TCRP
REPORT 81

TRANSIT
COOPERATIVE
RESEARCH
PROGRAM

Sponsored by
the Federal
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Toolbox for Transit Operator Fatigue

TRANSPORTATION RESEARCH BOARD

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TRANSIT COOPERATIVE RESEARCH PROGRAM

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Toolbox for Transit Operator Fatigue

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SUBJECT AREAS
Public Transit

Research Sponsored by the Federal Transit Administration in Cooperation with the Transit Development Corporation

TRANSPORTATION RESEARCH BOARD — NATIONAL RESEARCH COUNCIL

NATIONAL ACADEMY PRESS
WASHINGTON, D.C. — 2002

TRANSIT COOPERATIVE RESEARCH PROGRAM

The nation's growth and the need to meet mobility, environmental, and energy objectives place demands on public transit systems. Current systems, some of which are old and in need of upgrading, must expand service area, increase service frequency, and improve efficiency to serve these demands. Research is necessary to solve operating problems, to adapt appropriate new technologies from other industries, and to introduce innovations into the transit industry. The Transit Cooperative Research Program (TCRP) serves as one of the principal means by which the transit industry can develop innovative near-term solutions to meet demands placed on it.

The need for TCRP was originally identified in *TRB Special Report 213—Research for Public Transit: New Directions*, published in 1987 and based on a study sponsored by the Urban Mass Transportation Administration—now the Federal Transit Administration (FTA). A report by the American Public Transportation Association (APTA), *Transportation 2000*, also recognized the need for local, problem-solving research. TCRP, modeled after the longstanding and successful National Cooperative Highway Research Program, undertakes research and other technical activities in response to the needs of transit service providers. The scope of TCRP includes a variety of transit research fields including planning, service configuration, equipment, facilities, operations, human resources, maintenance, policy, and administrative practices.

TCRP was established under FTA sponsorship in July 1992. Proposed by the U.S. Department of Transportation, TCRP was authorized as part of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA). On May 13, 1992, a memorandum agreement outlining TCRP operating procedures was executed by the three cooperating organizations: FTA, the National Academies, acting through the Transportation Research Board (TRB); and the Transit Development Corporation, Inc. (TDC), a nonprofit educational and research organization established by APTA. TDC is responsible for forming the independent governing board, designated as the TCRP Oversight and Project Selection (TOPS) Committee.

Research problem statements for TCRP are solicited periodically but may be submitted to TRB by anyone at any time. It is the responsibility of the TOPS Committee to formulate the research program by identifying the highest priority projects. As part of the evaluation, the TOPS Committee defines funding levels and expected products.

Once selected, each project is assigned to an expert panel, appointed by the Transportation Research Board. The panels prepare project statements (requests for proposals), select contractors, and provide technical guidance and counsel throughout the life of the project. The process for developing research problem statements and selecting research agencies has been used by TRB in managing cooperative research programs since 1962. As in other TRB activities, TCRP project panels serve voluntarily without compensation.

Because research cannot have the desired impact if products fail to reach the intended audience, special emphasis is placed on disseminating TCRP results to the intended end users of the research: transit agencies, service providers, and suppliers. TRB provides a series of research reports, syntheses of transit practice, and other supporting material developed by TCRP research. APTA will arrange for workshops, training aids, field visits, and other activities to ensure that results are implemented by urban and rural transit industry practitioners.

The TCRP provides a forum where transit agencies can cooperatively address common operational problems. The TCRP results support and complement other ongoing transit research and training programs.

TCRP REPORT 81

Project F-10 FY 2000
ISSN 1073-4872
ISBN 0-309-06761-8
Library of Congress Control Number 2002109061

Price $33.00

NOTICE

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The members of the technical advisory panel selected to monitor this project and to review this report were chosen for recognized scholarly competence and with due consideration for the balance of disciplines appropriate to the project. The opinions and conclusions expressed or implied are those of the research agency that performed the research, and while they have been accepted as appropriate by the technical panel, they are not necessarily those of the Transportation Research Board, the National Research Council, the Transit Development Corporation, or the Federal Transit Administration of the U.S. Department of Transportation.

Each report is reviewed and accepted for publication by the technical panel according to procedures established and monitored by the Transportation Research Board Executive Committee and the Governing Board of the National Research Council.

To save time and money in disseminating the research findings, the report is essentially the original text as submitted by the research agency. This report has not been edited by TRB.

Special Notice

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TRANSIT COOPERATIVE RESEARCH PROGRAM

are available from:

Transportation Research Board
National Research Council
2101 Constitution Avenue, N.W.
Washington, D.C. 20418

and can be ordered through the Internet at
http://www.national-academies.org/trb/bookstore

Printed in the United States of America

FOREWORD

By Gwen Chisholm
Staff Officer
Transportation Research Board

TCRP REPORT 81: Toolbox for Transit Operator Fatigue documents principles, techniques, and strategies that are used in the development of fatigue-mitigation plans. The *Toolbox* includes a "how to" component on the design, implementation, and evaluation of fatigue-mitigation plans. The fatigue-mitigation plans may be used by senior managers, operations managers, safety officials, medical personnel, risk managers, human resource personnel, policymakers, and legal advisors.

The role that operator fatigue plays in mass transit safety has become one of the central issues that U.S. bus and rail transit agencies must address. Fatigue is increasingly cited as a contributing factor in bus and rail transit accidents. The National Transportation Safety Board lists human fatigue as an area where significant improvement is needed in order to increase transportation safety. In its legislative proposals for authorization of the Rail Safety Act, the Federal Railroad Administration has suggested that fatigue-mitigation plans be implemented by all U.S. railroads. The Federal Transit Administration has developed a fatigue-awareness training program that a number of U.S. transit properties have used to help their front line and supervisory employees understand how fatigue can affect human performance. In addition to reducing accidents, mitigating fatigue can also reduce the cost of transit operations. Costs due to lost productivity, employee absenteeism, employee turnover rate, reduced morale, and increased wear and tear on equipment are affected by employee fatigue.

The body of research that has been completed on the effects of fatigue on human performance is significant and demonstrates clearly that transit agencies must seek to mitigate its impact on their operations. Available research findings, as well as fatigue-mitigation efforts in other industries, provide the transit industry with a firm basis for understanding where efforts need to be focused in dealing with this issue. Building on the work that has been completed to date, the *Toolbox* is designed to provide U.S. transit operators with a variety of resources, methods, and techniques for reducing operator fatigue and minimizing its effects.

Foster-Miller, Inc. prepared this report for TCRP Project F-10. To achieve the project's objective of assembling a toolbox—based on principles, techniques, strategies, and available resources—that can be used in the development of fatigue-mitigation plans, a comprehensive literature review was undertaken to identify proven fatigue-management strategies and techniques. Based on the literature review, a set of candidate countermeasures suitable for the transit industry was identified. To ensure that the *Toolbox* would be responsive to the needs and concerns of the transit industry, Foster-Miller assembled a Transit Industry Panel. The role of this panel was to review intermediate results of the research team, such as the list of candidate countermeasures, and to provide guidance on both the content and organization of the *Toolbox*. The *Toolbox* includes descriptions of fatigue-management programs from organizations representing all modes of transportation, including transit, and suggests a five-step approach for implementing a fatigue-management program

AUTHOR ACKNOWLEDGMENTS

This work was conducted under TCRP Project F-10 by a team headed by Foster-Miller, Inc. Judith Gertler of Foster-Miller was the principal investigator and project manager for this effort. The other members of the team were Sarah Acton, Foster-Miller; Stephen Popkin, Rantsu Consulting; and David Nelson, Kay O'Neil, and Gerry Pieri, KKO and Associates. Cynthia Black and Gayle Staffiere of Foster-Miller were responsible, respectively, for the editing and graphic design of this document. Susan McDonough, Foster-Miller, maintained the bibliographic database that was assembled for this project.

The American Public Transportation Association, the Federal Transit Administration, CT Transit and Phoenix Transit provided photographs that appear in this document.

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Introduction

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Concern with operator fatigue is not a new issue for the transportation industry. In 1907 Congress passed the Railroad Hours of Service Act to"promote the safety of employees and travelers upon railroads by limiting the hours of service of employees thereon." Subsequently Congress prescribed similar limitations for truckers, airline pilots and ship crews. Up until the past decade the approach to fatigue management for transportation operators was primarily one of limiting hours of work. In spite of these limitations on operator hours, an alarming number of accidents, in both transportation and industrial settings, resulted from human fatigue. The U.S. Department of Transportation, its modal administrations, individual transportation service providers and their industry organizations are exploring alternative strategies and countermeasures to reduce operator fatigue and its risks. The intent of this toolbox is to provide techniques and tools that the transit industry can employ for this purpose.

Why Transit Operator Fatigue Is Important

The transportation industries have always needed employees to work long and unusual hours to meet the needs of their customers. The growth of the global economy and advances in technology seem to have expanded the number of jobs that operate outside the boundaries of the normal work day, including many jobs in the transport sector. While the North American urban transit industry may not be the nation's leader in 24/7 operations, many systems are expanding the temporal scope of their operations to meet the mobility needs of their customers. Long and unusual hours of service create the need for staff to work when their bodies tell them they should be sleeping or when their families require attention.

Recent polls conducted by the National Sleep Foundation (NSF) document the prevalence of inadequate sleep among Americans. Sleep experts recommend 8 hours of sleep nightly for adults yet the NSF annual polls find that the average adult sleeps less than 7 hours during the workweek. Over 40 percent of adults say they are so sleepy during the day that it interferes with their daily activities a few days a month or more. In terms of sleepiness in the workplace, 40 percent of the American workforce report that sleepiness on the job reduces the quality of their work and one in five reports making occasional or frequent errors due to sleepiness. While no sleep profile data is available for transit operators, it is reasonable to assume that, as a group, their responses would be similar to the respondents to the NSF polls.

Faced with long service hours and a limited labor pool, many transit agencies may rely heavily on overtime to provide service. Long overtime assignments may increase the likelihood of fatigue for operators who may already be getting less than adequate rest and may be working at less than a fully alert state.

Fatigue can have serious performance consequences. Researchers in Australia found that after 17 hours of sustained wakefulness, hand-eye coordination decreased to a level equivalent to the performance of someone with a blood alcohol level of 0.05 percent. After 24 hours, performance decreased to the deficit observed in someone with a blood alcohol level of 0.10 percent, a level that exceeds the legal limit for"driving while intoxicated." Operators who start their shifts after an extended period of wakefulness may risk experiencing this level of performance degradation.

Fatigue can have serious performance consequences.

Fatigue that is manifest in reduced alertness can also lead to accidents. On November 19, 1997, two GO Transit commuter rail trains in Toronto's Union Station were involved in a low-speed collision during the evening commuter peak. Fortunately, no serious injuries resulted. Investigators identified crew noncompliance with operating rules to be the cause of the accident. Since an experienced crew was involved, GO Transit concluded that reduced crew alertness was a likely contributor to the accident.

The consequences of operator fatigue can be significant for the operator and passengers as well as the transit agency. On June 5, 1995, two New York City Transit subway trains on the Williamsburg Bridge in Brooklyn, NY, collided when a train operator failed to respond to a stop signal and collided with a train standing ahead of him on the same track. The operator was killed. A total of 69 other people, including two with serious injuries, were treated for injuries sustained in the accident. Damages exceeded $2.3 million. National Transportation Safety Board (NTSB) investigators of this accident determined that the operator who failed to stop had fallen asleep at the controls.

Accidents due to fatigue or loss of alertness are not always the result of not getting enough sleep. The NTSB recently found fatigue-related causes for two light rail accidents at Baltimore-Washington International Airport. In one case, the operator responsible for an accident experienced severe fatigue because of undiagnosed obstructive sleep apnea and fell asleep at the controls. The NTSB attributed the other accident to the effects of

prescription pain-relieving medications and/or recent cocaine use, which caused the operator to fail to stop the train. Each accident resulted in injuries but fortunately no one was killed in either accident. The Maryland Transit Administration estimated that the cost of each accident exceeded $900,000.

A recent American Public Transportation Association (APTA) survey found that 20 percent (30 of 145) of responding transit agencies identified fatigue as a contributing factor to on-road accidents. Eight agencies (5 percent) identified fatigue as a factor in non-road accidents. The APTA survey also found that most transit agencies do not explicitly consider fatigue in their accident and injury investigation procedures. Thus, it is likely that fatigue-related accidents and worker injuries are more common than these statistics indicate.

As transit industry ridership continues to grow and service hours expand, operator fatigue has the potential for placing transit staff, customers and the general public at greater risk. Addressing the issue of operator fatigue in a preventive and proactive manner will help reduce potential consequences. Researchers have found that a complex interaction of timing of sleep, work schedule, environment, nutrition and drug issues all affect human alertness. Any approach to mitigating operator fatigue must address this spectrum of relevant issues. With proper planning and forethought, human fatigue and the risks that it carries for the public transit industry can be minimized.

Intended Toolbox Usage

Recognizing the potentially serious consequences of transit operator fatigue, the Transit Cooperative Research Program (TCRP) undertook the development of this toolbox of resources, methods and techniques to deal with operator fatigue issues. These tools are designed to be administered by the transit professional. Not all tools or strategies contained in the toolbox will work at a particular transit property, given the cultural and operational differences that exist among properties. Rather, transit agencies should view the tools in the toolbox as resources and ideas for consideration when developing their unique fatigue countermeasure program.

The intended audience for the toolbox includes all individuals who are likely to be involved in a transit agency's fatigue management program or affected by it. Some specific tools are geared to the individual operator while others are for use by supervisors and

managers involved in aspects of daily service planning and delivery. A primary goal of the toolbox is to provide a structured process for implementing a fatigue management program that incorporates appropriate tools.

Transit fatigue management plans will likely eventually apply to all operations employees. This means that all non-administrative positions involved in the movement or maintenance of vehicles, trains, and facilities such as vehicle operators, maintenance personnel, dispatchers, station operations personnel, and security personnel will be involved with and benefit from the development of a fatigue management program. However, because the potential risk of harm to the public is greatest with regard to operator fatigue, the major focus of the design of the toolbox is on vehicle operators, their supervisors and their schedulers.

Development of the Toolbox

The development of the fatigue toolbox began with a literature and research review to identify *proven* strategies and techniques for preventing fatigue, detecting a fatigued state, and minimizing the performance effects of fatigue when it occurs on the job. Based on this review, the research team identified a set of candidate countermeasures suitable for the transit industry.

To assure that the toolbox is responsive to the needs and concerns of the transit industry, a transit industry panel was assembled. The role of this 11-person panel was to review intermediate results of the research team, such as the list of candidate countermeasures, and provide guidance on both the content and organization of the toolbox. Based on feedback from the panel, a set of specific countermeasures was chosen for inclusion in the toolbox.

Scientific research can substantiate the validity of strategies and techniques for preventing, detecting and minimizing the effects of fatigue. An implementation process is best evaluated through anecdotal or qualitative measures. Contacts with transportation industry representatives provided insights on methods and strategies that led to success in the implementation of their respective fatigue management efforts. This information formed the basis for a recommended procedure for the development and implementation of a fatigue management program.

As work schedules tend to be a significant contributor to operator fatigue, representative schedules for bus, rail and commuter rail operations were examined. The purpose of this review was to identify the potentially problematic schedule characteristics and subsequently to guide the research team in formulating appropriate scheduling guidelines for inclusion in the toolbox.

All of the above elements – literature and research review, industry experiences, and schedule analysis – plus feedback from the transit industry panel and the TCRP Project Panel formed the basis for the toolbox organization and format. The content of the toolbox reflects the most useful and appropriate tools available today. Ongoing research is likely to produce new and improved techniques in coming years.

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2 How to Use the Toolbox

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The *Toolbox for Transit Operator Fatigue* consists of this document and the companion CD. The document is designed for the transit professional who will play a role in developing and implementing the agency's fatigue and alertness management program.

Chapter 3,"Understanding Human Fatigue,"is an overview of sleep, fatigue and alertness. It discusses the physiological principles of sleep and fatigue, concerns such as drugs and nutrition that affect alertness, and the performance consequences of fatigue in the workplace. Individuals with limited exposure to the issue of operator fatigue will find this section helpful. The Reading Lists in Chapter 3 offer suggestions for additional reading on these topics.

Chapter 4,"Teaming to Tackle Fatigue and Maximize Alertness," explains in detail how to develop and implement a fatigue management program.

Chapter 5,"Tools You Can Use,"is the heart of the toolbox. It contains the actual tools and explains who the intended users are. There are educational tools for operators,"process"tools to help both individual operators and managers identify and correct conditions that can lead to operator fatigue, and countermeasures that can be used by operators or managers to offset the consequences of fatigue during work time. The fatigue management program team should draw on the various tools in designing the program for their property. Reading through this document should stimulate ideas as to what is appropriate for the organization and its operators.

The tools described in this section have two different formats. The majority of the tools consist of a written document suitable for distribution to tool users. The companion CD contains copies of these stand-alone written tools so that it will be easy to select the tools applicable to a given fatigue management program and reproduce them. The remaining items are described in the text of Chapter 5 but due to their nature, there are no separate tools. For example, *Use and Abuse of Caffeine* has a written document but *Fatigue Hotline* does not.

The tools all appear in the text of Chapter 5 to make it easy for managers and fatigue program organizers to read and review them. Chapter 5 also includes a table that summarizes the tools, their

functions and their intended users. The tools fall into seven groupings:

1. Managing personal habits and behaviors.
2. Reporting for duty and managing service delivery.
3. Analyzing and creating runs.
4. Assigning personnel to cover temporary vacancies.
5. Designing facilities and equipment.
6. Recruiting and hiring new operators.
7. Investigating accidents.

Many of the tools will only be effective if implemented in conjunction with a fatigue and alertness training program that provides instructions on how to use them. The *Personal Alertness Manager*, *Personal Alertness Predictor*, and *Supervisor's Process for Identifying and Managing a Fatigue Employee* are in this category. Other tools, such as *Tips for Healthy Sleep*, *The Lifestyle of a Transit Operator: Is It for You?* and *Managing the Extraboard* can be used by operators without formal classroom training.

Some of the tools are interdependent. For example, the *Personal Alertness Manager* and *Do I Have a Sleep Disorder?* both require the use of the *Sleep Debt Index* tool. On the other hand, the *Sleep Debt Index* tool is a simple tool that can be used by itself to provide a quick "snapshot" of the fatigue level of the workforce.

The toolbox includes five appendices of additional information that may also be useful when designing a fatigue management program.

- Appendix A is a glossary of many of the fatigue-related terms in this document. It is particularly helpful when reading Chapter 3, "Understanding Human Fatigue."

- Appendix B describes several fatigue management tools currently under development. This appendix provides a preview of tools that are likely to be available in the next 1 to 2 years.

- Appendix C describes fatigue management programs and Success Stories from organizations representing all modes of transportation. Many of the tools and ideas in this toolbox came from transportation companies that have already implemented fatigue management programs. Highlights of

some of these programs appear throughout the text as "Success Stories," but the stories are presented in full in this appendix and give additional insight into successful, ongoing fatigue management programs.

- Appendix D contains a list of organizations that can provide other relevant materials and information. This appendix also includes a contact list of people who have successfully implemented fatigue initiatives at their transit agencies and are willing to answer questions about their experiences.

- Appendix E includes black and white reproductions of the color promotional posters that are on the CD and described in further detail below.

The CD contains additional materials that can be used when developing and publicizing a fatigue management program. There are brochures that can be reproduced and distributed as part of education and training. There are posters that promote specific tools and issues that relate to fatigue. These color posters, designed for break rooms, ready rooms or quiet rooms, are suitable for reproduction on 11 x 17-inch paper in an inkjet printer. If a color printer is not available, the CD can be taken to a local print shop and color copies of the posters can be made there. The CD also contains articles on fatigue and alertness topics that can be used in an employee newsletter.

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3 Understanding Human Fatigue

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Fatigue is the body's and mind's response to sleep loss, physical activity or mental activity. People who are fatigued report feeling tired, losing motivation and desiring rest. Fatigue is usually accompanied by changes in behavior, many of which degrade work performance. Decreases in vigilance or attention, impaired judgment and slow response times can all result from fatigue. Fatigue and decreased alertness have the potential to affect productivity, customer relations and employee morale, safety and general health. This chapter explains how people sleep, things that affect their ability to get a good night's sleep, options they have to feel more alert, and the performance effects of fatigue in the workplace.

Nature of Sleep

Research over the past 50 years has made major contributions to understanding the nature of sleep and its relationship to human performance. Historically the medical community believed that the brain was inactive during sleep, but research over the past half century has demonstrated that sleep actually consists of several stages and parts of the brain are often very active. Sleep is a complex state comprised of many behaviors and even after years of research many questions still remain unanswered.

Sleep Fundamentals

A typical night's sleep consists of cyclic sleep stages. The only way that the different stages are easily recognizable is through the use of electroencephalography (EEG), which measures changes in the electrical potentials on the surface of the brain. With the possible exception of rapid eye movement sleep (REM), merely observing an individual asleep will not identify the various sleep stages. Human sleep consists of several cycles about 90 minutes long. Each cycle consists of several sleep stages, some deeper than others and not all of them conducive to dreaming. The basic stages of sleep are the following:

- Stage 1 occurs as we drift off to sleep. This is a relaxed, half-awake state of "falling asleep" or light sleep.
- As relaxation proceeds, the heart rate slows and Stage 2 sleep begins. During this period movement ceases and muscle tension eases.
- Stages 3 and 4, often referred to as slow-wave sleep, are characterized by different brain activity levels. These are very

deep states of sleep and the type of sleep that is truly restful and restorative.

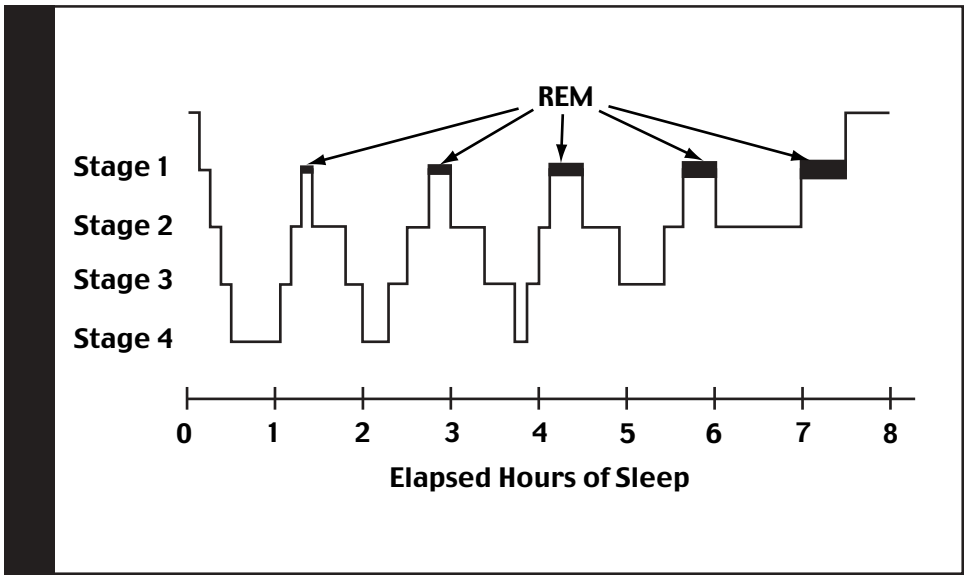
- REM, rapid eye movement or dreaming sleep, occurs last. This sleep, as the name suggests, is characterized by rapid eye movements. REM or dream sleep occurs at the end of the 90-minute cycle. This part of the sleep cycle is characterized by significant brain activity. However, during REM sleep there is a lack of muscle tone, thus preventing the individual from "acting out" dreams.

During the night, sleep behavior systematically alternates between the slow wave and REM stages, as illustrated in Figure 1. As the night progresses, REM periods lengthen so that the last one before awakening may comprise almost half of the sleep cycle.

Upon awakening, individuals experience varying levels of "sleep inertia" or grogginess that can last from a few minutes to as long as 15 or 20 minutes, depending upon several factors. These include the time of day, the length of time that the individual had been sleeping, the extent of the individual's sleep debt and the length of time since the individual's last major sleep period. This grogginess can negatively influence performance for as long as 30 minutes and perhaps even longer. However, noise and activity usually reverse sleep inertia within 15 minutes.

Sleep specialists agree that adults need an average of 7 1/2 to 8 hours of sleep every night. However, there are exceptions. Some

Figure 1. Sleep cycles



individuals can function normally on as little as 6 hours of sleep while others require 9 hours. To be restful and restorative, sleep must proceed through all the sleep cycles. This is why eight 1-hour naps do not provide the restorative rest of a continuous sleep period.

Sleep is an involuntary behavior that cannot be postponed indefinitely. Once the alertness tank is empty, only sleep will refill it, so the fatigued individual will eventually fall asleep.

Performance of a fatigued individual degrades long before involuntary sleep occurs. Sleep deprivation engages the body's immune defense mechanism and subsequently decreases feelings of well-being and physical and mental performance. There does seem to be a relationship between type of task and the rate of performance degradation. Performance on vigilance tasks degrades more rapidly under sleep-deprived conditions than performance on endurance tasks.

There is a large body of research that substantiates the relationship between human performance and fatigue. Researchers in Australia found that after 17 hours of sustained wakefulness, hand-eye coordination decreased to a level equivalent to the performance of someone with a blood alcohol level of 0.05 percent. After 24 hours, performance decreased to the deficit observed in someone with a blood alcohol level of 0.10 percent, a level that exceeds the legal limit for"driving while intoxicated." Another study showed that vigilance, or attention tasks were significantly effected if one received less than 5 hours of sleep on a given night, while simple arithmetic skills remain intact until less than three hours of sleep is obtained. Other research has shown that similar sleep debts can also affect mood, memory, and reaction time, at least in the near term. These effects compound daily, but the degree of impact depends upon the type of task.

Alertness and the Circadian System

Besides sleep, the other major determinant of alertness and waking performance is the internal circadian clock. A variety of biological rhythms control the human body. Biological rhythms that repeat approximately every 24 hours are termed"circadian rhythms"(from the Latin *circa*, for around and *diem*, for day). An internal clock controls these rhythms and is synchronized to daily time cues in the environment, such as light and darkness. Hormone production, body temperature and sleepiness are all under the

control of the body's internal clock and all follow the same cycle over the 24-hour daily period. This cycle has a peak in the late afternoon and a trough in the early morning.

Alertness is at its lowest levels between 3 and 5 a.m. and 3 and 5 p.m.

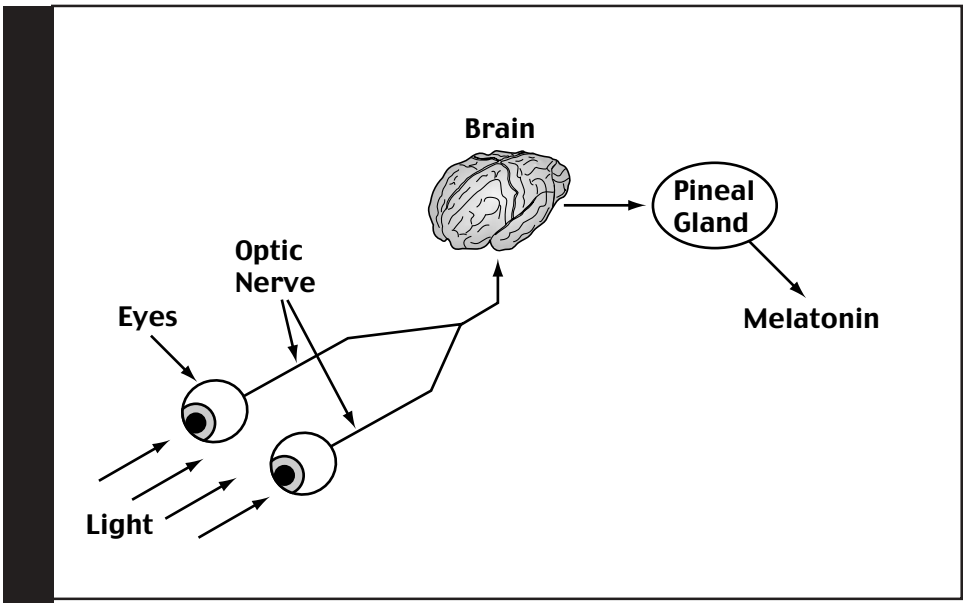
In addition to the biological drive to sleep at night, the human circadian rhythm has two periods during the day when the level of alertness declines. Alertness is at its lowest levels between 3 and 5 a.m. and 3 and 5 p.m. The early morning drop in alertness is significantly more pronounced than the afternoon dip. The afternoon dip occurs whether or not a meal has been consumed, although a meal may exacerbate it. The afternoon dip does not lead to the same degradation in performance as the early morning drop does and is not always noticeable as other physiological and psychological stressors can easily mask its effects.

Alertness is also a function of the time since the last sleep period and the length of that sleep period as well as time of day. Assuming an individual awakes following the desired 8 hours of sleep, the alertness tank will be full at the start of the day. Upon awakening, the alertness tank begins to empty as the day's activity proceeds. Individuals who did not get adequate sleep begin the day with their alertness tanks partially empty. As the day progresses the drain on the alertness tank combined with the body's natural circadian cycle results in the variation in alertness. By nighttime, the alertness tank is nearly empty and sleep occurs.

Light in the environment influences human circadian rhythms by stimulating the brain, which in turn synchronizes the biological clock (see Figure 2). Light entering the eye is converted into electrochemical energy. The signals from the light travel over the optic nerve to the brain. The brain responds to the light level information from the eyes with neural signals to the pineal gland. The pineal responds by secreting the hormone melatonin and distributing it to the body as directed by the brain. Melatonin, referred to as the hormone of darkness, signals the body that it is night. It helps the body reset body rhythms each day, switching the body between day and night modes. *Entrainment* refers to the process of synchronizing all physiological functions to follow the circadian rhythm.

By nature humans are diurnal, conducting activity during daylight and sleeping at night. Light entrains the body hormonally for periods of activity and sleep. Therefore, periods of sleep are not readily rescheduled, deferred or resisted. Moving to a new work schedule that requires a change in sleep pattern, therefore, is

Figure 2.
Elements controlling circadian rhythm



difficult and the human body can take from several days to weeks to adjust. Adjustment may never be complete for people who work nights and sleep during daylight hours, especially those who return to nighttime sleep on days off.

Sleep and Individual Differences

Research has shown that women get more restorative Stage 3 and 4 sleep than men at all ages. With aging, both men and women tend to have less Stage 3 and 4 sleep and increased periods of lighter Stage 1 and 2 sleep. However, women's sleep systems seem to age at a slower pace than men's, giving them longer and more restful sleep.

In spite of the fact that women tend to get more deep sleep than men and tend to sleep longer, there are times when a woman's sleep is disrupted. Conditions unique to women, like the menstrual cycle, pregnancy and menopause, can affect how well a woman sleeps. Changing levels of hormones that a woman experiences throughout the month have an impact on sleep. Hormonal changes at menopause have a similar impact, and both hormonal and physical changes during pregnancy disrupt sleep.

People, regardless of sex or age, seem to have different preferred activity and sleep times. The terms "lark" and "owl" refer to these two distinctly different activity preferences. Larks describe themselves as "morning people." They arise early and claim to

perform best during morning hours in comparison with the remainder of the day. In contrast, owls claim to perform best later in the day. They tend to stay awake later at night and sleep late when given the opportunity. Owls more easily adapt to changing work schedules and some studies show they work best on evening shifts. It is important to recognize that individual patterns of sleep and activity can be anywhere on the scale between the larks and the owls.

Naps

Napping is one of the most popular coping mechanisms for those working nontraditional hours. Shiftwork, especially during the late night and early morning hours, can negatively impact the quality and quantity of sleep of the worker. To compensate for this loss of quality sleep time, shiftworkers often self-prescribe additional sleep in the form of naps. People working nights or very early morning hours tend to nap more than those on rotating or variable schedules, who in turn nap more than those working day shifts. While science is split as to the benefits and consequences of napping, there is significant evidence of the value of supplementing the primary sleep period with a nap. In recent years both railroads and airlines have instituted policies that permit napping during work hours.

Success Story

Napping in the transportation environment has been explored with regard to air traffic controllers and pilots. Research conducted at the FAA Civil Aeromedical Institute investigated the effects of napping on the midnight shift for air traffic controllers. The results of this work suggest that naps taken during the midnight shift could be useful as a countermeasure to performance problems and sleepiness. NASA researchers found that pilots who were given an opportunity for a 40-minute nap during a 9-hour flight had better subsequent performance and physiological alertness compared to the no-rest group.

Research has shown that subjective sleepiness and sleep quality seem to be a function of the total sleep over the course of the day, and not a function of the number or lengths of the naps. In other words, napping can be effective for meeting the daily sleep requirements, but the length of the nap determines whether or not it significantly adds to a short main sleep period. A nap of less than 90 minutes, or one that does not go through an entire sleep cycle of slow wave and REM sleep, will not significantly add to a short main sleep period and may not prevent the onset of fatigue. While a nap of up to 20 minutes may not compensate for inadequate daily sleep, it may eliminate the performance manifestations of fatigue for a short period of time. This type of nap is usually unscheduled and results from an uncontrollable sleep pressure or need to sleep. As such, this "emergency" nap should be reserved for infrequent use and not be a regular component of an individual's sleep schedule. Scheduled naps of appropriate timing and duration, well integrated into the worker's sleep management program are a better course of action. With all naps the issue of sleep inertia or hangover is a factor, just as it is with main sleep periods.

Nap placement may be key to the consequences of napping. The timing of a nap rather than its length has more of an effect on an individual's alertness or performance following the nap. Research showing a benefit to napping placed the nap right before the work start time while research reporting a performance decrement due to napping allowed napping to occur throughout the day as desired. This illustrates the complexity of napping. Both the length and timing of a nap are co-dependent on each other and may affect one's performance and alertness differently depending upon their level.

While many research questions still remain with regard to naps, when used appropriately napping is a viable strategy for supplementing an inadequate main sleep period and as such can improve on-the-job alertness. Since napping is a primary self-prescribed fatigue countermeasure, often without regard to appropriate usage and potential negative consequences, providing information on effective napping strategies can help the workforce to be more alert on the job.

As a final point, it should be noted that a nap is different from a microsleep. Specifically, a nap is a conscious, voluntary attempt to obtain additional sleep while a microsleep is an involuntary loss of consciousness or an onset of a non-responsive state due to extreme sleep pressure or need to sleep. A microsleep often occurs without the person being aware of it. While microsleeps are very short, on the order of seconds, it is enough time to miss a signal or cause an accident. Microsleeps do not add to one's sleep length nor do they relieve the building sleep pressure, as does a nap. Rather they are just a manifestation of an extreme need for sleep.

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Common Sleep Disorders

Physicians trained in sleep medicine are best equipped to diagnose and treat these problems.

All sleep disorders can lead to a sleep debt that results in worktime sleepiness and reduced alertness. It is especially important that individuals whose jobs involve public safety not have an undiagnosed or uncontrolled sleep disorder. Medical treatment for many sleep disorders allows individuals with the problem to continue to operate vehicles or perform other safety critical jobs. The"Tools You Can Use"section contains a self-screening questionnaire for sleep disorder problems as well as information on medical screening for individuals who think they may have a sleep disorder.

The *International Classification of Sleep Disorders, Diagnostic and Coding Manual*, published by the American Sleep Disorders Association, lists over 80 recognized sleep disorders. The most common ones are the following:

- *Insomnia* is a disorder related to difficulty in initiating or maintaining sleep. The individual may experience difficulty falling and/or staying asleep, frequent awakenings during the night or early morning awakenings. Some forms of insomnia may be a response to stresses in daily life. Insomnia may be a short-term response to a one-time stressful event such as a family problem or illness. Long-term insomnia is usually associated with underlying psychological conditions, one of the conditions described below or some other medical condition.

- *Sleep Apnea* is a breathing disorder characterized by brief and recurrent interruptions of breathing during sleep. It occurs in all age groups and both sexes but is more common among men. The National Sleep Foundation estimates that 4 percent of middle-aged men and 2 percent of middle-aged women experience excessive daytime sleepiness resulting

from sleep apnea. There are two types of sleep apnea: central and obstructive. With central sleep apnea, the brain fails to send a signal to the breathing muscles to initiate respiration. Obstructive sleep apnea, which is far more common than central sleep apnea, occurs when the airways close down during sleep thus preventing adequate breathing. The lack of adequate breathing can lead to sleep disruption, decreased blood oxygen levels and cardiovascular problems. Frequent interruptions to deep restorative sleep usually lead to excessive daytime sleepiness. People most likely to have or develop sleep apnea include those who snore loudly and are overweight, or have some structural abnormality in the nose, throat or other parts of the upper airway. Undiagnosed or untreated sleep apnea may have life-threatening consequences to both the individual and those around him/her. An individual with untreated sleep apnea may experience learning and memory difficulties, and more seriously, is at greater risk of falling asleep while operating a vehicle.

- *Narcolepsy* is a chronic neurological disorder characterized by excessive daytime sleepiness, sudden loss of muscle control or cataplexy, intense or vivid dreams upon falling asleep and problems sleeping at night. For people with narcolepsy, the messages from the brain about when to sleep and when to be awake do not always arrive in the intended place or at the intended time. As with individuals who suffer from sleep apnea, someone who has narcolepsy that is not medically treated risks falling asleep while operating a vehicle. First symptoms of narcolepsy usually appear between the ages of 15 and 30.

- Sleepers with *Periodic Limb Movement* disorder involuntarily move a limb, usually a leg, in exactly the same way over the course of the night. Movements can occur as often as every 10 seconds and disrupt sleep. As a result, the individual will experience bouts of daytime sleepiness.

- *Restless Legs Syndrome* is characterized by uncomfortable feelings in the legs before falling asleep. The feelings subside in response to movement but then return. This interferes with falling asleep and can cause severe insomnia. Individuals with restless legs syndrome usually accumulate large sleep debts after many nights of restless legs until

finally the resulting sleepiness is strong enough to overcome the uncomfortable feelings and sleep occurs. Once the sleep debt is reduced, however, the insomnia returns.

Any of these conditions can result in bouts of daytime sleepiness, reduced alertness and overall lack of energy. Physicians trained in sleep medicine are best equipped to diagnose and treat these problems. A primary care physician should be able to refer patients to a sleep specialist for evaluation. The American Academy of Sleep Medicine (AASM) is dedicated to maintaining high medical standards in the diagnosis and treatment of these problems. A listing of the sleep disorder centers that have been accredited by the AASM can be found at http://www.aasmnet.org. (See Appendix D for organizations that provide information on sleep disorders.)

Health, Nutrition and Lifestyle

Chronic sleep deprivation and shiftwork can have health consequences, while nutrition and lifestyle play a significant role in an individual's ability to sleep well and get adequate rest.

General Health

Most research to date on the consequences of sleep deprivation has examined the performance and not health consequences of total sleep deprivation. Recently researchers at the University of Chicago conducted research to determine the effect of partial chronic sleep loss on overall health. This research found that accumulated sleep debt may lead to increased risk of serious health problems, including obesity, diabetes, and high blood pressure. The study found that even in young, healthy people, a sleep debt of three or four hours a night over the course of a week affects the body's ability to process carbohydrates, manage stress, maintain a proper balance of hormones and fight off infection.

While research on the health consequences of sleep deprivation has only recently been undertaken, shiftwork researchers have repeatedly documented the health effects of working at other than daytime hours.

Shiftworkers, those who work outside the typical 8 a.m. to 5 p.m. work schedule, are prone to certain health problems. The most common complaints are upset stomachs, constipation, and stomach ulcers. The human digestive system works on a 24-hour

basis in concert with the circadian rhythm. Because digestive processes tend to slow down during the night, eating during the night can lead to digestive upsets. Shiftwork can also aggravate some health problems. Cardiovascular disorders and diabetes are two such problems.

Nutrition

A balanced diet can help reduce fatigue levels. A diet that includes fresh fruits and vegetables can improve an individual's health as well as keep sickness at bay. Proper nutrition boosts the immune system and wards off illnesses that can cause physical fatigue and disrupt sleep.

Eating meals at regular times is important. The timing of meals is almost as important as what an individual eats. Eating at regular times according to the body's natural circadian rhythm is an important strategy for anchoring the circadian cycle, which makes the body more resilient to sleep debt. Eating breakfast in the morning starts the body's metabolism and provides energy after the overnight fast. It also prevents midmorning irritability and lethargy. The midday meal is important for sustained alertness in the afternoon. Protein (e.g., meat, eggs, beans) is important at this meal because it is believed to trigger a rise in dopamine, a brain chemical associated with mental energy. Similarly, excessive intake of carbohydrates (e.g., sugars and starches) at midday may increase serotonin, a brain chemical involved in sleepiness. A well-balanced evening meal is important because it must sustain the body overnight.

While eating at regular times is important, eating before sleep can disturb sleep. The stomach and intestines decrease in activity while a person is asleep. If the stomach is forced to digest at times when it is normally slowed down, sleep disturbances occur. Large meals and those rich in carbohydrates less than 4 hours before bedtime are especially problematic.

Drinking adequate fluids is as important as regular meals because dehydration can lead to fatigue and lack of concentration. Research has shown that significant deterioration in certain cognitive skills can occur with 2 percent body dehydration levels. At this level of dehydration significant deterioration in math, short-term memory and visual tracking occur. At 5 percent dehydration the individual exhibits impatience, sleepiness, headache, and difficulty concentrating. In addition to maintaining cognitive function and alertness, drinking adequate water helps keep the

digestive and circulatory systems operating properly. Water brings healthy nutrients to cells and carries away toxins. Drinking enough water is important but people who find themselves waking too often during sleep to use the bathroom should try to limit intake right before bedtime.

Exercise and Physical Fitness

Physical fitness has many benefits in terms of overall health and resistance to tiring easily. Exercise speeds up metabolism and increases blood flow, carrying oxygen to the brain. The increase in metabolism and blood flow helps to keep a person awake. Exercise also helps the body cope with stress and can help individuals suffering from depression, a condition that can be characterized by fatigue. Physical exercise can also help reduce a person's susceptibility to certain diseases and infections.

Physical exercise can also help reduce a person's susceptibility to certain diseases and infections.

The question of when to exercise is a subject of much debate. Some argue that exercise too close to bedtime will delay sleep because of increased heart rate and temperature that result from exercise. Others claim that exercise far from bedtime will not enhance sleep. There are no conclusive studies to substantiate either position. The conventional wisdom on this point appears to be to stop exercising at least 2 hours before sleep.

Exercise may not make much of a difference in the sleep of individuals who already sleep well, but it may benefit those who have difficulties. Researchers at Stanford University studied the effect of a 4-month moderate exercise program on a group of older adults with moderate sleep problems. After 4 months of exercise, the exercise group slept nearly an hour longer each night, fell asleep faster, napped less, and reported better overall sleep quality while the non-exercisers continued to sleep poorly.

Substances to Avoid

In addition to exercise, a healthy lifestyle means avoiding certain substances. Tobacco, alcohol, and other types of toxins, including recreational drugs, can affect an individual's health and ability to perform on the job. Limiting or eliminating these substances can lead to a healthier lifestyle for the individual employee and the individual's family. Having an overall healthy lifestyle can help reduce the causes of fatigue so that job performance increases and there is energy and ability to participate in social activities as well.

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Drugs and Alertness

Drugs are a concern with respect to operator alertness in several respects. First, there are drugs and other substances that are recognized as enhancing alertness or reducing the performance degradation effects of fatigue. In addition, there are other drugs prescribed for specific ailments that can have sedating side effects. When using these substances, the operator must be aware of the potential compromise to one's alertness. Finally, there are other

drugs that interfere with sleep and can result in a sleep debt. This section discusses stimulants and sleep agents for background purposes, not to advocate the use of any of the drugs or substances mentioned here.

Drugs to Improve Alertness

There are several classes of drugs, both over-the-counter and prescription, that can temporarily improve alertness, performance, and vigilance. These drugs have to be taken in increasing quantities over time to maintain a particular level of alertness. These drugs are described below. This section also describes one popular herbal substance whose effect on alertness is unsubstantiated.

Caffeine

The most common alertness-enhancing drug is caffeine. Many foods and beverages, such as coffee, tea and colas, contain caffeine in varying amounts. (See "Strategic Use of Caffeine" in Chapter 5 for a list of the caffeine content of foods and beverages.) Research conducted at the U.S. Army Research Institute of Behavioral Medicine, Natick, MA, has examined the effect of caffeine on the human body and mind. This research suggests that caffeine can enhance both physical and mental function. Physically, this drug has been shown to improve endurance and aerobic activity. Caffeine can also affect "mental energy" by enhancing vigor, efficiency, and clear-headedness, as well as vigilance and alertness. Some of these effects can occur with as little as 32 mg of caffeine, equivalent to a weak cup of tea. Caffeine improves both visual and auditory vigilance and usually takes about 15 to 20 minutes to take effect.

Tolerance is developed when caffeine is used on a regular basis.

While the effects of caffeine are independent of age and gender, certain factors can extend or decrease the length of caffeine's effect. In medium to light users of caffeine, the effects last about 5 to 6 hours, while in high level users the effects only last 3 to 4 hours. In pregnant women the effects can last up to 11 hours. Tolerance is developed when caffeine is used on a regular basis.

Caffeine has some short-term benefits in terms of increased alertness, but use of caffeine has limitations and risks. Consuming over 400 mg at a time has been shown to degrade performance by producing physical symptoms such as uncontrollable shaking and an inability to focus mentally. Caffeinated beverages and food taken within 4 hours of bedtime may disrupt sleep, leading to

poorer sleep and further dependency on caffeine during waking hours. Excessive consumption of coffee can also lead to gastrointestinal problems.

Caffeine is a drug and its use should be viewed with the same precautions afforded to other drugs. While individuals self-medicate with caffeine, there are still guidelines on its use that should be followed. Use of caffeine should be a short-term measure to be used until more substantial countermeasures – such as changing sleep/wake routines, nutritional habits and work schedule – can be implemented. When necessary, caffeine should be used strategically throughout the day and not in large quantities that may have negative side effects.

Ephedrine

Ephedrine is another alertness-enhancing drug. Commonly sold as a diet aid, ephedrine produces a stimulant-like effect that is present at low doses and gives the feeling of physical arousal and energy. Although it can enhance vigilance and alertness, ephedrine can elevate heart rate and blood pressure at doses that do not affect cognitive function. This drug is more often used for physical energy than for its effects on mood and mental performance. Excessive use of ephedrine can lead to problems with the kidneys and other organs.

Modafinil

Modafinil is a relatively new prescription medication that the FDA has approved only for the treatment of narcolepsy. Military organizations have conducted research with healthy subjects to determine modafinil's potential to counteract the effects of prolonged sleeplessness. Researchers in France confirmed its value under these circumstances. Because modafinil is not approved for uses other than narcolepsy, it should not be considered a fatigue countermeasure in the civilian workforce.

Ginseng

While ginseng, an herbal preparation, is popular in the consumer market due to its centuries old reputation for increasing energy, research shows no conclusive evidence that ginseng actually improves mental or physical performance or alertness.

Drugs that Induce Sleepiness

A number of over-the-counter drugs can induce sleepiness as a side effect. Current over-the-counter allergy medications, many of which were formerly available only by prescription, cause

drowsiness. In fact, their sleep-inducing effects may be present up to 24 hours after the drug is taken. Many people do not realize that antihistamines contain the same ingredients as over-the-counter sleep aids, and carry the same extended risk of drowsiness.

Many prescription drugs can also induce sleepiness as a side effect. However, unlike the situation with over-the-counter preparations, the physician prescribing the medication or the pharmacist will usually caution the patient on this side effect. In addition, the prescription drug container will usually have a brightly colored warning label. Types of prescription medications that can induce sleep include antihistamines, anti-anxiety drugs, cough syrups, muscle relaxers, pain medication, and migraine medication.

In recent years, articles in a wide variety of publications have made claims that melatonin, as a dietary supplement, is a sleep agent. Melatonin is a hormone made naturally by the pineal gland in response to a signal from the brain that darkness has come. While many people refer to melatonin as the hormone of sleep, it is actually the hormone of darkness. The melatonin sold as an over-the-counter dietary supplement is synthetic or, on occasion, animal melatonin. In spite of the fact that melatonin is readily available and many people use it, few studies have been done to determine its efficacy, safety, side effects and long-term effects. Moreover, the appropriate dosage and timing of the dosage remain to be determined.

Drugs that Interfere with Sleep

A number of over-the-counter drugs and other substances have a stimulating effect and can interfere with sleep. Decongestant cold remedies can be particularly problematic because they contain pseudoephedrine. This substance causes an increased heart rate, which makes it difficult to sleep. “Alertness aids” sold under various brand names are basically caffeine in pill form. Diet pills, which can contain caffeine or ephedrine alkaloids, also interfere with sleep.

Drinking alcoholic beverages can also interfere with sleep. Initially, consumption of alcohol will induce sleep, but alcohol also alters normal sleep cycles. It retards the onset of REM sleep and may increase initial deep sleep. Once the alcohol is metabolized, REM sleep is triggered and the individual may awaken more easily. Thus, alcohol has a negative effect on the timing of an individual’s sleep cycles resulting in sleep that is less refreshing.

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Work Schedules and Performance

Sleep deprivation, time since waking and working non-standard hours (i.e., time of day) can lead to performance degradation. The practice of working non-standard shifts, and in particular the night shift, has been shown to impact a person's sleep/wake rhythm, circadian rhythm, sleep and cognitive performance. Such disruptions to the sleep/wake rhythm, especially if they happen repeatedly as when working nights or early morning hours, may adversely affect the circadian rhythm in several different ways, including changing the timing of hormonal secretions for various biological processes and destroying the 24-hour cycle of sleepiness and wakefulness. These effects, in turn, may diminish sleep length and bring about the onset of sleep deprivation. Sleeping during daylight hours, that is at circadian inappropriate times, has been shown to lead to reduced daily sleep, increased risk of chronic sleep deprivation and increased feelings of sleepiness while awake.

Some research has reported that night workers tended to lose, on average, 4 hours of sleep per week. This indicates a real possibility that night/early morning shift transit workers are chronically sleep deprived. Furthermore, there is data indicating that these night shiftworkers exhibited performance degradation and sleep behavior consistent with those who are chronically, partially sleep

deprived. While it is possible that this sleep debt may be offset through longer non-workday nocturnal sleep and napping, it may be just as likely that this debt is never repaid. Given today's busy, on-the-go lifestyle with respect to family and social life (e.g., bringing children to and from school, time with family and friends) and the internal and external pressure to work during off days, these sleep recovery strategies may go unused or be used in an ineffectual manner.

Whether reflecting nocturnal working time or a chronic partial sleep debt, there has been a lot of research examining the effects of limited and displaced sleep and working at night on worker safety and performance. In many cases performance is affected by the phase of the circadian rhythm; best performance on many tasks usually can be achieved during the circadian peak, while poorer performance is often observed during the circadian trough. However, this link does not span all types of performance and in some cases, it is only the speed at which the task is performed that is negatively affected, not the accuracy until after exceeding a certain level of sleepiness or deprivation. It is important to remember, though, that performance on a particular task or job is dynamic and is affected by a complex interaction consisting of time of day, time on task, time since waking, shift rotation, and the various other work schedule components.

Four primary work schedule characteristics thus far have been found to have a significant impact on worker safety.

Four primary work schedule characteristics thus far have been found to have a significant impact on worker safety and performance. They are:

1. Time of day when work is performed.
2. Number of hours on duty.
3. Number of consecutive night shifts worked.
4. Variability in work start time and the inclusion of backwards rotation.

Each of these is discussed in the following sections.

Time of Day When Work Is Performed

There are numerous books and reports documenting the human circadian rhythm and its affect on biological and cognitive processes. These materials conclude that not all hours of the day are equal with respect to human performance. The human is a

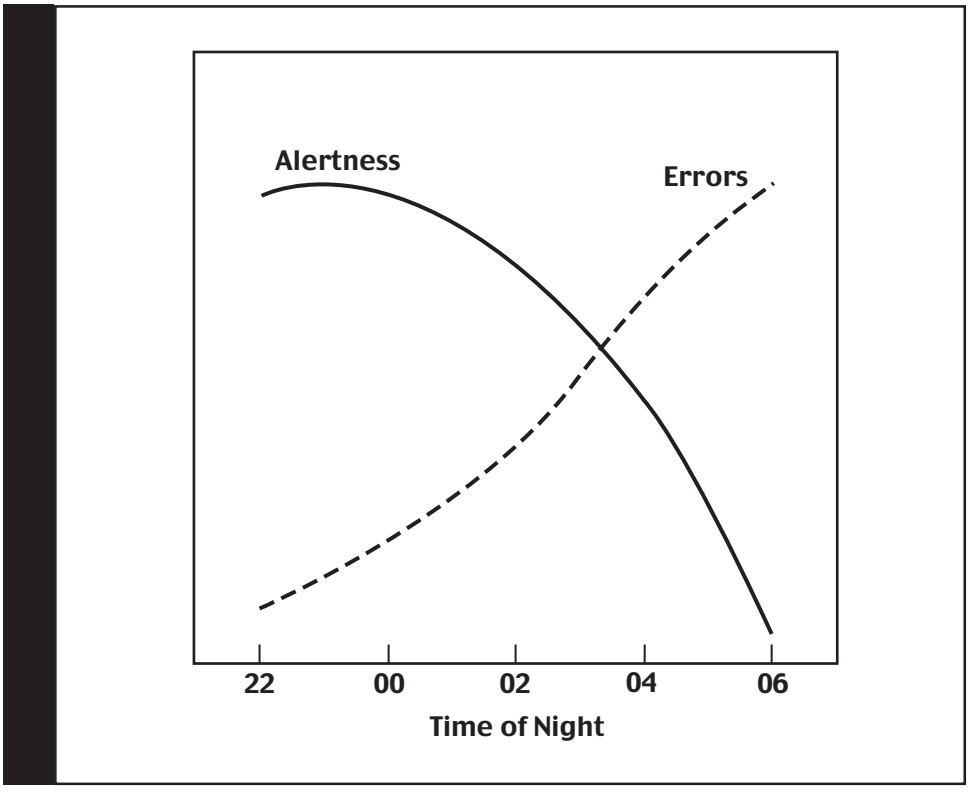
daytime animal, and as such, has difficulty maintaining alertness during the early morning hours. When required to work during these times, people have been shown to make more errors than they would during conventional work times.

Figure 3 illustrates the relationship between alertness and likelihood of error by time during nighttime hours. The dark solid line on the figure indicates alertness level and the lighter, broken line indicates number of errors. Notice the early morning hours when alertness decreases and number of errors increases. Research studies have also shown that there is an incremental progression in amount of risk of an accident from day to evening to nighttime work hours.

Number of Hours on Duty

The National Institute of Occupational Safety and Health as well as other international research bodies have been studying the effects of extended workdays and overtime work for nearly 20 years. Their general recommendations are that the duration of a work shift should be dependent upon the type of work being performed, the consequences of an error and time of day at which

Figure 3. Alertness versus likelihood of error over night shift



the work is performed. The longer people work, the more tired or less alert they become. For example, research with airline pilots has examined sleepiness over the course of a shift on two succeeding days. This research found that feelings of sleepiness increase as the shift progresses, regardless of time of day. And there is a cumulative effect where the rate of feeling sleepy on the second day is greater than on the first. While the literature does suggest a plateau for this degradation, the role of off days is evident. The off time from one shift to the next typically is not enough time to fully recover from the prior day's work activity.

Number of Consecutive Night Shifts Worked

There appear to be cumulative effects with working night shifts. Though the research is not conclusive, the European guidelines for work scheduling, referred to as BEST guidelines (Bulletin of European Studies on Time), typically try to limit the number of consecutive night shifts to two to four. Research has shown how the relative risk of having an accident increases over four consecutive night shifts as compared with day shifts. The difference in relative risk between the day and night shift is pronounced after the first shift and the onset of sleep debt.

Relative risk of having an accident increases over four consecutive night shifts as compared with day shifts.

Variability in Work Start Time

While there is no firm evidence supporting direction of rotation for long-term adaptation to working shifts, there do seem to be some performance and safety advantages for rotating in a forward direction. Forward rotation, day-afternoon-night shift, necessarily leads to at least 24 hours of off time between work shifts. Backward rotating schedules have change points that allow for both less and more than 24 hours off time; backwards rotating schedules are popular with workers because they get more continuous off time at the end of the work week than they would on a forward rotating schedule. Given that the relative risk of fatigue and possibly accidents for night shifts is already higher than that for day shifts, especially over consecutive night runs, starting the sequence of night runs in a sleep-deprived state is likely to only make the situation worse. The situation becomes even more problematic when split shifts and extra duty periods are incorporated into the work schedule. However, as long as the schedule itself is known and is stable, these changes in work start time over the course of the week can be addressed in a comprehensive fatigue management program.

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4 Teaming to Tackle Fatigue and Maximize Alertness

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This chapter describes the process of building and maintaining a successful fatigue and alertness management policy and program. The process consists of five interrelated elements:

1. Secure and maintain senior management commitment.
2. Policy and program development.
3. Communication and training.
4. Manage fatigue and alertness.
5. Monitor, review and modify.

Figure 4 shows the fatigue and alertness program management process as a flow chart diagram. Table 1 indicates the toolbox components that can be employed in each element of the fatigue management program.

Secure and Maintain Senior Management Commitment

A fatigue/alertness management program needs visibility and support at the highest management levels in the organization in order to be successful. Ideally, the chief executive and board of the transit enterprise should define and document their fatigue/alertness management policy to provide the foundation for the organization to tackle fatigue and manage alertness.

Commitment from senior management is absolutely critical to developing a successful program. In some cases, securing and maintaining that commitment will be easy. In other cases, the staff of the enterprise may need to brief the chief executive and board regarding the role employers should play in maintaining proper levels of alertness among operators. Information to support this briefing for senior management may be developed from this toolbox or by working with an outside expert. (See "Why Transit Operator Fatigue Is Important" in Chapter 1.)

Objectives should be stated clearly. For example, a typical objective might be: *improving safety and efficiency in the transit organization by cooperating with the workforce to reduce fatigue and maximize alertness in the workplace.* After senior management provides policy direction, it should move into an ongoing support and oversight role in the following manner:

- Demonstrate a commitment to alertness management and ensure that the policy is understood, implemented and maintained at all levels in the organization.

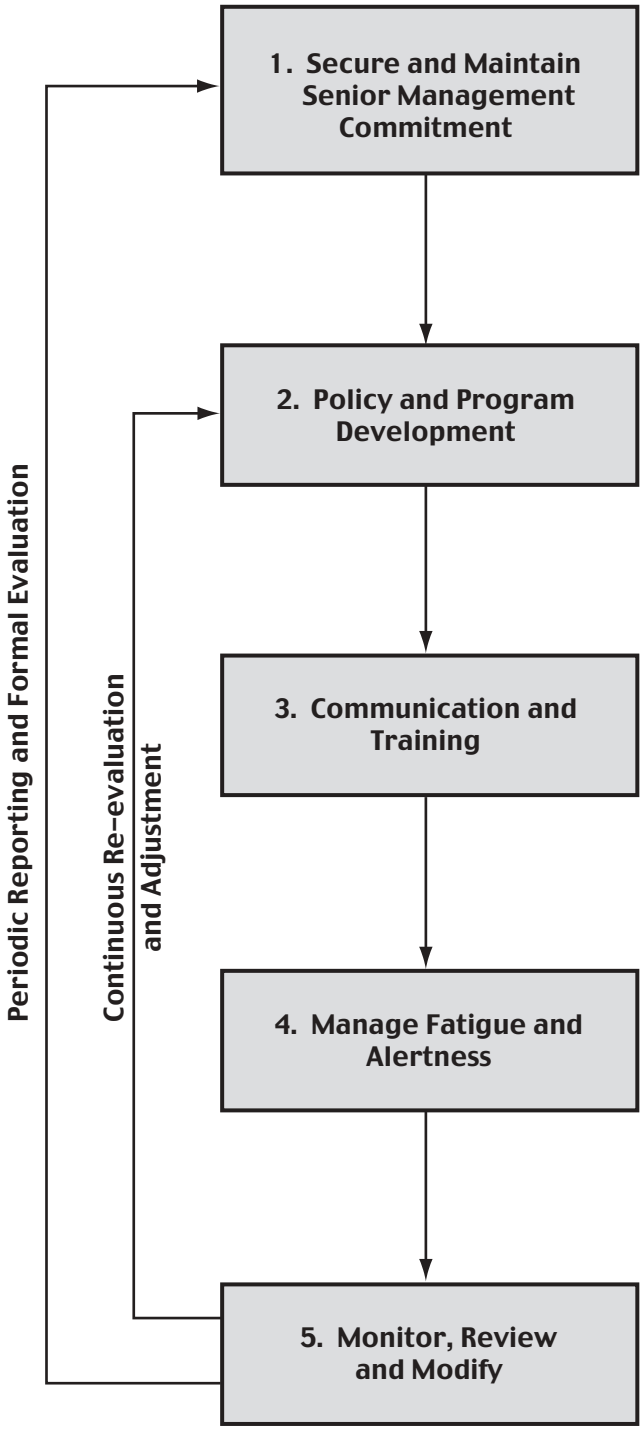

Figure 4. Fatigue and alertness program management process diagram

Table 1. Relationship of toolbox components to fatigue management program elements

Program Element	Toolbox Component
Secure and Maintain Senior Management Commitment	"Why Transit Operator Fatigue Is Important," Chapter 1 "Success Stories," Appendix C
Policy and Program Development	"Understanding Human Fatigue," Chapter 3 "Tools You Can Use," Chapter 5 "Glossary," Appendix A "Success Stories," Appendix C "Organizational Resources," Appendix D
Communication and Training	Posters and newsletter articles on CD
Manage Fatigue and Alertness	"Tools You Can Use," Chapter 5
Monitor, Review and Modify	"Tools You Can Use," Chapter 5 "Fatigue Tools of Tomorrow," Appendix B

- Delegate to agency staff the responsibility and authority to develop, maintain, execute and evaluate the fatigue management program.

- Receive and review fatigue/alertness program reports at regular intervals so the program can be modified/improved as needed.

Policy and Program Development

Once senior management has established an initial policy objective, empowered agency staff and labor representatives need to work out the details of the policy and program for their agency. Experience has shown that a participative process for developing the fatigue and alertness management policy and program produces the most successful results. The program team should include representatives of both management and labor. Management representatives may include, but not be limited to, the operations, human resource/labor relations, and safety departments. Labor representatives should include both labor leadership and rank-and-file representatives of affected labor classifications.

Success Story

In late 1997 the Federal Railroad Administration invited representatives of both labor and management in the railroad industry to form the North American Rail Alertness Partnership (NARAP) to address fatigue issues. NARAP meets on a regular basis to share the results of current scientific research and to discuss experiences of pilot projects in the railroad industry. NARAP members find this to be a valuable forum, not only for discussion of issues but also for sharing experiences.

The team must develop their enterprise's fatigue and alertness management policy and its framework for managing fatigue and alertness. Senior management must ultimately endorse this policy, but they do not need to be encumbered with working out the details. The team should be responsible for developing the details of the organization's policy and program. The policy may include:

- Statement of goals and objectives.
- Responsibilities and authority for managing fatigue and alertness in the workplace.
- Documentation of the support and expertise available to the program.
- Policies regarding employee alertness and fatigue, including possible disciplinary action for failure to maintain satisfactory levels of alertness on the job.
- Plan for reporting and reviewing organizational progress toward fatigue/alertness goals.

The policy development process will require the program team to educate themselves and senior management on fatigue issues. (Chapter 3 of this toolbox contains a suitable overview of human fatigue issues.) In that regard, this toolbox can be an invaluable information resource. The team may also need outside expertise in steering program development and in the education of senior management. The program team may also find it useful to develop partnerships or liaisons with other properties that have already developed and implemented fatigue and alertness management policies and programs.

As stated earlier, the program team must be empowered to decide which issues to address and then to develop the organization's program of appropriate countermeasures. (Recommended countermeasures are described in Chapter 5.) In preparing the policy and program, the team will need to evaluate the work environment and assess the corporate climate relative to making changes that address fatigue issues. All recommended countermeasures are not necessarily appropriate at every work site. The program team may wish to consider only alternatives and countermeasures that are"pay and cost neutral." The program team may also decide to focus initially on measures that do not

require a change in the agency's work rules or collective bargaining agreements.

In deciding which countermeasures and strategies will work best for their organization, the program team will need to consider what changes in work rules, collective bargaining agreements and corporate policies would be required. For example, if the agency rules prohibit sleeping on agency property, the implementation of a napping facility will require a rule change. In some cases, the program team may choose to defer or avoid certain recommended countermeasures because they would create a conflict with long-standing agreements between labor and management. In these cases, the program team may wish to educate senior management and labor executives concerning these conflicts and identify adjustments in work rules and collective bargaining agreements that would support fatigue and alertness goals.

The program team should assemble baseline information for use in periodic program evaluation.

Both to help establish credible goals and objectives and to measure progress toward those goals, the program team should assemble baseline information for use in periodic program evaluation. Baseline information might include:

- Overtime charges – hours per operator.
- Absenteeism – sick time per employee.
- Overall safety measures.
  - On-duty employee injuries per hours worked.
  - Accidents per 100,000 vehicle-miles.
  - Vehicle maintenance patterns.
  - Discipline for safety rule violations.
  - Accidents/incidents where fatigue was a causal factor.
- Management and work practices.
  - Is fatigue considered in contract negotiations?
  - Is fatigue considered as a possible causal factor when investigating accidents and employee injuries?
  - Are schedulers considering fatigue when designing schedules?
  - Are crew callers or supervisors considering fatigue when filling vacancies?
  - Are supervisors mindful of fatigue symptoms when an employee reports for duty?
  - Is screening for sleep disorders a part of the new hire physical?

  - Does the new hire recruitment process set realistic expectations for operator candidates regarding hours of work?

- Assessment of operator alertness.
  - Sleep Debt Index.
  - Anecdotal information.

The Sleep Debt Index (see"Managing Personal Habits and Behaviors"in Chapter 5) provides a simple method to gauge the alertness of operators. This tool can be distributed to all operators with instructions to complete the survey and return it anonymously. Examining the sleep debt indexes for the workforce will give an indication of overall operator alertness in the organization. If it is not possible to collect Sleep Debt Index data, an alternative but less reliable method is to confer with supervisors regarding their assessments of operator alertness levels.

Communication and Training

Careful, but vigorous, communication is critical when"rolling out" the new policy in the workplace. Once the policy and program have been adopted, they must be communicated to the organization. At this stage, outreach is required to inform employees of the renewed commitment to safety by working to manage fatigue and maximize alertness in the workplace. Ideally fatigue and alertness become common considerations in management and line supervision of transportation operators. To achieve this heightened consciousness of fatigue an initial outreach and ongoing training program are required. The CD that accompanies this toolbox contains posters and newsletter articles that can be used by the transit enterprise for publicizing their fatigue and alertness programs.

Specific fatigue countermeasures become operational at this stage. The first activity is usually training for all stakeholder groups. A fatigue awareness training program for operators typically should cover principles of sleep and fatigue and the performance consequences of inadequate rest. Training on techniques and strategies to minimize the risk of fatigue on the job is another important topic to include. This type of training is usually 1 to 2 hours in length and includes the following topics:

- Why operator fatigue is a concern.
- Definition of fatigue, its symptoms and causes.

- Sleep structure – stages of sleep, sleep quality, sleep debt.
- Measuring personal fatigue – the Sleep Debt Index.
- Circadian rhythms.
- Shiftwork effects.
- Relationship between work, off-time and fatigue.
- Drugs/substances that affect sleep and alertness.
- Sleep disorders.
- Personal strategies for maintaining alertness on the job.

Training for management includes a briefer, higher level discussion of the above topics as well as:

- Identification of fatigue-related incidents/accidents and associated costs.

- Agency policy and operational strategies for managing fatigue.

The following training strategies have proven successful:

- Consider an outside trainer for senior management but use on-property trainers for operations supervisors and employees.

- Provide education during paid duty time.

- Reinforce training with periodic updates (e.g., bulletins, refresher courses, agency newsletters).

Overall, the fatigue and alertness management program will benefit from open lines of communication among all stakeholders including labor, line supervisors, middle managers and senior management. Providing information to families of employees can stimulate or reinforce the employee's willingness to focus attention on this important issue.

Manage Fatigue and Alertness

Day-to-day management of the fatigue and alertness program is the responsibility of all members of the transit enterprise, both labor and management.

Having "talked the talk" of commitment to fatigue and alertness issues, the enterprise must now "walk the walk." Line supervisors

and schedulers need to explicitly consider fatigue and alertness issues in conducting their work. Line supervisors and operators need to discuss sleep hygiene and the operator's obligation to report to work rested and ready for duty. Employees with symptoms of chronic fatigue must be counseled. Where there are cases of acute fatigue, line supervision must act within the guidelines provided by senior management. Senior management and labor relations must support line supervision when they enforce guidelines regarding symptoms of acute fatigue among vehicle operators. At first these actions may seem awkward and forced, but when the organization is making a genuine commitment towards managing fatigue and alertness, these new perspectives and regimens will be present every day at the bus garage, car barn and transit terminal.

Ongoing training and feedback are key elements in effective fatigue and alertness management. Intensive initial training is important, but it does not permanently immunize the entire organization against problems with fatigue and alertness. Remember, new employees will require training. Veteran operators will need additional fatigue training as part of periodic agency refresher training. Just as importantly, employees will be promoted from labor into management. Therefore, ongoing management training on the policies, philosophy and techniques of the organization's fatigue and alertness management program is critical to success.

Monitor, Review and Modify

Management is a process, not a goal. To effectively manage any program, ongoing monitoring, evaluation and adjustment are required. The need to measure and maintain holds true for fatigue and alertness management. Ongoing evaluation is necessary to determine if a program remains effective and relevant. Circumstances change and the periodic review of previous decisions and long-standing policies is essential to organizational vitality.

Both internal and external changes in the fatigue environment must be considered. Internally, management should be concerned with the ongoing progress and effectiveness of the enterprise's own fatigue and alertness management program. Over time they should be sensitive to changes in workforce demographics and operations that will require changes in the fatigue management plan. Externally, management should be vigilant concerning

changes in the environment that may affect the operator's work, rest and recovery cycles and also monitor the science and technology of fatigue and alertness management for effective new tools and techniques.

Internal indications of program and policy effectiveness can be derived in many ways including:

- Informal feedback from stakeholders.
- Review of attendance, safety and financial records.
- Formal before/after subjective and physiological ratings.
- Ability to meet contractual (or statutory) work and rest requirements.

Data relating to safety, fatigue and alertness should be assembled and published for senior management review.

At periodic intervals (perhaps annually) data relating to safety, fatigue and alertness should be assembled and published for senior management review and broad organizational visibility. Reports should include analyses of trends in the baseline statistics collected during program planning (see the Develop Policy and Program subsection), as well as a summary of the number and percentage of the workforce that has participated in fatigue awareness training. The reports should note trends in the frequency of incidents and accidents where fatigue was a causal factor. The reports may also contain anecdotal elements relating to reported changes in personal habits. The team may also consider a survey of operators designed to see if changes in sleep habits and other behaviors can be documented.

Staff responsible for managing the safety function of the transit enterprise should not only monitor this "internal scan" of program effectiveness but also maintain an "external scan" of developments in the environment that may change the fatigue and alertness management program. In particular, the organization should be vigilant concerning emerging technologies and state-of-the-art fatigue research. Valuable new countermeasures to identify and combat fatigue and to augment alertness may become available in the future. (See Appendix B for a description of countermeasures currently under development.)

When the report is presented to senior management it should include specific recommendations relative to the scope and focus of the policy and program. Is the program having the desired

impact on the organization? Are some program elements proving ineffective? Are some program elements very effective? Are any elements of the policy unworkable or unenforceable? Have problems occurred? What is the program costing? How much has it saved us? Each of these questions should be addressed in the periodic report with recommendations for changes in the policy and program necessary to correct deficiencies and better focus the flow of resources to strategies and countermeasures that seem the most effective at this transit enterprise. During the next reporting cycle, the program team should specifically consider the effectiveness of any changes in the program or policy that were directed by senior staff.

5 Tools You Can Use

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Transit agencies have at least seven opportunities to manage the adverse effects of operator sleepiness and fatigue. Opportunities for intervention are as follows:

1. Managing personal habits and behaviors.
2. Reporting for duty and managing service delivery.
3. Analyzing and creating runs.
4. Assigning personnel to cover temporary vacancies.
5. Designing facilities and equipment.
6. Recruiting and hiring new operators.
7. Investigating accidents.

This chapter discusses these seven opportunities for fatigue management and provides specific tools a transit agency can use to understand and change operations in general and operator behavior specifically.

Table 2 provides a listing of all of the tools, a brief description of each one, and the intended users of each tool. Each tool is explained and included in full in this chapter, and most of them are available as individual, stand-alone documents on the CD that accompanies the toolbox to facilitate distribution to individual transit operators as needed.

The actual "tools" are identified in this chapter with the following symbol: . Tools that are available as stand-alone documents on the CD are marked with this symbol CD in Table 2.

Managing Personal Habits and Behaviors

Each worker lives a private life outside of the job. In that private life the worker engages in recreational activities, pursues personal interests, cares for a family, eats and sleeps. It is the responsibility of the employee to fit his or her personal schedule around the requirements of the job. In the transportation industry personal schedules and available jobs do not always mesh. Where there is a bad fit, there is stress. Where there is a bad fit, sleep and nutrition are often compromised to meet life's other requirements. Stress, lack of sleep, and poor nutrition lead to fatigue that can impact safety and work performance.

Ultimately it is the responsibility of the employee to find a way to fit the job into his/her private life or to find a new job that provides a better fit. However, some employees may need help integrating

Table 2. Tools and their intended users

Opportunity for Intervention	Tool	Function	Intended User(s)
1. Managing personal habits and behaviors	Sleep Debt Index	Assess overall level of sleep debt and resulting sleepiness	Vehicle operators, supervisors
	Personal Alertness Manager	Analyze and improve personal work/sleep patterns	Vehicle operators
	Personal Alertness Predictor	Predict on-duty alertness	Vehicle operators
	Use and Abuse of Caffeine	Determine appropriate use of caffeine and sources of caffeine	Vehicle operators
	Drugs and Alertness	Understand drugs that affect alertness	Vehicle operators, medical department
	Strategic Napping	Determine when to nap	Vehicle operators
	Exercise Basics	Understand relationship between exercise, fatigue and sleep	Vehicle operators
	Break Time Stretches	Stretching exercises to improve circulation and loosen tight areas after extended period of sitting	Vehicle operators
	Tips for Healthy Sleep	Guidelines for fostering restorative sleep	Vehicle operators
	Making Your Family Part of Your Fatigue Management Strategy	Suggestions on family's role in managing fatigue	Vehicle operators
	Do I Have a Sleep Disorder?	Self-evaluation for potential sleep disorders	Medical department, human resources, vehicle operators
	Run Selector	Process and guidance on selecting runs	Vehicle operators
	Adjusting to Shiftwork	Guidance on how to adapt to shiftwork	Vehicle operators

Table 2. Tools and their intended users (continued)

Opportunity for Intervention	Tool	Function	Intended User(s)
2. Reporting for duty and managing service delivery	Fatigue Hotline	Resource for answering fatigue-related questions	Vehicle operators, schedulers, operations supervisors
	CD Fatigued Employee Process for Supervisors	Guidance on managing fatigued employees	Operations supervisors
	Rest Breaks	Importance of rest breaks in maintaining alertness	Vehicle operators, operations management, schedulers
	Work Variety	Strategy for reducing boredom and enhancing alertness	Vehicle operators, operations management, schedulers
3. Analyzing and creating runs	CD Procedures for Developing Fatigue-Resistant Schedules	Ways to design schedules to minimize operator fatigue	Operations management, schedulers
	Alternatives to Long Spreads and Split Shifts	Ways to meet peak demands without fatiguing the operator	Operations management, vehicle operators
4. Assigning personnel to cover temporary vacancies	CD Guidelines for Filling Temporary Vacancies	Ways to make schedule changes without fatiguing the operator	Operations management, schedulers, crew dispatchers, vehicle operators, labor union, medical department
	Managing the Extraboard	Provide work schedule predictability to the operator	Operations management, schedulers, crew dispatchers, vehicle operators, labor union
	Special Events	Minimize potentially fatiguing work assignments	Operations management, schedulers

Table 2. Tools and their intended users (continued)

Opportunity for Intervention	Tool	Function	Intended User(s)
5. Designing facilities and equipment	Napping/Quiet Facility	Provide on-property facility for rest and napping	Vehicle operators who work split shift or on-call assignment, operations management, facility management
	Exercise Equipment	Provide facilities for exercise during breaks	Vehicle operators, facility management
	Vending Equipment	Provide healthy snacks that stimulate alertness	Vehicle operators, facility management
6. Recruiting and hiring new operators	 The Lifestyle of a Transit Operator: Is it for You?	Set realistic expectations for operator candidates regarding hours of work	Human resources
	 Medical Examination	Screen for sleep disorders	Medical department
	New Hire Training	Provide fatigue basics as part of new hire training	Human resources, training department
7. Investigating accidents	 Fatigue Investigation Procedure	Determine if fatigue is a factor in accidents and incidents	Operations management, safety officer, risk management officers, medical department, schedulers

their jobs with their private lives, especially with regard to how much rest is required to make them a safe and productive transit operator.

Techniques, strategies and considerations that are included in the toolbox to help the transit operating employee adjust his/her personal behaviors and habits to better cope with possible job and scheduling-related fatigue include:

- Advice on assessing his/her degree of sleep debt.
- Advice on evaluating progress toward reducing fatigue and maintaining healthy sleep.
- A pencil and paper exercise for the employee to self-evaluate the fatigue impacts of home and work schedules.

- Advice on how caffeine can be used strategically to ward off the effects of fatigue when rest is not possible.
- Information on the caffeine content of foods and drugs to help employees better understand the impact of their dietary choices on alertness.
- Advice on how napping can be most effectively used to combat fatigue.
- Advice on how exercise can be used to increase vigor and reduce fatigue.
- Information on over-the-counter drugs that can cause loss of alertness.
- General tips for healthy sleep.
- Information to help employees determine if they may have a sleep disorder.

Sleep Debt Index

The Sleep Debt Index (SDI) is based on the Epworth Sleepiness Scale, a scientifically developed tool for assessing sleep debt and resulting sleepiness. Operators can use the SDI to judge their own levels of alertness and sleep debt. Operators need to assess these factors to use other tools in the toolbox, especially the *Personal Alertness Manager, Do I Have a Sleep Disorder?* and the *Run Selector.* Transit enterprise management can also employ the Sleep Debt Index anonymously to assess status and trends in overall alertness in the workforce.

Sleep Debt Index (SDI)

To evaluate your overall daytime sleepiness and related sleep debt, use the self-evaluation tool that appears below in Figure 5. This is the Epworth Sleepiness Scale, a scientifically developed tool for assessing sleep debt and resulting sleepiness.

If your score is over 20 you should seek medical advice. If your score is 5 or less, you do not have a serious sleep debt but it is probably worthwhile for you to examine your personal work/sleep pattern and determine where changes are possible that will reduce your sleep debt and improve your alertness. If your score is

Figure 5. Self-assessment using the Sleep Debt Index

How likely are you to doze off or fall asleep in the following situations? Score yourself using the following scale:

0 = Would never doze off
1 = Slight chance of dozing
2 = Moderate chance of dozing
3 = High chance of dozing

_____ Sitting and reading

_____ Watching TV

_____ Sitting, inactive in a public place (e.g., a theater 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 a lunch without alcohol

_____ In a car, while stopped for a few minutes in traffic

_____ Total Score

Evaluate your total score:

0–5	**Slight or no sleep debt**
6–10	**Moderate sleep debt**
11–20	**Heavy sleep debt**
21–24	**Extreme sleep debt**

between 6 and 20, you should develop a personal fatigue management plan. 

Personal Alertness Manager

This tool consists of a process for assessing a personal schedule, identifying changes that can lead to increased alertness, and evaluating the implementation of these changes. It will be most effective and useful if the process is explained as part of an overall alertness training program.

Personal Alertness Manager

Before considering the merits and implementation of particular countermeasures it is important to assess your current level of sleepiness and your sleep-work schedule. This is not a one-time activity, however, as life routines and work schedules do change over time. Therefore, it is important to reassess your level of sleepiness, work schedule, and its potential for elevating your on-the-job level of fatigue at regular intervals and at specific change points throughout your working life. Events that may necessitate a reassessment of your schedule include changes in family responsibilities, personal commitments and financial needs.

Why Use this Tool

Your goal is to remain in control of your alertness level and not to be overcome by events. You should be as proactive as possible in planning your time to maximize your work time alertness while balancing it against the other activities in your life. There will always be surprises and changes that occur requiring you to react, so the more you can plan your known activities, the better prepared you will be when you do need to respond to an unplanned event.

This tool can be used in two ways: 1) to help you understand where you currently are with regard to fatigue, and 2) to help you plan for future changes. It requires that you follow the directions closely and fill in the information *daily* for at least 1 month. Ideally, this activity will become part of your daily planning routine, making it easier to monitor and be aware of changes.

Self–Assessment of Sleep Debt

To evaluate your overall daytime sleepiness and related sleep debt, use the Sleep Debt Index tool. If you score between 6 and 20, this tool is for you. If your score is over 20 you should seek medical advice. If your score is 5 or less, you do not have a serious sleep debt but it is probably worthwhile for you to examine your personal work/sleep pattern and determine where changes are possible that will reduce your sleep debt and improve your alertness. You can use this self-assessment to monitor your alertness after you have made changes to your personal schedule.

Getting to Know Your Schedule

It is important to understand your work and sleep schedules because they affect each other. In addition, your personal life also

puts demands on you, such as the time you need to pick up/drop off children at school, go shopping or perform home chores. To understand how your time is allocated, fill in the personal Work/Sleep Log for 4 weeks. (See Figure 6.) This should be a typical period, one that characterizes your typical daily routines. Do not start this process if you plan to go on vacation, training or temporary or extended assignments during the next 4 weeks. Wait until you have 4 weeks of regular duty and a typical life event schedule prior to beginning to fill in this form.

This log is set up on a weekly basis with a row for each day of the week. Blanks for the day and date are in the left-hand column. It will be easier for you to see your weekly sleep and work patterns if you start completing the form at the beginning of your workweek. Fill out the log in the morning or upon waking from your main sleep period. Remember that *main sleep period* refers to the time when you plan to obtain the majority of your sleep for the day; this does not refer to a nap period. You should begin filling in the log after the first main sleep period of your start day. When recording times in the log, round times to the nearest half-hour.

How to Use the Personal Work/Sleep Log

1. Look at your current planned work schedule and personal calendar and pick a starting date that will allow for 4 weeks of typical work and personal activities.

2. You will need four copies of the form, one for each week of the period that you will record information. On each form, fill in the dates corresponding to the period when you will complete the log. Enter the week at the top and the day and date in the left-hand column.

3. Within an hour after waking from your main sleep period, using the "morning" portion of the log:
   a. Record the time you went to bed and when you awoke.
   b. Compute the number of hours that you slept.

Day and Date	I Went to Bed at:	I Got Out of Bed at:	I Slept for a Total of (hours):	When I Woke Up for the Day I Felt: (Use scale shown at bottom)
Day 1 Day ___ Date ___				
Day 2 Day ___ Date ___				
Day 3 Day ___ Date ___				
Day 4 Day ___ Date ___				
Day 5 Day ___ Date ___				
Day 6 Day ___ Date ___				
Day 7 Day ___ Date ___				
Weekly Total				
Daily Average				

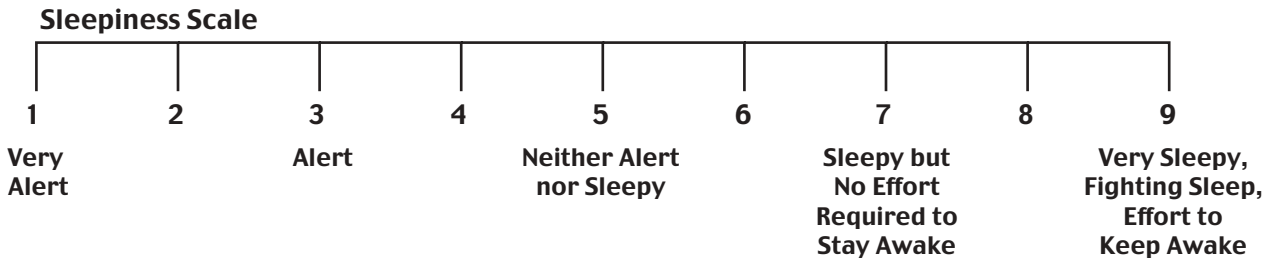


Figure 6. Personal Work/Sleep Log

Day and Date	I Began Work at:	I Ended Work at:	I Worked for a Total of (hours):	This Included Overtime hours of:	Personal Obligations Required (hours):	I Napped From:	I Napped To:	I Napped for a Total of (hours):	Right Now I Feel: (Use Scale at Bottom)
Day 1 Day ___ Date ___									
Day 2 Day ___ Date ___									
Day 3 Day ___ Date ___									
Day 4 Day ___ Date ___									
Day 5 Day ___ Date ___									
Day 6 Day ___ Date ___									
Day 7 Day ___ Date ___									
Weekly Total									
Daily Average									

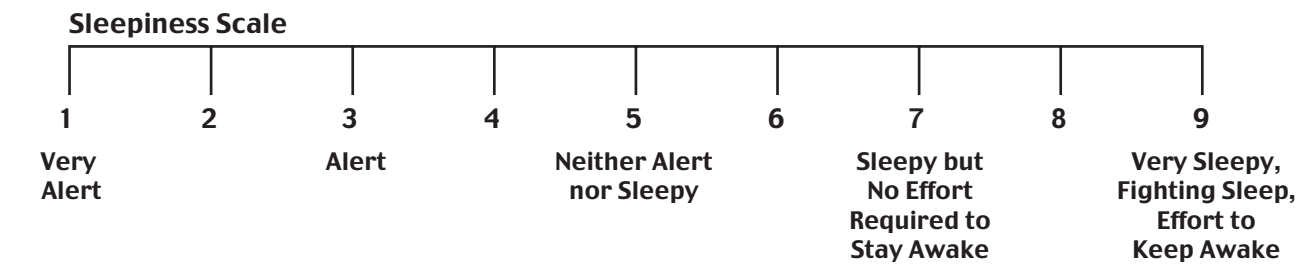
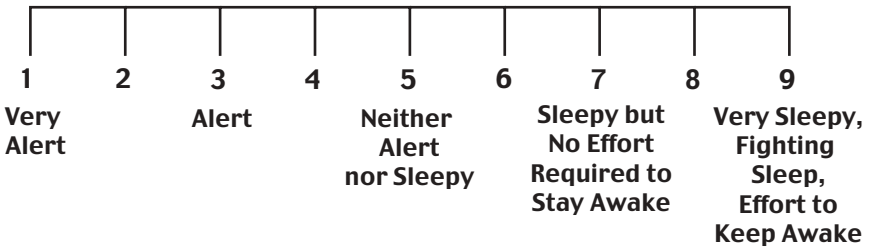


Figure 6. Personal Work/Sleep Log (continued)

c. Enter your sleepiness score in the right-hand column. Use the following scale:



This scale also appears at the bottom of the log form.

4. An hour or less before your next main sleep period, complete the "end of day" portion of the log form.
   a. Enter the start and end times of your work period. If you worked a split shift or more than one shift, record both work periods.
   b. Compute the total number of hours that you worked. If this total includes *voluntary* overtime, record these overtime hours in the "overtime" column. (Voluntary overtime is work time beyond your normal schedule that you were not required to do.)
   c. Determine the number of hours you devoted to personal obligations, *including your commute time*, and record this in the "personal obligations" column.
   d. Enter the starting time, ending time and length of any naps.
   e. Rate your level of sleepiness using the scale at the bottom of the form and enter this value in the right-hand column.

5. At the end of the week, calculate the weekly totals for sleep, work, overtime, personal obligations and naps. Compute the daily average for these values by dividing by the number of days that you had an entry in the category. For example, if you napped on 2 days, then divide the total napping hours by 2.

6. At the end of the week, total the sleepiness scores for waking and bedtime and compute the daily averages by

dividing by 7. If you missed a daily main sleep period, you should not enter a bedtime score or the following wake-up score.

7. Optional: You may also find it helpful to plot your wake-up and bedtime sleepiness scores on the graph that accompanies the log. There are separate graphs for the wake-up and bedtime scores. Place a "•" at the location that corresponds to your score for each day. At the end of the week, connect the points with a line. Figure 7 contains a copy of this graph.

Analysis and Interpretation of Your Personal Work/Sleep Log

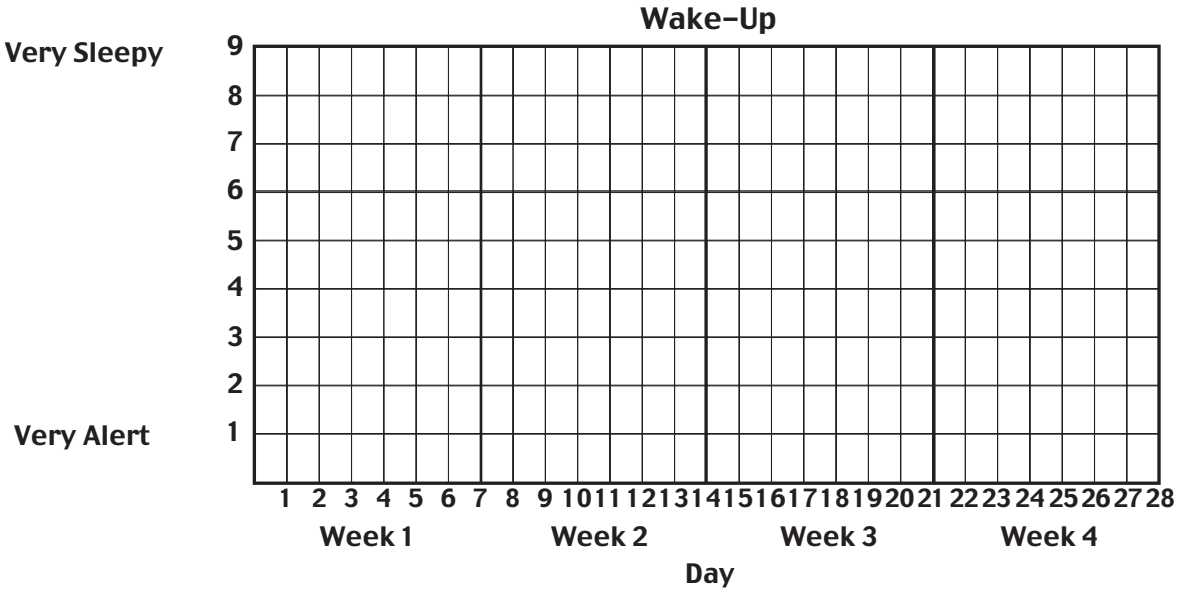
After filling in the log for the 4-week period, you are ready to review the information to learn about your sleep hygiene and risk of reduced alertness while at work. Referring to your logs, answer the questions shown in Table 3. If you answer "yes" to a question, read the information that follows the question. This information should help you to understand and possibly resolve any problem areas.

Planning Activity

After reviewing your 4 weeks of log information, you have probably come up with at least a few areas for improvement. Make a list of the changes that you will make in your overall schedule that will allow you to be more alert. These changes may be countermeasures, such as a daytime nap, a reduction in your voluntary overtime or modifications to your personal obligations. Re-arrange your sleep times as a last resort. If you are napping in the "no nap zone" (10 a.m. to 1 p.m.), you probably want to change this. You may want to have your fatigue manager or supervisor review your plan.

Re–Evaluation

Once you have created your plan, you should try to follow it as closely as possible. While following it you should also continue filling in the log forms as you did for your initial assessment. Just prior to re-evaluation, you should complete the Sleep Debt Index tool. Follow the same procedures for evaluating your plan as you did for your initial assessment. You should notice your Sleep Debt Index Score declining and the Daily Wake-up and Bedtime Sleepiness Scores following closer to their appropriate ranges. If you are graphing your sleepiness scores, more of them should now fall in the shaded area.



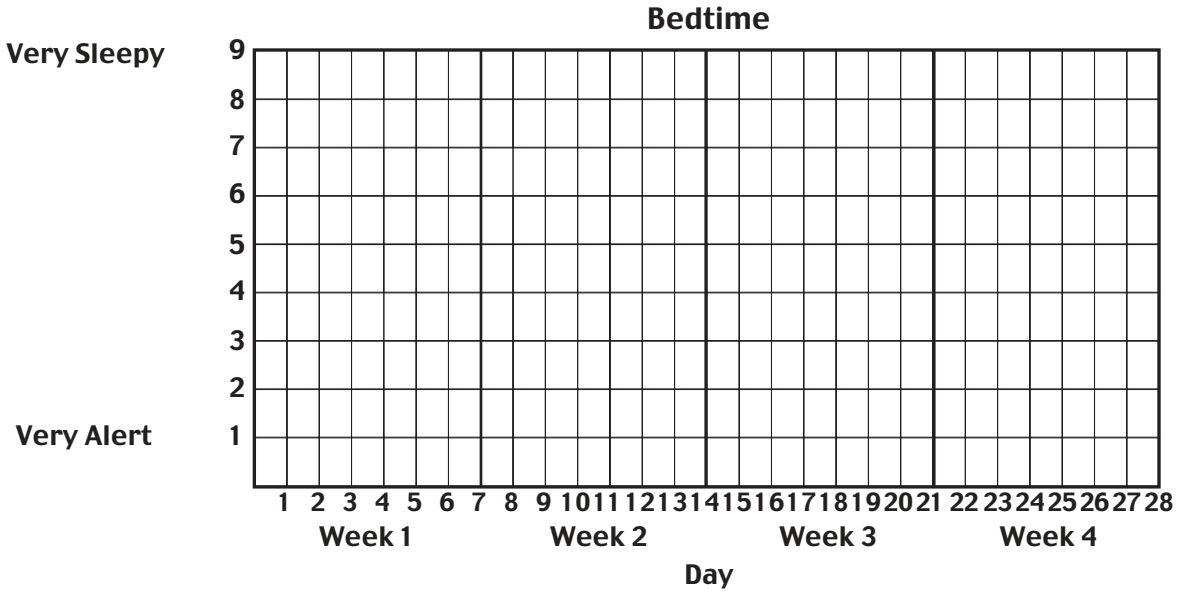


Figure 7. Sleepiness score graph

Table 3. Guidance for analyzing your work/sleep schedule

Question	Advice
Work Time	
Are all your work start times within an hour window of one another? Are all your work end times within an hour window of each other? Are the lengths of all of your workdays within 2 hours of each other?	Generally speaking it is easier for the person to plan for his or her alertness, and it is easier for the body to prepare and acclimate to constant routines than ones that contain a lot of variation. If your work schedule does contain a lot of variation, you might consider one of the following actions: • Talk with scheduler about making your work pattern more regular. • Bid on a more regular work pattern during the next bidding season. • Put extra effort into planning your sleep/wake schedule to make sure it is as constant as possible, including going to bed later or getting up earlier than you might otherwise in order to match your workday habits.
Are any of your work periods broken up by a break or split greater than 2 hours?	Split shifts may be disruptive to your daily pattern and may increase your level of fatigue, especially to the work period after the split. For those who work a split shift, consider the following: • The split should *not* be used to work extra hours, either within your transit operation or at another company. • It could be used to catch a nap either at home or in a company-provided facility, if that is one of the temporary countermeasures you are using, or to take care of routine chores that would otherwise take up your off-time. • You want this time to be productive so that your off-time is more free but whatever activity you choose for this off period should not contribute significantly to your level of stress, workload or fatigue.
Do you have specific workdays that exceed 10 hours?	**Work days in excess of 10 hours are very demanding on your level of alertness** and increase your off-time pressure to take care of your other activities. • Try to minimize the number of long shifts in your run bid. • If you have 1 or 2 long days a week, try to avoid having them as your first or last day of the work week.
Is your average workday over 9 hours?	If you are consistently working more than 9 hours a day, you are running a risk for the buildup of fatigue over the course of the week. **Five 8-hour days is preferable.**

Table 3. Guidance for analyzing your work/sleep schedule (continued)

Question	Advice
Work Time (continued)	
Do you work overtime one or more times a week?	The lure of extra money is often attractive, but it may significantly disrupt your personal routine and your ability to recover to your off-time alertness level. Working overtime also tends to lessen sleep time as there are now fewer hours to accomplish all the other life tasks and social pleasantries. **If you choose to work overtime, set a specific, achievable financial and time goal, so that you do not end up continuing to work overtime.** It is probably best that you work an extra day with similar though shortened work times.
Is your weekly overtime total 8 hours or more?	Working one or more extra shifts per week, whether it is an extra workday or spread over the planned worked days through additional hours, does result in added stress and fatigue for you. You need to recover, both physiologically and socially, from this additional stress and fatigue. • If overtime work is necessary, try to make sure it is on a separate day from your regular work schedule but during your normal work hours. • Its duration should be less than a regular shift.
Do any of your work periods occur in minor or major sleepiness zones?	It is likely that you will be assigned to work during periods falling into at least the minor (3 to 5 p.m.) and perhaps the major (3 to 5 a.m.) sleepiness zones. If you will be working within these zones, you should plan ahead for use of a countermeasure to circumvent the increased feelings of sleepiness that will occur.
Sleep and Nap Time	
Are all your sleep start times within an hour window of one another? Are all your sleep end times within an hour window of one another?	As with work time, it is generally easier for the person with a constant routine to plan for his or her alertness, and it is easier for the body to prepare for sleep and wakefulness than with routines that contain a lot of variation. If your sleep schedule does contain a lot of variation, you might consider one of the following actions: • Set your sleep start time to a time that is possible across the entire week. • Plan your sleep start time at a point in or very near a minor or major sleepiness zone. • Rework your work and personal schedule to allow this kind of sleep start time anchoring.
Are any of your sleep periods broken up by a break or split greater than a half hour?	Split sleep periods generally decrease the restorative value of the sleep period, especially if there are several hours in between the sleep periods. Try to adjust your work and personal schedule to allow for one consolidated sleep period.

Table 3. Guidance for analyzing your work/sleep schedule (continued)

Question	Advice
Sleep and Nap Time (continued)	
Do you have specific sleep durations less than 6 hours?	Sleep periods of less than 6 hours are generally not adequate to completely refresh you, fill up your "alertness" tank and guard against fatigue-related safety and performance deficits. Determine the cause of shortened sleep periods, and correct this problem so as to allow for at least 7 hours of sleep daily.
Is your average sleep duration under 7 hours?	If you are consistently obtaining less than 7 hours of sleep it is likely that you are building up a chronic partial sleep debt, making you more at risk for increased feelings of fatigue during the day and at work. Review your sleep and social schedule in order to anchor your sleep start and end times to allow for at least 7 hours of sleep daily. If you cannot adjust your schedule to accommodate a longer sleep period, take advantage of non-workdays to reduce your sleep debt.
Do you take a nap at least once a week during a workday or in preparation for a workday?	While napping is a favorite countermeasure for shiftworkers who feel they are not otherwise able to get enough sleep, it should be used only sparingly and for short periods of time. Examine your use of napping. If you are using naps to make up sleep time, **consider reworking your main sleep period to include enough sleep time.** Sleep during your main sleep period is more refreshing than naptime sleep. Napping may also have the unintended side effect of disturbing your main sleep period, thereby leading to the need for more napping, the risk of building a sleep debt and increased risk of fatigue during work hours.
Are your naps longer than 20 minutes?	Naps longer than 30 minutes are more likely to be associated with a noticeable sleep inertia or sleep "hangover," that is, feelings of grogginess and not feeling fully awake for at least a half hour from waking. Given that most of the benefit of a nap is likely obtained in the first 20 to 30 minutes, longer naps may not contribute much more to your level of alertness immediately after waking, and require a half hour of down time after the nap before you are at your peak after-nap alertness.
Are your naps placed near the sleepiness zones or the "no nap zone" (10 a.m. to 1 p.m.)?	To aid in your use of time set aside for the nap, it should fall as close to the sleepiness zones (3 to 5 p.m. and 3 to 5 a.m.) as possible, and not in the "no nap zone" (10 a.m. to 1 p.m.).
If you have multiple naps during the week, are they all at the same time and of the same duration?	If you do take multiple naps during the week, you are probably overusing this countermeasure and should consider ways of consolidating your main sleep period. Until this consolidation takes place, try to arrange your nap times so that they all fall roughly at the same time of day for same reasons that you anchor your main sleep time.

Table 3. Guidance for analyzing your work/sleep schedule (continued)

Question	Advice
Effectiveness of Strategies and Countermeasures	
Do you feel you have enough free/non-obligated time to take care of your personal and social needs?	Without enough free time you may start feeling stressed and anxious which can affect your sleep quality. In addition you may also start skimping on your sleep time in order to fulfill your other social and personal responsibilities, which in turn, could lead to a sleep debt and increases in on-the-job fatigue.
Is there variability in your wake-up or bedtime Personal Sleepiness Score? (Review Wake-Up graph)	If your values vary more than one point from day to day, and you record them within an hour of each other, then it is likely that some other factors are influencing these assessments. The values should be around 1 or 2 when waking up and between 7 and 8 when ready for bed. Significant deviation from this may indicate inappropriate use of fatigue countermeasures, a sleep problem, a high stress or workload, or other issues that influence your sleepiness.
Are your workday wake-up scores on average 6 or higher? (Review Wake-Up graph)	Wake-up scores this high indicate a non-refreshing sleep period. It may be too short, incorrectly placed, interrupted, or show symptoms of a sleep-related disorder. Review your other analyses for further clues as to a cause.
Are your workday bedtime scores on average 5 or less? (Review Bedtime graph)	Bedtime scores this low typically indicate inappropriate use of countermeasures (for example, too much napping or taking caffeine too close to bedtime) or inappropriate time of the sleep period (for example, in the no nap zone). Review your use of countermeasures to determine the problem and change as appropriate.
Assess your sleep debt using the Sleep Debt Index tool. Is your score over 10?	Scores of 11 or higher indicate that the current set of countermeasures in your fatigue program are not appropriate or are not working for you. Scores over 20 indicate a very serious sleep debt. You should consult a physician as well as rework your fatigue management program. Values of 0 to 5 are ideal while 6 to 10 indicates a slight sleep deprivation requiring minor adjustment to your schedule.

The re-evaluation process will help you to fine-tune your personal fatigue management plan. This process will also help you to make adjustments resulting from a new work schedule or changes in personal obligations. Consider which countermeasures seemed to work best and which should be dropped or redesigned for your situation. You should review your progress regularly until you reach an optimum balance that maximizes your on-duty alertness. Once you arrive at this maintenance phase, you need to review your plan less frequently, perhaps every 3 to 6 months, or whenever there are changes to your work assignment or your personal schedule. Figure 8 provides an overview of the overall Personal Alertness Manager as a flowchart.

Sample Analysis of Personal Work/Sleep Schedule

Assume that a transit operator has collected 4 weeks of work/sleep data on the Personal Work/Sleep Log. Table 4 summarizes the

Figure 8. Personal Alertness Manager process

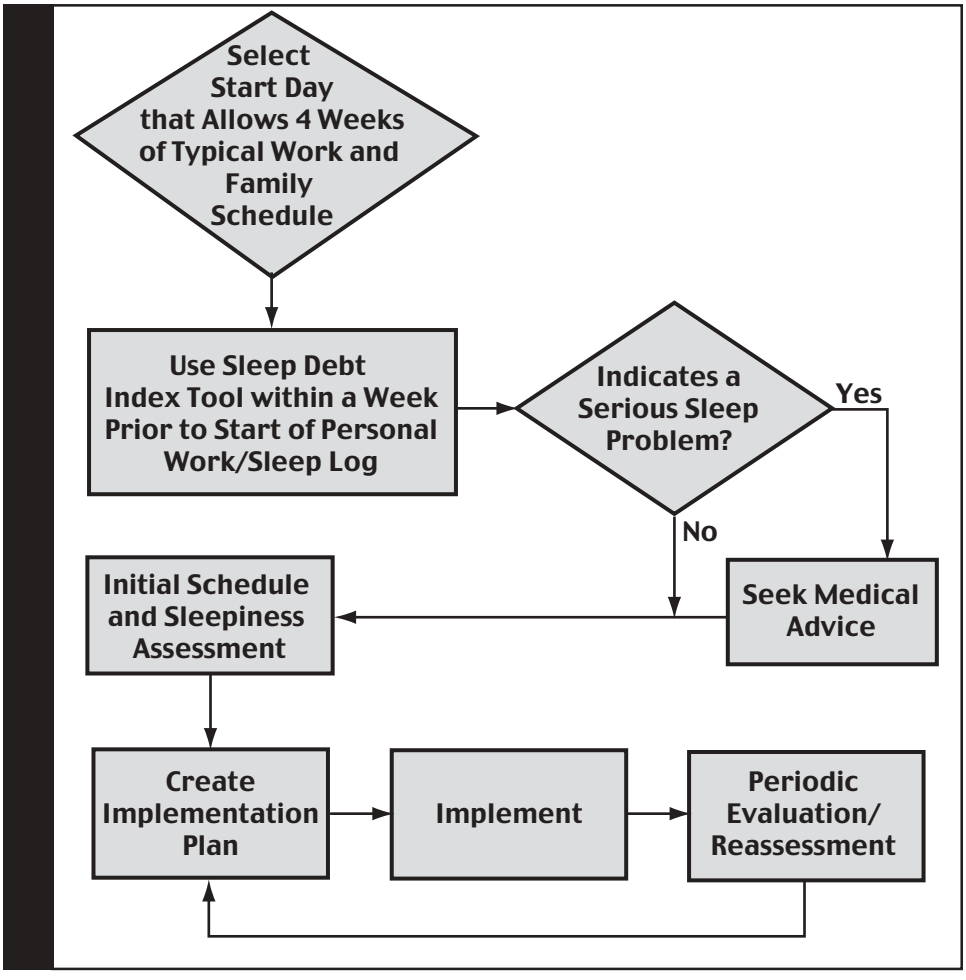


Table 4. Daily averages by week for sample personal Work/Sleep Log

Measure	Week 1	Week 2	Week 3	Week 4
Sleep (hrs)	6.6	6.7	6.4	6.9
Work hours	9	8.7	8.7	8.2
Total weekly voluntary overtime hours	6	12	21	9
Personal obligations (hours)	3.8	4.5	3.8	3.8
Naptime (hours)	1.5	2	1.5	1.3
Wake-up sleepiness	3.1	3.0	4.1	2.6
Bedtime sleepiness	7.5	8	8.2	7.2

daily averages for each of the 4 weeks. Figure 9 contains the log for Week 1 and Figure 10 contains the morning and evening sleepiness scores displayed in a graph.

It appears that this individual is not getting adequate rest. For all 4 weeks the average daily sleep was below the recommended level of 7 to 8 hours. Based on this individual's wake-up sleepiness scores, the individual is chronically sleepy. The wake-up score should be 1 or 2. Bedtime scores should be 7 or 8. This individual is attempting to compensate for this sleepiness with occasional naps, but that does not seem to be a solution to getting adequate rest, perhaps because some of the naps are in the"no nap zone" (10 a.m. to 1 p.m.). (See"Strategic Napping"tool.) During the"no nap zone"(10 a.m. to 1 p.m.) it is more difficult to fall asleep and sleep may be less restful.

Over the 4-week period captured in the logs this individual worked a total of 6, 12, 21 and 9 hours of voluntary overtime per week. This level of overtime, combined with personal obligations, which average 4 hours per day including commute time, is likely the source of the fatigue. This individual needs to re-evaluate the need to work this level of overtime as working less overtime will increase the opportunity for additional sleep.

Finally, this individual is not taking advantage of non-work days to compensate for the sleep debt accumulated during the workweek. The sleep periods on off days are not any longer than those on workdays. While it is preferable to get adequate sleep every night, if personal obligations do not permit this sleep pattern, then days off can be used to reduce any sleep debt. (See Figure 9.)

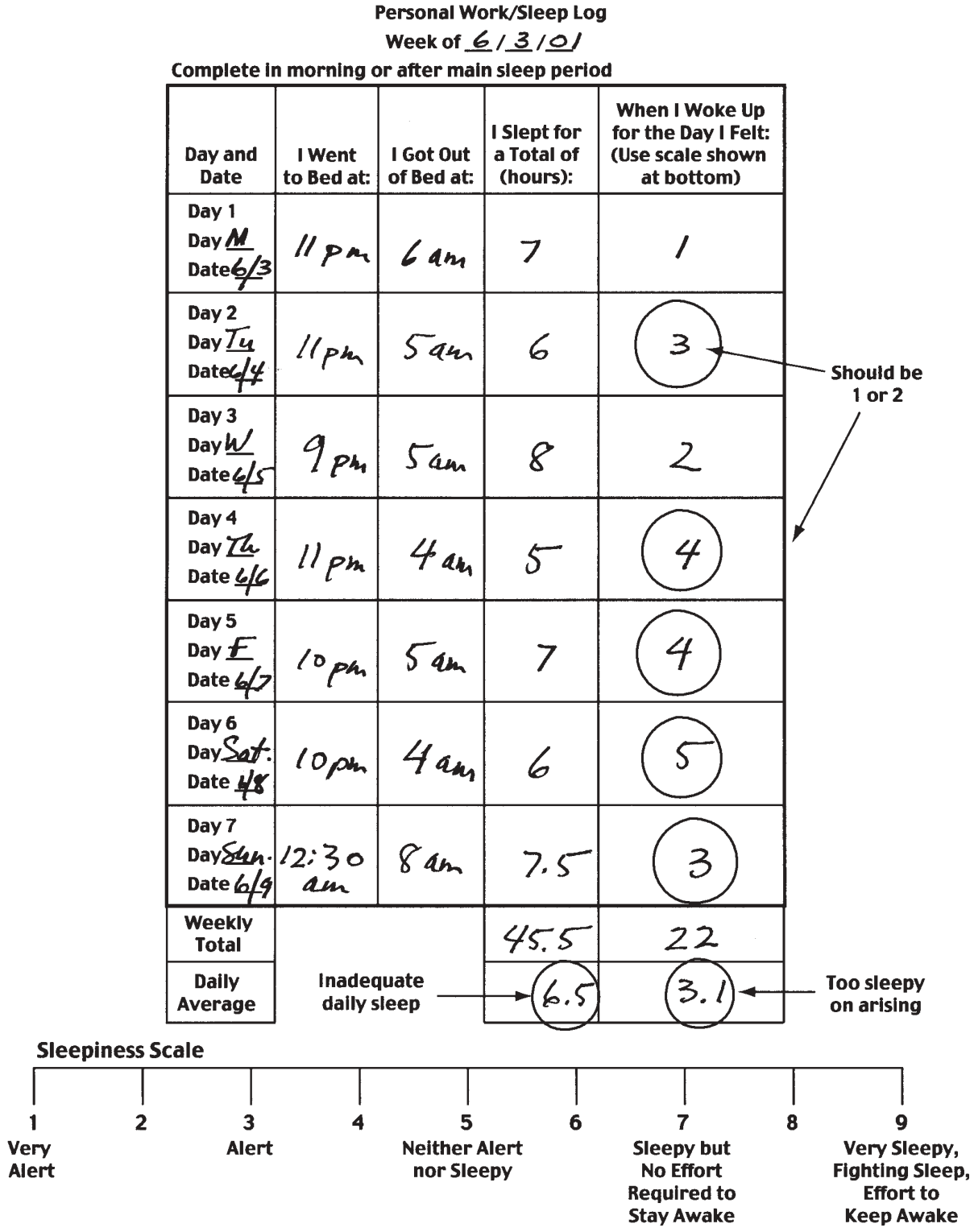


Figure 9. Work/Sleep Log for week 1 with problems highlighted

Complete at end of day or before main sleep period

Day and Date	I Began Work at:	I Ended Work at:	I Worked for a Total of (hours):	This Included Overtime hours of:	Personal Obligations Required (hours):	I Napped From:	I Napped To:	I Napped for a Total of (hours):	Right Now I Feel: (Use Scale at Bottom)
Day 1 Day M Date 6/3	7am	4pm	9		3	5pm	6pm	1	7
Day 2 Day Tu Date 6/4	6 am	6 pm	10		3	10 am	11 am	1	7
Day 3 Day W Date 6/5	6 am	5 pm	9		4				7
Day 4 Day Th. Date 6/6	5 am	noon	7		4	3pm	5pm	2	9
Day 5 Day F Date 6/7	5 am	7pm	11	6	3	10 am	noon	2	9
Day 6 Day Sat Date 6/8					4				8
Day 7 Day Sun Date 6/9					4				7
Weekly Total			46	6	25			6	53
Daily Average			9.2		3.6			1.5	7.5

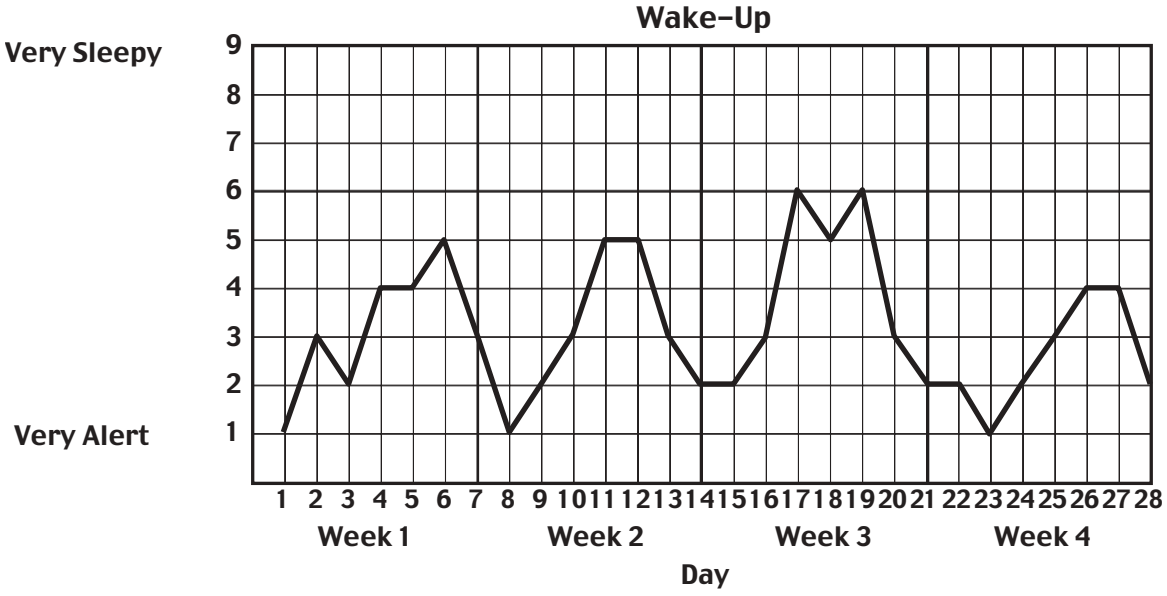
Should be 7 or 8

Naps in "no nap" zone

Sleepiness Scale

1	2	3	4	5	6	7	8	9
Very Alert		Alert		Neither Alert nor Sleepy		Sleepy but No Effort Required to Stay Awake		Very Sleepy, Fighting Sleep, Effort to Keep Awake

Figure 9. Work/Sleep Log for week 1 with problems highlighted (continued)



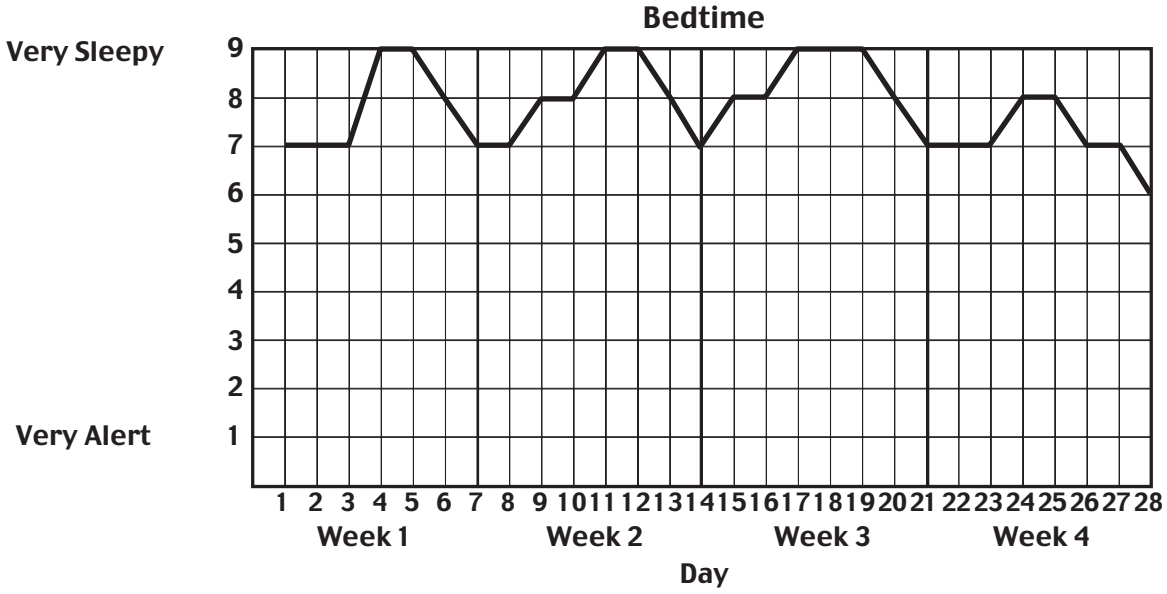


Figure 10. Sample plot of sleepiness scores

Personal Alertness Predictor

The Personal Alertness Predictor gives employees an opportunity to chart their work and sleep schedules and see how they affect alertness during the course of the work period.

Personal Alertness Predictor

The Personal Alertness Predictor is a tool for predicting your alertness during the day. By using this tool you will 1) better understand how your work and sleep schedules combine to affect your alertness and 2) be able to plan fatigue countermeasures to help you through periods of reduced alertness during your work day. This tool might also be used to predict how working overtime and additional shifts would impact your alertness.

Figure 11 contains a graph, which is the basis of the Personal Alertness Predictor. Using this graph you will be able to predict your alertness level based on the time of day and the number of hours since you awoke for the day. You can use this tool to plan when you may need to employ countermeasures if your sleep schedule does not allow for adequate rest on a given day.

Figure 11. Personal alertness prediction tool

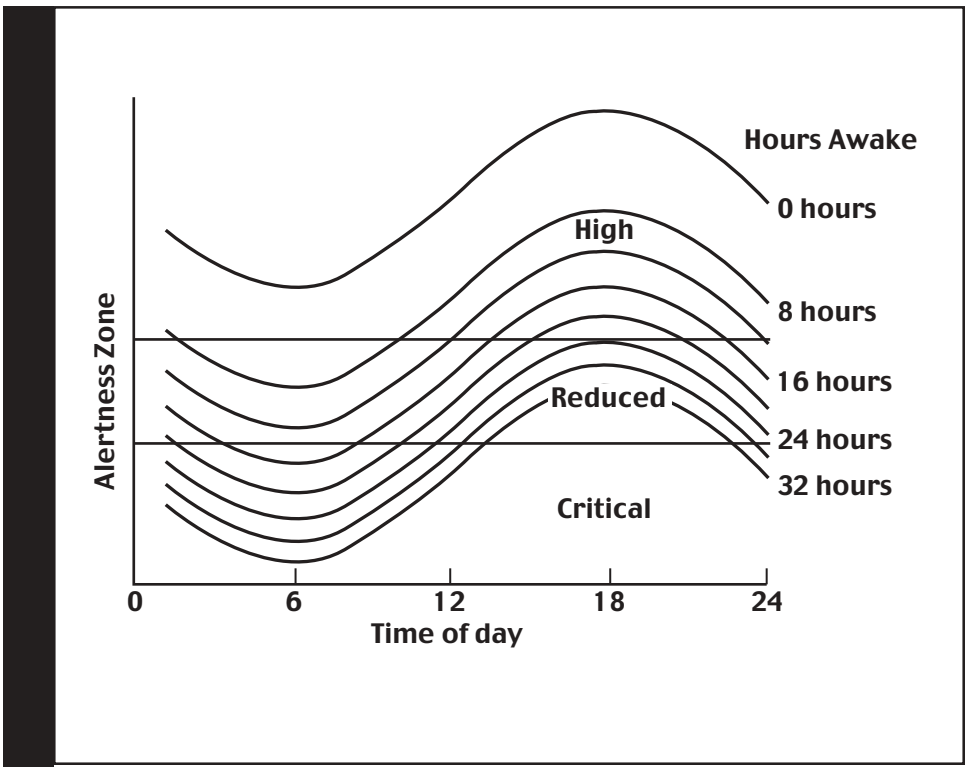


Figure 12 contains a decision diagram to help you use this tool and Figure 13 illustrates the example used to explain this tool.

To predict your alertness at any time during the day, follow these steps:

1. Count the hours between the end of your most recent sleep period that exceeded 5.5 hours and the time for which you want to predict your alertness. (Note: If your last main sleep period was less than 5.5 hours and you were not planning on supplementing it with napping prior to the work period, use the end of the sleep period that preceded your most recent sleep period when calculating time awake.) For example, if you start work at 11 p.m. and got up at 9 a.m., you will have been awake for 14 hours when you report to work at 11 p.m.

2. Go to the graph and select the "hours awake" curve that most closely matches this time, rounding up. If you have been awake for 14 hours, use the "16 hours" curve.

3. On the horizontal axis identify the time of day for which you want to predict your alertness. Draw a line up from this time to the curve that you selected. If you are interested in your alertness when you report to work at 11 p.m., draw your line from "23" on the Time of Day axis to the "16 hour" curve.

4. Follow steps 1, 2, and 3 for additional times during your workday.

5. Determine if any of the hours you will be working fall within the reduced or critical alertness range. In our example, you would be in the reduced alertness zone when beginning work at 11 p.m.

6. If any hours do fall within this time, your first course of action is to try to move or elongate your sleep period. If this is not possible or still does not provide adequate alertness reserves, consider the following actions, depending upon the predicted severity:
   a. You should treat those hours that do fall within the reduced alertness zone with some concern, especially if they fall towards the end of your shift. You may want

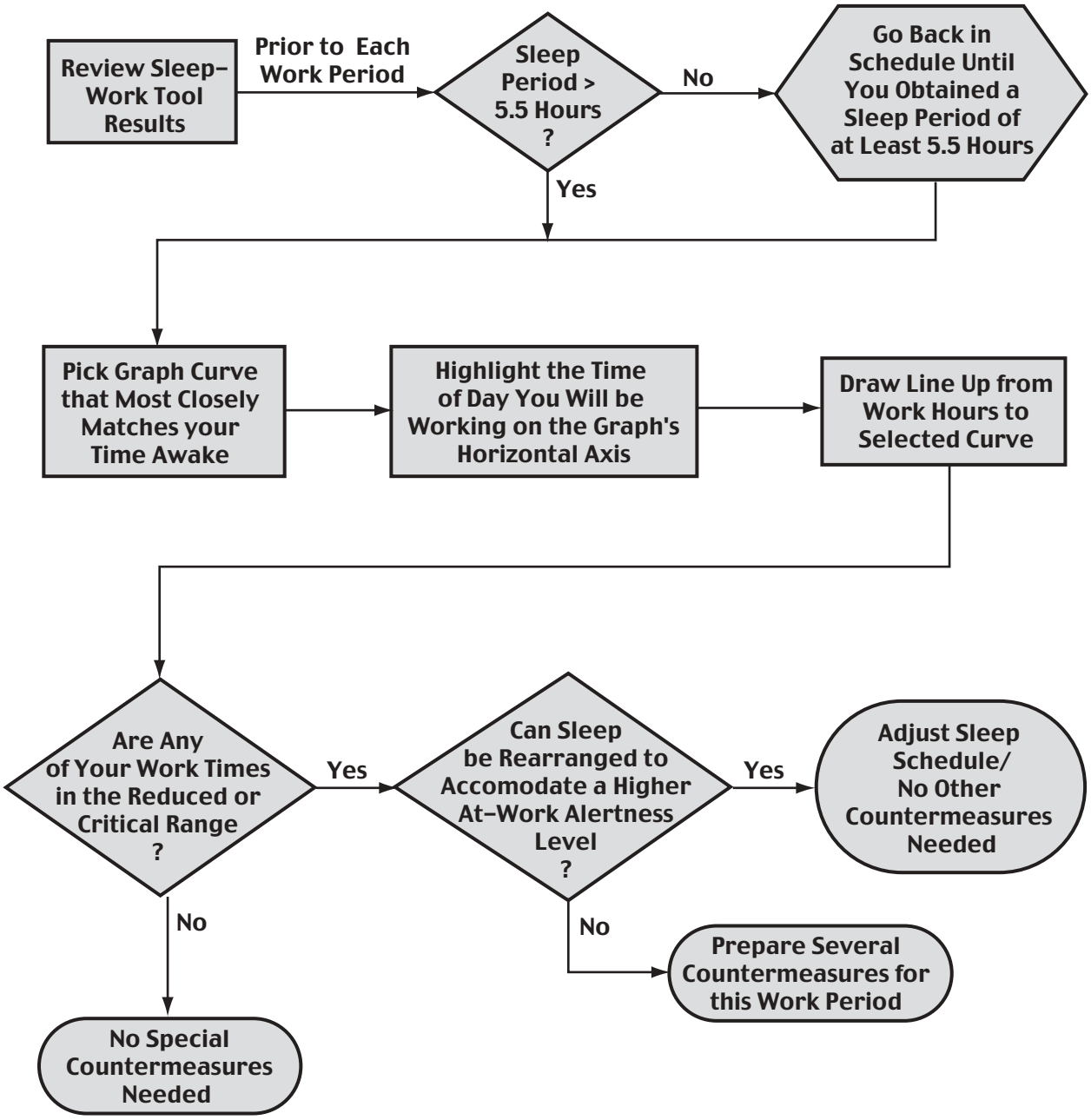
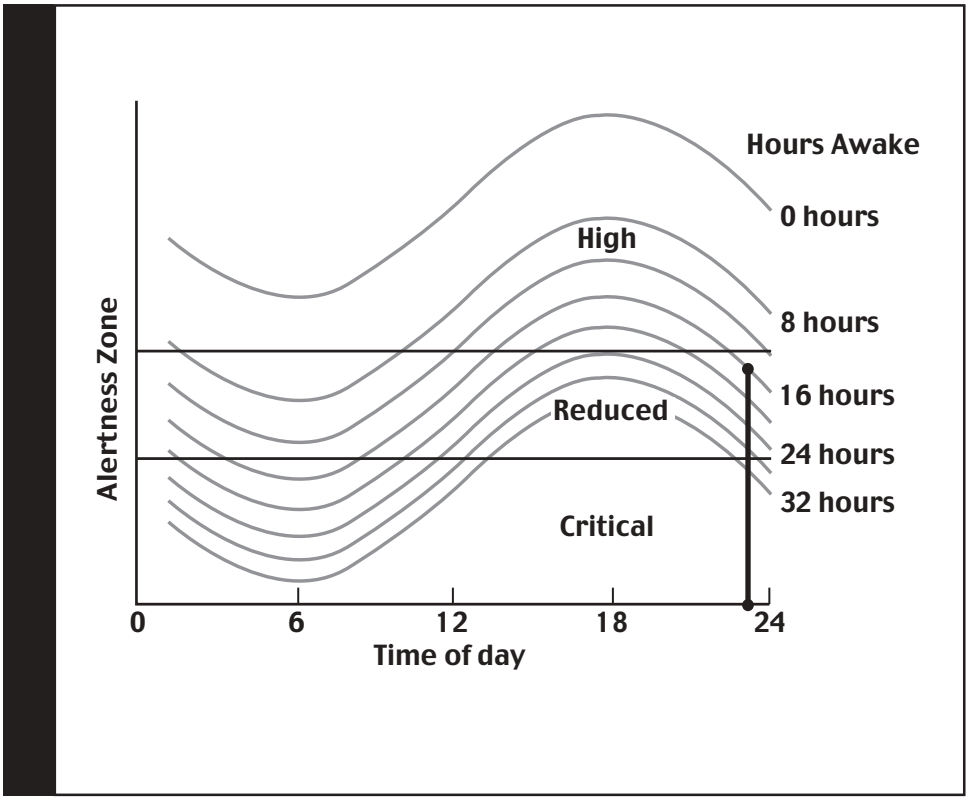


Figure 12. Process for assessing personal alertness

Figure 13. Using the Personal Alertness Predictor



to plan on implementing one countermeasure during your work period, at least 1 hour prior to when the alertness dip is predicted. Such countermeasures may be a nap during your lunch period, consuming caffeine or avoiding a heavy meal.

b. If your predicted alertness level falls into the critical band, you should consider implementing at least two countermeasures, ideally one of them being a nap. Again, countermeasures should be planned and implemented at least 1 hour prior to entering the critical band.

It is important to remember that this tool is for predicting sleepiness or loss of alertness not necessarily fatigue or any performance decrements. end T

Strategic Use of Caffeine

The strategic use of caffeine is a tool that a transit operator can use when s/he feels that his/her alertness is reduced. The information

in the tool is designed for distribution to operators and other employees who are likely to use caffeine as a routine fatigue countermeasure. The companion CD contains a poster showing the caffeine content of various food and beverages. Placement in the break room or near vending machines will raise employee awareness of their level of caffeine usage.

Use and Abuse of Caffeine

Caffeine can be an effective alertness booster if used properly. It can be a short-term measure to be used until more substantial countermeasures – such as changing sleep/wake routines, nutritional habits and work schedule – can be implemented. It should not be viewed as an ongoing strategy for maintaining alertness.

Caffeine is a drug and its use carries risks. Tolerance develops when caffeine is used on a regular basis. When coffee is the source of caffeine, consuming it in large quantities brings the risk of gastrointestinal problems. Headaches can result from an abrupt cessation in caffeine use. Breaking a caffeine habit requires a gradual tapering in usage.

Table 5 provides the caffeine content of popular foods and beverages. Heightened alertness occurs within 15 to 20 minutes of consuming caffeine. Medium to light users of caffeine will experience enhanced alertness for 5 to 6 hours. In high-level users the feeling will last up to 4 hours. Depending upon the individual's caffeine adaptation, as little as 32 milligrams of caffeine, equivalent to the amount in a weak cup of tea, can produce increased alertness. The response to caffeine varies by individual.

Times when caffeine use is appropriate:

- Midway through the night shift on the first or second day of the work week. (The first two nights of the work week are most difficult if you slept at night on your days off. See "Adapting to Shiftwork.")

- Mid-afternoon when the afternoon dip in alertness is significant due to inadequate nighttime sleep.

Table 5. Caffeine content of foods and beverages

Food	Serving Size	Milligrams of Caffeine
Coffee		
Regular*	8 oz.	80-150
Decaffeinated	8 oz.	5
Tea		
Brewed**	8 oz.	9-50
Decaffeinated	8 oz.	3-9
Herbal (fruit)***	8 oz.	0
Iced	12 oz.	22-70
Chocolate		
Hot Cocoa	8 oz.	5-8
Milk Chocolate	1 oz.	1-15
Dark Chocolate	1 oz.	5-35
Soft Drinks		
Coca-Cola	12 oz.	46
Pepsi	12 oz.	38
Dr. Pepper	12 oz.	41
Surge	12 oz.	51
Mountain Dew	12 oz.	55
Jolt	12 oz.	71
Sprite	12 oz.	0
7-Up	12 oz.	0

*Depending on roast, method, and whether served with creamer, milk, etc.
**Depending on time steeped and type of tea leaves.
***Most fruit or herbal tea contains no caffeine. There are some exceptions.

Source:
Walsleben, J.A., and Baron-Faust, R. *A Woman's Guide to Sleep.* New York: Crown Publishers, (2000).
Lieberman, H.R., "Caffeine." *Factors Affecting Human Performance Vol. II: The Physical Environment,* pp. 49-72. London: Academic Press, (1992).

- Prior to an early morning commute home but not within 4 hours of a planned sleep period.

Warning: Since caffeine can interfere with sleep, avoid consuming caffeine within 4 hours of bedtime. end T

Drugs that Affect Alertness

This tool consists of information on the effects of drugs on alertness. The information will be most effective if it is distributed in conjunction with a fatigue awareness program.

Drugs and Alertness

Many drugs, both over-the-counter and prescription, can affect your alertness. With prescription drugs, your pharmacist will likely warn you of the sedating effects of a medication. For over-the-counter drugs you must be vigilant and read the fine print on the box. Table 6 provides a list of popular over-the-counter drugs that will affect your alertness. Over-the-counter allergy medications are especially problematic because their sedating properties can persist up to 24 hours after they are taken. Timing these medications so that they are not taken during the periods of reduced alertness will help to temper their sedating properties.

Similarly you need to be aware of drugs and other substances that interfere with sleep. Over-the-counter drugs that are likely to prevent you from sleeping are listed in Table 7.

Your agency may have a policy regarding operating a vehicle while taking certain prescription or over-the-counter medication that will affect your alertness. Make sure to understand and follow this policy.

Table 6. Over-the-counter drugs that induce sleepiness

Medication Type	Drug Names
Allergy Medications (Antihistamines)	Brompheniramine (Dimetapp® Allergy, Nasahist B®) Chlorpheniramine (Chlor-Trimeton®) Clemastine (Tavist-1®,Tavist-D®) Diphenhydramine (Benadryl®)
Sleep Aids	Diphenhydramine (Nytol®, Sominex®)
Alcohol	Alcohol (Nyquil® liquid)
Motion Sickness Tablets	Dimenhydrinate (Dramamine®) Meclizine (Dramamine II®)
Pain Medications	Naproxen sodium (Aleve®) Diphenhydramine (an active ingredient in Tylenol P.M.)

Table 7. Over-the-counter drugs and other substances that interfere with sleep

Type of Drug	Drug Names
Alertness Aids	Caffeine (Vivarin®, No-Doz®)
Decongestants	Pseudoephedrine (Sudafed®)
Diet Pills	Caffeine Ephedra® Chromium Piccolanate
Tobacco	Nicotine

Strategic Napping

This tool consists of advice on the appropriate use of naps as a fatigue countermeasure. This information should be distributed as part of a fatigue awareness program.

Strategic Napping

Napping can be a helpful aid to fighting fatigue and maintaining your alertness while on duty. *Naps should not be used as a substitute for appropriately timed main sleep periods*; however, they may provide the additional sleep you need when an unusual situation prevents you from obtaining your regular, planned amount of sleep. There are two important reasons why napping should not be used regularly to replace portions of your main sleep period:

1. One solid, continuous sleep period has a greater restorative and refreshing effect on you than several sleep periods broken out over the course of the day.

2. Napping disrupts your main sleep routine, the time your body has become accustomed to sleep, and may lead to difficulty sleeping during the main sleep hours, subsequently leading to the onset of a sleep debt.

When Napping Is Appropriate

There are, of course, times when naps become necessary in order to maintain an appropriate level of alertness and vigilance during your work-time duties. For example, you may have stayed up late with a sick child or unexpectedly worked a double shift. In such cases it is important to first realize that you may be *at risk* of being unduly sleepy during your workday, and that feelings of fatigue are

more likely to come on sooner and stronger during your work period. Acknowledging this possibility you need to consider your current state and your schedule for the next 24 hours to determine the best course of action.

Figure 14 provides the steps you need to follow to determine if a nap is appropriate, and if so, when it should take place. Once you are aware that you had a shortened or fitful main sleep period, you need to assess the severity of this acute sleep loss. Consider a nap if:

- You slept less than 5.5 hours in your bed.
- You had two or more periods of wakefulness of 30 minutes or longer.
- You felt you were in a continual state of drifting in and out of sleep.
- You felt unusually and intensely tired and lethargic upon waking.

If any of the above situations occur then it is likely that your sleep quality and its recuperative abilities have been significantly compromised. Under any of these circumstances a strategically placed nap is likely to benefit your alertness level. If, on the other hand, you woke up once or twice and quickly went back to sleep or felt just a bit less refreshed than usual in the morning, your alertness level is likely to remain at its usual levels throughout the day and a nap is not necessary or advised.

Should you have a shortened or difficult sleep period and are able to continue it even after your normal wake-up time, then by all means do so. This will be the most efficient use of your sleep time. However, this continuation of sleep may not be possible depending upon your schedule and time of day. Deciding that extra sleep is needed and that a continuation of the main sleep is not possible, the next steps are for you to determine where and when a nap should be taken and for how long.

Ideally the nap should occur at home where you have the greatest control over the environment, which may include blackout curtains, ear plugs or other sleep promoting devices, and you have access to your own bed (see *Tips for Healthy Sleep*). If you must nap

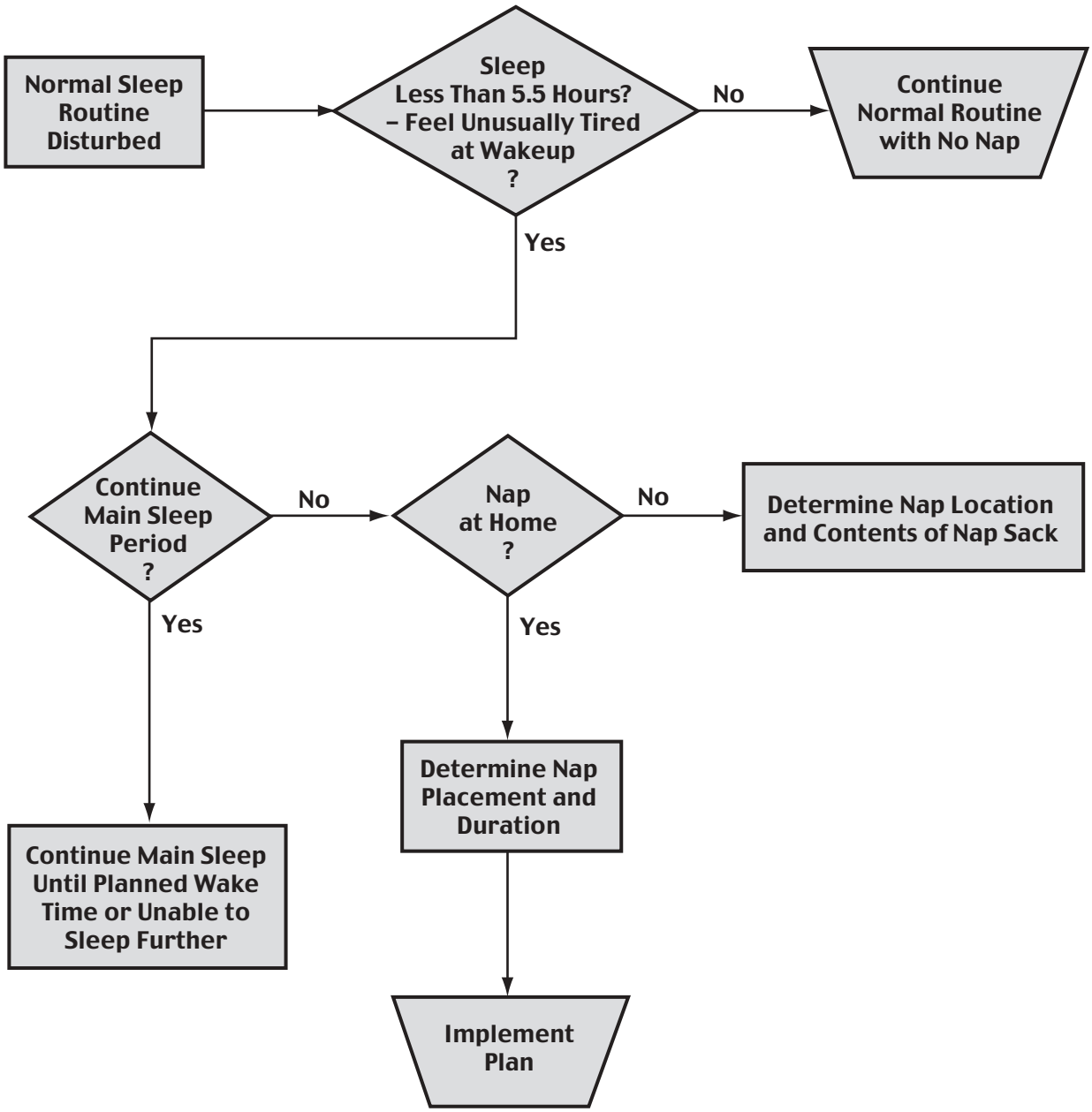


Figure 14. Process for determining napping strategy

away from home, prepare your "Nap Sack" and remember to take it with you. Depending upon the location for your planned nap, such as your company's nap facility, the back of your car, or a ready room, your "Nap Sack" might contain one or more of the following items:

- Eye shade.
- Good quality ear plugs.
- Inflatable neck support.
- Pillow.
- Blanket.
- Portable alarm clock.

Nap Timing

Next you need to determine the best time for your nap given your schedule. Remembering your circadian rhythm, you know that there are times of day that are more and less conducive to sleeping, regardless of how tired you feel or how much sleep you lost. Trying to nap at a time when your body is physiologically becoming more awake may lead to an unsuccessful nap. That is, you spend more time trying to get to sleep than you do actually napping – if you fall asleep at all. Follow these rules of thumb to determine the timing of your nap:

1. Avoid the period from 10 a.m. to 1 p.m. This is your "no nap zone" (10 a.m. to 1 p.m.). Naps become more restorative the further they are from your "no nap zone" (10 a.m. to 1 p.m.).

2. Try to take advantage of the mid-afternoon dip when your alertness will naturally drop. This is a natural nap period.

3. Naps should be placed as close to the start of your work period as possible to reap the most gain. In some cases, napping during your lunch break may provide the maximum benefit, if there is a place to properly nap.

4. There should be at least 15 to 20 minutes between your nap and when you are to operate your vehicle. This will enable you to overcome any sleep inertia you may be experiencing. You have an opportunity to refresh yourself and if necessary, consume a caffeinated beverage.

5. As with your main sleep period, you should refrain from drinking caffeinated beverages immediately prior to your nap as the stimulating effect of the caffeine or the need to use the bathroom may prevent you from falling asleep or interrupt your nap prematurely.

The length of the nap will vary depending on the amount of time available to you and the severity of the sleep debt you are trying to repay. Typically your nap should be under 1 hour, as longer naps tend to create greater disruption to your next main sleep period. In addition, longer naps may leave you with greater sleep inertia, taking you longer to regain your level of alertness. Naps of 15 to 30 minutes provide the greatest alerting benefit with the fewest risks to extended sleep inertia or interference with the next main sleep period.

Napping Don'ts

When attempting to nap:

- Do not take any sort of sleeping aid or eat a heavy meal. These actions will make you feel sleepy longer after you need to get up from your nap period.

- Do not take any other substances that may help you to relax as they may interfere with your ability to wake up with minimal sleepiness and performance side effects.

- Do not smoke. Nicotine is a stimulant and can interfere with your ability to fall asleep.

"Emergency" Napping

While the above guidelines should help you plan and prepare for a nap on days following disturbed sleep periods, you may also encounter situations in which all of a sudden you feel extremely sleepy. In this case, the best thing to do, if possible, is to immediately nap for 15 to 30 minutes, regardless of your circadian rhythm or how much sleep you had during the previous main sleep period. If you are on duty, you may have to engage some other countermeasure until you are able to go on break – you should scout out possible napping venues for all locations where you may be spending your break period.

One Caution

You should pursue medical attention if episodes of extreme sleepiness continue to occur without explanation. 

Exercise and Break Time Stretches

This tool consists of two handouts. One summarizes the benefits of exercise, the components of a regular exercise program, and suggestions regarding the timing of exercise, including the relationship between sleep and exercise. The second handout describes stretching exercises suitable for break time. The companion CD contains a copy of this tool as well as a brochure, "Fitness Fundamentals," prepared by the President's Council on Physical Fitness and Sports. This brochure provides information on developing a personal exercise program. This information can be provided to employees as part of a fatigue awareness training program. Depending upon the time allotted for this training, this material can be part of an introductory program or follow-up training. Separately, transit agencies can encourage physical fitness by providing on-site facilities or including discounts for health club memberships as a part of a health insurance benefit.

Exercise Basics

A program of regular exercise has many benefits. Exercise builds stamina, which reduces the onset of fatigue. It can also:

- Reduce risk of dying from coronary heart disease and/or developing high blood pressure, colon cancer, and diabetes.
- Help reduce blood pressure in some people with hypertension.
- Help maintain healthy bones, muscles, and joints.
- Help control weight, develop lean muscle, and reduce body fat.
- Foster improvements in mood and feelings of well-being and reduce symptoms of anxiety and depression.

Elements of a Fitness Program

An effective fitness program consists of the following three components:

- *Aerobic fitness* – Aerobic exercise and activities improve the function and efficiency of your heart, lungs and blood vessels. Activities such as running, walking, swimming and biking build aerobic fitness.

- *Muscle strength and endurance* – Using resistance builds muscle tone and strength, helps improve posture and makes muscles and bones more resistant to injury. Push-ups, sit-ups and moderate weight training build strength and endurance and increases blood flow and metabolism.

- *Flexibility* – Stretching exercises increase flexibility and reduce the chance of muscle strain or injury.

Timing of Exercise

Personal preference, job and family responsibilities, availability of exercise facilities and weather all determine the best time for your workout. Many people find that an early morning workout makes them more alert and energetic on the job. Recent studies show that exercise increases metabolism not only during a workout but also following the workout, allowing you to burn more calories. Late afternoon may be preferable as a change of pace after the workday as a stress reliever.

Avoid exercising during extremely hot, humid weather because of the risk of dehydration or heat exhaustion. Exercising within 2 hours after eating is not advisable. Digestion makes demands on the circulatory system that, when combined with exercise, can be taxing on the body.

Exercise and Sleep

Exercise may not make much of a difference in your sleep if you are already a healthy sleeper. However, if you have difficulty falling or staying asleep, the quality of your sleep is likely to improve if you adhere to a regular exercise program. Since exercise increases heart rate and metabolism, exercise within 2 hours of sleep may make it difficult for you to fall asleep. endT

Break Time Stretches

Feelings of fatigue can result from remaining seated for a long time. Being in this position causes blood to pool in the lower legs and feet, makes the hamstring muscles tighten up and causes back and neck muscles to stiffen. Stretching exercises improve circulation and loosen tight areas. These exercises, shown in Figure 15, are designed to restore your circulation and loosen muscles that become tight and relieve feelings of fatigue that can result from sitting in your vehicle.

Tips for Healthy Sleep

This tool consists of a set of personal guidelines to improve one's sleep. They are suitable for distribution through a fatigue awareness training program or as material distributed by the medical department.

Tips for Healthy Sleep

Understand Your Own Sleep Cycle

- Determine your optimum sleep length by recording sleep start and end times (without use of an alarm clock) on your second consecutive day off or during a vacation period.
- Sleep as much as you need to feel refreshed and healthy the following day, but not more.
- Most adults need between 7.5 to 8 hours every night.
- Establish a habitual bedtime and wake-time schedule. Also, when sleeping during nighttime hours, try to wake up at the same time every day, regardless of when you go to sleep and whether or not it is a workday.
- Exercise daily, preferably in the late afternoon but not within 2 hours of going to sleep.
- Too much activity prior to bedtime can stimulate your body and make it difficult to relax for sleep.
- Avoid heavy meals just prior to your sleep period.
- Avoid the use of sleep aids whenever possible. Talk to your doctor or pharmacist about the potential side effects of your

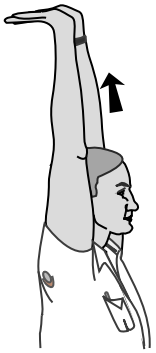
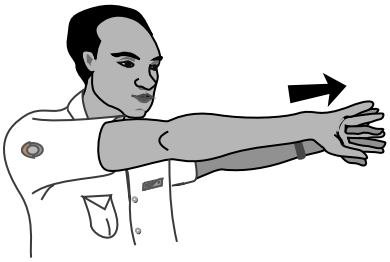
BODY PART	DIRECTIONS	DIAGRAM
Neck	Head Turn–Keeping your head level, turn your chin towards a shoulder. You should feel the stretch in along the neck, opposite the shoulder your chin is towards. Hold the stretch for about 10 seconds and relax. Repeat twice, each side.	
Shoulders	Shoulder Shrug–With arms hanging loosely at your side, raise you shoulders towards the ceiling until you feel a slight tension in the shoulders and neck area. Hold for 5 seconds, then relax. 2 times.	
Arms	Overhead Stretch–Raise your hands above your head and interlace your fingers with palms upwards. Push slightly up and back until you feel slight tension in the upper back, arms, and shoulders. Hold stretch for 15 seconds, then relax.	
	Arms Straight in Front–Interlace fingers, palms facing out, and hold arms straight out in front of you until you feel tension in the arms, shoulders, middle of upper back, hands and fingers. Hold for 15 seconds.	

Figure 15. Break time stretches

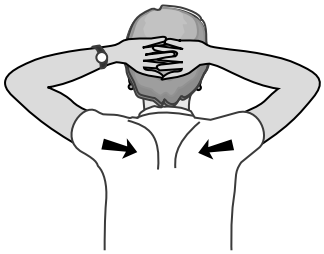
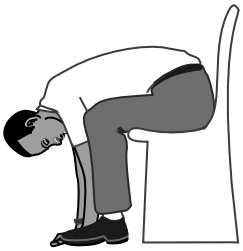
BODY PART	DIRECTIONS	DIAGRAM
Arms (cont.)	Triceps and Top of Shoulders- Bend one arm behind your head with one hand holding the other arm at the elbow, allowing the hand of the bent arm to rest on the upper back between the shoulder blades. Gently push the elbow of the bent arm down towards the back to stretch the triceps and top of shoulders. Hold for 15 seconds and then repeat with other arm.	
Upper Back	Shoulder Blade Stretch- Interlace fingers behind your head. Keeping your elbows straight, gently pull your arms back by pushing your shoulder blades together. Hold for 4–5 seconds. Can be done seated or standing.	
Entire Back	Bend while Sitting-Lean forward and touch the floor with your hand if possible. This promotes circulation even if you do not feel a stretch. Hold for 15–20 seconds.	
	Twist while Standing- Keeping your feet pointed straight ahead and knees slightly bent, place hands on hips and gently twist your waist.	

Figure 15. Break time stretches (continued)

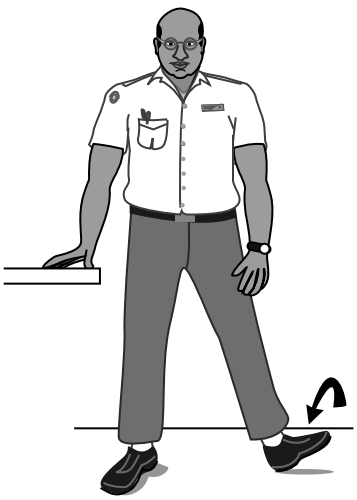
BODY PART	DIRECTIONS	DIAGRAM
Legs	Calf Stretch–Stand a little away from a wall or other solid support and rest your head into your forearms bracing the wall. Bend one leg slightly and place foot on the ground straight in front of you. Step backwards with opposite leg and slowly move your hips forward until you feel the stretch in your calf. Do not bounce. Hold for 10–15 seconds. Repeat with other leg.	
Ankle/Feet	Achilles Tendon Stretch–Keeping a similar position as in the Calf Stretch, straighten your back by placing your hands on the wall with arms outstretched. Bend the knee of the leg behind you slightly and lower your hips downward until you feel the tension in the Achilles tendon. Hold for 5–10 seconds and repeat with other foot.	
	Ankle Rotation–While standing, support yourself by holding on to something for balance. Lift one foot slightly and rotate the ankle 10–12 times clockwise, then counterclockwise. Repeat with the other foot.	

Figure 15. Break time stretches (continued)

prescription medication on your sleep. Discuss ways these effects may be mitigated (i.e., timing when medicine is taken, etc.).

Environment

- Make sure the bedroom is quiet. Wear earplugs if you sleep in a noisy environment or run a fan to create "white noise" to drown out the disruptions.
- The bedroom should be dark. If you work the night shift and must sleep during the day, use heavy shades over the windows and wear an eye mask to keep the light out of your eyes.
- Keep the bedroom temperature at around 65°F.
- Use your bed only for sleeping and sex. Do not read, study or watch TV in bed.
- Room should be devoid of allergens if this is a problem.

Relaxation and Other Techniques

- Try a relaxation routine such as a hot bath or massage before bed.
- Don't go to bed until you feel sleepy. If it's bedtime but you're not tired, do something to relax (like reading) until you feel sleepy.
- A light snack may help sleep. A heavy meal will not.
- An occasional sleeping pill may help, but chronic use is ineffective.
- If you can't sleep, get out of bed, go to another room, and do something relaxing until you feel sleepy.

Things to Avoid

- Caffeine in the late afternoon and evening disturbs sleep, even in those who feel it does not.
- Refrain from drinking alcohol at least 3 hours before bedtime. Alcohol may make falling asleep easier, but that sleep is fragmented and less restorative.

- Cut down on smoking. Chronic tobacco use disturbs sleep.
- Don't rehash today's problems or worry about tomorrow's schedule. Try writing "to do" lists for the next day to clear those items from your mind.
- Avoid napping if you have difficulty falling asleep at night.
- Drink fewer fluids before going to sleep if waking during the night to use the bathroom is a problem.

Role of the Family

Success Story
The Union Pacific Railroad felt that some of their employees were working many hours of overtime to finance obligations caused by poor family budget practices. They now offer financial planning training to their employees.

The employee's family can play a critical role in the employee's efforts to get adequate sleep. Experience in the railroad industry has proven this to be true. This section offers suggestions as to actions that the transit agency can take to promote family member involvement. There is also information that can be provided to employees as part of a fatigue awareness training program.

Transit Agency

One way to involve family members with the agency's fatigue management efforts is to include family members in the fatigue management program. If time and budgetary constraints do not permit this, the employees should be encouraged to share the training materials with their families. Sending any materials, such as agency newsletters, that discuss fatigue issues to the employee's home will increase the likelihood that the information is shared.

Success Story
The Association of American Railroads reports that family involvement is key to a successful fatigue management program as spouses can be influential in changing the employee's personal habits and behaviors.

Frequently operators seek overtime work to meet ongoing family expenses. This is problematic if it leads to chronic fatigue. Many times the family budget demands the overtime work. By making financial planning assistance available to employees the agency can indirectly reduce a potential fatigue risk. There are a number of ways in which financial counseling can be made available. These include:

- Credit Unions. If there is an on-site credit union, the credit union may be willing to provide counseling to its members.
- Employee Assistance Programs. The Employee Assistance Program may be capable of providing family budgeting assistance.

- Financial Planning Tools. Make financial planning and budgeting literature available to employees in conjunction with your fatigue training program.

Employee

This tool is designed to help transit workers understand the impact a transit schedule can have on the family.

Making Your Family Part of Your Fatigue Management Strategy

Your schedule as a transit operator will likely affect your entire family. They must understand that there will be occasions when your schedule does not permit your participation in family activities. If you have an early start time or a late release, your sleep period may not be the same as the rest of the family. You will have to ask for their cooperation so that you can get adequate undisturbed rest.

The work schedule of a transit operator can strain family relationships, especially during the first few years on the job. You should discuss your schedule and how it affects you with your family. Open communication is essential to working out compromises that everyone supports.

In planning your personal work/sleep schedule, allocate specific time blocks for family time. Try to have at least one meal a day together as a family. This might be breakfast if you work an evening or night shift.

Figure 16 provides a checklist of these considerations. 

Sleep Disorder Screening

There are potential actions for both the employee and the transit agency with regard to sleep disorder screening. This section contains two subsections. One provides options for the transit agency. The second section presents tools that an employee can use to determine if s/he has symptoms of a sleep disorder.

Transit Agency

There are a number of options to guide the transit agency's approach to screening for sleep disorders. Three strategies are the following:

Family Checklist

- ☐ Discuss with family importance of rest to your job safety and health
  - ☐ Present work schedule and alertness plan
  - ☐ Share with family information on sleep, sleep hygiene, and how food and drugs (e.g., caffeine) can affect getting good quality sleep
  - ☐ Ask family for ideas and input as to how you can get enough rest
- ☐ Agree on family social time and quiet time
  - ☐ At least one meal a day with family
  - ☐ Important family events written into alertness/schedule plan
  - ☐ Quiet hours posted in kitchen or other place where family can see
  - ☐ Inform friends and extended family of your quiet time so that they will not call or plan activities for you to attend during that time
- ☐ Prepare home environment to facilitate alertness plan
  - ☐ Follow "Tips for Healthy Sleep" to prepare your sleeping environment (with consent of spouse)
  - ☐ Turn off telephone in room unless you are on call
  - ☐ Plan meals, both in their timing and content, which facilitate your alertness plan
  - ☐ Consider reducing the amount of caffeinated and alcoholic beverages available at home
  - ☐ Discuss smoking cessation with spouse, if applicable
  - ☐ Make sure your family is aware of your work and planned rest schedule by posting it in a place where they will see it
  - ☐ Place a special marker on the front door of your house or to your bedroom door indicating that the house is now a "quiet zone"
- ☐ Constantly seek feedback from family and provide feedback to family about success of living with the work schedule so that everyone is able to adjust comfortably to it

Figure 16. Checklist for family involvement in alertness plan

- Information - At a minimum the agency should provide information to its employees on why an operator with a sleep disorder poses a risk to himself, the agency and the public, and how to recognize the symptoms of a sleep disorder. The information in the next section is useful for this purpose.

- Health Insurance Coverage - Try to offer health insurance coverage that will pay for screening and treatment for sleep disorders if the employee's primary care physician refers the individual for this evaluation.

- Counseling – Under this option the agency contracts with a third party to provide medically supervised confidential sleep disorder screening and counseling. The third party sets up a screening and treatment program and guides the employee through the process. A medically trained sleep counselor assesses the employee's symptoms and assesses the need for a comprehensive sleep study. If a sleep study is the appropriate course of action, the counselor arranges for the sleep study and assists the employee with any necessary medical insurance forms. Once the results of the sleep study are available, the counselor follows the employee through the treatment process. If the agency chooses this option, there must be a procedure that guarantees confidentiality to every employee who participates.

Employee

This tool consists of information that will help an employee to determine whether or not s/he may have a sleep disorder. This information should be provided after a fatigue awareness program that provides an overview of common sleep disorders and their symptoms.

Do I Have a Sleep Disorder?

Obtaining the proper amount of daily sleep is the single most important thing you can do to maintain your alertness level while at work. Your job demands that you maintain a high level of alertness and vigilance throughout the work period. To this end, it is better that you act proactively given the risk of accident and injury to you and the public.

However, no matter what countermeasures you use or how you try to change your work and sleep time, if you have a medical

condition that affects your sleep, your alertness will be compromised. Having a sleep problem is serious and is not something that will resolve itself without medical attention. Similarly, it is not something to be ashamed of. Sleep disorders are physiological illnesses, and like any serious illness, you want to see your physician for treatment as quickly as possible. Some remedies are very quick and effective, such as the CPAP (continuous positive airway pressure) machine to help avoid episodes of sleep apnea, while others are more long term and may require medication. It is likely that your health insurance or your company's Employee Assistance Program will pay for the screening and treatment.

The following two checklists will help you decide if you should seek medical advice concerning a sleep-related illness. You should use these tools right before you switch shift schedules, or at least quarterly if your schedule does not change. These tools are not for diagnosis, nor do they indicate with certainty that you do have a sleep disorder. If these tools, a symptom checklist and a sleepiness scale, do indicate an excessive level of sleepiness and there is no obvious explanation as to why (for example, staying up late with a sick child), you should see your physician as soon as possible. Do not try to resolve the problem yourself through use of additional countermeasures, such as caffeine or extra napping. This might just exacerbate the problem or cover up important clues as to the real problem.

Sleep Characteristics Checklist

Below is a simple checklist of symptoms that are related to sleep illnesses. If you are experiencing one or more of these symptoms over multiple weeks you should seek medical advice as soon as possible.

1. You are told that you **snore loudly and often.**

2. You are told that **you stop breathing** or sound as though you are having difficulty catching your breath **when asleep.**

3. You find yourself becoming **sleepy or actually falling asleep when performing** your **daily activities**, especially those that are sedentary like reading, watching TV or driving.

4. You find yourself having **trouble falling or staying asleep**, or waking up early or unrefreshed three or more nights per week.

5. You **experience a nervous, creeping or tingling feeling in your legs** when trying to sleep.

6. Your **sleep is regularly interrupted** due to gastrointestinal distress, need to urinate, acid reflux, pain, night terrors, or an uncomfortable environment (for example too much light or noise in the room, unpleasant temperature, etc.).

Self–Assessment of Sleep Debt

Use the Sleep Debt Index (SDI) tool to assess your general sleepiness state. When you answer the questions, consider how you *usually* feel. Like the checklist tool, this self-assessment tool focuses on symptoms that are linked to sleep disorders. In this case, it is screening for unusually high levels of sleepiness. If you find a potential problem, seek medical advice immediately. Even if the problem is not related to a sleep disorder, it is increasing your risk of loss of adequate alertness while at work and should be resolved.

Seeking Medical Advice

Sleep medicine is a relatively new area of specialization for most physicians. While they may know something of sleep and its disorders, many may not be conversant with the latest information and treatments. Ask your physician about his or her background with regard to sleep medicine. If they are not familiar with current diagnostic methods and treatments, ask for a referral to a board certified sleep clinic or specialist. These are people and places that are up to date with the best diagnostic procedures and treatment regimes.

It is likely that they will ask you to answer the same questions as you have done above, so bring this information along. It will also be beneficial to bring your Personal Work/Sleep Log, (see Personal Alertness Manager) which gives your sleep start and end times, and your personal sleep scores. This information will make it easier for your sleep physician to determine if you have a sleep problem, and if so, what it might be.

These illnesses are physiological in nature, and like many other diseases, will not go away without treatment. Seeking medical

advice and following through with it is the safest and healthiest course of action you can take. 

Picking Your Runs

This tool consists of a procedure that operators can use to plan for the run bidding process. It will be most useful if it is explained to operators as part of a fatigue training session.

Run Selector

Transit operators, unlike many other professionals, have the opportunity to change their work schedules annually if not more frequently. As you know, your work schedule can be one of the major contributors to your level of sleepiness at work. Therefore picking the best work schedule available to you during these change periods is the single most important action that you can take to influence your on-duty level of alertness. You should take this opportunity seriously.

As with everything else related to fatigue management, your run selection will take some thought and careful planning. Your goal is to choose a work schedule that 1) allows you to obtain adequate continuous sleep each night, 2) does not significantly impact your personal schedule, and ultimately 3) reduces your need to use other alertness countermeasures. This is also the time to review your finances to determine the level of income you need to maintain your household. If you *need* to work more than 40 hours a week, it is better to pick a run that has the number of hours you need rather than to haphazardly pick up overtime work here and there. Planning when you work puts you in control of your time, reduces stress and family tensions as you know how much you will be earning and when you will be at work, and allows you to institute the appropriate alertness strategies and countermeasures, if necessary.

You will need time to understand your needs and prepare for the run bidding, so plan ahead. Start your preparations at least 1 month ahead of the selection period. As a prerequisite you should use the Personal Alertness Manager to understand the shortcomings of your current work system. You will also need to look at your calendar to determine upcoming significant dates or times you wish to have off, and to examine your finances. If you have a partner or older children, you will want to include them in your planning and decision making for your new run.

Step 1. **Determine your decision timeframe**. Find out when the next selection will take place. Plan on starting this work schedule selection activity at least 1 month before it is time to place your bid. If possible, find out what changes are planned for the new runs. This should give you ample time to go through the entire exercise and make the best selection possible.

Step 2. **Review your Personal Work/Sleep Log**. The information contained on these forms will provide the basis of determining the best runs for you to select. Take out your marked up logs and evaluation sheets for your current schedule. If you have not yet completed this task, by all means do so as this will provide you with the richest source of information about the impact of your current schedule and what changes you should strive to attain in your new schedule. Review your evaluation, marking down at least two points about your current schedule that you would like to keep and two issues that your analysis indicated that you should change.

Step 2A. Your work schedule may contain subtle features that can lead to increased risk of sleepiness while at work. The advice in Table 8 includes key schedule features that you should try to avoid whenever possible. Review the work schedule data you have collected with an eye on determining if any of these features are in

Table 8. Work scheduling BEST practices

1. Minimize sequences of very late night or very early morning shifts – no more than 2 to 4 nights in succession.
2. Avoid short intervals of off-time between shifts.
3. Avoid working both weekend days.
4. Avoid working every day of the week.
5. Consider working shorter shift periods for very late night or very early morning runs.
6. If on a rotating shift schedule, make sure it rotates in a forward direction – day, evening, night – rather than backwards: night, evening, day.
7. Keep your schedule as regular and predictable as possible – try to stay within an hour of shift start and end times.
8. Prepare for short-term shift changes - for example if the state fair is in town and the agency must provide extra transportation.
9. Avoid relying on overtime.

your current schedule. In addition, in Step 5, when you are making your plans for the upcoming selection, try to eliminate as many of these features from the new schedule you pick as possible.

Step 3. **Plan personal activities**. Take out your personal calendar and review the months that will be included in the next run bid. Write down important dates and times, such as vacations, school vacation periods, planned surgeries by immediate relatives, etc., as well as other planned, regularly occurring activities, such as an adult education class or Little League games. Speak with your family if applicable about their expectations regarding the amount and placement of your time with them.

Step 4. **Review your personal finances**. Living beyond your means, accumulating large credit card debt, will lead to increased stress levels and a never-ending need to work overtime hours, usually at the expense of free/family time and sleep. Earnings and spending expectations have to be realistic and agreed upon by the family. Seeking guidance from a financial planner may be useful if you have not had formal training or a lot of practice at producing a family budget.

Step 5. **Determine your work time budget**. Now that you know the days and times of day when you cannot work, and your target level of income, it is time to put together a time budget. Start by dividing your hourly rate into your desired monthly earnings for the period to compute the number of hours you must work. Divide this number by four (the number of weeks in a month) to obtain a rough estimate of the number of hours you need to work over the week to meet your budget goals. Some companies have a pay differential for late night/early morning work, work on weekends, holidays and daily hours in excess of 8.

Figure 17 is a template for computing your weekly pay based on your weekly hours. The Regular Hours category is for all hours you have chosen that are considered within your regular pay rate. The other categories will vary by property; only use those categories that your property supports with a pay differential and which apply to the hours you have elected to work. This is an iterative process, allowing you to produce the best time allocations related to your goals. It may be prudent to come up with several alternative distributions in case your first choice is not available.

Step 6. **Create your ideal personal schedule**. At this point you know your fiscal and family obligations, have reviewed your

Figure 17. Desirable weekly wages

Type of hours	Pay Rate $/hour	Multiply	Number of hours		Total Dollar Value
Regular		X		=	$
OT		X		=	$
Night		X		=	$
Weekend		X		=	$
Total					$

personal sleep/work schedule for areas of improvement, and have identified features in your current work schedule that may make you more prone to sleepiness while at work. You are now ready to sketch out several versions of your ideal work schedule that matches with this information.

Using the Personal Work/Sleep Log form, start filling in your committed family/social times. Next fill in your sleep times, making sure that 1) they are a continuous 7.5 hour block of time if at all possible, 2) they are in a circadian appropriate time, or at least not in the "no nap zone" (10 a.m. to 1 p.m.), and 3) allow you to work the number of hours and times you had planned for in Step 5. Once you write down your personal schedule information, review it for the following:

- Does it maximize your ability to rest? Remember, discontinuous sleep periods, short sleep periods, and sleep at certain times of day can lead to your being sleep deprived, and therefore, extra sleepy on the job.

- Are you able to meet most of your social obligations and demands? If not, it is likely you will sacrifice your sleep time to perform these social tasks.

- Does this schedule provide you with enough open time for work to meet your fiscal demands? If the amount of time,

and placement of that time in relation to pay differentials, will not satisfy your fiscal obligations, you are likely to work unplanned overtime to make up the difference. The goal is to plan all your work activity, as unplanned events will probably disrupt your sleep time and other events, creating a major disruption to your fatigue management plan. It is better to schedule in overtime hours so you can plan for them, rather than take them in a haphazard fashion, and then try to cope with them in a reactive fashion.

You will probably have to go through several iterations to come up with a personal schedule that suits you, your family, and your financial plan, and is realistic with regard to the hours you will be working. It is best to come up with several different workable personal schedules, which vary in how well they maximize the points listed above. Include your family as much as possible in this schedule development as they have to live with it too.

Step 7. **Create possible work schedules**. With your core social and sleep time marked on your schedule, you can now start trying to include the possible work schedules. Many properties provide the upcoming run selections well ahead of the bid process. To give yourself the most time to work with the possible new runs, try to complete Steps 1 through 6 before the new runs are revealed. If your property does not present its new runs ahead of the bid process, you will have to do a little extra work to prepare.

If you do know the available runs ahead of the bidding period, consider all runs that are realistic given your seniority. Obtain copies of these runs and, at home, compare them to your time available to work. It is likely that none of the schedules will fit exactly into the several social schedules you have created. You will have to do some compromising in order to get several of these runs to fit. Remember, though, that the more you compromise on your personal schedule, the more at risk you are at reducing your sleep time and creating a sleep debt that may reduce your alertness at work. You need to guard your sleep time jealously, especially if you start giving up some of your other social time. Again work with your family on this so they see the alternatives, and understand why it may not be possible for you to be with them as frequently as they would like. In addition, apply the schedule guidelines given in Table 8 to the new runs you are considering. Try to pick the runs that best meet these guidelines and also meet your personal schedule.

If your bidding system does not allow the operators to see the new schedules ahead of the actual run bidding, you will have to write down two lists, one giving the timing of ideal schedules, schedules that would fall mostly within your planned ideal work times, and a second list of minimum requirements, schedules that do not violate the core minimum necessary personal time you need to sleep, spend time at home and work to make a living. In this circumstance it will not be possible to evaluate the components of the work schedules ahead of time to determine if they contain features that may decrease your on-the-job alertness. Rather, you will have to perform this analysis after the fact, and it is likely that you will have to plan additional countermeasures to compensate.

Bid on the schedule that you think best accommodates your personal schedule.

Step 8. **Analyze your new schedule**. Once you have obtained the work schedule you will be on for the next bid period, immediately start trying to adapt it into one of your personal schedules. Perform a schedule analysis as described above to determine if there are features in the schedule that could lead to sleepiness at work. In addition, review your work schedule using the Personal Alertness Predictor tool to determine the appropriate placement, if needed, of at-work fatigue countermeasures. Lastly, and most importantly, share the schedule with your family, and make changes to your personal schedule, and perhaps your financial plan, with their input. It is important for them to know your needs for sleep and your time constraints given your new schedule.

Step 9. **Continue filling in personal log**. This activity will show you how well you are adapting to the new schedule and what additional countermeasures or changes to your personal schedule are necessary to maintain your alertness level throughout the workday. These logs will also provide you with important information during the next bidding cycle.

Adjusting to Shiftwork

This tool provides information on strategies that facilitate the employee's adjustment to shiftwork. Employees will find this information most useful if it is also discussed in a fatigue awareness training session.

Adjusting to Shiftwork

Shiftwork refers to any work schedule in which the majority of the work hours are outside the period 8 a.m. to 5 p.m. or requires working different sets of hours over the workweek. There are several problems with adapting to shiftwork. First, working the night shift in particular, or hours that touch upon the night shift (1 a.m. to 7 a.m.), makes it difficult to get adequate sleep. Humans are diurnal by nature, active during the day and asleep at night. The body resists changes to this pattern, but there are sleep strategies that can help the shiftworker to reduce this disruption and get adequate rest. In addition to the sleep disruption, working the evening shift or on weekends limits the time available for socialization and family activities. Workers who must accommodate constant variation in their shift assignments, such as working rotating schedules, face additional problems. Since transit service operates beyond the standard workday hours, there will always be workers who must adjust to working nights and irregular shiftwork schedules.

As you have probably experienced, these work time constraints placed on your personal and sleep schedule require a fair amount of adaptation. The problem is that you may adapt to these work schedules in a way that is harmful to maintaining alertness while on duty. To help prevent this, this tool is designed as a reference list of actions to help you adapt to working shifts.

When to Sleep

Sleep experts report that adults need 8 hours of sleep a day although some individuals are perfectly alert with less while others require more. There are several strategies that the night worker can try to get adequate rest while working nights. The first strategy centers on sleep time anchoring. Setting a specific sleep start time and/or end time will allow you to:

- Better plan your free time around your sleep instead of the other way around.
- Provide an external rhythm or routine for your body to get used to, and thus perhaps make adjustments to take maximum advantage of the provided sleep time.
- Better use the other provided tools, including the Personal Alertness Manager tool, to determine if additional alertness countermeasures are needed while on duty.

A second, related strategy is for you to anchor on sleep duration, regardless of time of day. Specifically, you can determine the amount of sleep you need during the daytime and then try to fit that period somewhere in the day as a continuous whole or in pieces. This strategy is a bit problematic, however, and really should only be used as a fall-back if you cannot anchor your daily sleep times so that you will be getting your full 7- to 8-hour sleep period.

Many night workers actually do employ a split sleep strategy consisting of two sleep periods. This is another strategy. The main or "anchor" sleep period occurs following the shift. The worker returns home at the end of the shift and sleeps for 4 to 5 hours. Then, prior to starting work that night s/he takes a nap for 3 hours. The advantage of this strategy is that the worker does not arrive at work with a large sleep debt. Some night workers prefer to sleep in one longer period when they return from work or in the mid-afternoon when there is a natural tendency to be sleepy. Morning sleep gives the advantage of a free afternoon.

After working for three days on the night shift the body begins to adapt to the inverted sleep schedule. Unfortunately, if night workers revert to a "normal" sleep schedule on non-work days, the body's adaptation to the adjusted sleep pattern is lost. For this reason, some sleep experts suggest that the worker try to maintain a common "anchor" sleep period on both work and non-work days. Maintaining this "anchor" sleep period minimizes the difficulties in readjusting to the sleep schedule necessitated once the workweek begins again.

There is no one "best" sleep pattern for all shiftworkers. Each individual must determine the scheme that provides the most restful sleep.

When returning to day work and a "normal" sleep schedule, a brief sleep of roughly 2 hours followed by a long nighttime sleep will facilitate returning the body's biological clock back to its natural pattern.

The following guidelines will help you to tailor your sleep pattern to your work schedule:

- *Anchor your sleep start time, end time and/or duration.*
  - For people *not working night shifts*, plan on:
    - Obtaining 8 hours of sleep each night.

  - One continuous sleep period each day without naps or other sleep periods.
  - Starting your sleep time prior to 3 a.m. and ending your sleep time prior to 11 a.m.
- For people *working night shifts*, plan on:
  - Trying to get 9 hours sleep per day; calculate that you will need another hour of sleep per day than your day-working counterparts due to less restorative sleep.
  - If possible, waiting to start your main sleep period until you hit your circadian midday dip – around 2 to 3 p.m., and sleep for 9 continuous hours.
  - If unable to wait to sleep or have other time constraints during the day, start your first sleep period as soon after work as possible. Calculate how many more hours you need to equal 9 and try to get those either starting at the midday dip or prior to going to work for the following shift. If you choose this second option remember to leave at least 1 hour between when you wake up and when you are to report to duty.

- *Do not take random naps unless you are really tired*. Unscheduled sleep periods may have an immediate alerting effect but may have negative long-term consequences to the efficiency of your main sleep period.

- *You should follow as closely as possible the same sleep schedule on both work days and days off.* If you work nights, this may not be feasible due to family and social activities. For night workers whose personal schedules allow them to continue their workday sleep pattern on days off *and* who feel their bodies are adjusted to the night work schedule, this is an appropriate sleep strategy. However, most people never completely adapt to working nights and sleeping during the day. This means that you will probably be less fatigued if you return to nighttime sleep on days off.

- *Maintaining your sleep schedule is key*. You should get up at your planned wake-up times, regardless of whether you have the opportunity to sleep longer to maintain the ritual. If you find yourself breaking your plan more than once a week, again, you may want to rethink your anchor times.

- *Seek your family's support in respecting your sleep time*. Remember that is it not just you who must adjust to shift work. Your entire family must adapt. Explain to them that your work schedule will require you to sleep undisturbed at specific times.

When to Eat, What to Eat on Shiftwork

Improper eating is a problem for many Americans, but for a number of reasons it is even more of an issue for the transit shiftworker. Lack of kitchen facilities can make it impractical to bring healthy, home cooked meals to work. Inadequate or poor food vending services can make it difficult to purchase a healthy meal. Perhaps most important, the body processes food differently at different times of the day.

Shiftworkers frequently have bouts of gastrointestinal distress and acid reflux. The lifestyle of a shiftworker lends itself to eating a high fat, nutrient poor diet, which can lead to obesity, heart disease and a general weakening of the immune system. In addition, the timing of food intake is likely to influence your ability to fall asleep or maintain proper wakefulness. The guidelines below are for everyone, though they hold especially true for people working the night shift.

- *Make a nutrition plan*. Planning your meals ahead of time, and when you will eat them will play a large role in how well you will adapt to working shifts. Analyze what you are currently eating and determine its caloric and fat content.

- *Avoid drinking caffeinated beverages for at least* ***4 hours before sleep***. In fact, you should reduce your use of caffeine as much as possible. Drinking caffeine prior to bedtime leads to two problems, being forced awake due to the caffeine when you want to sleep, and being forced to wake up during the sleep to use the bathroom. This suggestion holds true for planned nap times as well as your main sleep period. On the first two night shifts of the week you may find that you need a caffeinated beverage to get you through the period of reduced alertness in the early morning. Be sure that it is consumed at least 4 hours before a planned sleep period after work.

- *Eat at or before 1 a.m. and after 5 a.m.* Your body has a rhythm for food digestion, which slows down during the late night-early morning hours. If you eat heavy meals during this

time, the food will likely remain undigested for much longer than normal, which may lead to you having gastrointestinal distress or constipation. You are also more likely to convert the food into stored fat.

- *Avoid meals of more than 600 calories as they can induce sleepiness.* Large meals right before or during your work period should be avoided, regardless of your work shift. This is because your body is diverting its resources to digest your food and store it rather than use your reserves to maintain proper body functioning and alertness.

- *Avoid foods high in fat content because they are harder to digest during the night.* It is also more likely that these foods will lead to weight gain if your job is primarily sedentary.

- If you notice big discrepancies in what you eat and what you should eat, and when:
  - Try to plan out (with your family if applicable) your meals right before and during your work period.
  - If you do not pack a lunch, avoid restaurants that serve only fried, fast or greasy food. If you must eat from vending machines, try to avoid foods high in carbohydrates, such as cold cut sandwich meats and chips.

As with the sleep schedule, each individual must determine the eating pattern that along with exercise helps you stay physically fit and does not compromise alertness during nighttime hours.

Social Contact and Activity

Working at non-traditional hours can compromise time available for family and social activities. All family members will have to make adjustments to accommodate your new lifestyle. Therefore it is especially important that you speak with your family and include them when you make decisions about how you allocate your time. These adjustment strategies include:

- *Expect to spend less time with your family and friends*. Your job requires you to sleep enough to perform at an acceptable, alert state when on duty. For this to happen you cannot skimp on your sleep time. Rather, plan times when you will see your friends and daily time for your family so no one feels neglected.

- *Set aside pre-arranged times to spend with family members*. Open blocks of time can easily be filled with chores, hobbies or other activities that do not include the other members of the household. This becomes a problem when it is time for you to sleep and you realize that you have not paid enough attention to those around you, and thus forgo the sleep to spend the time with family or friends. Work with your family to set aside some scheduled time each day to spend with them. In addition, check your calendar to make sure you are aware of all important dates (e.g., birthdays, after school activities, etc.) and plan for them as best you can.

- *Declare the bedroom off-limits to family members during sleep periods*. Except for emergencies and other such urgent times, no one should be allowed to enter the room where you are sleeping. This is your time to yourself and other people must learn to respect this.

- *Start or maintain an exercise regime*. Exercise has many benefits including weight maintenance, improved health, stress reduction and better sleep.

- *Try to find the easiest and quickest commute routes*. This is especially important at the end of a night shift when you are sleepy and tired from work yet still have to negotiate your trip back home. This will also give you more time at home for family, friends or sleep. 

Success Story

The Union Pacific Railroad (UP) established a fatigue hotline that employees can use for any questions related to fatigue. UP contracts for this service through the company that handles their employee assistance program. UP's Director Alertness Management met with the company and trained their representatives to respond to employee inquiries. UP has found this to be a satisfactory arrangement.

Reporting for Duty and Managing Service Delivery

In the daily give-and-take between work life and home life even the most conscientious and fastidious employee can find her/himself in a circumstance where s/he is already tired as s/he heads in for work. The toolbox includes techniques that can be employed to help catch fatigue before it becomes a problem on the job. It also provides tools to help determine when fatigue has definitely become a problem for the management of service delivery. Possible tools and strategies in this area include:

- A fatigue hotline where employees can seek counseling and advice.

- A supervisor's process providing techniques for detecting and managing a fatigued employee.

Success Story

American Airlines established a fatigue hotline to respond to crew member questions regarding fatigue. A nurse from American's medical department, who also teaches American's fatigue awareness course, responds to questions on the hotline. Questions that she has answered involve topics such as in-flight napping strategies and caffeine use on work vs. non-work days.

- Guidelines for operator rest breaks.
- Suggestions on how work variety can help reduce fatigue and improve operator performance.

Fatigue Hotline

The purpose of this hotline is to respond to employee questions regarding personal strategies for managing fatigue. An individual with knowledge of sleep and fatigue principles must staff a fatigue hotline. This might be someone in the medical department or possibly someone in the safety department. Alternatively, the transit agency could contract with an outside occupational health agency or provide this service through its Employee Assistance Program. The hotline will be most effective after a fatigue education and training program.

Fatigued Employee Process for Supervisors

If a supervisor suspects an employee is struggling with fatigue issues, there are guidelines s/he can follow to successfully manage the situation.

Fatigued Employee Process for Supervisors

The identification and management of a fatigued employee is a difficult task for any supervisor. First you must determine that the employee is in a state of reduced alertness and then chose the appropriate course of action.

Detecting Fatigue

Assessing an operator's level of alertness would be easier if there were a test similar to the one available for detecting the presence of drugs or alcohol. Unfortunately there is no such objective test for detecting fatigue. In the future a readiness-to-work device may be available, but for now, you will have to rely on your own judgment.

A supervisor who sees an operator report to work each day is best able to judge whether a particular individual may be less than fully alert and ready to work. Signs and symptoms to look for include:

- An employee who is usually upbeat and cheerful appears moody, quick to anger, or withdrawn.
- The employee's communication in preparing for work is inaccurate or incomplete.

- A normally diligent employee who displays a lack of interest in work.

- A normally quick employee whose reaction time appears impaired.

- Any employee nodding off or napping at inappropriate times and places.

If any of the above symptoms of fatigue are apparent, you might ask the following:

- How much sleep did you get last night?
- How much sleep did you get in the last 3 days?
- How many hours have you worked in the past week?
- When was the last time you had a day off?

You must decide if the employee is fit to work. Factors you should consider include both the employee's work and sleep schedules and your knowledge of the typical behavior of that employee. If the employee averaged less than 7.5 hours of sleep over the past 3 days, s/he is likely fatigued. Remember, it is also possible that the sluggish behavior is due to other circumstances such as illness or possible substance abuse.

Managing the Fatigued Employee

There are two different situations that you must be prepared to handle: the acute incidence of fatigue and the chronic pattern of consistently reduced alertness.

- In the case of *acute fatigue*, you are concerned that on this day the operator is too tired to safely start and complete his tour of duty.

- In the case of *chronic fatigue*, you are noting a consistent pattern of employee behavior suggesting the operator is often, or always, tired when working (but not to an acute degree).

Acute Fatigue

In this situation the operator reports for duty or returns from a break and appears to be in a state of significantly reduced alertness. Determining that the operator is too fatigued to safely operate a vehicle is not an easy decision. Once the determination

is made, you must decide on a course of action. Many factors influence a supervisor's options. Are there clear agency policies or work rules governing fatigue? If not, your decision must take into account the following considerations:

- If the employee is sent home without pay, a grievance may result.
- If the employee is sent home and the spareboard for the day is exhausted, you may have to cancel the run and reduce service or ask another operator to extend his/her day.
- Will agency management support your decision?
- In making this decision you need to weigh the possibility of a grievance or unhappy customers against that of a fatigued and accident-prone operator making an error.
- What happens if there is an accident? Will agency management question not only the operator's fitness-for-work but also your judgment?

Each agency should determine how it expects supervisors to handle cases of acute operator fatigue. Allowing employees to go home sick if they are too fatigued to work has both pros and cons. If a fatigued operator can go home "sick" without loss of pay s/he is more likely to self-report a true state of fatigue. But some will seek to "beat the system" and get paid for not working. Sending an employee home without pay penalizes the employee and invites a grievance. No agency has found the one best way to handle these cases. Operating agencies should formulate guidelines for supervisors regarding their options for removing an operating employee from service due to acute fatigue. The policy should be formulated with consideration of the overall rate of acute fatigue found on the property and the agency's other policies regarding safety, labor relations and collective bargaining.

Chronic Fatigue

An employee who appears chronically fatigued (tired every day) but still able to work is a candidate for counseling or coaching from his/her supervisor. Coaching is a method for bringing about improvement in an employee's behavior. It involves constructive criticism, feedback and advice designed to help people improve. Workplace coaching is much like traditional coaching on the

athletic field or instruction in the performing arts. Through coaching you should help the operator to identify the cause of his/her fatigue and corrective actions for mitigation. If your workload does not allow adequate time to coach a chronically fatigued employee, the agency's Employee Assistance Program or Medical Department may be able to provide this service.

Coaching a Fatigued Employee

In coaching an operator on a chronic fatigue problem, you can use the 10 steps that follow to structure the discussion. Sample comments are included with each step.

Step 1. Get to the point.

"The purpose of this meeting is to talk about your alertness on the job."

"I asked you here to discuss a problem about your alertness behind the wheel."

"I want to spend some time discussing how important it is to be alert while driving the bus."

Step 2. State why you are having this conversation.

"I have a concern about your alertness level on the job."

"You appear to be coming to work fatigued."

Step 3. Describe what you know.

"Lately when you report to duty you appear tired."

"I was informed that you were yawning and swerving on the road."

"Your co-workers have reported that your reaction time is sometimes slow."

"Riders have complained to our customer service office that you were driving erratically and appeared to be nodding off."

"When I was told, I looked into the issue by having an observer ride your bus."

Step 4. Describe the consequences of the continued behavior.

"If this continues, then (cite agency policy if one exists)."

"As a customer, I would not ride with you."

Step 5. Describe how you feel about what you know.

"I am very concerned about you not getting proper rest at night."

"I do not think it is safe that you are operating a subway train when tired."

Step 6. Encourage the employee to give his/her side of the story.

"Now, that's what I know but what is your view..."

"OK, now what is your reaction?"

Step 7. Ask as many questions as you need to understand the situation from the other person's perspective.

"Do you feel that you have to work the overtime?"

"When do you expect your personal/family situation to improve so that you will get more rest?"

Step 8. Decide what specific actions must be done, when and communicate that to the other party.

"I believe you must examine your personal and work schedules and allow time for adequate rest."

"I believe that you must reduce the amount of overtime that you work."

Step 9. Summarize the conversation.

"Let's recap, you will...and I will..."

Step 10. Follow up.

"I will contact you next..."

When coaching an operator regarding a potential fatigue problem, you should keep the following in mind:

- **Document the facts**. Take note of and document the occurrences of reduced alertness before initiating a coaching session.

- **Coach with compassion**. Show an interest in the operator's well-being.

- **Focus on behavior**. Discuss the instances where the employee was less than fully alert on the job. Examine behavior (not attitudes) concerning individuals who are fatigued.

- **Listen actively**. An essential component of counseling employees is listening carefully to both their presentation of facts and their feelings. Listening will encourage the employee to talk. As the employee talks about his or her problem, you may develop a better understanding of how to help improve job performance.

- **Review principles of sleep and fatigue**. Assuming the agency has offered a fatigue training course to operators, review the principles that were stressed in the course. If not, have some materials handy to give to the operator.

- **Offer constructive feedback and advice.** One way of giving advice is to begin with an insightful question. For example, you might ask,"Could the real cause of your problem be that you are working too much overtime?" Or"I know that someone in your family has been ill. Has this caused you to sleep less?" If the employee answers yes to this type of question, then you can help the employee to find a solution to the problem. You can recommend that the employee use the Personal Alertness Manager to determine the aspects of his/her personal schedule that are causing the fatigue or suggest EAP resources to help with stressful personal situations.

- **Obtain a commitment to change and follow up.** People frequently agree to make improvements but are not really committed to change. An agreement for a follow-up meeting is one means to motivate the employee to follow through on the commitment. 

Rest Breaks

Rest breaks are a 10- to 15-minute complete break from work. In the transit environment, this means being relieved of the task of operating a vehicle and leaving the vehicle. The worker can use this time to use the restroom, eat, sit, socialize or engage in a light exercise routine. The availability of a"break room"enhances the restorative value of the rest break. Research has shown that breaks are effective in countering fatigue and sustaining vigilance; however, little research has explored the most beneficial timing, length and activity during breaks. This is likely to vary with the time of day or night, number of hours on duty and individual preferences.

Work Variety

Under this countermeasure, runs that make up each job are constructed so that the operator is assigned to different routes over the course of the day. This will provide work variety, which can prevent or alleviate reduced alertness from boredom. Research has shown that for both sleep-deprived and non-sleep-deprived individuals, variety in work tasks appears to enhance performance.

Analyzing and Creating Runs

When runs are created, either manually or with a computer, the objective is to develop the lowest cost set of work assignments that covers the trips required by the service plan subject to the collective bargaining wage scales and work rules. The combination of the work rules, wage scales and service plan creates some work assignments that are more fatiguing than others. Split days with long spreads can be more fatiguing than straight days. Runs that start late in the day to cover late evening service may interfere with the opportunity for adequate rest.

This section offers methods and considerations to help the transit agency avoid the creation of work assignments that can lead to operator fatigue. These toolbox elements include:

- A discussion of the guidelines for the development of fatigue-resistant worker schedules and fatigue pitfalls to avoid. This element provides a procedure for analyzing schedules for fatigue potential and developing alternatives.

- Suggestions regarding alternatives to long spreads and split shifts.

Developing Fatigue–Resistant Schedules

This tool provides a process for developing work schedules that are designed to minimize the risk of fatiguing the operator. The process consists of three stages: preparation, schedule analysis and redesign. This tool is designed for use by the person responsible for developing work schedules. If you organize your operator's work on a weekly basis, then you can use this tool. Alternatively, if you organize your operator's work on a daily basis and allow each operator to bid on a week's work by choosing individual runs for each day, then this tool is not appropriate for your organization.

Procedures for Developing Fatigue–Resistant Schedules

Creating work schedules based on established principles (such as the Bulletin of European Studies on Time schedules known as "BEST" guidelines) is the single most effective way the organization can minimize risk of fatigued workers. Your operators arrange their other life activities – and sleep – around their work schedules. Should their work schedule require them to work nights, for example, they are likely to sleep less given the nature of human sleep and the inherent difficulty with daytime sleep. In addition, people like to spend time with their families and friends and therefore may sacrifice their sleep time to fulfill social needs and obligations. While it is prudent to train the operators on how to organize their off-time to obtain enough sleep, you should also try to evaluate and, if necessary, rework their work schedules to minimize the chances of having a sleepy operator report for duty.

Given that the agency needs to provide service during times when most people would be asleep or with family, it is impossible to totally eliminate schedules that might lead to a sleep debt. Rather, it is important that you understand how the components of the work schedules you generate can contribute to fatigue and, to whatever extent possible, minimize these components. This section provides two tools to assist you in evaluating your operator's work schedules. In addition, reference is made to

current and forthcoming software that might help you in this endeavor.

The first tool will help you visualize the work schedule characteristics that are of greatest significance with respect to fatigue. Once you can see the schedule features of importance, you can use the second tool to interpret how to improve the schedule. This is a process that you will need to conduct each time service changes necessitate new runs and operator schedules. If you use scheduling software to generate your runs, you should try to adapt the concepts presented here to your scheduling program. You should be able to generate the graphical displays described below as well as enter rules into the schedule generator module to minimize potentially fatiguing aspects in your work schedules.

Preparation

Prior to beginning the work schedule evaluation process, you will need to do the following:

1. *Explore functionality of your scheduling software.* Determine if scheduling software provides for the inclusion of additional scheduling constraints. Also, determine whether or not it can perform staffing and scheduling analyses. You should also be familiar with the types of graphs and reports that your software provides. If your current software version does not have these features, find out if there is an upgrade available.

2. *Perform a staffing analysis and inventory.* You need to know the optimal number of people you should have on your rosters as well as the actual number. In addition it is important to know how you are currently distributing your overtime work. Determine the average amount of planned and unplanned overtime your operators receive. Determine if the overtime is shared evenly across your operators or if it is concentrated within a certain subgroup (e.g., people with more seniority). Assembling this information will allow you to determine the factors that contribute to fluctuations in operator schedules and, hopefully, to rework the schedules to avoid this uncertainty.

3. *Obtain baseline information on the level of sleepiness of the operators following current schedules.* It is likely that the person responsible for the property's fatigue management

program has already collected this information. Ask that person to forward the pertinent information to you and review it before you begin analyzing your schedules.

If information has not yet been collected, make sure the following items are included in a forthcoming survey effort:

- *Age* – Older operators have greater difficulty adjusting to rotating shift work as well as working late nights. You want to determine if these types of schedules will affect a significant portion of your operator population and if so, look for ways to minimize the number of schedules that consist of multiple late nights.
- *Job Tenure* – High workload runs are obviously more challenging to new hires than more experienced operators. Combining these runs with early morning starts or late night completion is not desirable. If you have a large number of operators with limited experience, you probably want to minimize the number of difficult assignments such as longer runs or split shifts that combine an early morning or a late night with rush hour traffic.
- *Family Status* - Operators with younger children at home are likely to need to plan their home time with some precision in order to pick up the children from school, participate in family activities, and meet other family obligations. Having overtime work suddenly presented to them could be a hardship or mean that the time they have to spend with the family at home will compromise their sleep time. Try to schedule as much of the work time, even overtime, as possible, so the operators can plan their home time accordingly to get enough sleep.
- *Alertness Assessment* – The best way to determine the impact of your scheduling is by gathering information on the level of alertness in your workforce. This may be done informally by talking with workers or union representatives about their qualitative impressions of worker alertness. If feasible, you can collect anonymous quantitative information on worker alertness by having your operators use the Sleep Debt Index. This tool will give you data for tracking fatigue management progress, with scheduling being one of the largest components. A large initial sleepiness score indicates that more aggressive scheduling changes are probably in order.

Figure 18 provides a flowchart of the procedure to use in preparing for schedule analysis.

Use Table 9 as a checklist and worksheet to collect the necessary information prior to beginning your schedule evaluation. If you find that your scheduling software does not provide many of the functions listed, you may want to inquire about software upgrades or consider purchasing a new package. Alternately, you may want to obtain a copy of the U.S. Department of Transportation schedule evaluation software, which is free and will provide you with graphs and schedule analysis and evaluation tools. (See Appendix B.)

There are different ways of calculating staffing needs. If you have not performed a staffing analysis, you might want to consider doing so as the number of employees you have available does directly affect the types and ergonomic quality of work schedules you have available to you. One straightforward formula for estimating the overall staffing level is

$$\frac{\text{Weekly platform hours}}{\text{Average weekly employee-hours available to work}}$$

where average weekly employee-hours available to work equals normal work week hours minus benefit and other hours away from work.

Lastly, understanding your workforce and their degree of potential alertness problems will provide you with guidance as to how much latitude you have in creating work schedules and what potential problem areas to address.

Work Schedule Visualization and Analysis

The next step is to prepare the nominal work schedules for analysis using a graphical depiction. Nominal work schedules are the schedules that you developed and bid, not the actual schedules worked by your operators. It is useful to graph only different schedules, that is, if two different runs operate on the same schedule, only plot one schedule. Furthermore, if you have a number of similar schedules offset by 10 or 15 minutes, only plot the schedule hourly. If you have many work schedules and your scheduling software does not produce the type of graph described below, then choose those schedules that:

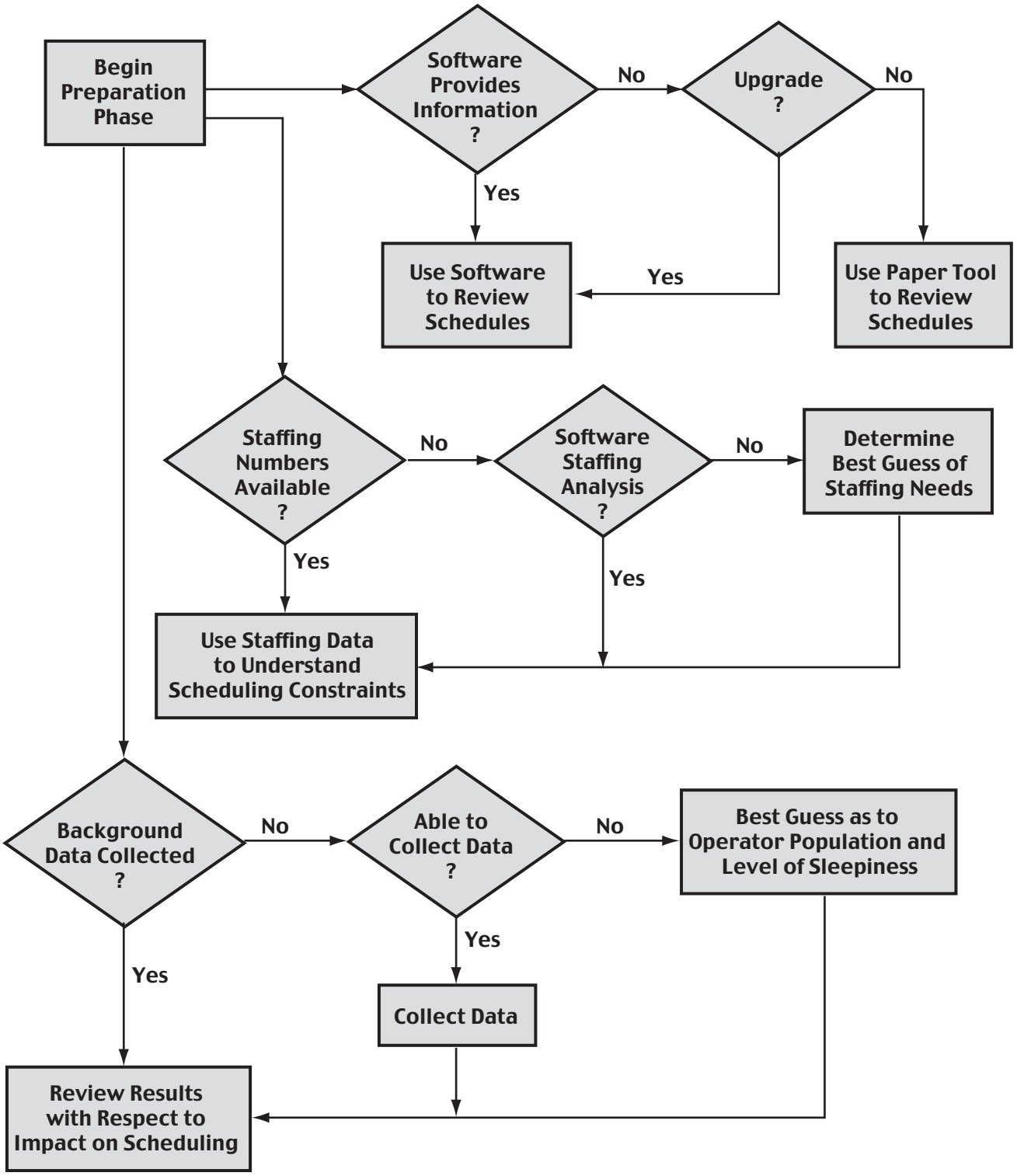


Figure 18. Preparing for schedule analysis

Table 9. Schedule evaluation checklist

Scheduling software able to: (check if available)

_____ Add fatigue-related scheduling constraints
_____ Create graphs
_____ Perform staffing analysis
_____ Perform schedule analysis

Staffing analysis results (enter values)

Estimate of required number of operators _____
Current number of operators _____
Planned overtime for schedule period (hr/wk) _____

Work force information (check if available)

_____ Age distribution
_____ Tenure distribution
_____ Family status
_____ Alertness assessment (Sleep Debt Index)

- Are most commonly worked by the subpopulations identified during the preparation step.
- Are longer than 9 hours.
- Overlap the late night/early morning hours.

Once you have collected the appropriate nominal work schedules, it is time to begin generating the graphs. If you are using your own software to generate these plots then follow its instructions for data entry and plot output. If not, you can use the template in Figure 19. In most cases you will only need to plot one schedule week unless you use a two- (or more) week schedule cycle. In those cases where the cycle extends beyond 1 week, plot out the entire cycle.

Schedule Name/Number _____

Days Off	Day	6am	7am	8am	9am	10am	11am	Noon	1pm	2pm	3pm	4pm	5pm	6pm	7pm	8pm	9pm	10pm	11pm	Mid	1am	2am	3am	4am	5am	Day
	Su																									M
	M																									T
	T																									W
	W																									Th
	Th																									F
	F																									S
	S																									Su

Figure 19. Schedule analysis template

This graph has time plotted on the horizontal axis and day of the week on the vertical axis. The plot templates provided start at 6 a.m. day 1 and continue on until 5:59 a.m. on day 2 (e.g., 6 a.m. Sunday to 5:59 a.m. Monday). Plotting your schedules in this fashion allows you to see the schedule features that have the greatest likelihood of leading to alertness conflicts in transit schedules. These features include:

- Undesirable shift start times.
- Variability from day to day in start time.
- Use of split shifts.
- Long shifts.
- Interference with typical social and family periods.
- Variability in shift length.

If using the template, shade in the cells that match the hours indicated on the nominal schedule. A dark line on the midnight hour separates day 1 from day 2. Given that these plots are in hour increments, if the schedule requires 15 or more minutes of work within the hour, fill the plot cell. Place Xs in the left-hand column to indicate scheduled days off.

As an example, the work schedule in Table 10 is depicted in Figure 20.

Once you have started plotting the work schedules you will begin to see reoccurring patterns. Examine each schedule with regard to the criteria in Table 11. Enter your assessment for each schedule with regard to each criterion in the worksheet (Figure 21).

Table 10. Sample work schedule

	Work Period	
Day	Start	End
Sunday	9 a.m.	8:30 p.m.
Monday	11:30 a.m.	8:30 p.m.
Tuesday	11:30 a.m.	10 p.m.
Wednesday	11:30 a.m.	10 p.m.
Thursday	X	X
Friday	X	X
Saturday	11:30 a.m.	7:20 p.m.

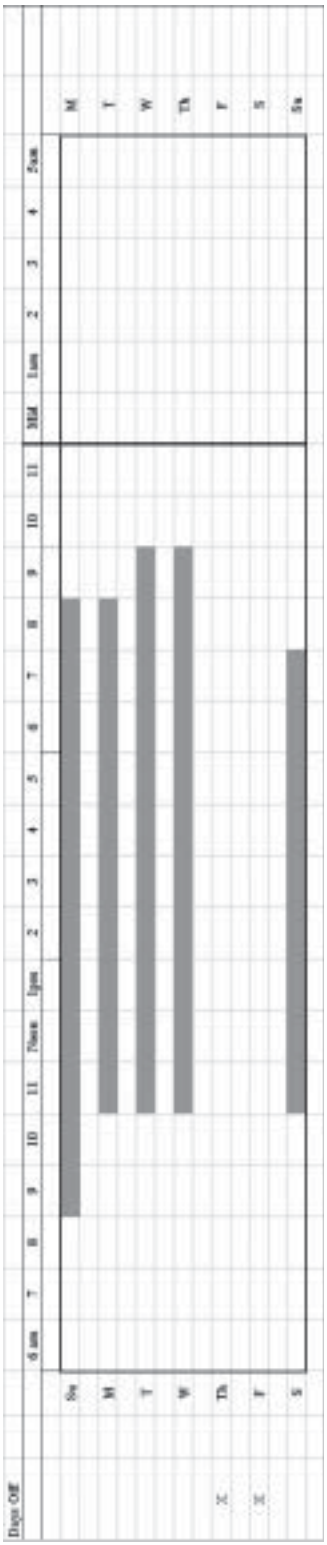


Figure 20. Sample graph

Table 11. Schedule components and undesirable and desirable values

Component	Undesirable Values	Desirable Values
Shift Start Time	1 a.m. to 6 a.m.	Other than 1 a.m. to 6 a.m.
Shift Start Variability	4 hours or more	Less than 4 hours
Use of Split Shifts	More than one sign-on per day with more than 2 hours lag	One sign-on per day, or less than 2 hours lag between sign-ons
Shift length	Greater than 9 hours	Less than 9 hours, dependent on workload of route
Social Time Interference	Job involves work during 6 p.m. to midnight or weekends	Job does not involve work during 6 p.m. to midnight or weekends
Shift Length Variability	Any shift is more than 3 hours longer/shorter than another	No shift is more than 3 hours longer/shorter than another

The Appendix to this tool illustrates common work schedule patterns found in the transit industry and explains their impact upon the worker. Pay close attention to these patterns when reviewing your schedules. Remember to take into account the needs of any at-risk workforce sub-populations that you uncovered during your preparation work.

The worksheet gives you a partial snapshot of how your current work schedules and job assignments may be affecting your workforce. To complete the picture you need an additional piece of information. Specifically, you need to determine the number of changes that occur between the nominal work schedule and the implemented schedule.

Select 30 operators with regular schedules (not extraboard) at random over the course of several weeks. Examine either payroll data or paper/electronic sign on/off records for the individual during those weeks and tabulate the number of changes made to the nominal schedule. This includes unscheduled overtime work. Add the number of weekly changes together and divide by 30 to compute the average number of unplanned schedule changes per operator that occur weekly at your property. Ideally this number should be low, indicating that you have developed regular and predictable schedules for your operators.

	Effects Operator Subgroup? (Yes/No)			Has the Following Features (Yes/No)					
Schedule No.	Age	Tenure	Family	Shift Start Time 1 a.m.–6 a.m.	Shift Start Variability > 4 hours	Splits > 2 hours	Shift > 9 hours	Social Time Conflict	Shift Length Variability
1									
2									
Total Yes									
% Affected									

Figure 21. Worksheet for schedule analysis results

Schedule Redesign

After carrying out the above analyses, you know the capabilities of your scheduling tools and you have an overview of the characteristics of the people for whom you are creating work schedules, including their level of sleepiness. Through your work schedule visualization efforts you also know how your work schedules stack up against desirable schedule characteristics. This is your starting point for creating new work schedule designs. Each new schedule generation episode will require you to 1) evaluate the alertness level of the operator workforce, and 2) evaluate your runs against the BEST criteria (see description below) with an eye on minimizing unplanned overtime and schedule adjustments.

If your scheduling software allows you to enter constraints, consider starting with the constraints suggested in Table 11. Focus on those that specifically apply to your workforce or your scheduling issues. For example, you may want to limit the spread time of a split shift or reduce start time variability to under 4 hours. If you schedule by hand, write down the constraints in a priority order and use this list to evaluate your new schedules. This is more art than science. You are trying to balance the needs of the operation against the benefits of less fatiguing work schedules.

BEST Scheduling Practices

The European Foundation for the Improvement of Living and Working Conditions publishes the BEST (Bulletin of European Studies on Time) guidelines for work scheduling. These publications synthesize the current research and theory around work scheduling practices and present it to the general public in an easy to use format. These booklets are written and edited by the foremost authorities in this scientific area, although they are focused on application within the European Union. Table 12 summarizes the current consensus in the shift work literature and the BEST guidelines regarding the development of work schedules. Research supports each of these recommendations. Consider these recommendations when developing your work schedules, but pay closest attention to the specific issues you evaluated in the previous section.

Each of these scheduling components has implications reaching far beyond reporting time. Furthermore, they are intended as a guide rather than a checklist, with the various positive and negative aspects being weighed against what you found in the preparatory

Table 12. Work scheduling BEST practices*

1. *Minimize schedules comprised solely of permanent night shifts.* Night shifts inevitably lead to less sleep time and less refreshing sleep, both of which can lead to the buildup of a sleep debt and increased sleepiness on the job.
2. *Minimize sequences of nights* – no more than 2 to 4 nights in succession. If people are working nights, try to have them also work a couple day shifts, if possible, to avoid their obtaining a chronic sleep debt.
3. *Avoid fast double-backs* – that is, short intervals of time off between shifts. People need to perform a variety of activities between working episodes. If this time is truncated then it is likely that the operators will shorten their sleep periods to accomplish their other activities, and thereby potentially fall into a sleep debt.
4. *Plan schedules with at least one free weekend day.* Many people rely on weekends to spend time with family and to accomplish larger personal tasks. It is also a time people generally unwind and sleep later.
5. *Avoid extended work sequences* – at least 1 day off per week. People need time off to take care of their personal and social obligations. Most people, when given the choice, would probably choose to earn extra money, but this makes it more difficult for them to take care of their other activities and ultimately ends up with shortened sleep time and an increased risk of at-work sleepiness. Avoid or break this cycle by incorporating off-days into their work schedule.
6. *Fix shift length to task load* – length of duty dependent upon mental/physical demands – operators should be scheduled for fewer hours on demanding runs. People have only so many mental resources and reserves to tap before they start becoming tired and fatigued, which leads to a drop in vigilance. Try to avoid allowing your operators to become run down by limiting the length of their schedules during rush hour, special events and other difficult runs.
7. *Consider night shifts that are shorter than day or evening shifts.* People working the night shift are working in unnatural and difficult conditions. Consistent with the concept of reduced hours for high workload shifts, people working nights should not be put on extended work schedules – over 8 hours.
8. *If you rotate shifts, rotate shifts in a forward direction.* While backwards rotation leads to extended time off at the end of the workweek, it also can lead to short off times between changeovers. This should be avoided. Time off is a necessary component to good shift scheduling.
9. *If you run a 24-hour operation, delay early morning shift starts.* Shift changes between 2 and 5 a.m. make it more challenging for the person coming on duty to obtain enough restorative sleep.
10. *Keep schedules regular and predictable, including overtime.* The more predictable and regular your work schedules, the easier it will be for the operators to plan around it and obtain their necessary amount of sleep.
11. *Allow some individual flexibility* – If not already in place, create an easy but controllable mechanism for operators to change out times if they have to keep a scheduled medical appointment, etc. Employees should be encouraged to schedule their activities as much as possible instead of waiting to call off sick, thereby affecting the schedule of another operator who will have to be called in or kept on unexpectedly.
12. *Limit short-term shift changes* – Give plenty of notice when changing shift schedules and what the new schedules will be. This will give the operators time to review the changes and decide which ones are best for them to bid on.
13. *Staff appropriately; avoid relying on overtime when feasible* – Creating opportunities for employees to work 7 days a week is not advisable, as it will most likely affect their on-the-job alertness.
*Wedderburn, A. "Guidelines for Shiftworkers," *Bulletin of European Shiftwork Topics,* Dublin: European Foundation for the Improvement of Living and Working Conditions, (1991).

and analysis phases of the evaluation. For example, to minimize multiple night shifts, and to provide workers with extra time off, some schedulers use fast double-backs, allowing only 8 hours between work shifts, but this strategy can result in a fatigued operator reporting for duty on the last shift. A split shift situation is a similar concept in transit, though the dead time tends to be only several hours in duration. Is it better to go on continuous or slowly rotating nights rather than use a fast double-back? Like everything else, it depends on many other factors. These factors include the demographics of your workforce (i.e., age, tenure), local and company culture (i.e., employees wanting to spend time with family or make as much money as possible), operational policies concerns (i.e., allows employee flexibility in calling off or switching runs, inadequate staffing), and other scheduling issues (i.e., start times, overtime, use of spare board).

There has been some interest in the use of compressed workweeks. The idea is that by working three or four 12-hour days, the employee would have that many extra off days to recover. The decision to use compressed weeks should be considered cautiously, especially by transit properties, which are by nature sensitive to accidents and public safety. One potential downside of compressed workweeks is that the employee is available for additional overtime work or can take a second job, thereby defeating the potential recovery effects of a 3-day weekend. Transit companies using split shifts may consider their employees to be in a similar situation except the operators do not have the possibility for an extended off-time. This is why the duration of the split should be minimized.

It is unlikely that all schedules will meet all of the work scheduling BEST practices since the scheduling process must satisfy service requirements and collective bargaining agreements. Nonetheless, within these constraints you should look for opportunities to develop less fatiguing schedules that will also positively impact your operators' physical and mental health. Creating a work schedule requires a lot of background data on the operation and its employee population, and considerable forethought on how each of these components can affect the performance and well-being of the employee.

Once you create your new schedules, either by hand or using a scheduling tool, make sure to document what scheduling BEST practices you followed, how you prioritized them and why. Two

months after implementation you should start the process over again, beginning with collecting information on operator alertness. Over time you will become more sensitive to which BEST practices are most effective in mitigating potential sleep debt in your work schedules.

Tool Appendix

Sample Work Schedules

This appendix presents the analysis of nine different work schedules. They are derived from actual work schedules and are considered to be typical of the majority of work schedules seen in the transit industry. You can use them as guides for understanding how to examine and evaluate your own work schedules.

Each of the nine work schedules is first represented as a graph. Below each graph is a grid providing a rating for the schedule on seven fatigue-related alertness features common to transit schedules. The rating is one of the following:

- A checkmark (√) indicating that the schedule complies with the BEST guidelines for that feature.
- A minus sign (-) which means that the schedule completely fails to comply with BEST.
- A zero (0) which indicates that the schedule falls short of full compliance or is towards the outer bounds of compliance, but is not completely out of bounds.

The right-hand column provides an overall assessment of the schedule's level of risk for creating a sleep debt or reduced alertness for the operator exposed to it. This section provides an explanation of the most important positive and negative elements of each schedule with respect to fatigue management.

Much of this type of analysis is a judgment call at first until you start receiving feedback as to how your schedules affect the level of on-duty alertness of your operators. Use the information provided in this guide as a starting point for understanding your schedules. Ultimately, however, the information you collect and the feedback you receive about your schedules will provide you with the most

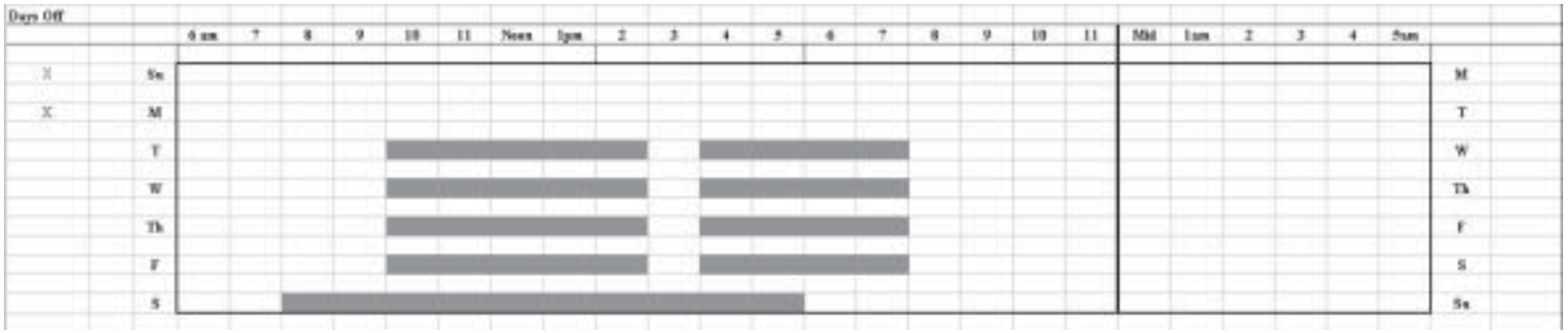
important information for understanding and improving your schedules.

The schedule in Figure 22 represents a fairly typical work time, with a delayed start time (10 a.m.) and an hour"lunch"period. Notice that the Saturday work period violates two BEST guidelines, that of working during social time (all day Saturday and Sunday) and breaking the schedule pattern and thereby adding variability in lifestyle planning. This schedule should not significantly increase on-the-job level of fatigue.

The schedule in Figure 23 includes a bit more start and end time variability than Schedule 1 and requires work on both Saturday and Sunday. In addition three of the work shifts are over 10 hours long, which may be difficult if the run is either technically challenging or very simple to perform. Given the hours of work, it is unlikely that the operator would take a second job that might further interfere with sleep or social arrangements. This schedule probably does not lead to partial sleep debt and increased feelings of fatigue at work.

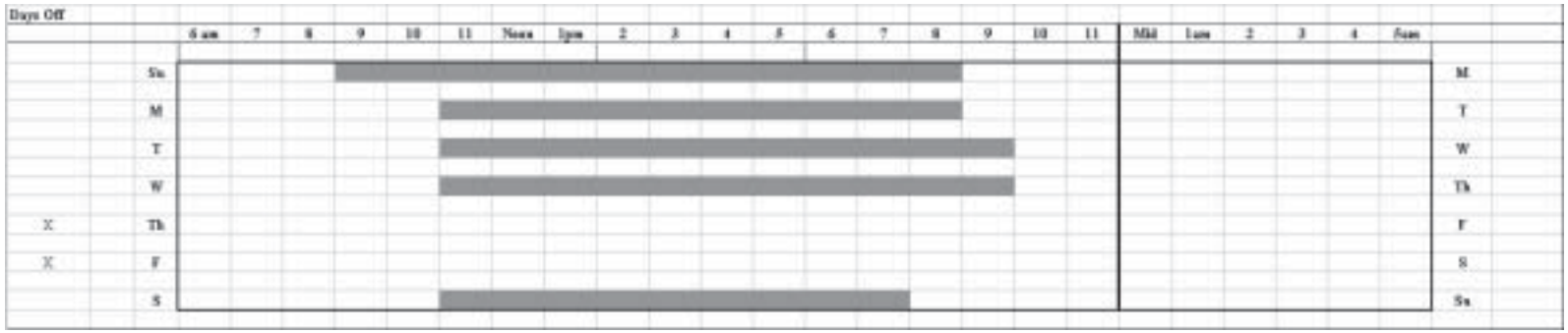
While schedule variability and weekend work are not a problem for Schedule 3, shown in Figure 24, the actual timing of the work is. Specifically, work begins between 4 and 5 a.m. and is preceded by the wake-up routine and the commute to the yard. This situation is likely to be further compounded by the operator's need or wish to spend time with family, friends or doing personal errands. The shift work literature suggests that those working this schedule would be partially sleep deprived and may be at a greater risk of a fatigue-related incident during the first few hours of duty.

These next two schedules build off of the points made for Schedule 3. Specifically, while these schedules are consistent and do not require weekend work, they have an early start time that may lead to possible sleep debt. In addition, Schedule 4 (see Figure 25) requires 12 hours of operational time with a 2+ hour split, while Schedule 5 (see Figure 26) requires less on-duty time but a much longer shift split. Obviously extended duty times can only exacerbate the problems related to diminished sleep. The splits are placed at a time when napping is easier, but it is unknown whether there are facilities available for this activity without the person having to commute home. In addition, the longer split seen in Schedule 5 provides the operator with an opportunity to take part-time or extra work, thereby eroding any



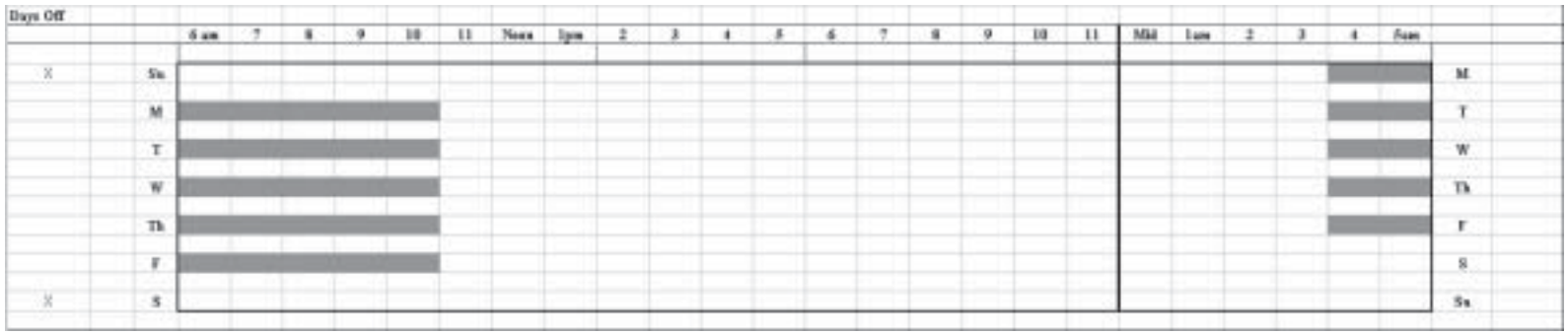
Shift Start Time	Direction of Rotation	Shift Start Time Variability	Use of a Split Shift	Social Time Interference	Shift Length	Shift Length Variability	Risk of Reduced Alertness
√	√	0	√	-	√	√	Low

Figure 22. Schedule 1



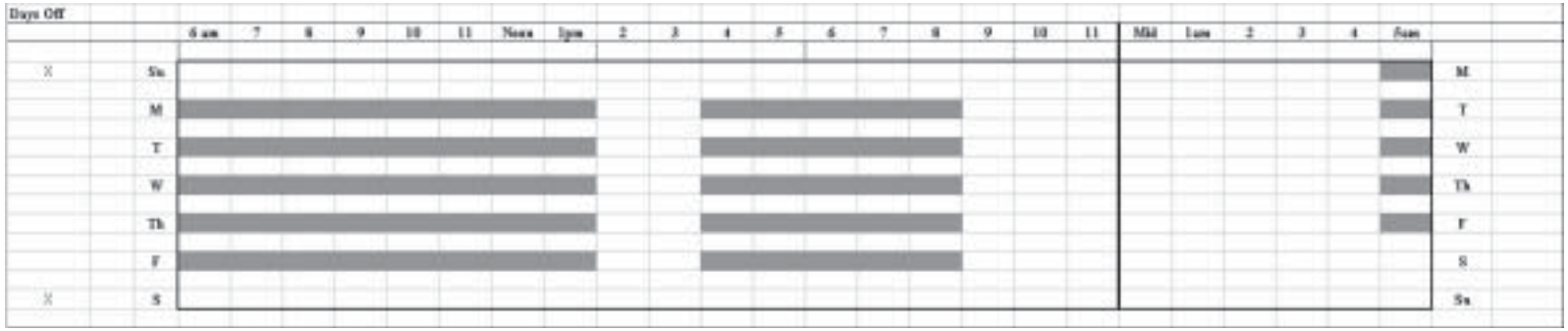
Shift Start Time	Direction of Rotation	Shift Start Time Variability	Use of a Split Shift	Social Time Interference	Shift Length	Shift Length Variability	Risk of Reduced Alertness
√	√	0	√	-	-	0	Low

Figure 23. Schedule 2



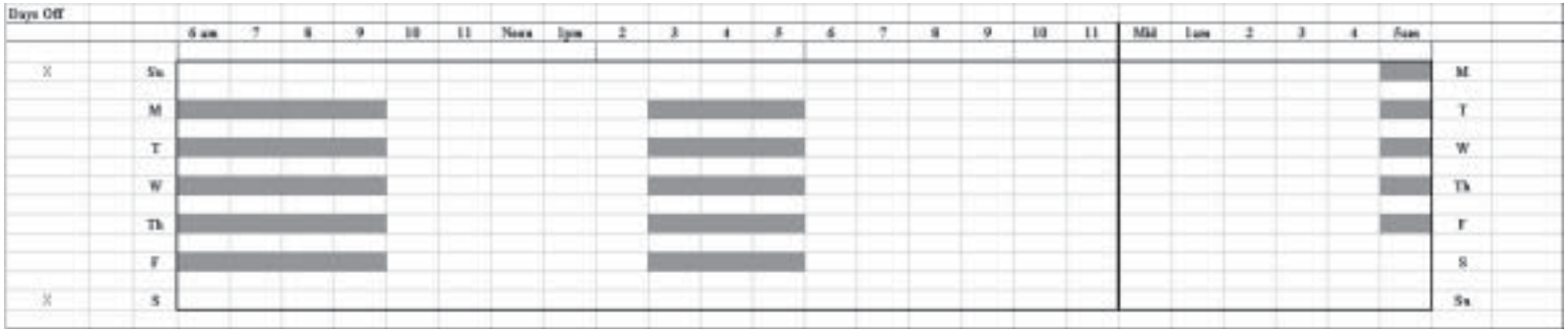
Shift Start Time	Direction of Rotation	Shift Start Time Variability	Use of a Split Shift	Social Time Interference	Shift Length	Shift Length Variability	Risk of Reduced Alertness
–	√	√	√	√	√	√	Low/medium

Figure 24. Schedule 3



Shift Start Time	Direction of Rotation	Shift Start Time Variability	Use of a Split Shift	Social Time Interference	Shift Length	Shift Length Variability	Risk of Reduced Alertness
0	√	√	–	–	–	√	Medium/high

Figure 25. Schedule 4



Shift Start Time	Direction of Rotation	Shift Start Time Variability	Use of a Split Shift	Social Time Interference	Shift Length	Shift Length Variability	Risk of Reduced Alertness
0	√	√	–	√	√	√	Medium

Figure 26. Schedule 5

benefit of the"rest period." Depending on how these schedules are implemented and the individual situations of operators assigned to them, these schedules may lead to a significant increase in fatigue at both the beginning and end of the shifts.

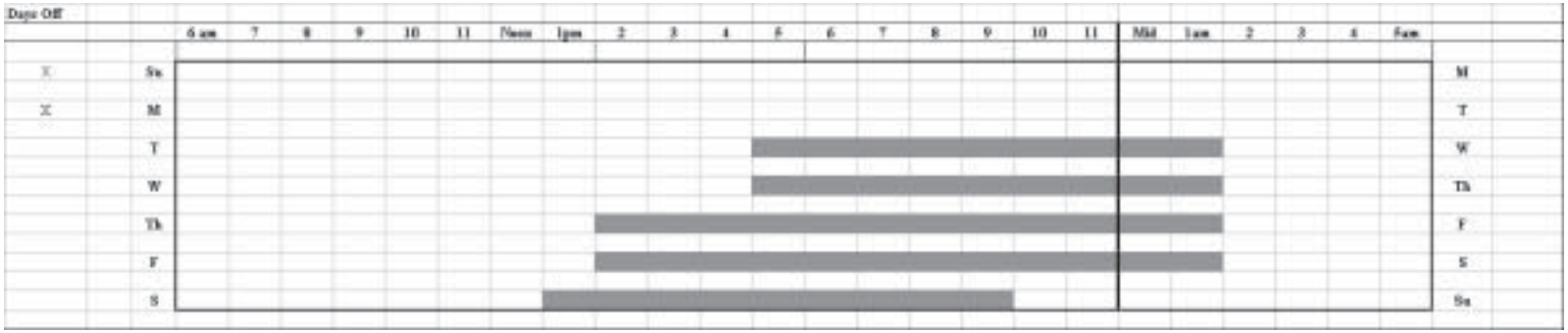
Schedules 6 and 7 (see Figures 27 and 28) both show long work episodes that end during the early morning hours and combine a time-on-task with a time-of-day effect to produce potentially significant increases in fatigue. At least one weekend day is devoted to work as well at times (i.e., 6 to 9 p.m.) that are normally dedicated to family and social activities. In addition there is great variability in work start time in a backward rotating direction that is known to lead to feelings of fatigue. These changes, especially in Schedule 7, are quite pronounced, but these work-period start times remain during the daytime and thus may not as strongly impact alertness.

Schedule 8 (see Figure 29) is an example of a highly irregular work pattern. The work start and end times, length of split and length of work period all vary from day to day. In addition, both weekend days are scheduled and two shifts occur during the early morning. This type of highly variable work schedule can easily lead to increased on-duty fatigue given the hours worked, duration of the shifts and the difficulty in planning regularity in the operator's social, family and personal life.

As a continuous operation, transit lines run around the clock and will incur work schedule issues similar to those found in industrial shift work. The schedule shown in Figure 30 has a 10-hour duration, 6 hours of which occur during the late night/early morning hours when the potential for on-the-job fatigue is at its highest. The lack of variability in the work start and end times makes the schedule easy to plan, but also provides the operator with an opportunity for taking on additional work. end T

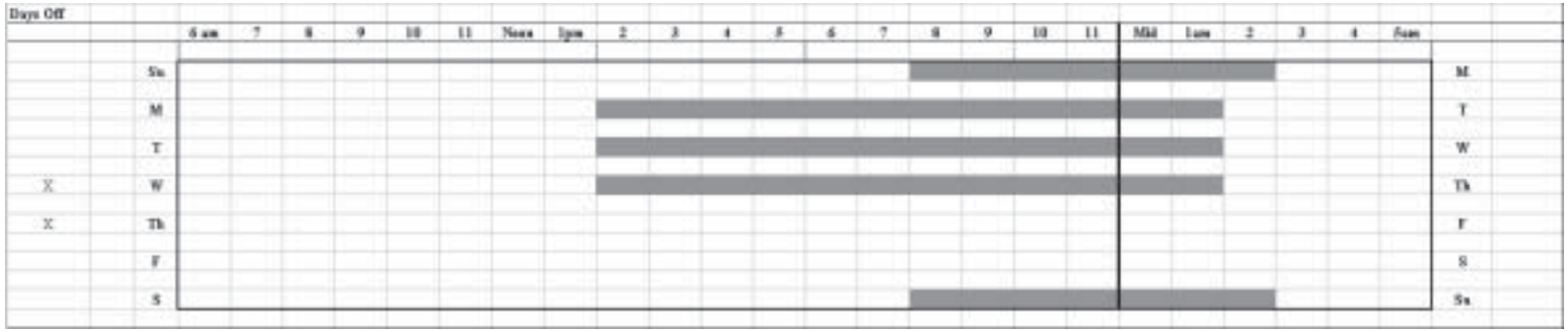
Alternatives to Long Spreads and Split Shifts

Meeting the demands of the morning and afternoon peak periods requires additional operators at these times. Traditionally full-time operators have covered the peak requirements with a daily work cycle beginning in the morning peak, followed by a midday release period and a second tour of duty in the afternoon peak. These long spread split shift days are generally both tiring for the operator and expensive for the transit agency. However, split shifts are less expensive to the agency than hiring two full-time employees with



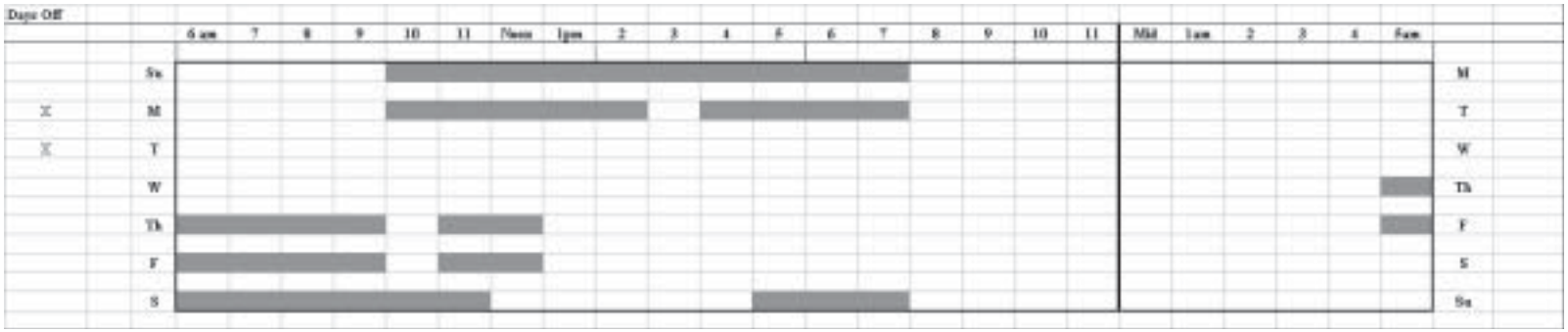
Shift Start Time	Direction of Rotation	Shift Start Time Variability	Use of a Split Shift	Social Time Interference	Shift Length	Shift Length Variability	Risk of Reduced Alertness
√	–	–	√	–	–	0	Medium

Figure 27. Schedule 6



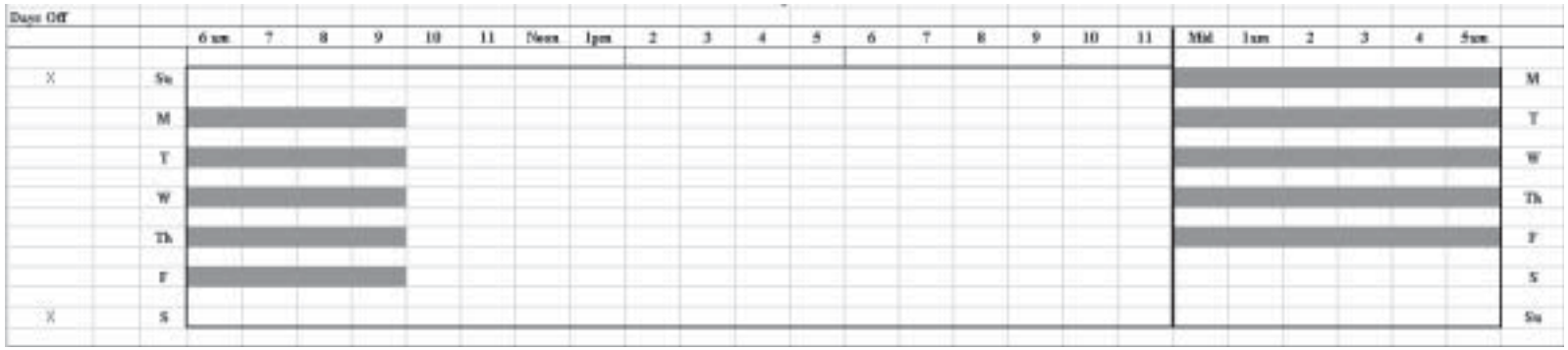
Shift Start Time	Direction of Rotation	Shift Start Time Variability	Use of a Split Shift	Social Time Interference	Shift Length	Shift Length Variability	Risk of Reduced Alertness
√	–	–	√	–	–	–	Medium/high

Figure 28. Schedule 7



Shift Start Time	Direction of Rotation	Shift Start Time Variability	Use of a Split Shift	Social Time Interference	Shift Length	Shift Length Variability	Risk of Reduced Alertness
0	–	–	–	–	–	–	High

Figure 29. Schedule 8



Shift Start Time	Direction of Rotation	Shift Start Time Variability	Use of a Split Shift	Social Time Interference	Shift Length	Shift Length Variability	Risk of Reduced Alertness
–	√	√	√	√	–	√	High

Figure 30. Schedule 9

full benefits. In the last few decades, some transit agencies have hired part-time operators to provide extra service during peak periods. Some part-time operators work both peaks. Part-time operators at some agencies work only one peak period. Each arrangement has its benefits and costs to both the operator and the agency. All can potentially result in operator fatigue. The full-time operator with the long spread may benefit from premium spread pay, but the long elapsed period between departure for work and return home may compromise the individual's daily sleep period. If the part-time operator in fact wants to work full-time and s/he also works a second job, this individual may get inadequate rest leading to a compromise in on-the-job alertness. On the other hand, some individuals seek to work limited hours and the part-time position does not present the risk of fatigue related to a second job. Regardless of whether or not the driver holds a second job, the long spread for part-time operators who work both daily peaks is especially fatiguing. From a fatigue perspective, it is of interest to minimize these situations by developing innovative approaches to both scheduling and staffing.

One such innovative approach involves the use of retired drivers to meet peak service requirements. These drivers bid for peak-period part-time assignments and are allowed to work only one period per day, perhaps limited to 4 hours. The retired drivers are paid at the highest rate for an experienced driver. The transit authority generally avoids any incremental overhead cost for benefit items with this arrangement because the retired drivers are already receiving benefits from the retirement program. Depending upon the need for part-time drivers, some combination of retirees and part-timers might be employed.

Staffing an operation with both part-time and full-time operators allows the agency to minimize its pay-to-platform ratio. From an economic perspective this is desirable but in recent years the transit industry has been less than fully satisfied in its use of part-time workers. Many agencies report high turnover among part-time workers. Some find that this group is more likely to work in a fatigued state. A recent TCRP study points out that there are many individuals who seek only part-time work and recommends that agency recruitment for part-time positions focus on this group.*

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*Charles River Associates Incorporated. "Part-Time Transit Operators: The Trends and Impacts." TCRP Report 68. National Academy Press, Washington, DC, (2001).

Success Story

Management at Phoenix Transit (in Arizona) found that attrition among its part-time drivers was exceptionally high. These employees received lower wages than their full-time counterparts and were not eligible for benefits. Management decided to discontinue the part-time positions and went to a full-time workforce. To accommodate peak periods without creating additional split shift jobs, Phoenix Transit implemented an innovative program whereby retired drivers are hired back for 20 to 25 hours per week to work not more than one peak period a day. The agency pays these experienced drivers at the maximum hourly rate, but because they are retirees, there is no need to pay benefits. Phoenix Transit feels this arrangement has been extremely successful. They have experienced drivers who may be less likely to be fatigued doing the peak runs. Management feels there has been a positive effect on safety, although no formal study has been conducted.

Filling part-time operator positions with individuals who limit their work hours by choice not only solves the retention problems discussed in the TCRP report but also all but reduces the risk that this group of operators will be subject to reduced alertness on the job. Individuals who choose to work less than a full-time 40-hour workweek usually do so because of other commitments such as family or education obligations. Because this group has self-selected a limited work schedule, they may also recognize that the limited hours will allow time for personal time, including adequate rest.

Assigning Personnel to Cover Temporary Vacancies

Each day the operations managers of the transit enterprise find themselves with some vacancies, extra work, delays and other operational circumstances that disrupt the smooth rotation of duties described in the run book. Some employees decide to work in the pool of employees set aside for this extra work (referred to as the extraboard, spareboard or cover list). The schedules of these employees can be especially fatiguing. When the spareboard, extraboard or cover list is exhausted managers attempt to cover the open work with overtime by extending some employees' shifts or calling others to work on their rest days. These arrangements may also be fatiguing.

This section includes techniques, strategies and considerations to help the transit agency and its employees design and implement procedures for the coverage of open work in a manner that does not create circumstances known to promote debilitating levels of operator fatigue. These elements include:

- Suggested guidelines for filling vacancies in a way that avoids arrangements known to fatigue operators.
- Recommendations regarding the establishment and management of "call windows" for extraboard employees to provide opportunities for adoption of a regular schedule of rest and recovery.
- Strategies regarding staffing for special events (e.g., shuttles to the state fairgrounds) or for emergencies (e.g., a blizzard) that temporarily add to the workload of some of operators at a transit enterprise.

Minimizing Operator Fatigue

This tool consists of a set of guidelines that the crew caller or supervisor should consider when assigning personnel to cover temporary vacancies. These principles are a subset of the work schedule guidelines that apply when generating work schedules for bid.

Guidelines for Filling Temporary Vacancies

Illness and personal responsibilities can create temporary vacancies on your daily roster. When this occurs the vacancy must be filled on short notice so that service is not disrupted. In selecting an operator to cover the open work you should attempt to assign an employee who is not likely to become fatigued with the added work.

The European Foundation for the Improvement of Living and Working Conditions publishes the BEST (Bulletin on European Studies on Time) guidelines on work scheduling. The following scheduling practices, based on the BEST guidelines, will help to minimize the risk of fatiguing the operator:

- *Avoid short intervals of time off between shifts* – People need to perform a variety of activities between working periods. If this time is truncated then it is likely that the operators will shorten their sleep period to accomplish their other activities, and thereby potentially fall into a sleep debt.

- *Avoid extended work sequences* – Workers should have at least one day off per week. People need time off to take care of their personal and social obligations. Most people, when given the choice, would probably choose to earn extra money, but this makes it more difficult for them to take care of their other activities and ultimately ends up with shortened sleep time and an increased risk of at-work sleepiness. Avoid filling the vacancy with an operator who has not had a day off in a week.

- *Fix shift length to task load* – The length of duty should be dependent upon mental/physical demands so operators should be scheduled fewer hours on demanding runs. People have limited alertness reserves to tap before they start becoming tired and fatigued, which leads to a drop in vigilance. Try to avoid assigning overtime to an operator

who has already worked during rush hour, special events or any other difficult runs.

- *Rotate shifts in a forward direction* – Backward rotation – starting work today at an earlier time than yesterday – is fatiguing. Avoid this pattern when selecting an operator to fill the vacancy. 

Managing the Extraboard

Recognizing that not all mechanisms for covering vacant work with available personnel yield similar impacts on fatigue, alertness and finance, some transit enterprises have explored a variety of creative ways to manage the extraboard. Among the most practical and useful is the application of "call windows" for extraboard staff, providing staff with the ability to predict when they are most likely to be called for relief work. This enables the extraboard staff to sequence their personal lives so that they are rested and ready when they are called for duty. This section describes how the call window concept works in general, and then provides details on how specific properties interleave the call window concept with other strategies and policies they employ to minimize the fatiguing aspects of temporary worker assignments that cover vacancies in the crew roster.

At all transit operations, many, if not most, vacancies are known the day prior to service. Most agencies divide the extraboard into two or three "shifts," where the employee is on call for a work assignment that begins during their shift. The least elegant approach has all the morning shift extraboard employees report to work at the start of the service day, usually around 4:30 a.m. Each extraboard employee remains in the operator waiting area or lounge until notified of an available run. Under this regime, the "worst-case" scenario is one where an employee reports for work at 4:30 a.m. and is assigned to cover a 12-hour run beginning at 11:59 a.m. Upon the completion of this long day the employee would report to work again the next morning promptly at 4:30 a.m. Such an approach to extraboard management is not only fatiguing, it is also a very inefficient use of the transit enterprise's limited labor and financial resources. In the example, the employee would be paid for 19.5 on-duty hours work from 4:30 a.m. until the end of the tour of work. Some transit agencies have developed approaches to managing the extraboard that lead to more economic and less fatiguing solutions to the problem of covering vacant runs.

Most North American transit enterprises recognize the importance of labor seniority in the assignment of work. A workable process in North America generally entails some element of choice in selecting work duties with more senior employees granted the privilege of picking their work before more junior employees with less time at the job. The following sections describe the unique elements concerning how two properties manage to avoid operator fatigue and maximize alertness among their extraboard staff while recognizing seniority. The practices at these two agencies illustrate how creative approaches can minimize the risk of fatiguing the extraboard operators.

Property A

One eastern transit bus property maintains three distinct extraboard rosters – early, matinee and late. Drivers on the early board bid their work by phone the previous day. Operators on the matinee board for work starting after 10:40 a.m. call between 9 and 10 a.m. on the same day. Those on the late board for work starting after 2:10 p.m. call between 10 a.m. and noon. If there are more extraboard drivers than jobs, some "protect" (standby) jobs are made available. Early run start times range from pullout at 4:10 a.m. through 10:39 a.m. Matinee run start times range from 10:40 a.m. through 2:09 p.m. Late run start times range from 2:10 p.m. through evening. If an operator does not call during his/her call-in time, the dispatcher will assign work to such operator prior to the next bidder's call-in time.

Each day's bids are reviewed by the dispatcher for "work distribution." To satisfy work distribution criteria there must be a mandatory minimum rest time for the operator between work periods. The mandatory minimum rest time depends on how many hours the employee works in a 24-hour period. For 12 hours continuous work (less than a 3-hour break) the employee must be off 8 hours. Work up to 16 hours must include a 4-hour break away from property then a 10-hour rest. If an extraboard employee has insufficient rest for the next rotation, the employee is not eligible for the next day's regular work, but is eligible for a later rotation. For example, on the next day, an early operator could be eligible for any work that the matinee board had not picked. All extraboard operators are guaranteed a day's work (and pay) even though they may be working a "protect" or stand-by assignment.

The extra work management policies and procedures at this agency incorporate several of the BEST principles discussed above. In

particular this agency's policies keep schedules regular and predictable, avoid fast double-backs, rotate shifts in a forward direction, limit short-term shift changes, allow some individual flexibility, and give plenty of notice when changing shift schedules.

Property B

At one large rapid transit property, there had been several serious accidents where fatigue may have been a contributing factor. As a consequence, management and labor established and enforce several work and service policies aimed at reducing operator fatigue and promoting alertness on the job:

1. No operator may work a spread greater than 16 hours without 8 hours rest.

2. All rapid transit work is scheduled with straight runs. (No swings or spread.)

3. By contract, all posted operator runs must range between 8 hours and 9 hours, 59 minutes in duration.

4. A minimum of 8 hours off is required from the end of one assignment to the start of the next. (This does *not* guarantee 8 hours rest since commuting is included in the 8 hours off.)

5. No operator is allowed to work more than 6 days without a day off.

6. No employee is allowed to hold a second job outside the transit agency.

7. Workers can work "doubles" on overtime to cover vacancies that cannot be covered from the extraboard, but in creating "doubles" the agency is trying to cut back to 14 or even 12 hours.

At this agency, the extraboard list is divided into three tours. An employee selects a tour of duty (early, midday, or midnight) and is assigned work that starts within that time window. The crew assignment office assigns the operator to a report location and time, trying to place the operator at a location where they know or anticipate a vacancy will occur. Unlike the eastern bus property in Example A, at this agency the crew assignment office makes *specific* extraboard assignments. The employee does not pick them.

The extraboard operator can pick up additional work, to a maximum of 9 hours 59 minutes, until the eighth hour of his first assignment. If he does, the crew assignment office needs to communicate with the field supervisor who assigns the work so that this operator can be relieved before 16 hours have elapsed. The supervisor also needs to provide feedback to the crew dispatcher at the end of each tour to ensure that long working employees get the 8 hours mandatory minimum rest.

The property introduced a procedure whereby any overtime over 1 hour is communicated back to the crew dispatcher so that the extraboard employee is not assigned to his next job without the required 8 hours of rest. The introduction of this feedback to the crew office represented a major change in process. The property also introduced customized software to allow tracking and enforcement of the minimum 8-hour rest rule.

The extra work management policies and procedures at this rapid transit agency incorporate several of the BEST principles discussed under *Procedures for Developing Fatigue-Resistant Schedules.* In particular this agency's policies, avoid fast double-backs, rotate shifts in a forward direction, avoid extended work sequences – 8 or more continuous work days, keep schedules regular and predictable, limit short-term shift changes, give plenty of notice when changing shift schedules, and avoid excessive reliance on overtime.

In developing its policy and program to manage fatigue and maximize alertness in the workplace, each transit enterprise should assess how its extraboard management procedures conform with the BEST principles and the practices of its peers.

Special Events

From time to time, circumstances in the community served by a transit enterprise greatly increase the demand for transit labor. Such circumstances are usually short term and may include civic festivals such as the state fair, a major sporting event, or the closing of a bridge for maintenance or repairs. In some cases the excessive demand for labor is created by circumstances such as blizzards, hurricanes, or flu epidemics. In some emergencies the workers on hand are asked to work long hours and double shifts because their relief cannot get to work. All these special events create the opportunity for excessive operator fatigue. The transit enterprise should explicitly recognize the increased potential for fatigue that

is created and take appropriate proactive measures in keeping with BEST principles.

Particular policies and considerations that may be useful for agencies facing the short-term need for operators to work longer hours than usual include:

- Minimize sequences of nights – no more than 2 to 4 nights in succession.
- Encourage napping by operators who are subject to long hours on duty.
- Plan schedules with some free weekends.
- Avoid extended work sequences – 8 or more continuous work days.
- Keep the longer schedules fairly regular and predictable.
- Consider night shifts that are shorter than day or evening shifts.
- Rotate shifts in a forward direction.
- Avoid fast double-backs.
- Make shift change times flexible, if possible.
- Allow some individual flexibility in how each worker covers her/his long tour of duty.

Transit agencies have found a number of strategies to be effective in responding to special events and extraordinary circumstances that create the need for extra operator hours. These strategies include the following:

- *Right to refuse work* - At one property, operators have the nominal right to refuse overtime assignments if they have more than 5 years of seniority, but the culture of the organization does not allow them to refuse the work if the agency (and operator) cannot find relief. Moreover, it is reported that no operators refuse extra work if there is a "real" emergency. At other properties, operators do not have

the nominal right to refuse overtime, but supervisors are urged to use discretion in disciplining employees who indicate that they would prefer time off over extra work and pay. Some properties have the contractual right to call operators in to work overtime on their rest days, but most avoid doing so, allowing their employees to rest.

- *Guaranteed Rest* - At most agencies, operators are not allowed to operate for more than 16 hours straight without 8 hours of rest.

- *Special Consideration to Split Shift Operators* - One agency has "special runs" of less than 7 hours of platform time over a 14-hour spread. Operators with these long days are guaranteed 8 hours of pay and avoid weekend work. During emergencies these operators must make themselves available during splits for extra work. This gives the agency additional operators to handle short-term emergencies such as the early release of commuters on the afternoon of a snowstorm.

- *Advance Planning* - When a special event is on the planning horizon, one agency advertises the need for extra workers about 30 days in advance. Operators bid on these future openings the same as they would bid for overtime. Operators with more seniority get first choice of the extra work. When making awards, the crew dispatcher determines whether each bidding operator would have sufficient time off duty at the time of the assignment to handle the added work without violating hours of service guidelines.

Designing Facilities and Equipment

Opportunities to help mitigate, manage or avoid operator fatigue present themselves when transit agencies are designing facilities and/or purchasing new rolling stock. In the design of reporting locations and bus garages, facilities can be provided to help operators begin their runs rested and ready for work. Regarding rolling stock, vehicle operating compartments are much more comfortable and transit vehicles are much easier to operate safely than they were 50 years ago because of improvements in technology. Agencies should always seek vehicle innovations that make the task of driving a bus, or running a train, safer and less fatiguing.

Specific toolbox elements relating to the design of facilities and equipment primarily relate to the provision of amenities at reporting and layover facilities that help operators use their breaks to return to work rested and refreshed. These amenities include:

- A napping or quiet facility to allow operators to take a rest break before reporting to their second half or before they head off for a long commute home.
- Exercise equipment to allow operators to release tensions and build strength and stamina during their rest or release periods.
- Vending equipment for operators to obtain and consume healthy nutritious snacks to help increase health and reduce fatigue.
- Vending machines that dispense products with caffeine to help ward off the inevitable occasions where fatigue and work need to mix.

Success Story

When Phoenix Transit renovated a bus garage in 1994 the agency incorporated single-sex sleeping facilities in the renovation plans. A former conference room became the napping facility where the women's bunkroom accommodates four people and the men's, ten people. Phoenix Transit's maintenance department has a linen supply contract so that there are always clean linens on the beds. The room is soundproofed and dark and each bunkroom has a temperature control unit. Extraboard drivers are encouraged to use the napping facility and are provided with beepers for notification when they are needed. Drivers who mark off at midday at another location are able to travel to the facility via van service.

Napping/Quiet Facility

Under this countermeasure, a transit property provides a well-designed and well-maintained napping facility and encourages employees to use it. An ideal napping facility is a room with beds, clean linens and silence (see Figure 31). An alternative to this type of facility is a room with recliners (see Figure 32). The room should be soundproof, cool and dark. If napping facilities cannot be provided at all points where an employee can mark off for a midday break, transportation to the facility might be provided. If your agency's rules prohibit sleeping on company property, a change in rules must occur to allow employees to use the napping/quiet facility.

Research has demonstrated the restorative value of napping. Employees with split shifts and on-call drivers are candidates for naps.

Exercise Equipment

Exercise has many benefits including helping to manage stress and boost energy levels. Employees should be encouraged to exercise on their own time as part of an overall health routine. Under this countermeasure, where feasible, the agency provides exercise equipment (e.g., treadmill or exercise bike) in an employee lounge

Figure 31. Napping room at Phoenix Transit

for workers to use before and after work, or during their break between split shifts (see Figure 33). To encourage the use of the exercise equipment, employees are given information explaining that exercise helps reduce stress and increase energy. This education component also includes simple stretching exercises that can be done before the start of a run or during a break. A poster explaining the stretching exercises can be posted in the employee lounge. (See "Exercise Basics" and "Break Time Stretches.") The "Break Time Stretches" poster on the accompanying CD is suitable for posting in the exercise area or break room.

Figure 32. Quiet room at Connecticut Transit (CTTransit)

Success Story

In 1990 the Hartford Division of CTTransit became the first on this property to have a "quiet room." In addition to the conventional-looking ready room with pool tables, pinball machines and loud conversation, this facility was designed to give operators a restful alternative. Similar quiet rooms are planned for new facilities in Stamford, which will be renovated in 2002, and New Haven, which is scheduled to have a new garage in 2004.

Vending Equipment

Vending equipment in ready rooms and other areas that operators use during breaks should offer nutritious snacks such as nuts, raisins, fresh fruit and granola bars. These and other items that contain protein will provide sustained energy. In contrast, items that are high in carbohydrates and sugar provide only a short-lived energy boost.

Vending equipment should also offer items containing caffeine for occasions when an operator needs a boost in alertness to complete the day's work. Caffeine-containing foods and beverages that can be offered include coffee, tea, hot chocolate and chocolate candy bars as well as carbonated beverages such as colas, Surge, Mountain Dew and Jolt.

Profits, if any, from the vending machines can fund exercise equipment or some other alertness related tool.

Figure 33. Fitness facility at CTTransit's Hartford facility

Success Story

CTTransit's Hartford facility includes a fitness center that is available to all employees for a nominal fee. CTTransit's bus operators are frequent users of the facility. Similar facilities will be a part of other garages scheduled for renovation.

Recruiting and Hiring New Operators

A transit agency can take measures to avoid future problems with fatigue when recruiting and hiring new operators. These measures include screening employees to avoid fatigue risks and advising qualified operator candidates of the potentially fatiguing schedules that may be demanded of them, especially when they are junior, or even part-time, employees. Recruiting and screening for healthy employees as transit operators will help reduce problems with fatigue. Applicants with sleep disorders and unhealthy lifestyles can be deferred from the applicant pool until their problems are corrected. Knowledge of the realities of working nights, weekends and early mornings can cause some otherwise qualified applicants to reconsider their commitment to the lifestyle of the transit operator.

Specific elements of the toolbox relating to the recruitment and hiring of new operators include:

- Suggestions for recruiting literature that will inform the prospective operator of the nature of transit work schedules and articulate the employee's obligation to get the rest and sleep necessary to report for scheduled duty as required.

- Recommendations to ensure that the required pre-employment medical examination includes all the screens necessary to determine that potential sleep disorders are not overlooked.

- Recommendations for the training of new employees to ensure that they have been indoctrinated regarding appropriate sleep hygiene and personal habits to help ensure that they will be rested and ready and able to provide safe service to the agency's customers.

Job Preview

Recruitment and screening of new operators provides an opportunity for the candidate to develop an understanding of the requirements of the job and the work schedule that s/he is likely to have. When prospective employees consider a job as a transit operator they should understand that they may regularly work unusual hours. They will need to adapt their lives to meet the schedule of the job. The amount of adaptation required will vary from agency to agency and from time to time. It is important for any novice operator to also understand lifestyle adjustments that the job may necessitate.

This tool is a job preview handout designed for distribution to operator candidates. It emphasizes key points concerning scheduling that the prospective operator should understand.

The Lifestyle of a Transit Operator: Is It for You?

- **You must be ready to work.** As a transit operator, the lives of our customers and the public are in your hands. You must be alert and vigilant while operating a transit vehicle. You must arrive at work promptly, properly rested and ready to work.

- **Transit operators work early mornings, late nights and weekends**. Our transit system provides service every day, many hours each day. Non-standard work hours are essential to providing this service. You will be required to work outside the "normal" Monday through Friday, 8 to 5 work schedule. You will be required to work during some holidays, in bad weather and during national and local emergencies. This will likely be true during most of your career as an operator.

- **Your personal schedule must adapt to your work schedule.** Your work schedule may require sleeping at unusual hours, eating at different times and having fewer opportunities to be with your friends and family.

- **Adapting your personal schedule to the job can be stressful.** Coping with transit shiftwork will require a commitment from you and your family. Some people find it very difficult to adapt to working late-night/early morning shifts.

- **You must be ready to rest at work when you have the chance.** Your schedule will provide breaks. But you may find yourself at a location where food or toilet facilities are not available. When working this type of route you must plan ahead and bring food with you. Proper nutrition and hydration are important in maintaining alertness at the controls of your vehicle. 

Medical Examination

New hire physicals provide an opportunity to screen candidates for undiagnosed or untreated sleep disorders. The Federal Motor Carrier Safety Administration (FMCSA) developed a health screening procedure for commercial drivers who operate interstate. A similar procedure is suitable for transit operators. Although bus drivers in nearly all states must hold a Commercial Driver's License (CDL), few require a physical to obtain or maintain this license.

The FMCSA regulations stipulate that the certifying physician must review specific medical factors with the candidate and report the findings on the "Medical Examination Report for Commercial

Driver Fitness Determination" (49 CFR Part 391). The operator must obtain this medical certification every 2 years to maintain a current CDL. The FMCSA form includes a "health history" section that the driver must complete. Specifically, the driver must indicate on the form whether or not s/he has any of the listed medical problems including, "Sleep disorders, pauses in breathing while asleep, daytime sleepiness, loud snoring." The instructions that accompany this form advise the physician to review the employee's responses under "health history" and to discuss any "yes" responses with the employee. This procedure encourages the physician to explore and resolve any potential sleep problems with the employee. If the physician finds that the individual has "an established medical history or clinical diagnosis of a respiratory dysfunction likely to interfere with his ability to control and drive a commercial motor vehicle safely," then the individual does not meet the physical qualifications for a CDL. This type of medical screening of operator candidates will identify those who are at risk of reduced alertness behind the wheel. The ability to maintain alertness is a bona fide occupational qualification for transit operators and as such should not create the risk of violating the Americans with Disabilities Act. New hire candidates who do not meet the physical qualifications can be deferred until the sleep disorder is no longer likely to interfere with the individual's ability to safely operate a transit vehicle.

This medical examination procedure is suitable for both new hires and periodic examinations for existing operators. The FMSCA requires operators of interstate commercial motor vehicles to pass the physical examination every 2 years. In developing a policy regarding re-examination of transit operators, transit agencies can use the FMCSA requirement as a guide. Transit agencies should explore whether or not their medical disability policies apply in cases where a current operator develops a sleep disorder.

A copy of the "Medical Examination Report for Commercial Driver Fitness Determination" appears on the CD that accompanies this document.

New Hire Training

The new hire training program should educate new operators regarding the principles of sleep and fatigue and the performance consequences of inadequate rest. Training on techniques and strategies to minimize the risk of fatigue on the job is also

Success Story

NYCT Rapid Transit Division developed a Fatigue Awareness program that is a part of new hire training for all subway operators. This module is also a part of the refresher course that the agency gives to all subway operators every 3 to 4 years. NYCT based their training manual on one developed by the Burlington Northern/Santa Fe Railroad.

important. This type of training is usually 1 to 2 hours long and includes the following topics:

- Why operator fatigue is a concern.
- Definition of fatigue, its symptoms and causes.
- Sleep structure - stages of sleep, sleep quality and sleep debt.
- Circadian rhythms.
- Shift work effects.
- Relationship between work, off-time and fatigue.
- Drugs/substances that affect sleeping and alertness.
- Sleep disorders.
- Personal strategies for maintaining alertness on the job.

Supervisors who oversee operators and crew dispatchers who are responsible for establishing work schedules should also receive the same training.

The Transportation Safety Institute offers an 8-hour Instructor's Course in Fatigue Awareness for Employees. Transit agencies without the resources to develop their own training program can send their instructors to this course to learn how to teach the TSI-developed course"Fatigue Awareness for Employees." For more information on the TSI course contact:

Transportation Safety Institute
Transit Safety and Security Division
(405) 954-3682
www.tsi.dot.gov

Investigating Accidents

In spite of efforts to promote a safe operation, all transit agencies inevitably must deal with vehicle collisions, personal injuries and resulting property damage. Such an event may be due to any of a number of causes. Equipment failures are responsible for some accidents. In other cases human error contributes to the accident. There are many manifestations of human error, some due to fatigue or reduced alertness. When investigating an accident or employee injury, the investigator should collect adequate data to determine whether or not operator fatigue was a factor.

This tool consists of a structured procedure for determining if fatigue played a role in an accident or injury. If fatigue is found to

be a contributor to accidents and injuries, the next step will be to correct the situation that resulted in the operator becoming fatigued. The Transportation Safety Board of Canada developed the investigation procedure guide that follows. It consists of a series of questions and responses that are indicative of a fatigued state.

The accident investigation procedure begins by examining the following four factors:

1. Time of day of the occurrence.
2. Disruption of the operator's normal circadian rhythm.
3. Number of hours since the operator's awakening.
4. Operator's 72-hour sleep history.

If any of these factors indicates a problem, then fatigue should be investigated in depth using a two-stage process. First, establish that the operator was in a fatigued state, and second, determine if the unsafe act or decision was consistent with the type of behavior expected of a fatigued person.

Application of this procedure requires an individual who is knowledgeable regarding human fatigue and the consequences of fatigue in terms of human performance.

Fatigue Investigation Procedure

Fatigue should be considered as a potential underlying factor in virtually all accidents and injuries. Four questions provide guidance as to the initial assessment of fatigue as a contributing factor to an occurrence:

1. *At what time of day did the occurrence take place?* If it occurred between 3 and 5 p.m. or 3 and 5 a.m., fatigue may have played a role.

2. *Was the operator's normal circadian rhythm disrupted?* If the operator was working at a time when s/he was normally sleeping, fatigue may have played a role.

3. *How many hours had it been since awakening?* If the operator was awake for more than 16 hours, fatigue may have played a role.

4. *Does the 72-hour sleep history suggest a sleep debt?* If the operator was averaging less than 7 hours of sleep per night, fatigue may have played a role.

If the answer to any of the above questions indicates a situation where fatigue may have contributed to the incident, then fatigue should be investigated in depth.

To establish fatigue as a contributing factor, it must be demonstrated that:

- The person or crew was in a fatigued state.
- The unsafe act or decision is consistent with the type of behavior expected of a fatigued person or crew.

Checklists on the following pages can be used to aid in the collection of fatigue-related data and the determination of fatigue as a causal factor:

Checklist 1, ***Establishing the fatigued state,*** consists of four columns: *Issue*, *Probes*, *Desirable Responses and Notes*. The first column, *Issue,* is a listing of significant factors relating to fatigue. Each *Issue* is accompanied by a list of *Probes*, questions that examine various aspects of the issue. Probe questions are important in determining whether the *Issue* is pertinent to the occurrence. The third column, *Desirable Responses,* provides a foundation for analysis of fatigue; that is, any response different from the best-case represents a potential reduction in rested state. The fourth is for investigator notes.

Checklist 2, ***Establishing the link between fatigue and the unsafe act/decision,*** consists of three columns. The first two, *Performance Impairment* and *Indicators,* describe the possible effects of fatigue on performance. The third is for investigator notes.

Checklist 1 - Establishing the fatigued state

Issue	Probes	Desirable Response	Notes
Quantity of Sleep	What was the length of last consolidated sleep period?	7.5 to 8.5 hours	
	Start time?	Normal circadian rhythm, late evening	
	Awake Time?	Normal circadian rhythm, early morning	
	Was your sleep interrupted (for how long)?	No	
	Have you had any naps since your last consolidated sleep?	Yes	
	Duration of naps?	Had opportunity for restorative (1.5 to 2 hours) or strategic (20 minutes) nap prior to start of late shift	
Summary - establish whether or not there was a sleep debt	Describe your sleep patterns in the last 72 hours. (Apply sleep credit system)	2 credits for each hour of sleep; loss of one credit for each hour awake - should be positive value	
Quality of Sleep	How did the sleep period relate to the individual's normal sleep cycle i.e., start/finish time? (See "Quantity of Sleep")	Normal circadian rhythm, late evening/early morning	
	Sleep disruptions?	No awakenings	
	Sleep environment?	Proper environmental conditions (quiet, comfortable temperature, fresh air, own bed, dark room)	
Summary - establish whether or not the sleep was restorative	Sleep pathologies?	None	

Checklist 1 - Establishing the fatigued state (continued)

Issue	Probes	Desirable Response	Notes
Work History	Hours on duty and/or on call prior to the occurrence?	Situation dependent - hours on duty and/or on call and type of duty that ensure appropriate level of alertness for the task	
Summary - establish whether the hours worked and the type of duty or activities involved had an impact on the quantity and quality of sleep	Work history in preceding week?	Number of hours on duty and/or on call and type of duty that do not lead to a cumulative fatigue effect	
Irregular Schedules	Was he/she a shiftworker?	No (Shiftworkers never fully adapt in terms of sleep quality)	
	If yes, was it a permanent shift?	Yes – Days	
	If no, was it rotating (vs. irregular) shiftwork? How are overtime or double shifts scheduled?	Yes - Rotating clockwise, rotation slow (1 day for each hour advanced), night shift shorter, and at the end of cycle	
	How are overtime or double shifts scheduled?	Scheduled when operators will be most alert in the context of their circadian rhythm	
	Scheduling of critical safety tasks?	Scheduled when operators will be most alert in the context of their circadian rhythm	
Summary - establish whether the scheduling was problematic with regards to its impact on quantity and quality of sleep	Is there a fatigue countermeasure program in place?	Yes	

Checklist 2 - Establishing the link between fatigue and the unsafe act/decision

Performance Impairment	Indicators	Notes
Attention	Overlooked sequential task element Incorrectly ordered sequential task element Preoccupied with single tasks or elements Exhibited lack of awareness of poor performance Reverted to old habits Focused on a minor problem despite risk of major one Did not appreciate gravity of situation Did not anticipate danger Displayed decreased vigilance Did not observe warning signs	
Memory	Forgot a task or elements of a task Forgot the sequence of tasks or task elements Inaccurately recalled operational events	
Alertness	Succumbed to uncontrollable sleep in form of microsleep, nap, or long sleep episode Displayed automatic behavior syndrome	
Reaction Time	Responded slowly to normal, abnormal or emergency stimuli Failed to respond altogether to normal, abnormal or emergency stimuli	

Checklist 2 - Establishing the link between fatigue and the unsafe act/decision (continued)

Performance Impairment	Indicators	Notes
Problem-solving Ability	Displayed flawed logic Displayed problems with arithmetic, geometric or other cognitive processing tasks Applied inappropriate corrective action Did not accurately interpret situation Displayed poor judgement of distance, speed, and/or time	
Mood	Was less conversant than normal Did not perform low-demand tasks Was irritable Distracted by discomfort	
Attitude	Displayed a willingness to take risks Ignored normal checks or procedures Displayed a "don't care" attitude	
Physiological Effects	Exhibited speech effects - slurred, rate, content Exhibited reduced manual dexterity - key-punch entry errors, switch selection	

Glossary

A

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Automatic Behavior Syndrome (ABS). A period of several minutes or more during which a person is able to continue performing routine duties but is incapable of active cognition. For example, a trucker displaying ABS would keep his rig on the road but miss his intended exit. Automatic behavior is more likely to occur when a person is sleep deprived or has a sleep disorder. A person's eyes remain open during this automatic behavior even though the individual usually has no memory of the incident.

Acrophase. The time at which the circadian rhythm reaches its peak. This is typically when an individual is at the greatest arousal or alertness level.

Acute Sleep Loss. The impairment of performance and vigilance resulting from getting significantly less sleep than needed for cognitive functioning. This generally occurs with less than 4 hours of sleep in a 1-night period.

Alertness. The optimal activated state of the brain. An alert person is attentive and can perform normal physical and mental functions. Alertness is a dynamic state and may vary from second to second.

Apnea. A pause in breathing that lasts 10 seconds or longer. A person with the sleep-apnea syndrome has many episodes during sleep periods. These episodes disrupt the individual's normal sleep cycle and may lead to acute or drastic sleep deprivation.

Arousal. A change in an individual from asleep to awake. Partial arousal refers to the transition from deep sleep into a lighter sleep stage. Full arousal is when an individual is fully awake and cognizant.

Awake. The person is conscious and aware of the surroundings.

Biological Clock. Also referred to as our internal clock or circadian clock, our biological clock is a group of nerve cells located in the brain which regulate the precise timing of body functions, including daily cycles of alertness and sleepiness. The biological clock sustains circadian rhythm.

Circadian Disruption. Disturbance of the circadian rhythm. Circadian disruption can result from trans-meridian travel, irregular work schedules, or failing to get adequate sleep during the night. It can lead to difficulty sleeping at appropriate times, problems maintaining alertness, and fatigue. The body may adjust, but slowly.

Circadian Rhythm. (*circa* = around or about; *diem* = day) Self-sustained biological rhythms that have a period of about 1 day (24 hours).

Clockwise or Forward Rotating Shift. A work schedule in which the shift moves forward, from day to evening to night.

Counterclockwise or Backwards Rotating Shift. A work schedule in which the shift moves backward, from night to evening to day.

Diurnal. Being active during the day and asleep at night.

Environmental Time Cues. (*zeitgebers*) A signal from outside an organism that helps synchronize rhythms, such as sunlight and mealtimes.

Fast Rotation. A work schedule in which shift rotations occur within a period of less than 1 week.

Fatigue. (Physical) Physical discomfort from overworking a group of muscles. (Mental) Difficulty concentrating, difficulty processing important signals, and problems staying awake in critical situations. Fatigue can concern the impairment of physiological and/or cognitive performance.

Fixed Shift. A work schedule in which the hours of work remain the same over time.

Hypnagogic Hallucinations. Vivid images that occur at the beginning of sleep. These are particularly intense when sleep begins with a REM period, as frequently occurs in narcolepsy.

Irregular Shift. A work schedule that is variable and unpredictable.

Main Sleep Period. Time when an individual obtains the majority of his/her daily sleep.

Microsleep. A lapse from wakefulness into sleep that lasts just a few seconds; often associated with excessive daytime sleepiness and automatic behavior.

Narcolepsy. A sleep disorder characterized by excessive sleepiness, abnormal REM sleep, hypnagogic hallucinations, problems sleeping at night, and falling asleep suddenly at inappropriate times during the day.

Nocturnal. Being active at night and asleep during the day.

Non-restorative Sleep. Sleep that is not refreshing, usually including little or no REM sleep stage.

NREM Sleep (pronounced *non rem*). Non-rapid-eye-movement sleep; that is, all the sleep except for REM sleep. NREM and REM periods alternate during sleep in cycles that last approximately 90 minutes. NREM sleep includes stages 1, 2, 3, and 4.

Periodic Limb Movements (PLM). Repetitive twitching, usually of the legs and feet, during sleep. Leg jerks occur in regular intervals, 10 to 60 seconds apart, and may or may not wake the sleeper.

Phase Advance. The movement of sleep to a position earlier in the 24-hour sleep-wake cycle; for example a change of sleeping from 11 p.m. to 7 a.m. to sleeping from 8 p.m. to 4 a.m.; often seen in the elderly.

Phase Delay. The opposite of phase advance; that is, a shift to a later sleep time, for example, a change of sleeping from 11 p.m. to 6 a.m. to sleeping from 3 to 10 a.m.; often seen in 15- to 25-year-olds.

Restless Leg Syndrome. A disorder characterized by disagreeable leg sensations, usually prior to sleep onset, that causes an almost irresistible urge to move the legs.

REM Sleep. Named for the rapid eye movement that typically occurs during this state. It is a period of intense brain activity often associated with dreams. There is a paralysis of voluntary muscles. In humans, REM sleep occurs regularly about every 90 minutes.

Shiftwork. Any non-standard schedule in which most of the work hours are outside the period 8 a.m. to 5 p.m.

Sleep Debt. The state of chronic fatigue and sleepiness that results from the lack of sufficient sleep or disrupted sleep.

Sleep Homeostasis. The physiological process in which the body attempts to balance its internal state of activation during wakefulness. From awakening, the body continues to expend resources that only seem to be replenished with sleep. As these resources start to deplete, homeostatic sleep pressure starts to build, eventually signaling the body that it is time for sleep. This process also seems to work in reverse, telling the body that it is time to awaken after the resources have been replenished. This homeostatic process is typically coordinated with the circadian rhythm.

Sleep Hygiene. The conditions and practices that promote effective sleep. These include regularity of bedtime and arise time, restriction of alcohol and caffeine before bedtime, exercise, proper bedroom environment, and other factors.

Sleep Inertia. A short-lived feeling of lethargy immediately following awakening from a sleep period.

Sleep Latency. The time from "lights out" until the beginning of sleep.

Sleep Stages. The brain goes through four phases of sleep, starting with light sleep and becoming progressively deeper. After the deepest stage is reached, REM sleep episodes occur in a fairly regular pattern. It appears that all stages of sleep are required in order to maintain or restore alertness.

B Fatigue Tools of Tomorrow

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Special Notice

The Transportation Research Board, the National Research Council, the Transit Development Corporation, and the Federal Transit Administration (sponsor of the Transit Cooperative Research Program) do not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the clarity and completeness of the project reporting.

Several private companies are developing technologies designed to detect a fatigued operator. Others are working on analytic models that show promise for predicting when an operator will become fatigued or if a schedule is likely to fatigue an operator. This appendix describes two technologies that may have application in the transit industry but remain to be validated against operator performance. A description of a schedule analysis tool being developed under Department of Transportation (DOT) sponsorship is also a part of this appendix, along with a summary of the status of the various analytic models. As with the other tools in the toolbox, these tools would be a part of an overall fatigue management program.

Copilot

Copilot is a system that is designed to detect operator loss of alertness while operating a vehicle. This device continuously measures the eyelid opening using infrared reflected from the retina. An increase in the percentage of time that the eyes are closed triggers a warning alarm. The system has a video camera mounted on the dashboard or some other location near the operator. (See Figure B-1.)

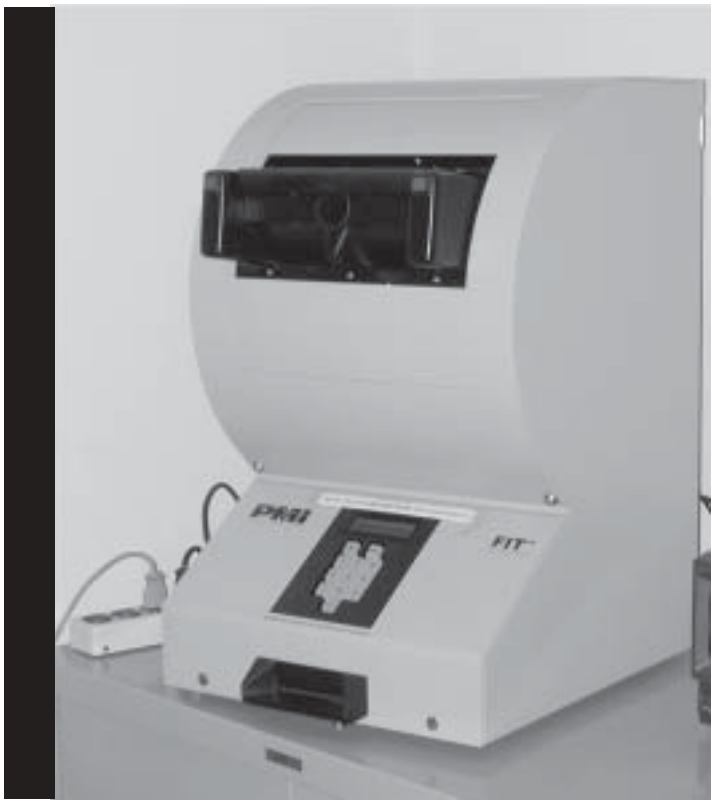
Figure B–1. Copilot

To date there has been limited testing of the device in commercial motor vehicles. Performance may be severely degraded by sunlight on the subject's face. The device is not reliable if the operator is wearing sunglasses or if there is excessive sun reflection on the operator. Vision risks from exposure to the infrared used by Copilot have not been determined. Because this device is still in the prototype stage, a price has not yet been established.

FIT2000/2500

The FIT 2000/2500 is a device that assesses alertness-related fitness-for-duty through examination of the pupil characteristics of the eyes. The device records four properties of the user's eyes and compares them to baseline measures of that individual under alert conditions. The device itself looks like a vision tester and requires the user to peer into a visor after s/he has entered his/her unique identification code via the numeric pad. (See Figure B-2.) The user is then exposed to a series of light flashes and visual targeting exercises.

Figure B–2. FIT2000/2500



The results of these procedures are compared with the user's baseline measures. If the user is beyond the threshold for his/her alert state, s/he "fails" the test and is required to speak with the supervisor before going on duty. It is then the supervisor's task to assess the worker's cognitive state and his/her ability to perform the job in a safe manner. The entire test takes about 30 seconds to complete, with feedback provided immediately to the worker and supervisor. These devices cost $15,000 to $25,000 per unit.

Experience to date with FIT has shown the following:

- FIT provides a quick and relatively easy way to spot potentially problematic behavior and provide the appropriate intervention.

- It has not been thoroughly validated for fatigue impairment. The FIT was initially developed and tested as a screen for drug and alcohol impairment. There are conflicting reports regarding whether the four pupil-related measures respond in a similar manner and indicate the same level of impaired performance when the user is tired or fatigued.

- Unlike drugs and alcohol, which if taken before work would wear off during the course of the shift, fatigue is likely to increase throughout the work period and can also be exacerbated by the time of day. The FIT device currently does not have any means to predict future levels of fatigue based on current state; it only provides an immediate snapshot of the worker's condition.

- FIT2000/2500 may be useful to the employer who is concerned about chronic fatigue produced by working many days in a row or identifying inadequate rest periods between shifts.

DOT Scheduling Tool

The DOT is funding the development of software specifically for the representation and analysis of work schedules. This software will provide the ability to analyze work schedule data qualitatively using a range of graphical devices (e.g., raster plots, etc.), analyze this information quantitatively, using a range of statistical techniques, and produce corresponding graphical displays and reports. Transportation work schedulers are the targeted user group for this tool. The tool will allow the scheduler to visually

interpret and understand the amount of variability contained within a particular schedule as well as other relevant features of a work schedule (e.g., night hours). Because this tool will facilitate the reading and interpretation of work schedules, it will assist the scheduler in the identification of safety critical parts of that schedule and in the formulation of alternative schedules. DOT will distribute this tool at no cost to transit agencies. The planned release date for the software is July 2002.

Analytic Models

Analytic or mathematical models provide a method for predicting whether or not a work schedule is potentially fatiguing. Today there are at least six such models available for this purpose. Most of the models require the user to provide 1) real or projected sleep-wake data and 2) a work schedule. The model will yield predictions of alertness level throughout the day. These prediction values are usually mapped to a well-validated, accepted alertness/sleepiness scale.

These models can be either computer-based or simple paper-based graphs. One computer-based modeling package requires only work schedule data to make alertness predictions. This package, however, has been designed for a specific population of rail workers and may not lead to appropriate predictions for those working in transit. While the paper-based tool provides only gross prediction values, it does give the individual a feel for how his/her daily routine can potentially affect on-duty alertness, and how this level might be maximized through changes in sleep-wake behavior.

Experience to date has shown the following:

- The models have great potential for evaluating the effects of different scheduling regimes and answering what-if type questions posed by schedulers and operators.

- None of these models has been validated against U.S. transit operators. Most have been developed using only laboratory and historical data. Therefore, it is very difficult to make any assumption about transit operator performance based on predictions from available models.

- Adapting a model for transit operators will require collecting sleep-wake data from a representative sample of transit workers. This will be costly and time-consuming.

- Computerized modeling packages cost a minimum of $10,000 plus on-site support to utilize and maintain them.

Both transit schedulers and individual operators can potentially use analytic models. Transit schedulers would use them to identify potentially fatiguing schedules and then attempt to modify the problem schedules. Individual operators might use a paper and pencil version to help determine if a specific schedule will be fatiguing given personal commuting time and non-work commitments.

Table B-1 summarizes the characteristics of the six currently available analytic fatigue models. These models are not yet ready for widespread use as none have had their predictions validated against many types of behavior and performance, including the operation of a transit vehicle. In addition, some of the models are not in easy reach of use given that they are not yet available in software such as the Jewett model, are incorporated in an expensive individually worn wrist device such as the Belenky model, or are proprietary and require the purchase of consulting services to use such as CAS (Circadian Alertness Simulator). The remaining three models, FAST (Fatigue Avoidance Scheduling Tool), FAID (Fatigue Audit InterDyne), and the Three Process Model either require sleep-wake data or have not been validated against operator performance in the U.S. transit industry. Currently the SAIC FAST model looks most promising for near future use given its validation and development under DOT sponsorship. Once the model is developed and validated, a transit property will need to consider how it can use the information provided by the model. The existing labor agreement may limit how such a model might be used. Use of this type of tool may open legal issues for both the property and operator, but it may also be a valuable tool for accident investigation, countermeasure evaluation, and training for schedulers and operators alike.

Table B–1. Characteristics of analytic fatigue models

Model	Developers	Features	Validation/ Reports	Usage	Limitations
Three Process Model	Simon Folkard, UK and Torbjorn Åkerstedt, Sweden	Takes into account sleep inertia; based on large pool of field data	(1-4)	All shiftwork applications that have fairly regular work schedules	Problems handling irregular work schedules; fixed circadian process; best results if build on data collected from population
Fatigue Audit InterDyne	Drew Dawson and Interdynamics, Australia	Wizards, key performance indicators Multiple sort options for outputs Gantt plot with roster comparisons Zoom in on output tables, special version for bus and truck operations; does not require sleep/wake data for predictions	(5)	To evaluate and generate work schedules that are optimized to minimize fatigue; create call lists for dispatchers	Developed for use in a different country with different work practices. Needs to be validated for U.S. operations
Circadian Alertness Simulator	Martin Moore-Ede and Circadian Technologies, USA	This model takes into account a number of individual difference variables when making its predictions	Model remains unpublished in the open literature	This model has been run on thousands of individual work schedules, including those working in transit, and compared against actigraph and EEG data	As no validation studies have been published in the open literature it is difficult to make an assessment of its utility; software is run strictly by developer under a consulting agreement

Table B-1. Characteristics of analytic fatigue models (continued)

Model	Developers	Features	Validation/ Reports	Usage	Limitations
Fatigue Avoidance Scheduling Tool	Steven Hursh and SAIC, USA	Model developed using large data pool, able to account for basic light/dark cycle anywhere in the world, accepts actigraph input or assumes a standard sleep/wake cycle based on criteria, accounts for drug interactions	(6)	Allows predictions of alertness and effectiveness with only work schedule data; accounts for local ambient lighting conditions and drug interactions; currently under development by DOT for low cost industry use	Model not validated against transit operator performance or tested in relation to split shifts; light model is very basic and does not account for realistic amount of light entering retina and superchiasmatic nucleus as does the Jewett model
Sleep/ Performance Prediction Model	Greg Belenky and U.S. Army	Model validated against EEG data, model integrated into actigraph device, performance-based	(7)	Model sold in combination with accelerometer watch with fuel gauge, useful for planning future alertness level and learning about lifestyle planning, not for general use at property	Relies on data being collected from an actigraph before it can produce predictions; expensive unit, exact algorithms unknown
Kronauer/ Jewett Two Process Sleep Model	Richard Kronauer, Charles Czeisler, Megan Jewett	Predicts alertness, subjective alertness and cognitive performance, strong ambient light component that can account for unusual light/dark cycles	(8,9)	This model's strength is in predicting circadian phase changes due to transmeridian travel	Requires user to keep a sleep log in order for model to make accurate predictions, software application still in design phase

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C Fatigue Management Program Success Stories

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APPENDIX C – PROGRAM SUCCESS STORIES

Throughout the transportation industry, efforts to address operator fatigue vary from education and training programs to comprehensive alertness management programs. This appendix describes the range of activities, how they were implemented and the lessons learned from each.

Marine

U.S. Coast Guard (USCG) Research and Development Center

The USCG R&D Center initiated the Crew Endurance Program to focus on the development and implementation of techniques to maximize crew endurance. The term "crew endurance" refers to the ability to maintain performance within safe limits while enduring job related physiological and psychological challenges. Crew endurance is a function of the complex interaction of several factors. These factors are mental state, body clock, sleep environment and physical conditioning.

The Coast Guard's Crew Endurance Management System (CEMS) was derived from the Crew Endurance Management System originally developed for the Army Safety Center in the early 1990s. The CEMS coordinates a vast network of interrelated factors such as:

- Company mission (e.g., provide transport for oil companies).
- Equipment limitations (e.g., type of vessel, onboard crew facilities).
- Environmental factors (e.g., voyage duration, noise and light levels).
- Crewmembers' physiological and psychological limitations.
- Company's crew rest and work hours policies.

The CEMS is designed to produce work and rest management plans that optimize alertness and performance during duty hours.

Implementation of a CEMS requires an initial evaluation of the current work policies on crew rest. The next step is the formation of a Crew Endurance Working Group with officers and licensed personnel from each department on the vessel. The Working Group meets to develop a crew endurance plan based on

information from the initial evaluation and the unique circumstances for that vessel. In addition, an education program instructs the crew and company management on various aspects of sleep management, alertness and fatigue.

The CEMS is a process that allows company and ship management to develop a crew endurance plan that meets their specific needs. This system does not prescribe specific schedules or techniques but rather it provides a process for maximizing endurance, preventing fatigue and enhancing the overall safety of the operation. The Coast Guard has established partnerships with towing, shipping and ferryboat companies to develop and implement Crew Endurance Management Systems.

The R&D Center is in the process of preparing a "how to" guide for the implementation of a crew endurance management system for deep draft vessels.

Two of the fatigue countermeasure programs described below were conducted in partnership with the Coast Guard.

Ocean Shipholdings

The West German Ministry for Technology and Research funded a study that established the fatiguing effects of the traditional three-watch system of 4 hours on watch and 8 hours off. The same study also proposed an alternate watch system that would give ships' officers an extended period of off-time, thus allowing for a block of unbroken sleep each day. An officer of Ocean Shipholdings became aware of the study and wanted to experiment with the alternate watch schedule proposed by the German study. (Ocean Shipholdings is engaged in the worldwide carriage of liquid bulk commodities.) Management at Ocean Shipholdings supported the concept and sent information to the captains of all of their ships. One captain requested permission to experiment with the new schedule for 1 month. At the end of that month the crew opted to continue with the schedule because they felt more rested. Due to the success of the trial, other ships wanted to try the new schedule.

Ship crews consist of licensed and unlicensed crewmembers. The licensed crew includes the Captain or Master, Radio Operator, Engineer and other skilled crafts. The unlicensed crews are primarily those who work on deck and handle cargo. Initially Ocean Shipholdings instituted the alternate watch schedule for only the licensed crews. By the end of 1998 all of the licensed crews in their entire fleet were on the new schedule. After hearing

about the favorable response to the new schedule, the unlicensed crews also requested a change to the new schedule. By the end of 1999 all crews worked in accordance with the modified schedule consisting of a 2-hour work period, a 6-hour work period and two off-duty periods of 4 hours and 12 hours.

The process of changing to the new schedule was not problem-free. The new schedule represented a cultural change for veteran mariners and many resisted the change. Several ships went back to the old schedule after a trial period but then reverted to the new schedule. Potential loss of overtime was an issue for the crews. The ship's officers were able to show that the new schedule was "overtime neutral" thereby circumventing a potential roadblock.

The masters and officers on each ship handled the entire process of changing to the new schedules. They talked amongst themselves and with their crews and then requested permission to start standing the alternate watch system. Corporate management at Ocean Shipholdings feels that this was a key factor in the success of the plan because the individuals who were affected were directly involved in the decision to try the new watch schedule. Onboard crews implemented the change to the new watch schedule and as a result there was no cost to the company to make the change.

Ocean Shipholdings measures the success of this fatigue countermeasure in terms of:

- Positive feedback from crews in terms of how they feel.
- A decrease in observed errors and near miss incidents attributed to fatigue related issues.
- Ability to meet statutory work and rest requirements.

No formal evaluation study has been conducted.

Ingram Barge

Ingram Barge Company is one of the largest fully integrated barge companies, operating 60 towboats principally on the Mississippi River system. Typically, a crew of 9 to 10 shipmates works 28 days on duty followed by 28 days off duty. Each on duty day's schedule consists of 6 hours on followed by 6 hours off. Recognizing the potentially fatiguing effects of this watch schedule and its

associated safety risks, management at Ingram Barge sought a non-regulatory approach to managing crew fatigue and alertness. Through their involvement in industry working groups with the U.S. Coast Guard, Ingram entered into a cooperative partnership directly with the USCG Research and Development Center. The purpose of this partnership is to study crew endurance factors and to develop countermeasures to maximize endurance and alertness.

One Ingram vessel participated in the first phase of the Crew Endurance Project. With guidance from the USCG Research and Development Center, a 1 1/2-day workshop was held with the crews to educate them on fatigue and alertness issues and to develop a crew-designed plan for the vessel. Information presented at the crew workshop included the nature of the biological clock, sleep/rest management strategies, stress management, management of environmental factors and diet. Considerable time was spent analyzing the crew's work cycle and schedule. The crew opted to try a modified watch schedule of 7-on/7-off/5-on/5-off. They chose this schedule because it offered minimal disruption or change to their established work and meal routines. In addition, the 7-hour off duty period provided an opportunity for 6 hours of uninterrupted sleep.

Recognizing that the individual can take actions to minimize his/her level of fatigue or alertness impairment, the participants in the workshop agreed on the following personal alertness management issues:

- Anticipate first watch on arrival and maximize rest accordingly before arriving at the vessel.
- Limit alcohol intake before returning to the vessel.
- Avoid overeating or going to sleep on a full stomach.
- Manage caffeine intake so as to not impact sleep.
- Stay physically fit using exercise bike.

To improve the overall living environment onboard, workshop participants requested:

- Installing blackout curtains in sleeping areas.

- Increasing light in lounge and galley for crew working at night.
- Increasing recreational/leisure activities by installing satellite TV and an exercise bike.
- Increasing cell phone minutes per crewmember for calls home.

Soon after implementing the new work schedule the deck crew became uneasy with the change and reverted to the 6/6 watch schedule. However, the wheelhouse crew continued with the 7/5 system. The Coast Guard is in the process of evaluating data collected to assess the effectiveness of this set of changes. From Ingram's perspective the criterion for measuring the success of the alternative watch is the amount of consolidated rest that the crew is able to get. Preliminary results indicate that the crewmembers on the 7/5 schedule were two to three times more likely to get more than 5 hours of sleep in the primary sleep period. Also the entertainment activities, such as the satellite TV, were much more appreciated than the opportunity to exercise.

There were pockets of both support and resistance within the vessel's crew. A representative from Ingram Barge indicated that a key to making any change is to propose an alternative that has a "level of consistency" so that the crew knows what to expect. From his perspective, the ability to change is due 90 percent to behavioral issues and 10 percent to management issues.

The vessel that participated in the first phase trial has returned to the 6/6 schedule but a second boat is currently trying the modified schedule. Because Ingram's management recognizes the importance of the fatigue issue, they are currently incorporating fatigue and alertness topics into their leadership training with wheelhouse crews. They are also adding a module on crew endurance and alertness to the company's new hire orientation program.

Keystone Shipping

Keystone operates a fleet of oceangoing tanker ships. After learning about alternatives to the traditional 6-on/6-off watch schedule from a trade magazine, Keystone Shipping explored the possibility of adopting an alternative schedule for their vessels. Corporate management circulated information on the alternate schedule to the officers on their vessels and gave them the option

to try the alternative arrangement. For 3 months one of their vessels adopted an alternative schedule. Initially there was some resistance from labor because of the perception that overtime would be lost, but once the "overtime neutral" nature of the alternative was explained, the crew supported the new schedule. Keystone has not yet tried to assess the impact of the alternate schedule on safety measures such as observable crew errors or accidents. Overall, management feels an alternate work schedule is feasible on long trips but not on vessels that are constantly in and out of ports and thus have irregular work schedules.

Aviation

NASA Fatigue Countermeasure Program

In 1980, responding to a Congressional request, NASA Ames Research Center created a program to examine whether "there is a safety problem of uncertain magnitude, due to transmeridian flying and a potential problem due to fatigue in association with various factors found in air transport operations." The NASA Ames Fatigue/Jet Lag Program was created to collect systematic, scientific information on fatigue, sleep, circadian rhythms, and performance in flight operations. Three program goals were established and continue to guide research efforts:

- Determine the extent of fatigue, sleep loss and circadian disruption in flight operations.
- Determine the impact of these factors on flight crew performance.
- Develop and evaluate countermeasures to mitigate the adverse effects of these factors and maximize flight crew performance and alertness.

Since 1980, studies have been conducted in a variety of aviation environments and controlled laboratory environments, as well as in a full-mission flight simulator. In 1999, the name of the group was changed to the Fatigue Countermeasures Group to reflect the change in emphasis to the development and evaluation of countermeasures.

Numerous publications from the NASA Ames Fatigue Countermeasures Group document the consequences of fatigue in

operational environments as well as personal strategies for combating fatigue both preventively and operationally on the job. Several NASA studies have focused on strategic napping in operational settings as a countermeasure.

To disseminate the results of their research and to educate the aviation community on strategies for alertness management in flight operations, NASA developed their Education and Training Module. The training module was designed 1) to explain the current state of knowledge about the physiological mechanisms underlying fatigue, 2) to demonstrate how this knowledge can be applied to improving flight crew sleep, performance and alertness and 3) to offer strategies for alertness management. NASA designed the training module for use by a trained instructor. It has an interactive format that provides a forum for discussion.

The NASA Education and Training Module was first offered in 1993. Since that time NASA developed and offers a "Train the Trainer" program so that instructors from airlines as well as other industries can disseminate the information. NASA estimates that, to date, over 116,000 flight crew personnel have received this training. Airlines report using the training program for both new hire and recurrent training. This Education and Training Module has also been the basis for programs in other industries. For example, the Burlington Northern Santa Fe Railroad developed a version for their train crews and the Transportation Safety Institute used it in creating fatigue management courses for transit operators, managers and supervisors.

In 1998 NASA conducted a follow-up survey with former course participants. More than half of the survey respondents reported that the NASA Training Module provided a basis for positive changes related to fatigue in their organization.*

NASA recently developed a version of the course suitable for regional and commuter airlines. While regional and commuter pilots do not face the jet lag problem, they may have schedules that result in extended duty cycles. A version for general aviation is

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*Rosekind, M.R., Neri, D.F., Gregory, K.B., Mallis, M.M., Bowman, S.L., and Oyung, R.L. "A NASA Education and Training Module on Alertness Management: A Survey of Implementation and Application," *Sleep* Vol. 24, Abstract Supplement (2001).

under development and will be web-based, since offering a live course to this segment of the pilot community is not feasible.

Air Transport Association (ATA)

The ATA is an industry organization representing the major U.S. air carriers. The member carriers move 95 percent of the nation's passengers and cargo. Faced with a proposed FAA rule concerning hours of service for pilots, the airline industry, through ATA, developed a multi-faceted approach to alertness management. Their guiding principles are the following:

- A comprehensive approach is required to address the complexity of alertness management in aviation operations.
- Scientific knowledge will provide the basis and guidance for activities and actions.
- Providing flexibility will be critical to balance the complexity and diversity of operational demand.
- Successfully managing alertness in the air transport industry is a shared responsibility among all stakeholders.

For several years the ATA has encouraged their member airlines to implement the NASA fatigue training program or a similar one for their employees and in fact many airlines have done this. Others have developed and tailored their own materials based on the NASA program. (See discussion below for specific examples.)

The ATA Alertness Management Initiative resulted from the efforts of an airline industry task force that looked at fatigue-related issues in commercial aviation. In September 2000 the ATA announced this initiative and reported that their member carriers were taking actions to reduce fatigue risks and improve safety. These include eliminating tail end ferry flights where a pilot could fly a full day but then ferry an empty plane to another location, establishing duty limits (current regulations only govern flight time) and implementing fatigue education and countermeasure programs. As part of this initiative, the ATA also established a Scientific Advisory Board, consisting of acknowledged experts on fatigue, to identify gaps in scientific knowledge and provide guidance to the industry. Future efforts will address scheduling principles and guidelines and will suggest changes to current hours-of-service regulations.

An ATA representative who has been a long-time advocate of the NASA Training Program feels that change is more likely to come about when there is commitment from the highest level of management. This is key to progress in changing corporate culture with regard to fatigue.

Delta Airlines

In the summer of 2000 Delta initiated a formal fatigue management program under their Senior Vice President, Flight Operations. The current focus of the program is on education. Delta has been using the NASA training program for several years. As part of their distributed recurrent pilot training program they include a 10-page handout on "sleep basics." Under the new initiative, there is now a 1-1/2-hour class for the senior management pilots in the company who oversee flight operations. Delta plans to conduct a study to determine the appropriate use of the onboard rest facility for their long distance flights. Flights that exceed 8 hours require two pilots, thus providing the opportunity for planned rest breaks.

The Senior Pilot with responsibility for the Delta fatigue program believes that both the individual and the company must share responsibility for managing fatigue in aviation operations. He has seen a change in the industry's attitude toward fatigue. In the past it was unacceptable for a pilot to decline to work because s/he was fatigued as a result of the work schedule. Now this is acceptable; however, a Delta crewmember will not be paid under these circumstances. In contrast, American Airlines examines each case and decides whether or not to deny pay.

American Airlines

American was the first carrier to initiate a fatigue management program. A representative from American's Medical Department was among the first participants in the NASA Training Program in 1993. American's Medical Director at the time was a former NASA staff member who recognized the fatigue risks in the aviation environment and advocated for actions to minimize these risks. Following the training program, a nurse in American's Medical Department conducted fatigue training classes that were offered to pilots and flight attendants on a voluntary basis. Attendance was poor because crewmembers were not willing to arrive early for work or stay following a flight in order to receive the training. American recognized that the fatigue training had to be a mandatory part of both their new hire and recurrent training and made the change.

Initially pilots dismissed the 1 hour 15 minute training session because they did not think that the instructor, a registered nurse, understood their jobs. To develop credibility and rapport with the flight crews she accompanied them on flights,"lived"their schedules and learned to"speak their language." She succeeded in gaining their confidence through this activity. Her fatigue training session is now one of the highest rated at American Airlines.

Nearly all of American's pilots have been exposed to American's fatigue training. About 2 years ago American developed a 1-hour film on fatigue issues that can be distributed to individuals who are unable to attend the live course. On request, American's fatigue trainer has given the training to other groups in the company who work irregular schedules. These include corporate communications and flight simulator technical support.

American has instituted two other related countermeasures. There is a corporate Fatigue Hotline where employees can call for advice on a fatigue issue. The fatigue instructor responds to these inquiries. In addition, the company intranet frequently includes articles on fatigue issues.

There has been a change in the corporate culture at American relative to fatigue since these programs were instituted. A request from a crewmember to not work due to fatigue is now acceptable. The company has also eliminated tail end flights where a pilot is required to fly an empty plane to a final destination following the termination of a revenue flight.

American's fatigue program instructor suggested the following as being key to the success of any fatigue management program:

- Management must support and attend the class.
- Work groups involved with flight crews must also receive the training (e.g., crew dispatchers, schedulers).
- Both management and employees must be open to change.

Regional and Commuter Airlines

The Regional Airline Association represents the regional and commuter airlines. As smaller airlines these organizations do not have the resources of the major carriers and as a result fatigue countermeasure efforts in this segment of the industry have been

limited to the NASA Training Program. As an organization, the Regional Airline Association has not undertaken any fatigue initiatives.

According to a representative from the Airline Pilots Association (ALPA), the pilots' union, regional and commuter pilots often have extremely fatiguing schedules. They have short layovers that do not permit adequate rest and in some instances they are not even provided with a hotel room. The ALPA is advocating for duty limits, as recommended by ATA. Since takeoffs and landings constitute the heaviest workload, ALPA has suggested limiting the number of landings rather than just the total number of hours on duty. From ALPA's perspective, airlines with Chief Pilots who appreciate the fatigue issue are more likely to be pro-active in addressing it.

Highway

Federal Motor Carrier Safety Administration (FMCSA), Office of Motor Carrier Research and Standards

While most of FMCSA's activities have focused on the development and testing of new technologies and the effect of operating practices on driver fatigue, they have also supported several training and awareness campaigns to educate drivers about fatigue and its associated risks. Together with the American Trucking Association and the National Private Truck Council, the FMCSA has undertaken an active outreach program to inform motor carriers, professional truck driver associations and truckers themselves about the hazards of driving while fatigued. Under this initiative the FMCSA funded the development of brochures, public safety announcements, and a video to educate truckers and their families about fatigue and the importance of adequate sleep. A train-the-trainer instructional program was also developed and has been conducted for over 2,000 fleet safety managers and truck driver training personnel.

FMCSA's responsibilities extend to intercity motorcoach/bus drivers. An ongoing study will develop a compendium of principal fatigue issues affecting motorcoach drivers and recommend countermeasures. Under this program, the FMCSA developed a video designed to educate motor coach drivers about fatigue and methods to reduce it. It was distributed to all members of the American Bus Association.

Western Australia Department of Transport

The Western Australia Department of Transport has been exploring an alternative to hours-of-service regulations. Following a number of serious truck accidents resulting from driver fatigue, the Australian motor carrier industry took the initiative to manage the problem themselves rather than be faced with additional government regulations.

Under a pilot program, any trucking company that demonstrates their ability to manage driver fatigue through a structured program of countermeasure strategies will be given a waiver with respect to hours-of-service regulations. The drivers have been involved in the development of new schedules, and due to their involvement have expressed more job satisfaction. The program is designed to manage a driver's time more efficiently and get the job done safely. Canada is currently considering this approach to "alternative compliance."

Challenger Motor Freight

Challenger is a Canadian-based company that provides trucking services from Canada through the United States and into Mexico with a fleet of 625 trucks. For several years the company's President and Vice President Risk Management have been concerned about driver fatigue and ways to prevent it. They have visited Australian trucking companies to explore fatigue countermeasure strategies. Their first step has been to create an awareness of the issue among their drivers and dispatchers. Working through their occupational health and safety consultant, Challenger provided information to their employees on the need for adequate rest along with strategies for maintaining alertness in the cab. Brochures as well as company newsletters were used to convey the information.

Challenger also provides a quarterly "audio newsletter" to their drivers. Since 1997 three audio newsletters have featured a discussion on fatigue. Challenger drivers listen to the tapes on the job. Management feels these audiotapes have been successful in creating an awareness of fatigue/alertness among their drivers.

All new trucks purchased for the Challenger fleet now have a heater and massage unit incorporated into the driver's seat. This type of seat was originally installed to relieve back problems, but drivers reported that it also reduces fatigue.

Challenger's drivers will participate in the upcoming FMCSA sponsored pilot test of Fatigue Management Technologies. Based on the results of this study Challenger management will decide whether or not to invest in any of the technologies.

Houg Enterprises

Houg is a small trucking company with 140 employees. They have a trainer on their staff who works with the drivers in small groups regarding fatigue management. During the training session, the trainer uses an 11-minute video,"Iron Mike and the Hobo," to explain the dangers of driving when fatigued. Employees are encouraged to educate their families about the importance of adequate sleep in relation to their job. The trainer feels that training or counseling in small groups is ideal because the participants have an opportunity to interact and share social or health problems related to inadequate sleep.

Greyhound Bus Lines

Greyhound Lines, Inc., a unit of Laidlaw, Inc., is the largest North American provider of intercity bus transportation, serving more than 3,700 destinations with 20,000 daily departures across the continent. On an average day Greyhound has 4,500 drivers on duty. For many years the company has had an active fatigue management effort under their Director of Safety. Greyhound's approach to engineering fatigue management has two primary components: driver training and schedule design.

The new hire training program includes modules on personal fatigue management and nutrition. One of the goals of Greyhound's training is to educate their drivers about off-duty behavior and how it can affect on-duty performance. The training program also covers nutrition and its relationship to driver performance. (For example, from experience Greyhound has found that eating high-fat foods reduces driver alertness.) Greyhound staff members developed the majority of the training materials but "Motorcoach Operator Fatigue," a video produced by the Federal Motor Carrier Safety Administration, is also used.

Greyhound has developed an approach to scheduling runs that is a key element of engineering fatigue management. Company policy requires the following with respect to hours of work:

- Scheduled on-duty time must be less than 9 hours.

- Off-duty time between scheduled runs must be at least 9 hours at an away from home location and 10 hours when at a home location.

- For extraboard drivers, call time when away from home is at least 2 hours and at home it is 2 to 3 hours, depending upon commuting conditions in the driver's home location.

At least four times a year a group of managers and drivers meets to establish driver runs. In addition to the above policies, an attempt is made to minimize inverted work cycles that require a driver to rapidly rotate starting times. The company has software that assists the scheduling group in establishing runs.

The company has the following procedures that are designed to facilitate healthy rest periods for their drivers:

- A centralized dispatch facility in Dallas handles all driver assignments. To assist extraboard drivers in planning their personal time, these drivers can call the dispatch center to determine their position on the call list.

- A driver who feels too fatigued to drive on a given day can ask to be removed from the call list for 24 hours without penalty.

- While on duty, a driver who becomes fatigued or otherwise unable to continue a run can call the dispatch center and request a relief driver.

- Greyhound has strict company rules against coercing drivers to work when they indicate they are fatigued or under the influence of drugs or alcohol. All calls are recorded and any violation of this policy by a dispatcher or supervisor receives management attention.

Greyhound feels their low accident rate of 0.058 accidents per million bus-miles is indicative of both the success of their fatigue management program and the overall importance of safety to their bus operations.

Railroad

The railroad industry, probably more so than any other sector of the transportation industry, has implemented comprehensive fatigue management programs. Because of the extensive experience in this mode, railroad industry representatives contacted by the research team offered significant"lessons learned." This section has a brief description of the measures taken by each organization followed by their experiential learning. The description of each railroad's fatigue program and the American Association of Railroads (AAR) involvement is based on *Fatigue Countermeasures in the Railroad Industry: Past and Current Developments*.*

Association of American Railroads

The railroad industry's concern with operator fatigue dates back to 1992 when the AAR established the Work Rest Task Force. Representatives of the major railroads as well as two unions came together to investigate issues relative to crew scheduling. The first objective of this Task Force was to develop a database that could be used to describe and measure factors associated with work schedules in the railroad industry. Over a period of 4 years the Task Force assembled, organized and analyzed data from five major railroads. The second objective of the Task Force was to determine the relationship between work shift factors and accidents and injuries. This was not achieved due to the complexity of factors involved in every accident and injury.

In late 1997 the Federal Railroad Administration formed the North American Rail Alertness Partnership (NARAP) as a forum for the railroad industry, labor unions and government to share information on the issue of fatigue. NARAP includes members of the Work Rest Task Force along with other representatives of railroad labor and the FRA. This group meets on a regular basis to share experiences with regard to fatigue management.

Based on involvement in both the Work Rest Task Force and NARAP, and familiarity with fatigue management efforts of the Class 1 railroads, a representative of the AAR offered insights on the overall process of developing and implementing a fatigue

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*Sherry, P."Fatigue Countermeasures in the Railroad Industry: Past and Current Developments." Counseling Psychology Program Intermodal Transportation Institute, University of Denver, (June 2000).

management program. From his perspective, unfortunately it seems as though concern with operator fatigue still requires an accident or noticed incident to instigate a major fatigue mitigation effort. No matter what precipitates the start, however, it will take a lot of time, especially with the buy-in and trust building.

The first step is education, starting with senior management and union officials, and working down to the operator. This education is the foundation for gaining buy-in from all the stakeholders. The fear of government regulation, while always present, is not enough to achieve strong buy-in from management or labor. The initial stance from both parties is that they will lose out financially with any change, especially one that comes from Congress in a one-size-fits-all form. For true buy-in the senior people have to understand the real impact of fatigue on their workforce's safety and efficiency and their bottom line costs. It is often best if this foundation of information comes from a credible outside source or contractor. Using an outside contractor helps overcome mistrust within most rail organizations.

The families of the train crews are a group of stakeholders that should be included for early involvement and buy-in. Once they understand the impact that fatigue has on worker health and well-being they can be effective instruments for change. Experience in the railroad industry has proven that many times they can be more persuasive than any industry or labor representatives in changing the behavior of the operating staff.

Data is absolutely critical to the development of a fatigue mitigation program. If fatigue principles can be illustrated in terms of the operator's actual schedule, the operator is more likely to make the connection between his/her daily life and the possible, and perhaps already manifested, consequences. Once the message is understood on a personal level it becomes important and buy-in has begun.

Each railroad tends to see itself as unique, so major positive efforts at one railroad tend not to translate to others, at least not easily or quickly. However, this attitude is changing as industry and labor association meetings provide forums for discussing this issue. These types of activities help plant seeds in the different organizations, making it more likely that a fatigue program will be successful.

The bottom line is to expect a barrier. The initial steps in formulating a fatigue program are difficult and time consuming. Based on the experiences in the railroad industry, this AAR representative makes the following suggestions:

- Keep expectations low and move in very small steps.
- Expect and plan for slips and reversals. Allow at least double the number of months you feel it will take to put an initial program in place. Otherwise the pressure to show results quickly will prevent the program from ever succeeding.

American Short Line and Regional Railroad Association (ASLRRA)

The short lines do have an interest in fatigue management programs but there is not a lot of independent activity at present. Irregular schedules, especially ones that include night work, are less of a problem for shortline carriers than for the Class 1 railroads. Of greater concern is the number of consecutive days worked, and the subsequent inability to ever fully recover from the work period.

Class 1 railroads have served as mentors to some smaller railroads and offered help and guidance with fatigue management. Because a short line operation may be no larger than a small division of a Class 1 railroad, any operational change may impact the majority of their operation. Implementing such a change represents more of a risk to a short line railroad than a Class 1. For this reason, the short lines are cautious, waiting to see what approaches prove to be successful for the Class 1 railroads. The ASLRRA developed their own fatigue program for their members, but it has yet to be implemented. They will wait until more information is available on the Class 1 programs.

Amtrak

Amtrak initiated a fatigue management program in 1999. Phase I of their program involved a series of educational seminars to develop an awareness of fatigue issues among conductors, engineers, management, and union leaders. In addition, a survey and interviews of 142 employees were conducted. Phase II of the program consisted of a fatigue risk assessment of all crews in one area. The purpose of this assessment was to determine the extent to which employees were at risk of being fatigued based on their schedules. In Phase III, currently underway, possible fatigue countermeasure interventions are being evaluated. These include

fatigue management training, napping policies, rest facility standards, sleep apnea screening, alertness monitoring, crew scheduling and the implementation of various operating practices to reduce fatigue. Based on Amtrak's progress to date, their fatigue coordinator offered some insights.

Initiation of a fatigue management program requires a critical number of people in the organization to be aware *and* in agreement that fatigue is a real threat to workplace safety and profitability. Without this initial buy-in, there will be an endless stream of excuses why the company should not focus time and resources on fatigue mitigation. Senior management is the first to be brought on board. Subordinate managers are very sensitive and reactive to the wishes of those above them, and will pick up on whether their superiors are serious about focusing on fatigue. If senior management is serious about the problem, then the entire management system within the company will respond to effect their wish and vision. If upper management is not convinced, little will be done to address the issue. This is not to say that the lower level managers do not notice fatigue-related problems. Line managers are very aware of fatigue-related issues, at least as they manifest themselves in crew mark offs, but they do not feel confident in approaching this problem on their own.

One of the first steps toward creating a successful fatigue program is the creation and empowerment of a steering committee. All the major stakeholders should be represented as well as those with direct knowledge of how fatigue is impacting the company (i.e., line managers). It is advantageous to have a champion in senior management who will push the fatigue issue, and not just agree that it should be studied and resolved. This type of hands-on approach from senior staff does get noticed and builds trust in the other stakeholders that something will be done about the issue.

Once there is internal agreement that fatigue is an issue of concern, the next step is to thoroughly educate the stakeholders as to the nature, causes and consequences of fatigue. This information should be augmented with actual company data and situations to make it as relevant as possible. Amtrak found that bringing in a respected outside contractor was helpful in this regard. The contractor was able to design the specific educational information and tools around the data they collected from the company. The effort, therefore, was not seen as a management-only initiative, but rather provided by an independent neutral

source. In addition, industry meetings, both for management and labor, as well as NARAP, continue to focus on fatigue issues, resulting in a reinforcement of the importance of the issue. The outside contractor, though, remains the catalyst for driving the change process within the company. Of course, continuous feedback and communication among all parties is necessary for the process to work effectively.

One point Amtrak stresses is that fatigue is not just a train and engine crew issue, but potentially affects all personnel, including managers. Amtrak managers, especially line managers, are expected to be on-call 24/7. Some managers do tend to work long hours, many times on other than a weekday, first-shift schedule. The concern is that poor management decisions made by a fatigued manager will cost the organization time and money or jeopardize safety. Fatigue, therefore, is being viewed as a systemic problem, and not just relegated to a specific category of employee.

Noteworthy is the open culture currently prevailing in the railroad industry for sharing information on what countermeasure programs and processes seem to work and what do not. The exchange of information about different work scheduling systems and their impact on staffing, mark offs, sick leave, and employee morale has been extremely beneficial. This sharing of information has accelerated the industry's handling of the fatigue issue. Of course not all this information is taken at face value. Some fatigue management practices work or fail due to culture, climate or other factors that do differ from railroad to railroad. It is usually evident, though, as to why a program failed or succeeded and its likelihood of doing the same on another property.

The Amtrak representative believes that it is very important to have the right culture and mindset going into a fatigue management program. There must be frank discussion and problem solving, not an opportunity for contract negotiations or bargaining. There will be situations in which a few very senior employees will not want to change their lifestyle, regardless of the benefits to the other employees or the organization. The best approach may be to just let them have their way until they retire or until they change their minds through peer pressure. Otherwise, the process will bog down in contract negotiations and union grievances.

Union Pacific (UP)

UP recognized fatigue as an issue in the late 1980s and by the early 1990s they distributed the *Railroaders Handbook* and a companion

videotape, published by Synchrotech, to all train and engine crew employees. A subsequent sleep education program given to a subset of these employees produced positive results in terms of self-assessment of sleepiness. In 1997, in collaboration with the FRA and the labor unions, the UP developed a comprehensive safety program known as the Safety Assurance and Compliance Program (SACP). One SACP subgroup was established to oversee fatigue countermeasure efforts. As a result the UP initiated a comprehensive fatigue management program that includes the following components:

1. Appointment of a Director of Alertness Management.

2. Establishment of the Alertness Management Program (AMP) to provide education, specific strategies, scheduling guidelines and the initiation of a healthy sleep project designed to identify sleep disorders.

3. Consulting services from world-renowned sleep experts to assist in developing a comprehensive, systematic and integrated approach to fatigue management.

UP initiatives under their AMP include an updated education-training program for employees, a bimonthly Alertness Management Newsletter, experimental crew scheduling projects, implementation of a napping policy in five areas, evaluation of crew lodging, and development of a comprehensive 4-year strategic and operation plan for alertness management. In assessing the effectiveness of specific initiatives, UP has examined absenteeism, average on-duty time, and number of assigned rest days as well as qualitative feedback obtained through "town meetings" and focus groups.

UP's Director of Alertness Management stressed that education is critical at the beginning. It is especially important that senior management recognize fatigue-related problems. Bottom line labor utilization issues such as sick time and attrition *are* of major concern to senior management, so it is worthwhile to collect the data needed to show the relationship between operational performance and fatigue. For example, the UP has considered number of mark offs, staffing levels, extra payments, and the number of people, including crew callers, necessary to keep the system running. It is also important to focus on the societal and employee health impacts from fatigue and to not downplay the need for adequate and healthy sleep. The macho anti-sleep culture

can be dismantled through medical facts and empirical research. Managers and operators both underestimate the wide range of ill effects brought on by sleep debt. This needs to be reiterated at regular intervals and through different forums and media for the point to become acknowledged and accepted.

The UP does not limit fatigue education to classroom environments. Rather, all possible venues and education models are utilized to completely permeate the atmosphere around the stakeholders. This includes bringing in the family, and having the spouses understand the health and safety implications. The UP uses informational mailings to the families, town hall-type meetings and focus group sessions to both provide information to these stakeholders and to collect data that can be used to tailor the fatigue management program.

The UP has adopted Procheska's Transtheoretical Model of Behavioral Change to provide structure to their fatigue management process. (The phases of change in the Procheska model are pre-contemplation, contemplation, planning or preparation, action, maintenance and relapse.) Collecting data throughout the process is important to understand where people are with respect to changing their views, to track their changes and to modify and update the fatigue management program to keep it on target. Focus groups are one way of collecting this information. In addition, the UP administers surveys at various intervals though the process. It is especially important to collect this type of information when implementing Procheska's model as each of the stages has different education and information needs and requirements.

While the family tends to understand the influence of fatigue on the engineer (i.e., s/he is grumpy or sleepy when at home), the employee tends to focus on financial remuneration. Typically, they have to be assured that any new program will not reduce their paychecks. Unfortunately, some employees become used to a lifestyle that requires them to work an excessive number of hours. To address this issue, the UP has begun to provide financial planning and conflict resolution education. In this way the employees and their families are given the tools to map out a plan for living within their means but without having to work excessive overtime.

Union leadership needs to be brought in at about the same time as senior management and provided with similar information. It is

critical to be up front and forthright with all parties or mistrust will take root and the entire process will be undermined. A particularly successful strategy for building trust between parties and accomplishing good fatigue management programs has been the Australian approach of local empowerment. In this model, the local employees and management at a specific property formulate their own fatigue management solution rather than having it come from corporate headquarters. For this to occur, all vested parties must go through an intensive educational process to thoroughly understand all of the issues that must be considered in a fatigue management program. Corporate headquarters does establish general guidelines that a program must follow. However, there is enough latitude within these boundaries that most locations are able to develop successful solutions tailored to their particular needs. This type of process acknowledges that the people at the individual properties know their situation best. Through empowerment they can develop their ideal solution, and in doing so, invest a lot of themselves and have a sense of ownership. Any program just driven down from corporate is generally viewed with suspicion and will ultimately fail through rumors or lack of commitment from the stakeholders.

Canadian Pacific Railroad (CP)

In the early 1990s Transport Canada charged the Canadian railroads to develop policies and procedures to deal with crew rest and fatigue problems. A task force of Canadian Railroads, including CP, formed to address these issues under the CANALERT project. Specifically, CANALERT addressed employee work schedules, rest facilities, en route napping, terminal napping facilities, locomotive cab audio system, and lifestyle training and individual counseling. This first major fatigue countermeasure effort in the railroad industry led to the concept of"time windows" for employee call, and the introduction of napping policies. Both represented major changes in the industry's operating practices. The effectiveness of each countermeasure was assessed in terms of changes in sleep patterns, employee attendance patterns and objective measures of alertness. The most significant improvements were in terms of the decrease in variability of sleep duration and an increase in sleep quality at the Calgary Terminal and an overall drop in absenteeism from 8.1 percent to 3.2 percent. Over half of the participants reported taking opportunity (as opposed to planned) naps.

The next phase of the CANALERT effort at CP focused on CP's Calgary Terminal and included the establishment of time pools for

assignment to work, implementation of a napping policy and guaranteed rest periods. Since the fall of 1997 the railroad has broadened their focus to include track program and equipment employees under a pilot project. This project is a joint labor/management initiative and is being facilitated by an outside consulting company. The joint project task force, using knowledge gained from an employee survey, developed a set of countermeasures that are currently being implemented and evaluated.

Based on CP's experience, the biggest hurdle in initiating a fatigue management program is overcoming the stakeholders' misconceptions of what the program entails or its intended outcome. The stakeholders have their own biases and opinions, and it can be very difficult to convince them that there are other points of view to consider. When starting out it is critical to identify the leaders in the "informal" organization. Initial meetings need to include and persuade these people. If these initial meetings go poorly it is likely that the remainder of the program will be spent backtracking with minimal forward progress.

The initial meetings should involve all of the decision makers from both management and union. This minimizes suspicion and allows the two sides to understand each other's needs and important issues. The meeting facilitator must be responsive to the needs of both sides and stand firm when it comes to empirical evidence. This same process is repeated with the employees, but in this case the focus is more on what to expect and how to integrate the change into their daily routine. CP found it very important to be proactive with the employees.

Many programs fail within the first few weeks due to complaints and an outcry from an ill-prepared workforce. Much of the outcry can be avoided, however, by providing the employees with information and tools to help them integrate the specifics of the program into their daily lives. An open line of communication and a lot of personal contact during the first few weeks of a new program are vital.

The project team must be able to assess unexpected difficulties with the program and make changes on the fly. The program should be as accommodating as possible while not losing sight of its intended goal. The project team needs to be large enough to handle this challenge. One person is usually not sufficient.

Typically there is a small percentage (not more than 5 percent) of employees who refuse to relinquish their ability to work as much as they possibly can. CP left these people to continue their lifestyle, but efforts were made to recruit their families in the attempt to change their behavior. Spousal involvement is usually helpful in changing attitudes about putting in excessive work time. One other way to gain a high level of cooperation is to have senior management not only involved but also driving the process. Knowing that change will take place, union officials, line management and train crews will all want to have their say, and through doing so, begin to develop buy-in and interest in the outcome.

Transit

Federal Transit Administration (FTA)

In response to a National Transportation Safety Board (NTSB) recommendation, the FTA sponsored the development of three fatigue awareness seminars and an instructor course. The Transportation Safety Institute (TSI) offers the courses listed in Table C-1.

TSI conducts the seminars at five different locations annually. Transit agencies can request that the course be offered in their area. Only the instructor's course has a fee ($25 per participant), but the transit agency must arrange for a training facility. Neither the FTA nor TSI has done any follow-up on the effectiveness of the course in terms of implementation of the skills and information that it presents.

Phoenix Transit

In the late 1980s management at Phoenix Transit determined there was a need for a napping facility for their bus drivers. Initially the facility was in an outfitted trailer. When a bus garage was renovated in 1994 the agency incorporated single-sex sleeping facilities in the renovation plans. A former conference room

Table C–1. Courses offered by TSI

Seminar Title	Duration
Fatigue Awareness for Employees	2 hours
Fatigue Awareness for Supervisors	3 hours
Fatigue Awareness for Managers	1 1/2 hours
Instructor's Course in Fatigue Awareness for Employees	8 hours

became the napping facility where the women's bunkroom accommodates four people and the men's, ten people. Phoenix Transit's maintenance department has a linen supply contract so that there are always clean linens on the beds. The room is soundproofed and dark and each bunkroom has a temperature control unit. Extraboard drivers are encouraged to use the napping facility and are provided with beepers for notification when they are needed. Drivers who mark off at midday at another location are able to travel to the facility via van service.

Around the same time that the sleep room was instituted, management found that attrition among the part-time drivers was exceptionally high. These employees received lower wages than their full-time counterparts and were not eligible for benefits. Management decided to discontinue the part-time positions and went to a full-time work force. To accommodate peak periods without creating additional split shift jobs, Phoenix Transit implemented an innovative program whereby retired drivers are hired back for 20 to 25 hours per week to work not more than one peak period a day. The agency pays these experienced drivers at premium pay, but because they are retirees, there is no need to pay benefits. Phoenix Transit feels this arrangement has been extremely successful. They have highly skilled, reliable drivers who are not fatigued doing the peak runs. Management feels there has been a positive effect on safety, although no formal study has confirmed this.

Management personnel at Phoenix Transit do not necessarily come from within the agency. In fact, the agency actively recruits candidates with higher education who are external to the agency. The agency has adopted this philosophy because they believe outsiders help bring innovation to their operation. Having a management team with a range of experiences facilitated the introduction of the sleeping facility and the policy with regard to using retired drivers.

Recently the agency began teaching fatigue basics in recurrent training for their drivers. No assessment of the effectiveness of this training is available.

Phoenix is in the process of planning an at-grade rail line that will be built in 3 to 4 years. The equipment facility for this new line will include sleeping rooms.

New York City Transit (NYCT)

Following a fatal accident that was attributed to operator fatigue, the NTSB recommended that NYCT institute fatigue training for their subway operators. The NYCT Rapid Transit Operations Division based their training manual on one developed by the Burlington Northern Santa Fe Railroad. The training program instructs employees on a variety of fatigue-related topics including the use of"anchored sleep,"proper nutrition (especially when working nights), and strategic use of caffeine. The fatigue training module is also a part of the refresher course that is given to subway operators every 3 1/2 to 4 years. NYCT's trainer for this program reported that employees generally accept the training and take the information home to their families.

At the same time that NYCT instituted their fatigue training program, the agency re-emphasized to their supervisors the importance of assessing each of their employees with regard to fitness for duty. In addition to screening for signs of alcohol or substance abuse, supervisors may ask questions to assess the employee's fatigue level.

NYCT's Rapid Transit Operations Division has undertaken the following additional initiatives with respect to managing operator fatigue:

- Approximately 5 years ago the Rapid Transit Operations Division evaluated several fatigue countermeasure technologies but found them not sufficiently mature and proven to justify their use with subway operators.

- The Rapid Transit Operations Division has an hours-of-work bulletin that limits hours of work. Specifically, an employee may not work more than 16 consecutive hours. (This is likely to change to 14 hours in the near future.) In addition, an employee must have an off-duty period of at least 8 hours between each day's work and every employee must have at least 1 day off per week.

- With regard to work schedules, the scheduling department considers fatigue consequences in developing operator schedules. There are no split shifts or part-time jobs in the Rapid Transit Division. The scheduling department is currently evaluating the fatigue prediction model developed

in Australia to determine whether or not it is appropriate for the NYCT Rapid Transit Operations Division.

- NYCT Rapid Transit Operations Division has no part-time positions and all employees must obtain permission to hold a second job.

- All employees in safety sensitive positions must participate in a fatigue awareness training module.

Connecticut Transit

CTTransit does not have a formal fatigue management program but they have instituted three measures to counteract potential operator fatigue. First, they have actively promoted fatigue awareness through a series of articles in the monthly company newsletter that is mailed to each employee's home. The articles focused on lifestyle behaviors that affect daytime alertness as well as proper sleep and rest. For example, over-the-counter medications that cause drowsiness and personal schedules that do not allow time for adequate sleep have been the subjects of these articles.

A number of years ago CTTransit changed their procedure by which spareboard drivers bid their daily work. Historically they all showed up at 4:30 or 5:00 a.m. to bid open work for that day. Under this system, senior operators maximized their pay by passing up the early starting work and taking work that ran late but allowed them to earn overtime pay. The consequence for these drivers was a long day. The current system assigns spareboard operators to one of three call lists: early, midday or late. Operators on the early list call in the day before to choose their work for the next day. This practice has the double benefit of reducing operating expense and shortening the spread of the spareboard operators' workday.

Finally, CTTransit is allocating space for an operators' "quiet room" in their division facilities. In 1990, the Hartford Division became the first to have a"quiet room." In addition to the conventional-looking ready room with pool tables, pinball machines, and loud conversation, the facility was designed to give operators a restful alternative. The Hartford facility also includes a fitness center that is available to all employees for a nominal fee. Similar quiet rooms and fitness centers are being planned for new facilities in Stamford, which will be renovated in 2002, and New Haven, which is scheduled to have a new garage in 2004.

Metro Transit

In January 1999 Metro Transit in Minneapolis conducted the first of a series of fatigue awareness training sessions. Trainers from the Transportation Safety Institute conducted the initial session for senior management and union officers followed by one for managers and supervisors. Metro Transit developed a customized version of the TSI program for employees and conducted subsequent training for bus operators with their own trainers who are part of the Safety Department. Overall, a total of 1,600 individuals were exposed to this training.

In 2001 fatigue management became a part of operator refresher training. Metro Transit produced a video that covers fatigue along with nutrition, exercise and back care. This video is used in the initial training for new drivers as well as the refresher training. While the video provides some discussion of fatigue, Metro Transit intends to introduce a more comprehensive discussion of fatigue in new driver training in the future.

While Metro Transit has not done a formal evaluation of the impact of this training, there is the following anecdotal evidence of the value of the training:

- Based on information provided in the training program, a number of bus operators voluntarily sought medical evaluation for a possible sleep disorder. At least 10 bus operators reported to the Safety Department that they had taken this action and were receiving treatment for a sleep disorder.

- The year following the introduction of the fatigue training program Metro Transit and their bus operators union conducted contract negotiations. As a result of the knowledge gained through the training, the new labor agreement at Metro Transit limits the daily work period to 14 hours and requires 8 hours off duty between work periods. In 3 years the daily limit will decrease to 12 hours. Prior labor agreements did not limit daily work hours.

- Bus operators periodically contact the trainers with fatigue-related issues. Because the trainers are Safety Department staff members they are easily accessible at the operator's home garage.

- During the week of the state fair, a period when bus operators can work extensive overtime, many bus operators declined to work the levels they had in prior years.

The success of Metro Transit's program has been due in large part to the efforts of several senior managers who are committed to taking steps to reduce the risks associated with operator fatigue. The General Manager, in particular, was instrumental in initiating the training effort. Also, union officials were incorporated into the program in the early stages. Both labor and management recognized the need for addressing the issue of operator fatigue and saw the benefits to both individual operators and the overall operation.

Capital Metro

Capital Metro operates the bus service in Austin, TX with 700 bus operators. All operators must participate in a 1-hour safety training session every other month. In accordance with their labor contract, Capital Metro pays the operators overtime to attend these sessions. For the past year Capital Metro's Director of Safety has devoted one session with each group of operators to a discussion of operator fatigue. The Director of Safety identified the need to address operator fatigue and developed the materials for this training session. Through industry organizations he has shared his training materials with other properties. The Director of Safety is working with the Training Department, which is responsible for new hire training for bus operators, to incorporate the entire 45-minute fatigue module in their new hire training. Currently new hires are exposed to about half of the material.

The Vehicle Maintenance Department at Capital Metro works a 24/7 schedule. Their responsibilities involve driving buses in non-revenue service. This group of employees receives a 1-hour safety training session each month and will be exposed to the operator fatigue module this year.

While Capital Metro has not conducted a formal evaluation of the effectiveness of their fatigue training, there are indications that it has been successful. Since the introduction of the program, there have been no reports of operator fatigue from passengers or co-workers. Also, the number of accidents has dropped.

In a separate effort, Capital Metro is introducing "quiet rooms" in addition to the traditional ready rooms in their garages. One such

facility opened this year and another will be ready this spring. The quiet rooms are furnished with recliners and room-darkening shades. The Director of Safety is also encouraging the agency to include employee exercise facilities in future construction programs.

NJTransit

NJTransit's Rail Division has taken several actions to prevent fatigue among their Engineering Department employees. These employees were perceived as being at greatest risk of fatigue because they are not covered by the hours-of-service regulations that limit the hours of duty of train and engine crews. Examination of work records revealed that many times, especially following a derailment or other emergency situation, Engineering Department employees worked excessive hours.

NJTransit has implemented two measures to guarantee these employees adequate off-duty time for rest. Internal policy limits Engineering Department employees to 12 hours on duty in any 24-hour period. In addition, when program maintenance projects require the employee to travel to a distant work site, NJTransit provides lodging near the work site. These employees also receive a 30-minute overview presentation on fatigue as part of the safety education program

In terms of train and engine crews, NJTransit has instituted the following initiatives:

- Overnight split shifts have been eliminated.
- In 1998 NJT initiated an aggressive hiring program that allows for reduction in the number and duration of daytime split shifts.
- Labor agreements for the train and engine employees provide that extraboard employees must have a minimum of 1 day off each week.
- When making relief assignments, forward rotation is the preferred strategy.
- Starting in 2002, fatigue education will be a part of periodic operating rules training for train and engine crews.

Since the start of the fatigue initiatives, NJTransit has not seen any change in the number of injuries, the number of equipment defects or absences due to sickness; however, it may be premature to judge the success or failure of the programs.

Citizen's Area Transit (CAT)

ATC is the contract operator for the fixed route bus service in the Las Vegas area. This service operates as Citizen's Area Transit. At the 1999 annual ATC corporate conference for property safety officers, the ATC Director of Safety strongly advised all properties to address operator fatigue. In response to this direction from the corporate organization, the Director of Safety for CAT instituted annual fatigue awareness training for all 800 bus operators on the property. This training session is 1 1/4 hours in length. In addition, the Director of Safety gives new hires an introduction to fatigue as part of new hire training. The goal of this training is to get the new operators to begin thinking about possible fatigue on the job and possible strategies to promote alertness. Recently CAT managers and supervisors, including the General Manager, participated in the training course offered by the Transportation Safety Institute.

Training has been the major focus of CAT's fatigue program. In addition, the Director of Safety has encouraged the Operations Department to allow for increased turnaround times in runs so that drivers have the opportunity to get out of the bus and have a break. In addition, CAT's garages include"quiet rooms."

CAT has an hours-of-service limitation in their labor contract. The maximum length of a workday is 14 hours and an operator must have at least 9 hours off between work periods.

GO Transit

The Transport Canada investigation of a low-speed collision of two GO Transit commuter trains in 1997 identified crew noncompliance with operating rules as the cause of the crash. Further review of the incident by Canadian National, the operator of GO Transit's commuter service, suggested that operator fatigue was most likely the reason for the rule violation. Because of the railroad industry's concern with fatigue among train and engine personnel and the success of the CANALERT project in identifying effective fatigue countermeasures, GO Transit embarked on a Crew Alertness program.

GO Transit crews work primarily split shift assignments. The first segment of on-duty time begins about 4:30 a.m. and ends no later than 10 a.m. There is an off-duty period from 10 a.m. to about 3 p.m. when the second half of the split begins. By 8 p.m. the work period is over. GO Transit management felt that this long split created considerable risk of operator fatigue, especially for individuals who fill in from the spareboard and are not accustomed to this type of work schedule. While the two peak periods necessitated the need for split shifts, management felt some modifications of the schedule might be possible.

GO Transit engaged the services of a consultant to assist in assessing the risk of operator fatigue for their train crews. Based on the consultant's review of crew sleep/work patterns a number of changes were implemented with respect to start and finish times, the rest break between shifts, duty time and duty miles. Feedback from the crews indicates that the changes have been beneficial in terms of their sleep and length of time between work periods.

GO Transit feels that these changes have reduced the risk of operator fatigue, but they also see the need to continue working on the problem. Managing operator fatigue is an evolutionary process and changes must be made in stages. GO has plans to build an exercise facility in the crew center and hopes to provide lifestyle counseling for their crews.

The support of GO senior management, the support and trust of labor and the support of CN whose crews operate the GO commuter service have been key to the success of GO Transit's efforts to date.

Southeastern Pennsylvania Transportation Authority (SEPTA)

In June 2000 two SEPTA trolleys were involved in a rear-end collision at an underground station. When SEPTA officials investigated the incident, operator fatigue appeared to be a contributory factor. The operator of the rear trolley had less than 8 hours of rest prior to the start of the shift. This incident was the catalyst that initiated SEPTA's concern with potential risks of operator fatigue.

SEPTA's Director of Safety met with personnel from the Operations Department and the state safety oversight agency to develop a plan for identifying and correcting any situations that create a risk for operator fatigue. SEPTA examined both overtime and accident records but did not find any correlation between the

two. Nevertheless, SEPTA developed an automated process to track monthly labor hours and identify operators who work more than 15 hours in any day or more than 30 hours in 2 consecutive days. While SEPTA's labor agreement permits scheduling operators for as many as 18 hours in 1 day, operations personnel recognize that working in excess of 15 hours in 1 day can lead to fatigue.

In the past year SEPTA began providing fatigue awareness brochures to its new hires. Most recently they have begun to consider periodic medical screening to identify physical factors that contribute to reduced alertness. (Commuter rail engineers have periodic physicals in accordance with FRA regulation. SEPTA requires a physical examination as a condition of initial hire for its other operators; periodic physicals are not required.)

A Joint Health and Safety Committee, co-chaired by the director of safety and a labor representative and consisting of representatives from both operations and infrastructure departments, continues to evaluate fatigue risks and appropriate countermeasures. This group is currently trying to develop an hours-of-service policy that limits work hours to permit adequate rest.

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Resources and Contact List

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Organization	Description of Services
American Academy of Sleep Medicine 6301 Bandel Rd., Suite 101 Rochester, MN 55901 507-287-6006 www.aasmnet.org	Professional society for field of sleep medicine. Web site provides basic information on sleep disorders and list of accredited sleep disorder screening centers by state. Patient brochures available for sale.
American Sleep Apnea Association A.W.A.K.E. Network 1424 K Street, N.W., Suite 302 Washington, D.C. 20005 202-293-3650 email: asaa@sleepapnea.org www.sleepapnea.org	Patient support organization. Provides information about sleep apnea symptoms and treatment options.
Better Sleep Council 501 Wythe Street Alexandria, VA 22314 703-683-8371 www.bettersleep.org	Industry association for the mattress industry. Brochure available.
Narcolepsy Network Reed Hartman Corporate Center 10921 Reed Hartman Highway Cincinnati, OH 45242 513-891-3522 513-891-3836 fax email: narnet@aol.com www.narcolepsynetwork.org	Patient support organization. Provides information on symptoms and treatment for narcolepsy.
National Center on Sleep Disorders Research National Heart, Lung, and Blood Institute Two Rockledge Center, Suite 10038 6701 Rockledge Drive, MSC 7920 Bethesda, MD 20892-7920 301-435-0199 www.nhlbi.nih.gov/about/ncsdr	Government agency that sponsors research on sleep disorders. Brochures available through web site.
National Institute of Neurological Disorders and Stroke Brain Resources and Information Network P.O. Box 5801 Bethesda, MD 20824 800-352-9424 www.ninds.nih.gov	Government agency. Brochure available on *Understanding Sleep.*

Organization	Description of Services
National Sleep Foundation 1522 K St., N.W. #510 Washington, D.C. 20005 202-341-3471 www.sleepfoundation.org	Support organization. Web site provides information on sleep hygiene and sleep disorders, as well as news on latest sleep research and book reviews. Email newsletter available. Pamphlets on many topics available for purchase.
North American Rail Alertness Partnership http://narap.org	Industry organization of railroaders, regulators and researchers who meet quarterly to share ideas, learn about current scientific developments, and provide input to researchers. Email newsletter available.
President's Council on Physical Fitness and Sports HHH Building 200 Independence Avenue, S.W. Washington, D.C. 20201 http://www.fitness.gov	Government agency providing information on physical activity and health, and fitness programs.
Sleep/Wake Disorders Canada 3080 Yonge Street, Suite 5055 Toronto, Ontario M4N 3N1 416-483-9654 http://swdca.org	Support organization. Canadian equivalent of National Sleep Foundation. Web site contains copies of sleep disorder brochures available in printed form from Sleep/Wake Disorders Canada.
Transportation Safety Institute Transit Safety and Security Division, DTI-80 P.O. Box 25082 Oklahoma City, OK 73125-5050 405-954-3682 http://www.tsi.dot.gov/divisions/Transit/transit.htm	Government agency. TSI offers Fatigue Awareness courses for employees, supervisors and managers. Also offer instructor's course. Courses offered at five locations annually.

Transit Agency Contacts

These individuals have been involved in fatigue initiatives at their properties.

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Don Carrico
Operations Manager
ATC – Phoenix
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Greg Percy
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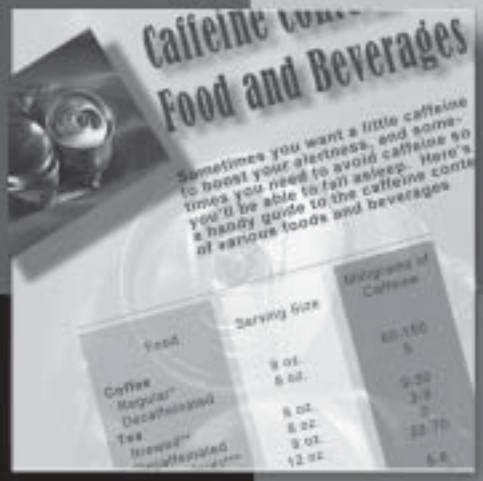
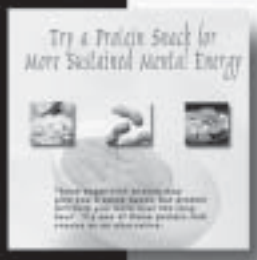
gregp@gotransit.com

Mark Ostertag
Safety Coordinator
Capital Metro, Austin
(512)389-7478
mark.ostertag@capmetro.org


Food and Beverages
Sometimes you want a little caffeine
Food
Serving Size
Milligrams of Caffeine


Try a Protein Snack for
More Sustained Mental Energy

Posters

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Caffeine Content of Food and Beverages

Sometimes you want a little caffeine to boost your alertness, and sometimes you need to avoid caffeine so you'll be able to fall asleep. Here's a handy guide to the caffeine content of various foods and beverages

Food	Serving Size	Milligrams of Caffeine
Coffee		
Regular*	8 oz.	80-150
Decaffeinated	8 oz.	5
Tea		
Brewed**	8 oz.	9-50
Decaffeinated	8 oz.	3-9
Herbal (fruit)***	8 oz.	0
Iced	12 oz.	22-70
Chocolate		
Hot Cocoa	8 oz.	5-8
Milk Chocolate	1 oz.	1-15
Dark Chocolate	1 oz.	5-35
Soft Drinks		
Coca-Cola	12 oz.	46
Pepsi	12 oz.	38
Dr. Pepper	12 oz.	41
Surge	12 oz.	51
Mountain Dew	12 oz.	55
Jolt	12 oz.	71
Sprite	12 oz.	0
7-Up	12 oz.	0

*Depending on roast, method, and whether served with creamer, milk, etc.
**Depending on time steeped and type of tea leaves.
***Most fruit or herbal tea contains no caffeine. There are some exceptions.

Help Stop Fatigue in its Tracks!

10 Tips for Healthy Sleep

- ✔ *Sleep as much as you need to feel refreshed (about 8 hours a night)*
- ✔ *Try to go to bed and get up at the same time every day*
- ✔ *Exercise daily, but not within 2 hours of bedtime*
- ✔ *Don't drink alcohol or caffeinated beverages within 4 hours of bedtime*
- ✔ *Avoid heavy meals just prior to going to sleep*
- ✔ *Avoid regular use of sleep aids*
- ✔ *Make sure the bedroom is quiet, cool and dark*
- ✔ *If it's bedtime and you're not tired, do something relaxing until you feel sleepy like reading or a nice, hot bath*
- ✔ *Avoid napping if you have trouble falling asleep at night*
- ✔ *Drink fewer fluids before bedtime*

Help Stop Fatigue in its Tracks!

Are you

a Lark or an Owl

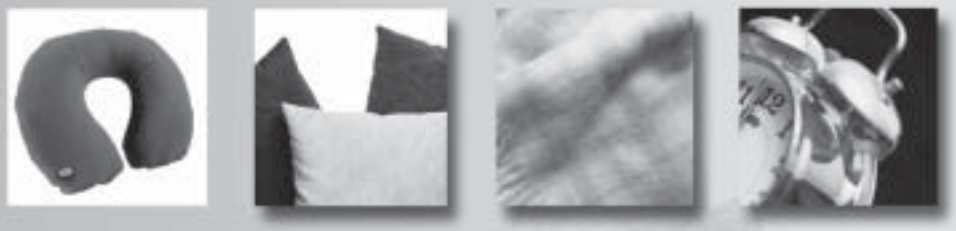
"Larks"
arise early and
do their best work
during the morning

"Owls"
stay up late, sleep in,
and do their best work
later in the day

Owls adapt more easily to changing work schedules and often do their best work on evening shifts. Are you working at the time of day that suits you best, or would a schedule change help you feel less fatigued?

Help Stop Fatigue in its Tracks!

Remember to Take your "Nap Sack" with you



Eye Shade

Ear Plugs

Inflatable Neck Support

Pillow

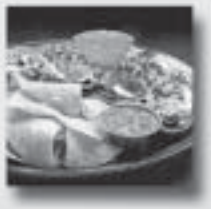
Blanket

Alarm Clock

Help Stop Fatigue in its Tracks!

Try a Protein Snack for More Sustained Mental Energy





Those sugar-rich snacks may give you a quick boost, but protein will help you more over the long haul. Try one of these protein-rich snacks as an alternative:

Nuts	Pudding
Cheese cubes	Beef jerky
String cheese	Hard-boiled egg
Cottage cheese	Taco chips & bean dip
Yogurt	Soy products (drinks, snack foods, power bars)
Peanut butter & apple slices	

Help Stop Fatigue in its Tracks!

Break Time Stretches

Neck
Head Turn

Back
Bend while Sitting

Back
Twist while Standing

Upper Back
Shoulder Blade Stretch

Ankle/Feet
Achilles Tendon Stretch

Ankle/Feet
Ankle Rotation

Shoulders
Shoulder Shrug

Legs
Calf Stretch

Arms
Overhead Stretch

Arms
Triceps and Top of Shoulders

Arms
Straight in Front

Help Stop Fatigue in its Tracks!

The **Transportation Research Board** is a unit of the National Research Council, which serves the National Academy of Sciences and the National Academy of Engineering. The Board's mission is to promote innovation and progress in transportation by stimulating and conducting research, facilitating the dissemination of information, and encouraging the implementation of research results. The Board's varied activities annually draw on approximately 4,000 engineers, scientists, and other transportation researchers and practitioners from the public and private sectors and academia, all of whom contribute their expertise in the public interest. The program is supported by state transportation departments, federal agencies including the component administrations of the U.S. Department of Transportation, and other organizations and individuals interested in the development of transportation.

The National Academy of Sciences is a private, nonprofit, self-perpetuating society of distinguished scholars engaged in scientific and engineering research, dedicated to the furtherance of science and technology and to their use for the general welfare. Upon the authority of the charter granted to it by the Congress in 1863, the Academy has a mandate that requires it to advise the federal government on scientific and technical matters. Dr. Bruce M. Alberts is president of the National Academy of Sciences.

The National Academy of Engineering was established in 1964, under the charter of the National Academy of Sciences, as a parallel organization of outstanding engineers. It is autonomous in its administration and in the selection of its members, sharing with the National Academy of Sciences the responsibility for advising the federal government. The National Academy of Engineering also sponsors engineering programs aimed at meeting national needs, encourages education and research, and recognizes the superior achievements of engineers. Dr. William A. Wulf is president of the National Academy of Engineering.

The Institute of Medicine was established in 1970 by the National Academy of Sciences to secure the services of eminent members of appropriate professions in the examination of policy matters pertaining to the health of the public. The Institute acts under the responsibility given to the National Academy of Sciences by its congressional charter to be an adviser to the federal government and, upon its own initiative, to identify issues of medical care, research, and education. Dr. Kenneth I. Shine is president of the Institute of Medicine.

The National Research Council was organized by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academy's purpose of furthering knowledge and advising the federal government. Functioning in accordance with general policies determined by the Academy, the Council has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in providing services to the government, the public, and the scientific and engineering communities. The Council is administered jointly by both the Academies and the Institute of Medicine. Dr. Bruce M. Alberts and Dr. William A. Wulf are chairman and vice chairman, respectively, of the National Research Council.

Abbreviations used without definitions in TRB publications:

AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
IEEE	Institute of Electrical and Electronics Engineers
ITE	Institute of Transportation Engineers
NCHRP	National Cooperative Highway Research Program
NCTRP	National Cooperative Transit Research and Development Program
NHTSA	National Highway Traffic Safety Administration
SAE	Society of Automotive Engineers
TCRP	Transit Cooperative Research Program
TRB	Transportation Research Board
U.S.DOT	United States Department of Transportation

THE NATIONAL ACADEMIES

Advisers to the Nation on Science, Engineering, and Medicine

National Academy of Sciences
National Academy of Engineering
Institute of Medicine
National Research Council