriers must strive to create work cultures, incentive systems, training opportunities, etc. that underscore the importance of minimizing driver fatigue, not only to drivers but to external customers (e.g. shippers, receivers, tour operators)." This recognition of the impact of customer demands on driver fatigue cannot be ignored. It has been shown that "a number of industry practices, such as a strong safety culture, improved dispatcher scheduling practices, and company assistance with loading and unloading, can reduce incidents and risks for drivers" (Morrow and Crum, 2004).

In 1988, the U.S. Congress directed the Department of Transportation to conduct a study to determine the relationship among hours-of-service regulations, driver fatigue, and the frequency of serious accidents involving commercial motor vehicles. As a result, the Driver Fatigue and Alertness Study was initiated in 1989 by the Federal Highway Administration in response to the Congressional directive contained in the Truck and Bus Safety Regulatory Act. This study, conducted jointly with Transport Canada, was completed in 1996 and was the largest and most comprehensive study on driver fatigue and alertness in North America (Wylie et al., 1996). It provided extensive information on the alertness, driving performance and physiological and subjective states of CMV drivers as they perform in real-life, revenue-generating routes.

The key findings from this study supported previous findings and included the following:

- CMV drivers were most affected by the influences of circadian cycles, showing greater signs of fatigue in the period between midnight and dawn than at any other time of the day, regardless of when their time-on-duty period began. This circadian influence was greater than on-duty duration, or the number of hours of driving.

- After time-of-day, the length of the last principal sleep period had the strongest relationship to variation in fatigue.
- Driving schedules that required different start times from one day to the next resulted in higher levels of fatigue than regular schedules having the same start time each day.
- Drivers overall obtained about 2 hours less time in bed, and 2.5 hours less actual sleep time than their reported ideal daily amount of sleep (7.2 hrs).
- As is the case with individuals in the public at large and other occupations, truck drivers did not readily recognize and respond to the subtle signs of fatigue onset.
- Perhaps the most compelling outcome of the research completed to date relates to the need for improvements in the regulations governing hours of service for CMV drivers. While it is logical to place limits on the number of hours a driver can work, this approach alone does not take into account current scientific knowledge. For instance, it does not consider factors such as the impact of the circadian cycle, the quantity and quality of sleep obtained, and the driver's general fitness for duty.
- Countermeasures to fatigue were recommended by the study to include adequate sleep, innovative programs for fatigue management, driver screening, fitness for duty, alertness monitoring systems, and additional research. The need for partnerships among government, industry, drivers, safety groups, the scientific community and shippers was emphasized, since such collaborations can be the only mechanism to provide effective solutions to commercial motor vehicle driver fatigue.

The findings have led the motor transportation industry to consider these factors when developing an FMP. In a concurrent development in the aviation industry, the National Aeronautics and Space Administration (NASA) recommended a comparable approach to fatigue management in which they suggested similar factors that should be addressed in an integrated approach to managing fatigue in an operational setting. That approach was based on the FMP developed in collaboration with the Federal Aviation Administration after extensive evaluation of fatigue in the aviation community (Rosekind et al., 1996). Their recommended factors include education and training, hours-of-service review, scheduling practices, fatigue countermeasures, design and technology, research and health care issues. Considerable development of comprehensive approaches to fatigue risk management in transportation operations has occurred in the past few years. Rhodes et al. (in press) developed a multimodal set of guidelines for fatigue risk management programs (FRMPs) for Canadian transportation operations. The U.S. Department of Transportation has developed a fatigue management reference guide for all modes (McCallum et al., 2003). All states and territories in Australia will be expected to develop their own code of practice for managing fatigue in motor carrier operations (Bottomley, 2003). This process is currently ongoing, some states already establishing their codes of practice (e.g. Queensland, Western Australia, Northern Territories, and New South Wales). These approaches involve regulation through hours-of-service rules combined with the implementation of FMPs to ensure that motor carriers can remain safe while also meeting their operational demands.

Based on these examples, the challenge is to incorporate fatigue-related science and knowledge into an FMP, while balancing the needs of operational demands and legislative requirements.

2.3 Factors that Influence Fatigue in Commercial Motor Carrier Operations

Fatigue is an internal psychophysiological condition that is produced by the interaction between individual and systemic responses to a wide range of factors, including circadian rhythms, sleep loss, boredom and monotony, excessive task demands, and operational requirements. Fatigue is characterized by a diminished ability to do work, diminished alertness and vigilance, decreased attention, slowed reaction time, poor response to stimuli, impaired judgment, and depression of mood and motivation in drivers' behaviour.

Recent research shows that fatigue has a direct effect on driving ability and can be compared to similar effects shown by alcohol on driving performance (Dawson & Reid, 1997; Lamond & Dawson, 1999; Arnedt et al., 2000; Williamson, Feyer, et al., 2001). These independent research teams, using subjects performing driving tasks on a driving simulator, all found very similar results. Wakefulness sustained for just over 18 hours resulted in a decrement in performance similar to that found when subjects had 0.05 percent blood alcohol concentration (BAC). If the subjects remained awake for 24 hours their performance was similar to that while having a BAC of more than 0.08, the upper allowable legal limit for driving a vehicle in Canada. If stopped with this level of BAC, the driver would be charged with impaired driving and legal action would result. Clearly, driving at the end of a long day after being awake for 24 hours would not be considered safe from a legal standpoint, if a similar law was imposed for fatigue.

Other factors can worsen when combined with the effects of fatigue. For example, the combination of alcohol mixed with fatigue causes greater decrements in driving performance than each on their own (Mascord et al., 1995). Banks et al. (2004) found that significantly lower driving performance occurred when subjects were partially sleep deprived (just 5 hours of sleep during the night prior to the testing) and had less than 0.05 percent BAC, than occurred either with only alcohol in the blood (i.e. after a full 7 to 8 hours of sleep during the night prior to the test with less than 0.05 percent BAC) or without alcohol in the blood following the restricted 5 hour sleep. Horne et al. (2003) also found that low doses (less than 0.05 percent BAC) of alcohol combined with high levels of sleepiness results in significantly higher decrements in lane drifting than found when subjects had only low levels of alcohol in their blood, or just high levels of sleepiness. Drivers must be aware that just one drink combined with the levels of sleepiness that occur when sleep is restricted to only five hours (a normal occurrence for commercial drivers) affects their driving as though they have had two or three drinks. Greater levels of sleepiness will result in even greater reductions in performance. Given the difficulties involved in managing fatigue, company rules on zero tolerance for driving with alcohol in the blood may be a prudent strategy to maintain. Similar effects can occur when fatigued drivers take some prescription or over-the-counter drugs (see NTSB, 1990 for a discussion of the impact of drugs on accident risk).

Fatigue issues in CMC operations can be conceptualized as being broken down into three interrelated areas: the driver, the environment, and operational factors. The eventual solution to managing fatigue for drivers will come from understanding and addressing the relationships among these areas. Specifically, the following factors must be taken into consideration:

Driver Factors

- circadian performance rhythm (e.g., time of day)
- sleep deprivation sleep debt
- sleep disorders
- sleep hygiene practices
- general physical health
- lifestyle factors (e.g. fitness, physical activity, use of drugs and alcohol)
- diet
- emotional state
- domestic factors

Environmental Factors

- weather
- road conditions
- seasonal variations
- engineering/ergonomics (including vibration, thermal environment, cab design, sleeper berth design, etc.)

Operational Factors

- hours-of-service regulations (currently under federal revision)
- owner/operator issues and contracting
- loading/unloading practices
- dispatching practices
- rest areas
- sleeper berth regulations
- corporate culture

While there is little that can be done about environmental factors, driver and operational factors can be better managed to reduce fatigue and promote effective alertness assurance-related practices. Key to changing such practices and modifying driver behaviour and operational conditions are appropriate educational and training modules targeted at key stakeholders in the industry (drivers, dispatchers, managers, families and shippers). The FMP program to be described developed such targeted educational opportunities. However, it is important to note that education was only one component of a comprehensive program that also included operational changes such as revisions to dispatching practices, as well as sleep disorder screening and treatment. Examples of other transportation industries that have

adopted similar integrated approaches include aviation (McCulloch et al., 2003), marine (Makeig et. al., 1993; Rhodes & Gil, 2002; Comperatore & Kwan Rivera, 2003), and the rail industry (NTC, 2004). These approaches are risk-based and involve education, policy development, schedule development, and evaluation. A similar integrated approach is being developed for mining, including the transportation of ore (Shaw et al., 2007).

2.4 Sleep Apnea as a Key Component of Fatigue Management

Section 2.3 outlines the interaction between a multitude of individual and systemic factors that are believed to contribute to the development of fatigue in CMV drivers. Among these factors, sleep disorders (and in particular sleep apnea) are increasingly recognized as relatively easily diagnosed conditions that when treated, have the potential benefit of significantly reducing fatigue for those individuals afflicted.

Sleep apnea is one of the most common sleep disorders, a condition in which breathing frequently stops (i.e. apnea), or is substantially reduced on a regular basis throughout the individual's sleep time (see National Sleep Foundation website http://www.sleepfoundation.org/site/apps/nlnet/content3.aspx?c=huIXKjM0IxF&b=4815077&content_id={7688F47E-2F41-49BB-A8DB-77B908AF2B9F}&notoc=1 for a quick reference to more detail). Each apneic episode can end with partial awakening as breathing is restored, with the ongoing repeated awakenings contributing significantly to a lack of restorative sleep. Possible symptoms include excessive daytime sleepiness, difficulties with memory and concentration, increased irritability, impaired vigilance and reaction time, and increased vulnerability to mistakes and accidents. When the condition is significant, it can also be associated with notable medical morbidity in the form of high blood pressure, cardiac arrhythmia, and the resultant potential consequences.

Various epidemiological studies have estimated that a significant percentage of the population can suffer from this condition, frequently going undiagnosed and untreated without the individual sufferer being aware that they might have a significant medical disorder. A landmark study identified the prevalence of sleep apnea to be around 24 percent of men and 9 percent of women workers between the ages of 30 and 60 years, of which 80 percent were undiagnosed and untreated (Young et al., 1997). Typical patients tended to be overweight and middle aged or older, with a large neck/collar size, and history of loud snoring. Sleep apnea has particular significance for CMV drivers in that accident rates of drivers with untreated sleep apnea are 2-3 times higher than other drivers (American Thoracic Society position paper, 1994; Suratt & Findley, 1999).

Sleep apnea is emerging as a concern in the transportation sector because of its profound disruption of sleep and its association with increased statistical risk of crash involvement (Stutts, 2000). Obesity is a prime risk factor for sleep apnea, and the incidence of obesity among CMV drivers is approximately twice of that of the general population (Roberts & York, 2000). A major FMCSA study estimated the prevalence of sleep apnea among commercial drivers, and also quantitatively assessed how sleep apnea impairs driver performance (Pack et al., 2002). The study found that mild sleep apnea occurs in 17.6 percent of those holding commercial driver licenses, moderate sleep apnea in 5.8 percent and severe sleep apnea in 4.7 percent. The study also found progressive decrements in vigilance and other performance indicators with increasing severity of the sleep apnea condition. Sleep

apnea sufferers tended to sleep less than other drivers, with the most marked deficits occurring in individuals with both severe sleep apnea and average sleep duration of less than 5 hours per day. This finding is of particular significance considering the results of the Canada/U.S. Fatigue and Alertness study that placed the average number of hours of sleep of participating drivers below 5 during workdays.

The above incidence estimates, as well as associated research findings on alertness and performance deficits, justify designating sleep apnea as a priority medical concern for CMV drivers. Currently, a nocturnal polysomnogram (PSG) is the gold standard for the diagnosis and treatment of this condition. The procedure involves an overnight stay in a sleep laboratory for one or two nights. This laboratory sleep assessment represents a significant cost, and is in scarce supply in many parts of Canada and the U.S. Ambulatory screening, which can be done in the home environment or outside the sleep laboratory, has demonstrated usefulness when sleep apnea is suspected, is less costly, but is still limited by accessibility to equipment and professional expertise.

An effective sleep apnea identification and treatment process could be of benefit to the CMC industry as a cost-effective approach to the detection of drivers at risk for the condition. Such a sleep apnea diagnosis and treatment program can be both a significant value to the transportation sector, and an essential component of an integrated FMP. On its own, it could substantially reduce the risk of fatigue-related transportation incidents for individuals that are affected.

2.5 Evaluation of FMPs

The review of the literature suggests that full-scale evaluations of FMP are lacking. A subjective assessment of a fatigue management system was conducted by the Civil Aviation Safety Authority in Australia (McCulloch et al., 2003). The results of this assessment showed that fatigue management systems must be introduced through a process of constant close consultation with all stakeholders and continual improvement and adjustment. Furthermore, it was suggested that clear and easy to understand guidelines must be provided to all stakeholders at the beginning of the consultation process. Burgess-Limerick and Bowen-Rotsaert (2002) conducted a pilot evaluation project of Queensland Transport's FMP, finding that companies reported positive results from the FMP implementation. Machin (2001; 2003) conducted a survey of motor coach drivers who were part of a pilot implementation of an fatigue management educational program. He found that the drivers reported that they did successfully apply most of the strategies learned, and that they felt the program did help them reduce fatigue. However, they also said that they did not receive adequate support from the companies to apply the strategies, and felt that this led to increased stress. The U.S. Coast Guard (USCG) found that subjective response to their Crew Endurance Program indicated that crew members obtained more sleep and suffered less sleepiness (Comperatori & Carvalhais, 2001). Moreover, the literature stated that the USCG has yet to conduct a formal evaluation of its FMP.

Several approaches to FMP have been introduced for other motor carrier operations such as those developed in Queensland Australia (see Burgess-Limerick and Bowen-Rotsaert, 2002), and Western Australia (Transport Regional Policy Section, 1998). Although evaluations of these programs show that they appear to help drivers manage fatigue, these programs are not

managed adequately and lack a strong interventional process. The present study (Phase II) uses an improved, more integrated, comprehensive process for managing fatigue and a much more effective approach to evaluating FMPs.

2.6 The Need to Develop an Integrated and Comprehensive Approach to Fatigue Management

From the background literature presented above, it is clear that for any FMP to be successful, it must comprehensively address the multiple factors that affect fatigue and provide an integrated approach to address this problem. As a consequence, this project developed educational approaches targeted to key stakeholders including drivers, managers, dispatchers and families with the goal of altering both driver and operational factors. A key component of the program was working with managers and dispatchers to ensure that to the degree possible sleep and fatigue related factors were taken into consideration in determining when and where to schedule/dispatch drivers. In order to provide assistance to dispatchers in their role, a series of biocompatible guidelines were developed to assist them in scheduling drivers. In addition, sleep disorder assessment and rehabilitation were also incorporated in order to address a fundamental medical cause of fatigue.

3 PROJECT OVERVIEW

The overall goal of this project is to develop, evaluate, and provide a strategy to implement and evaluate the empirical techniques to evaluate, to the extent possible in a pilot study, a comprehensive FMP for the CMC industry operating under different jurisdictional regulations across North America. Such an active education and fatigue management plan is intended to reduce fatigue-related incidents, and decrease the personal and economic cost to drivers, companies, workers compensation programs and insurance carriers. More appropriate management of fatigue may also have a positive impact on productivity while decreasing the impact on drivers and companies through better biocompatible scheduling and accommodation.

As has been stated earlier, the long, unpredictable hours of work that include substantial night work as well as the monotony of the task and the demographically aging driver population make the management of fatigue critical to the effective functioning of the industry. Given the potential accident and incident risk associated with fatigue in this industry, and the potential savings in terms of costs and quality of life for drivers, the urgent need for a proven, comprehensive approach to fatigue management in this population has been recognized.

3.1 Overall Project Plan

The overall project consists of four phases:

- Phase I involved the reassessment of current research, informational and educational approaches to fatigue management, in addition to the development of a new comprehensive and focused approach to fatigue management for the commercial motor carrier industry in particular.
- Phase II involved the development and assessment of educational modules for drivers, company management and dispatching staff, as well as drivers' families. In addition, Phase II saw the development, pilot testing and further assessment of potential tools to evaluate levels of individual fatigue and alertness, involving both subjective (questionnaire) and objective measures (vigilance and actigraphy) in a field operational setting with drivers on revenue generating routes. This phase of the project commenced in the summer of 2000, with the Alberta section concluding in March of 2003, the Quebec section concluding in the spring of 2004, and the Texas section concluding in January of 2005.
- Phase III will focus on an empirical evaluation of this comprehensive FMP compared to the benefit associated with current industry practice with regard to fatigue management. The evaluation of this approach is expected to result in a FMP designed to reduce fatigue in the driver population and enhance the quality of life for drivers and their families, as well as to reduce fatigue risk and increase productivity for employers.
- Phase IV of the project will involve finalization of a recommended practice guidelines manual, tools, training materials, and FMP performance indicators, policies, practices and procedures for drivers and motor carriers.

4 PHASE I: PROGRAM DEVELOPMENT AND BETA TESTING OF FIELD ASSESSMENT TOOLS

4.1 Program Development

Phase I of the project had two goals:

i. to develop the concept of a comprehensive FMP for the CMC industry through consultation with the industry and a review of existing literature and educational modules; and

ii. to beta test potential field assessment tools that might be of use in later phases of the project.

In order to design an FMP that would not only be accepted by the companies and drivers, but would also effectively address fatigue issues and concerns, it was critical to involve those who work in the industry. Initial involvement was through the use of three focus group sessions. One focus group was held with drivers, another with dispatchers/shift supervisors, and a third with management from three trucking companies and one bus company. The focus groups provided information on participants' basic understanding of fatigue and fatigue countermeasures. Information on key messages that these groups desired as part of their education and the ways they felt it would be most appropriately delivered was also collected. Finally, the focus groups provided information on which tools and measures would be acceptable in an FMP pilot study in an operational environment.

Following the focus groups, a comprehensive review of the literature and synthesis of information from various team members and industry partners was used to:

- Itemize and detail the fundamental causes of fatigue;
- Examine the consequences of fatigue and reduced alertness;
- Identify strategies to reduce fatigue at both individual and organizational levels; and
- Prepare teaching materials on fatigue management (manuals, slides, video, handouts) for driver trainers.

Based on a review of the information gathered, it was decided that the existing educational material for commercial drivers, their employers, and their families did not meet the needs of industry in a number of ways. First, the existing information was rather simplistic and lacked a comprehensive approach to the topic (in much of the educational material the focus was solely on driver lifestyle factors). Moreover, such programs offered little in the way of sleep and sleep disorder education. Finally, the programs focused on the driver alone and not on the entire group of stakeholders that influence fatigue management in the commercial motor carrier industry. An updated, more relevant set of educational materials tailored to the needs of additional target audiences (such as dispatchers) were created. These materials were designed with the following objectives in mind:

- To address the needs of the various stakeholders in the commercial motor carrier industry (i.e. drivers, dispatchers, company management, as well as drivers' families);

- To identify the various stakeholders and their respective responsibilities in terms of managing driver fatigue;
- To present a more comprehensive overview of the causes/sources of fatigue and stress; and
- To focus on sleep and sleep disorders as a major issue that can enhance the ability of the commercial motor carrier industry to reduce driver fatigue.

4.2 Beta Testing of Field Assessment Tools

The purpose of the beta test was to evaluate the instruments and equipment to be used in data collection during subsequent phases of the project. Six drivers participated in the beta testing, three were bus drivers, two were tank truck drivers and one was general freight tractor-trailer driver. Drivers completed questionnaires, were provided with an orientation to the FMP, and subsequently participated in a period of en route data collection over three consecutive days using both subjective (questionnaires) and objective (psychomotor vigilance test or PVT and Actigraph) measures.

The beta test confirmed the utility of both the questionnaires and the objective data collection technology. A review of instructions and methodology revealed some areas of concern that were subsequently modified for the Phase II Protocol. In general, it was learned that the instructions were not sufficiently detailed for field staff to collect clean and complete samples of the questionnaires and objective data. As a result, it was clear that standardized procedures were needed to ensure that consistent interpretations could be made with regard to the instructions to the drivers and any questions that might arise during the process. It was also expected that this would be an evolving standard, and that Phase II would provide additional lessons learned that would be helpful for subsequent phases of this research.

5 PHASE II: EDUCATIONAL MODULE DEVELOPMENT AND ASSESSMENT OF METHODS AND PROCEDURES

5.1 Objectives

The main goals of this phase were threefold: (i) to assess the feasibility and utility of the educational material and its delivery to audiences; (ii) to assess the methodology, measurement tools and procedures in an operational environment for use in future phases; and (iii) to refine both of these aspects for Phase III. More specifically, the formal objectives for Phase II were to:

- Develop, pilot test and assess the feasibility of various tools and measures of individual fatigue and alertness, using both subjective (questionnaire) and objective measures (vigilance and actigraphy), in a field-operational setting with drivers on revenue-generating routes.
- Develop and evaluate core and supplementary educational modules. The core educational module is intended to provide key fatigue management information to drivers, whereas the supplementary modules are designed to enhance the learning experience and provide reinforcement for key selected topics such as wellness and lifestyle, sleep hygiene and sleep disorders, as well as alertness-enhancing trip planning and scheduling practices.
- Tailor education modules to dispatchers', schedulers', and managers' specific needs.
- Develop a Family Forum education module.
- Develop interventional measures such as screening for sleep apnea, as well as guidelines for dispatchers on biocompatible scheduling.

5.2 Educational Module Development

While the basic educational material was developed in Phase I, the detailed material was developed in Phase II and a package was prepared that included detailed instructional materials with overheads or PowerPoint presentations in addition to participant manuals that could be retained for future reference by drivers, managers, dispatchers, schedulers, and drivers' families.

The education material was originally developed based on a train-the-trainer model. The intent was that the initial training would be offered to company trainers as a one-day course, who would then return to their companies and deliver a series of half-day seminars to train drivers, dispatchers, and managers. Subsequent training modules would be offered as half-day courses to trainers with the intention that trainers would deliver a series of 1-2 hour seminars which could be fit into safety seminars that currently exist in many companies.

The educational approach for drivers had two components: (i) a core presentation highlighting the key elements of fatigue management; and (ii) supplementary modules on specific topics about fatigue management. The supplementary modules were designed to provide additional information on specific, highly relevant topics of interest to drivers, with the added benefits of reinforcing their learning from the core module while promoting increased awareness among

managers and dispatchers, thereby demonstrating the ongoing, continuous commitment of the organization to fatigue management. This continuous adult learning approach was also chosen as a means of promoting enhanced individual learning, retention and behaviour change on the job. A brief description of the educational material and the method of delivery follow.

5.2.1 Core Seminar

- A basic course on fatigue and fatigue management that included such subjects as sleep, circadian rhythms, sleep hygiene, self-detection of fatigue, fatigue countermeasures, safety/risk management, and additional ergonomic and human factor aspects was delivered to target audiences in a four-hour workshop, including breaks.
- Instructional techniques included lectures, question and answer periods, and discussion. Training aids and resources, including PowerPoint presentations, were used to support training activities.
- An orientation to resources such as the manuals and slides, wellness checkpoint material and supplements (body mass index or BMI charts, sleep apnea fact sheets, sleep masks, earplugs and "catnapper" audio tapes), pamphlets (food guide, physical activity guide, travellers' stretching guides), and pocketsize reminder cards ("Ten Commandments for a Better Sleep") were provided.

5.2.2 Supplementary Modules

These modules were designed to be delivered subsequent to the core module, providing additional information on specific topics such as trip planning, wellness and lifestyle, and sleep and sleep disorders. This additional information contained a small amount of review information, but mostly provided details that could not be included in the limited time for the core module.

Module 1: *Wellness and Lifestyle*

This module focused on lifestyle management for drivers, including health, nutrition, exercise, ergonomics and human factors aspects, all of which can affect fatigue. This module addressed in more detail, the practical side of fatigue management and provided an open forum dealing with many of the day-to-day issues specific to drivers.

Module 2: *Sleep and Sleep Disorders*

This module provided participants with important background information on sleep disorders most relevant to individuals in this industry. Treatment options, potential challenges, and signs and symptoms of sleep disorders were discussed. The module also provided participants with specific tools for addressing sleep hygiene. Some issues addressed, included sleep schedules, alternate methods to help promote sleep, and strategies to optimize the sleep environment and improve the quality of sleep for both on-duty and off-duty periods.

Module 3: *Trip Planning*

This module focused on assisting drivers to develop skills to better plan their personal schedules taking into consideration the preparation required to return to work fit-for-duty following time off, and incorporating fatigue management principles into everyday routines.

5.2.3 FMP for Managers and Dispatchers

Managers and dispatchers received a basic education session appropriate to their needs of approximately two hours in length. In addition, this module provided them with a set of dispatching principles to support the implementation of the FMP within their company.

5.2.4 Family Forum

Recognizing the impact a driver's family life has on his/her fatigue, this one-hour presentation was delivered to drivers' families in order to familiarize them on issues related to sleep and fatigue management in the trucking industry.

5.3 Assessment of Methods and Procedures

5.3.1 Primary Objectives of the Assessment Phase

The primary objective of this component of Phase II was to conduct a pilot field test of the methods and procedures that would be potentially employed in Phase III of the project to assess the feasibility and utility of the proposed measure under operational conditions. Knowledge gained from this component of the study would allow for refinements in the measures, procedures or methodology that would be necessary for Phase III. While the intention was not to rely on the data as evaluative of the impact of the FMP on drivers, the data could be useful in identifying preliminary trends related to the impact of the program on the sleep and fatigue of the participants.

5.3.2 Overall Research Design

As stated above, the fatigue management pilot study was designed to gather preliminary information on the practicality and acceptability of several measurement tools to assess driver fatigue in operational settings. The overall design of the study was to collect subjective and objective information prior to and following the delivery of the FMP in order to test all components of the procedures during this pilot study in as realistic a manner as possible. As stated earlier, however, no post-FMP data were collected for the Texas pilot as was done in Alberta and Quebec.

For the initial collection periods, data were gathered over a standard work-week (5-6 days) on revenue-generating routes operating within the current hours-of-service rules. Specifically, subjective measures of fatigue were collected using an en route questionnaire, and objective measures of performance were collected using a psychomotor vigilance task. Both the subjective and objective measures were collected at the beginning, middle and end of the driving period for a full shift cycle (5-6 days). Continuous sleep and wakefulness information

was collected over a 9 or 10-day period (2 days prior to the driving schedule, during, and 2 days following the driving schedule) using non-invasive wrist activity technology.

In summary, general questionnaires, including demographic, fatigue, performance and sleep pattern data were administered prior to the implementation of the education module. The project design then called for this information to be collected again (in Alberta and Quebec) following the delivery of the educational and sleep disorder screening, assessment, and treatment interventions.

5.4 Procedures

5.4.1 Ethics Review

Ethics approval was received from the appropriate Research Ethics Board (Canada) or Institutional Review Board (U.S.). All data acquired on drivers and companies continues to be treated confidentially. This study was conducted according to the principles of ICH Good Clinical Practice and the Declaration of Helsinki (2000).

5.4.2 Participant Eligibility

To participate, drivers had to meet a set of eligibility criteria. Specifically, each driver had to:

- be a volunteer;
- be between the ages of 21 and 64 years;
- hold a valid CMV licence (confirmed with documentation);
- have worked for a minimum of three years as a Class I commercial driver;
- have a personal driving record indicative of a safe driver (confirmed by company records), defined as having no at-fault accidents in the past three years (this definition is consistent with recent field studies in this area such as the Canada/U.S. Fatigue Management Technologies study); and
- participate frequently in fatiguing schedules as defined by drivers themselves and company managers/dispatchers. No specific definition beyond that of the perception of the drivers and their managers/dispatchers was given, since specific schedules within the companies were relatively unknown. However, since the project parameters associated with fatigue (long driving hours, long strings of consecutive driving days/nights, as well as night driving) were known to drivers and dispatchers, it was expected that such parameters would be taken into consideration in determining which schedules were permitted for the study.

Exclusion criterion:

- Any driver who was a team driver.

5.4.3 Recruitment Procedure

Volunteer drivers from the participating carrier were invited to attend an informational and recruitment session, which was vital in developing rapport with company staff and introducing potential participants to the concept of an FMP. Following this introductory seminar, drivers were asked to complete a Pre-Screening Questionnaire (Appendix A) as a means of identifying potential participants and to establish a baseline database. According to the information in the questionnaires, eligible drivers were identified and were randomly selected from this pool. Selection was done using a random-number generator as applied to assigned candidate participant numbers.

Survey Participants

As part of initial testing all interested participants were invited to complete the baseline Driver Questionnaire (Appendix B). Ultimately, completed questionnaires were obtained from 89 drivers (73 in Alberta, and 8 each in Quebec and Texas), 45 of whom went on to become participants in the study (29 in Alberta, and 8 each in Quebec and Texas). Informed Consent was obtained from all participating drivers prior to their completing any study-related procedures.

Driver Participants

Baseline field-testing was completed with all study drivers from the participating companies. In total, 45 drivers (29 in Alberta, and 8 each in Quebec and Texas) completed the baseline field-testing to gather the necessary subjective and objective measurements of sleep and fatigue. Subjective assessments were completed using a series of questionnaires, while the objective assessments were completed using a PVT for fatigue, and wrist Actigraphy for sleep.

Partner Participants

Partners of the original 89 drivers who completed the baseline Driver Questionnaire were asked to complete an anonymous Partner Questionnaire. A total of 48 useable surveys were returned.

5.5 Subjective and Objective Measures

A combination of subjective and objective measures was used due to the range of information that was to be assessed in this study. Part of the intent of Phase II was to evaluate the measures in order to refine them as necessary for Phase III. Table 1 provides a summary of the measures used in Phase II.

Table 1 Objective and subjective measures used in Phase II

Area	Measure	Tool	Frequency of Measurement	Test Duration
Cognitive/ Performance	Vigilance and Reaction time	Psychomotor Vigilance Test Source: Dinges et al., 1985	3 times per shift over 5-6 days	10 minutes
	Subjective Workload Assessment	Modified NASA-TLX Modified from: Hart & Staveland, 1988	End of shift	30 seconds
Sleep	Quantity	Actigraphy Sources: Brooks et al., 1988; Sadeh et al., 1995; Sadeh et al., 1989	Continuous – no driver effort over 9-10 days	N/A
	Quality	Work/Activities/Sleep & Performance Record Modified from: Shapiro et al., 1997	Minimum of 2 entries per day at lights off and lights on	3 minutes
	Objective Sleep Monitoring	Polysomnography	1or 2 nights as outlined	6-8 hours
Fatigue	Fatigue Rating	Subjective Assessment of Fatigue Modified from: Colwell & Heslegrave, 1993	End of shift	1-2 minutes
	Alertness Rating	Retrospective Alertness Inventory Source: Folkard et al., 1995	End of shift	30 seconds
	En Route Driver Rating	Stanford Sleepiness Scale. Source: Hoddes et al., 1973; Modified from: Colwell & Heslegrave, 1993	Beginning, middle and end of shift	30 seconds
Psychological Well-being	Mood Rating	Current Mood Assessment Questionnaire. Modified from: Donderi et al., 1995; Colquhoun et al., 1968a and 1968b	2 times per shift, beginning and end	30 seconds
	Quality of Life	SF-12 Health Survey. Source: Ware et al., 1993	Baseline, combined with General History Questionnaire	1-2 minutes
General	General History	General History Questionnaire Modified from: Heslegrave, 1999	Baseline	20 minutes for the complete questionnaire
	Satisfaction Survey	Family Member / Partner Satisfaction Survey	Baseline, combined with General History Questionnaire	5 minutes
	Physical Well-being	Somatic Symptom Checklist Modified from: Heslegrave, 1999	Beginning, middle and end of shift	1 minute

5.5.1 Subjective Measures

For some types of information, such as sleep habits, fatigue, mood, and quality of life, the preferred sources of information are the drivers themselves and their partners.

Driver Questionnaire

A comprehensive questionnaire (Appendix B) was developed to survey the current effects of fatigue on drivers and to examine their strategies for coping with fatigue. The questionnaire took about 30 minutes for the driver to complete and collected information on the following areas: General (demographics, type of route, etc.), Medical history, Scheduling and sleep, Sleep and well-being, Coping with fatigue, Fatigue and alertness, Family and friends, Quality of life (SF-12) and Satisfaction.

This questionnaire was based, in part, on a questionnaire which was distributed to Canadian air traffic controllers to assess shift-work and well being (Heslegrave, Rhodes et al., 1999) and which has been modified to assess issues relevant to fatigue in Canadian Coast Guard and Search and Rescue operations. This questionnaire was also based on questionnaires developed for the fatigue and alertness research on commercial drivers (Wylie et al., 1996; Williamson et al., 2000).

The SF-12 (12-Item Short Form Health Survey) was developed from the Medical Outcomes Study (Ware et al., 1993) to be a much shorter, yet valid, alternative to the SF-36 for use in surveys of health outcomes. The SF-36 was designed for use in clinical practice and research, health policy evaluations, and general population surveys. The SF-36 includes one multi-item scale that assesses eight health concepts: 1) limitations in physical activities because of health problems; 2) limitations in social activities because of physical or emotional problems; 3) limitations in usual role activities because of physical health problems; 4) bodily pain; 5) general mental health (psychological distress and well-being); 6) limitations in usual role activities because of emotional problems; 7) vitality (energy and fatigue); and 8) general health perceptions. The survey was constructed for self-administration by persons 14 years of age and older, and for administration by a trained interviewer in person or by telephone. The SF-12 is a standard, widely used generic quality of life measure of those same eight concepts.

En-Route Driver Survey

The En-Route Driver Survey (Appendix C) includes the following assessments to be completed during driving days:

- Stanford Sleepiness Scale (SSS): The SSS is a simple numerical scale developed by Hoddes et al. (1973), which takes approximately 20 seconds to complete. It has seven anchors implying different states of fatigue or alertness, and is commonly used in research on the effects of sleep and, by implication, fatigue and alertness (Wylie et al., 1996). This assessment is completed at the beginning, middle and end of the driver's shift.
- Somatic Symptom Checklist: The Somatic Symptom Checklist was used by Heslegrave, Rhodes et al. (1999) in studies on air traffic controllers and in the nuclear power industry to assess the impact of shift work on somatic symptoms. This assessment is completed at the beginning, middle and end of the driver's shift.

- Current Mood Assessment: A driver's mood is evaluated by obtaining subjective ratings of alertness, happiness, calmness, patience, confidence and desire to interact with people. The questions are based on a scale by Donderi et al. (1995) and Colquhoun et al. (1968a, 1968b). Several of the questions were re-worded to reflect an individual versus a crew environment. This assessment is completed at both the beginning and end of the driver's shift.
- Fatigue and Alertness Assessment of Performance: The impact of fatigue and alertness on performance was based on the Performance Assessment Questionnaire by Colwell and Heslegrave (1993) and is designed to get at the early signs and symptoms of fatigue and working shifts. This assessment is completed at the end of the driver's shift.
- Subjective Workload Assessment: A Subjective Workload Assessment was adapted from the NASA Task Load Index (NASA TLX) to assess the level of workload required during a driver's shift. The NASA TLX developed by Hart and Staveland (1988) is a multi-dimensional subjective workload measure, which has been validated extensively in a range of operational environments. It is a standard tool for assessing residual processing capacity in terms of physical, mental and temporal demands, and can be completed within 30 seconds. This assessment is completed at the end of the driver's shift.

Partner Questionnaire

The Partner Questionnaire consisted of 11 items developed by the investigators to survey partners on:

- their knowledge of the effects of fatigue on CMV drivers;
- their perception of their partner's level of fatigue;
- the impact of the partner's schedule and level of fatigue on relationships, activities and family life; and
- their interest in learning more about fatigue management.

Partners were defined as wife, common-law partner, girl/boy friend, or roommate.

5.5.2 Objective Measures

Psychomotor Vigilance Test (PVT)

A PVT was incorporated into the driver's routine at the beginning, middle and end of the day's driving to assess, in a more objective manner, attention and cognitive performance. The PVT and the driver's subjective assessment of fatigue were administered over the same 5-6 day driving period.

The PVT was developed and validated by Dr. David Dinges at the University of Pennsylvania and has been used as an indicator of general psychomotor impairment in a number of international studies. The PVT measures an individual's sustained attention (Dinges & Powell, 1985, Dinges et al., 1997) through simple visual reaction time tasks. This task was

also the primary performance measure used in the Fatigue and Alertness Trucking Study (Wylie et al., 1996).

The PVT uses a 10-minute task in which the driver responds to visual stimuli by pressing a response key on the device. Throughout the trial, reaction times and lapses (defined as reaction times of greater than 500 milliseconds) are measured.

Wrist Activity Measure

Wrist activity technology (actigraphy) was used to monitor sleep and wake periods 24 hours a day over 9 or 10 days to assess the amount and regularity of sleep that occurred before, during and after the 5 or 6-day driving schedule (which includes 2 days prior to the driving schedule and 2 days following the driving schedule). The "SleepWatch-L" Actigraph was used (Ambulatory Monitoring Cat. #23.000.L), with Action-W scoring software (version 2).

Ambulatory monitoring devices (i.e. sleep monitor watch) have been used to establish behavioural activity patterns, and to assist in characterizing sleep duration and quality (cf., Brooks et al., 1988). Subjects wear a wrist watch-type measurement device continuously throughout the en route data collection period to monitor the level of wrist activity. This device uses a miniature computerized accelerometer and summarizes the amount of wrist activity every 30 seconds. A computer algorithm then scores this activity to determine the sleep/wake behaviour of the individual.

5.5.3 Pre-/Post-FMP Data Collection

In Alberta and Quebec, a repeat of the original en route field-testing phase was completed over 9-10 days with drivers from the participating companies. Pre-intervention field-testing of the Alberta sample suggested that changes should be made to the data collection procedures and these were examined in the post-intervention field-testing in a limited manner (10 drivers), due to attrition in the number of participating drivers and refusal by some drivers to continue participation.

5.6 FMP Intervention

The uniqueness of the FMP intervention in this project lies in its comprehensiveness and the fact that it attacks the fatigue problem with a number of concurrent approaches. Most other fatigue management initiatives are limited to one or more educational or interventional components, usually directed only at the drivers themselves. The components of the FMP in Phase II of this project were:

- Sleep disorder screening, assessment, and treatment
- Educational modules for:
  - Drivers (core and supplementary modules)
  - Managers, dispatchers, and schedulers
  - Family of drivers (family forum)
- Recommended guidelines for biocompatible scheduling

5.6.1 Sleep Disorder Screening, Assessment, and Treatment

All drivers in Alberta and Texas completed the sleep apnea screening process (refer to Figure 1 for the screening algorithm). Along with the drivers from Quebec referred directly to the sleep laboratory (the remaining driver in Quebec changed companies prior to the sleep laboratory activities), all drivers were invited for a sleep clinician office evaluation by a participating investigator, following standard clinical practice in sleep medicine.

The consultation included an interview geared to clarify clinical information on top of the data obtained from the ambulatory screening, as well as to address the possibility of another sleep disorder besides sleep apnea contributing to the individual's symptomatology. The office visit also provided the opportunity to address the difficulties in obtaining adequate sleep in differing environments and provided drivers with a basic understanding of sleep hygiene measures, as well as coaching on how to take a power nap.

Based on the results of the ambulatory screening (performed in Alberta and Texas only), drivers identified as positive index cases (RDI ≥ 20 in Alberta and 15 in Texas), were referred to the sleep lab for full sleep studies following standards of practice for polysomnography. It should be noted that the threshold for positive index cases in the Texas pilot was reduced from a Respiratory Disturbance Index (RDI) of 20 to 15, in order to fit more closely with the criteria from the 2002 study conducted by Pack et al. Using the Pack criteria, an RDI of 5 to 15 indicates mild sleep apnea, 15 to 30 represents moderate sleep apnea, and greater than 30 represents severe sleep apnea (note it is this threshold (RDI = 15) that is depicted in Figure 1).

The sleep laboratory assessment included, at a minimum, a two-channel electroencephalogram (EEG), bilateral electro-oculogram (EOG), submental electromyogram (EMG), bilateral leg EMG, and electrocardiogram (EKG). Respiratory monitoring included snoring, airflow, respiratory effort and oxygen saturation.

Following standard diagnostic polysomnography, treatment and rehabilitation recommendations were made, based on the outcome of the above-mentioned study. Individuals with a mild degree of OSA were advised regarding weight loss, positional training and dental appliance treatment to control the degree of snoring and mild respiratory disturbance noted. Medical intervention was not a requirement for these individuals.

Individuals with a confirmed RDI/AHI ≥ 20 (15 in Texas) underwent a second study night of Continuous Positive Airway Pressure (CPAP) in the sleep laboratory in an attempt to control their condition. CPAP is the most effective treatment for severe sleep apnea, in which a light mask is worn over on the nose – an air blower is then used to provide the required air pressure for normal sleep and breathing to occur, without snoring or apneic events. Subsequently, these participants were equipped with a CPAP device and seen within 4 to 6 weeks for follow up to monitor their progress and degree of compliance with this treatment.

Sleep apnea screening is also best done through a combination of subjective and objective measures. While periods of total or partial absence of breathing (apnea or hypopnea, respectively) can be determined solely by objective measures, their impact on alertness and performance is best determined through a combination of subjective and objective measures.

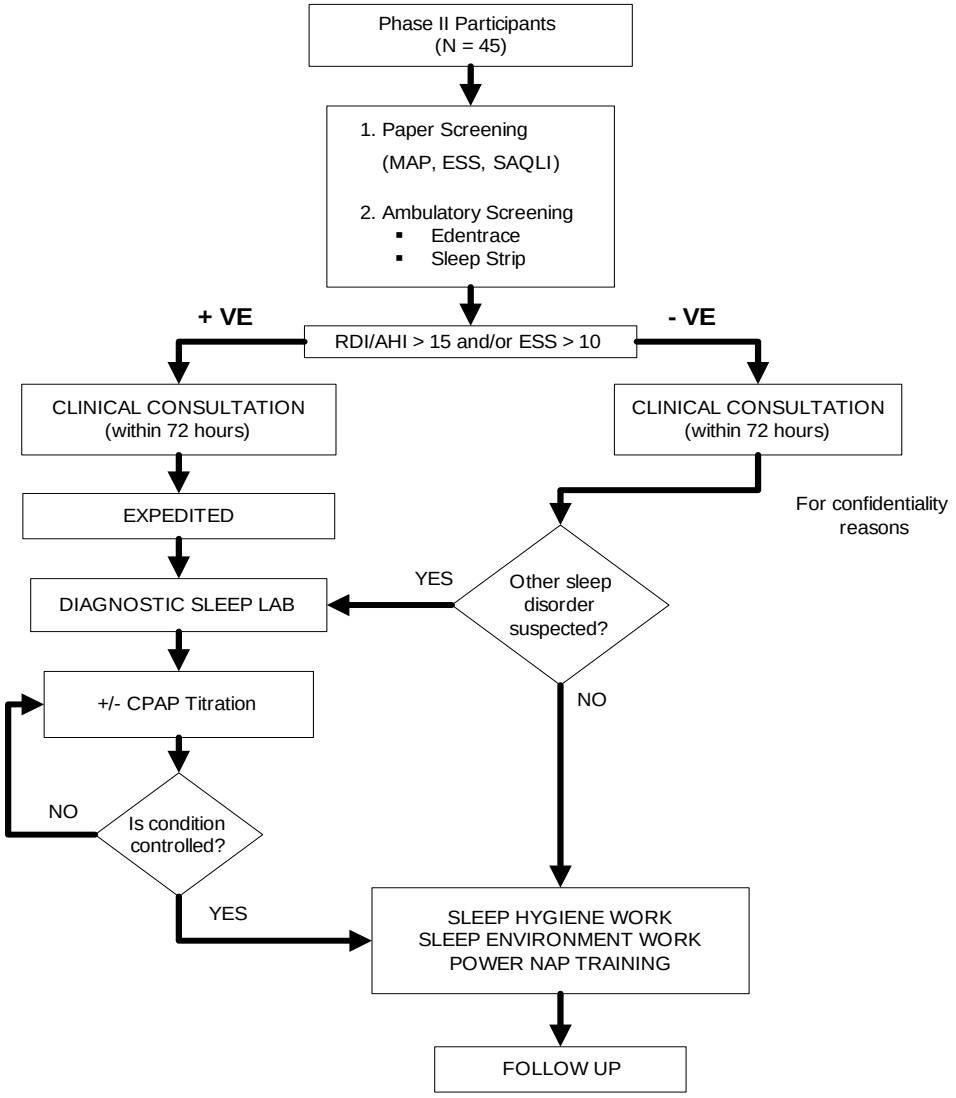


Figure 1 Sleep apnea screening/rehab algorithm

Subjective Measures

Sleep apnea screening was conducted following completion of baseline data collection and delivery of the core educational module. All participants completed the following screening tools: multivariable apnea prediction (MAP) index questionnaire (Appendix D), Epworth Sleepiness Scale (Appendix E) and the Calgary Sleep Apnea Quality of Life Index (Appendix F).

- The MAP is a screening form for sleep apnea, which incorporates symptoms of sleep apnea, age, gender and BMI (Maislin et al., 1995). It has been shown to have test-retest reliability of .92, and to be a better predictor than self-report of symptoms or BMI alone. When the MAP was compared to the gold standard of clinical measure for apnea, the RDI

obtained from polysomnography, overall predictive ability was .79. Hence, the MAP has the potential for use as a very simple paper-screening tool.

- The Epworth Sleepiness Scale (ESS) is a validated sleep questionnaire that measures the expectation of falling asleep in eight different situations. The probability of dozing ranges across four ratings, from 0 (low) to 3 (high). The highest score on this scale is 24, indicative of severe daytime sleepiness (Johns, 1991).
- The Sleep Apnea Quality of Life Index (SAQLI) is a comprehensive health related quality of life measure developed for use in clinical trials among patients with sleep apnea (Flemons and Reimer, 1998). The 18-item SAQLI used in this project was derived from data and the original SAQLI. It has been demonstrated to have a high degree of internal consistency, face validity and positive correlation with the SF-36 (another well-validated health quality of life assessment), and it has been successfully used in a self-administered format.

Objective Measures

To evaluate ways to render sleep apnea screening practical for the CMV industry, as well as to meet the data collection needs of this project, the Edentrace, a common ambulatory screening device, was tested in conjunction with the SleepStrip® (Moustache), a newer and much less costly technology.

Note #1: The Texas pilot made use of an upgraded version of the SleepStrip® than was employed in the Alberta pilot, where a number of technical difficulties were encountered with this technology).

Note #2: In Quebec, all drivers were referred directly to the sleep laboratory, bypassing this step in the assessment process for sleep apnea.

Ambulatory Screening – Edentrace

All participants were asked to undergo one night of ambulatory screening using the Edentrace 2 screening device. This device is a six-channel validated ambulatory monitoring device that records snoring, body position, heart rate, respiratory effort, airflow and oxygen saturation. In validation studies (Emsellem et al., 1990) the device was found to have high sensitivity and specificity (0.95 and 0.96 respectively) in a group of 67 patients undergoing simultaneous Edentrace recording and polysomnography sleep recording for sleep apnea. Another study (Redline et al., 1991) reported a high level agreement between RDI obtained from PSG and scores from the six-channel Edentrace device (R=0.96).

The device requires a set-up orientation of roughly 15 minutes, and can be used by the individual in their home/motel environment. Scoring of the results requires roughly half an hour of technical scoring time, and subsequent sleep specialist interpretation.

Ambulatory Screening – SleepStrip® (Moustache)

In addition to the Edentrace, all participants in Alberta and Texas were invited to use a new simplified disposable apnea-screening device developed for home use, equipped with a

microchip and accompanying software for data analysis. The device measures both oral and nasal airflow during sleep and produces a score approximating the severity of sleep-disordered breathing. Previous versions of the SleepStrip® have been validated in a number of studies using sleep laboratory polysomnography as a comparative reference (Shochat et al., 2000). Validation of the latest version (used in the Texas pilot) was presented at the European Respiratory Society, 14th Annual Congress in Glasgow, Scotland (Shochat et al., 2004).

The potential advantage of this device, compared to the more complex ambulatory screening units, is its disposable nature, reduced cost, ease of application and use, and lack of requirement of additional technical time in scoring results. As such, it could present a significant advantage in its potential for large-scale population screening.

While an upgraded version of the SleepStrip® was used in Texas with few problems, a number of technical difficulties were encountered in Alberta with the previous model, resulting in one-third of Alberta drivers not having reliable data. It should be noted that the previous version of the SleepStrip® produced an estimate of the individual's apnea-hypopnea index, or AHI (an hourly average of the number of apneic and hypopneic events), whereas the upgraded model produced a severity score from 0 to 3 based on the person's AHI. The scores for the upgraded version are calculated as follows:

- 0 – Indication of no sleep apnea (less than 15 events per hour)
- 1 – Indication of mild sleep apnea (15-24 events per hour)
- 2 – Indication of moderate sleep apnea (25-39 events per hour)
- 3 – Indication of severe sleep apnea (40 or more events per hour)
- E – Error indication (study was too short or other problems occurred)

5.6.2 Educational Modules

While the train-the-trainer approach was initially favoured, results from the earlier portions of Phase II demonstrated that improvements could be made to the educational delivery approach. Specifically, it was found that company trainers had a highly variable level of knowledge with respect to the subject matter, and that a number of them did not possess adequate skills in the area of adult education techniques. As a result, the decision was made to have project staff deliver the balance of training in Phase II in order to provide a more consistent quality of training to the participants. As mentioned above, this approach was used for the delivery of the Supplementary modules in Alberta (except for one company) and Quebec, as well as the delivery of all educational modules in the Texas pilot. Other changes involved the addition of a pre-post session knowledge test that was administered to the Texas participants only (Appendix G). The evaluation of the acceptance and subjective value of the training modules was accomplished by assessing the feedback provided by the evaluation questionnaire, and the effectiveness of the sessions was determined by the results of the comparison between the scores on the pre-post session tests.

Core Educational Module

Company trainers delivered the *Core Module* to all participating drivers in Alberta and Quebec. Project staff attended each session in order to provide assistance in the delivery of the training where necessary and to monitor feedback and assess the level of educational instruction. In Texas, the *Core Module* was delivered by project staff as a means of expediting the educational delivery process within this final jurisdiction for the Phase II study. An evaluation questionnaire was administered to participants at the end of the session (for all three jurisdictions). A pre-session test of knowledge was administered to the participants just prior to the commencement of the session and post-session test was given at the end of the session (Texas only - see Appendix G for the format of the evaluation questionnaire and the test).

Supplementary Modules

The Supplementary Modules were delivered by project staff in all jurisdictions with the exception of one of the four participating carriers in Alberta, where company trainers completed this task. Other than this one carrier, project staff delivered the supplementary module training due, in large part, to procedural difficulties with the carriers (conflicting driver schedules, lack of company trainer availability). An evaluation questionnaire was administered to participants at the end of each session (for all three jurisdictions). A pre-session test of knowledge was administered to the participants just prior to the commencement of the session and post-session test was given at the end of the session (Texas only - see Appendix G for the format of the evaluation questionnaire and the test).

FMP for Managers and Dispatchers

A set of principles for dispatchers was incorporated into the *FMP for Managers and Dispatchers* module. This module was delivered by project staff to representative personnel from the participating companies in all jurisdictions.

Family Forum

This presentation was designed to assist in familiarizing drivers' families on issues related to sleep and fatigue management. The module was delivered by project staff to drivers and their partners in all jurisdictions.

5.7 Data Management and Analysis

The primary focus of this pilot is to develop the educational material, test the sleep apnea screening process, and field test the various measures and tools proposed for data collection in a field operational environment geared to minimally interfere with the driver's occupational functioning on revenue generating routes. Measuring the long-term impact of the various intervention measures was not the primary objective. Hence, the focus on data management and analysis was to establish the appropriate process for creating a database and refining the protocols and procedures for collecting the data.

Interventional measures were introduced in rapid succession and, therefore, did not allow sufficient timeframe for significant behavioural change to occur before the second set of data collection was conducted in Alberta and Quebec. The primary purpose of the second round of data collection was to test initial changes made to the data collection processes and provide for additional improvements in process and turn-around time with the participating drivers with a focus on ensuring that the data collection process planned for Phase III was both more efficient (done smoothly and on schedule) and effective (ensuring that all data elements were properly collected and recorded). Although the results provided show a number of interesting findings and trends, they have to be viewed in the context of the above limitations.

In terms of the statistical approach in this pilot study, this pilot study was intended to be hypothesis generating and to provide potential effect sizes and variability estimates so that a Phase III study could be properly powered. Thus, what is reported here is primarily observational data using descriptive statistics rather than inferential statistics given the intent of the study. Where sample sizes warrant, estimates of variability are included to provide the ability to estimate sample sizes for Phase III that would lead to a study of adequate statistical power to provide meaningful information.

6 LOGISTICAL AND QUALITATIVE FINDINGS AND IMPLICATIONS

This section highlights the observational lessons learned as a result of this pilot phase. Corrective actions for future phases of the FMP are identified in section 8.

6.1 Data Collection Procedures

- Based on the experience from the Alberta and Quebec pilot studies, the timeframe to complete all pre-study procedures (i.e. recruitment presentations, consenting of subjects, orientation to data collection equipment, etc.) was reduced substantially for the Texas pilot (all activities were accomplished in less than three days).
- Several delays resulted in a lengthy en route data collection period at baseline in the Alberta pilot; however, the second round of en route data collection proceeded much more quickly and efficiently, with turn-around time of two weeks per group studied using the available sets of equipment. In Texas, the en route data collection activities were also completed within a two-week timeframe, with good compliance from the majority of the drivers. Additional modifications to the en route logs may be required, however, in order to maximize the gathering of SSS data, and clarify the time drivers went to sleep.
- A number of difficulties were encountered in terms of scheduling drivers for sleep disorder screening, treatment and follow-up in the Alberta pilot study. Associated with these scheduling difficulties was reluctance on the part of some drivers to report to a central location to participate in the PSG study, which in some cases represented significant travel and, occasionally, lost work time. In the Texas pilot, however, the scheduling of drivers for these activities was made much easier by the assistance of the participating carrier's local management group. This strong collaboration allowed all activities to be completed in less than five weeks.
- During the Alberta pilot, bus drivers in most cases were unable to complete the mid-shift PVT due to operational constraints.
- A significant number of technical difficulties were encountered with the SleepStrip® used as part of the ambulatory sleep apnea screening process in Alberta; however, the upgraded version of this device used in the Texas pilot was much more reliable. Although problems were encountered with one Texas driver, minimal difficulties were experienced with the device overall.

6.2 Educational Approach

- The train-the-trainer approach used in Alberta revealed marked inconsistencies among company trainers in terms of their subject matter knowledge, their ability to engage and transfer this knowledge to drivers, as well as the comprehensiveness of training delivery overall. To correct for this, project staff delivered the balance of training in Quebec and Texas.

- Based on the experience from the Alberta and Quebec pilot studies, all three baseline education modules *(Driver Core, FMP for Managers and Dispatchers,* and *Family Forum)* were delivered at the outset of FMP implementation in Texas as a means of establishing a common level of knowledge among each of these stakeholder groups with respect to fatigue management early in the project. Total time for the delivery of these modules in Texas was less than one week.
- Close collaboration with local management staff in Texas allowed the delivery of all training modules to be planned well in advance and carried out in an efficient manner.
- The supplementary modules for drivers were delivered in the following order: *Wellness and Lifestyle*, *Sleep and Sleep Disorders*, and finally *Trip Planning*, which was not necessarily related to their importance in changing driver behaviours.
- Evaluation of the training modules in Alberta and Quebec was largely a result of anecdotal evidence provided by company managers and drivers. As a result, a formal evaluation procedure was piloted in Texas, yielding positive feedback from both drivers as well as company management as to the value and comprehensiveness of the educational modules.
- None of the participating companies' key clients (those representing the greatest revenue source) attended the *FMP for Managers and Dispatcher*s module in Phase II. This was a disappointment in the Phase II implementation of this aspect of the FMP.
- The logistics of the *Family Forum* in Phase II was an education module delivered to a larger number of families within a condensed period of time. It is noted that for greater success in this aspect it may be necessary to coordinate the schedules of drivers' spouses along with those of the drivers themselves.
- The design of the quizzes covered all aspects of the education. Perhaps more selected evaluation might be appropriate where questions are focussed on those aspects of topics that are least known to the general public but are crucial to the health and well being of the drivers.
- The training should include strategies, tools, and approaches that managers and dispatchers can use to monitor drivers' fatigue levels, behaviours, and workloads, and to make decisions regarding recourse (e.g. impact on driver compensation, provisions for modified work, impact on schedules, etc.). Information not covered to date in this training would include clear guidelines for what constitutes cause for action (application of strategies), and examples of positive policies on the responsibilities for drivers and companies.

6.3 Sleep Disorder Screening, Assessment, and Treatment

- The sleep disorder screening, assessment, and treatment process and procedures proved to be feasible within a field operational CMC environment.
- The approach allowed the research team to efficiently identify those drivers who were at risk for obstructive sleep apnea (OSA) and provide appropriate treatment to these drivers.

- Drivers were able to comply with the process and associated scheduling requirements through their supervisors who worked with the research team to arrange times and dates for screening, assessment, and treatment. While such scheduling was difficult, anecdotally it was reported that allowing screening, assessment and treatment at times that did not conflict with work schedules was an appropriate strategy.
- Drivers signed a consent form that clearly stated that the drivers must agree to follow the appropriate treatment recommendations resulting from the sleep disorder screening, assessment, and treatment process. This ensured that no driver's condition would need to be reported to authorities, since in some jurisdictions (e.g. Alberta) if a driver is receiving appropriate treatment, and the condition is controlled, that driver could legally continue to drive.
- The paper screening and the ambulatory tools used in Phase II seemed to provide reasonably reliable information which met the requirements for effective sleep disorder screening, when used in combination by a trained clinician.

6.4 Data Management

- Missing data in all areas of this field study was a major problem in this study. To address this issue, future studies should devote more resources to data management and quality assurance than were reasonable for this pilot study.
- Data was partially entered at different sites using different data bases and coding systems (i.e. Excel, SPSS) resulting in excess work to consolidate into one database and limiting the ability to pool data across sites.

6.5 Project Communication

- Based on the experience gained from the Alberta and Quebec pilot studies, a significant amount of time and effort was invested with management from the participating carrier in Texas (including executive management at head office, as well as local management at the Houston terminal) prior to the project as a means of familiarizing them with all aspects of the project, and securing their commitment to carrying out the study-related procedures on schedule.
- All attempts were made to maximize direct communication with the drivers in an effort to keep them engaged over the course the project, especially during the Texas pilot. Face-to-face contact with project staff was established via the recruitment presentations, educational deliveries, orientation to the en route data collection equipment, pick-up and drop-off appointments for the sleep apnea screening tools, as well as impromptu meetings at the terminal. Frequent telephone contact was also made with the drivers to ensure the data collection activities were proceeding well, to schedule appointment times for the sleep apnea screening and treatment procedures, as well as to troubleshoot any problem areas with these activities.
- In spite of the significant progress made in clarifying the time commitment required for the data collection activities, educational modules, as well as the sleep apnea screening and treatment activities, the fact remains that drivers are often required to take time away from work in order to complete these activities. Compensation issues were self-evident.

7 ANALYTICAL RESULTS

Results from the Phase II project are described in this section of the report. The analytical plan included pooling results where possible to make comparison between samples from different jurisdictions. This process, however, was complicated by a large amount of missing data (particularly obvious when drivers went into a rapid succession of work shifts) and the slight adjustments to measures and methods as this pilot process progressed. Consequently, as noted above, the initial sample size was limited, and was further eroded by attrition among the subject drivers in all jurisdictions. Hence, most of the data are reported in terms of descriptive statistics (see Section 5.7 for brief discussion of the statistical analysis). However, despite the limitations of sample size, it was possible to identify some potentially important effects within the participant driver group and our focus will be on those effects.

Also note that the Quebec and Texas data are represented for the eight drivers who began the project in each of these jurisdictions. The Alberta data are based primarily on the 29 participant drivers who began the project. However, the results from the initial (baseline) data collection are reported for both the 29 participant drivers (i.e. those who participated in both the en route testing and the comprehensive FMP) and 44 non-participant drivers (i.e. those who attended an information session but were not eligible or not selected for the en route component).

7.1 Study Demographics

A total of 45 participants (44 male, one female) were recruited for the FMP pilot study among the three jurisdictions. As seen in Table 2, drivers had an average age of 47.6 years and tended to be highly experienced at their job (mean of 22.4 years as a truck driver). Drivers had worked between 1 and 31 years with their respective companies, with an average tenure of 13.0 years. On the whole, drivers had a higher average BMI than the recommended healthy range of 18.5 to 24.9 as established by Health Canada (2003), although it must be noted that while a BMI of 29.0 is considered to be in the overweight category it does not represent significant obesity.

In terms of comparisons across jurisdictions, Quebec drivers tended to be younger than those in Alberta and Texas, Alberta drivers tended to be the most experienced at their job, and Texas drivers tended to be significantly more overweight than those in Alberta or Quebec.

Table 2 Driver demographics

	Alberta Participants[1] (n=29)	Quebec Participants[1] (n=8)	Texas Participants[1] (n=8)	Total Participants[1] (n=45)
Age	51.1 (8.1)	37.0 (8.0)	45.9 (11.7)	47.6 (10.1)
BMI	28.0 (4.5)	26.0 (3.3)	35.4 (8.4)	29.0 (6.0)
Years as a CMV Driver	26.7 (7.6)	10.9 (8.7)	18.0 (14.9)	22.4 (11.1)
Years with Current Company	16.7 (7.7)	3.9 (2.6)	8.4 (5.9)	13.0 (8.5)

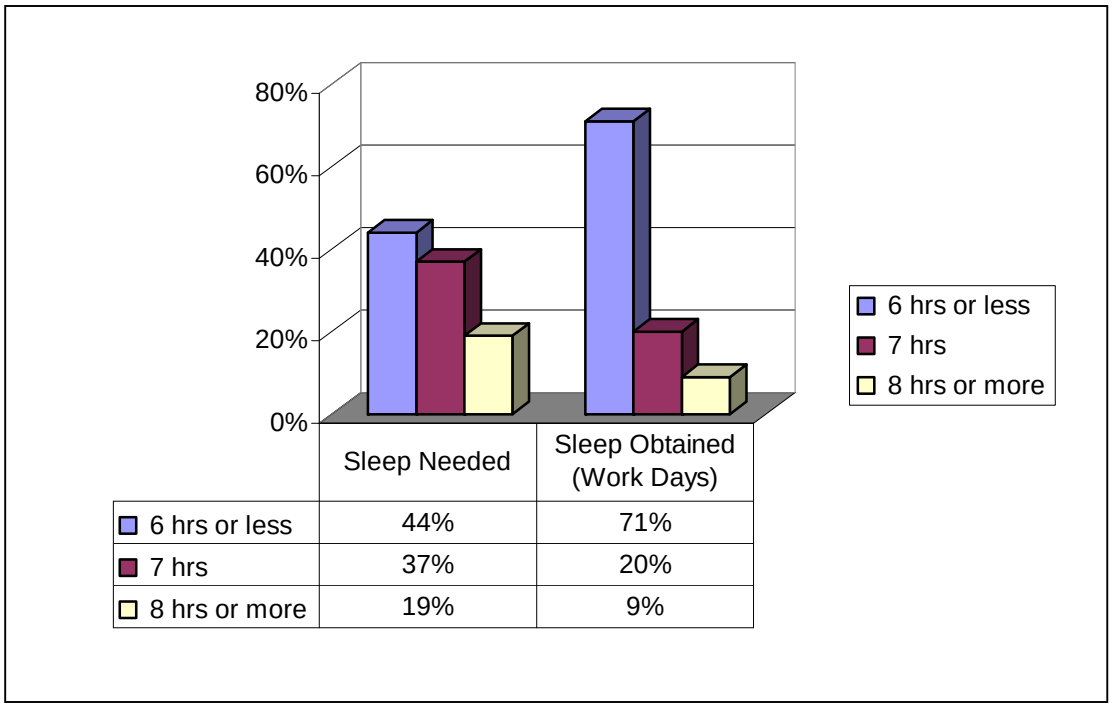
[1] Mean (standard deviation)

7.2 Driver Questionnaire

The comprehensive baseline Driver Questionnaire was designed primarily to assess the effects of fatigue on drivers and to examine their strategies for coping with fatigue. The questionnaire was completed during the driver recruitment process by 73 drivers in Alberta (from which the 29 volunteer study participants were selected), and by 8 drivers in each of Quebec and Texas, for a total of 89 respondents. The key highlights from the Driver Questionnaire as they pertain to sleep and fatigue are as follows.

7.2.1 Sleep

- Figure 2 shows that 56 percent of drivers reported needing at least seven hours of sleep to feel alert (37 percent said they needed seven hours of sleep, and 19 percent reported needing eight or more hours) yet on 29 percent of drivers (about half) achieved this amount of sleep during work days; in addition, 67 percent reported getting less sleep than they need on a chronic basis.
- Figure 3 shows that 21 percent of drivers reported going 21 or more continuous hours without sleep in the past two weeks.
- 60 percent of drivers reported sleeping eight hours or more on their days off to try to compensate for their lack of sleep on workdays.



	Sleep Needed	Sleep Obtained (Work Days)
6 hrs or less	44%	71%
7 hrs	37%	20%
8 hrs or more	19%	9%

Figure 2 Comparison of sleep needed with sleep obtained (all respondents, n=89)

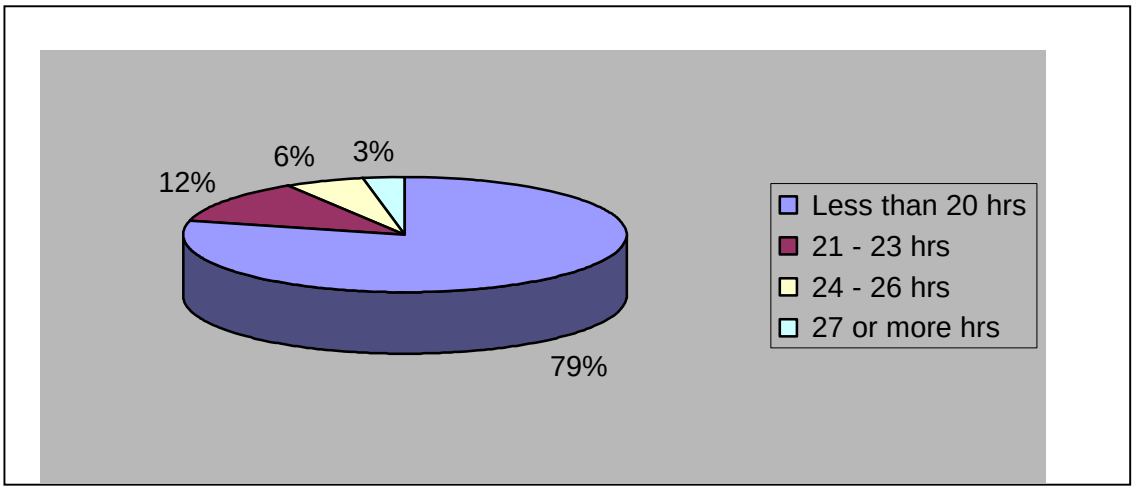


Figure 3 Length of time without sleep in the past two weeks (n=89)

7.2.2 Fatigue and Alertness

- Figure 4 shows that 81 percent of drivers reported making mistakes or mental errors at least several times a year due to fatigue, with 32 percent reporting errors at least several times a month.
- Figure 5 shows that 32 percent of drivers reported nodding off or falling asleep while driving to or from work in the past year.
- Over 50 percent of drivers reported sometimes being drowsy while working.
- 70 percent of drivers indicated that impaired alertness had affected their mental effectiveness at least several times in the past year, including 13 percent who were affected several times a week.
- Irritability while working related to fatigue was reported by 82 percent.
- Drivers overall saw their work as being especially mentally demanding (over 71 percent of all drivers rated this as high or very high), stressful (61 percent) and fatiguing (45 percent).

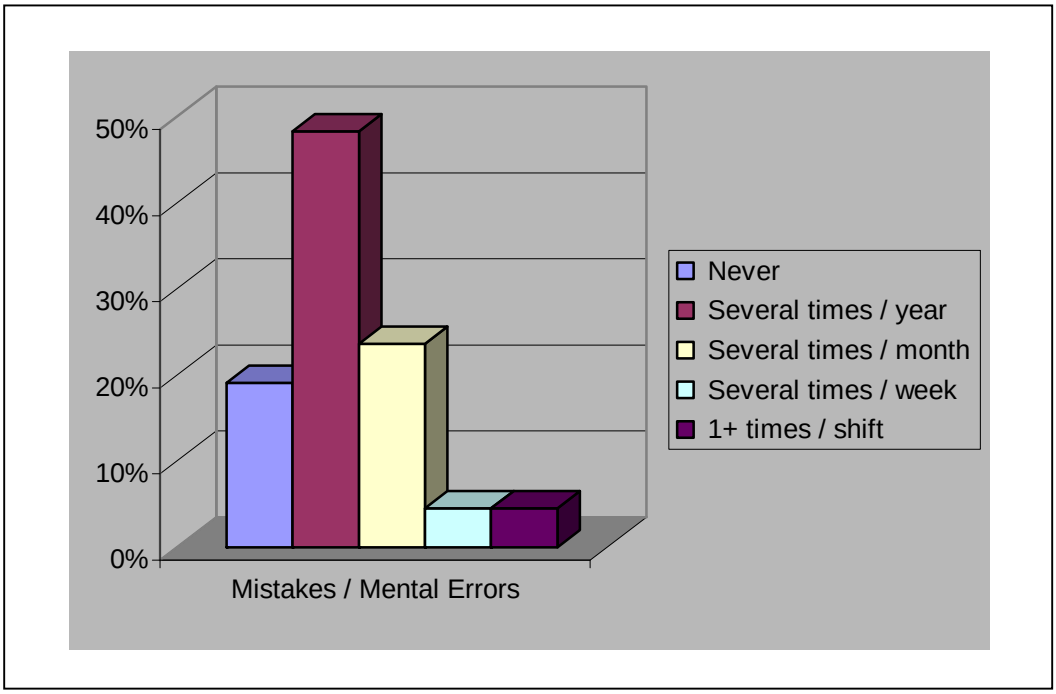


Figure 4 Frequency of mistakes or mental errors at work due to fatigue (n=89)

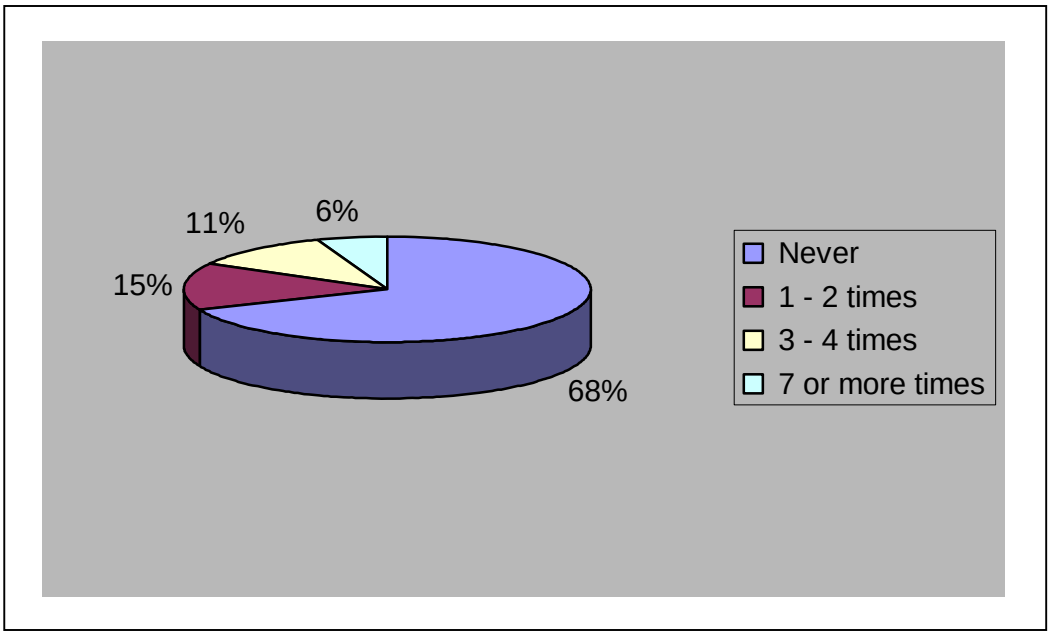


Figure 5 Frequency of nodding off or falling asleep while driving to or from work in the past year (n=89)

7.3 En-Route Measures

The En-Route Driver Survey (Appendix C) provided a method by which subjective assessments of sleep and fatigue could be tracked over each driving period (beginning, middle, and end of the shift), as well as across days. In addition, objective measures of sleep and fatigue were captured using wrist actigraphy (objective sleep measurement) and psychomotor vigilance testing (objective fatigue measurement). The following sections present the data gathered during the two data collection periods (Round #1 = baseline, Round #2 = end of Phase II) for Alberta. Where possible, comparisons between jurisdictions are presented, in addition to comparisons between Rounds #1 and #2 for drivers who provided complete data sets for each round (Alberta only). Round #2 actigraphy data were not available for the Quebec drivers at the time of writing this report. As discussed previously, all data were only gathered at baseline in Texas.

7.3.1 Measures of Sleep

The data in Table 3 show the average of the subjective estimate of hours of sleep compared to the average as recorded objectively by Actigraphy. Round #2 data are presented only for those drivers who had complete subjective and objective data sets in each round of data collection (Alberta only).

Table 3 Driver estimates of sleep per 24-hour period compared to actigraphy results, in minutes (SD)

Jurisdiction	Data collection period	Sample size	Mean **on-duty** sleep duration from **actigraphy**	Mean **off-duty** sleep duration from **actigraphy**	Mean **total** sleep duration from **actigraphy**	Mean **total** sleep duration (**subjective**)
Alberta	Round #1 (pre-FMP)	n=24	304.4 (128.9)	341.1 (126.8)	317.0 (129.0)	421.6 (38.4)
	Round #2 (post-FMP)	n=10	352.0 (80.3)	453.3 (101.2)	396.2 (102.7)	438.7 (27.8)
Quebec	Round #1 (pre-FMP)	n=4	335.3 (101.9)	443.0 (275.02)	362.3 (127.7)	430.5 (82.5)
	Round #2 (post-FMP)	not avail	not avail	not avail	not avail	not avail
Texas	Round #1 (pre-FMP)	n=4	276.2 (117.5)	270.3 (109.3)	275.2 (113.9)	419.9 (121.9)
Total	Round #1 (only)	n=32	305.3 (116.1)	351.5 (170.4)	318.2 (123.5)	424.0 (121.6)

As can be seen in Table 3, drivers tended to overestimate the amount of sleep they were getting (e.g. Alberta difference of 104.6 minutes at baseline, and 42.5 minutes at the end of Phase II). Patterns of actual and subjective sleep time varied across individual drivers and jurisdictions. Some drivers consistently slept about 5 hours a day whether they were on duty or off; other drivers did extensive catch-up by as many as 15 hours sleep on days off. Day of the week made a difference for some with less sleep when days off fell on weekends. Also the types and lengths of shifts varied widely with some doing split shifts over a couple of days with only short breaks, and other drivers working relatively regular schedules. The estimates provided by drivers are probably closer to time in bed than to actual sleep time, although it is not possible to state this absolutely.

It is also interesting to compare the amount of sleep obtained by drivers between on-duty and off-duty days. Based on actigraphy data, at baseline, Alberta drivers on average were only able to sleep 304 minutes during on-duty days (5 hours and 4 minutes) over a 24-hour period, with off-duty sleep only being about 37 minutes longer than on-duty sleep time. Data from the end of Phase II show that drivers averaged 352 minutes of sleep during on-duty days (5 hours and 52 minutes), with off-duty sleep being 103 minutes longer than on-duty sleep

time. The on-duty sleep time was extended by some 48 minutes after the FMP intervention. The off-duty sleep increased from Round #1 to Round #2 by 112 minutes.

Table 3 also shows the increase in objective sleep time obtained by Quebec drivers at Round #1 between 5.6 hours on duty and 7.1 hours when off duty. The Texas drivers showed a reduction in sleep duration when on-duty sleep (276.2) is compared with off-duty sleep (270.3). It is clear that the Texas drivers were typically obtaining very little sleep on both days on and off duty. Note the large standard deviations throughout Table 3, which is indicative of the wide variability in sleep duration across the drivers and the small sample sizes.

Notwithstanding the above, a more direct comparison of sleep time is obtained by looking at those drivers who completed both rounds of data collection. In total, ten drivers completed the second round of data collection; however, only seven (Alberta only) had complete actigraphy data sets each time. Data for these seven drivers are presented in Table 4.

Table 4 Alberta driver estimates of sleep per 24-hour period compared to actigraphy results for comparison group (n=7), in minutes (SD)

Data collection period	Mean **on-duty** sleep duration from **actigraphy**	Mean **off-duty** sleep duration from **actigraphy**	Mean **total** sleep duration from **actigraphy**	Mean **total** sleep duration (**subjective**)
Round #1 (baseline)	309.3 (121.2)	355.9 (163.0)	324.8 (136.7)	421.3 (33.5)
Round #2 (end Phase II)	357.1 (85.1)	481.9 (77.2)	410.6 (102.3)	437.9 (28.1)

Results in Table 4 (available for Alberta only) are similar to those seen for the entire sample (Table 3) in each round of data collection; namely, that these drivers (both rounds n=7) also tended to overestimate their sleep time (subjective average estimate of more than seven hours of sleep overall, including days off and work days), while actually obtaining an average of slightly over five hours of sleep (mean 309.3 minutes) during on-duty days, and less than six hours of sleep (mean 355.9 minutes) during off-duty days according to the actigraphy results. In the second set of data collection, after rapid introduction of the program and its interventional measures, on-duty sleep time for the group increased by 48 minutes, while off-duty sleep time increased by over 2 hours (mean 126 minutes). Although the change appears to be a significant improvement, the small sample size and the significant standard deviation preclude a statistically significant conclusion at this point. Of perhaps greater interest among this subset is that drivers increased their on-duty sleep time by some 48 minutes, which is exactly the same as the larger sample (Round #1 n=24; Round #2 n=10).

Also related to sleep duration are the results of the sleep apnea assessment and treatment process (see section 6.4). As noted above, ten drivers completed both rounds of data collection, although only seven had complete actigraphy data sets each time. Of these seven drivers, three were treated for either moderate or severe sleep apnea (via CPAP) between the first and second rounds of data collection. The other four drivers were determined either not

to have apnea at all, or to have a mild degree of apnea requiring only behavioural interventions. Table 5 shows the difference in sleep duration for these seven drivers.

Table 5 Change in mean total sleep duration (actigraphy data) for Alberta apnea group, in minutes (SD)

	Apnea group (n=3)	Non-apnea group (n=4)	Total group (n=7)
Round #1 (baseline)	236.4 (143.6)	381.9 (97.6)	324.8 (136.7)
Round #2 (end Phase II)	408.5 (69.3)	411.7 (106.5)	410.6 (102.3)
Percent Change	72.8%	7.8%	26.4%

Initial sleep duration among the apnea group was substantially less than the non-apnea group and increased dramatically after receiving treatment for their condition. On average, these drivers' sleep time increased by almost three hours in a 24-hour period (from 3.94 hours to 6.81 hours). This is a major contributing factor to the overall increase in sleep time determined for the groups discussed above. Although the increase in the non-apnea group was rather modest when compared to the change experienced by the apnea group, the non-apnea group still increased their sleep duration by 30 minutes.

7.3.2 Measures of Fatigue

The Phase II experience involved a host of measures to assess fatigue among participating drivers. Subjective ratings were obtained from several instruments included in the En Route Driver Survey (e.g. Stanford Sleepiness Scale, Somatic Symptom Checklist), with objective measures of fatigue being derived from psychomotor vigilance testing.

Stanford Sleepiness Scale (SSS)

The SSS was used as the primary tool for assessing driver fatigue subjectively. The instrument has seven anchors, implying different levels of fatigue and alertness, with 1 = Alert, wide awake, the most alert, through to 7 = Almost in reverie, hard to stay awake, the most sleepy.

Of the 29 Alberta drivers who completed the En Route Driver Survey in Round #1, only 21 complete SSS data sets were obtained (five drivers were bus operators who did not complete the mid-shift rating, while three additional drivers had incomplete ratings). Of these 21 drivers, 20 scored a 3 (not at full alertness) on the 7-point SSS during their assessment periods. Moreover, two drivers started every shift with a score of 3 or higher and two drivers ended every shift with a score of 4 (foggy) or higher. Seventy-seven percent of the drivers indicated that they were less than fully alert (i.e. SSS scores of 2-7) during the testing period, and 10 percent started or ended every driving period with moderate to severe levels of sleepiness (i.e. SSS scores of 5-7).

Table 6 shows a breakdown of the average SSS scores at the beginning, middle and end of the shift for each data collection period for the Alberta sample. These data suggest a pattern of increased sleepiness as the shift progressed, as well as across days of driving. The changes were more apparent, however, across the shift (average increase of 54 percent in Round #1, and 89 percent in Round #2) than across days of driving (average increase of 10 percent in Round #1, and 2 percent in Round #2). The table also reveals that less sleepiness occurred in the Round #2 data compared with that of Round #1, This indicates a clear improvement (negative percent values indicate less sleepiness), likely due to the increased sleep drivers obtained in Round #2 over Round #1.

Table 6 Mean (SD) SSS ratings at beginning, middle and end of shifts for days 1, 2 and 3 in each round of data collection, Alberta

Round #1 (n=13)	Day 1	Day 2	Day 3	Mean by time on shift
Beginning of Shift	1.64 (0.70)	1.91 (1.00)	2.05 (1.02)	**1.95(0.71)**
Middle of Shift	2.48 (1.45)	2.24 (1.23)	2.61 (1.23)	**2.49(0.98)**
End of Shift	2.84 (1.18)	2.83 (1.27)	2.86 (1.06)	**3.15(0.90)**
Mean by number of days on shift	**2.49(0.79)**	**2.51(0.87)**	**2.59(0.89)**	**2.53(0.75)**

Round #2 (n=4)	Day 1	Day 2	Day 3	Mean by time on shift
Beginning of Shift	1.29(0.49)	1.50(0.84)	1.80(0.84)	**1.60(0.64)**
Middle of Shift	1.5(0.58)	1.75(0.50)	1.33(0.58)	**1.44(0.51)**
End of Shift	2.6(1.14)	2.43(1.13)	1.75(0.50)	**1.92(0.63)**
Mean by number of days on shift	**1.92(0.50)**	**2.00(0.86)**	**NR[1]**	**1.77(0.84)**

% difference between pre and post	**-29.68**	**-25.5**	**NR[1]**	**-42.94**

[1]Not reported as only one subject consistently responded across categories

Table 7 shows the pre/post results for subjective sleepiness for Quebec. When looking at levels of sleepiness over the shift, data similar to Alberta emerges. Sleepiness increases from the beginning toward the end of the shift. However, over the three data collection days sleepiness appears to be higher on the first day. Also, the trend in the Quebec sleepiness data differs from that of the Alberta data when comparing Round #1 and Round #2 results. The

drivers reported higher sleepiness during the Round #2 data collection period than that of Round #1.

No post data collection was conducted for the Texas drivers (Table 8). However, sleepiness reported for the single collection period is similar to that found in Alberta and Quebec where it increases from the beginning to the end of the shift, and generally from the first day to the third.

What is not obvious from the summarized data for the first three work days are the number of drivers who rated themselves at: 5 = Fogginess, losing interest in staying awake; 6 = sleepiness, prefer to be lying down; and 7 = Almost in reverie, hard to stay awake on the SSS at the beginning, middle or end of a driving shift (see Table 9). Some drivers in all three jurisdictions reported high levels of sleepiness throughout the data collection period.

Table 7 Mean (SD) SSS ratings at beginning, middle and end of shifts for days 1, 2 and 3 in each round of data collection, Quebec jurisdiction

Round #1 (n=7)	Day 1	Day 2	Day 3	Mean by time on shift
Beginning of Shift	1.60 (0.55)	2.67 (2.08)	1.60 (0.55)	1.85 (1.07)
Middle of Shift	3.00 (1.87)	2.50 (1.22)	2.80 (0.84)	2.75 (1.29)
End of Shift	4.86 (1.07)	4.00 (1.26)	4.43 (1.51)	4.45 (1.28)
Mean by number of days on shift	3.35 (1.84)	3.13 (1.51)	3.12 (1.62)	3.20 (1.63)

Round #2 (n=6)	Day 1	Day 2	Day 3	Mean by time on shift
Beginning of Shift	2.25 (0.5)	2.60 (0.55)	3.00 (1.10)	2.67 (0.82)
Middle of Shift	3.50 (1.52)	2.00 (1.10)	2.80 (0.84)	2.76 (1.30)
End of Shift	5.00 (1.55)	4.50 (1.38)	4.33 (1.51)	4.61 (1.42)
Mean by number of days on shift	3.75 (1.69)	3.06 (1.52)	3.41 (1.33)	3.40 (1.51)

% difference between pre and post	**10.7**	**2.3**	**8.5**	**5.9**

Table 8 Mean (SD) SSS ratings at beginning, middle and end of shifts for days 1, 2 and 3 at baseline, Texas jurisdiction (n=5)

	Day 1	Day 2	Day 3	Mean by time on shift
Beginning of Shift	2.20 (0.84)	2.00 (1.00)	2.20 (0.84)	2.13 (0.83)
Middle of Shift	2.20 (0.84)	1.75 (0.96)	2.40 (1.52)	2.14 (1.10)
End of Shift	2.60 (0.55)	3.00 (1.73)	3.40 (2.51)	3.00 (1.69)
Mean by number of days on shift	2.33 (0.72)	2.29 (1.33)	2.67 (1.72)	2.43 (1.30)

Table 9 Number of drivers by site, days and time on shift with scores of >5 on the SSS

		Day1			Day2			Day3			
Site & SSS		beg	mid	end	beg	mid	end	beg	mid	end	TOT
AB											
N=23	5	1	1	3		1	3			2	11
	6		2			1					3
	7										
Que											
N=7	5			3	1		2				6
	6			2	1		1				4
	7					1					1
Texas											
N=6	5	1	1							2	4
	6						1				2
	7										0
TOTAL		2	4	8	2	3	7	0	0	4	31

Somatic Symptom Checklist

The 5-point Somatic Symptom Checklist was also included in the En Route Driver Survey. Due to a marked amount of missing data, only 14 of the 29 drivers in Alberta round #1 had useable data sets. In the data presented in Figures 6 to 10, the ordinate scale values on all graphs based on a 5-point scale truncated to show what differences are present. It should be noted that all differences in physical symptoms are small and do not represent extreme values of these symptoms (3 being moderate symptoms). Nevertheless, Figures 6 to 10 appear to show changes that would be consistent with expectations across time and shifts.

As shown in Figures 6 to 10, such physical symptoms directly associated with fatigue tended to increase toward the end of the shift for all jurisdictions and data collection periods (headache and stomach disturbances were rarely identified, however). Data are presented for the first three consecutive days of driving in all cases. A similar trend was seen among those

drivers who completed the second round of en route data collection in Alberta. The second round data also shows a reduction in the fatigue scores when compared to the baseline (Round #1) data.

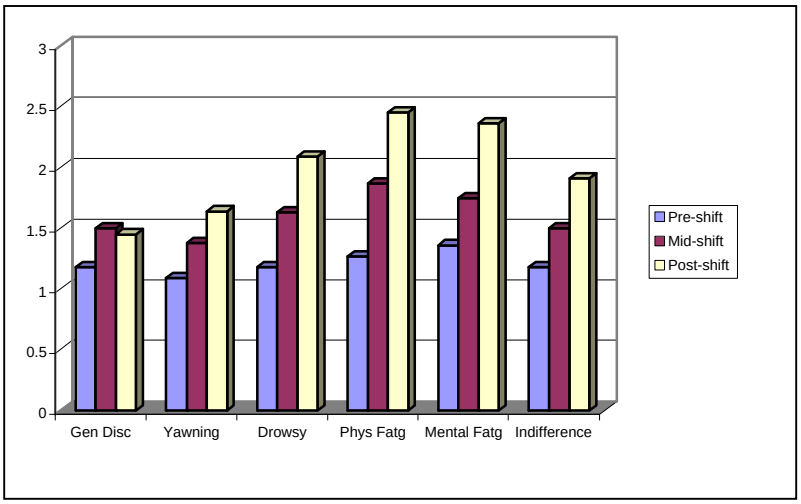


Figure 6 **Symptoms of general discomfort (Gen Disc), yawning, drowsiness (Drowsy), physical fatigue (Phys Fatg), mental fatigue (Mental Fatg), and indifference within a shift <u>at baseline</u> (Alberta jurisdiction, n=14)**

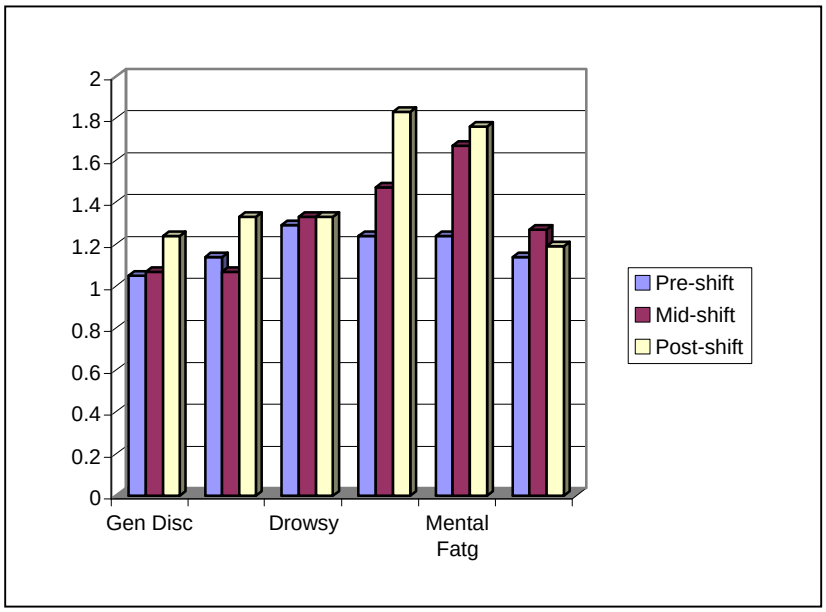


Figure 7 **Symptoms of general discomfort (Gen Disc), yawning, drowsiness (Drowsy), physical fatigue (Phys Fatg), mental fatigue (Mental Fatg), and indifference within a shift <u>at end of Phase II</u> (Alberta jurisdiction, n=6)**

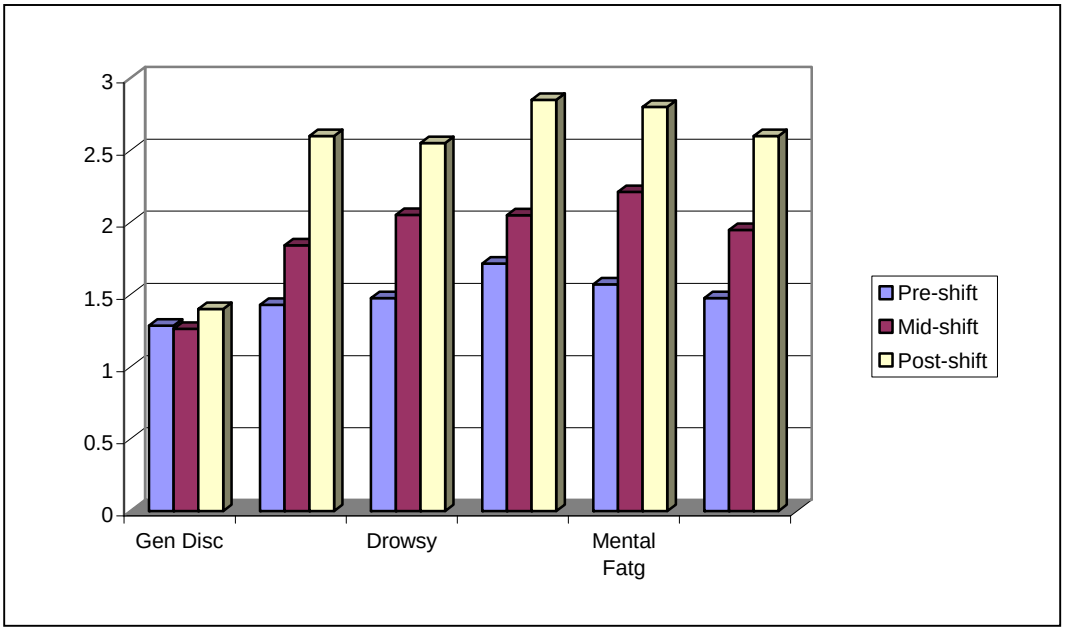


Figure 8 **Symptoms of general discomfort (Gen Disc), yawning, drowsiness (Drowsy), physical fatigue (Phys Fatg), mental fatigue (Mental Fatg), and indifference over the course of a shift <u>at baseline</u> (Quebec jurisdiction, n=7)**

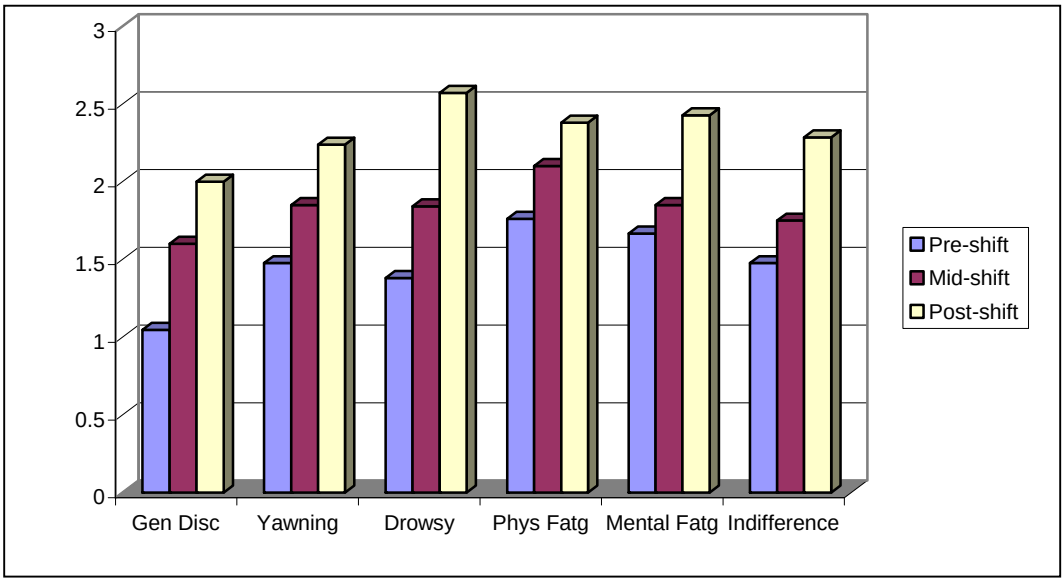


Figure 9 **Symptoms of general discomfort (Gen Disc), yawning, drowsiness (Drowsy), physical fatigue (Phys Fatg), mental fatigue (Mental Fatg), and indifference within a shift <u>at end of Phase II</u> (Quebec jurisdiction, n=7)**

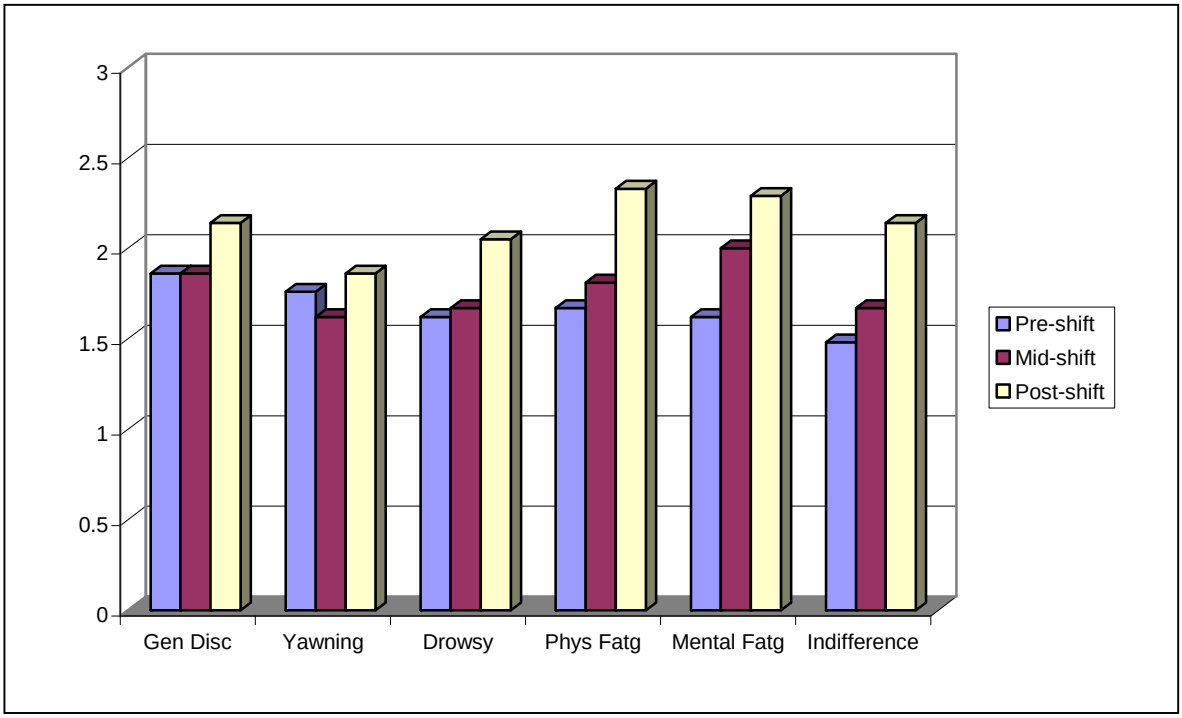


Figure 10 Symptoms of general discomfort (Gen Disc), yawning, drowsiness (Drowsy), physical fatigue (Phys Fatg), mental fatigue (Mental Fatg), and indifference over the course of a shift at baseline (Texas jurisdiction, n=7)

Current Mood, Subjective Workload and Fatigue & Alertness Assessments

The remaining three components of the En Route Driver Survey (Current Mood Assessment, Subjective Workload Assessment, and Fatigue & Alertness Assessment) did not yield any consistent findings for either data collection period.

Psychomotor Vigilance Test

During Phase II, the PVT was used as the basis for measuring driver fatigue objectively. This 10-minute test of a driver's reaction times was completed at the beginning, middle and end of each shift. No consistent changes were found when mean reaction times were summarized. Given that most data from the PVT is reported in terms of lapse data, that data is reported in this document. As will be seen, the number of lapses (reaction time > 500 ms) occurring is more revealing (Tables 10 and 11).

Table 10 Number of drivers by site, days and time on shift with scores of >300 ms for the PVT

		Day1			Day2			Day3			
Site PVT mean RT>300		beg	mid	end	beg	mid	end	beg	mid	end	TOT
AB											
N=19	>300	3	2	1			2	1	2	2	13
	>400										
	>500										
Que											
N=8	>300	1	1	1		1	2	1		1	
	>400		1	1					1	2	5
	>500										
Texas											
N=55	>300	1			1	1		1			4
	>400										
	>500										
TOT		5	4	3	1	2	4	3	3	5	22

The PVT data for lapses (reaction time responses in excess of 500 ms) are reported in Tables 10 to 15 for the different assessment periods in each jurisdiction. These data provide evidence in the expected direction of increasing fatigue with time and days on shift though this is not the case uniformly. However, for all data points the standard deviations are greater than the means themselves, which indicates that the sample was not large enough to reliably capture the impact of the FMP on PVT lapses.

With the above caveat in mind, the PVT data generally show an increase in lapses over the duration of the shift. At baseline, lapses in attention were seen in 23 percent and 40 percent of drivers during the middle and at the end of the shift, respectively. Eight drivers had no lapses, whereas two drivers had 23 and 15 lapses respectively across driving days. As well, 20 percent of drivers had three or more lapses during at least one 10-minute test period per shift.

Table 11 Mean PVT lapses within and across three work shifts at baseline, Alberta jurisdiction (n=19)

	Day 1	Day 2	Day 3	Mean by time on shift
Beginning of Shift	1.60(2.8)	0.9(1.1)	0.61(1.1)	1.03(1.7)
Middle of Shift	1.12((1.4)	1.37(3.1)	1.06(1.2)	1.18(1.9)
End of Shift	0.94(1.9)	1.05(1.8)	0.56(0.9)	0.85(1.5)
Mean by number of days on shift	1.22(1.1)	1.11(1.0)	0.74(0.6)	1.02(1.7)

Table 12 Mean PVT lapses within and across shifts at end of Phase II, Alberta jurisdiction (n=10)

	Day 1	Day 2	Day 3	Mean by time on shift
Beginning of Shift	0.36(0.7)	0.45(0.8)	0.6(1.3)	0.47(0.9)
Middle of Shift	0.6(0.9)	0.67(1.7)	0.44(1.0)	0.57(1.2)
End of Shift	0.36(0.5)	1.09(2.2)	0.(0.7)	0.70(1.1)
Mean by number of days on shift	0.44(0.7)	0.73(1.5)	0.58(1.0)	0.58(1.1)

Table 13 Mean PVT lapses within and across shifts at baseline, Quebec jurisdiction (n=8)

	Day 1	Day 2	Day 3	Mean by time on shift
Beginning of Shift	0.71 (1.50)	2.75 (6.23)	2.25 (3.88)	2.23 (1.50)
Middle of Shift	1.00 (1.53)	3.50 (6.48)	3.88 (7.90)	2.79 (5.30)
End of Shift	3.63 (5.58)	3.75 (5.28)	5.75 (10.50)	4.38 (7.12)
Mean by number of days on shift	2.11 (2.87)	3.33 (5.99)	3.96 (7.42)	3.13 (5.43)

Table 14 Mean PVT lapses within and across shifts at end of Phase II, Quebec jurisdiction (n=7)

	Day 1	Day 2	Day 3	Mean by time on shift
Beginning of Shift	n/a	1.57 (3.74)	2.14 (4.38)	1.86 (4.06)
Middle of Shift	n/a	1.00 (1.73)	3.33 (6.71)	2.16 (4.22)
End of Shift	9.00 (15.70) excluded	8.14 (14.33)	5.29 (10.69)	6.75.(9.04)
Mean by number of days on shift	n/a	3.57 (6.6)	3.59 (7.26)	3.57 (6.93)

Table 15 Mean PVT lapses within and across shifts at baseline, Texas jurisdiction (n=4)

	Day 1	Day 2	Day 3	Mean by time on shift
Beginning of Shift	1.00 (1.15)	0.50 (0.58)	0.50 (0.58)	0.67 (0.78)
Middle of Shift	0.00 (0.00)	0.50 (0.58)	1.25 (1.26)	0.58 (0.9)
End of Shift	0.25 (0.50)	0.50 (0.58)	0.25 (0.50)	0.33 (0.49)
Mean by number of days on shift	0.42 (0.55)	0.50 (0.58)	0.67 (0.67)	0.53 (0.60)

In order to best understand the PVT data given the variability in numbers of subjects contributing to the data, lapses were compared for those drivers who completed both rounds of data collection in Alberta (n=9). For this Alberta cohort, data were collected prior to and following the FMP intervention. As can be seen in Figure 11, attentional lapses increase from the beginning of the shift to the end of the shift 100 percent prior to the FMP but only by 52 percent following the FMP intervention. Moreover, following the FMP implementation overall lapses declined by 44 percent with most of this improvement coming from post-shift improvements. Such results are encouraging with regard to the potential success of the proposed FMP.

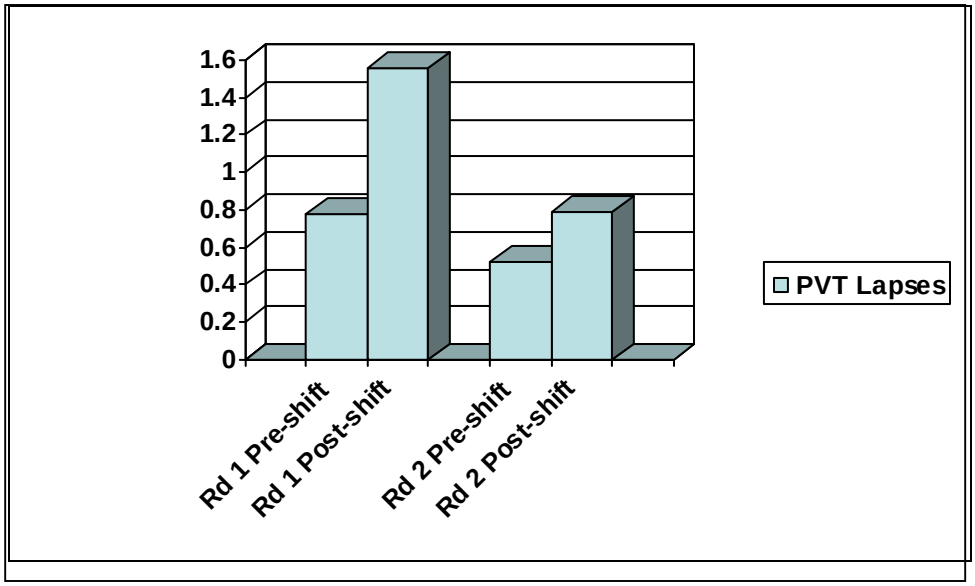


Figure 11 Pre- vs. post-shift comparison of mean PVT lapses for both rounds of data collection, Alberta jurisdiction (n=9)

7.4 Sleep Disorder Screening. Assessment, and Treatment Data Results

The data related to sleep apnea screening are shown in Table 16 for the 35 drivers who completed this portion of the study (21 in Alberta, 7 in Quebec and 7 in Texas). The table includes the results of the Edentrace and SleepStrip® screening tools (Alberta and Texas only), the subjective measure of sleepiness as determined by the ESS, and the results from the sleep disorder diagnostic assessment (PSG).

In assessing for the prevalence of sleep apnea in this sample, 28 of 35 drivers had an Edentrace RDI measure, 33 of 35 had an Epworth score, and 27 of 35 drivers were studied in the laboratory. All positive index cases on the Edentrace ambulatory screening study subsequently participated in a full diagnostic PSG.

It should be noted that the RDI was used to assess the PSG RDI measure using the severity criteria used by Pack (2002) for the Texas data. This severity criteria has become the accepted standard. The severity criteria according to the Pack et al. approach are: an RDI of 5 to 15 indicates mild sleep apnea, 15 to 30 represents moderate sleep apnea, and greater than 30 represents severe sleep apnea. For this analysis the Pack et al. criteria is used.

Table 16 Sleep disorder screening results

GROUP	SUBJECT	ESS	SLEEPSTRIP ® RESULT	AMBULATORY RDI	PSG RDI
ALBERTA	1	7	AHI = 82	76.5	64.9
	2	N/A	N/A	37.6	13.6
	3	9	AHI = 34	42.1	34.1
	4	16	AHI = 2	4.5	7.8
	5	6	AHI = 4	8.4	N/A
	6	6	AHI = 2	3.4	N/A
	7	7	AHI = 12	32.3	13.4
	8	15	AHI = 24	6.6	N/A
	9	3	N/A	29.5	14.7
	10	6	N/A	1.4	5.1
	11	5	AHI = 2	6.3	3.1
	12	8	AHI = 2	14.4	11.8
	13	3	N/A	14.2	17.5
	14	4	AHI = 28	21.7	6.7
	15	4	AHI = 2	10.5	N/A
	16	7	AHI = 4	22.5	9.7
	17	10	AHI = 28	16.9	3.0
	18	2	N/A	1.3	9.6
	19	8	N/A	3.1	N/A
	20	10	AHI = 2	3.8	1.2
	21	6	N/A	11.9	N/A
QUEBEC	01	3	N/A	N/A	5.9
	02	10	N/A	N/A	4.4
	03	4	N/A	N/A	0.0
	05	9	N/A	N/A	5.4
	06	7	N/A	N/A	7.5
	07	8	N/A	N/A	2.9
	08	N/A	N/A	N/A	5.6
TEXAS	01	7	Score = 0	3.1	N/A
	03	7	N/A	15.8	5.0
	04	7	Score = 0	13.5	12.8
	05	3	Score = 1	27.6	15.4
	06	14	Score = 2	17.5	6.9
	07	7	Score = 0	2.8	N/A
	08	19	Score = 2	13.4	5.0

The number of positive index cases based on the Pack criteria and the Edentrace were 6 mild, 4 moderate and 4 severe sleep apnea cases (total of 14) of the 21 drivers in Alberta and 2 mild and 3 moderate sleep apnea cases of the 7 drivers in Texas. Although the PSG confirmation assessment changed the severity of the degree of sleep apnea in some cases, only 2 cases changed the diagnosis of sleep apnea in Alberta – one case of moderate sleep apnea on screening was not verified as sleep apnea by PSG and one case of no apnea became a mild sleep apnea case by PSG assessment. For the Texas cohort of 7 drivers, 2 cases of moderate apnea were confirmed as mild apnea.

Thus, 67 percent of the drivers in Alberta and 70 percent in Texas drivers were screened to have some degree of sleep apnea and only one of these 28 drivers was not confirmed to have sleep apnea while one who was not a positive case had sleep apnea to a mild extent. Overall, there was a 93 percent accuracy of the Edentrace screening tool for diagnosing sleep apnea.

7.5 Evaluation of the Educational Modules

Feedback obtained on the educational modules in the Alberta and Quebec pilot studies, while positive, was carried out mainly on an ad hoc basis. Notwithstanding the favourable comments received from drivers and company management as to the value and comprehensiveness of the training, it was recognized that a more structured method of collecting feedback was required. As a result, a Participant Evaluation form was pilot-tested in Texas as a means of capturing data on reaction to the training (this was administered to participants in all modules, with the exception of the *Family Forum*).

In addition, a quiz was delivered to the Texas drivers both before and after the *Driver Core* session, as well as each of the supplementary modules, in an effort to quantify the learning obtained from these modules. In all cases, participants were asked to complete the pre-module quiz just before the module commenced. After each module, the participants were asked to complete the post-module quiz. In an attempt to obtain complete responses, all participants were reminded of the need to complete both quizzes; however, several individuals did not complete all of the post-module quizzes. The evaluation forms and quizzes used in Texas have been attached to this report (Appendix G), and the results of these assessments are presented below.

7.5.1 Measures of Reaction to Training

Driver Core Module

- 6 of the 7 drivers of the Texas drivers rated the module overall as "excellent" (the highest rating on the five-point scale), with the remaining 25 percent rating the module as "very good". The same ratings were obtained for the workshop materials (i.e. participant handbooks and PowerPoint presentation).

- All drivers rated the trainer as "excellent" in terms of subject matter knowledge, encouraging group discussion, answering questions clearly and engaging the audience.

- 75 percent of the drivers found the session length (3-4 hours) to be "just right", with the remaining 25 percent rating it as "too short".

- All drivers either "agreed" or "strongly agreed" that the training content was relevant to their job, that the course would help reduce their fatigue, and that they planned to use the strategies learned in the course to reduce their fatigue.

- 75 percent of the drivers rated themselves as being "completely" engaged in the training and participating in the discussion, with the remaining 25 percent rating themselves as being "somewhat" engaged in the session.

- Those elements found to be the most useful were the information on the causes and effects of driver fatigue and the importance of sleep quality (i.e. more than just the quantity of sleep one gets). No comments were made as to the elements of the module found to be the least useful, and no changes to the module were suggested.

FMP for Managers and Dispatchers

- All participants rated the module overall as "excellent" (the highest rating on the five-point scale), and also rated the workshop materials (i.e. participant handbooks and PowerPoint presentation) as "very good".

- All participants rated the trainer as either "excellent" or "very good" in terms of subject matter knowledge, encouraging group discussion, answering questions clearly and engaging the audience.

- All participants found the session length (1.5 hours) to be "just right".

- All participants "agreed" that the training content was relevant to their job, that the course would help reduce their fatigue, and that they planned to use the strategies learned in the course to reduce their fatigue. *****

- All participants rated themselves as being "completely" engaged in the training and participating in the discussion.

- No comments were noted as to the most/least useful elements of the module, nor for suggested improvements to the module.

***** Note: Given that this module is intended to provide company management with the knowledge to help drivers reduce their fatigue (i.e. not the fatigue of the managers themselves), these items should be modified accordingly for Phase III.

Supplementary Modules*

Trip Planning module

- Overall assessment of the module according to the participants was that it was excellent (100 percent).
- Most of the participants (80 percent) rated that the trainer as excellent in all areas.
- All of the participants rated the training materials as excellent.
- All agreed that the duration of the module was just right.
- The majority (80 percent) strongly agreed that the training materials were relevant to their job.
- All strongly agreed that the module will help them reduce their fatigue and that they plan to use the strategies learned in the module to help reduce their fatigue.
- Most (80 percent) of the participants responded that they were completely or mostly actively engaged in the training and participated in the discussion.

None of the participants identified information that was least valuable to them, nor found that anything they felt was missing from the module.

Wellness and Lifestyle module

- The participants rated the module as excellent (60 percent), or very good (40 percent).
- Generally, the participants rated the trainer excellent (80 percent) or very good (20 percent).
- The participants responded that the workshop materials were excellent (60 percent) or very good (40 percent).
- They all felt that the module was just right in duration.
- Most of the participants (80 percent) strongly agreed that the training material was relevant to their job.
- Most (80 percent) of the participants strongly agreed or agreed that the module will help them reduce their fatigue and felt that they would use the strategies they learned, and that they were actively engaged in the training and participated in the discussion.

Sleep and Sleep Disorders module

- The majority of participants (80 percent) rated the module, overall, as being excellent.
- The participants rated the trainer's knowledge, ability to answer questions clearly, and enthusiasm as excellent (80 percent).
- The workshop materials were generally rated as excellent.
- Most of the participants found the module just right in duration (80 percent), and one participant (20 percent) found the module too short.
- The majority of the participants (80 percent) strongly agreed or agreed that the training material was relevant to their job, that the module will help them reduce their fatigue, they plan to use the strategies learned, and that they were actively engaged in the training and participated in the discussion.

* Note: The supplementary modules were tested only with the Texas drivers, as they were not available for the Alberta and Quebec drivers.

While the number of assessments completed is too small to make any definitive conclusions about the value of these educational modules (between 2 and 6 responses were obtained for each module), the results obtained give an indication that they are perceived as useful in terms of providing the participants with the information and tools required to reduce their fatigue. In addition, many concepts from the *Driver Core* module were reinforced during the supplementary modules, as suggested by the questions asked by the participants and their discussions during the session; however, a more comprehensive test of knowledge would be required to determine how effective this was.

8 DISCUSSION

The Fatigue Management Program for North American Commercial Motor Carriers research project marks the first time that a broad spectrum, comprehensive FMP consisting of educational, clinical and operational interventions has been implemented and studied in a commercial motor vehicle operational setting. In that regard, it is an ambitious project.

In part due to the very nature of the research project – that of conducting ongoing research over a number of months in an active commercial motor carrier setting – a number of limitations were encountered. In assessing the outcomes, it must be kept in mind that this is a complex field study and in that context, normal routes and business practices are maintained by companies and drivers during the duration of the study.

Sample numbers are, for the most part, small and therefore cannot be taken as substantive evidence for or against effectiveness of either specific components of the FMP, or of the full program implementation. As a consequence, it is important to emphasize that while the findings at this point are interesting and useful, the data should not be generalized to the CMV driver population as a whole. The following discussion should be viewed as preliminary pilot data and observations, albeit identifying some interesting results and pointing to the need for further research in this area.

In all jurisdictions, missing data from the en route, as well as the sleep apnea screening and treatment activities further lessened the completeness of the data. However, the purpose of Phase II was to test the implementation of the program, as well as the data collection processes and measures. Phase II provides recommendations for ways to solve these problems. The Phase III study can benefit from the wisdom of these recommendations.

Finally, the nature of the field data collection process is such that the drivers themselves must be compliant with regard to completing measures at required times, and even with full intended compliance on the part of the drivers there are times when they simply cannot do what is expected of them. Therefore, the Phase III sample must be large enough to accommodate such limitations.

8.1 Sleep Duration

Both the subjective and objective en route data collected during Round #1 and Round #2 supported the need for action to deal with issues of fatigue in this population. While almost 56 percent of the drivers identified subjectively the need for seven or more hours of sleep in order to feel fully alert, 67 percent of the sample reported to be getting less than their ideal requirement. In spite of that recognition, there is still a tendency to overestimate the actual sleep time obtained during the en route period of data collection. During the initial round of testing for Alberta, drivers on average estimated that they were obtaining slightly over 7 hours of sleep per day and that estimate increased in the second round to 7.3 hours of sleep. However, the actigraphy data demonstrated that these Alberta drivers overestimated the amount of sleep they obtained in Round #1 by more than 1.7 hours (about 25 percent) while those in Round #2 overestimated their sleep by about 42 minutes (10 percent).

These data also show drivers were obtaining approximately ½ hour more sleep than did the data in the Fatigue and Alertness Study (Wylie et al., 1996). However, similar to the Wylie et

al. study, drivers showed that they obtained substantially less sleep on a daily basis than their stated ideal requirements. Clearly, if drivers obtain less sleep than they feel they need in order to feel alert and refreshed, then they are at an increased risk for fatigue-related difficulties. While individuals differ in the amount of sleep they need to feel alert and refreshed, failing to achieve optimal levels supports the assertion that such drivers are potentially at risk. In addition, these findings tend to be consistent with research related to shift-workers, who are also found to obtain less sleep per night than the general population (National Sleep Foundation, 2000).

The above data tend to suggest that drivers are therefore continuously building up a sleep debt as the week progresses. While the Alberta drivers reported that on off-duty days they often slept 8 hours or more in order to recover from the work-week, Round #1 actigraphy data suggest that they continue to obtain less than their ideal sleep (5.7 hours compared with an average of 7 hours for the ideal) and are therefore not obtaining the level of recovery that was either estimated or required. During Round #2, drivers' on-duty sleep actually increased from 5.1 hours per 24-hour period in Round #1, to 5.9 hours per 24-hour period, while off-duty sleep increased from 5.7 to 7.6 hours per night according to Actigraphy data.

Overall, when drivers participated in both rounds of data collection before and after the FMP program, their on-duty sleep time increased by 48 minutes. While not conclusive, these data suggest that the FMP can lead to substantial increases in on-duty sleep time that would reduce the fatigue of drivers.

The results of the sleep apnea assessment and treatment process appeared to lead to marked improvements in sleep duration. As noted above, ten drivers completed both rounds of data collection, although only seven had complete actigraphy data sets each time. Of these seven drivers, three were treated for either moderate or severe sleep apnea (via CPAP) between the first and second rounds of data collection. The other four drivers were determined either not to have apnea at all, or to have a mild degree of apnea requiring only behavioural interventions.

Initial sleep duration among the apnea group was substantially less than the non-apnea group and increased dramatically after receiving treatment for their condition (from 3.94 hours to 6.81 hours, nearly a three-hour improvement). Although the increase in the non-apnea group was rather modest when compared to the change experienced by the apnea group, the non-apnea group still increased their sleep duration by 30 minutes.

Despite the fact that the sample size of those treated for apnea (n=3) precludes any general conclusions, these data are consistent with the assertion that CPAP is effective in increasing the quantity of sleep among apnea sufferers and thus, the concept of sleep disorder screening and treatment should serve as an integral component of any FMP for the CMV driver population. Moreover, the non-apnea group also showed real increases in sleep duration, which is consistent with the assertion that generally, FMP intervention can also show benefit in terms of sleep duration.

Taking into consideration the limitations of overall sample size, and the fact that full implementation of the FMP did not occur prior to completion of the second round of data collection, the changes in driver sleep both for apnea sufferers and non-apnea sufferers do suggest a potentially positive result arising from the FMP implementation.

8.2 Fatigue

When conducting the baseline research, it was clear from the drivers' response to the questionnaire that they find their occupation to have a strong element of fatigue associated with it. A majority of the drivers consider their work to be both highly mentally demanding (71 percent) and highly stressful (61 percent). When this finding of significant mental demand is combined with high stress and limited sleep as noted in earlier sections, this may lead to increasing the risk of fatigue-related incidents (Mitler et al., 1988).

Conventional wisdom supports that most individuals require 6 to 8 hours of sleep per day in order to function at peak efficiency. Consistent with this thinking, 56 percent of the drivers indicated that they required at least 7 hours of sleep in order to feel alert. However, a significant majority of the drivers (67 percent) reported that on a regular basis they were getting less sleep than they require, while 21 percent reported going more than 20 continuous hours without sleep during the two weeks preceding questionnaire completion; as well, 31 percent reported nodding off or falling asleep while driving to or from work during the past year.

As could be expected under such circumstances, drivers also reported making mistakes or mental errors due to fatigue, with 81 percent reporting making mistakes at least several times a year and 33 percent at least several times per month. The fact that 50 percent also reported sometimes being drowsy while working and 19 percent reported sometimes or frequently drifting into sleep while working, raises additional concern for driver and public safety and supports the need for programs to effectively deal with sleep and fatigue matters in this population. Parenthetically, other shift worker populations report similar sleep and fatigue-related difficulties (Davis et al., 1999; Heslegrave, Reinish et al., 1999; Heslegrave, Rhodes et al., 2000; National Sleep Foundation, 2000).

During the initial round of en route testing it was noted that somatic symptoms directly associated with fatigue tended to increase over the length of time on task, with drowsiness, physical and mental fatigue increasing by the greatest margins. The finding that task duration affects physical and mental fatigue is a common finding in the ergonomic and human factors literature and is described in all textbooks in this area.

Of particular interest are the results of the SSS. These data show a trend of increasing fatigue levels across the shift from beginning to end (by about 35 percent) and also across days 1 to 3 (by about 8 percent) demonstrating the impact of driving duration within and across shifts. Unfortunately, it would not be appropriate to draw a parallel of this finding with other studies such as Wylie et al., since the purposes and methodologies of the two studies were different (suffice to say that time on task effects were confounded with time of day effects for this pilot study, and the design could not allow these factors to be separated). While the sample size is too small to draw definitive conclusions, the results are consistent with increasing fatigue within and across driving shifts, thus providing added support with regard to the potential impact of the FMP. However, it must be emphasized that while this pattern generally held for the beginning and middle portions of the shift, it reversed at the end of the shift. Regrettably, no analyses were completed to afford any speculation on whether there were differences in shift length or time of day effects that could have led to this anomalous finding. Such

analyses will, however, be completed in subsequent phases of this research, should a similar pattern present itself.

The PVT data were also of interest. During Round #1 of the en route data collection, PVT lapses were noted to increase over the duration of a shift with 23 percent of the drivers demonstrating lapses in attention at mid-shift and 40 percent demonstrating lapses at the end of the shift. Figure 11 provides a graphic comparison of the PVT data for the group of drivers who completed the data collection process in both Rounds #1 and # 2. Taking into consideration the size of this sample and the fact that it also contained two drivers who had been treated for sleep apnea, the data are consistent with expectations that there would be a drop in PVT lapses and, by extension, a drop in driver fatigue following FMP intervention. In this case, the data show decreases in lapses both pre and post shift. These data are consistent with the interpretation that the FMP potentially contributed to this change.

8.3 Sleep Disorder Screening

Overall, the results of this study show the value of a step-wise approach to OSA screening, whereby only those individuals screened as having a possible sleep disorder were referred to the sleep laboratory. The results showed that ambulatory screening was successful in screening those with and without sleep apnea and could be a cost-effective method for companies to screen for sleep apnea. The SleepStrip® was introduced to the process in an attempt to find an additional tool that would provide an even more cost-effective preliminary screening device, and while results from the Alberta pilot revealed a number of technical difficulties with this device, the upgraded model used in the Texas pilot showed little of the same. As a result, the preliminary findings suggest promise for such a tool in the future, although further validation will be required through additional research such as that planned for Phase III.

If the scoring criteria from Pack et al. (2002) are used, this pilot study identified 60 to 70 percent of the sample drivers with at least a mild degree of sleep apnea. This high prevalence of at least a mild degree of sleep apnea in the sample CMV driver population is similar to the prevalence rate reported by Stoohs et al. (1995). As such, it is significantly higher than the prevalence rate reported in the Pack study, which was similar to the rates noted in the general population. While this finding raises an important question regarding further research in this area, the differences in study methodology and the limitations of our sample size preclude us from making definitive conclusions regarding that comparison. The Pack study involved a much larger sample size and was younger overall than the mean age of our driver sample. As previously discussed, there is also a possibility that our sample was somewhat skewed by volunteer bias if individuals suspecting that they might be having a problem tended to be more likely to volunteer in order to obtain a diagnosis and treatment more readily than the public medical system would provide.

While there are a number of potential explanations for the differences between the Pack results and those in Phase II, the Phase II data suggest that sleep disorders and sleep apnea are potentially high in this population. A larger sample in Phase III will be necessary to evaluate these findings. However, from the perspective of the potential value of the FMP, these results suggest that the sleep disorder component of the FMP may have a dramatic impact on the sleep duration of CMV drivers. This is reflected by the fact that Phase II drivers diagnosed

with moderate to severe sleep apnea (44 percent of drivers fell into these categories) and, of those drivers in the Alberta sample, those apneic drivers increased their sleep duration by nearly 3 hours following the FMP intervention.

8.4 Educational Modules

The implementation, acceptance and effective utilization of an FMP into an ongoing commercial operation is a significant exercise in creating and sustaining organization change. As such, it requires commitment and understanding at all levels in the organization but most particularly among senior leadership, managers, dispatchers and the drivers who are most directly affected. The modules designed for this research project were broadly based and focused on providing both the groups identified above as well as drivers' families with the level of understanding required to support the ongoing FMP. Based on the learning from the Phase II studies in Alberta and Quebec, a number of changes were made to the delivery of the educational Modules in the Texas pilot:

i) **Elimination of a train-the-trainer approach in favour of experienced trainers:** Project staff experienced in training delivery to adult audiences, and with sufficient subject matter knowledge, delivered all training in the Texas pilot, which allowed for a more consistent and higher quality of training to be presented to company managers and dispatchers, drivers and their families. Such an approach worked very well and is thus recommended for Phase III.

ii) **Delivery of baseline education to all stakeholders at the same time:** Recognizing the role that company management and drivers' families play in the project, as well as their ability to influence changes in driver behaviour (not to mention compliance with study procedures and timelines), the baseline educational modules (*Driver Core* module, *FMP for Managers and Dispatchers*, as well as the *Family Forum)* were all delivered at the outset of the FMP interventional period, in a period of less than one week for the Texas pilot.

iii) **Development of a strong collaboration with the participating carrier:** The ability to deliver the baseline educational modules in a matter of days was a testament to the positive collaboration developed with participating company from well before the project began. In particular, having local management involved in the planning and delivery of the educational modules made it clear to the drivers and dispatchers that the company stood behind this study, thereby adding additional credibility to the research (local management were present for the delivery of each educational module). Moreover, local management assisted with the logistics of the deliveries (i.e. scheduling dates convenient for the drivers, issuing reminders, and taking care of all food and beverage requirements for the participants and trainers). As stated previously, the visible support provided by the participating carrier was critical to the success of this study overall, and a similar approach should definitely be fostered in Phase III.

iv) **Implementation of a formal evaluation process:** Participant evaluation forms and pre/post quizzes were piloted for a number of the educational modules in Texas. Feedback from these tools showed that participants found the modules to

be highly valuable and useful, that the trainers were knowledgeable, that the training materials were effective, that the modules were of the proper duration, that the content was relevant to their job, and that they planned to use the strategies presented during the session to reduce their fatigue. The pre/post quizzes also showed that drivers increased their knowledge after taking part in the modules. While the number of assessments completed is too small to make any definitive conclusions about the value of these educational modules (response rates for each module were only 50 percent), the results obtained give a strong indication that they are perceived as useful in terms of providing the participants with the information and tools required to reduce their fatigue.

While the Phase II experience with the educational modules was largely positive, there are still a number of opportunities for improvement that should be noted for Phase III. These are detailed as follows:

8.4.1 Content of the *FMP for Managers and Dispatchers* module

"Dispatching Guidelines" were originally intended as a stand-alone product to be provided to managers and dispatchers. However, when considering the importance of delivering FMP training to these groups early in the FMP process, as well as providing them with assistance to change behaviours as a means of creating an environment supportive of effective fatigue management, it made sense to incorporate those guidelines into the *FMP for Managers and Dispatchers* module.

When this module is delivered at the outset of the FMP intervention during Phase III, in conjunction with the visible commitment to the project by the leadership of the participating companies, it will increase the probability of dispatchers taking fatigue management principles into consideration when scheduling drivers' routes. While the guidelines themselves represent current "best practice" approaches for scheduling CMV drivers, the Phase II experience demonstrated that the participating companies (especially dispatchers) could have benefited from additional support to integrate the recommendations into their scheduling practices. Methods to improve this level of support are recommended for future phases of this research.

8.4.2 Participation at the *FMP for Managers and Dispatchers* module

As Phase III will strive to generate cultural change within the companies' local operations, it is vital that all management and dispatching staff attend this module in order to promote fatigue-conscious decision-making at all levels of the operation. As a result, multiple deliveries of the *FMP for Managers and Dispatchers* module may be required within each jurisdiction. Further, these deliveries should be scheduled in such a fashion as to maximize group size in each session in order that a healthy discussion is generated by the participants, thereby maximizing the chance of behaviour change as a result of group decision-making. The strategies of training and group discussions were shown to be most useful in a study by Gregersen et al. (1996) as a means of improving road safety among drivers in a large European utility company.

In addition to the above, beyond maximizing the participation of local management in this module, Phase III should also look to involve key personnel from the participating carriers' major clients as a means of providing them with an introduction to the FMP and gaining their buy-in to the study. In doing so, the FMP should be marketed to the carriers' clients as an initiative undertaken by the carrier to improve their safety practices, thereby maximizing the likelihood of delivering their products safely and on time. In terms of learning for Phase III, the desire to involve the carrier's clients as stakeholders in the *FMP for Managers and Dispatchers* module should be addressed at the very outset of the project, during the relationship-building phase with the carrier. Such participation is highly recommended in Phase III as a means of demonstrating to the companies' local management groups the support offered to the FMP by their most important clients.

8.4.3 Order of the Supplementary Modules for Drivers

An assessment of the educational modules, particularly the delivery schedule for the supplementary modules, was done based on their potential of influencing behaviour change on the part of the drivers. In this regard, the *Trip Planning* module was judged to be the most important in terms of its impact on the day-to-day behaviour of drivers (this module focuses on what the driver has to do in order to better plan his/her work schedule, taking fatigue management principles into consideration) and, as such, it was decided that this module should be delivered prior to the other two. The second module in order of priority would then be *Wellness and Lifestyle* (also because of its emphasis on changes in driver behaviour), and finally, *Sleep and Sleep Disorders* because it is primarily a reinforcement of the material initially provided in the *Driver Core* module.

8.4.4 Logistics of the *Family Forum*

In all jurisdictions, delivering the *Family Forum* as planned proved to be difficult. In organizing this module for Phase III, it cannot be ignored that the schedules of the drivers' spouses must also be considered along with the schedules of the drivers themselves. It was originally thought that a weekend delivery would work best in bringing together a group of drivers and their spouses; however, this approach has not yielded great success in Phase II. While this strategy should not necessarily be abandoned for Phase III, it is recommended that alternative delivery approaches be considered as well (e.g. evening deliveries during the week, CD or video of presentation, etc.). These plans will ultimately need to be worked out with the participating companies based on the schedules of those drivers who volunteer to participate in Phase III and their spouses. The logistics of the *Family Forum* will require further consideration for Phase III in order for this module to be delivered to a larger number of families within a condensed period of time.

8.4.5 Response Rates for Participant Evaluations

While the participant evaluation forms piloted in Texas provided a strong indication that the educational modules were seen to have value, only a 50 percent response rate was obtained for these evaluations. This will obviously need to improve for Phase III, and while it is unlikely that 100 percent response rates will be obtained, a minimum target of 80 percent should be established.

In order to maximize response rates in Phase III, evaluations should be handed out at the beginning of the module, which will allow the participants to complete the form during the delivery. While this was also done in the Texas pilot, some of the participants handed in blank evaluations. As a result, it is further proposed that a small prize be offered by way of a draw, to serve as an added incentive to complete the evaluation, as well as the pre/post quiz. Examples of such prizes could include books related to sleep or fatigue, relaxation tapes, or even gift certificates from local businesses. Regardless of what is offered, however, this strategy should result in higher response rates.

8.4.6 Knowledge Quizzes

The quizzes that are to be administered prior to each of the educational modules should be revisited and redesigned to ensure a better measure of learning. The questions should address those areas of understanding not generally available to the public at large. Examples include specific information on sleep, fatigue, diet, alertness, etc. that has been discovered only recently, or although critical to health and safety, may be a little known fact. Other examples may include general beliefs that may be incorrect or recently proven to be incorrect. It should be noted, however, that this new or enlightened information must be made available in the modules and supporting materials, so that participants are made aware of them. This also requires that the training session be long enough in duration to ensure that all the relevant material is included. One way to ensure inclusion is to make sure that each piece of the test information is included as part of the slides in the presentation.

The quizzes following a module may also be expanded to include, in addition to the pre-module questions, ones that test the participants' general knowledge of the module's subject matter to determine how much was learned during the session. Interactive computer-based versions could be made available for participants to test their knowledge at a later time. These interactive tests could also reinforce concepts by providing helpful hints, etc.

8.4.7 Compensation for Training Time

The educational modules in Phase II were delivered around the operational requirements of the participating carriers. While this training was delivered during off-duty time for some of the drivers, others were required to miss work in order to attend the educational modules and unfortunately, were not provided with compensation on the part of the participating company for doing so. As a result, during the Texas portion of the Phase II, the contractor compensated drivers for any lost time incurred in order to attend the educational sessions as a means of ensuring the drivers harboured no resentment to the project for taking away from their earning potential.

While less of an issue for management staff, it is strongly recommended that driver compensation be addressed as part of the overall budget for Phase III. In terms of compensation for training time, this need not necessarily come from the research grant, as this could potentially be negotiated with the participating carriers as part of their overall contribution to the research. Regardless of the source for this compensation, however, it is clear from the Phase II experience in all jurisdictions that drivers will not want to be penalized financially if they are to volunteer for a study such as this.

8.5 Data Collection Procedures

Significant delays were encountered during the first round of en route data collection in the Alberta pilot due to a variety of reasons, many of which were outside the control of any research participants. However, as a means of improving the data collection ability within those challenging circumstances, a clear set of protocol and procedures were developed following the initial set of data collection and implemented prior to Round #2. In addition, the contractor's group worked more effectively with the Operations Committee during the second part of the pilot, resulting in improved assistance in scheduling meetings with drivers, thereby reducing the turn-around time for data collection. Additional improvements resulted from direct communication with drivers via newsletters and increased face-to-face and telephone contact. This learning was subsequently applied in Quebec and Texas, which allowed for a more efficient process in collecting the en route data.

Moreover, experience from the previous pilot studies in Alberta and Quebec allowed the initial study-related procedures in Texas to be accomplished much more effectively. The process of pre-screening drivers against study inclusion/exclusion criteria, delivering recruitment talks, taking questions from would-be subjects, consenting drivers and finally equipping them with their en route data collection equipment was completed in less than three days for the eight participating drivers in Texas. In total, these activities took several months in the previous pilot studies.

It should be noted that a bus driver sample was included in the Alberta pilot. Although in many ways the working conditions for truck and bus drivers are similar, there are also significant differences that create special problems in data collection, most notably in the collection of mid-shift PVT data. Future research design will need to accommodate for this difference either through segregation of the bus sample or by standardizing the data collection methodology in a way that meets both research and operational requirements.

Finally, as one of the main objectives of Phase II was to pilot-test the data collection procedures and troubleshoot around any problem areas, the recommendations in the following sections are proposed for Phase III.

8.5.1 Driver Questionnaire

Overall, this tool delivered proper results, and no drivers had any problems or questions with the survey. Taking into account all three jurisdictions, this tool has now been pilot-tested with close to one hundred drivers and is recommended to be used in its current format for Phase III.

8.5.2 Actigraph and PVT

In order to minimize problems with the en route data collection equipment in Phase III, project staff should be conscious of checking in with the drivers periodically throughout their en route data collection period to ensure that all data is being collected properly or, in the event of problems, to trouble-shoot these on the spot with the driver.

As for the PVT, it is recommended that as a conclusion to their en route equipment orientation, all drivers should be able demonstrate to their Field Coordinator the proper manner by which to complete a PVT trial from beginning to end. Also, given that a driver may occasionally experience interruptions while conducting the PVT, it is recommended that the En Route Driver Survey be updated for Phase III to explicitly ask the driver about this or any other type disruption that could have affected their performance on this test.

8.5.3 Subjective (En Route) Logs

As a result of feedback obtained from drivers and company representatives relative to the difficulties encountered during the en route data collection process in the Alberta and Quebec pilot studies, driver directions for equipment use were improved prior to the Texas pilot. As an example, the Actigraph Log Sheet was updated in order to collect additional data relative to on-duty and off-duty days, to capture total nap time, and to record clearer estimates of the times drivers went to bed and woke up.

In spite of the above changes, however, the Texas pilot still revealed a discrepancy between subjective and objective measures of sleep time which may be related, at least in part, to the Actigraph Log Sheet. The log asks the driver to note the time they went to bed; however, it is apparent that a number of drivers do not go to sleep right away after getting in bed. In order to eliminate this confusion for Phase III, it is recommended that the Actigraph Log Sheet be modified to say "Time at Lights-Out" instead of "Time to Bed". Notwithstanding this observation, however, the Phase II data demonstrate that drivers' subjective estimates of sleep time are consistently higher than that as reported objectively by actigraphy. While the log may play some role in this discrepancy, it remains to be seen to what extent.

With regards to maximizing the gathering of data on the SSS, it is recommended that the drivers note their level of sleepiness in a box, as opposed to circling a number. This would likely obtain the best compliance, as all other rating scales ask the driver to check a box as well.

In addition, it is proposed that a "sample" en route log be supplied to all drivers for Phase III to avoid any confusion on the proper way to complete each assessment. Finally, it should be stressed to all drivers that they contact their Field Coordinator if they have any questions whatsoever, and this person will assist them with the proper way of completing any study-related task. Alternatively, at the beginning of the data collection period, a periodic review of log data for each driver through an arranged meeting would allow the Field Coordinator to spot problems and to provide needed advice.

8.5.4 Compensation for En Route Data Collection

An additional conclusion of the contractor's team related to subsequent phases of this research is that there is a need to clarify expectations and degree of commitment for both companies and study participants at the onset of the project. Although the participating drivers obtained the benefit of access to sleep disorder screening, assessment, and treatment procedures, that benefit was, in some cases, not fully recognized. In the future, this can be addressed by improvements in the initial communications, but it may also require some form of

compensation for drivers who assume expenses for travel and may encounter lost work time in order to undergo laboratory testing and treatment.

Further, in recognition of the time required to complete all of the assessments included in the En Route Driver Survey, an additional form of compensation is recommended to offset drivers' costs and potential lost income during the en route data collection periods. Ideally, Phase III will want to report on measures of both sleep and fatigue over the duration of a full week of driving, with a view to analyzing the effects of any potential sleep debt over this period of time. As such, some form of additional compensation would likely also serve as an incentive for the drivers to complete all tools during the data collection portions of the project.

Although some of the time was compensated by the participating companies, the lack of consistency in this regard resulted in the contractor group introducing a compensation mechanism in mid-pilot in order to facilitate continued data collection. This likely affected compliance with the procedures and any consequential study participant drop out rate.

8.6 Study Communications

As noted above, the implementation of an FMP in an organization is a change management process and, as such, needs to follow successful change management principles. The first priority is that the company executives actively sponsor the FMP, which requires understanding and commitment on their part. In order to achieve this, future projects will require an effective communications approach to provide company executives with a detailed understanding of the module and the nature of the commitment that will be required for a successful project. Part of this process will be obtaining executive commitment to actively and visibly sponsor the FMP within their own organizations, and to ensure that appropriate systems are in place to facilitate manager, dispatcher and driver participation in the process. Finally, it will be critical to ensure that managers, dispatchers and drivers are provided with ongoing information both in terms of supporting their efforts to change their own behaviours, as well as updating them as to the status of the project.

The need to strengthen ties and establish a more collaborative relationship with the participating carriers' management teams was a critical learning from the initial pilot studies in Alberta and Quebec. As such, a devoted effort was made in the Texas pilot to see this occur. Indeed, much of the success in completing the study-related tasks in an efficient and effective manner for the Texas pilot was due to a strong collaboration with the participating carrier (both head office and local contacts in Houston), the Texas Motor Transport Association, as well as the FMCSA. In particular, open and transparent communications with the participating carrier prior to study initialization was perhaps the most critical success factor for the Texas pilot, as it allowed the contractor group to familiarize local management with everything they needed to know in order for them to lend their assistance in completing all study-related tasks. Two individuals from the participating company in particular (both of whom operated in a supervisory capacity to the drivers) were selected by senior management to assist in marketing this study to the drivers, which helped significantly in locating interested participants. Moreover, these individuals continued to demonstrate their visible support and commitment throughout the project, which helped greatly in completing all study-related tasks on schedule.

More specifically with respect to the drivers, it will be necessary in Phase III to ensure that they also have an improved understanding of the nature of the commitment that they are making when agreeing to participate in the study. In this regard, the recruitment and consent processes must ensure that drivers fully understand what participation in the FMP will mean both in terms of benefits and personal commitment.

In addition, both as part of the educational modules and sleep laboratory activities, it will be important to ensure that drivers understand the importance of receiving treatment for sleep apnea, and of their own ongoing compliance with the treatment module. Because some drivers in Phase II did not fully understand the importance of these factors (mostly in Alberta), there was often difficulty in scheduling their attendance for clinical visits, as well as ensuring ongoing compliance with treatment. However, as described earlier these challenges were ultimately resolved.

Finally, with regards to driver communications, project staff in the Texas pilot strived to maintain a high level of open interaction, enthusiasm, and sense of humour with the drivers. Development of a similar relationship is strongly recommended for Phase III, as it successfully energized the drivers and got them excited about their participation in this research. Creating such an environment helps to keep the drivers engaged, making things easier and more effective. This will be critical for the success of Phase III given the extended timeframe of this project.

9 CONCLUSIONS AND RECOMMENDATIONS

9.1 Conclusions from the Analysis

While it was clear from the outset that Phase II was not intended to provide definitive data with regard to the level of fatigue and the efficacy of the proposed FMP, the results are consistent with findings previously noted in other studies related to commercial drivers and further emphasize the need for further research. While keeping in mind the inherent limitations of the pilot data that were previously discussed, our results demonstrate the following interesting findings that require more evaluation:

- As expected and demonstrated in other studies, the CMV drivers in our pilot clearly identified that they obtain significantly less sleep than what they require for optimal alertness.
- Fatigue was identified by the group as a significant occupational hazard, with family members also identifying the need for effective fatigue management as a way of addressing the issue.
- Subjective reporting of sleep time obtained was consistently overestimated from 10 to 34 percent, depending on the jurisdiction. Mean sleep time actually obtained during on-duty days barely exceeded 5 hours on average. In spite of reports regarding utilization of recovery time to catch up with sleep, our pilot study has demonstrated that sleep time during off-duty days was still less than 6 hours on average. This finding at least points in the direction of the role that cumulative sleep debt can play with regard to increased levels of fatigue. Such an interpretation of these results is highly consistent with current scholarly thinking in the area of fatigue and performance.
- The limited data available from drivers who participated in both data collection rounds demonstrated that the FMP intervention could have been instrumental in reducing both subjective and objective assessments of fatigue and increasing sleep duration. Moreover, when drivers treated for sleep apnea were included in the overall sample the changes were substantial, with about a 50 percent drop in PVT lapses and a 48-minute increase in on-duty sleep duration.
- Prevalence of sleep apnea in commercial drivers will continue to be debated in the literature and will require further study. While our pilot has identified a higher prevalence of apnea in a small study population than that reported for the general population, this fact cannot be generalized to the CMV population as a whole. While our conclusions are limited by the sample size, we have also effectively implemented a screening, assessment, and treatment process within company operational constraints and without having a negative impact on the individual driver's livelihood and driving privileges. Our preliminary data show that those individuals identified with apnea have greatly benefited from the nature of the intervention, as determined by measures of both subjective indices of fatigue and objective changes in total sleep duration.
- The educational components of the FMP were positively received by both company management and drivers. The delivery approach and schedule for these modules was

modified based on the learning from the Alberta and Quebec pilot studies, resulting in a much more efficient roll-out and improved quality of training, given that these modules were delivered by project staff familiar with adult education principles and with enhanced subject matter knowledge.

Overall the pilot was successful in accomplishing the intended objectives of generating a comprehensive education and awareness package and resolving most of the challenges presented in operational field testing for future evaluation of this integrated fatigue management intervention. The package developed in Phase II presents an appropriate balance between individual factors affecting fitness for duty, and operational factors that can be addressed as a corporate risk management and due diligence responsibility. While the groundwork has been laid for the next phase of the project, the effectiveness of the module would benefit from further evaluation in a large-scale scientific and operational study. In this regard, future research in this area will require an effective commitment by the company if it is to successfully achieve the objective of scientifically evaluating an FMP implementation.

Over the course of the pilot studies in Alberta, Quebec and Texas, substantial revisions have been made to the educational modules and the standard operating procedures for data collection. The data demonstrate that fatigue and sleep disorders exist in this population. The data are also supportive of the view that the proposed FMP has the potential to reduce fatigue and increase driver capability in the commercial motor carrier environment.

9.2 Summary Recommendations

The following is a summary list of the recommendations responding to the Phase II findings discussed in sections 7 and 8:

i. On the basis of the findings, Development of a North-American Fatigue Management Program for Commercial Motor Carriers should proceed to Phase III and undergo scientific evaluation to determine the efficacy of the Program and its components.

ii. The Phase III research should be conducted based on generally accepted empirical and clinical standards and procedures for data collection and analysis in a field-operational environment.

iii. To the extent possible, researchers should reinforce with participating companies that the FMP is a change management process requiring the active, visible support of company management. Moreover, companies should be made aware of the shared responsibility of the FMP and to avoid a solely operator-focused approach.

iv. To the extent possible, researchers should ensure drivers are fully informed and understand the commitment that is being made when they consent to participate in the FMP research process.

v. A staged sleep disorder screening, assessment, and treatment process should be included as an integral part of the FMP, along with the other major FMP components (education, corporate change, and FMP evaluation).

vi. Companies should be encouraged to develop policies that facilitate sleep disorder screening, assessment, and treatment; should ensure that drivers' visits to the sleep

lab are accommodated, and should provide a mechanism to support necessary follow up visits.

vii. Researchers should follow a continuous communications approach focused on the drivers and all levels of company management in order to enhance ongoing project support and retention of study participants. There is a need for substantial time and effort to be expended on communication with the participating companies' managers and executives in terms of two areas:

    1. providing them with education relative to the FMP in an early phase of the project;

    2. eliciting the ongoing and visible support of the FMP within their companies.

viii. Training in Phase III should be conducted by experienced trainers who are well versed in FMP educational content.

ix. The educational modules should have additional exercises, be more practical, and allow time to discuss issues.

x. Additional tools should be created to assess scheduling guidelines and impact of training.

xi. Additional tools should be designed to help drivers in assessing their level of fatigue.

xii. Additional tools should be developed to collect data for corporate outcome parameters beyond data collection with individual drivers as a benefit of a comprehensive FMP.

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Appendix A: Pre-Screening Questionnaire

Pre-Screening Questionnaire

Welcome to the Fatigue Management Program for Commercial Motor Carriers. This comprehensive fatigue management program represents a proactive, preventative effort to address fatigue management in the commercial transport industry. However, the success of this project rests on the participation of commercial drivers like you. This one page survey is intended to assist us to identify drivers that are both interested and qualified to participate in the study.

If you are considering participation in this study, please fill out the entire page, including your contact information and leave it with a representative. If, however, you are not interested in *full* study participation, you can still contribute by taking a few seconds to complete the "Background Information" portion of this questionnaire.

Please remember, all of the information that you provide will be held in the strictest of confidence and only the investigative team will have access to the information. Your cooperation is greatly appreciated and we thank you for your time and effort.

DRIVER INFORMATION

1. How long have you been a commercial driver? _____ years _____ months
2. Do you currently hold a valid CMV license?…… ……... ☐ Yes ☐ No
3. Have you worked for at least 3 years as a Class I commercial driver? ……... ☐ Yes ☐ No
4. Do you have a personal driving record indicative of a safe driver? …….……... ☐ Yes ☐ No
5. In your opinion, is your current driving schedule fatiguing? ……... ☐ Yes ☐ No
6. Are you a team driver?…… …….. ☐ Yes ☐ No

BACKGROUND INFORMATION

Age: _____ years _____ months Height: _____ ☐ in ☐ cm Weight: _____ ☐ lb ☐ kg

Gender: ☐ M ☐ F Neck size: _____ ☐ in ☐ cm

1. Do you snore or have you ever been told that you snore during sleep? …… ☐ Yes ☐ No
2. Do you or have you ever been told you choke, gasp or hold your breath during sleep? …… ☐ Yes ☐ No
3. Do you have hypertension / high blood pressure? …… ☐ Yes ☐ No
4. Have you ever been diagnosed with a sleeping disorder? …… ☐ Yes ☐ No

STUDY PARTICIPATION

I am interested in learning more about potential participation in this study. ☐ Yes ☐ No

If yes, please provide your contact information below:

_____ (Print Name)

_____ (Signature)

_____ (Home Phone)

_____ (Home Address)

For Administrative Use Only:

Site No.: _____ _____ Participant Initials: ____ ____ ____ Participant No.: ____ ____ ____

Appendix B: Driver Questionnaire

Fatigue Management Program

Driver Questionnaire

Canadian Sleep Institute

Better Health Through Better Sleep

#300 – 295 Midpark Way SE
Calgary, Alberta T2X 2A8

May 2003

Site #: ____ ____ **Participant #: ____ ____ ____** **Participant Initials: ____ ____ ____**

The Fatigue Management Program (FMP) represents a proactive preventative effort to address fatigue management in the commercial motor carrier industry.

However, the success of this project rests on the participation of the commercial drivers that take part. Please take the time to fill out all forms with care and ensure that all tasks are performed as the instructions dictate.

Your cooperation is greatly appreciated and we thank you for your time and effort.

Part 1

General History Questionnaire

Development of a North American Fatigue Management Program (FMP) for the Commercial Motor Carrier Industry

Thank you for your assistance in completing this questionnaire. Your valuable feedback will help us in determining the overall effectiveness of the Fatigue Management Program (FMP) from a driver's perspective.

Please read and answer each question carefully. Your time and cooperation in filling out this survey is greatly appreciated.

All answers are completely confidential and will be seen only by members of the research team.

General Information

1. Age: _____ 2. Gender: ○ Male ○ Female

3. Height: _____ (○ cm / ○ inches) 4. Weight: _____ (○ lbs / ○ kg)

5. a. How many years have you been a commercial driver? _____ (years)

   b. How many years have you been driving for this company? _____ (years)

6. Type of route schedule: ○ Variable ○ Fixed

7. In general, are you working the same hours day-to-day or do they change?
   ○ Same hours ○ Hours change

8. How many years have you been doing this type of schedule? _____ (years)

9. What percentage of your driving is done between midnight – 6:00am?
   ○ Less than 25% ○ 25 – 49% ○ 50 – 74% ○ 75 – 100%

10. Primary type of operation you currently perform (check all that apply):
    ○ Bus ○ Tanker ○ Reefer ○ Dry Van ○ Flatbed
    ○ Hazardous Materials ○ Load/Unload ○ Other (specify): _____

11. How far did you continue with formal education?
    ○ Some high school ○ Grade 12 diploma ○ Some college
    ○ University degree ○ Technical school ○ Other (specify): _____

Medical Information

1. a. Do you take any prescription or non-prescription medication on a regular basis?

   ○ No ○ Yes → If yes, please fill in the table below:

Type of Medication	Medical Condition

2. a. Do you have any other medical problems on an ongoing basis?
   (i.e. high blood pressure, epilepsy, diabetes)

   ○ No ○ Yes → If yes, please describe:

   _____

   _____

3. a. Do you routinely take on the road with you any prescription or non-prescription medications (i.e. caffeine pills, sleeping pills, aspirin, natural alternatives/herbal remedies)?

   ○ No ○ Yes → If yes, please list what type(s):

   _____

   _____

4. a. Do you currently smoke cigarettes? ○ Yes ○ No

   b. If yes, how many cigarettes do you smoke on average per day? _____

   c. If no, have you ever smoked? ○ Yes ○ No

   d. If yes, how long ago did you quit? _____ (years)

5. How many cups of caffeinated coffee, tea, or cola do you drink on average ***per day***?

   ○ 0 - 1 ○ 2 - 3 ○ 4 - 5 ○ More than 5

6. How often do you drink alcohol?

   ○ Daily ○ Several times a week ○ Weekly ○ Rarely ○ Never

Scheduling and Sleep

1. On average, how many ***hours of work*** do you do each week?

   ○ Less than 30 ○ 30 - 39 ○ 40 - 49 ○ 50 - 59 ○ 60 - 69 ○ 70 or more

2. On average, how many ***hours of driving*** do you do each week?

   ○ Less than 30 ○ 30 - 39 ○ 40 - 49 ○ 50 - 59 ○ 60 - 69 ○ 70 or more

3. What hours are you ***commonly*** working? (Please use the 24hr clock)

   (i) From: _____ To: _____ (ii) From: _____ To: _____ (iii) From: _____ To: _____

4. Given your most common schedule, what time do you consider the ***beginning*** of the day?

   _____

   (Use the 24-hour clock)

5. a. How frequently do you participate in loading and unloading?

   ○ Never ○ Few trips ○ Some trips ○ Most trips ○ Every trip

   b. If you do help load, how long on average does it take? _____ (minutes)

6. In a typical 24-hour period, how many sleep periods (of greater than 1.5 hours) do you take while on a trip?

   ○ None ○ 1 sleep period ○ 2 sleep periods ○ 3 or more sleep periods

7. a. When do you like taking your main sleep period?

   ○ Before a duty period

   ○ As soon as I get home

   b. Why do you prefer sleeping at this time? _____

8. Where do you spend your main sleep period?

   ○ At home ○ Motel ○ Sleeper berth ○ Other (specify): _____

9. a. In a typical 24-hour period how many naps do you take? _____

b. On average, how long do you nap for? _____ (in minutes)

	Worse			Same			Much better
10. How would you rate your sleep in a berth compared to that at home?	○	○	○	○	○	○	○

	Too little			Just right			Too much
11. How much sleep do you feel you get?	○	○	○	○	○	○	○

	Much less			Same			Much more
12. Do you find daytime sleeping as restful as nighttime sleeping?	○	○	○	○	○	○	○

	Much less			Same			Much more
13. Have you found it more difficult to cope with driving schedules as you have grown older?	○	○	○	○	○	○	○

	More morning			Neutral			More evening
14. One hears about “morning” and “evening” types of people. Which one of these types do you consider yourself to be?	○	○	○	○	○	○	○

	Never			Sometimes			Always
15. When you are slowed down by driving conditions, how often do you get less sleep in order to keep up with your delivery schedules?	○	○	○	○	○	○	○

	Less alert			No change			Alert longer
16. When you are required to do physical tasks related to your driving, such as loading, unloading or putting on tire chains, how does this affect your alertness on the road? Are you:	○	○	○	○	○	○	○

	Less alert			No change			Alert longer
17. How do long waits (due to road closures or loads not ready) affect your alertness on the road? Are you:	○	○	○	○	○	○	○

	No time allowed	Never enough time	Usually not enough time	Sometimes not enough time	Enough time
18. To what extent does your scheduling allow for unexpected events (e.g. poor weather, mechanical problems)?	○	○	○	○	○
19. To what extent does your scheduling allow time for rest and meal breaks?	○	○	○	○	○

	No involvement	Some involvement	A lot of involvement
20. How much involvement do you have in determining your schedule?	○	○	○

	Never	Few trips	Some trips	Most trips	Every trip
21. How often do you exceed the speed limit to meet a deadline?	○	○	○	○	○
22. How often does your schedule differ from company policy?	○	○	○	○	○

23. a. In normal situations, how many hours do you like to drive before stopping for a break: _____ (hours)

    b. In normal situations, how long is your usual stop: _____ (hours)

Sleep and Well-Being Information Section

How often do you?

	Never		Sometimes		Always
1. Feel fit and healthy	○	○	○	○	○
2. Fall asleep easily	○	○	○	○	○
3. Wake up easily	○	○	○	○	○
4. Sleep well through the night	○	○	○	○	○
5. Feel moody or grumpy	○	○	○	○	○
6. Feel tired and drained of energy	○	○	○	○	○
7. Feel short of breath	○	○	○	○	○
8. Suffer from constipation or diarrhea	○	○	○	○	○
9. Feel your heart racing or skipping	○	○	○	○	○
10. Have headaches	○	○	○	○	○
11. Momentarily freeze on the job when you are extremely tired	○	○	○	○	○
12. Find your appetite disturbed	○	○	○	○	○
13. Suffer from heartburn, indigestion, stomach ache	○	○	○	○	○
14. Feel nauseous	○	○	○	○	○
15. Feel dizzy	○	○	○	○	○
16. Feel dissatisfied with your sex life	○	○	○	○	○
17. Engage in regular physical activity	○	○	○	○	○
18. Experience lapses in your attention	○	○	○	○	○
19. Eat 3 nutritious meals a day	○	○	○	○	○

I am satisfied with…

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
20. The kind of work I do (commercial driving)	○	○	○	○	○
21. The job as a whole	○	○	○	○	○
22. The shift cycle I drive (i.e., days-on, days-off)	○	○	○	○	○
23. The schedule I drive (i.e., daily time of work)	○	○	○	○	○

Coping with Shiftwork

People use different methods to cope with fatigue and commercial driving. Which of the following methods do you use?

To help cope with fatigue I…

	Never		Sometimes		Always
1. Try to get an adequate amount of sleep daily	○	○	○	○	○
2. Nap to catch up on sleep at home	○	○	○	○	○
3. Nap on breaks	○	○	○	○	○
4. Take a short walk to get some fresh air	○	○	○	○	○
5. Drink water at work when I am tired	○	○	○	○	○
6. Drink coffee, tea or cola to perk me up	○	○	○	○	○
7. Have a smoke when I feel tired	○	○	○	○	○
8. Exercise regularly	○	○	○	○	○
9. Avoid alcohol	○	○	○	○	○
10. Eat nutritiously	○	○	○	○	○
11. Take vitamins, health supplements etc	○	○	○	○	○
12. Read in bed to fall asleep	○	○	○	○	○
13. Keep my bedroom very dark while I sleep	○	○	○	○	○
14. Take a hot shower or bath	○	○	○	○	○
15. Tell my spouse or partner (and/or family) to keep quiet while I sleep	○	○	○	○	○
16. Drink alcoholic beverages to fall asleep	○	○	○	○	○
17. Perform relaxation exercises or yoga	○	○	○	○	○
18. Engage in sexual activity	○	○	○	○	○
19. Try to avoid working overtime	○	○	○	○	○
20. Have a smoke to relax	○	○	○	○	○
21. Watch TV to relax	○	○	○	○	○
22. Take some time to just be alone	○	○	○	○	○
23. Plan my time carefully	○	○	○	○	○
24. Spend time with my spouse and/or family	○	○	○	○	○

Fatigue and Alertness

	Very low	Low	Average	High	Very high
1. How *physically* demanding is your work?	○	○	○	○	○
2. How *mentally* demanding is your work?	○	○	○	○	○
3. How *stressful* is your work?	○	○	○	○	○
4. How *boring* is your work?	○	○	○	○	○
5. How *fatiguing* is your work?	○	○	○	○	○

	5 or less hours	5 hours	6 hours	7 hours	8 or more hours
6. How many hours of sleep per day do you feel you *need* to feel alert and well rested?	○	○	○	○	○
7. How many hours of sleep per day on average are you *actually getting* on days that you work?	○	○	○	○	○
8. How many hours of sleep on average are you actually getting on your *days off*?	○	○	○	○	○

9. In the last three months, on how many trips do you notice each of the following while driving?

	Never	Few trips	Some trips	Most trips	*Every trip*
a) Sore eyes	○	○	○	○	○
b) Losses of concentration	○	○	○	○	○
c) Stiffness, cramps or feeling uncomfortable	○	○	○	○	○
d) Yawning	○	○	○	○	○
e) Unintentional changes in speed	○	○	○	○	○
f) Delayed or poor gear changing	○	○	○	○	○
g) Delays in breaking	○	○	○	○	○
h) Steering over marked lines	○	○	○	○	○
i) Poor overtaking decisions	○	○	○	○	○
j) Headaches	○	○	○	○	○

	Never	Seldom	Sometimes	Frequently	Almost always
10. How frequently do you use *stimulants* (caffeine, nicotine, etc.) to help yourself stay awake and mentally alert?	○	○	○	○	○
11. How frequently do you use *sleeping pills* to help yourself fall asleep?	○	○	○	○	○
12. How frequently do you use *alcoholic beverages* to help yourself fall asleep?	○	○	○	○	○
13. Do you generally have trouble falling asleep?	○	○	○	○	○
14. Are you a sound sleeper (once you fall asleep, you generally stay in deep sleep until it's time to get up)?	○	○	○	○	○
15. How often would you start a trip already tired?	○	○	○	○	○
16. How often are you fatigued to the point that you drift into sleep while working?	○	○	○	○	○
17. How often has fatigue caused you to be absent from work in the past year?	○	○	○	○	○
18. Do you feel your current schedule is making you overly tired or fatigued?	○	○	○	○	○
19. If yes, does this fatigue make you frequently feel drowsy while working?	○	○	○	○	○

	No control	Little control	Some control	A lot of control	Total control
20. How much control do you have over when and where you stop for a rest?	○	○	○	○	○

	Never	Several times a year	Several times per month	Several times per week	Once or more per shift
21. How often do you feel so tired that your driving is impaired?	○	○	○	○	○
22. How often do you feel *physically* fatigued to the point where you are not physically or mentally effective while working?	○	○	○	○	○
23. How often do you become irritable while working?	○	○	○	○	○
24. How often do you feel bored while driving?	○	○	○	○	○
25. How often do you make mistakes or mental errors while working?	○	○	○	○	○

	Never	Seldom	Don't know	Often	Almost always
26. Do you awaken frequently during sleep?	○	○	○	○	○
27. Do you feel tired when you wake up?	○	○	○	○	○

	None	One or two	Three or four	Five or six	Seven or more
28. How many times in the past year have you briefly nodded off or fallen asleep while driving to or from work?	○	○	○	○	○
29. How many motor vehicle accidents or near-accidents did you have in the past year?	○	○	○	○	○

	1-17	18-20	21-23	24-26	27 or more
30. During the last two weeks that you worked, what was the longest number of hours you went without sleep?	○	○	○	○	○

	Does not apply	No problem	Slight problem	Moderate problem	Major problem
31. How much of a problem is being "too tired" to do anything with your family?	○	○	○	○	○

	Almost never	Quite seldom	Don't know	Quite often	Almost always
32. How often is your appetite disturbed?	○	○	○	○	○

33. a. Would you tell your supervisor if you were worried about being too tired to ***start*** driving?

○ Yes ○ Maybe ○ No

b. If you answered "no" or "maybe", please explain: _____

_____

_____

34. a. Would you tell your supervisor if you were worried about being too tired to ***continue*** driving?

○ Yes ○ Maybe ○ No

b. If you answered "no" or "maybe", please explain: _____

_____

_____

Family, Partners & Friends

	Living alone	Shared accommodation	Living with partner	Living with family
1. Living status	○	○	○	○

	Yes	No	N/A
2. Do you have any children in the household?	○	○	○
3. If yes, are any children 6 years old or younger?	○	○	○
4. Do you feel that fatigue due to your work schedule or your schedule in general, has affected your family life?	○	○	○
5. Do you feel the need to sacrifice some sleep time in order to spend more time with your family or friends?	○	○	○

Quality of Life

Please answer every question. Some questions look like others, but each one is different. Please take the time to read and answer each question carefully by marking the box that best represents your response.

	Excellent	Very good	Good	Fair	Poor
1. In general, would you say your health is:	○	○	○	○	○

2. The following items are about activities you might do during a typical day. Does your health now limit you in these activities? If so, how much?

	Yes, limited a lot	Yes, limited a little	No, not limited at all
a. **Moderate activities**, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf	○	○	○
b. Climbing **several** flights of stairs	○	○	○

3. During the **past 4 weeks**, have you had any of the following problems with your work or other regular daily activities as a result of your physical health?

	Yes	No
a. **Accomplished less** than you would like	○	○
b. Were limited in the **kind** of work or other activities	○	○

4. During the **past 4 weeks**, have you had any of the following problems with your work or other regular daily activities as a result of any emotional problems (such as feeling depressed or anxious)?

	Yes	No
a. **Accomplished less** than you would like	○	○
b. Didn't do work or other activities as **carefully** as usual	○	○

	Not at all	A little bit	Moderately	Quite a bit	Extremely
5. During the **past 4 weeks**, how much did pain interfere with your normal work (including both work outside the home and housework)?	○	○	○	○	○

6. These questions are about how you feel and how things have been with you during the past 4 weeks. For each question, please give the one answer that comes closest to the way you have been feeling. How much of the time during the **past 4 weeks…**

	All of the time	Most of the time	A good bit of the time	Some of the time	A little of the time	None of the time
a. Have felt calm and peaceful?	○	○	○	○	○	○
b. Did you have a lot of energy?	○	○	○	○	○	○
c. Have you felt downhearted and blue?	○	○	○	○	○	○

	All of the time	Most of the time	Some of the time	A little of the time	None of the time
7. During the past 4 weeks, how much of the time has your physical health or emotional problems interfered with your social activities (like visiting your friends, relatives, etc.)?	○	○	○	○	○

Satisfaction

	None		Some		A Lot
1. How would you rate your current level of knowledge on fatigue and fatigue management?	○	○	○	○	○

	Not at all		Somewhat		A Lot
2. Generally, how much do you think ***drivers*** could benefit from a fatigue management program?	○	○	○	○	○
3. Specifically, how much could ***you*** benefit from participation in a fatigue management program?	○	○	○	○	○
4. How much do you think ***your family*** could benefit from information on fatigue and living with a shift worker countermeasures?	○	○	○	○	○

	None		Some		A Lot
5. Rate your typical level of fatigue:	○	○	○	○	○

	Very poorly				Very effectively
6. How effectively do you deal with fatigue?	○	○	○	○	○

7. What are your most effective ways of dealing with fatigue?

Part 2

Satisfaction Survey for Partners

Satisfaction Survey for Partners

A "partner" can be anyone who would have enough information and interaction with you to answer the following questions. Some examples are: wife, husband, common-law partner, girlfriend, boyfriend, son, daughter, roommate, mother, father, etc.

Due to the variety of relationships mentioned above, not all questions will apply. If a question does not apply or if you don't wish to supply an answer, then skip the question.

	Low			Medium			High
1. Please rate your knowledge about the underlying effects of fatigue on the commercial motor driver	○	○	○	○	○	○	○
2. Rate the level of fatigue you see typically in your partner	○	○	○	○	○	○	○

3. a. Have you ever found family life to be difficult as a result of your partner's job as a commercial motor vehicle (CMV) driver?

○ Yes ○ No

b. If yes, please describe these difficult times and why you felt that they were difficult (i.e. beginning of relationship, childcare problems, etc.):

_____

_____

_____

4. How has the <u>schedule</u> of being a CMV driver affected your partner in the following areas:

	Most affected			Neutral		Least affected	Not applicable
a. Love life/sexual relationship	○	○	○	○	○	○	
b. Interaction with children	○	○	○	○	○	○	
c. Day to day chores	○	○	○	○	○	○	
d. Social activities	○	○	○	○	○	○	
e. Interaction as a family or with other family member	○	○	○	○	○	○	

5. How has <u>fatigue</u> affected your partner's life in the following areas:

	Most affected		Neutral		Least affected	Not applicable
a. Love life/sexual relationship	○	○	○	○	○	○
b. Interaction with children	○	○	○	○	○	○
c. Day to day chores	○	○	○	○	○	○
d. Social activities	○	○	○	○	○	○
e. Interaction as a family or with other family member	○	○	○	○	○	○

	Very effectively			Neutral			Not effectively
6. How effectively does your partner deal with fatigue?	○	○	○	○	○	○	○

	Very affected			Neutral			Not affected
7. How much does your partner's fatigue currently affect your relationship and family life?	○	○	○	○	○	○	○

8. Do you feel that a fatigue management program would benefit: *(check all that apply)*

○ Your partner in his job ○ Yourself
○ Your partner in his home-life ○ Any children or family members

9. Do you feel a fatigue management program would be very beneficial to:

	Very beneficial	Somewhat	Not beneficial	No opinion / Don't know
a. Your partner?	○	○	○	○
b. To you and your family?	○	○	○	○

10. Would you be interested in learning more about fatigue management and family life?

○ Yes ○ No

11. Which would be the best media for providing information to you/and or your family?:

○ Pamphlets ○ Books ○ Videos ○ Discussion groups
○ Presentation geared to partners and/or families ○ Other (specify): _____

Thank you for your assistance in completing this survey!

Appendix C: En-Route Driver Package

EN ROUTE DRIVER PACKAGE

- FOR TRUCK DRIVERS -

Instruction Booklet

With Actigraph Log Sheets

Revised
December 2004

Site #: ____ ____ Group: ____ Participant #: ____ ____ ____ Participant Initials: ____ ____ ____

The Fatigue Management Program (FMP) represents a proactive preventative effort to address fatigue management in the commercial transportation industry. However, the success of this project rests on the participation of the commercial drivers that take part – people like you! Please take the time to fill out all forms with care and ensure that all tasks are performed as the instructions dictate.

Your cooperation is greatly appreciated and we thank you for your time and effort.

General Instructions

This booklet contains a schedule that is broken down in a day-by-day format. Each day there are a number of activities and short questionnaires that need to be filled out. The timing and sequence of these activities is very important as some tasks need to be done at the beginning of the shift, while others need to be done in the middle or at the end of the shift. Also, some short activities will need to be repeated during the day.

The following is a list of all the daily activities required of the driver en-route for this study:

1. Actigraph Log (Sleep-watch) – Continuous
2. En route driver rating – Three times per day
3. Log book and sleep questions – As required
4. Mood rating – Twice per shift (ideally, once at the beginning and once at the end of each shift)
5. Fatigue and Alertness rating – End of shift
6. Workload Assessment – End of shift
7. Factors Contributing to Your Fatigue – End of shift

The first page of each testing day (i.e. your working days) is marked "DAY 1, DAY 2, etc." and each day is divided into three major sections:

- Beginning of Shift
- Middle of Shift – **anytime after four (4) hours into your shift**
- End of Shift

These divisions are clearly labeled and should be easy to follow. In each of the major sections there will be a list of activities that need to be completed. It is important to perform every task in each section at the appropriate time. Please make a note in your daily log book when you are performing these activities.

More detailed instructions are provided in the next section for the Actigraph.

ACTIGRAPH INSTRUCTION SHEET

1. The Actigraph device is worn like a wrist-watch and should be worn on your dominant wrist.

2. Begin wearing the Actigraph on _____(date) at _____(time).

3. The Actigraph must be worn at ALL times (sleeping included), EXCEPT while you are taking a shower, bathing, swimming or any other water related activity. **This device is NOT waterproof**.

4. Please complete the Event Tracker (form enclosed), when and why the Actigraph was removed, and when it was replaced.

5. Please complete the daily Log-Sheet (form enclosed).

6. Make sure to press the event button (or the right-most button if there are two) each time you get into and out of bed.

7. Remove the Actigraph on _____(date) at _____(time), and return it.

8. Please be aware that the Actigraph is a very delicate and expensive piece of equipment. **Please handle with care.**

Should you have any questions or concerns regarding the use of this Actigraph, please contact your field coordinator _____ at _____ .

Actigraph Event Tracker

Date	Time	Event Description *(e.g., removed Actigraph for 20 minutes for shower)*
/ mm dd	:	
/ mm dd	:	
/ mm dd	:	
/ mm dd	:	
/ mm dd	:	
/ mm dd	:	
/ mm dd	:	
/ mm dd	:	
/ mm dd	:	
/ mm dd	:	
/ mm dd	:	
/ mm dd	:	
/ mm dd	:	
/ mm dd	:	

* Please use the 24-hour clock when entering the time of the event.

Modified:
December 3, 2004

Instructions for Actigraph Log Sheet

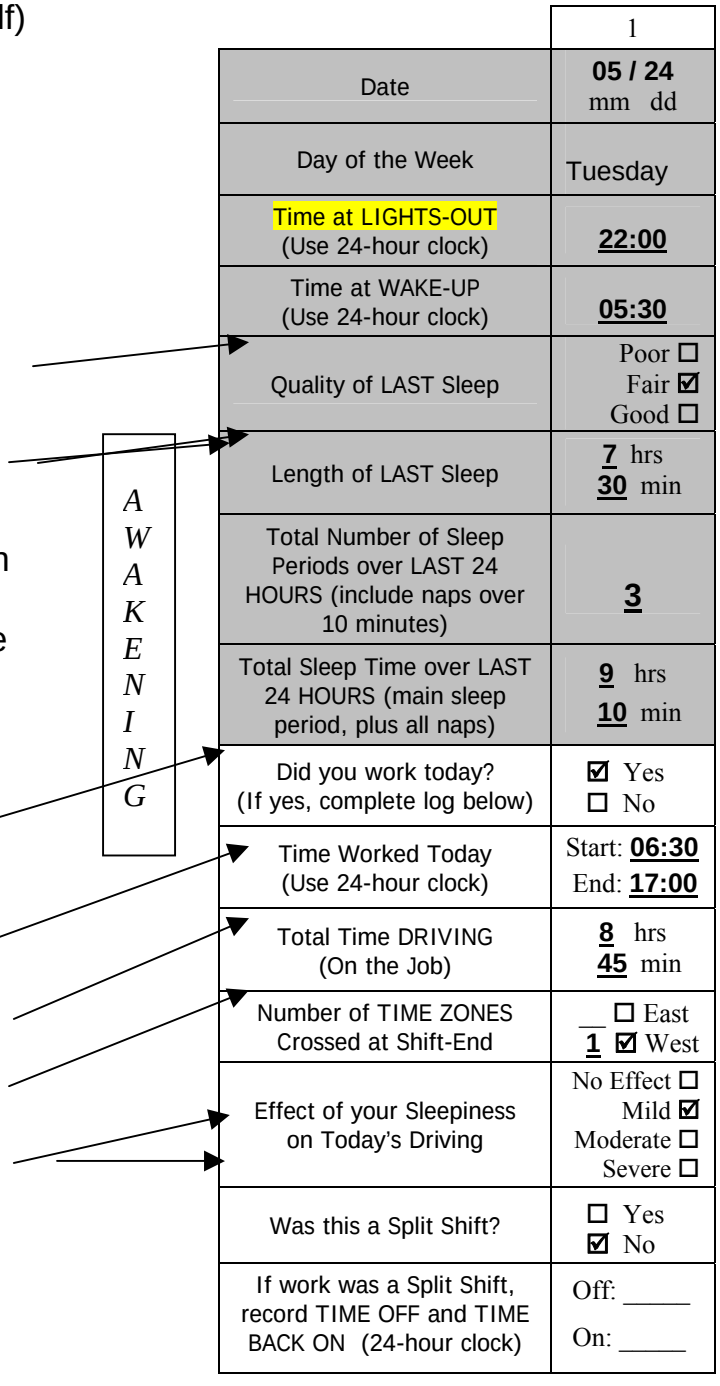
Shaded rows (top half of log) should be completed upon awakening, unshaded rows (bottom half) should be completed before bed.

Upon Awakening:

1. Record the date, the day of the week, the time you went to sleep, and the time you woke up after your MAIN SLEEP.
2. Rate your sleep as poor, fair, or good by checking off one of the boxes near the top of each column.
3. Record how many hours and minutes you slept.
4. Record the number of sleep periods you had in the past 24 hours (including naps over 10 minutes), as well as your total sleep time in the past 24 hours.

After Work:

1. Check whether or not you worked today (if yes, complete the remainder of the log; if no, stop here).
2. Enter the start and end times of your shift.
3. Record today's total driving time (on the job).
4. If you are parked in a different time zone than you started in today, record this on the log.
5. Rate the effect your sleepiness had on your driving today by checking off one of the boxes.
6. Check whether or not you worked a split shift today and, if so, record the times you stopped working and came back on.



Follow the **sample** above for each day on your own Log Sheet.

Modified: December 3, 2004

FMP Actigraph Log Sheet

		1	2	3	4	5	6	7	8	9
AWAKENING	Date	/ mm dd	/ mm dd	/ mm dd	/ mm dd	/ mm dd	/ mm dd	/ mm dd	/ mm dd	/ mm dd
	Day of the Week									
	Time at LIGHTS-OUT (Use 24-hour clock)	_____	_____	_____	_____	_____	_____	_____	_____	_____
	Time at WAKE-UP (Use 24-hour clock)	_____	_____	_____	_____	_____	_____	_____	_____	_____
	Quality of LAST Sleep	Poor ☐ Fair ☐ Good ☐	Poor ☐ Fair ☐ Good ☐	Poor ☐ Fair ☐ Good ☐	Poor ☐ Fair ☐ Good ☐	Poor ☐ Fair ☐ Good ☐	Poor ☐ Fair ☐ Good ☐	Poor ☐ Fair ☐ Good ☐	Poor ☐ Fair ☐ Good ☐	Poor ☐ Fair ☐ Good ☐
	Length of LAST Sleep	___ hrs ___ min	___ hrs ___ min	___ hrs ___ min	___ hrs ___ min	___ hrs ___ min	___ hrs ___ min	___ hrs ___ min	___ hrs ___ min	___ hrs ___ min
	Total Number of Sleep Periods over LAST 24 HOURS (include naps over 10 minutes)	_____	_____	_____	_____	_____	_____	_____	_____	_____
	Total Sleep Time over LAST 24 HOURS (main sleep period, plus all naps)	___ hrs ___ min	___ hrs ___ min	___ hrs ___ min	___ hrs ___ min	___ hrs ___ min	___ hrs ___ min	___ hrs ___ min	___ hrs ___ min	___ hrs ___ min
	Did you work today? (If yes, complete log below)	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No
AFTER WORK	Time Worked Today (Use 24-hour clock)	Start: _____ End: _____	Start: _____ End: _____	Start: _____ End: _____	Start: _____ End: _____	Start: _____ End: _____	Start: _____ End: _____	Start: _____ End: _____	Start: _____ End: _____	Start: _____ End: _____
	Total Time DRIVING (On the Job)	___ hrs ___ min	___ hrs ___ min	___ hrs ___ min	___ hrs ___ min	___ hrs ___ min	___ hrs ___ min	___ hrs ___ min	___ hrs ___ min	___ hrs ___ min
	Number of TIME ZONES Crossed at Shift-End	___ ☐ East ___ ☐ West	___ ☐ East ___ ☐ West	___ ☐ East ___ ☐ West	___ ☐ East ___ ☐ West	___ ☐ East ___ ☐ West	___ ☐ East ___ ☐ West	___ ☐ East ___ ☐ West	___ ☐ East ___ ☐ West	___ ☐ East ___ ☐ West
	Effect of your Sleepiness on Today's Driving	No Effect ☐ Mild ☐ Moderate ☐ Severe ☐	No Effect ☐ Mild ☐ Moderate ☐ Severe ☐	No Effect ☐ Mild ☐ Moderate ☐ Severe ☐	No Effect ☐ Mild ☐ Moderate ☐ Severe ☐	No Effect ☐ Mild ☐ Moderate ☐ Severe ☐	No Effect ☐ Mild ☐ Moderate ☐ Severe ☐	No Effect ☐ Mild ☐ Moderate ☐ Severe ☐	No Effect ☐ Mild ☐ Moderate ☐ Severe ☐	No Effect ☐ Mild ☐ Moderate ☐ Severe ☐
	Was this a Split Shift?	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No
	If work was a Split Shift, record TIME OFF and TIME BACK ON (24-hour clock)	Off: _____ On: _____	Off: _____ On: _____	Off: _____ On: _____	Off: _____ On: _____	Off: _____ On: _____	Off: _____ On: _____	Off: _____ On: _____	Off: _____ On: _____	Off: _____ On: _____

WORK DAY #1

Starting date: _____

Starting time: _____ _____

Site #: ____ ____ Group: ____ Participant #: ____ ____ ____ Participant Initials: ____ ____ ____

BEGINNING OF SHIFT – Please enter the current date and time:

_____

At this time you will need to do the following short tasks in order:

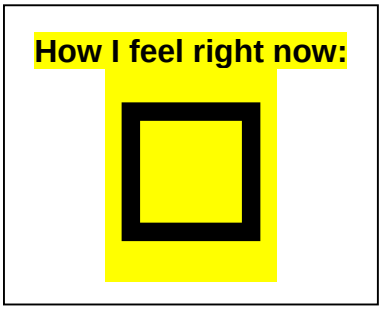
En Route Driver Rating

Current Mood Assessment

En Route Driver Rating

Please read the following seven statements. In the box, write the number that best describes how you feel right now.

1. **Feeling active and vital, alert, wide-awake.**
2. **Functioning at a high level but not at peak.**
3. **Relaxed, not at full alertness, responsive**
4. **A little foggy, not at peak, let down.**
5. **Fogginess, losing interest in staying awake, slowed down.**
6. **Sleepiness, prefer to be lying down.**
7. **Almost in reverie, sleep onset soon, hard to stay awake.**



Please describe how you have been feeling by rating the following signs and symptoms.

	Not at all	A little	Somewhat	Quite a bit	Extremely
General discomfort	☐	☐	☐	☐	☐
Stomach disturbances	☐	☐	☐	☐	☐
Headache	☐	☐	☐	☐	☐
Yawning	☐	☐	☐	☐	☐
Dizziness	☐	☐	☐	☐	☐
Drowsy	☐	☐	☐	☐	☐
Physical fatigue	☐	☐	☐	☐	☐
Mental fatigue	☐	☐	☐	☐	☐
Feelings of indifference	☐	☐	☐	☐	☐
Tension / Anxiety	☐	☐	☐	☐	☐

Current Mood Assessment

Please indicate on the scale below how you feel ***right now*** on the following items:

	Low			**Medium**			**High**
Overall alertness level	☐	☐	☐	☐	☐	☐	☐
Overall happiness level	☐	☐	☐	☐	☐	☐	☐
Overall level of calmness	☐	☐	☐	☐	☐	☐	☐
Overall irritability	☐	☐	☐	☐	☐	☐	☐
Current confidence level in abilities	☐	☐	☐	☐	☐	☐	☐
Desire to interact with people	☐	☐	☐	☐	☐	☐	☐

Before the end of your shift you will have some other things to complete, but for now you have completed the necessary tasks for the beginning of your shift.

MIDDLE OF SHIFT – Please enter the current date and time:

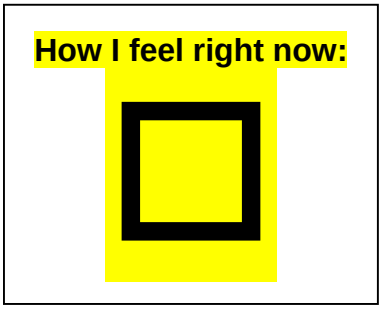
_____

At this time you should be at least four (4) hours into your shift and should still have a significant portion of your daily work to complete. Answer the following:

En Route Driver Rating

Please read the following seven statements. In the box, write the number that best describes how you feel right now.

1. **Feeling active and vital, alert, wide-awake.**
2. **Functioning at a high level but not at peak.**
3. **Relaxed, not at full alertness, responsive**
4. **A little foggy, not at peak, let down.**
5. **Fogginess, losing interest in staying awake, slowed down.**
6. **Sleepiness, prefer to be lying down.**
7. **Almost in reverie, sleep onset soon, hard to stay awake.**



Please describe how you have been feeling by rating the following signs and symptoms.

	Not at all	A little	Somewhat	Quite a bit	Extremely
General discomfort	☐	☐	☐	☐	☐
Stomach disturbances	☐	☐	☐	☐	☐
Headache	☐	☐	☐	☐	☐
Yawning	☐	☐	☐	☐	☐
Dizziness	☐	☐	☐	☐	☐
Drowsy	☐	☐	☐	☐	☐
Physical fatigue	☐	☐	☐	☐	☐
Mental fatigue	☐	☐	☐	☐	☐
Feelings of indifference	☐	☐	☐	☐	☐
Tension/Anxiety	☐	☐	☐	☐	☐

Before the end of your shift you will have some other things to complete, but for now you have completed the necessary tasks for the beginning and middle of your shift.

END OF SHIFT – Please enter the current date and time:

_____

At this time you should have completed your shift and should not have any other significant work to complete. You will need to do the following short tasks in order:

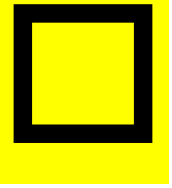
1. En Route Driver Rating
2. Current Mood Assessment
3. Workload Assessment
4. Fatigue and Alertness Rating
5. Factors Contributing to Your Fatigue

En Route Driver Rating

Please read the following seven statements. In the box, write the number that best describes how you feel right now.

1. **Feeling active and vital, alert, wide-awake.**
2. **Functioning at a high level but not at peak.**
3. **Relaxed, not at full alertness, responsive**
4. **A little foggy, not at peak, let down.**
5. **Fogginess, losing interest in staying awake, slowed down.**
6. **Sleepiness, prefer to be lying down.**
7. **Almost in reverie, sleep onset soon, hard to stay awake.**

How I feel right now:



Please describe how you have been feeling by rating the following signs and symptoms.

	Not at all	A little	Somewhat	Quite a bit	Extremely
General discomfort	☐	☐	☐	☐	☐
Stomach disturbances	☐	☐	☐	☐	☐
Headache	☐	☐	☐	☐	☐
Yawning	☐	☐	☐	☐	☐
Dizziness	☐	☐	☐	☐	☐
Drowsy	☐	☐	☐	☐	☐
Physical fatigue	☐	☐	☐	☐	☐
Mental fatigue	☐	☐	☐	☐	☐
Feelings of indifference	☐	☐	☐	☐	☐
Tension/Anxiety	☐	☐	☐	☐	☐

Current Mood Assessment

Please indicate on the scale below how you feel ***right now*** on the following items:

	Low			Medium			High
Overall alertness level	☐	☐	☐	☐	☐	☐	☐
Overall happiness level	☐	☐	☐	☐	☐	☐	☐
Overall level of calmness	☐	☐	☐	☐	☐	☐	☐
Overall irritability	☐	☐	☐	☐	☐	☐	☐
Current confidence level in abilities	☐	☐	☐	☐	☐	☐	☐
Desire to interact with people	☐	☐	☐	☐	☐	☐	☐

Workload Assessment

Workload has to do with the specific requirements and the level of effort needed to perform your job. Workload is affected by the job itself, your physical and mental state, and the surrounding environment. This can be divided into a number of components, as indicated below.

For each of the following, mark the box that most appropriately describes the workload ***you experienced*** on the job today.

	Low			Medium			High
Mental demand	☐	☐	☐	☐	☐	☐	☐
Visual demand	☐	☐	☐	☐	☐	☐	☐
Physical demand	☐	☐	☐	☐	☐	☐	☐
Temporal demand	☐	☐	☐	☐	☐	☐	☐
Performance	☐	☐	☐	☐	☐	☐	☐
Effort	☐	☐	☐	☐	☐	☐	☐
Frustration level	☐	☐	☐	☐	☐	☐	☐
Overall workload level	☐	☐	☐	☐	☐	☐	☐

Fatigue and Alertness

	Very Low	Low	Average	High	**Very high**
How *physically* demanding is your work?	☐	☐	☐	☐	☐
How *mentally* demanding is your work?	☐	☐	☐	☐	☐
How *stressful* is your work?	☐	☐	☐	☐	☐
How *boring* is your work?	☐	☐	☐	☐	☐
How *fatiguing* is your work?	☐	☐	☐	☐	☐

Factors Contributing to Your Fatigue

Please rate how the following factors contributed to your fatigue ***today***.

	Major effect	Minor effect	**No effect**	**N/A**
Having to load and unload	☐	☐	☐	☐
Rest breaks too short	☐	☐	☐	☐
Not getting enough sleep	☐	☐	☐	☐
Lack of rest areas	☐	☐	☐	☐
Poor road conditions	☐	☐	☐	☐
Heavy traffic	☐	☐	☐	☐
Bad weather	☐	☐	☐	☐
Poor diet and irregular eating	☐	☐	☐	☐
Split shift with long break (over 3 hours)	☐	☐	☐	☐
Difficult customers / passengers	☐	☐	☐	☐

All survey tasks for today should be complete now that your shift is over.

Thank you for participating in our study today.

Modified:
December 3, 2004

Please use the space below for any comments that you might have from your shift today. In particular, note if you experienced any interruptions or distractions while performing any of the PVT tests.

Comments:

WORK DAY #2

Starting date: _____

Starting time: _____ _____

Site #: ____ ____ Group: ____ Participant #: ____ ____ ____ Participant Initials: ____ ____ ____

WORK DAY #3

Starting date: _____

Starting time: _____ _____

Site #: ____ ____ Group: ____ Participant #: ____ ____ ____ Participant Initials: ____ ____ ____

WORK DAY #4

Starting date: _____

Starting time: _____ _____

Site #: ____ ____ Group: ____ Participant #: ____ ____ ____ Participant Initials: ____ ____ ____

WORK DAY #5

Starting date: _____

Starting time: _____ _____

Site #: ____ ____ Group: ____ Participant #: ____ ____ ____ Participant Initials: ____ ____ ____

WORK DAY #6

Starting date: _____

Starting time: _____ _____

Site #: ____ ____ Group: ____ Participant #: ____ ____ ____ Participant Initials: ____ ____ ____

WORK DAY #7

Starting date: _____

Starting time: _____ _____

Site #: ____ ____ Group: ____ Participant #: ____ ____ ____ Participant Initials: ____ ____ ____

Appendix D: Epworth Sleepiness Scale

Epworth Sleepiness Scale

Name: _____ Date: _____

How likely are you to doze off or fall asleep in the following situations, in contrast to feeling just tired? This refers to your usual way of life in the past month. Even if you have not done some of these things recently, try to work out how much they would have affected you.

Use the following scale to choose the most appropriate number for each situation:

0 = would never doze
1 = slight chance of dozing
2 = moderate chance of dozing
3 = high chance of dozing

Situation	Chance of Dozing
Sitting and reading	____
Watching TV	____
Sitting, inactive in a public place (e.g., theatre or a meeting)	____
As a passenger in a car for an hour without a break	____
Lying down to rest in the afternoon when circumstances permit	____
Sitting and talking to someone	____
Sitting quietly after lunch without alcohol	____
In a car, while stopped for a few minutes in traffic	____

Appendix E: Multivariable Apnea Prediction (MAP) and Sleep Symptom Frequency Form

MULTIVARIABLE APNEA PREDICTION AND SLEEP SYMPTOM FREQUENCY (MAP) FORM
UNIVERSITY OF PENNSYLVANIA
CENTER FOR SLEEP AND RESPIRATORY NEUROBIOLOGY

I agree to allow my answers in this MAP questionnaire to be used for research purposes. My understanding is that, if the answers are so used, my identity will be kept confidential.

_____
Signed

_____ _____
Name (print) Date

What is today's date? Month ____ Day _____ Year _____

When were you born? Month ____ Day _____ Year _____

What is your gender? Male _____ Female _____

What is your weight? Pounds _____

What is your height? Feet _____ Inches _____

The following questions refer to your behavior while sleeping, trying to sleep, or while feeling sleepy. Please fill in one circle for each question. During the last month have you had, or have been told about the following?

CODE:	0	1	2	3	4	(.8)
	Never	Rarely, less than once a week	1-2 times per week	3-4 times per week	5-7 times per week	Don't Know
Loud snoring	O	O	O	O	O	O
Your legs feel jumpy or jerk	O	O	O	O	O	O
Difficulty falling asleep	O	O	O	O	O	O
Frequent awakenings	O	O	O	O	O	O
Snorting or gasping	O	O	O	O	O	O
Falling asleep when at work	O	O	O	O	O	O

CODE:	0	1	2	3	4	(.8)
	Never	Rarely, less than once a week	1-2 times per week	3-4 times per week	5-7 times per week	Don't Know
Frequent tossing, turning, or thrashing	O	O	O	O	O	O
Your breathing, stops or you struggle for breath	O	O	O	O	O	O
Any snoring	O	O	O	O	O	O
Excessive sleepiness during the day	O	O	O	O	O	O
Morning headaches	O	O	O	O	O	O
Falling asleep while driving	O	O	O	O	O	O
Awaken feeling paralyzed,unable to move for short periods	O	O	O	O	O	O
Find yourself in a vivid dreamlike state when falling asleep or awakening even though you know you're awake	O	O	O	O	O	O

Appendix F: Short Sleep Apnea Quality of Life Index

Short Sleep Apnea Quality of Life Index

Name _____ Date _____

Please mark your answer with a checkmark (√) or an **X**

SECTION I

We would like to understand the impact that **your sleep apnea and/or snoring** have had on your daily activities, emotions, social activities, and about symptoms that may have resulted.

1. How much have you had to push yourself to remain alert during a typical day (e.g. work, school, childcare, housework)?

not at all	a small amount	a small to moderate amount	a moderate amount	a moderate to large amount	a large amount	a very large amount
☐	☐	☐	☐	☐	☐	☐

2. How often have you had to use all your energy to accomplish your most important activity (e.g. work, school, childcare, housework)?

never	a small amount of the time	a small to moderate of the time	a moderate amount of the time	a moderate to large of the time	a large amount of the time	a very large of the time
☐	☐	☐	☐	☐	☐	☐

3. How much difficulty have you had finding the energy to do other activities (e.g. exercise, relaxing activities)?

no difficulty	a small amount	a small to moderate amount	a moderate amount	a moderate to large amount	a large amount	a very large amount
☐	☐	☐	☐	☐	☐	☐

4. How much difficulty have you had fighting to stay awake?

no difficulty	a small amount	a small to moderate amount	a moderate amount	a moderate to large amount	a large amount	a very large amount
☐	☐	☐	☐	☐	☐	☐

5. How much of a problem has it been to be told that your snoring is irritating?

not a problem	a small problem	a small to moderate problem	a moderate problem	a moderate to large problem	a large proble	a very large problem
☐	☐	☐	☐	☐	☐	☐

6. How much of a problem have frequent conflicts or arguments been?

not a problem	a small problem	a small to moderate problem	a moderate problem	a moderate to large problem	a large problem	a very large problem
☐	☐	☐	☐	☐	☐	☐

7. How often have you looked for excuses for being tired?

never	a small amount of the time	a small to moderate of the time	a moderate amount of the time	a moderate to large of the time	a large amount of the time	a very large of the time
☐	☐	☐	☐	☐	☐	☐

8. How often have you not wanted to do things with your family and/or friends?

never	a small amount of the time	a small to moderate of the time	a moderate amount of the time	a moderate to large of the time	a large amount of the time	a very large of the time
☐	☐	☐	☐	☐	☐	☐

9. How often have you felt depressed, down, or hopeless?

never	a small amount of the time	a small to moderate of the time	a moderate amount of the time	a moderate to large of the time	a large amount of the time	a very large of the time
☐	☐	☐	☐	☐	☐	☐

10. How often have you been impatient?

never	a small amount of the time	a small to moderate of the time	a moderate amount of the time	a moderate to large of the time	a large amount of the time	a very large of the time
☐	☐	☐	☐	☐	☐	☐

11. How much of a problem has it been to cope with everyday issues?

not a problem	a small problem	a small to moderate problem	a moderate problem	a moderate to large problem	a large problem	a very large problem
☐	☐	☐	☐	☐	☐	☐

12. How much of a problem have you had with decreased energy?

not a problem	a small problem	a small to moderate problem	a moderate problem	a moderate to large problem	a large problem	a very large problem
☐	☐	☐	☐	☐	☐	☐

13. How much of a problem have you had with fatigue?

not a problem	a small problem	a small to moderate problem	a moderate problem	a moderate to large problem	a large problem	a very large problem
☐	☐	☐	☐	☐	☐	☐

14. How much of a problem have you had waking up feeling unrefreshed?

not a problem	a small problem	a small to moderate problem	a moderate problem	a moderate to large problem	a large problem	a very large problem
☐	☐	☐	☐	☐	☐	☐

SECTION II

(If you have **not** been using treatment for sleep apnea in the past 4 weeks **DO NOT** complete this section)

We would like you to mark below the **primary** treatment you are currently using for sleep apnea:

Treatment: Medication ○ CPAP ○ Dental appliance ○ Weight loss ○ Surgery ○ Other ○

_____ (please specify)

_____ (please specify)

Next we would like you list up to **three side effects** you have found most troubling as a result of **this treatment** – please write them in the spaces below. For each side effect please rate how much of a problem it has been to you in the **past 4 weeks**. Some side effects that people may experience include: nasal stuffiness, dry nose or throat, sore eyes, headache, sore throat, jaw pain, waking up frequently, stomach upset, increased saliva.

15. **Side effect 1** _____. How much of a problem have you had with this?

None	a small problem	a small to moderate problem	a moderate problem	a moderate to large problem	a large problem	a very large problem
☐	☐	☐	☐	☐	☐	☐

16. **Side effect 2** _____. How much of a problem have you had with this?

None	a small problem	a small to moderate problem	a moderate problem	a moderate to large problem	a large problem	a very large problem
☐	☐	☐	☐	☐	☐	☐

17. **Side effect 3** _____. How much of a problem have you had with this?

None	a small problem	a small to moderate problem	a moderate problem	a moderate to large problem	a large problem	a very large problem
☐	☐	☐	☐	☐	☐	☐

18. Considering these **side effects** please choose the statement that **best** describes the trade off between side effects and benefits. Overall, compared with the benefits, would you say that the problems with side effects you listed in question 15 –17 were (choose one):

Very minor compared to the benefits	Much less important than the benefits	Slightly less important than the benefits	About equal to the benefits	Greater than the benefits	Much greater than the benefits	Very much greater than the benefits
☐	☐	☐	☐	☐	☐	☐

Thank you for your cooperation in completing this questionnaire.