TP 13960E

Fatigue Management Guide for Canadian Marine Pilots

A Trainer's Handbook

November 2002

Prepared for

Marine Safety Directorate *and*
Transportation Development Centre *of*
Transport Canada

by Rhodes & Associates Inc.

TP 13960E

Fatigue Management Guide for Canadian Marine Pilots: A Trainer's Handbook

Prepared by
Wayne Rhodes and Valérie Gil
Rhodes & Associates Inc.

November 2002

This report reflects the views of the authors and not necessarily those of the Transportation Development Centre or the Marine Safety Directorate of Transport Canada.

Ce document est également disponible en français : *Guide de gestion de la fatigue pour les pilotes maritimes canadiens : manuel du formateur*, TP 13960F.

Desktop publishing by Transportation Development Centre, Transport Canada

Cover photo courtesy of the Pacific Pilotage Authority Canada

Acknowledgements

This handbook was developed with the support of the Great Lakes Pilotage Authority and Transport Canada's Marine Safety Directorate, in conjunction with the Transportation Development Centre. A steering committee consisting of members from these organizations and others from the marine industry and pilotages reviewed and contributed to the handbook. The following is a list of these representatives:

John A. Clarkson, Director, Marine Personnel Standards and Pilotage, Transport Canada
Jules St-Laurent, Senior Advisor, Pilotage, Transport Canada
Louis Gauthier, Lawyer and Counsel, Legal Services, Transport Canada
James D. Reid, Chief, Transportation Systems Technology, Transportation Development Centre, Transport Canada
Vincenzo Delle Donne, Project Manager and Consultant, Interface Consultants Inc.
Robert Lemire, President, Great Lakes Pilotage Authority
Captain Harvey Wade, Director of Operations, Great Lakes Pilotage Authority
Captain Daniel Trottier, Manager, Eastern Region, Great Lakes Pilotage Authority
Captain Elko Merk, President, Corporation of Professional Great Lakes Pilots
Jean-Claude Michaud, President, Laurentian Pilotage Authority
Captain Clément Deschênes, Director of Operations, Laurentian Pilotage Authority
Anthony McGuinness, Chief Executive Officer, Atlantic Pilotage Authority
Dennis McLennan, President & Chief Executive Officer, Pacific Pilotage Authority
Captain Michel Pouliot, President, Canadian Marine Pilots Association
Captain Gérard Belley, Vice-President, Great Lakes Region, Canadian Marine Pilots Association
Captain Guy Marmen, President, Corporation des pilotes du Bas Saint-Laurent
Captain Gilles Giroux, President, Pilotes du Saint-Laurent Central Inc.
Captain Pierre Boucher, President, Corporation of Upper St. Lawrence Pilots
Captain Maury Sjoquist, President, Canadian Merchant Service Guild
Captain Roger Paulus, President, St. Lawrence Seaway Pilots' Association
Ron Jacobs, Controller, St. Lawrence Seaway Pilots' Association
Nicole Trépanier, Chief Executive Officer, Association des armateurs du Saint-Laurent
Donald Morrison, President, Canadian Shipowners Association
Réjean Lanteigne, Vice-President, Canadian Shipowners Association
Captain Gilles Bélanger, President, The Shipping Federation of Canada
Raymond Johnston, President, Chamber of Maritime Commerce
Captain Peter Gill, President, British Columbia Coast Pilots Ltd.
Rick Bryant, President, Chamber of Shipping of British Columbia
Frank Flyntz, Director, U.S. Coast Guard, U.S. Great Lakes Pilotage
Dr. Carlos Comperatore, Researcher, U.S. Coast Guard, R&D Center
Leonard Kingsley, Project Manager, U.S. Coast Guard, R&D Center

The authors would also like to thank the scientists who reviewed the work and helped us in the development of this handbook. We are grateful to:

Dr. Victor Ujimoto, Guelph University
Dr. Tony Parker, Queensland University of Technology
Dr. Diane Boivin, McGill University
Dr. Ron Heslegrave, University of Toronto

Lastly, we are very grateful for the dedication and patience of the pilots who helped us to understand their job and the nature of their work environment. We thank them for allowing us to accompany them during their assignments and for providing us with their practical insights and wisdom.

Wayne Rhodes, Ph.D., C.P.E.
Valérie Gil, Ph.D.

Preface

This handbook is part of a fatigue management program that was developed for Transport Canada by Rhodes & Associates Inc. The development of the program involved two phases:

1. Research into fatigue issues in marine pilotage; and
2. Development of a fatigue management program (FMP).

The program consists of three components:

a. FMP implementation plan;
b. FMP training module; and
c. FMP guidelines for scheduling pilots and for monitoring and evaluating the FMP.

The Fatigue Management Guide for Canadian Marine Pilots: A Trainer's Handbook, TP 13960E, is the primary reference tool for the trainer responsible for the marine pilot fatigue management training module.

Fatigue Management Guide for Canadian Marine Pilots, TP 13959E, is the guide for participants in the six-hour training workshop.

Background material and supporting research is found in *Development of a Fatigue Management Program for Canadian Marine Pilots*, TP 13958E.

Contents

CD ATTACHMENT

Fatigue Management for Canadian Marine Pilots: PowerPoint Presentation
(*Microsoft PowerPoint 2000*)

List of Figures

List of Tables

1 INTRODUCTION

In response to the conclusions raised in the Ministerial Review of Outstanding Pilotage Issues (1999) and several Transportation Safety Board reports on fatigue related incidents, Transport Canada has developed a Marine Pilot Fatigue Management Program (FMP). The documentation that supports this program consists of three volumes:

- *Development of a Fatigue Management Program for Canadian Marine Pilots* – TP 13958E
- *Fatigue Management Guide for Canadian Marine Pilots* – TP 13959E
- *Fatigue Management Guide for Canadian Marine Pilots: A Trainer's Handbook* – TP 13960E

This handbook supports the trainer who will be delivering the six-hour marine pilot fatigue management training module.

Transport Canada does acknowledge that "fatigue" is a related transportation safety factor and have chosen to commence educating individuals in the marine sector.

Fatigue conditions can lead to degraded performance and difficulty remaining alert while performing tasks. The marine pilot fatigue management training module offers the training tool that will help the marine pilot understand the effects of irregular shifts. It accomplishes this by teaching them how to practice fatigue management strategies whenever possible. Finally, the course heightens their awareness of their physiological and performance deterioration, allowing them to act appropriately to mitigate the negative consequences of fatigue, which may lead to a safer operating environment.

1.1 Module Description

The Marine Pilot Fatigue Module consists of the training material required to conduct a six-hour workshop and has been delivered in a standard format that would permit the trainer to offer the material to a group of marine pilot candidates. The material comprises a participant's guide, a trainer's handbook, and a CD containing a slide presentation (Microsoft PowerPoint 2000) intended for use during the workshop.

1.2 FMP Background

Marine pilots often work in confined waters, under a wide range of weather and sea-state conditions. Often the vessels they navigate are foreign. Most of the time only a single marine pilot is on board. The job requires a high level of concentration and an equally high level of decision-making ability. Weather conditions may require marine pilots to continue working for extended periods of time and may result in acute sleep deprivation. In addition, several long assignments in a row can lead to chronic fatigue. Significant fatigue and sleepiness will result. The effects of fatigue and sleepiness on marine pilots potentially can result in loss of, or damage to, equipment and inefficient performance. Hence, there is a need to ensure that marine pilots are aware of the problems caused by sleep loss, and are equipped to apply effective strategies to obtain the best sleep possible. With this understanding, practical knowledge of the effects of

the time of day, and an appreciation for fatigue countermeasures will enable marine pilot to better maintain their performance on the job.

1.3 Purpose of the Training Module

The marine pilot fatigue management training module is designed to help marine pilot Instructors and marine pilots understand how their physiology and mental capabilities are affected under irregular shift conditions. The module provides them with strategies and knowledge that can be used to manage their fatigue. Instructors will learn a greater level of depth and become more cognizant of the sources of information and rationale for the instruction.

Marine pilots will learn how to plan their sleep, and to practice their fatigue management strategies whenever possible. Finally, their awareness will be heightened regarding their physiological and performance deterioration, allowing them to act appropriately to mitigate the negative consequences of fatigue.

1.4 Purpose of this Handbook

This *Trainer's Handbook* was prepared by Rhodes & Associates Inc. for Transport Canada to be used by marine pilot instructors. The handbook provides the background information needed to understand the basic concepts, presentation slides and narrative notes for delivery of the six-hour marine pilot fatigue management workshop, and an extensive bibliography of reference materials.

1.5 Objectives of the Six-Hour Training Module

The six-hour marine pilot fatigue module is to provide marine pilots with the information and knowledge required to understand:

- the nature of sleep and fatigue;
- the impacts of fatigue on performance and physiology; and
- the strategies they can use to mitigate or prevent these effects.

1.6 Organization of the Handbook

The handbook is organized as follows:

Section 1 This introduction.

Section 2 Provides background on the latest scientific information available at present and discusses the significance of such information to the concepts that will be taught. The focus will be on background information that applies directly to irregular shifts.

Section 3 Provides basic information about how the six-hour module can be delivered, the training goals, learning objectives (outcomes for the participant), and descriptions of suggested techniques. A CD containing the FMP presentation is attached at the back of the handbook.

Section 4 Consists of an extensive bibliography of reference material for use by the trainer in preparation for teaching the six-hour module, and references for support during the delivery of the module.

2 BACKGROUND INFORMATION

2.1 Short History of Sleep Research

The first scientific studies of sleep were conducted by Nathaniel Kleitman in the 1930s. He continued to study sleep and was joined in the 1950s by two of his students William Dement and Eugene Aserinsky. Together they formed the first research group specialized in the field of sleep. As technology progressed and more information was gathered the study of sleep became more sophisticated. Research today focuses on questions about ageing and its effects on sleep, about the role of hormonal and immune changes on sleep, and on the clinical treatment of sleep disorders.

2.2 Studies on the Nature and Function of Sleep

2.2.1 Important Sleep Research Studies

Intuitively everyone knows that sleep is a basic need. Although the research community can't give a complete explanation of the function of sleep, there is now evidence that sleep serves a restorative purpose. Studies on small mammals have shown that sleep is vital to maintain body temperature, health and performance. Without sleep, body systems lose their stability, health is compromised, and ultimately death can occur. Further studies are still needed to fully understand why we sleep. Some of the landmark studies that have moved our understanding of sleep further ahead are listed in Table 1.

Table 1 – Studies on the Structure and Function of Sleep

Study Topic	Researcher	Date	Application
Basic sleep physiology	Kleitman	1950s	Early evidence of human brain activity during sleep
Structure of sleep	Dement	1960-70s	Detailed structure of sleep manifested by a combination of physiological responses
Function of sleep	Rechtshaffen Horne	1979 1988	Physiological and psychological evidence of why we need to sleep
Effects of sleep deprivation	Naitoh Angus & Heslegrave	1969 1983/85	Military studies on sleep deprivation

2.2.2 The Measurement of Sleep

The work of scientists described above has resulted in a better understanding of the importance of the quality of sleep we obtain. The electroencephalogram or EEG is the continuous recording of brain waves measured from the scalp. EEG recordings show that the sleep period is characterized by distinct changes in the brain's electrical activity. Figure 1 below shows an EEG tracing.

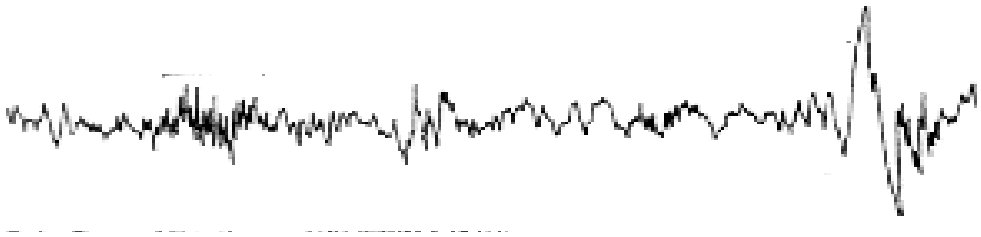


Figure 1 – Example of an EEG Trace

Figure 2 illustrates the location of the various electrodes used for monitoring sleep, the EEG (brainwave activity), electrooccuIogram (EOG – for eye movement), electromyogram (EMG – for muscle tone).

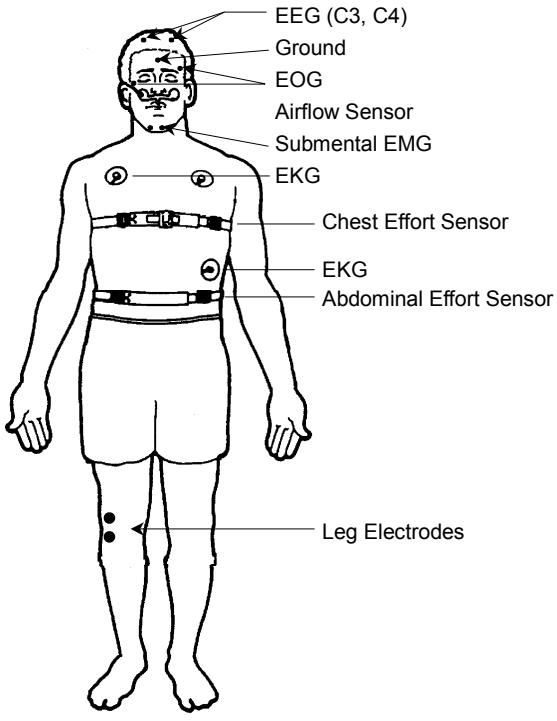


Figure 2 – Polysomnographic Hook-up

Other equipment is often needed to evaluate potential sleep disorders (Figure 2). Airflow, and chest and abdominal effort are also measured with respiratory bands to determine the rate and level of breathing. This information is useful for detecting times when the sleeper stops breathing (central and obstructive apneas), and times when the sleeper's breathing becomes shallow and strained (hypopneas). Often the oxygen content of the blood is measured using an oximeter, and heart rate will be monitored (electrocardiogram-EKG), to determine the impact of apnea events on the cardiovascular system. Finally, leg electrodes will be used to monitor restlessness or periodic movements (kicking).

2.2.3 Types of Sleep

Two distinct types of sleep have been identified according to their physiological characteristics: non-rapid eye movement (NREM) and rapid eye movement (REM) sleep. The measurement of eye movements and muscle tone in association with specific brain waves (EEG) patterns are necessary to determine the type of sleep we obtain. Figure 3 shows the EEG activity in wakefulness, NREM and REM sleep.

NREM sleep is further categorized into 4 sleep stages generally representing a sleep depth continuum:

- Stage 1 (transition between wake and sleep)
- Stage 2 (light sleep)
- Stage 3 and 4 (deep sleep)

The waking EEG pattern is recognized by a very tight, irregular waveform. This fast activity (wakefulness) is gradually replaced by the appearance of slower waves called theta waves and the eyes begin to show slow rolling movements. The person is slowly falling asleep.

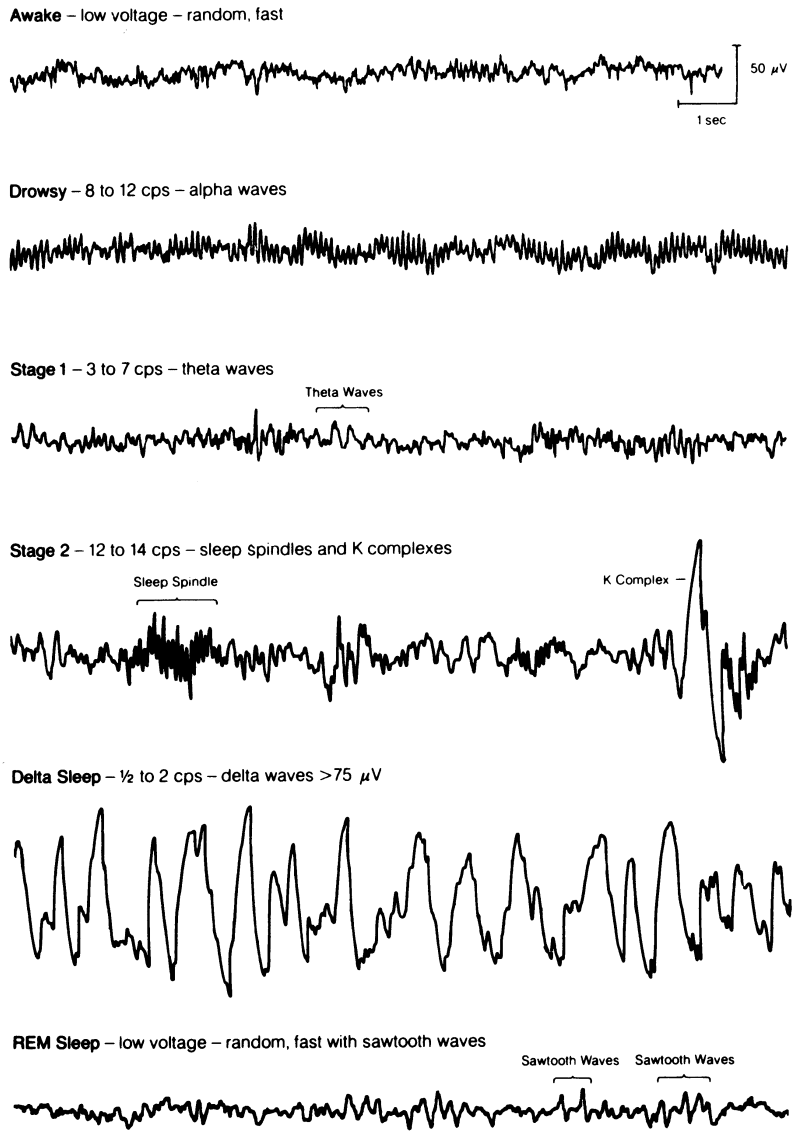
Stage 1 is a transition between wakefulness and sleep, the slightest event can bring back the individual to wakefulness. Normally we spend approximately 5% of our sleeping time in stage 1.

Stage 2 is the first "real" sleep stage and it represents over 50% of our total sleep time. In stage 2, the eyes do not move, muscle tone is low compared to wakefulness and EEG sleep spindles and K-complexes (see Figure 3) appear occasionally along the trace.

Stages 3 and 4 also called Slow Wave Sleep (SWS), cover approximately 20% of our total sleeping time. The tall and slow wave activity observed in the EEG is the hallmark of stage 3 and 4. They are called delta waves. Delta waves appear initially on only 20 to 50% of the recording (stage 3) and they slowly dominate the entire recording (stage 4). In these stages, sleep is very deep and it is difficult to be awakened by external events. If awakened, the individual is often confused or frightened. There are evidences that stages 3 and 4 play an important role in mental and physical recuperation and regeneration.

Finally, REM sleep, in appearance, is very similar to stage 1. It can be differentiated by the periodic appearance of "sawtooth waves". REM sleep is further characterized by bursts or rapid

eye movements (after which this sleep stage was named) and extremely low muscle tone. However, some small sporadic muscular twitches of the face and extremities can be seen. Dreams are particularly abundant during REM sleep. REM sleep represents 25% of our total sleeping time.

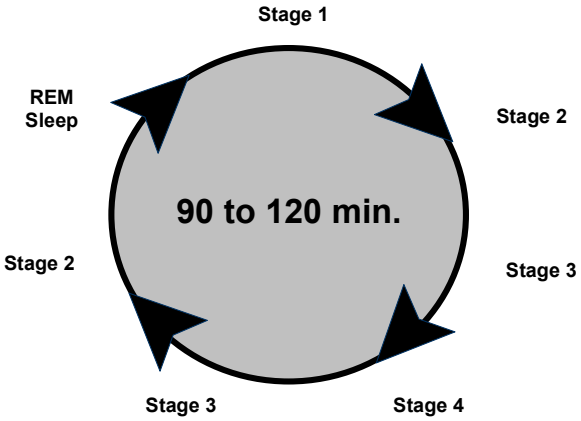


Source: Peter Hauri, *Current Concepts, The Sleep Disorders*, Upjohn, Kalamazoo, Michigan, 1982, p. 7.

Figure 3 – Stages and Type of Sleep Manifested by Brainwave Activity

2.2.4 Sleep structure

Sleep progresses in a cyclic manner (Figure 4). The average length of the NREM-REM sleep cycle is approximately 90 to 120 min. This cycle will be repeated 3 to 4 times during each typical night-time sleep period. Stage 1 being a transition stage, it is not present in every cycle. Stage 2 usually occurs prior to stage 3 and 4 sleep. Stage 3 and 4 may not be present in the last cycle of the night. REM always comes last in the cycle.



Adapted from *Shifting to Wellness*, Keyano College, 1995.

Figure 4 – Typical NREM/REM Sleep Cycle

In an individual sleeping normally at night, the first two cycles will contain more Slow Wave Sleep (deep sleep) and little REM sleep, whereas the last one or two will have less Slow Wave Sleep and more REM sleep. The quantity of SWS is regulated by the duration of prior waking, and the tendency for REM sleep is regulated by the position of the biological clock. REM tendency will be maximal near the endogenous temperature minimum. This normal sleep structure will be disrupted in individuals sleeping during the day after a night shift and sometimes the tendency for Stage 3 + 4 sleep will be high at the same time as the tendency for REM sleep.

Hypnograms

A hypnogram is a graphic representation that illustrates the timing, duration, and sequence of every sleep stage an individual experiences throughout his sleep period. Sleep structure will be affected by several factors such as age, time of day, and prior sleep loss.

When we look at the sleep structure of those who are sleeping at different times of the day, or who are sleep deprived, we see significant differences between an overnight (Figure 5a), a morning (Figure 5b), and an afternoon (Figure 5c) sleep.

Night-time Sleep

Figure 5a shows an example of a hypnogram illustrating the structure of a typical night-time sleep of an individual going through 5 NREM/REM cycles in 7.5 hours of sleep. This hypnogram shows the normal distribution of SWS and REM sleep. SWS occurs predominantly during the first half of the sleep period, while longer periods of REM sleep occur during the latter part.

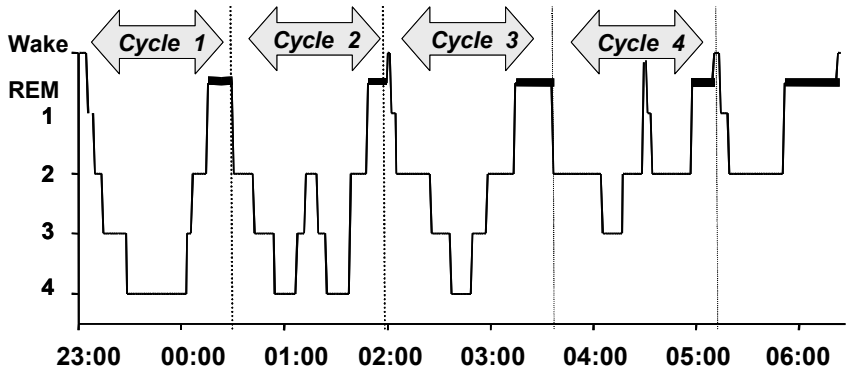


Figure 5a – Hypnogram for Nighttime Sleep

Late Morning Sleep

Note that in this example there is less SWS during a late morning sleep in Figure 5b in comparison with night sleep. However, since the quantity of SWS depends on the prior duration of wakefulness, you will tend to have more SWS especially after the first night shift. Also note that there are more awakenings towards the end of the sleep.

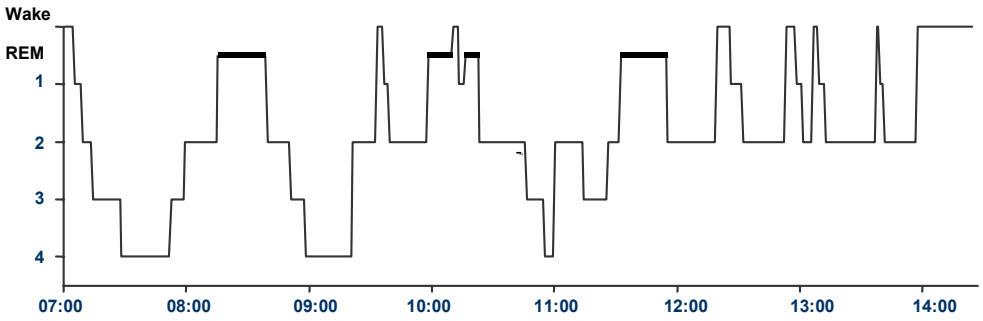


Figure 5b – Hypnogram for Late Morning Sleep

Afternoon Sleep

The proportion of SWS sleep will depend on the circadian clock, time of day and prior duration of the waking episode. Generally, afternoon sleep results in less REM sleep, and a greater proportion of SWS. Therefore, a marine pilot needs to know that if most of his or her sleep periods have been in the afternoon, for example, he will find that sooner or later he may need to recover some lost REM sleep. Conversely, he may need to recover SWS if all of his sleeping was done during the morning.

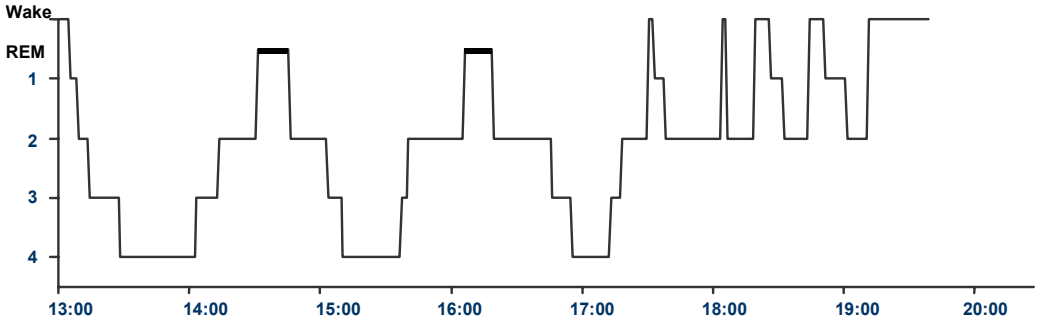


Figure 5c – Hypnogram for Afternoon Sleep

These deficits in REM and SWS can lead to decreased mental performance, psychological well-being, and increased complaints of fatigue.

2.2.5 Minimum Sleep Requirement

Researchers have tried to determine the minimum amount of sleep required to maintain performance. According to many sleep researchers the minimum during each 24-hour period ("day") is between 4.5 and 5.5 hours of continuous sleep. If you usually sleep between 7 to 8 hours per night, you may function adequately for a few days with this minimal amount of sleep. However this cannot be sustained for an extended period of time. If you get less than your required sleep for three or more consecutive days, you may perform as poorly as though you were legally drunk. Such tasks as driving, piloting, or operating dangerous equipment require that you be alert. Under extreme circumstances where sleep cannot be achieved continuously, research on napping shows that 10- to 20-minute naps at regular intervals during the day can help relieve some of the sleep deprivation and thus maintain minimum levels of performance for several days. However, researchers caution that levels of performance achieved using ultrashort sleep (short naps) to temporarily replace normal sleep, are always *well below that achieved when fully rested*. It is, however, better than having no sleep!

2.2.6 Impact of Individual Differences on Sleep

Sleep need is different for everyone. Some people require more sleep than others, ranging from 5.5 to 9 hours a day for people age 30 to 50 years. However, the majority require an average of 7 to 8 hours of daily sleep.

Age affects how much sleep we need and how much we can manage to get. It also affects how we obtain our required sleep, whether we get our sleep all at once or whether we augment it with naps. As we age we may have to augment our main sleep period with a nap because we cannot get the full amount of sleep we normally require during a single sleep period.

Figure 6 shows how much sleep we can obtain daily at various ages. Note that we start out requiring a very large amount of sleep. By the time we are in our 60s we get less than half of that. Some of this drop is due to a reduced requirement, but a significant reduction is because our bodies become less efficient as we age. We produce lower levels of hormones, our cell regeneration is slower, and our various systems do not work as efficiently. It is also dependent on the reduced flexibility of our biological clock, which restricts the times for restorative sleep to a narrower window. This effect can reduce the duration of our sleep, disrupt it by more awakenings, and reduce the amounts of SWS and REM sleep compared to when we were younger.

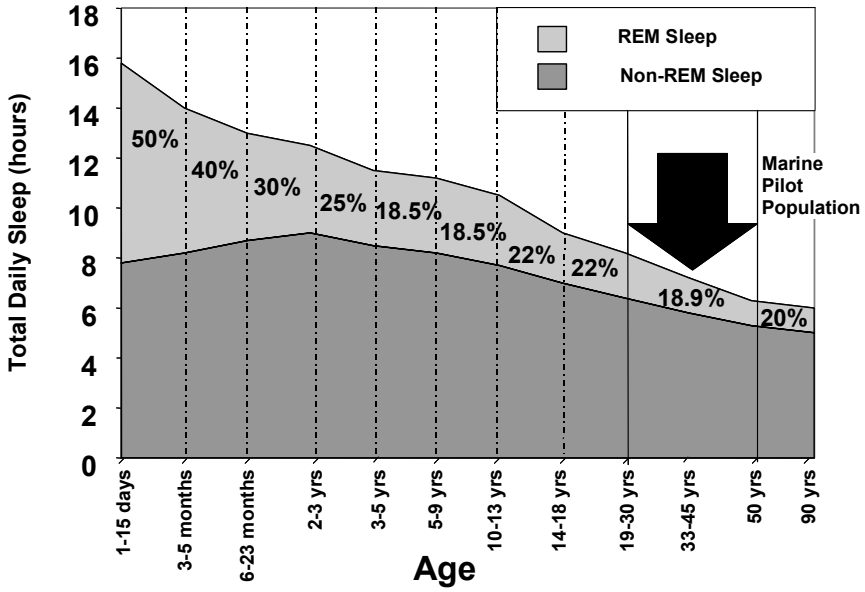


Figure 6 – Total Daily Amount of REM/Non-REM Sleep Obtained

Napping habits appear to be highly variable as well. They differ within and between all age groups. Naps decrease in duration and frequency as an infant matures (a biological effect), and are decreased in frequency in older children and adults, as cultural, social pressures interfere with our sleep patterns.

2.3 Scientific Inquiry into Our Biological Rhythms

Scientists interested in biological rhythms refer to their field as chronobiology. This area of study deals with how our bodies keep our various systems synchronized. They also examine how biological rhythms can become disrupted (e.g. jetlag, shift work, irregular work hours) and how it impacts on sleep, physiology, performance and well-being.

Most human behavioural and physiological processes are characterized by daily oscillations. Circadian rhythms are rhythms recurring once a day. Rhythms with longer or shorter frequencies are called infradian and ultradian rhythms, respectively. Examples of circadian rhythms are body temperature and some hormonal cycles (melatonin, cortisol etc.). An example of infradian rhythm is the human menstrual cycle. An example of an ultradian rhythm is the NREM/REM cycles within sleep. Environmental cues or zeitgebers will synchronize our internal time-keeping system (clock) and biological rhythms to the environment. In most species including humans, the most powerful zeitgebers is the light/dark cycle. Other possible zeitgebers are the changes of activity linked to the sleep/wake cycles and some other activities (meals, exercise, etc.) although their exact nature remains a matter of controversy.

Understanding the importance of biological rhythms in our daily functioning and how they respond to disruption will help us find ways to function under less than ideal conditions. Since Marine Pilots are sometimes working extended hours and at different times throughout the 24-hour daily cycle, it is important to know what are the implications of such unusual schedules.

There are two significant sleep/wake rhythms indicated by the scientific literature:

- The 24-hour rhythm of the sleep/wake cycle;
- The 12-hour rhythm of sleepiness and wakefulness.

2.3.1 The 24-Hour Sleep/Wake Cycle

The major sleep period for typical human adults occurs once a day. Although we follow a 24-hour cycle of sleeping and waking, this may be an artifact of our modern Western lifestyle (see Broughton's and Dinges's book for an excellent discussion of this topic). In fact napping patterns at all ages, in shift workers and in different cultures strongly support the evidence that there is an afternoon increase in sleep propensity (or tendency). Despite the fact that the art of napping is not recognized as a useful practice in Western society and that many great people were nappers (Napoleon, Edison, Churchill, Leonardo da Vinci), most of us do feel the need to nap in the afternoon. Biologically speaking it seems that we are actually "programmed" to have additional sleep/wake rhythms than the obligatory 24-hour cycle we recognise.

2.3.2 The 12-Hour Rhythm of Sleepiness

Scientists have found that if you look more closely into people's sleep habits and let them sleep when they want in an environment free of time cues, a robust two-per-day rhythm of sleep tendency appears in most people. The first is easily recognizable to anyone who has burned the

midnight oil or works nights. The pressure to sleep starts around our usual sleep time and peaks between 03:00 and 06:00. This is the slowest time for the body's metabolism; you feel cold, physically clumsy, mentally sluggish and inefficient. This lowest point in our biological rhythm coincides with the lowest point in our body temperature; it is called the circadian nadir.

The second point of maximum sleepiness occurs 12 hours later, between 14:00 to 16:00 in the afternoon. Even though naps are more prominent in countries with warm climates, midday heat is not the cause of afternoon sleepiness. Studies show the same two peak periods of sleepiness in people living at the equator or in North America. Even though afternoon sleepiness is often called the post-lunch dip, blaming lunch is a myth. Studies have shown that people feel sleepy in the afternoon even if they have no lunch at all. Moreover, no similar increase in sleepiness is seen after breakfast or dinner. Although not quite as strong as the first peak of sleepiness, this increase is obviously dependent on our internal biological rhythm not on other factors such as heat or lunch.

Figure 7 shows the two peak periods in a curve of 24-hour measurement of sleepiness. This curve can be seen as representing the potential for sleep. The probability for the actual "behaviour" of going to sleep does not only depend on how easy it is to fall asleep (sleepiness cycle), it also depends on social forces. Whether an individual actually takes a nap in the afternoon often depends on how socially acceptable it is. However, when an individual does not sleep or does not sleep enough, sleepiness is enhanced across all periods of the day and more so around the two natural peaks of the day. In fact, the greater the sleep pressure, the more likely the person will need to increase his or her effort to stay awake throughout the day, specifically in the mid-afternoon and early morning hours.

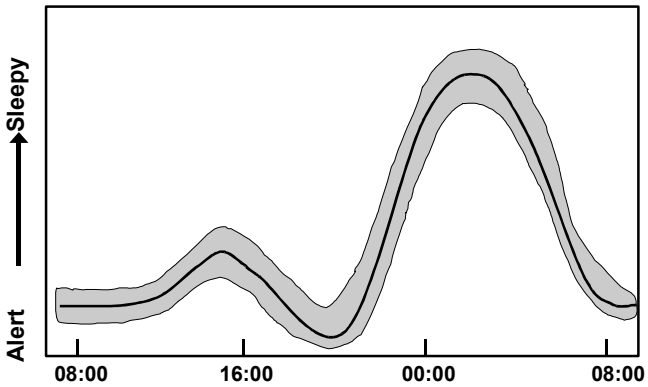


Figure 7 – Sleepiness Measured Over a 24-hour Cycle

In addition to these two peaks of sleepiness, studies have revealed two distinct zones of decreased sleepiness or increased arousal. These periods occur between 10:00 – 12:00, and 20:00 – 22:00 and are referred as the morning and evening forbidden zones for sleep. These zones represent periods of alertness when individuals find it very difficult to fall asleep even when they are very sleepy. Our awareness of these sleepiness peaks and forbidden zones can help us

determine roughly the best times to try to sleep and the times when we can perform at peak levels. Note that there are some individual variations in the exact timing of the forbidden zones for sleep and the sleepiness peaks.

2.4 Research on the Impacts of Irregular Shifts

Irregular shifts refer to work schedules where duration and timing of work periods are highly variable. The work schedule will comprise a mixture of day, evening and night shifts of short, normal and long duration. Examples (these are only a few examples) include:

- Working an 8 hour night shift, then a 10 hour evening shift, followed by a 14 hour day shift etc;
- Working three consecutive night shifts of 8 hours, 15 hours, and 12 hours; or
- Working continually for more than 24 hours with only one or two very short naps (less than 2-hours).

2.4.1 Effects of Partial and Total Sleep Loss on Performance

Working long hours will result in greater fatigue. However, how long one can work and how much fatigue is accumulated depend on factors such as time of day, the type of work involved, the age of the worker, and prior sleep deprivation.

Sleep loss can be classified as either acute or chronic (cumulative). Acute sleep loss results from very short periods (1 or 2 days maximum) when sleep is either totally absent or reduced to one short nap (less than 2 hour long) per 24 hours. The effects of acute sleep loss on performance are of short duration and are usually reversed by one good night of sleep (9 to 10 hours). Chronic sleep loss results from shortening the sleep period below what an individual normally needs for several days or even weeks. The effects of chronic sleep loss on performance and health may take longer to subside.

Studies of partial sleep deprivation show that although mood may suffer quickly, an adequate level of performance can be maintained for a few days with a little more than half of the usual amount of night sleep (5 hours). Increased sleepiness and performance decrements occurred when similar schedules were maintained for more than 4 days or when sleep was reduced below 5 hours per day.

It has been shown that total sleep loss results in decrements in memory and decision-making. In fact, creative thought and problem solving become increasingly difficult as the sleep debt increases. By the 18th hour, a marine pilot will have great difficulty remembering things he has done or said a few moments ago (short-term memory) and his reaction time will have slowed (almost doubled in duration). By the 24th hour his ability to think creatively and make decisions will be dangerously low. Research by Dawson and colleagues (1998) has demonstrated that after a 12-hour shift, fatigue impairs responses, reaction times, logical reasoning, hand-eye co-ordination, and decision making in ways similar to having a blood alcohol content of 0.048%. Results from other studies (Comperatore & Kingsley, 1998; Condon et al., 1988; Sanquist et al.,

1996) indicate that fatigued individuals are not able to accurately perceive the accumulation of fatigue. Sleep loss effects on performance and perception are similar to the effects of alcohol. Marine pilots can still do simple tasks and follow procedures but novel situations or having to respond quickly to a problem will be very difficult, and pilots are very susceptible to making errors. At this point the marine pilot has a higher probability of giving an incorrect command or misjudging distances and duration. Vigilance tasks such as monitoring radar and traffic will be more error prone when the marine pilot must continue to work for over 18 hours without sleep.

Pilcher and Huffcutt examined the data of 143 field studies on sleep deprivation and concluded that sleep deprivation strongly impairs human functioning. Furthermore, mood and vigilance tasks are more affected than physical performance.

More recently, several scientific papers have looked at the impact of fatigue on driving performance and found that sleepiness was responsible for 40% of all vehicular accidents. Other well known on-the-job sleep-related accidents include the oil spill involving the Exxon Valdez tanker, two nuclear power-plant incidents (Three Mile Island and Chernobyl), the Bhopal chemical release and the Challenger disaster. It is obvious that the lack of sleep from working long shifts or through the night can lead to poor judgement, reduced alertness and concentration, and higher risks of accidents.

2.4.2 Impact of Age on Ability to Cope

It has become clear that age does affect our ability to cope with irregular shifts. The majority of the current population of marine pilots are between 40 and 60 years of age. This age group has more difficulty adjusting to irregular schedules, and will be more affected by the negative impact of sleep loss and fatigue. Various scientists have examined the impact of age on coping with irregular schedules and have all found that as we age, our ability to adjust and maintain performance degrades significantly. Difficulties begin to occur at significant levels after 40 years of age. In fact the International Labour Organization has recommended that those who have worked shifts for 20 years or who have reached the age of 55 be placed in a day job.

As we age we are generally less flexible physiologically and socially than young people. Indeed, our hormonal levels are reduced, our circadian rhythms are less flexible and do not adjust very quickly to changes, and we tend to be less fit than when we were younger. Researchers examined the medical and lifestyle factors affecting workers' abilities to work irregular shifts. They saw age, medical problems and reduced fitness as being the main reasons for decreased tolerance of irregular shifts. They also found that these factors interacted and increased potential difficulties with working shifts. If an individual was older and had health problems, he would be more likely to find the irregular schedule difficult to tolerate. Also, if the individual was less fit, more health problems were indicated.

As we age, our sleep also tends to be less efficient. Sleep studies of older workers found less delta wave activity, or slow wave sleep, than in younger workers. They also show more awakenings during sleep and shorter sleep duration. A reduction in sleep efficiency will result in a need to supplement our main sleep with naps. Often, though, because of the lack of

opportunity to nap, older workers just continue to function on less sleep (see Hauri and Linde for a discussion of the relationship between age and insomnia). Marine pilots, who are over 45 years of age, must consider taking naps to augment their main sleep period if they want to be fully prepared to take on a long shift on the bridge.

2.4.3 The Impact of Irregular Schedules on Biological Rhythm and Performance

Research has been conducted examining a number of shift schedules for crews working on submarines and merchant vessels. The results showed how the changing sleep/wake schedules kept by the mariners significantly disrupted their biological rhythms. This disruption was manifested in shifts in the biological rhythms of various hormones and body temperature. The shifts in these rhythms were not consistent with those that would result if the body was adapting effectively to the work schedule.

Other researchers give additional reasons for this type of disruption. They cite that only some of the body rhythms, such as those more associated to the sleep/wake cycle will adjust rapidly to a change in shift, while others, namely those more tightly coupled to the circadian clock, will change more slowly and will not adjust as easily. Therefore, a changing sleep/wake schedule that encourages only some shifting will never allow the body to be fully adjusted resulting in performance and health decrements. Moreover, the sleep/wake schedule will occur out of phase with other zeitgebers (environmental cues) that help our systems synchronize. It is clear that displaced sleep whether shortened or not is associated with deficits in the ability to perform a wide range of tasks. Moreover, long hours of work overlapping with our "circadian night", (the time when our bodies are used to going to sleep) lead to serious decrements in decision-making abilities, perception and, if fatigue is severe enough, some short-term memory loss. Similar decrements in performance can also happen during the afternoon dip, although the effects may not be as severe. Cumulative effects of time of day and circadian disruption will result in greater performance decrements and increase the risks of errors.

2.4.4 The Nature of Fatigue

We have all experienced situations where fatigue sneaks up and causes unexpected slow and inaccurate performance. Generally, it begins by intermittent episodes of fatigue characterized by brief lapses of attention to the tasks during which details are missed and accuracy is impaired. As the shift continues we experience some short-term memory loss and increased difficulty in making decisions. Boring and monotonous tasks, like monitoring instruments (little change in regime) that would otherwise not be a problem to perform increase these feelings and symptoms of fatigue. In addition, if we are working through our circadian low point (latter half of the night), degradation will increase dramatically. Finally, other signs of fatigue include phenomena known as "night shift paralysis" and "microsleeps". They are good indicators of a high level of fatigue.

Night shift paralysis consists of episodes during which the person is unable to perform voluntary movements. These episodes usually start suddenly and disappear spontaneously or can be

stopped by touching the person. During these episodes the individual may feel awake or half-awake. The occurrence of night shift paralysis appears to be linked to transitions into REM sleep, a stage of sleep during which we are normally paralyzed. These episodes have been described by nurses, air traffic controllers, power plant operators, and various other individuals who sleep irregularly, change time zones or work shifts. Night shift paralysis usually occurs when there is a high propensity toward REM sleep and mostly between 03:00 and 06:00.

Ultimately, we may experience a "microsleep", a situation where we actually fall asleep for a few seconds or even minutes. We then wake up with a start and wonder how long we were out for. These microsleeps will continue to happen more frequently if we continue through our shift without any sleep. Microsleeps will occur very easily in situations when we are doing routine and almost automatic tasks such as driving a vehicle. Thousands (almost 800,000 in the U.S. per year) of motor accidents every year are attributed to fatigued drivers falling asleep behind the wheel. Traversing open water where traffic levels are low is another situation where our vigilance is lessened due to the routine nature of the task. When a marine pilot is fatigued, such routine tasks can lead to loss of attention and sometimes microsleeps.

It is important to note that individuals cannot accurately gauge their own level of impairment due to lack of sleep and will often deny being affected by fatigue. A study of this process found EEG evidence of sleep during work. Workers' brain waves were monitored while they worked, allowing the researchers to pinpoint those episodes when workers slipped into a sleep state. Interestingly, the workers were unaware of having slept, but were aware of their sleepiness. Surveys of truck drivers have shown that 60% of them say that fatigue is not a problem for them but 40% say it is a problem for others!

2.4.5 Signs of Fatigue

After cumulative or acute sleep loss, the human body begins to show signs of fatigue. Researchers have examined the condition of fatigue and have suggested a list of physical and mental characteristics that indicate when an individual is severely fatigued. These physical and mental characteristics or signs are shown in Table 2.

2.4.6 Impact on Health

Statistics from various studies indicate that 20% of the shift-working population leave after a very short period of time due to serious problems. Only 10% actually claim to have no complaints about shift work. That leaves 70% that tolerate shiftwork but have various complaints about it. According to researchers, those working irregular shifts have a higher incidence than the general population of the following health problems:

- Gastrointestinal disturbances;
- Cardiovascular disorders;
- Sleep disturbances; and
- Substance abuse.

Moreover, recent studies have shown that sleep loss disrupts the normal pattern of the immune system. In contrast, other studies did not find this trend among employees on certified sick leave, but add that long-term studies need to be done. Such studies would follow personnel who have worked irregular schedules, until either retirement or even after leaving their shiftwork job. This information would be useful to show the real impact of shiftwork on personnel health.

Table 2 – Signs of Fatigue

Major indicators of severe fatigue are:	Other indicators of severe fatigue are:
• Eyes go out of focus or close for a moment • Slowed, slurred speech • Blurred vision, seeing mirages ahead • Wandering and disconnected thoughts • Can't stop yawning • Head nodding • Forgetting to communicate with crew • Incorrect reading of equipment • Forgetting to check the ship's position on regular basis • Missing a reference point • Can't remember the last command given • Missing radio calls • Giving the wrong commands • Difficulty concentrating	• Heavy and burning eyes • Headaches and stomach aches • Drowsy • Inattention to minor, but potentially important details • Reduced morale and motivation • Degraded mental abilities (including memory, decision-making and perception) • Increased distractibility and irritability • Reluctance to initiate tasks and take command • Reduced sense of humour • Tendency to exaggerate • Tendency to take unnecessary risks • Slowed reaction time • Increased errors and tolerance for errors

2.5 Scientific Basis for Strategies, Interventions and Countermeasures

The nature of marine pilot work, with its irregular sleep/wake schedule makes it ideal to consider using a variety of sleepiness countermeasures. Countermeasures include napping scenarios and the use of strategies to stay awake.

2.5.1 Sleep Prior to Work Periods

Some scientific investigation has been conducted into the effectiveness of planned napping in preparation for work periods. Many people working nights find that a nap before the night shift can help them maintain their attention during the low point in their biological rhythm. The studies provide reasonable support for taking planned naps before an expected period of work.

The research shows that taking a planned nap ahead of the work period can reduce the normal degradation in performance seen on night shifts and during long periods of sleep deprivation. This approach takes advantage of the fact that a well-rested individual can manage the loss of one's night sleep better while individuals who are already fatigued are likely to suffer profound performance decrements from the first night. The research supports the concept of napping in advance to ward off sleepiness or sleep loss before it builds up. However, the nap shouldn't be planned during the forbidden zones for sleep. More studies are needed to determine how long the sleep period must be, and what timing is best.

2.5.2 Split Sleep Periods

Under irregular sleep/wake schedules, sleep may have to be taken when there is an opportunity rather than when it might be best as determined by biological rhythms (at night). It is strategically advantageous to marine pilots who cannot obtain their sleep in a single night of eight hours to split their sleep into two or more periods per 24 hours. This strategy will require some adaptation but napping may be the only way to get some sleep. Under circumstances where sleep has to be reduced, performance effectiveness has been shown to be better when sleep is split into several episodes. Beneficial effects may be due to the fact that we can more easily sustain shorter periods of wakefulness than longer ones. Split sleep strategy prevents excessive accumulation of sleepiness. Splitting sleep during the 24-hour period will help the marine pilot stay more alert and awake than if sleep deprived. Short naps at regular intervals can also help prevent the occurrence of night shift paralysis and microsleep events.

2.5.3 Nap Timing and Duration

While napping is accepted as a useful measure for increasing alertness, it is important to find the best time and duration for the naps in order to maintain acceptable performance levels.

Strategic napping during an extended work period that includes the nadir helps personnel maintain their cognitive performance. Without the nap, personnel show significant drops in their cognitive performance. Timing and duration of a nap are very important during a midnight shift. A research team compared 30- and 50-minute naps, each occurring early and late in the night (01:00 and 01:20 for the early naps, and 03:50 and 04:10 for the later naps). These researchers found that regardless of the timing, all of the naps significantly improved the ability to maintain performance. Hence, naps do not totally eliminate the normal circadian dip in performance experienced in the early morning hours (between 03:00 and 06:00), but they help maintain performance and alertness. Naps should be avoided during the forbidden zones for sleep.

Nap duration will be a function of the interaction between time available, time of day and the amount of prior wakefulness. That is, if the nap occurs during the periods of the day where alertness is higher (forbidden zones for sleep), sleep is more difficult to obtain, even if a person has been awake for more than 18 hours. *The best time to nap is during the circadian peaks of sleepiness.* Naps taken in the afternoon after lunchtime or at night will provide maximum sleep efficiency and minimal sleep latency (time needed to fall asleep).

Mid-afternoon naps are ideal because it is a natural point in our biological rhythm to get to sleep easily and the forbidden zone for sleep follows it a few hours later. This means that an individual will have less difficulty waking up from an afternoon nap than from a nap taken between 02:00 and 05:00. For better sleep efficiency, naps should be taken lying down on a cot or bed. A less refreshing sleep can be obtained while in a seated position. A little sleep is better than no sleep at all. However rest alone is no substitute for sleep.

2.5.4 Sleep Inertia

Improvement of performance and alertness upon awakening from a nap may not be immediately apparent. Initially, performance may actually be worse than before the nap. This transitional period of confusion, impairment of performance, and inability to think clearly is called sleep inertia. Sleep inertia severity is greatly increased if subjects take naps while sleep deprived. Sleep inertia is stronger when sleep deprivation prior to the nap is increased. Research shows that it takes anywhere from 10 to 120 minutes for sleep inertia to dissipate. A recent study has shown that caffeine intake immediately upon awakening contributes to eliminate more rapidly the negative effects of sleep inertia. Therefore, some planning is necessary to provide for caffeine beverages and at least a 5 to 20-minute recovery period, or if immediate response is required, support should be given to the individual waking up until sleep inertia has disappeared.

At work, marine pilots should plan for naps at times when piloting conditions are more predictable and a qualified ship's officer can competently navigate the vessel on his/her own. The marine pilot should always allow a minimum of 10 minutes for recovery upon awakening from a nap. Unpleasant mental and physical after effects from naps should *not* be considered a major reason for not napping since sleep inertia will give way to improved performance and mood. Napping is highly recommended to marine pilots as a countermeasure for severe fatigue rather than fighting off waves of sleepiness.

2.5.5 Strategies to Stay Awake

Stimulant

Caffeine is the most common stimulant used to maintain alertness, particularly when we are very tired. The strong stimulating effects of caffeine peak within 30 minute to 1 hour, and it may take up to eight hours to clear the system. As a stimulant, caffeine must be used carefully since it increases heart rate, blood pressure and urination. Caffeine may be addictive if used too much and for too long. Heavy users (more than four cups per day) may suffer withdrawal symptoms such as headaches, restlessness, and fatigue. These symptoms will disappear after several days. If caffeine is ingested as large quantities of coffee or tea, the tannins and acids may be harmful to the stomach, particularly during the night when digestion is slowed down. Health and Welfare Canada recommends a *maximum* of 400 to 450 mg of caffeine per day, or approximately three to four cups of coffee. There are people who are sensitive to as little as the equivalent of three cups of coffee.

Caffeine is found in coffee, tea, cola drinks, chocolate and a variety of drugs. Caffeine consumption prior to sleep or in large doses increases awakenings, reduces slow wave sleep, and shortens the sleep period. Note the frequent and early awakenings (06h00) in Figure 8.

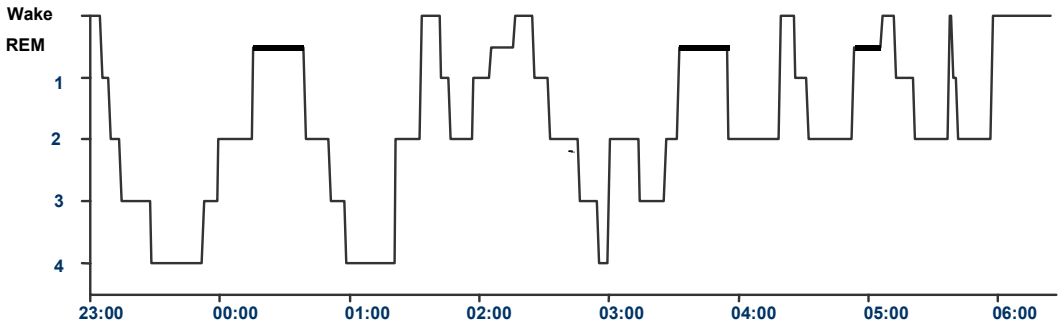


Figure 8 – Effect of Caffeine on Sleep

Nicotine has a double effect. At low concentration in the blood it will produce relaxation. At higher blood concentration it produces a stimulant effect. Smokers may take longer to fall asleep than non-smokers and their sleep duration is reduced by 30 min per night on average. Habitual smokers who try to stop smoking will report sleep disturbances.

Some scientists have shown that working in a bright-light environment can help maintain alertness. However, exposure to bright light can have marked effects on the timing, duration, and quality of your sleep. Bright light can shift your body rhythms and the direction of the shift is dependent on the time of day of exposure. Remember light is the main cue for our body to maintain synchronization of our internal rhythms to the environment. More research is needed to evaluate the effectiveness of using bright light exposure for workers that switch from being "night active" to "day active" within only a few days.

Exercise can also help to keep the body from feeling sluggish. Getting up and moving around when there is a break between job tasks can revive you for a short period of time, depending on how fatigued you are. Stepping out into the cool air and taking a walk around the deck will help to shake off some of the sleepiness.

Sounds can help the marine pilot stay alert, providing they are intermittent and loud enough. Casual conversation can help keep people awake and on task providing that it is not too engaging. However, it should be remember that the beneficial effect of these last countermeasures is often short lived and can give the false impression that alertness is better than it really is.

Sleep Aids (Sleeping Pills, Alcohol)

Sleeping Pills

People working irregular shifts often use sleeping pills to override their natural sleep/wake rhythm, allowing them to get to sleep. There are several disadvantages to using sleeping pills.

Sleeping pills are not as effective after a month. To keep the pills effective you often need to increase the dose or change to another type of sleeping medication. Moreover, sleeping pills can be addictive and if used for longer than two to three weeks they can result in substantial withdrawal effects. If you stop taking pills after long-term usage be prepared for rebound insomnia because your body has been accustomed to relying on the pills to sleep. This problem can be reduced by cutting back gradually or by using the pills intermittently (e.g. every third day or only for day sleep).

There are considerable differences in the speed of absorption and elimination by the body between the various types of drugs. A large number of the drugs on the market today are absorbed relatively rapidly and are effective within 20 to 45 min. The elimination duration can vary between 24 and 2 hours. The mode of action of existing sleeping pills has nothing to do with the normal biology of sleep. After prolonged use, sleep induced by most sleeping pills is abnormal, usually involving less REM and slow wave sleep. Sleeping pills do not necessarily improve mental performance the following day and can even reduce performance if the duration of action exceeds the duration of the sleep episode (hangover effect). The hangover effect depends on the type of sleeping pills and on how rapidly your body gets rid of these drugs. Elimination of the drug by the body will also depend on your health, age, the type of pill and dosage.

Most sleeping pills have side effects. These depend on the dosage, duration of action and elimination, and the condition of the individual (age, liver or kidney problems, etc.). The most common side effects of sleeping pills are anxiety, nausea, confusion, digestive upset, dizziness, frequent urination, and memory disturbances.

Sleeping pills should not be taken in combination with alcohol or other types of drugs that can affect vigilance (e.g. anti-allergic or cold medications). Sleeping pills *slow down respiration and increase awakening thresholds*. If sleeping pills are used, the normal ability to awaken during episodes of obstructive sleep apnea (brief interruptions of respiration during sleep) is reduced and the duration of these episodes is extended, placing the person at risk. People who snore heavily or have known respiratory problems should not use sleeping pills. Cases of respiratory arrests and death have even been reported by the use of sleeping pills in apneic patients.

Natural sleep is best but sometimes we may need help to sleep. Sleeping pills can provide an efficient solution when taken for short periods to temporally aid your sleep in periods of emotional difficulty, stress, or after surgery. If getting sleep continues to be a problem, you may need help to find the real causes of your poor sleep (medical, behavioural, or psychological) and start a treatment that will cure the problem.

Sleeping pills do not address the actual cause of the irregular shift worker's sleep difficulty. Whether sleeping pills can reset or synchronize your body rhythms remains a matter of controversy. It is generally believed that sleeping pills will indirectly reorganize the schedule of exposure to light and darkness, which can then exert a synchronizing effect on the human circadian clock.

Alcohol

Avoid having any alcohol before going to bed. Alcohol may help you fall asleep but it actually disturbs your sleep patterns. It will disrupt your sleep by causing early morning or even middle of the night awakening and prevent you from getting the proper amounts of slow wave and REM sleep you need to function properly (Figure 9). Alcohol is eliminated at approximately the rate of one drink (e.g., beer) per hour. Alcohol has a significant effect on respiration. People who snore heavily or have known respiratory problems should limit their ingestion and pay attention to the timing of their alcohol consumption to give time to their body to eliminate the alcohol before going to sleep. It is recommended that individuals diagnosed with sleep apnea take the same precautions as described above for sleeping pills.

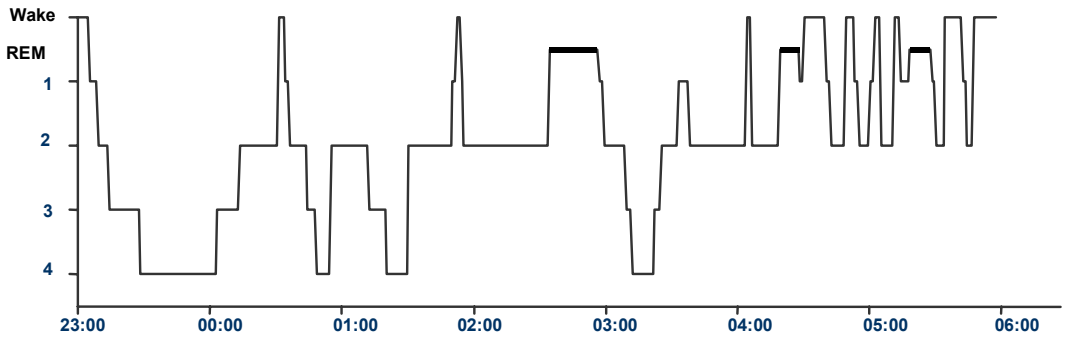


Figure 9 – Effect of Alcohol on Sleep

3 DELIVERY OF THE SIX-HOUR WORKSHOP

This section contains the instructions for the trainer to conduct the six-hour workshop.

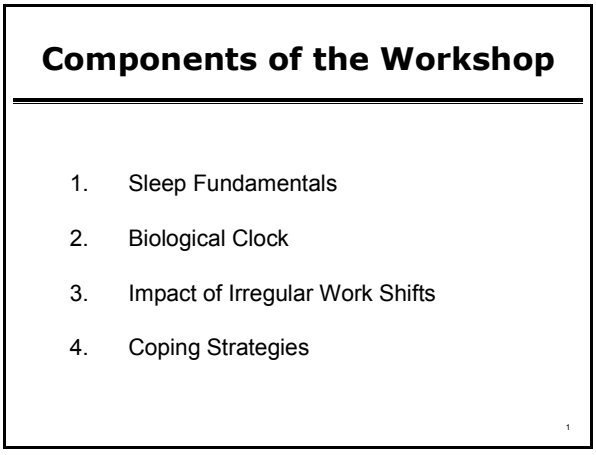
3.1 The Four Components of the Workshop

The workshop consists of the following four components. Each will take about an hour and a half to complete:

One Sleep Fundamentals
Two Biological Clock
Three Impact of Irregular Work Shifts
Four Coping Strategies (interventions and countermeasures)

Each component will be presented as follows:

- Training objectives
- Learning objectives
- Component content - narratives, including training instructions, and slides
- Questions at the end of the section to test the trainer's understanding of the material and training goals

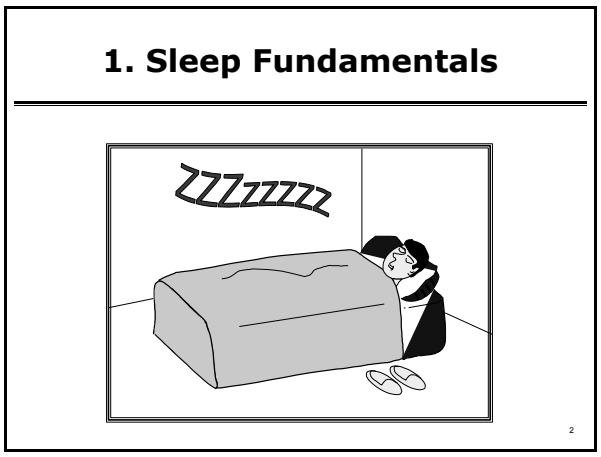


Slide 1

Narrative

The objectives will be presented at the beginning of each component.

3.2 Sleep Fundamentals



Slide 2

3.2.1 Training Objectives

The training objectives for this component are:

- To inform the participant of the basic characteristics of sleep and fatigue, and how they contribute to our health, performance and well-being
- To help the participant appreciate basic human sleep physiology

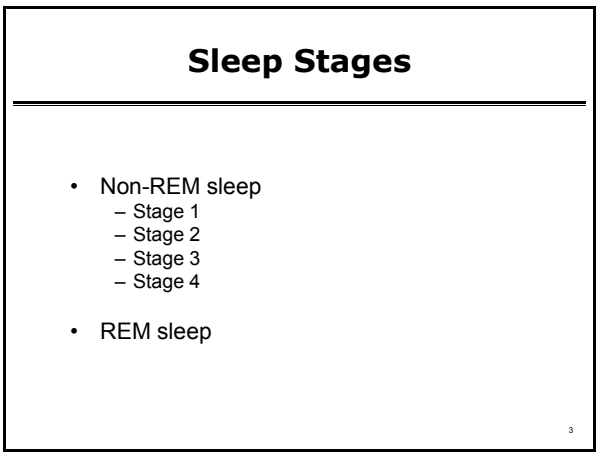
3.2.2 Learning Objectives

The participant must be able to do the following:

- Describe the basic characteristics of sleep
- Explain how sleep contributes to health, performance and well-being
- Describe how our bodies respond to sleep

Sleep Necessity

Sleep is as necessary as food or water, and no matter how much we try we cannot eliminate the need for sleep. We can reduce the amount of time we spend asleep, but not without consequences. Without sufficient sleep we can quickly become vulnerable to illnesses, errors, and accidents. Alertness and performance are directly related to quality and quantity of sleep.



Slide 3

Narrative

Scientists have identified two types of sleep according to their physiological characteristics:

- Rapid Eye Movement (REM) sleep or dream sleep, and
- Non Rapid Eye Movement (NREM).

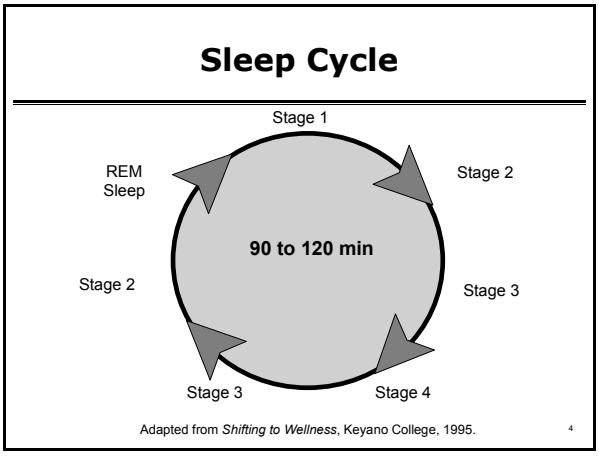
NREM sleep

- NREM sleep makes up the bulk of your sleep (75% of your night).
- NREM sleep has been categorized into four distinct sleep stages. These stages are:
  - Stage 1 (transition between wake and sleep)
  - Stage 2 (light sleep)
  - Stages 3 and 4 (deep sleep)

Stages 3 and 4 are considered to be the deepest levels of sleep. There is evidence that stage 3 and 4 play an important role in our mental and physical recuperation. To put it another way, these stages help us recharge our batteries. Depriving ourselves of this sleep can cause us to suffer fatigue and reduced physical and mental performance.

REM sleep

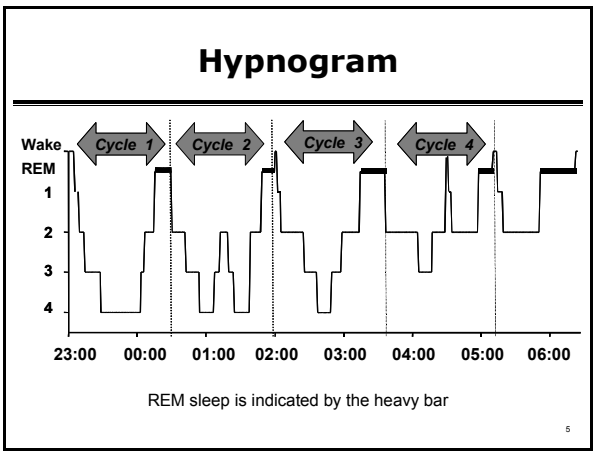
REM sleep appears to be responsible for helping us in our ability to learn and make decisions. More studies are needed to understand the function of REM and NREM sleep.



Slide 4

Narrative

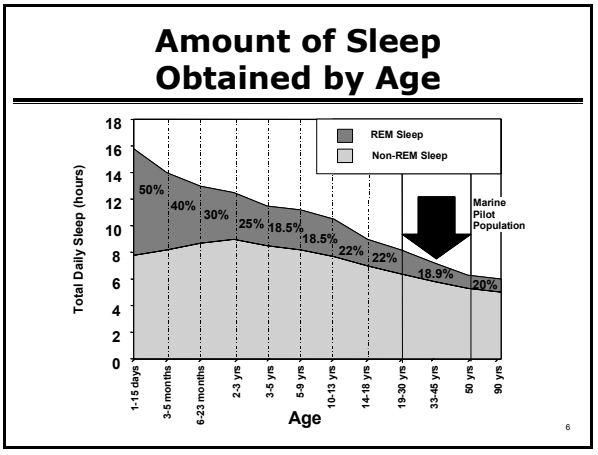
We sleep through a defined cycle of activity that repeats itself a few times during each sleep period. Often we go through four to five of these cycles. Once we decide to go to sleep, the cycle begins with us moving from being awake to Stage 1. Stage 1 being a transition stage, it is not present in every cycle. Then it proceeds into Stage 2, then Stage 3 and on to Stage 4. From Stage 4 it will go back shortly to Stage 3 and then Stage 2. From Stage 2 we proceed to REM sleep. One cycle takes 90 to 120 min.



Slide 5

Narrative

This is a hypnogram or graphic representation of our sleeping period, showing the cycles we just discussed and the time spent in the different stages of sleep. Note that under usual conditions, we get most of Stage 3 and 4 sleep, the deepest sleep, during the first part of the sleep period. In fact the time spent in stage 3 and 4 actually becomes shorter as the sleep period progresses, while the duration of each REM sleep periods gets longer towards the end of our total sleep period. When we wake up in the morning remembering a dream, we have usually awakened from REM sleep.



Slide 6

Narrative

The average sleep we need varies among people, but the majority of adults require an average of seven to eight hours of sleep each day. Sleep duration also varies with age. Note that we obtained up to 16 hours of sleep each day when we were babies. Also note that half of that sleep is REM sleep. This is perhaps because babies must learn quickly, and REM sleep promotes learning. Age also affects how much sleep we can manage to get and whether we get most of our sleep in one single sleep period (young adult) or whether we need to nap (infants and elderly). By the time we reach 60, sleep has been reduced by about two hours compared to what we obtained when we were 18. Note that this reduction is mostly due to a reduction in NREM sleep. This explains the impression that as we age our sleep gets lighter. Also, it should be emphasized that the present population of marine pilots is between the ages of 40 and 60.

Exercise 1: Sleep Requirement

Do you get enough sleep?

Find out how many participants sleep on average:

- between 5 and 6 hours on work days? On days off?
- between 6 and 7 hours on work days? On days off?
- between 7 and 8 hours on work days? On days off?
- more than 8 hours on work days? On days off?

How many participants fall asleep:

- in less than 5 minutes?
- in less than 10 minutes?
- in less than 20 minutes?
- in less than 30 minutes?

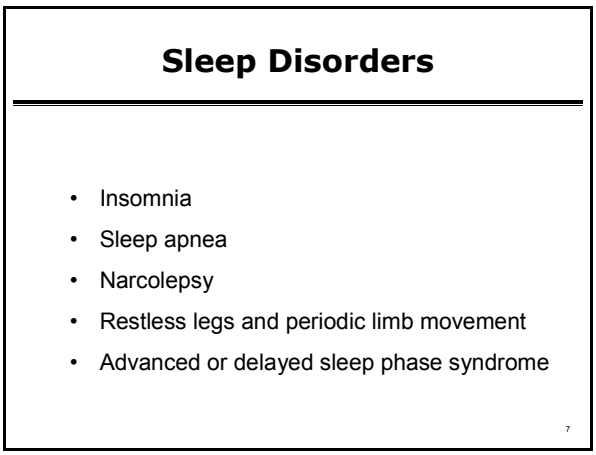
How many can nap any time any place?

Conclusion of the exercise:

Participants who say that they sleep more on weekends by at least an hour are cutting their sleep short during workdays compared to their natural sleep requirement.

Participants who say that they fall asleep in less than 10 minutes or can nap any time, any place are sleep deprived and are sleeping less than they need.

If participants sleep an adequate number of hours but still feel exhausted they need to find out if they have a sleep disorder. They should consult their doctors for proper diagnosis and treatment.



Slide 7

Narrative

One factor that people often overlook when they sleep poorly is that they may have a sleep disorder. If you have a sleep disorder, even good sleep habits and practices are not enough to get the proper amount and quality of sleep. A sleep disorder must be properly investigated and diagnosed by a qualified physician.

Insomnia

It is the most common sleep problem among workers who have irregular sleep schedules. Insomnias include: difficulty falling asleep, staying sleep, or waking up too often or too early. Chronic insomnia can be caused by depression, anxiety or stress, leg movements, medical problems, poor sleep habits or irregular sleep/wake schedules. Intermittent insomnia is usually caused by stress or worries. Sleeping pills can help treat insomnia, but only for a short period of time.

Sleep apnea/hypopnea

It is common in men over 40 who snore, have a neck size of 17 or more, and are overweight. The sleeper stops breathing or his breathing efficiency is reduced and the level of oxygen in the blood drops. The sleeper wakes up suddenly gasping or choking to take a breath and falls back to sleep immediately. The process can start over several hundred times a night resulting in a very disrupted sleep structure. As a result, people who suffer from sleep apnea are unaware of it and suffer from excessive sleepiness and fatigue. They will fall asleep easily during routine, non-stimulating activities such as driving, watching TV or movies. Other symptoms include personality changes, headaches, poor memory, irritability, and decreased sex drive. Sleep apnea can be associated with serious health problems, such as heart failure and high blood pressure.

Narcolepsy

People suffering from narcolepsy suffer from uncontrollable sleep attacks that occur several times a day. The sleep episodes typically last a few minutes, described as fully recuperative, and recur after several hours. In addition to sleep attacks, patients report sudden muscle weakness triggered by sudden emotion and lasting a few seconds. This is referred to as cataplexy. Narcolepsy is not common but the symptoms cause severe problems for sufferers. The excessive daytime sleepiness is usually a lifetime condition while cataplexy often reoccurs within a few years.

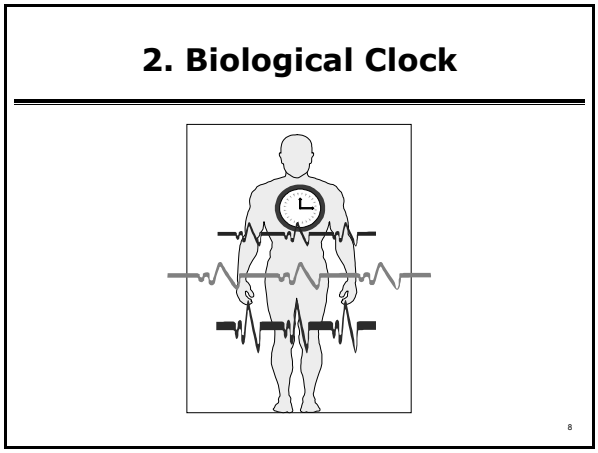
Restless Legs Syndrome and Periodic Limb Movements in Sleep

Restless legs syndrome is a neurological condition that is experienced as tingling, crawling or pickling sensations in the limbs (usually the legs) that causes the person to want to get up and move around. Usually the symptoms peak at the end of the day or bedtime and can cause severe difficulty falling asleep. Often restless legs syndrome will be associated with periodic limb movements that are characterized by repeated limb jerking (usually the legs) during sleep. These disorders will disrupt sleep and cause chronic insomnia and fatigue. Sometimes patients will suffer from daytime sleepiness instead of insomnia.

Advanced or Delayed Sleep Phase Syndrome

These syndromes are a result of the biological clock being slightly out of synch with the environment (normal day). If you have difficulty going to sleep at night and you can only fall asleep in the early morning hours, you may be suffering from delayed sleep phase syndrome. Delayed sleep phase syndrome is the most frequent disorder of the circadian system and is generally seen in adolescents and young adults who have difficulties waking up in the morning and attending school or work. These patients can be described as extreme night owls. Conversely, advanced sleep phase syndrome is usually seen in older people who have trouble staying awake in the evening and wake up too early in the morning. These patients can be described as extreme cases of morning larks (those who prefer to rise early each morning) and have tremendous difficulty adapting to evening or night shifts. This syndrome should be differentiated from depression that can also be associated with early morning awakenings. Both of these syndromes are associated with difficulties adjusting to a socially acceptable schedule and are typically difficult to treat.

3.3 Biological Clock



Slide 8

3.3.1 Training Objectives

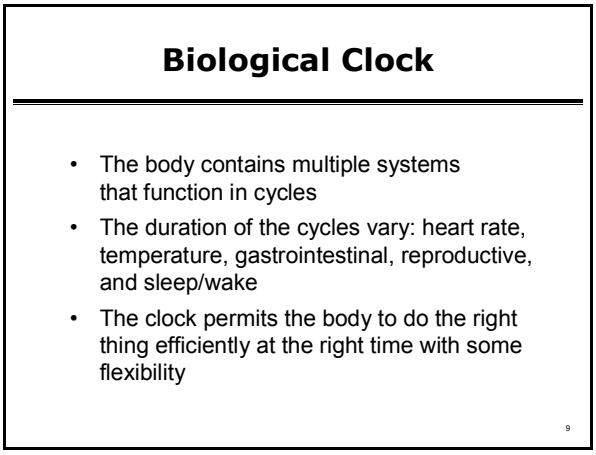
The training objectives for this component are:

- To inform the participant of various biological rhythms in the body
- To help the participant understand how their irregular shift schedules will affect these biological rhythms
- To define the relationship between sleep and other factors such as the environment, biological rhythms, and sleep schedules (including napping)

3.3.2 Learning Objectives

The participant must be able to do the following:

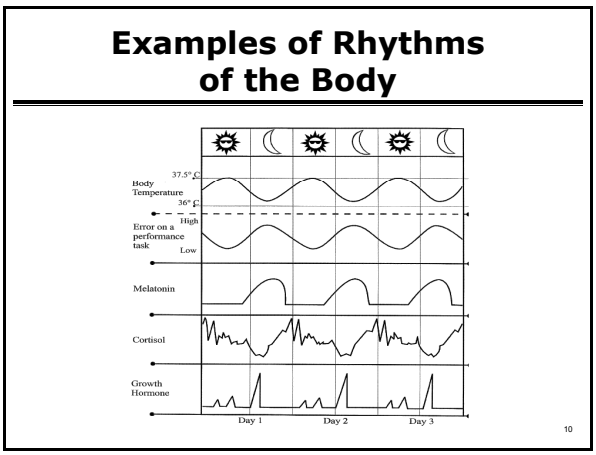
- Name and describe two biological rhythms
- Describe how biological rhythms are disrupted by irregular schedules
- Know how cues (zeitgebers) affect these rhythms
- Explain how sleep and alertness are impacted by biological rhythms



Slide 9

Narrative

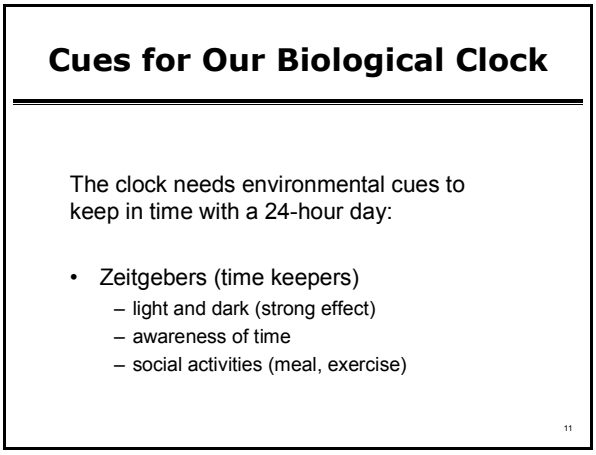
Our bodies contain a biological clock that keeps all of our systems in near-perfect synchrony. The body has many rhythms of varying lengths that are synchronized with each other. If changes in these rhythms occur, such as when you move into another time zone or change the timing of your sleep/wake cycle, the synchrony will be disrupted. The result is that your body no longer functions smoothly and this may lead to sleep and vigilance problems. Of course the effects are slightly different for each individual, and are related to the magnitude of the disruption to the rhythms. Although we have a certain amount of flexibility in our ability to adapt to changes, it does not take much to cause some disruption.



Slide 10

Narrative

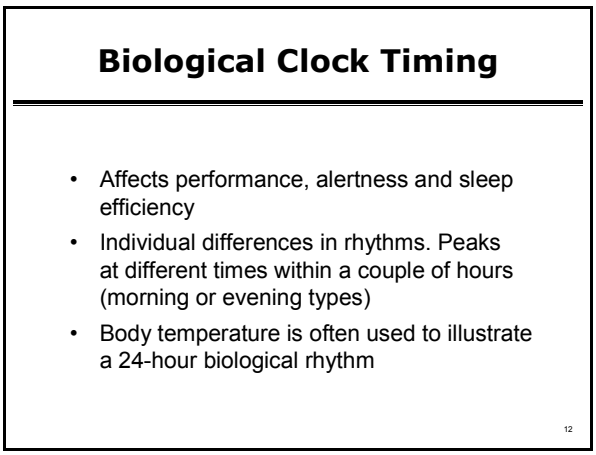
Some examples of our biological rhythms are shown here. The most well-known body rhythm is manifested by the fluctuations in our core body temperature. Various hormones also fluctuate during the 24-hour daily cycle. Melatonin, the hormone that may help induce and maintain sleep, increases at night and its levels are undetectable during the day. It also quickly decreases with exposure to light at night. Note that melatonin is highest about two hours before the low point of our body temperature cycle. Cortisol also has a strong circadian rhythm, with its highest concentrations observed at the regular time of awakening. Cortisol levels drops during the first half of the sleep episode. Growth hormone, by comparison, is much more associated to the appearance of sleep than to the biological clock. Greater levels will occur during SWS regardless of the time of the sleep episode.



Slide 11

Narrative

Environmental cues or zeitgebers will synchronize our internal time-keeping system (clock) and biological rhythms to the environment. In most species including humans, the most powerful zeitgeber is the light/dark cycle. Other possible zeitgebers are the changes of activity linked to the sleep/wake cycles and some other activities (meals, exercise etc.) although the mechanism for their influence remains to be shown.

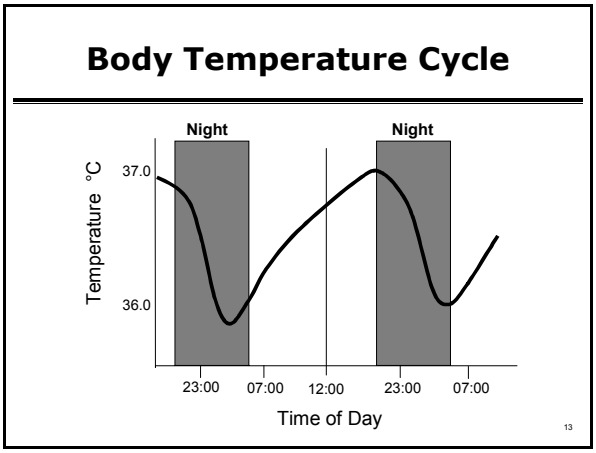


Slide 12

Narrative

Our biological clock can affect: our performance, alertness and sleep efficiency. Even if we are well rested our performance will vary throughout the day because of our biological rhythm. Our performance will decrease in the afternoon and it will degrade further during the night. Sleep, on the other hand, will be more efficient at night and in the afternoon.

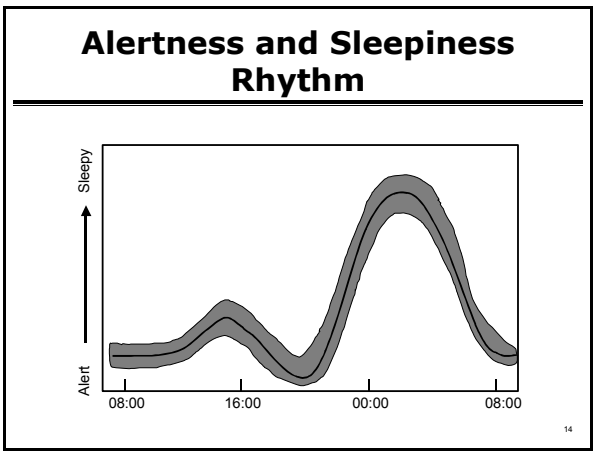
Each person's body rhythms are slightly different. Our peak performance and night-time nadir (the lowest point in our metabolism that occurs around 05:00 in the morning) can vary between people by several hours. We notice this when we realize that some people can get up more readily in the early morning than others. We might call such an individual a "morning person" or "lark". At the other extreme is the "night owl" or "evening person", who can stay up into the night, much longer than others.



Slide13

Narrative

To study biological rhythms, scientists isolated volunteers in a cave without external cues (daylight, clocks...) for as long as a month. They allowed them to sleep or wake when they wanted, but they could not know what time it was. Under these "free-running" environments people continued to show a sleep/wake rhythm confirming the existence of an internal clock. However, their rhythm was slightly longer than 24 hours. Their sleep time drifted by several minutes every day, to the point that they were awake during what should have been night and asleep during what should have been the day. Without exposure to environmental synchronizers their rhythms couldn't stay synchronized to the 24-hour day. Scientists also found that their body temperature followed a similar cycle. The body temperature cycle is now used as a good indicator of our personal biological rhythm. The temperature curve shows the trough at around 05:00 in the morning, about two hours before the regular time of awakening. This corresponds to the time, if awake all night, when we are most sleepy.

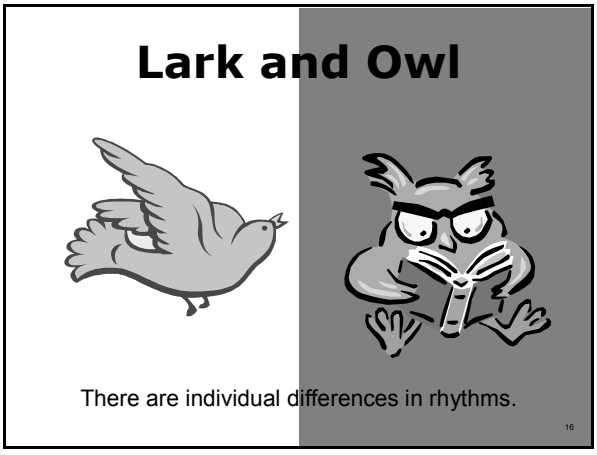


Slide 14

Narrative

The level of alertness and sleepiness will determine how well you can sleep but also how well you can perform, be attentive, be vigilant, and are able to think clearly. Researchers have measured subjects' ability to fall asleep over a period of 24 hours. Note that our sleepiness peaks twice a day. When we maintain a regular day-oriented schedule we are sleepier around our usual bedtime until the early morning hours (04:00) and again in the mid-afternoon (13:00-15:00). These two periods of increased sleepiness are called the sleep gates. Even though naps are more prominent in countries with warm climates, midday heat is not the cause of afternoon sleepiness. Studies show the same two peak periods of sleepiness in people living at the equator or in North America. Even though the afternoon sleepiness is often called the post-lunch dip, blaming lunch is also a myth. Studies have shown that people feel sleepy in the afternoon even if they have no lunch at all. Moreover, for most people, no similar increase in sleepiness is seen after breakfast or dinner. In addition to these two peaks of sleepiness, studies have revealed two distinct zones of decreased sleepiness or increased alertness. The first period occurs in the morning sometime after your usual wake time and a second period occurs between 19:00 and 22:00, just a few hours before your usual bedtime.

Slide 15

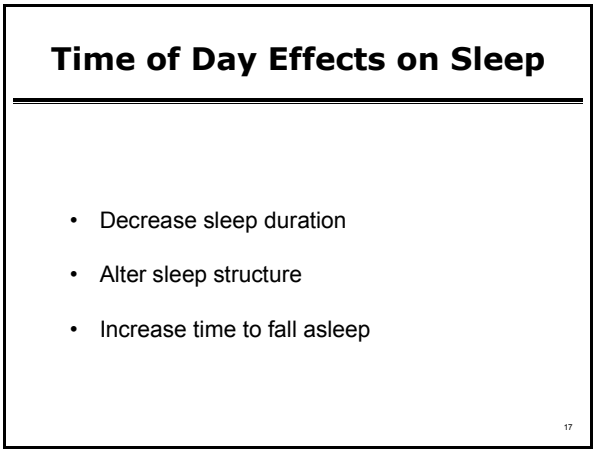


Slide 16

Performance peaks at different times within a couple of hours (morning and evening person).

Exercise 2: Are you a morning or an evening person?

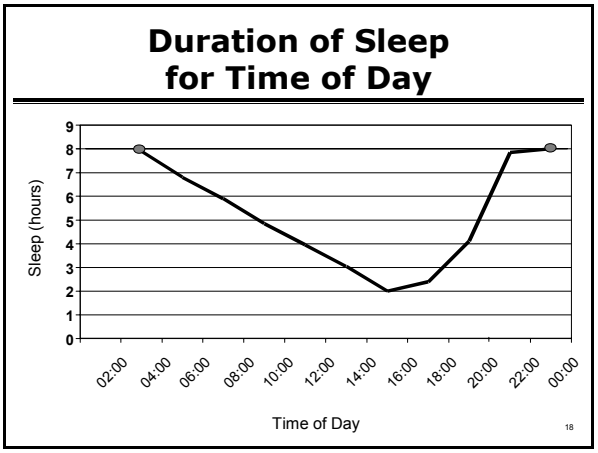
Have each complete the questionnaire (see pages 14 and 15 of the *Fatigue Management Guide for Canadian Marine Pilots* TP 13959E) then find out which each person is, recording the numbers on the flip chart. Use three columns to organize the results (28-41 MORNING TYPE; 21-27 NEITHER; and 8-20 EVENING TYPE). Have the participants relate some experiences that their type may have a bearing on (e.g., spouses who are opposites and the conflicts that can occur).



Slide 17

Narrative

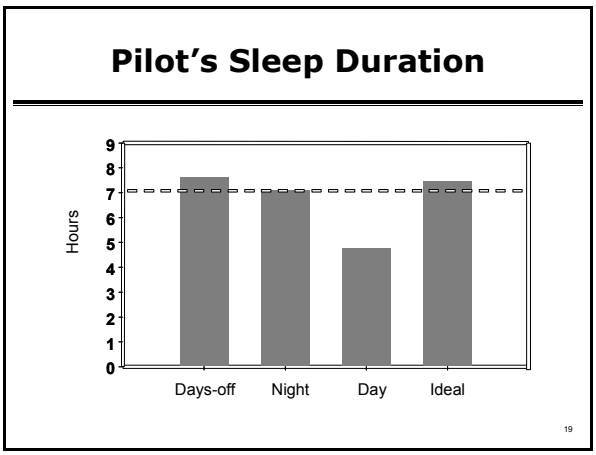
Irregular sleeping times result in a conflict with your biological clock. You find that you are attempting to sleep when your body wants to be wide awake, and you trying to stay awake when your body desperately wants to sleep.



Slide 18

Narrative

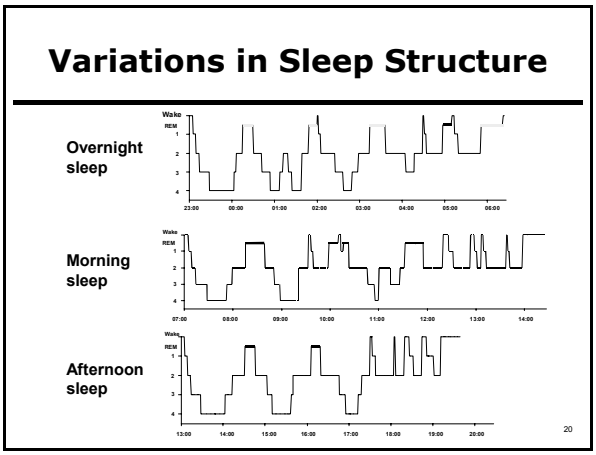
Throughout the day we have different tendencies for how long we can sleep. It is relatively easy for us to get our seven or eight hours of sleep during the night. Notice that when you go to sleep in the morning, after night work, you will sleep for approximately five hours. It is clear from this graph that biologically speaking "night" is the best time for sleeping. Notice that the graph is adjusted for an individual who regularly sleeps from 00:00 to 08:00. It should be advanced by two hours for someone who usually sleeps from 22:00 to 06:00.



Slide 19

Narrative

Canadian pilots reported that they were sleeping roughly seven hours a day when working days and during days off. This compares to the number of hours of sleep they said would be the ideal. However, these pilots also reported that they were getting an average of 4.5 hours of sleep when they worked nights. This means that if they work many nights in a row, the potential for building a severe sleep debt is high, leading to severely degraded performance as a result of their sleep deprived condition.



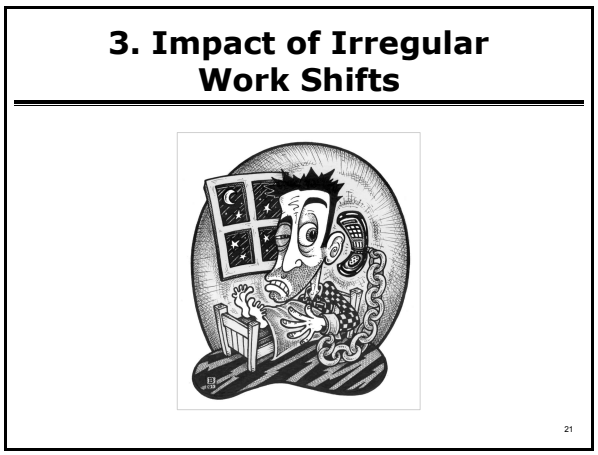
Slide 20

Narrative

Our sleep structure varies according to the time of day.

- Slow wave sleep (stages 3 & 4) is longer at night and shorter in the morning with the exception of the first day sleep following the first night shift.
- REM sleep is greater at night and in the morning, and is shorter in the afternoon.
- It may take longer to fall asleep during morning and afternoon sleep.
- A greater number of awakenings will occur during day sleep compared with night sleep.

3.4 Effects of Irregular Work Schedules



Slide 21

3.4.1 Training Objectives

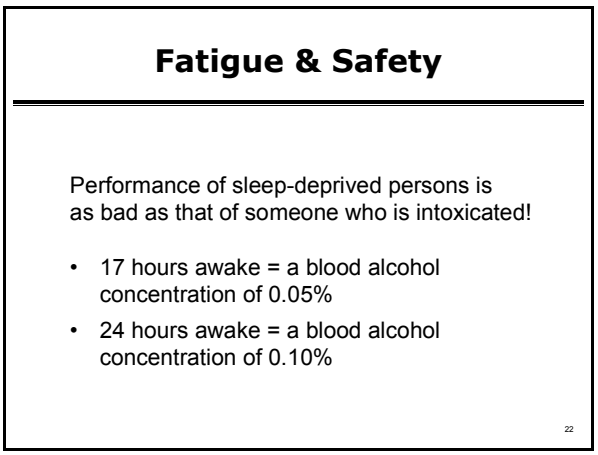
The training objectives for this component are:

- To inform the participant of the factors that are affected by irregular shifts
- To help the participant understand how irregular shift schedules affect these factors
- To show how these factors affect fatigue and work performance

3.4.2 Learning Objectives

The participant must be able to do the following:

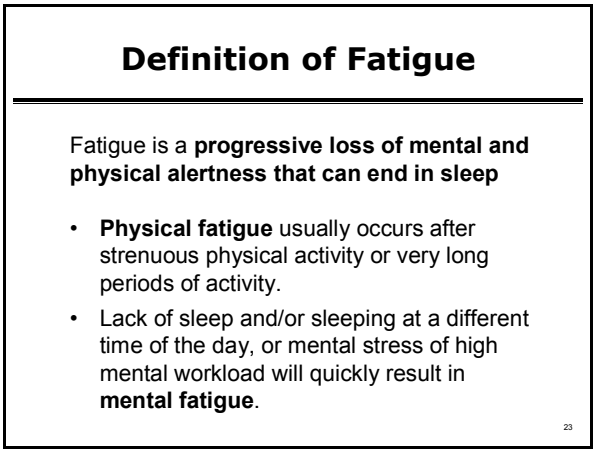
- Define fatigue and identify its causes
- Identify the warning signs of fatigue
- Name all of the factors that are affected by irregular work schedules
- Describe the process that occurs when working irregular work schedules
- Explain how this process leads to fatigue and ultimately degraded work performance
- Anticipate what difficulties they may face during long duration shifts



Slide 22

Narrative

Irregular shifts refer to work schedules where duration and timing of work periods are highly variable. The conflict between work and your biological clock results in greater fatigue while working and difficulty sleeping when off duty. Fatigue is a major threat to the safety of the marine pilot, as well as to the public. Research in Australia has demonstrated that after a 12-hour night shift, fatigue impairs responses, reaction times, logical reasoning, hand-eye co-ordination, and decision making in ways that are similar to a blood alcohol content of 0.048%. After 24 hours of wakefulness, performance is impaired to levels similar to a blood alcohol concentration (BAC) of 0.098%.



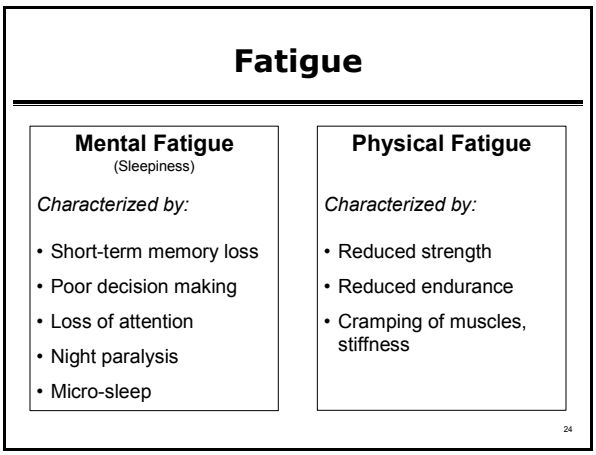
Slide 23

Narrative

Fatigue can be defined as a **progressive loss of mental and physical alertness that can end in sleep**.

Physical fatigue usually occurs after strenuous physical activity or very long periods of activity.

Lack of sleep and/or sleeping at a different time of the day, or mental stress or high mental workload will quickly result in mental fatigue.



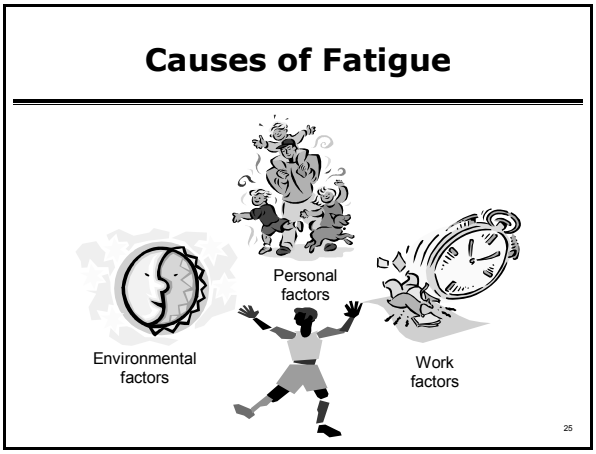
Slide 24

Narrative

We typically recognize the first signs of mental fatigue when we become increasingly inattentive while trying to concentrate on our job tasks. As fatigue increases, our short-term memory becomes less effective and we forget vital information. Our creativity and decision-making abilities start to wane and we have more difficulty dealing with novel situations. This causes us to have to work harder to avoid errors. If the workload is not too heavy we may be able to continue for some time. However, if the workload gets too heavy, or if we have to maintain it for too long, we may begin to make errors. In fact in some situations we may actually freeze in place and not be able to respond for a few seconds, even when we want to. This situation has been described in the scientific literature for a number of shift work populations and is called "night shift paralysis".

If the workload decreases, or sleep loss increases, we may even suffer "microsleep episodes" in which we actually fall asleep for a few seconds or even minutes. This type of event is not rare. We all have had microsleep episodes, while driving, reading a book, or doing other routine tasks. Following each episode, we often wake up with a start and cannot remember what happened. These microsleeps increase in frequency as we become more fatigued.

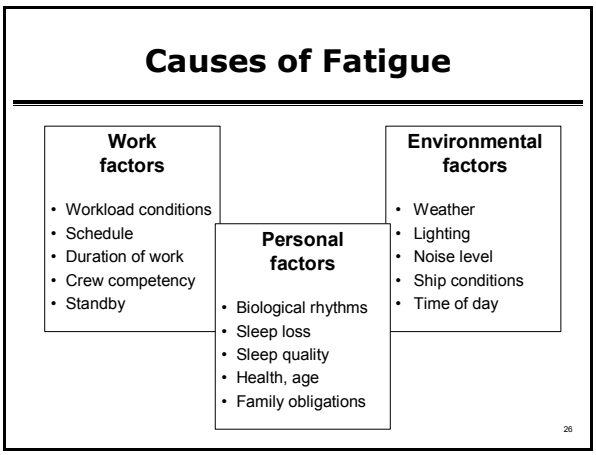
Physical fatigue makes us feel weaker and reduces our endurance, and we may find that our muscles become cramped, stiff and sore.



Slide 25

Narrative

When working at irregular times, you need to balance many factors and activities to optimize your performance and well being. How long one can work and how much fatigue is accumulated depend on factors such as time of day, the type of work involved, one's age, weather conditions, and prior sleep deprivation.



Slide 26

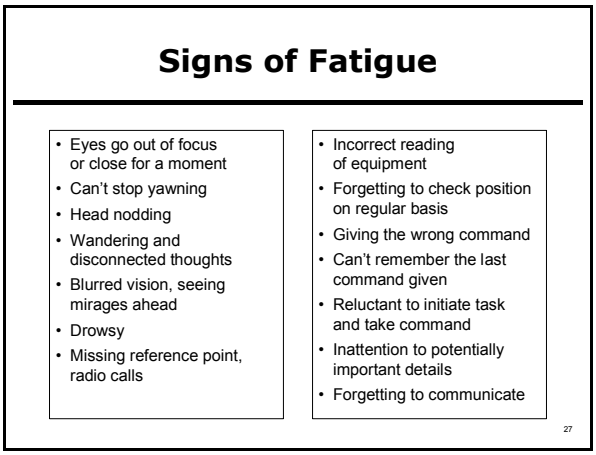
Narrative

Factors influencing marine pilot fatigue fall into three categories: work factors, personal factors and environmental factors.

The influence of work factors on your level of fatigue can vary with workload, length of duty periods, irregularity of schedules and work-related practices. Fatigue will increase quickly if you are not allowed adequate rest between activities.

Environmental factors are those dictated by elements that are largely outside of the marine pilot and pilotages' control. Time of day is the most important factor in fatigue-related incidents. The condition of being naturally sleepy at night combined with significant sleep loss can lead to an increased potential for error. Low levels of light and heat can also make people drowsy. Although little can be done about environmental factors, it is important to know how they can affect on your level of alertness so you can take additional precautions.

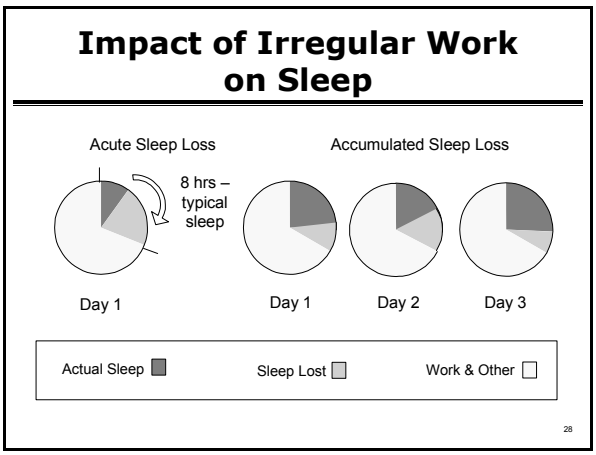
Some causes of fatigue are related to personal factors such as health, age, biological rhythms and family situation. However, you have much more control over personal factors, such as sleep hygiene and your ability to detect your level of fatigue.



Slide 27

Narrative

We also need to recognize the signs of fatigue. Knowing our level of fatigue will help us know when to let others know if we need added support (i.e. another set of eyes or just someone to make sure we stay on task). When you are feeling very sleepy, take an opportunistic nap when it is possible. The slide lists the main signs of severe fatigue. This is at the point where microsleeps happen in increasing frequency and night paralysis is a more likely possibility.



Slide 28

Narrative

Let's look at one of the main factors affecting performance, sleep or more specifically the lack of sleep. We lose sleep either by reducing a single sleep by a large amount (acute sleep loss), or by building up a sleep debt over time (accumulated sleep loss). The diagram illustrates acute and accumulated sleep loss. Note that in the acute condition only a very small portion (if any) of our daily sleep requirement is obtained. For example, in this slide 65% of the sleep required by an individual to function at 100% capacity has been lost. If we consider the accumulated sleep loss scenario, we see an individual losing about 20% of his daily requirement per day, resulting in 60% (3 days X 20%) less sleep. The amount of sleep lost is nearly equivalent.

However, the effects will be different. If your sleep/wake schedule results in an acute sleep loss condition, performance will be more impaired than during the first and second days of accumulated sleep loss. However, by the third day, performance will reach similar levels of impairment as in the acute condition.

Remember, working irregular schedules will result in irregular sleeping times, resulting in a conflict with your biological clock. Attempting to sleep at times when your body is less inclined to will ultimately result in *lost sleep*. The duration of the sleep period will be shorter, the structure will be altered by frequent awakenings, and time it takes to get to sleep will be longer.

Finally, the on-call nature of the job can affect sleep quality due to the stress of being on standby and the fact that sleep may be interrupted by calls from work. While it may be impossible to keep your sleep debt to zero all of the time, you need to make getting sleep a priority.

The only way to correct sleep loss is with adequate recovery sleep.

Performance is affected by

Biological clock

- Performance is significantly degraded during the night
- Performance is somewhat reduced during the afternoon (post-lunch) dip

Fatigue

- Performance is degraded with sleep loss (acute or cumulative)

29

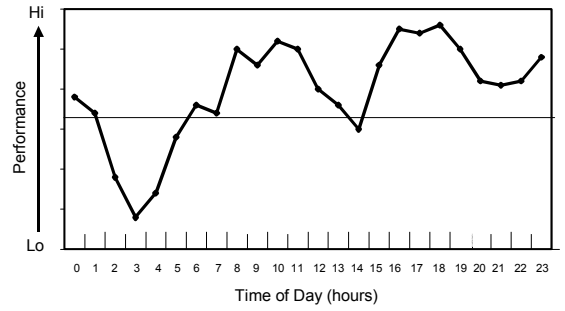
Slide 29

Narrative

A number of factors affect how well we do our job. Obvious ones are training, dedication and motivation to do a good job. However, there are other factors that we must consider:

- Performance is significantly degraded during our circadian "night"
- We can also suffer a decrement in performance during the afternoon dip
- Sleep loss can make these decrements even worse

Performance for Time of Day



Adapted from Folkard 1996

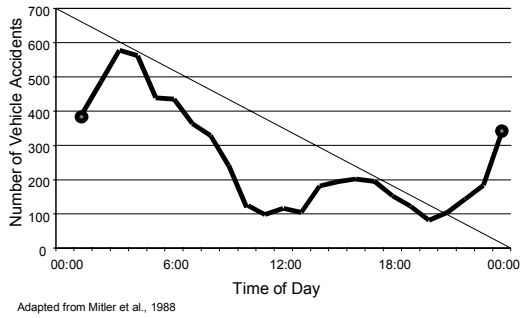
30

Slide 30

Narrative

Accidents and errors have been examined by scientists in many industrial and operational environments (heavy industry plants, nuclear power plant control rooms, petrochemical plants, truck drivers, etc.). The results are all consistent – night work has a significantly higher rate of errors, followed by day shifts, followed by working in the late afternoon and evenings. Also, it should be noted that a reduction in performance can be expected during the mid-afternoon.

Number of Fatigue-Related Vehicle Accidents



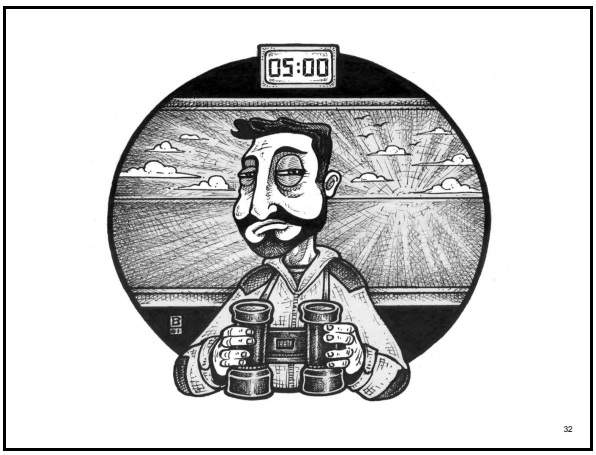
Adapted from Mitler et al., 1988

31

Slide 31

Narrative

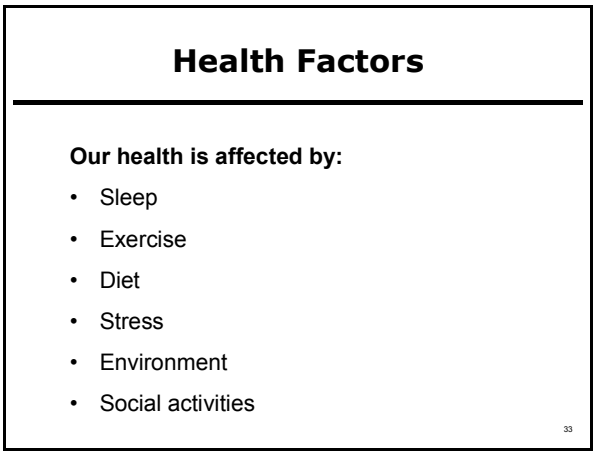
We see a similar pattern reflected in vehicular accidents that have been attributed to fatigue. This graph includes only those clearly related to fatigue such as single vehicle accidents and collisions where no brakes were applied and alcohol was not a factor. The graph shows U.S. statistics, but identical patterns can be seen worldwide. This reinforces the theory that night work is riskier, and that we suffer some performance decrement in the mid-afternoon.



Slide 32

Narrative

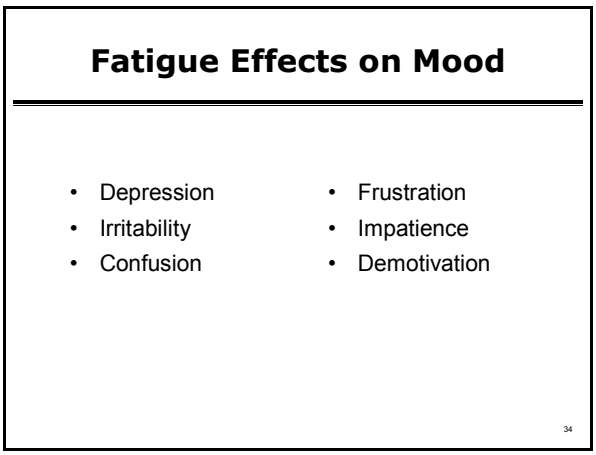
Many famous disasters happened when operators were working long hours, overnight, and/or with little sleep prior to the accident. Examples are the Exxon Valdez spill, the Challenger disaster, and the Chernobyl nuclear and Bophal chemical disasters. A railway-related disaster in Canada includes the Hinton train disaster and examples of fatigue related accidents involving a Canadian marine pilot are the grounding of the bulk carrier *Raven Arrow*, and the striking by the bulk carrier *Nirja* of the tanker *Hamilton Energy*.



Slide 33

Narrative

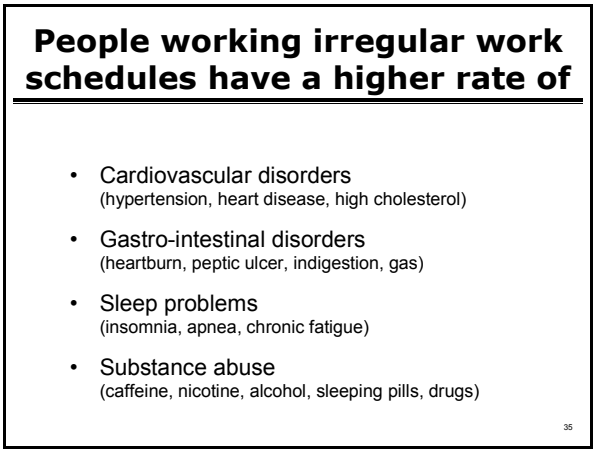
Our health is affected by many factors. Lack of sleep can lead to health problems directly, such as disrupted immune pattern, or indirectly through increased risk of accidents. Sleep loss has been linked to a host of socio-psychological problems such as depression. Fitness level affects our ability to maintain health and to recover from injury. Healthy eating also contributes to improved resistance to disease and overall energy levels. How we handle stress is a major factor in maintaining our health. The physical environment presents various toxins and substances with which our bodies must cope. Finally, our social activities also affect our levels of stress and our ability to maintain our health.



Slide 34

Narrative

Fatigue affects your mood. Be vigilant about how you behave when you are severely fatigued. If you find you are not responding normally, keep your temper in check and relax. **Recognize the impact of fatigue on your mood: it can make you more depressed, irritable, frustrated, impatient, confused and unmotivated.**



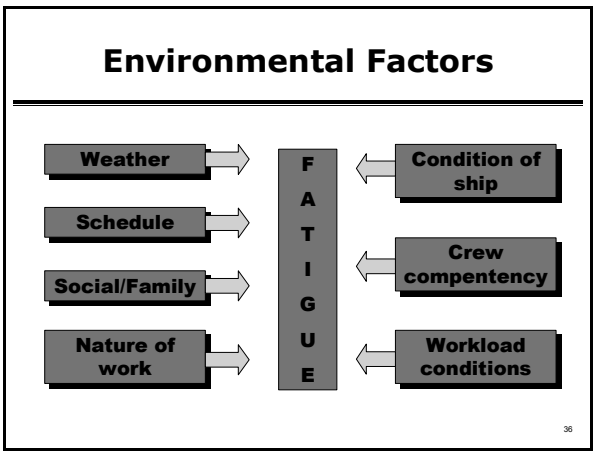
Slide 35

Narrative

When the marine pilot must move from the regular routine at home to the irregular routine on board the ship, the biological rhythm is disrupted, sleep is lost, and the body suffers. When we are young, we can bounce back a lot more easily than when we get older.

Various studies indicate that 20% of the shift-working population change jobs after a very short period of time due to serious problems. Only 10% actually claim to have no complaints about shift work. The remaining 70% tolerate shiftwork but have various complaints about it. To cope with disrupted schedules and the problems they cause, workers often adopt habits that increase the risk of health problems. For example, they will eat when their body is not always ready for digestion, and they increase their consumption of nicotine and stimulants (caffeine, etc.). Moreover, disruptions in rhythms and work schedule may reduce the available time for sleep and sleep quality, thus increasing sleep problems and the use of sleeping pills and sometimes alcohol. According to researchers, those working irregular shifts have higher complaints of health problems than the general population.

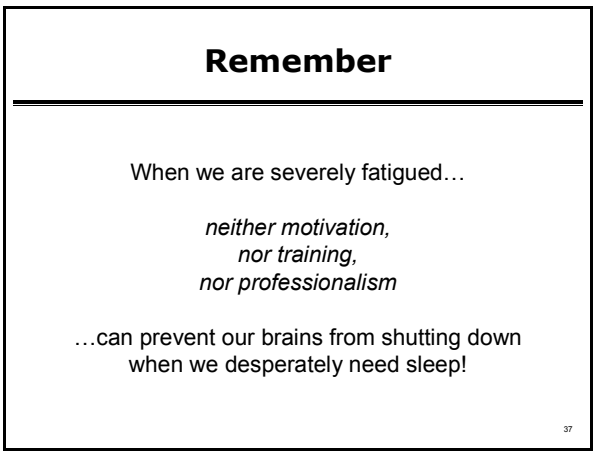
However, long-term studies need to be done to show the real impact of shiftwork on personal health.



Slide 36

Narrative

Environmental conditions can affect our sleep efficiency, levels of sleepiness and performance on the job. Lighting conditions can increase sleepiness and decrease performance. Darkness is a benefit for sleeping, but a problem if we need to remain alert. Bright conditions can help us stay alert but glare can interfere with our performance. Noise can either soothe us to sleep, or it can keep us awake. Outside an optimum range of temperature our performance will degrade, and our sleep efficiency will suffer. Under a light workload we may find it difficult to fend off sleepiness, particularly if we are sleep deprived.

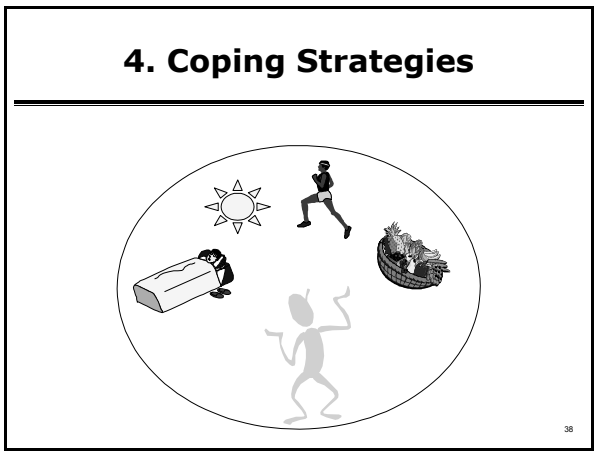


Slide 37

Narrative

Sleep is a basic need and no matter how hard we try, when we are sleep deprived we may find it impossible to stay awake.

3.5 Coping Strategies (Interventions and Countermeasures)



Slide 38

3.5.1 Training Objectives

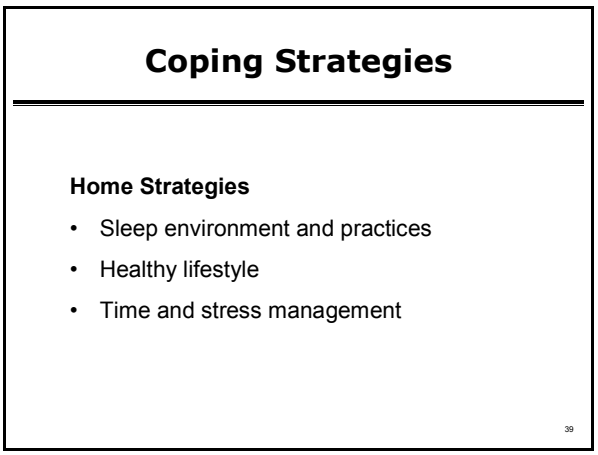
The training objectives for this component are:

- To inform the participants of various methods that may be used to counteract fatigue
- To provide the participants with the skills necessary to plan for the use of countermeasures before and during a shift
- To allow the participants to tailor the countermeasures to their own personal requirements

3.5.2 Learning Objectives

The participant must be able to do the following:

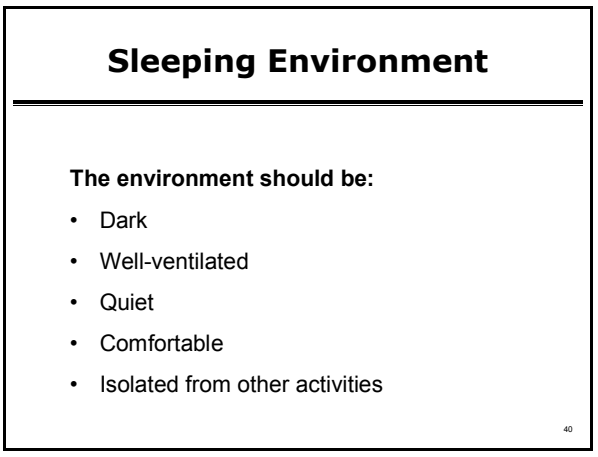
- Name and describe four major fatigue countermeasures
- Explain how these countermeasures improve alertness and/or reduce fatigue
- Recognize the pitfalls of countermeasures
- Use the timing of their own biological rhythm for planning rest breaks and naps
- Know when to expect such effects as sleep inertia (the grogginess experienced after a nap or sleep) etc.
- Apply countermeasures to manage their fatigue



Slide 39

Narrative

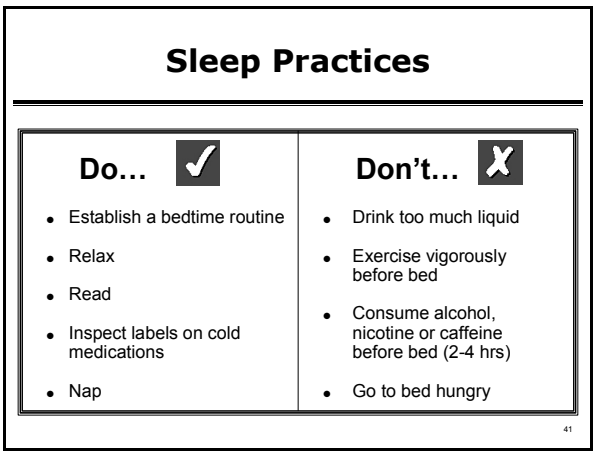
Here we have a list of fatigue counter-measures recognized by scientists and practitioners to be the most effective. These countermeasures can be applied at home.



Slide 40

Narrative

Several aspects of the sleeping environment at home can be changed. First the environment must be *dark*. Darkness is the main body cue to sleep. Creating a dark bedroom during the day means extra thick curtains or wearing eye-shades. The room should be *well ventilated* and *comfortable*. The *temperature* of the room should *not* be too hot (higher than 21 Celsius) or too cold (lower than 17 Celsius). More awakenings and lighter sleep will result if the temperature is not at a comfortable level. Keep the room *quiet* by installing soundproofing in the walls. Wearing earplugs, turning on a fan to create white noise, and asking the family to be quiet can also help. If possible, the room should be isolated from other activity areas in the house to avoid *interruptions and noise*. When not on call you should turn off the phone ringer and make sure you cannot be disturbed by the doorbell.



Slide 41

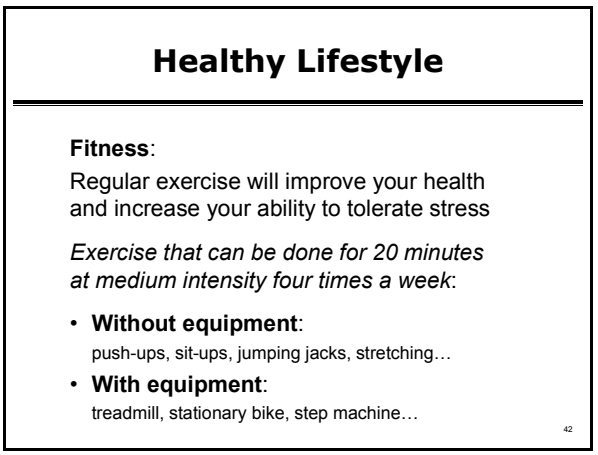
Narrative

There are many things that you can do to help prepare yourself for sleep. Developing a before-sleep routine can help trigger your sleep mechanism. Relaxation prior to getting into bed will help you ready your body for sleep. Sometimes reading or listening to soothing music is enough to put your mind at ease and help you drift off to sleep. Make sure that any medications, such as cold remedies, do not contain caffeine, alcohol or other stimulants. Avoid coffee at least four hours before bed because it takes at least that amount of time to reduce the levels of caffeine in the body. Avoid alcohol before going to bed because it will disrupt your sleep later in the sleep period and prevent you from getting the proper amounts of slow wave and REM sleep you need to function properly. It is not advisable to do any heavy high aerobic exercise before bed, since it will have a stimulating effect and increase your metabolism. Finally, eat something light prior to going to bed if you are hungry.

Napping

One of the best ways to get your body back on track when you are fatigued is to nap. Research has shown that taking a planned nap ahead of the work period in particular can reduce the normal degradation in performance seen on night shifts. This approach takes advantage of the fact that a well-rested individual can better manage the loss of one night's sleep than individuals who are already fatigued and likely to suffer profound performance decrements. Although you can't store up sleep by getting more than you need prior to work, you can minimize the impact of fatigue by being well rested prior to your work shift.

While naps can cause insomnia for people who can't fall asleep easily, they can help others. Under irregular sleep/wake schedules, however, naps may have to be taken when there is an opportunity to nap, rather than when it might be best as determined by your biological rhythms (i.e. at night or in the afternoon). Nap duration will be a function of the interaction between time of day and the amount of prior wakefulness. When napping in addition to a longer sleep period, keep the duration between 15 to 40 minutes to avoid waking up from a deep sleep. If you are planning a nap prior to a night shift, schedule a two-hour nap to end one or two hours before you need to work or drive. This is enough time for you to recover from a feeling of grogginess (sleep inertia) that may occur awakening from deep sleep.

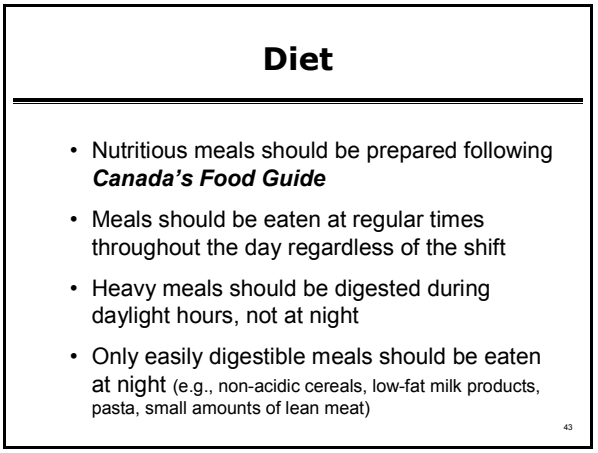


Slide 42

Narrative

Keeping fit and active will improve your ability to deal with the shift and other stresses that prevent you from obtaining sleep or staying alert. You can stay fit by getting 20 minutes of exercise at least four times a week. Remember don't exercise just before bedtime. Walking, jogging and going to a gym are exercises that can easily fit in a marine pilot's irregular schedule.

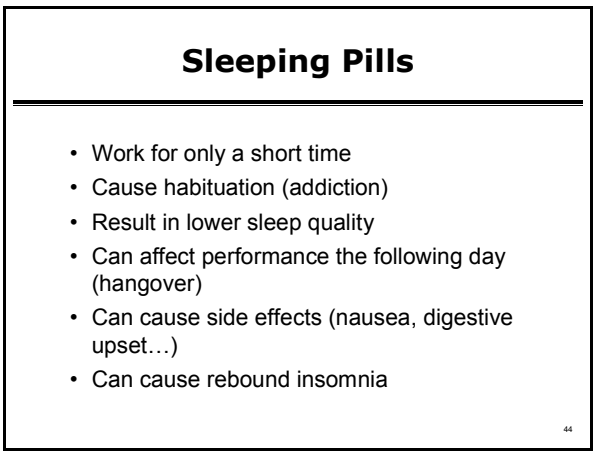
Exercise will help you maintain an optimal weight, reduce the risk of sleep apnea, heart disease, and diabetes (Type II). Exercise provides physical well-being, improves your mood, self-esteem and to some extent your job performance.



Slide 43

Narrative

It is difficult to stay alert on the job, and function well when you are hungry. If you do not keep your blood sugars up and do not have adequate nutritional resources in your body you will not perform well. This means eating well all of the time, if possible, since your body stores and uses food not only to provide you with energy, but also to build tissues and replenish reserves used during stressful situations. Eating well includes keeping a regular schedule for meals as much as feasible, and paying attention to the type of meal that is appropriate for your body at any given time. Make sure that you eat only easily digestible meals during your body's "night" and keep a heavy meal for another "scheduled" mealtime (e.g. just prior to the night shift). Digestion is influenced by the body's biological clock and by the anticipation of eating. The secretion of enzymes necessary for proper digestion occurs at regular meal times and slows down at night. Your digestive system is not prepared to digest large meals and hard-to-digest food during the night. Don't forget to drink lots of water throughout the day. Staying hydrated helps keep you healthy and alert. Make sure that you obtain a balanced daily diet as indicated by Canada's Food Guide.



Slide 44

Narrative

Natural sleep is best but sometimes you may need help to sleep. Sleeping pills can be taken only for short periods to temporarily aid your sleep in periods of emotional difficulty, stress, or for other medical reasons. If getting sleep continues to be a problem, you may need help to find the real causes (medical, behavioural, or psychological) and start a treatment to cure the problem.

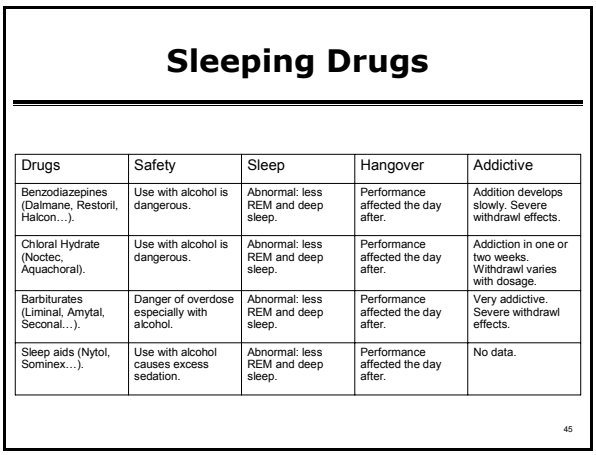
Usually, sleeping pills lose their effectiveness after a month. To keep the pills effective you need to increase the dose or change to another type of sleeping medication. Moreover, *sleeping pills are addictive and if used for longer than two to three weeks they may result in substantial withdrawal effects depending on the type of pill*. If you stop taking pills after long-term usage, be prepared for rebound insomnia because your body has been accustomed to relying on the pills to sleep.

Sleeping pills have nothing to do with the normal biology of sleep. Sleep brought by any type of pill is abnormal, and involves less REM and slow wave sleep, especially after prolonged usage. *Sleeping pills do not always and consistently improve mental performance* on the following day. Some pills can even reduce performance (hangover effect). The hangover effect depends on the type of pill and how rapidly your body gets rid of these drugs. Elimination of the drug by the body will depend on the type of pill, your health, age, and dosage. All sleeping pills have side effects. They may cause anxiety, nausea, confusion, digestive upset, dizziness, and frequent urination. **Use sleeping pills only on the advice of a physician.** Sleeping pills slow down respiration and should never be taken if you have respiratory problems.

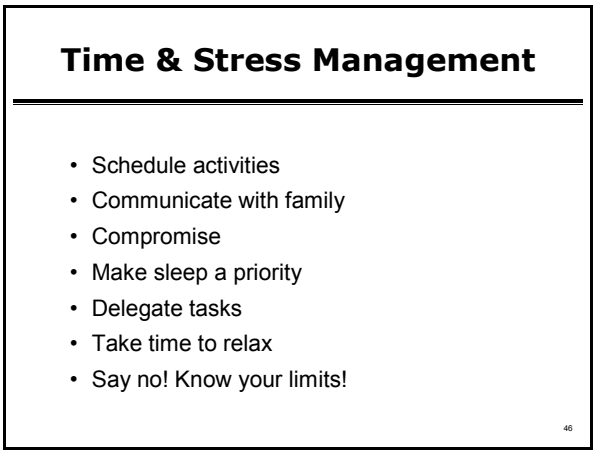
Important: Sleeping pills do not address the actual cause of the irregular shift worker's sleep difficulty, but can be useful if their action is limited and they are taken for short periods of time. However, care should be taken upon awakening since some hangover effect may occur.

Alcohol

Avoid any alcohol before going to bed. Alcohol may help you fall asleep but it actually disturbs your sleep patterns. It will disrupt your sleep by causing early morning or even middle of the night awakening and prevent you from getting the proper amounts of slow wave and REM sleep you need to function properly. Alcohol is eliminated at the rate of approximately one drink per hour. Alcohol restricts respiration. People who snore heavily or have known respiratory problems should limit their ingestion of alcohol and pay attention to the timing of their alcohol consumption so their body has time to eliminate the alcohol before going to sleep.



Slide 45



Slide 46

Narrative

One of the most challenging areas for a marine pilot is finding time to spend with family and friends while on tour of duty. To the family, a day off can look like a good day to do errands or play. To the marine pilot returning from a long night assignment, day looks like a good time to sleep. *Family obligations often compete with your need for sleep*. The first step is to communicate with your family and friends. Schedule your time to make sleep a priority followed immediately by spending time with your family. You can also help them understand the difficulty of irregular work and the fatigue you are experiencing by showing them your fatigue management guide booklet and talking about some of the more important areas that involve them.

Balancing work, family and social obligations, as well as finding time for yourself can cause stress and could lead to illness. Having unrealistic demands on time can cause stress. Disruption of your biological clock and its impact on sleep will also result in stress. Planning ahead, prioritizing activities, learning to say no and delegating tasks are essential skills that need to be learned and continually practised. Physical exercise and/or relaxing activities will help reduce your stress. Making time for sleep, family and friends will affect your sense of wellness. Say no to projects or activities that won't fit your time schedule or that will compromise your time for sleep or for being with your family. Live within your budget. *Know your limits!*

Coping Strategies

Work strategies

- Napping
- Strategies to stay awake
- Other strategies

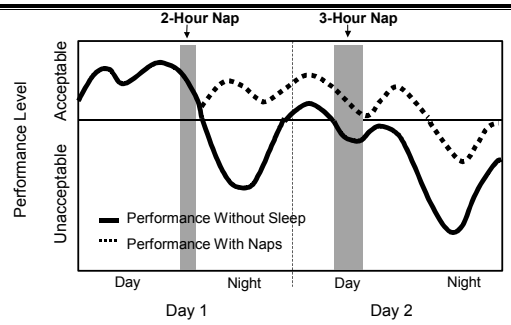
47

Slide 47

Narrative

These countermeasures can be applied in the work environment.

Nap Effects on Performance



48

Slide 48

Narrative

Sleep is obviously the best countermeasure against fatigue and performance decrement. Short naps have an extraordinary recuperative effect and their benefit in maintaining performance within acceptable levels should not be underestimated. Research has shown that this strategy works well to help maintain performance during long shifts even when sleep deprived. The graph shown here (slide 49) clearly illustrates the benefits of napping for maintaining performance.

Napping Strategies

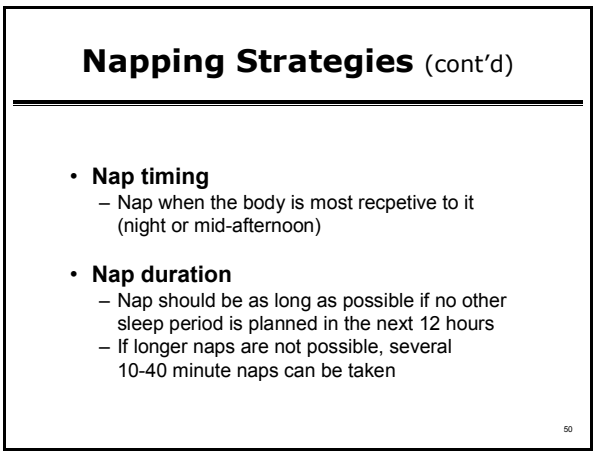
- **Planning**
  - Nap prior to sleep loss
  - If not possible, take opportunistic nap
- **Nap environment**
  - Napping should be done lying down
  - If possible, make sure your nap period is worry-free

49

Slide 49

Narrative

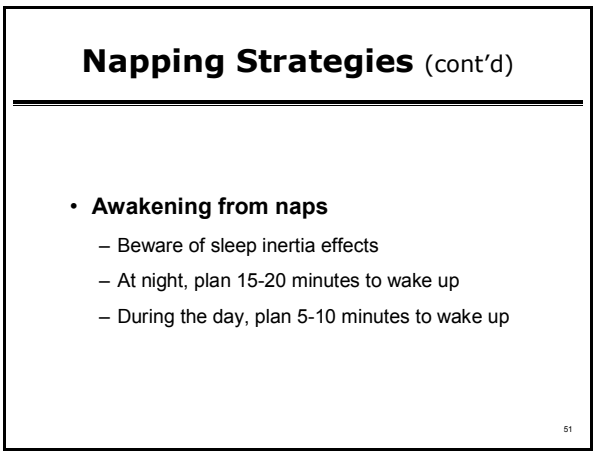
There are several factors to consider when taking a nap, such as work considerations and sleep timing. Marine pilots should consider taking naps in situations such as during a long lake crossing, while waiting for long periods at a lock, waiting to board a ship, or while anchored. Napping during these times will depend on other factors such as weather conditions, crew competency, traffic, etc.



Slide 50

Narrative

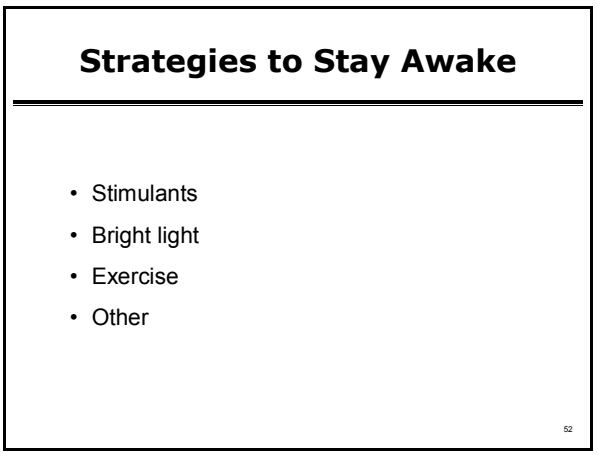
Naps taken at work depend on opportunities available but if you can plan your nap in advance you should choose times when you will fall asleep easily (consider your biological clock).



Slide 51

Narrative

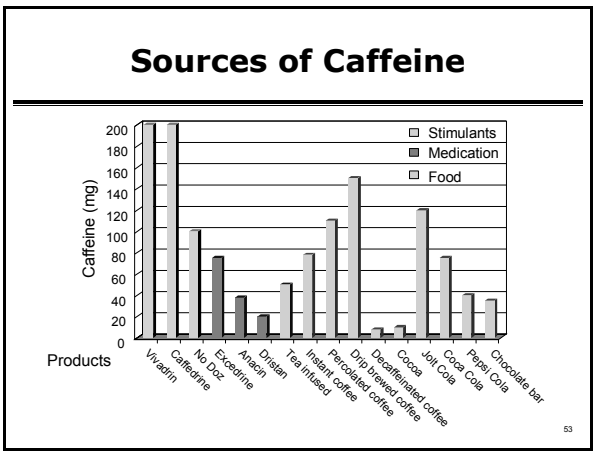
Nap duration should either be short (between 10 to 40 minutes) or long (90 minutes or more) to avoid the possibility of feeling drowsy upon awakening (sleep inertia). In any case, you should plan some time to wake up and recover from sleep inertia.



Slide 52

Narrative

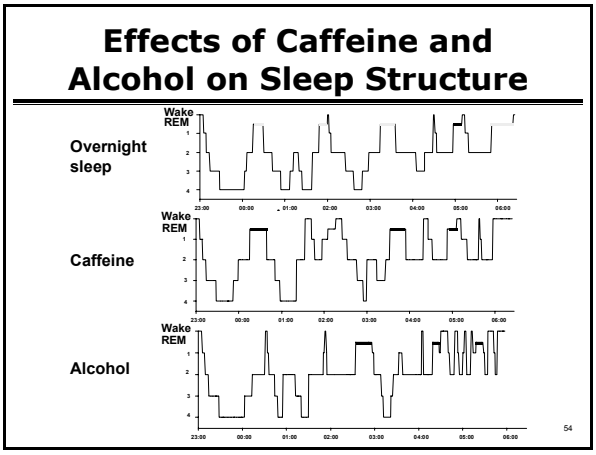
Sometimes you just can't get enough sleep, or nap when you should. Compounding this, you may have to work many hours without a break. Marine pilots may need to employ a strategy to maintain alertness on the job. Here we talk about some ways to maintain your alertness when you are working through the times when your body threatens to slip into microsleep episodes. Of course, these are no substitutes for getting the sleep you need. All these strategies can do is to delay temporarily the impact of fatigue.



Slide 53

Narrative

The most common stimulant used by those working irregular shifts is *caffeine* in the guise of coffee, cola or another caffeinated drink. *Nicotine* is also a stimulant. There are other over-the-counter stimulants like No-doze and Vivadrin that contain caffeine. The strong stimulating effects of caffeine peak within 30 minutes to one hour, and it may take up to eight hours for it to clear out of your system. As we age, we are more sensitive to the effects of stimulants because they take more time to eliminate. As a stimulant, caffeine must be used carefully since it increases heart rate, blood pressure and urination. Caffeine may be addictive if used too much, and for too long. Heavy users (more than four cups per day) who quit may suffer withdrawal symptoms such as headaches, restlessness, vomiting, depression, and fatigue. These symptoms will disappear after several days. If caffeine is ingested as large quantities of coffee or tea, the tannins and acids may be harmful to the stomach, particularly during the circadian nadir when digestion is slowed down. You can get an idea of their effects by comparing other sources of caffeine to those you are familiar with.



Slide 54

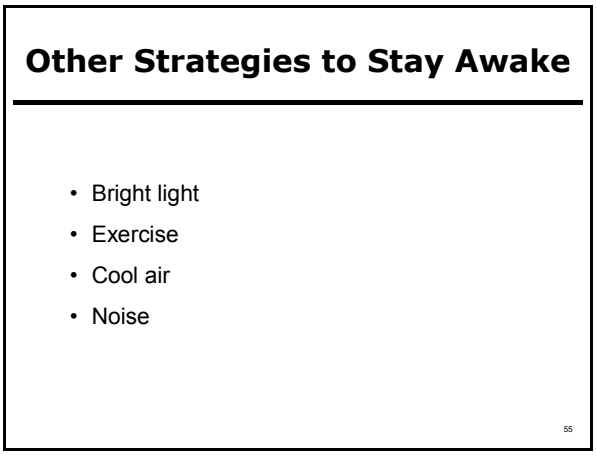
Narrative

Caffeine consumption prior to sleep or in large doses increases awakenings, reduces slow wave sleep, and shortens the sleep period. However, combining the arousing effect of caffeine and napping can be very effective. When planning a short nap (less than 20 minutes) take caffeine just before the nap and benefit from the peak effect of caffeine when you wake up. However, you should factor in the time it takes to drink your cup of coffee. Don't ingest caffeine beforehand if you plan to take a long nap. *Timing and moderation are the keys to effective use of caffeine.*

You can compare the impact of caffeine with *alcohol's* effect on sleep. Drinking alcohol prior to bed will increase the number of episodes of awakening during the latter part of the night and delay and reduce REM sleep.

Finally, *nicotine* has a double effect. At low concentrations in the blood it will produce relaxation. At higher blood concentrations it produces a stimulant effect. Smokers may take

longer to fall asleep than non-smokers and their sleep duration is reduced by 30 minutes per night on average. Habitual smokers who try to stop smoking will report sleep disturbances. The effects of nicotine on alertness are short lived and are not sufficient to overcome sleepiness due to sleep loss. Smoking also contributes to health problems such as lung cancer, heart disease and respiratory disorders.



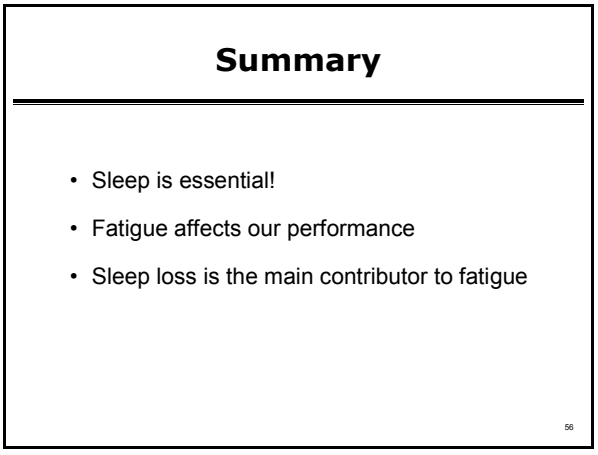
Slide 55

Narrative

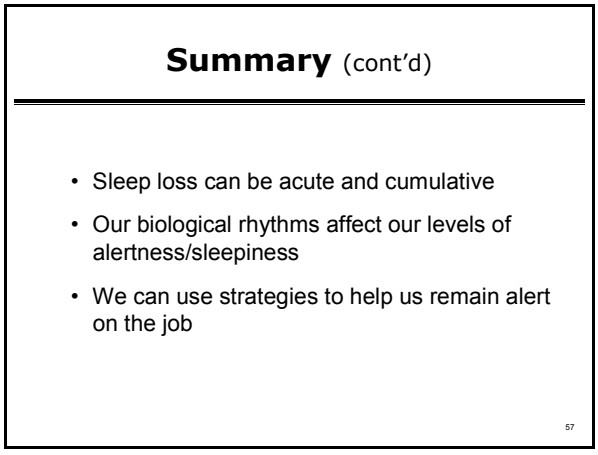
Some scientists have found that working in a bright-light environment helps maintain alertness. Fortunately, half of your time piloting ships is done in bright sunlit conditions, or at least during daylight. Unfortunately, half of your piloting tasks must be performed in darkness, a condition that will be conducive to dozing off.

Exercise can also help to keep the body from feeling sluggish. Getting up and moving around when there are a few minutes between job tasks can revive you for a short period of time, depending on how fatigued you are. Stepping out into the cool air and taking a walk around the deck will help to shake off some of the sleepiness.

Sounds can help you stay alert, providing they are intermittent and loud enough. Casual conversation can help keep you awake and on task providing that it is not too engaging.



Slide 56



Slide 57

4 BIBLIOGRAPHY

4.1 Source Books

Colquhoun, W.P, Costa, G., Folkard, S., and Knauth, P., eds. (1996) *Shiftwork: Problems and Solutions*. New York; Peter Lang.

Coren, S. (1996) *Sleep Thieves*. New York; Free Press.

Dement, W. (1992) *The Sleep Watchers*. Stanford; Stanford Alumni Association.

Dinges, D.F., and Broughton, R.J., eds. (1989) *Sleep and Alertness: Chronobiological, Behavioral, and Medical Aspects of Napping.* New York; Raven Press.

Hauri, P., and Linde, S. (1996) *No More Sleepless Nights*. New York; John Wiley & Sons.

Horne, J. (1988) *Why We Sleep*. New York; Oxford University Press.

Maas, J. (1998) *Power Sleep*. New York; Harper Perennial.

Monk, T.H., and Folkard, S. (1992) *Making Shiftwork Tolerable*. London; Taylor & Francis.

Nicholson, A.N., and Stone, B.M. (1982) *Sleep and Wakefulness Handbook for Flight Medical Officers*. NATO – AGARD –AG-270(E). Neuilly Sur Seine; Advisory Group for Aerospace Research & Development.

Shapiro, C., Heslegrave, R., Beyers, J., and Picard, L. (1997) *Working the Shift: A Self-Health Guide*. Toronto; JoliJoco.

Stampi, C., ed. (1992) *Why We Nap: Evolution, Chronobiology, and Functions of Polyphasic and Ultrashort Sleep*. Boston; Birkhäuser.

4.2 Reference Papers

1. Angus, R.G., and Heslegrave, R.J. (1983) The effects of sleep loss and sustained mental work: Implications for command and control performance. In *AGARD Conference Proceedings No. 338: Sustained Intensive Air Operations – Physiological and Performance Aspects.* Paris; NATO. pp. 11.1-11.20.

2. Angus, R.G., and Heslegrave, R.J. (1985) Effects of sleep loss on sustained cognitive performance during a command and control simulation. *Behavioral Research, Methods, Instruments and Computers*. 17: 55-67.

3. Baranski, J. (1995) Evidence for a Modafinil indiced "overconfidence" effect during sustained operations. *Proceedings of the 37th Annual Conference of the International Military Testing Association.* Toronto; Canadian Forces Personnel Applied Research Unit.

4. Broughton, R.J. (1989) Chronobiological aspects and models of sleep and napping. In Dinges, D.F., Broughton, R.J. (eds.) *Sleep and Alertness: Chronobiological, Behavioral, and Medical Aspects of Napping*. New York; Raven Press.

5. Buck, L., Brookes, J., and Webb, R. (1998) *Hours of Work and Rest of Canadian Ice Navigators on Board Foreign-Registered Vessels in Arctic Waters* (TP 13207E). Montreal; Transportation Development Centre, Transport Canada.

6. Buguet, A., Montmayeur, A., Pigeau, R., and Naitoh, P. (1995) Modafinil, d-amphetamine and placebo during 64 hours of sustained mental work. Effects on two nights of recovery sleep. *Journal of Sleep Research.* 4: 229-241.

7. Campbell, S. (1992) The timing and structure of spontaneous naps. In Stampi, C. (ed.) *Why We Nap: Evolution, Chronobiology, and Functions of Polyphasic and Ultrashort Sleep*. Boston; Birkhäuser.

8. Canadian Transportation Agency (1999) *Ministerial Review of Outstanding Pilotage Issues.*

9. Carskadon, M.A. (1989) Ontongeny of human sleepiness as measured by sleep latency. In Dinges, D.F., Broughton, R.J. (eds.) *Sleep and Alertness: Chronobiological, Behavioral, and Medical Aspects of Napping.* New York; Raven Press.

10. Colquhoun, W.P. (1996) Shiftwork at Sea: Studies of Watchkeeping. In Colquhoun, W.P., Costa, G., Folkard, S., Knauth, P. (eds.) *Shiftwork: Problems and Solutions*. New York; Peter Lang.

11. Comperatore, C.A., and Kingsley, L. (1998) *Crew Fatigue and Performance on U.S. Coast Guard Cutters*. Report no. CG-D-10-99 for U.S. Department of Transportation, United States Coast Guard Research and Development Center.

12. Condon, R., Colquhoun, W.P., Plett, R., DeVol, D., and Fletcher, N. (1988) Work at sea: A study of sleep, and of circadian rhythms in physiological and psychological functions, in watchkeepers on merchant vessels – IV: Rhythms in performance and alertness. *International Archives of Occupational and Environmental Health*. 60: 405-411.

13. Coren, S. (1996) *Sleep Thieves*. New York; Free Press.

14. Davis, S.C., Hamilton, K., and Heslegrave, R.J. (1997) *Study on Extended Coast Guard Crewing Periods – Phase 1* (TP 12976E). Montreal; Transportation Development Centre, Transport Canada.

15. Davis, S.C., Hamilton, K., and Heslegrave, R.J. (1998) *Study on Extended Coast Guard Crewing Periods – Phase 2* (TP 13248E). Montreal; Transportation Development Centre, Transport Canada.

16. Dawson, D., Lamond, N., Donkin, C., and Reid, K. (1998) Quantitative similarity between the cognitive psychomotor performance decrement associated with sustained wakefulness and alcohol intoxication. In Hartley, L. (ed.) *Proceedings of the Third International Conference on Fatigue in Transportation: Managing Fatigue in Transportation*. Fremantle, Australia. pp 231-256.

17. Dement, W. (1992) *The Sleep Watchers*. Stanford; Stanford Alumni Association.

18. Dinges, D.F., Orne, M.T., Whitehouse, W.G., and Orne, E.C. (1987) Temporal placement of a nap for alertness: Contributions of circadian phase and prior wakefulness. *Sleep.* 10: 313-329.

19. Dinges, D.F., Whitehouse, W.G., Orne, E.C., and Orne, M.T. (1988) The benefits of a nap during prolonged work and wakefulness. *Work and Stress.* 2: 139-153.

20. Folkard, S. (1996) Biological disruption in shiftworkers. In Colquhoun, W.P., Costa, G., Folkard, S., Knauth, P. (eds.) *Shiftwork: Problems and Solutions*. New York; Peter Lang.

21. Folkard, S., and Condon, R. (1987) Night Shift Paralysis in Air Traffic Control. *Ergonomics.* 20: 1353-1653.

22. Friedman, J., Globus, G., Huntley, A., Mullaney, D., Naitoh, P., and Johnson, L. (1977) Performance and mood during and after gradual sleep reduction. *Psychophysiology.* 14: 245-250.

23. Hamilton, P., Wilkinson, R.T., and Edwards, R.S. (1972) A study of four days of partial sleep deprivation. In Colquhoun, W.P. (ed.) *Aspects of Human Efficiency*. London; The English Universities Press.

24. Horne, J. (1988) *Why We Sleep.* New York; Oxford University Press.

25. Keyano College (1995) *Shifting to Wellness*. Fort McMurray.

26. Kleitman, N. (1963) *Sleep and Wakefulness.* Chicago; University of Chicago Press.

27. Lavie, P. (1989) Ultradian aspects. In Dinges, D.F., Broughton, R.J. (eds.) *Sleep and Alertness: Chronobiological, Behavioral, and Medical Aspects of Napping.* New York; Raven Press.

28. Lavie, P. (1992) Beyond circadian regulation: Ultradian components of sleep-wake cycles. In Stampi, C. (ed.) *Why We Nap: Evolution, Chronobiology, and Functions of Polyphasic and Ultrashort Sleep*. Boston; Birkhäuser.

29. Mitler, M., Carskadon, M., and Czeisler, C. (1988) Catastrophes, sleep, and public policy. Consensus report. *Sleep*. 11(1): 100-109.

30. Murphy, P.J., and Mombourquette, C.J. (1998) Fatigue, Sleep Loss, and Operational Performance. *Personnel Research Team Operational Effectiveness Guide 98-1*. Ottawa; National Defence Headquarters.

31. Naitoh, P. (1969) *Sleep loss and its effects on performance*. U.S. Navy Medical Neuropsychiatric Research Unit Technical Report 68-3. San Diego; U.S. Navy Medical Neuropsychiatric Research Unit.

32. Naitoh, P. (1992) Minimum sleep to maintain performance: The search for sleep quantum in sustained operations. In Stampi, C. (ed.) *Why We Nap: Evolution, Chronobiology, and Functions of Polyphasic and Ultrashort Sleep*. Boston; Birkhäuser.

33. Naitoh, P. (1976) Sleep deprivation in human subjects: A reappraisal. *Waking and Sleeping*. 1: 53-60.

34. Naitoh, P., and Townsend, R.E. (1970) The role of sleep deprivation in human factors. *Human Factors*. 12: 575-585.

35. Pigeau, R., Naitoh, P., Buguet, A., McCann, C., Baranski, J., Taylor, M., Thompson, M., and Mack, I. (1995) Modafinil, d-Amphetimine and placebo during 64 hours of sustained mental work. Effects on mood, fatigue, cognitive performance and body temperature. *Journal of Sleep Research*. 4: 212-228.

36. Pilcher, J.J., and Huffcutt, A.I. (1996) Effects of sleep deprivation on performance: a meta-analysis. *Sleep*. 19(4): 318-326.

37. Rechtshaffen, A. (1979) The function of sleep: Methodological issues. In Drucker-Colin, R., Shkurovich, M., Sterman, M.B. (eds.) *The Functions of Sleep*. New York; Academic Press.

38. Rosa, R. (1995) Extended workshifts and excessive fatigue. *Journal of Sleep Research*. 4(2): 51-56.

39. Sallenen, M., Härmä, M., Äkerstedt, T., Rosa, R., and Lillqvist, O. (1998) Promoting alertness with a short nap during the night shift. *Journal of Sleep Research*. 7: 240-247.

40. Sanquist, T.F., Raby, M., Maloney, A.L., and Carvalhais, A.B. (1996) *Fatigue and Alertness in Merchant Marine Personnel: A Field Study of Work and Sleep Patterns*. Springfield, Virginia; National Technical Information Service.

41. Seminara, J.L., and Shavelson, R.J. (1969) Effectiveness of space crew performance subsequent to sudden sleep arousal. *Aerospace Medicine*. 40: 723-727.

42. Torsvall, L., Akerstedt, T., Gillander, K., and Knutsson, A. (1989) Sleep on the night shift: Twenty-four hour EEG monitoring of spontaneous sleep/wake behavior. *Psychophysiology*. 26: 352-358.

43. Webb, W.B. (1992) Developmental aspects and a behavioral model of human sleep. In Stampi, C. (ed.) *Why We Nap: Evolution, Chronobiology, and Functions of Polyphasic and Ultrashort Sleep*. Boston; Birkhäuser.

44. Webb, W.B., and Dinges, D.F. (1989) Cultural perspectives on napping and the siesta. In Dinges, D.F., Broughton, R.J. (eds.) *Sleep and Alertness: Chronobiological, Behavioral, and Medical Aspects of Napping.* New York; Raven Press.

45. Wilkinson, R.T., Edwards, R.S., and Haines, E. (1966) Performance following a night of reduced sleep. *Psychonomic Science. 5*: 471-472.

5 INDEX