U. S. COAST GUARD GUIDE FOR MANAGING CREW ENDURANCE RISK FACTORS

Version 2.1

U.S. Coast Guard Research & Development Center

U.S. Coast Guard Research and Development Center

1082 Shennecossett Road, Groton, CT 06340-6048

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U. S. COAST GUARD GUIDE FOR THE MANAGEMENT OF CREW ENDURANCE RISK FACTORS

Version 2.1

Final Report

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N O T I C E

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16. Abstract (MAXIMUM 200 WORDS)

A ship's endurance depends on how long it can support operations at sea without replenishing supplies or requiring in-port maintenance. Similarly, crew endurance can be described as a function of physiological and psychological factors that support crewmembers' ability to perform their jobs effectively. Recent studies of Coast Guard personnel on cutters, at small boat stations, and at air stations have shown that some of our traditional work practices can lead to poor endurance, which translates to poor readiness. This *Guide* will show you how to manage crew endurance. It explains the different endurance risk factors and takes you step-by-step through the process of identifying these risks at your unit and implementing the controls necessary to improve crew endurance and mission effectiveness. These practical methods have been tested and proven on Coast Guard cutters, at Coast Guard air stations, at small boat stations, and on commercial vessels.

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FOREWORD

We all recognize that Coast Guard personnel endure challenging work environments that can compromise alertness and performance. Long work hours, harsh working conditions, extreme temperatures, frequent separation from loved ones and fatigue are all too familiar demands that our people encounter on a regular basis. Despite the steadfast dedication and motivation our people have for the mission, exposure to these factors may compromise crew endurance, increase operational risk, and reduce mission readiness. As we confront current challenges, and prepare for new opportunities that technology and operational demands will bring, we must acknowledge that the protection of our people remains our highest priority and do our best to ensure that crew endurance limits are not exceeded. This *Guide* will help you understand what crew endurance risk is, recognize the factors that compromise endurance, and develop strategies to manage and control crew endurance risk.

The information offered in the *Guide* was developed specifically for, and tested on, Coast Guard assets. A number of operational units are currently using the *Guide* to control crew endurance risk and improve operational readiness. It is an easy to read, step-by-step tool for identifying and managing crew endurance risk. The "Risk Assessment" section provides an objective and simple method of identifying crew endurance risk factors. If risk is identified, it guides you to information on how to manage the risk. The "Controls" section provides concise information on a variety of issues (e.g., sleep, caffeine, stress, motion sickness, etc.) that can compromise endurance. This information is ideal for all-hands and safety stand-down meetings to educate our people on how crew endurance risk factors degrade work as well as personal health, safety, and well-being. The "Implementation" section provides a step-by-step process to institute and test crew endurance management efforts.

Responsibility for managing crew endurance risk factors is shared at three distinct levels; the Coast Guard, the command, and the individual. The Coast Guard, at the Service level, develops policy and sets standards of performance. Our increasing knowledge of crew endurance risk factors will be incorporated as we review existing and develop new policies and standards. The Coast Guard has developed this *Guide*, and will continue to update and refine the guidance it provides. Commands transform policies and standards into action. Commands shall read and apply the information in the *Guide*. It provides information needed to protect our most valuable asset, our people, and shall be used to predict and plan proactively to prevent crew endurance risk factors that can compromise operational readiness. The individual Coast Guard crew member is the final critical link to mitigating risk factors. Every crew member must assume individual responsibility to develop and comply with a personal endurance plan to ensure they are ready and able to stand the watch.

The *Guide* provides the tools you need to manage crew endurance risk factors, but it will only help if it is employed as part of the daily operational planning process.

Use it! It works!

Rear Admiral Terry M. Cross
Assistant Commandant for Operations

EXECUTIVE SUMMARY

Crew endurance – the ability of crewmembers to maintain a normal level of performance within established safety constraints – is affected by several operational factors, including sleep quality and duration; body-clock stability; environmental conditions (temperature, noise, ship motion, etc.); emotional state; stress level; diet; and physical conditioning. Just as a ship's endurance determines how long it can support operations at sea, crew endurance determines how effectively personnel can perform their jobs.

Recent studies of Coast Guard (CG) crews conducted on cutters, small-boat stations, and air stations have shown that some of the Coast Guard's traditional work practices can lead to decreased alertness, which can then compromise readiness. In fact, 70% of the CG personnel studied exhibited signs of compromised alertness. While we might like to believe we can be *Semper Paratus* under any conditions, this simply is not the case: Long work days, frequent schedule rotations, insufficient sleep, and extreme environmental conditions take their toll on the human body, leaving even Coast Guard personnel less-than-ready for duty. If we are to be *Always Ready*, we must make crew endurance a top priority.

Any CG unit experiencing one or more of the following among its personnel is at risk of compromised endurance and readiness:

- Insufficient sleep duration (< 7-8 hrs.)
- Poor sleep quality (awakenings)
- Breaking sleep into multiple "naps"
- Main sleep during the daytime
- Rotating between day and night work
- Long work days (>12 hr.)
- No opportunities to make up lost sleep
- Poor diet (high fat, sugar, caffeine)
- High workload
- High work stress
- Lack of control over work environment or decisions
- Exposure to extreme environment (cold, heat, high seas)
- No opportunity to exercise
- High family stress (child and parent care, divorce, finances)
- Isolation from family

The good news is that crew endurance can be managed. Through research studies conducted on CG cutters, small-boat stations, and air stations, we have developed practical, proven methods for identifying and managing the operational hazards that could compromise the safety and effectiveness of Coast Guard operations.

This guide takes you step-by-step through the process of understanding what endurance is, identifying specific endurance risk factors within a unit, exploring possible methods for controlling these risk factors, and successfully implementing a crew endurance management (CEM) plan within a unit. The methods discussed in this guide are not theoretical; they are practical, workable methods that have been successfully implemented and proven on Coast Guard cutters, air stations, and small-boat stations, as well as on commercial vessels. In short: they work.

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Start Here!

Purpose of This Guide

This guide provides proven “how to” methods for controlling the operational risk factors that can degrade crew endurance and safety in the United States Coast Guard.

How to Use This Guide

It is recommended that you approach this guide by scanning it, paying particular attention to the information contained in the framed boxes, in order to familiarize yourself with the general content, the approach taken, and the overall structure. If your unit has an immediate need, scanning the guide can also be an efficient way gaining cues on possible areas for immediate focus. (Of particular interest to leaders are the boxes labeled ‘Management Nuggets’.)

After scanning the guide, it is recommended that you read it in its entirety, paying particular attention to the assessment checklists. These checklists are designed to help you identify and address ‘problem areas’ in specific operations.

Organization of This Guide

This guide is organized as follows:

Chapter 1 introduces the concepts of crew endurance and crew endurance management (CEM).

Section I: Implementation Process

Chapter 2 describes the five steps in CEM implementation process: (1) forming a CEM Working Group, (2) conducting a crew endurance risk assessment, (3) developing a CEM plan, (4) deploying a CEM plan, and (5) assessing the effectiveness of a CEM plan.

Chapter 3 identifies and describes two categories of crew-endurance risk factor.

Section II: Educational Resources

Chapter 4 discusses the relationship of sleep physiology to crew endurance.

Chapter 5 provides detailed information on watch schedules and light management.

Chapter 6 discusses the impact of caffeine and certain medications (OTC and prescription) on crew endurance.

Chapter 7 discusses the impact of stress (personal and work-related) on crew endurance.

Chapter 8 discusses the impact of temperature extremes and wave motion on crew endurance.

Chapter 9 discusses the impact of diet and exercise on crew endurance.

<u>Section III: Addenda</u>

Appendix A contains *The Berthing Guide*, a set of guidelines for optimizing crew quarters for sleeping.

Appendix B contains *The Light Management Guide*, a set of guidelines for adapting crewmembers to night work.

Appendix C contains a list of references.

It is recommended that pertinent parts of these chapters be distributed to all unit personnel as a way of educating them on crew-endurance hazards and on the methods individuals can use to control these hazards.

CEMS Tool

For best results, it is recommended that you use this guide in conjunction with the CEM Tool, which automates many of the procedures involved in implementing a successful CEM program.

Help

For assistance on any aspect of implementing a CEM program, or to make suggestions concerning this guide, please contact:

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1. Optimizing Crew Endurance

Recent studies of Coast Guard (CG) crews on cutters, small-boat stations, and air stations have shown that some of our traditional work practices may lead to decreases in crew alertness that could compromise readiness. In fact, *70% of the CG personnel studied exhibited signs of compromised alertness.* While we might like to believe we can be *Semper Paratus* under any conditions, this simply is not the case: Long work days, insufficient sleep, and extreme environmental conditions take their toll on the human body, leaving even Coast Guard personnel less-than-ready for duty. If we are to be *Always Ready*, we must make crew endurance a top priority. This guide provides specific instructions on how to identify and manage crew-endurance risk factors in CG operations.

If your unit experiences any of the following, your crewmembers are at risk for compromised endurance and readiness:

- Insufficient sleep duration (< 7-8 hrs.)
- Poor sleep quality (awakenings)
- Breaking sleep into multiple ‘naps’
- Main sleep during the daytime
- Rotating between day and night work
- Long work days (>12 hr.)
- No opportunities to make up lost sleep
- Poor diet (high fat, sugar, caffeine)
- High workload
- High work stress
- Lack of control over work environment or decisions
- Exposure to extreme environment (cold, heat, high seas)
- Little opportunity to exercise
- High family stress (child and parent care, divorce, finances)
- Isolation from family

1.1 What Is Crew Endurance?

Crew endurance refers to the ability of crewmembers to maintain a normal level of performance within established safety limits. Crew endurance is a function of several factors, called crew endurance risk factors, including:

- Sleep quality and duration
- Biological clock attunement

- Psychological state (stress level)
- Level of heat/cold, noise, ship motion, etc.
- Personal diet
- Physical conditioning

This guide provides specific instructions on how to identify and manage crew endurance risk factors in CG operations.

1.1.1 Endurance: It's All About Energy

Energy is the capacity to do work. Simply put, if we have energy, we can work; if we do not have energy, we cannot work. Energy is needed by every cell in the human body in order to function properly. In our bodies, energy is packaged as a molecule called adenosine tri-phosphate, or ATP.

In order to make ATP, the body requires food, water, oxygen, and sleep. In fact, restoring energy, by producing ATP, is one of the main functions of sleep. Studies have shown that *7 to 9 hours of continuous sleep* are necessary for the body to produce the ATP required for crewmembers to maintain normal levels of alertness and performance.

Insufficient Sleep = Insufficient Energy

Unfortunately, ATP cannot be acquired through dietary supplements; it can only be produced internally, within the cells of the body. One needs to be wary, therefore, of any advertisement for a nutritional supplement that claims to boost energy resources. In truth, such supplements can only provide the raw materials (nutrients) with which the body cam then produce ATP.

Bottom line: The only way to produce sufficient energy is by getting the right amount of sleep and the right amount of the proper nutrients.

1.1.2 When Energy Demand Exceeds Production

The way the human body creates and uses energy is similar to the way an electric company makes and distributes energy. Just as the electric company's production capacity limits the amount of electricity that a town can use each day, the amount of ATP our bodies produce limits the amount of energy we can spend. If the human body does not produce sufficient ATP, the brain, the nervous system, and all our other body systems cannot function effectively. Research clearly shows that when humans experience energy deficits, their physical and mental abilities are significantly reduced. Under these conditions:

- We do not think clearly
- We become irritable
- We do not communicate well with each other
- We become withdrawn and less willing to resolve issues and problems
- Our ability to ward off disease is impaired
- We experience fatigue throughout our work and leisure hours; and, because we cannot compensate for our lack of energy, our ability to carry out physical and mental tasks is compromised
- Thus, we compromise our safety and the safety of those around us

1.1.3 Keeping Energy Levels High

Adequate sleep, proper nutrition, and regular exercise are essential not only for maintaining good health and fitness, but also for producing the energy the body requires. Sometimes, however, the hectic pace of Coast Guard life tempts crewmembers into postponing exercise for another day, or into opting for a greasy cheeseburger instead of a fresh salad.

In fact, one of the negative effects of chronic stress and fatigue is to challenge one's resolve to exercise regularly, eat nutritious foods, and obtain sufficient sleep. The following checklist can help crewmembers meet this challenge head on:

Personal Guidelines for Maintaining Energy

- ❑ **Exercise daily: any form of regular exercise helps: 20-minute walks, jogging, weight lifting, 10-minute aerobic workouts, etc.**
- ❑ **Consume a balanced diet: low sugar, low fat, low starch, high in green and yellow vegetables, high in chicken, turkey, and fish (no turkey before watch)**
- ❑ **Get 7 to 8 hours of continuous, uninterrupted sleep daily**
- ❑ **Manage personal stress: Use relaxation methods**

1.2 What Is Crew Endurance Management?

The Coast Guard (CG) operates a large fleet of vessels and aircraft in performing its mission. The CG also influences the operations of commercial maritime vessels, including shipping and supply vessels, ferryboats, and barge tows. A key element to the safe and efficient operation of these vessels and craft is the ability of crewmembers to perform duties within safety limits while enduring environmental, psychological, physiological, and organizational stressors.

In maritime environments, many factors affect crewmember endurance, including sleep deprivation, job-related stress, fatigue, and extreme weather conditions. Reduced crew endurance can result in performance errors and significant loss, such as spills, groundings, collisions, and injuries. Adding to the risk in the maritime industry is increasing competitive pressure to reduce cost by minimizing crew levels

In response to this situation, the CG's Research and Development Center developed the Crew Endurance Management System (CEMS). CEMS is designed to prevent the impact of fatigue, workload, stress, and environmental stressors on the performance and health of crewmembers working in Coast Guard Units. In these environments, personnel work in around-the-clock operations and experience frequent transitions from daytime-to-nighttime duty hours; long work days (for example, 12-16 hours per day); exposure to extreme environmental conditions (for example, noise, vibration, heat, cold); high workload; and frequent separation from family and friends. These operational demands are naturally incompatible with human physiology and ultimately result in reduced crew endurance and morale, increased performance errors, high rates of personnel turn over, low workforce experience, and reduced operational safety.

Endurance management has a key advantage over "fatigue management" in that the latter only controls factors that cause fatigue or sleepiness. CEMS focuses on any stressor, factor, or system of factors that might adversely affect crew performance and/or cause human error (for example, loss of situational awareness due to stress; performance error caused by workload; degraded performance caused by engine fumes, etc.).

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Section I: Implementation Process

Section I provides specific instructions on how to identify and manage crew-endurance risk factors in CG operations:

- Chapter 2 describes the five steps in CEM implementation process: (1) forming a CEM Working Group, (2) conducting a crew endurance risk assessment, (3) developing a CEM plan, (4) deploying a CEM plan, and (5) assessing the effectiveness of a CEM plan.
- Chapter 3 identifies and describes two categories of crew-endurance risk factors.

2. Implementing a CEM Program

In this section, you will learn:

- The 5-step process for implementing a Crew Endurance Management (CEM) program
- How to get started implementing a successful CEM program

2.1 The CEM Implementation Process

The process for implementing a successful CEM program consists of the following tasks:

Step 1: Form a CEM Working Group

Step 2: Conduct a crew-endurance risk assessment

Step 3: Develop a CEM plan for controlling crew-endurance risk factors

Step 4: Deploy the CEM plan

Step 5: Assess the effectiveness of the CEM plan

2.2 Step 1 – Form a CEM Working Group

The first and most important step in implementing a successful CEM program is forming a CEM Working Group. The CEM Working Group is responsible for the timely and effective completion of all the other steps in the implementation process. The Working Group:

- Conducts an initial risk assessment
- Develops a CEM plan
- Supervises plan deployment and assessment

The Working Group is especially effective when it includes members from every functional area in the target unit. While a few representatives might be able to make a good first cut at identifying the risk factors affecting a unit, and at developing an appropriate CEM plan around these factors, it is unlikely that they would be able to identify the risk factors affecting every department or group within the unit.

As a case in point, managers in a commercial maritime organization were recently asked to list the CE risk factors their personnel were facing. In a separate session, vessel crewmembers were asked to list the CE risk factors they were facing in their departments. When the two lists were compared, there were striking differences. This example underscores the need for a Working Group to represent every major group or function within a unit.

If a unit is very small, or if resources are not available to support a Working Group, a Working Group of one well-chosen member can be charged with identifying as many of the unit's risk factors as possible. In such a case, it is highly recommended that this

Working Group of one hold informal discussions with other unit members toward ensuring that the most important risk factors are in fact identified, as well as, subsequently, to get feedback on a draft CEM plan before it is implemented.

All members of the CEM Working Group should be educated in the concepts and science underlying CEM, and in the process for developing and implementing a CEM plan. In this regard, each Working Group member should read this guide *in its entirety*.

2.3 Step 2 – Conduct a Crew Endurance Risk Assessment

The second step in implementing a successful CEM program is to identify the specific CE risk factors that are affecting current operations, and to explore possible controls.

2.3.1 Risk Factor Assessment

Studies by the CG Research & Development Center (R&DC) have identified several crew-endurance risk factors common in CG operations. These risk factors have been compiled into an easy-to-use rating form (the Crew Endurance Risk Factors Assessment Form) to facilitate crew-endurance risk assessments. See next page.

The Working Group uses this form to identify all the crew-endurance risk factors currently affecting their unit, and to assess how frequently these factors are affecting operations. The references in bold map the user to additional information (including management and control information) concerning the listed risk factors.

Each member of the Working Group should be asked to use the Crew Endurance Risk Factors Assessment Form to identify all the risk factors he or she believes are currently affecting unit operations (<u>all</u> operations, not just the operations in his/her own department or group).

If a risk factor is present, the Working Group member rates, on a scale of 0-7, how often the risk occurs each week (for example, if it occurs three times per week, the Working Group member places a **3** in the space provided).

If the unit has more than one mission or operational tempo, it is recommended the Working Group conduct a risk assessment for each one. For example, a unit might have a hectic summer search and rescue (SAR) season, versus a low-tempo winter season. Or a cutter crew might experience different endurance risks at sea than they do in port.

When the Working Group completes an assessment, the results should be displayed as a bar chart in order to give a visual appreciation for the relative amount of exposure to the identified risk factors.

Figure 2-1 shows hypothetical data for a cutter crew during extended law-enforcement (LE) missions (A), and for the same crew while in port (B).

The requirements of the law enforcement mission would likely put the crew under a different set of watch schedules, operational activities, and stressors such as reduced communication with family than it would under the in-port scenario.

Studying the effects of different operational scenarios and tempos on the Deck, Operations, Engineering, and Support departments can help to identify the types of endurance risks to which the crew is subjected, as well as when these risks are most likely to occur. The plots make it easy to see not only how exposure to risk factors might vary with operating conditions, but also how resources might be allocated to manage the risk.

Using these plots, the Working Group can begin to define the circumstances that expose the unit to the various identified risk factors. In this regard, the Working Group should consider the following questions for each risk factor identified:

- To which people or departments does the risk factor apply?
- Under what conditions does the risk factor occur?
- How frequently does the risk factor occur?

CREW ENDURANCE RISK FACTORS ASSESSMENT FORM

Write in the number of days per week (0-7) that each risk factor (Insufficient Daily Sleep, for example) occurs in your unit. Also note: (1) to which people or departments they apply; and (2) under what conditions they occur.

__ Insufficient daily sleep duration (less than 7-8 hours of *uninterrupted* sleep; **Ch. 4**)

__ Poor sleep quality (awakenings during main sleep period due to work-related disruptions, ship motion, or noisy environment; **Ch. 4**)

__ Sleep fragmentation (breaking sleep into multiple rest periods–"naps"–because unable to take a single, 7-8 hour sleep; **Ch. 4**)

__ Scheduling main sleep period during the day (the human body is designed to sleep at night; **Ch. 4**)

__ Changing work/rest schedules (rotating between working days and working nights one or more times per week; **Ch. 5**)

__ Long work days (exceeding 12 hours; **Ch. 5**)

__ No opportunities to make up lost sleep (napping during the day is not possible; **Ch. 4**)

__ Poor diet (menu includes frequent fried foods, high fat and sugar content, frequent caffeine consumption; **Ch. 9, Ch. 6**)

__ High workload (high physical and-or mental effort requirements; **Ch. 7**)

__ High work stress (caused by extreme environment, high sustained physical or mental workload, rotating work schedules, and-or authoritarian leadership style; **Ch. 7**)

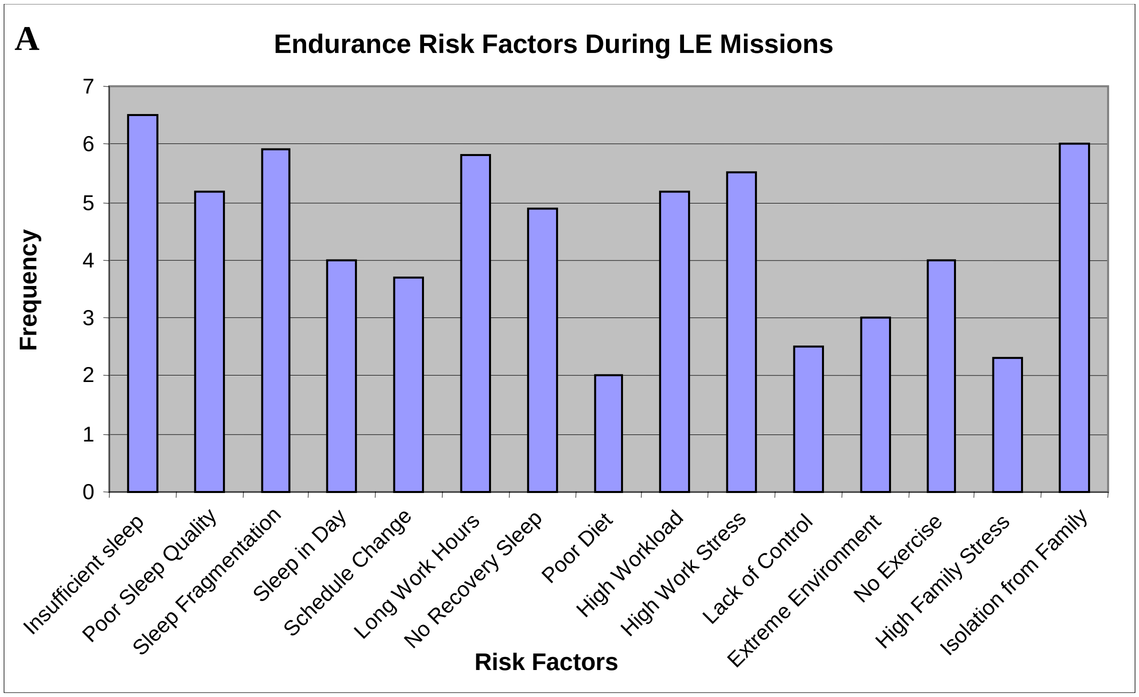
__ Lack of control over work environment or decisions (workers are isolated and not allowed to contribute in problem identification and resolution; **Ch. 7**)

__ Excessive exposure to extreme environmental conditions (cold, heat, high seas; **Ch. 8**)

__ No opportunity for exercise (not enough time or no equipment/facilities; **Ch. 7, Ch. 9**)

__ High Family stress (child and parent care, divorce, finances; **Ch. 7**)

__ Isolation from family (need to know how family is doing; **Ch. 7**)



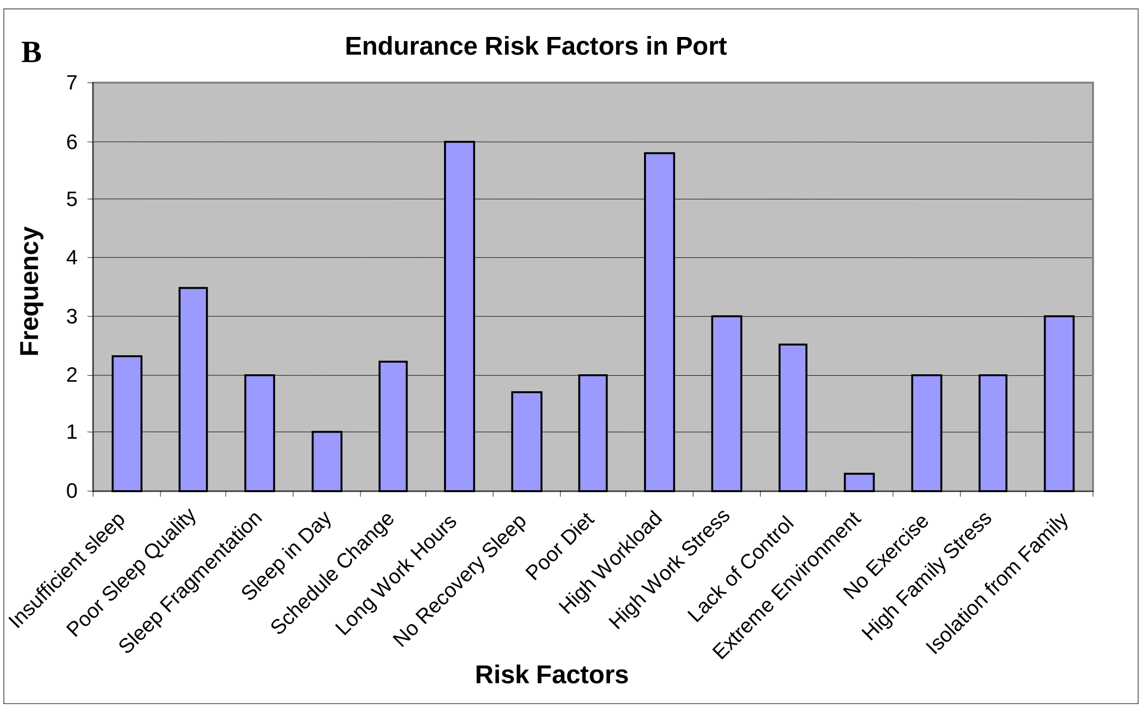


Figure 2-1. Relative Exposure to CE Risk Factors

For example, if the Working Group members identify the first factor (*Insufficient daily sleep duration*), they should discuss under what conditions and how frequently insufficient sleep occurs. Does it occur everyday, because normal work schedules do not allow for nine or more consecutive hours off (to accommodate sleeping, showering, and eating)? Or do crewmembers only experience insufficient sleep once or twice a week, when they rotate watch schedules or have a special assignment. Or does insufficient sleep occur very rarely, due to an unusually long SAR case or other mission requirement. Understanding the sources of these risk factors, and how frequently they occur, allows the unit to determine which factors are the more important contributors to crew endurance risk, and which are sufficiently under the unit's control to do something about them.

Notice that any of the endurance risk factors can significantly degrade performance and compromise operational safety and effectiveness. The detection of several risk factors affecting unit operations is of great concern because two or more endurance risk factors will interact and impact performance more adversely than would be predicted by the impact of the factors singly (that is, the negative influence of the whole is greater than the sum of its parts).

In addition to the Working Group assessment, it is recommended that Working Group members discuss the endurance risk factors with the department or work-unit members they represent in order to ensure that all crew endurance risk concerns are identified. Besides improving the accuracy of the endurance risk assessment, such communication will build ownership in the CEM process for the entire unit.

2.4 Step 3 – Develop a CEM Plan

After compiling a list of risk factors, the Working Group is ready to begin developing a plan for controlling these risk factors. This plan should identify the risk factors, suggest possible controls for each risk factor, and lay out a detailed implementation strategy.

The what/why/how questions posed earlier will be useful to defend the plan and answer questions from senior cadre members. Getting buy-in from all command staff and department heads is critical to the success of the plan.

Once the senior cadre approves the plan, unit members should be briefed on the plan and afforded an opportunity to ask questions. This is a very critical step. If unit members perceive they are part of the process, and have a voice, they are more likely to support the plan.

Before developing a CEM plan, the Working Group should have:

- Studied this guide thoroughly
- Completed a Crew Endurance Factors Risk Assessment
- Analyzed the results of the risk factors assessment to prioritize the unit's crew-endurance hazards

The risk assessment conducted in Step 2 identifies the specific crew-endurance hazards that currently exist in an operational unit. The next step is to consider the types of controls (discussed in detail in Chapter 3) that can be implemented to reduce or eliminate these hazards. One tool that is especially useful in this regard is the Crew Endurance Management Model discussed in Section 2.4.2.

2.4.1 Risk Factor Controls

At this point, the Working Group (WG) should have a good measure of their unit's exposure to crew-endurance risk. It is time now to explore and assess possible controls for each risk identified.

In exploring possible controls, it is recommended that the Working Group record each potential control and answer the following questions concerning it:

- What risk factor does it control?
- Why will it control this risk factor?
- How will it control this risk factor?
- How will it be implemented?

The answer to these questions will help the WG determine if and how the control might affect other levels of the system.

It is also helpful to categorize potential controls into three groups: **immediate**, **mid-range**, and **long-term**.

> **Immediate** controls can be implemented on the spot and do not require much effort or resources. Examples include installing door-assists to prevent slamming in berthing areas, hanging signs that mandate 'quiet areas', and reducing or eliminating pipes during specific times of day.
>
> **Mid-range** controls require significant time to plan and/or resources to implement. Examples include installing new mattresses, curtains, and air conditioning/filtration systems in sleep environments.
>
> **Long-term** controls often require substantial resources or the kind of infrastructure changes that can only be accomplished during yard or refurbishing periods. Examples of controls include improving ventilation systems or berthing areas, and adding exercise and recreational facilities.

2.4.2 Exploring & Assessing Risk Factor Controls

Making changes in one area of a system is likely to have a ripple effect on other areas. For example, during the transfer season, many units find themselves short of experienced personnel qualified to stand watch and to train other personnel. This shortfall often requires that remaining personnel work longer work hours, with the result that these personnel get less sleep and suffer disruptions to their body clock (from changing the watch rotation from a 1-in-6 to a 1-in-5 or 1-in-4).

In this scenario, USCG policies determining the frequency and timing of personnel transfers ripple out to affect the number of qualified personnel available, the watch regimes used, the length of work hours, the level of crew endurance, and the degree of unit readiness. This larger view of interrelatedness is called a "systems approach".

The Crew Endurance Management Model is designed to help Working Groups select the best possible controls (refer to Chapter **3**) for reducing or eliminating the effects of specific risk factors.

Under this Model, for each risk factor (Insufficient Sleep, for example), there are four levels of contributing elements to consider when selecting controls (see Figure 2-2):

- Mission
- Personal
- Organizational
- Environmental

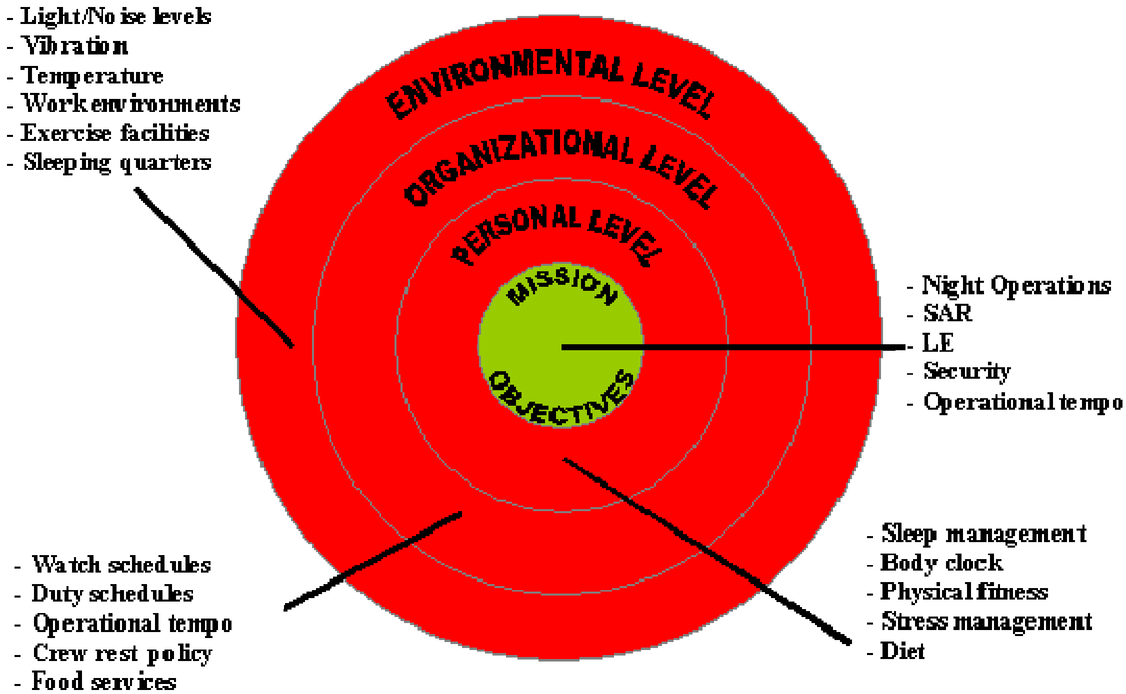


Figure 2-2. Crew Endurance Management Model

The Crew Endurance Management Model first identifies contributing elements related to mission that might be controlled toward decreasing endurance risk. The second level addresses contributing elements that individual crewmembers can control. The third level addresses such contributing elements as watch schedules, patrol schedules, and sleeping quarters. These elements are under the control of the command staff, and directly support (or detract from) the ability of crewmembers to maintain endurance. The fourth level addresses such environmental elements as shipboard temperature & humidity, lighting, berthing-quarters conditions, fumes, and noise.

The outer two levels are the most flexible, and are likely where most controls will be deployed.

2.4.2.1 *Mission Level*

The first level in the crew-endurance management model includes such contributing elements as B-0 operations, night ops, and long work days. Because of their close relationship to core elements of mission, these contributing elements are often immutable to any significant degree of control.

2.4.2.2 *Personal Level*

The second level in the crew-endurance management model includes such personal-related contributing elements as poor sleep habits, high stress, poor diet, lack of exercise, and misuse of caffeine and other stimulants.

Although this level provides some degree of flexibility (versus mission objectives), it is constrained by human physiology. For example, any changes in individual regimens and routines, including changes to nighttime duty, must take into consideration the human body's requirements for 7-8 hours of uninterrupted daily sleep, nutritious foods, and regular exercise.

The success of changes to individual regimens and routines depends heavily on command and department-head support, as well as on alignment with mission objectives. Thus, management personnel must understand that to endure job-related challenges, crewmembers must consume a healthy diet, maintain a consistent exercise program, manage stress, manage sleep and the body clock, and limit exposure to environmental stressors such as extreme temperatures, noise, and vibration. Chapter 3 provides specific controls for these endurance risk factors.

In cases where operational requirements interfere with execution of a personal endurance plan, the goal should be to return to the plan as soon as possible. For example, when SARs disrupt sleep an average of two days a week, obtaining 7 to 8 hours of quality sleep in five of seven consecutive days would go a long way toward maintaining a high level of endurance.

2.4.2.3 *Organizational Level*

The third level of the crew-endurance model consists of such organizational-related contributing elements as early-morning 'pipes', early-morning all-hands evolutions, sleep-depriving watch schedules, little time off, and no opportunity for napping.

A unit's policies and procedures have a direct influence not only on the unit's overall mission objectives but also on crewmember personal endurance. Examples of crew-endurance organizational support include the following actions:

- Analyzing tradition-driven events that can adversely impact endurance.

  For example, on several CG cutters, limiting the use of loudspeakers between 1800-1000, and not piping reveille, have been shown to improve the duration of crewmember sleep. Similarly, berthing-area cleanups can be done in the afternoon, rather than in the morning when night workers are trying to sleep.

- Making policy changes that promote napping under certain situations (see napping guidelines in Section 4.7).
- Making modifications to sleeping quarters (such as adding light-blocking curtains and sound insulation) that directly support efforts by crewmembers to obtain quality sleep.
- Providing separate berthing quarters for daytime sleepers.
- Providing access to leisure facilities and exercise equipment that offer stress reduction, better health, and improved morale.
- Making modifications to watch schedules to optimize crew rest, and to avoid chronic sleep loss (details in this section).
- Instituting light management through increased lighting in operational spaces to improve alertness (see light management suggestions in Section 5.6).
- Implementing shipboard crew-endurance training for both management staff and personnel.
- Coordinating routines (briefings, planning sessions, meal schedules, training schedules) to prevent disruption of rest periods.
- Providing entrees of broiled or grilled chicken, turkey, and fish, as well as vegetables and low-starch foods, to help maintain an energy-efficient diet.
- Reducing fried foods and high-sugar snacks will also improve energy efficiency and availability.
- Disseminating nutrition information to help personnel make the right choices.

Ultimately, command officers and department heads should agree on supporting the implementation of a plan that includes watch-schedule modifications, sleep and light management schedules, crew-endurance education for all personnel, and plans that optimize sleep and maintain proper timing of the biological clock.

2.4.2.4 Environmental Level

The fourth level of the crew-endurance management model consists of such environmental-related contributing elements as engine noise and vibration, light in the berthing quarters, uncomfortable ambient conditions (temperature and humidity), fumes, and uncomfortable bedding.

Unavoidable environmental elements such as motion sickness and temperature extremes are addressed with specific training; for example, on how to avoid or lessen the effects of motion sickness.

2.4.3 Selecting Risk Controls

Developing a crew-endurance plan involves selecting appropriate controls for the risk factors identified in the Crew Endurance Risk Assessment (refer to Chapter 3). Some controls are relatively easy to implement (especially in the outer levels of the CE management model), and even though these usually involve making only small changes, such as eliminating "pipes" or improving sleeping quarters, they can have highly beneficial effects. Some changes, such as instituting new watch schedules, or implementing a napping policy, might meet with some resistance at first, but can reap large endurance rewards if encouraged into full acceptance.

Controls should be selected that will eliminate or mitigate as many of high-priority hazards as possible. To accommodate this goal, the Working Group should make a table consisting of (1) all the risk factors, (2) the possible controls identified for each risk, and (3) whether the controls can be implemented immediately, in short-term (6-12 months), in or long-term (>12 months). Also included in this table should be mention of any constraints on the use of any of the possible controls. Table 2-1 is an example.

Table 2-1. Sample Crew Endurance Plan Format

Endurance Risk	Control(s)	Time to Implement	Constraint(s)
Poor quality sleep	Reduce pipes Change work schedules Insulate berthing spaces	Immediate Immediate – 6 months 6-12 months	None Insufficient qualified personnel Expense
No exercise	Provide PT time Purchase equipment	Immediate Immediate – 6 months	None Expense

Designing a CEM plan is likely to stimulate some lively discussions on the pros and cons of various potential "improvements". Working Group members are urged to keep an open mind to all suggestions, and to embrace the attitude that no one likes change, but nothing is ever improved without it.

Once the Working Group has developed a complete CEM plan, the plan should be reviewed by other key personnel to ensure that none of its elements is potentially harmful to any of the unit's missions. This is particularly important when the Working Group does not have representation from all departments in the unit. It is also recommended that the risk assessment checklist be applied to the new CEM plan as a double check on whether the plan might inadvertently introduce new risks.

MANAGEMENT NUGGETS: **Crew Endurance Management requires the development of work and rest management plans (and enabling actions) that optimize alertness and performance during duty hours. This goal is accomplished by:**

- **Forming a ship/unit Working Group to coordinate training, to document crew rest during implementation of new work schedules, and to support overall implementation of crew endurance practices**
- **Providing information to department heads on how to design and implement work schedules that meet the operational objectives of the vessel while maintaining a stable body clock**
- **Providing information to personnel on how to maximize the benefits of rest opportunities**
- **Implementing crew-rest evaluations that document: (1) the timing and number of rest opportunities available for crewmembers, and (2) crewmembers commitment to taking advantage of rest opportunities.**

2.4.4 Example Plan

This section provides the thoughts, activities, and documentation of one WG concerning step 3 of the CEM implementation process.

How the CEM implementation process is executed depends on the personality and makeup of the responsible WG. The following example demonstrates a very systematic, objective, and deliberate action plan.

This WG began by establishing specific objectives to focus and coordinate their actions. Their objectives were:

- Be willing to fail; try new things
- Learn to recognize signs of endurance risk – use the RFA for clues
- Show ties between OPTEMPO and endurance
- Mesh the "research" on endurance with "real life" experience
- Create a system and climate at the unit that maximizes endurance
- Maintain mission orientation – don't focus so much on endurance issues that we forget why we are here
- Better define what we expect of watchstanders
- Establish "bag limits" – people know what they are and respect them
- Keep the crew informed of what we are doing

In addition to the objectives, the WG identified potential barriers that could jeopardize the success of their efforts. These barriers included:

- Having enough qualified people aboard
- Tradition – holding onto ideas "because we've always done it that way"
- Mission requirements
- External environment – weather, tasking from Operational Cdr, etc.
- Internal environment – our own willingness to try new things
- Resistance to change
- Individual/departmental rivalries
- Lack of communications (spawns rumors)
- Lack of support

The WG realized that while some of the barriers are beyond their control (for example, SPEAR process), the unit owns most of the barriers and needs to work to overcome them.

With the objectives and barriers as a foundation, the WG used their RFA results to begin exploring controls. The RFA showed a high incidence of all the core risk factors, so the WG focused their attention on controls to improve sleep. The WG knew from reading the COMDTINST, and parts of the online CEM Guide, that sleep is most restorative if: (1) it's taken in a continuous period of at least 6 hours (ideally 8 hours) in duration, (2) occurs at approximately the same time each day, and (3) is not disrupted by noise, temperature, light, poor bedding, etc. Using this information, the WG brainstormed a list of potential controls that could improve sleep. These controls were categorized into short-term (ST), those that could be implemented virtually immediately; and long-term (LT), those that required additional study or resources.

Keep in mind that this is just a brainstormed list; the WG did not necessarily do all of these things – they are just a starting point:

- Create 'pipe free' time periods (prior to 1015 or after 1945) (ST)
- Berthing areas based on watch schedule versus departments (LT)
- Watchstations modify their own watches to meet sleep objectives (LT)
- Weekly berthing area cleanups Friday afternoon versus Sat morning (ST)
- Keep training within core hours of 1015-1600 (ST)
- Authorize Saturday late rack (LT)
- Eliminate 'reveille' and 'taps' pipes (ST)
- Daily berthing cleanups in the afternoon vice morning (ST)
- Adjust length of watches (LT)
- Change lighting – examine research around lighting and sleep patterns (LT)

- Designate ‘night workers’ (LT)
- Examine boarding/boarding team process (LT)
- Establish 1-3 watch rotations for watchstanders in which their only work is to stand watches. Other qualified personnel are day workers. Rotate through watchstanding/daywork on a 2-week schedule. (LT)
- Examine all hands evolutions (LT)
- Modify crew entertainment options. Separate crew lounges from sleeping areas (LT)
- Increase cross-training (LT)
- Reduce noise in berthing areas (ST/LT)
- Assign people to watches based on personal desires (that is, acknowledging that some people are ‘night people’ and some are ‘day people’) (LT)
- Seek ways to improve attitude and morale as ways to increase endurance (LT)
- Examine patrol lengths (LT)
- Balance admin/watchstanding requirements (LT)

This list provided a good starting point for the WG to explore options to control endurance risk. Not all of these ideas were used. The WG explored the best combination of ideas to achieve a risk exposure profile that was acceptable to the unit toward achieving their mission responsibilities and controlling endurance risk.

2.5 Step 4 – Deploy the CEM Plan

Once a CEM implementation plan has been approved and unit buy-in has been attained, the individual controls called for in the plan can be implemented.

In this regard, it is vital that the WG work diligently to provide everyone in the unit with accurate information concerning all the impending changes as soon as possible. Hopefully, the WG has been providing and soliciting information from unit members throughout the earlier steps in the implementation process. However, those members most stressed by the impending changes will have a tendency to misrepresent these changes in order to reinforce their personal resistance. These misrepresentations must be challenged and corrected early on so they do not become instilled in the unit as reality.

Successful implementation of crew endurance management (CEM) plans requires the execution of 5 tasks (Table 2-2).

Table 2-2. Tasks for Implementing an Endurance Management Plan.

Task 1	Education
Task 2	Environmental Changes
Task 3	Light Management
Task 4	Endurance Coaches
Task 5	Schedule Changes

For best results, these five tasks must be executed in sequence. It is very common for WGs to identify work schedules as the primary endurance risk and move to make changes prior to conducting the previous steps. Previous efforts have shown that executing the tasks a la carte is not successful. Tasks build upon each other, so it's essential to complete each task in sequence, as follows:

Task 1 - Education is the cornerstone to any CEM plan. The focus should be on the dissemination of accurate information on the factors that affect endurance, with an emphasis on dispelling misconceptions and misinformation. Education should be directed at all levels of the unit – command, supervisory, and crew. Recommended education topics include the physiological need for sleep, how sleep is disrupted, the consequences of disrupted sleep, approaches to promote and protect sleep at work and home, and diet considerations, as well as various personal and work-environment issues, including stress, exercise, alcohol and medication use, and ambient environmental factors.

A particularly effective way of introducing CEM principles and concepts is to make CEM a topic at unit safety training. The basics of CEM can be taught in this context at a gradual pace. After the training is complete, the CEM plan developed by the WG in step 3 can be introduced and discussed at length. Topics and detailed information from this *Guide* should be distributed to all personnel prior to the training, so they can familiarize themselves with the subject matter to be covered, and thereafter have CEM reference material readily available to them.

The specific elements of a new CEM plan should not be deployed until all personnel have been fully educated, and have had an opportunity to comment on the details of the plan. The latter consideration in particular will build ownership and improve acceptance of the CEM plan. Depending on the number and types of changes proposed in the CEM plan, it might be useful to phase-in the changes gradually in order to limit the amount of change that personnel need to deal with at any one time. Remember: Change is stressful!

Task 2 - Environmental change is directed at removing, or minimizing, barriers that expose individuals to endurance risk factors. Under Task 1, the members of a unit learn that certain environmental factors compromise endurance; under Task 2, they implement measures to control these factors. For example, let's say that the members of a unit have learned, under Task 1, that noise, light, temperature, bedding are risk factors that disrupt sleep and compromise endurance. The unit would then use Steps 2 and 3 of the CEM process to determine whether these risk factors were currently impacting crewmembers. If it were determined these factors were currently impacting the unit, the unit would then execute, under Task 2, the necessary measures to control them.

Task 3 - Light management is essential if endurance-management efforts include physiological adaptation to nighttime work schedules. The education task (task 1) informs crewmembers that light is the primary cue to the biological clock that influences circadian rhythms, and that exposing themselves to specific light sources at prescribed times improves alertness and promotes physiological adaptation to nighttime schedules. Refer to Section 5.6 for details on light management.

Task 4 - Endurance coaches provide on-site guidance concerning endurance management activities; they also observe and correct any behavior that can compromise the endurance management plan. WG members are typically also endurance coaches; however, additional people can participate in the process. These individuals play a critical role in promoting and advancing endurance management efforts.

Task 5 - Schedule changes are often necessary for aligning human physiology with operational/mission requirements. Many work schedules in use today unknowingly place crewmembers at risk for endurance lapses. However, most of these schedules can be corrected without causing any adverse effect to operational or mission response capabilities. In fact, these corrections tend to improve operational readiness.

Note: WGs should avoid placing schedule changes as the first task in a CEM plan, because schedule changes can easily be viewed as the only task necessary for solving sleep and fatigue problems, with the result that all the other tasks listed in the plan are either greatly discounted or bypassed altogether.

The success of any CEM plan depends on active participation and encouragement by leaders at all levels of an organization. If a unit is making significant organizational changes (such as instituting a napping policy, or changing work schedules), proactive leadership advocacy is an absolute requirement. These principal players must, above all other personnel, master how to control crew-endurance risks, and how to create a collaborative network throughout a unit. Ultimately, these leaders must teach, support, encourage, and lead personnel to a consistent practice of sound endurance practices.

The WG should continuously monitor the changes called for by their CEM plan in order to identify and correct any problems. In this regard, the WG should encourage personnel to provide feedback on any problems they encounter. Once the CEM plan is completely deployed and appears to be running smoothly, the WG should wait at least 30 days before initiating any evaluations of the plan's overall effectiveness.

MANAGEMENT NUGGET: **Successful implementation of a CEM plan to improve endurance requires an aggressive education program designed to educate the command staff and department chiefs on how to implement and coordinate the specific terms of the plan.**

2.6 Step 5 – Assess the CEM Plan

Assessing a CEM plan consists of:

- Evaluating the effectiveness of the CEM plan
- Periodically reassessing the plan; continuing the education process

2.6.1 Evaluating a CEM Plan

CEM plans should be evaluated periodically to ensure they are working as effectively as possible. The Working Group can perform this assessment informally by querying personnel concerning their reactions to the CEM plan. For example:

- Are they getting additional sleep, and is that sleep of better quality (that is, fewer disruptions)?
- Do they have more energy on the job; do night-watch personnel feel more alert?
- Have department heads noticed any changes in performance?

Asking such questions is a simple way to determine whether the CEM plan is having the desired effect. It is also a good way to identify any unanticipated consequences that are having a negative effect.

Another method of evaluation is to use the Crew Endurance Risk Factors Assessment Form to determine if the number and/or frequencies of the risk factors have decreased. Any risk factors still occurring two or more times per week should be addressed with appropriate modifications to the current plan.

Realizing only modest improvements during the initial stages of CEM plan deployment is normal. In fact, improvements are usually realized iteratively, with each periodic evaluation leading to yet more improvements. For example, a periodic evaluation may reveal that some crewmembers are not getting sufficient sleep even though their watch schedules, as well as the unit's training and other schedules, have been appropriately modified. In this case, it may be that individuals identified are not making responsible choices to get the sleep they need (for example, they may be staying up late to watch TV). A discussion with personnel concerning the direct link between maintaining a high level of endurance and responsibly managing one's schedule may solve the problem.

The Working Group should continue to discuss endurance issues with personnel and to identify additional variables that might be contributing to lower-than-desired endurance levels. Such oversight will lead to an improved CEM plan and to satisfactory endurance levels for most personnel. Because Coast Guard service is 24-by-7, 365 days per year, occasions requiring prolonged duty periods, to the detriment of maintaining endurance, will always occur; however, if personnel will make an effort to average 7 to 8 hours of good-quality sleep per 24-hour period, week over week, this practice alone will go a long way toward providing personnel with the endurance necessary to make it through temporary periods of extended work hours and elevated stress.

2.6.2 Reassessing a CEM Plan

The Coast Guard is a dynamic and evolving organization. This means that many units will see changes in their missions over time. When operational requirements change, the Working Group should consider whether these changes will impact crew endurance, and to seek adjustments to the unit's CEM plan accordingly. Even when the unit's mission stays relatively the same, it is a good idea to periodically reassess crew endurance to ensure that personnel are maintaining satisfactory controls over stressors and sleep needs.

It is strongly suggested that the Crew Endurance Risk Factors Assessment be performed periodically to check on whether crew endurance is satisfactory, and to identify any new risk factors that might be reducing endurance. If the results appear to be unsatisfactory, then appropriate modifications to the CEM plan should be made.

Annual refresher training on crew endurance is needed to remind personnel of the goals of the unit's CEM plan, and of their responsibilities within the plan. And, of course, any new members to the unit should be provided with education on crew endurance and the unit's CEM plan.

Following these steps will help the Working Group develop, implement, and monitor a successful CEM plan. Unit personnel will benefit by achieving better sleep, lower stress, better overall health, and higher energy. The unit will benefit by having better performance and morale, better safety, and improved readiness and mission effectiveness.

2.7 Further Information

Further information on equipment, development, and implementation of CEM plans can be obtained by contacting Crew Endurance Team members at U.S. Coast Guard Headquarters' Office of Safety and Environmental Health (G-WKS),or:

Antonio Carvalhais, Ph.D.
United States Coast Guard
Office of Safety and Environmental (CG-113), Room 5308
2100 2nd Street SW
Washington, DC 20593-0001
Tel: 202-267-2244
E-mail: acarvalhais@comdt.uscg.mil
Web: http://www.uscg.mil/safety/cem.htm

3. Crew Endurance Risk Factors

A review of the scientific literature, and results from assessments of specific CG operations, produced a list of risk factors that can promote or compromise crew endurance. These risk factors can be categorized into two groups: (1) core and (2) modulating. Core risk factors have a direct effect on endurance levels. They determine directly whether energy stores are replenished. Modulating risk factors by themselves may or may not compromise endurance. These factors are often associated with the physical and emotional state of 'burnout', because these factors can sap energy stores and at the same time retard the ability of core factors to replenish energy.

3.1 Core Risk Factors

Most of the core risk factors are sleep-related and can be better understood and appreciated by being familiar with the physiology of sleep. Before proceeding further, therefore, it is recommended the reader refer to Chapter 4: Sleep.

- Insufficient Daily Sleep. It is well established that the human body needs approximately 7-8 hours of sleep per 24-hour period in order to replenish physical and mental functions. Some people may require more or less than the 7-8 hour norm, but these are exceptions and may underlie disorders (for example, sleep apnea) that affect sleep.
- Poor Sleep Quality. The quality of the sleep is as important, if not more important, than how long one sleeps. Sleep environments that are hot, noisy, or bright, or that have uncomfortable bedding, compromise the quality, and by extension, the restorative value, of the sleep.
- Fragmented Sleep. Sleep is fragmented when the physiological ideal 8-hour sleep period is split into two or more episodes. For example, a person standing the mid-watch typically has one sleep episode before watch and a second sleep episode after watch. Split sleep is not as restorative as a single continuous sleep period of 8 hours because of the physiology of sleep: During sleep, the brain cycles several times through five different stages, with different restorative functions occurring during each cycle. If the sleep period is less than 8 hours, the brain cannot go through all the cycles, resulting in some restorative functions not being achieved.

  For example, the sleep stage of Rapid Eye Movement (REM) that is associated with dreaming activities, and commonly thought to replenish cognitive functions, appears in all sleep cycles but is the dominate activity in the later cycles of sleep, typically after hour 3 of the 8-hour sleep period. Splitting sleep into two episodes of 3 to 4 hours would deprive the crewmember of REM and cognitive function restoration.
- Main Sleep During the Day. Human physiology is programmed for sleep during night hours (2200 to 0600) and wakefulness during day hours (0600 to 2200). During these times, specific biochemical activities occur that

promote sleep and alertness. Day sleep disrupts these biochemical cycles with predictable consequences: Loss of attention and alertness, sleepiness, and fluctuations in mood. Adapting to night work requires adjusting the release of biochemicals, but this adjustment can take weeks, and might not occur at all, depending on how much control crewmembers have over their work/home environment.

- Changing Work/Rest Schedule. Switching from day to night work produces physiological disruptions very similar to those experienced in 'jetlag'. Standing a watch schedule that rotates is like crossing multiple time zones every time the schedule rotates.

- Long work days. Human performance begins to decrease approximately 12 hours after one arises from sleep. After 24 hours, performance is reduced by 25 percent. Twenty-five percent might not seem like much, but when you factor in the type of task, the environmental conditions, the ability to replenish energy stores with sufficient good quality sleep, and the frequency of exposure to long work days, the decrease can accumulate well beyond 25%. Also, for certain tasks (for example, evaluating how to engage a potentially hostile situation, or analyzing an unknown biochemical agent), a 25 % reduction in performance can mean the difference between success and failure, or even between life and death.

- No Opportunities to Make Up Sleep. If individuals require 8 hours of sleep per day to fully restore their energy stores, but they only get 6 hours per day, they accumulate two hours of sleep debt per day. This sleep debt continues to accumulate until these individuals are able to extend their sleep periods to at least 8 hours per 24-hour period.

  Because human physiology requires that sleep debt be paid back, unpaid sleep debt can result in chronic incidences of performance degradation, mood fluctuation, and unpredictable behavior.

3.2 Modulating Risk Factors

The modulating risk factors tend to exacerbate the effects of the core risk factors. For further information on these risk factors, refer to Chapters **6** – **9**.

- High Workload. Sustained high workload compromises endurance because higher energy expenditure is needed to fulfill task demands. Research also shows that maintaining high workload for sustained periods of time can lead to 'burnout', which is a chronic state of endurance compromise.

- Lack of Control over Work Environment. Research shows that individuals who have (or perceive) little control over their work conditions experience higher levels of stress, lower performance, and lower job satisfaction, and are detached from their job. As a result, they expend greater amounts of energy to perform their job.

- Exposure to Extreme Environments. The body must expend higher amounts of energy to protect itself from extreme conditions. For example, the body uses energy to heat itself when cold, and to maintain balance in heavy seas. Sustained exposure to extreme environments requires more energy, and increases the potential for injury and negative health consequences.
- Poor Diet. Certain types of food can actually induce drowsiness and promote sleepiness. Potatoes, dairy products, turkey, and foods high in sugar can induce a biochemical reaction in the brain that promotes sleepiness. These foods should be avoided during night operations, when sleepiness is already elevated due to physiology.
- Exercise. Physically fit individuals burn less energy when performing their job, and more efficiently replenish expended energy. Exercise promotes sleep and therefore aids in replenishing energy stores.
- High Stress. Three sources of stress are particularly relevant for CG operations: (1) work, (2) family, and (3) isolation. All three require higher amounts of energy to maintain focus and performance; hence, if they are sustained over long periods, they can compromise endurance. Also, although stress can actually improve performance in the short term, by releasing hormones that prepare an individual to act, these same hormones, sustained at high levels, can actually debilitate and paralyze an individual.
    - Work Stress. Time pressure, pace of work, volume of work, communication, interpersonal relations, and environmental conditions all contribute to work stress. These sources of stress can degrade endurance and job performance.
    - Family Stress. Child and parent care, finances, marital problems, conflict with others, and poor support systems are examples of family stress that can compromise endurance. Crewmembers confronting these stressors should be identified and offered support programs.
    - Isolation from Family. The uncertainty of what is happening to family members, and the inability to be present to comfort or support their activities, is one of the greatest sources of stress for some individuals. Efforts to improve or maintain contact with family (by e-mail or telephone) have been shown to reduce stress and to improve performance.

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Section II: Educational Resource

Section II serves as a resource for information on the core and modulating risk factors:

- Chapter 4 discusses the relationship of sleep physiology to crew endurance.
- Chapter 5 provides detailed information on watch schedules and light management.
- Chapter 6 discusses the impact of caffeine and certain medications (OTC and prescription) on crew endurance.
- Chapter 7 discusses the impact of stress (personal and work-related) on crew endurance.
- Chapter 8 discusses the impact of temperature extremes and wave motion on crew endurance.
- Chapter 9 discusses the impact of diet and exercise on crew endurance.

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4. Sleep

In this chapter you will learn:

- How many hours of uninterrupted sleep the average person requires daily
- How the body replenishes its energy supply
- How the biological clock regulates energy and alertness
- Why keeping regular sleep and light-exposure schedules is important
- How to manage personal sleep
- How napping can help maintain endurance on night watch
- How napping can help maintain endurance under continuous operations

4.1 Introduction

Sleep is a basic physiological function without which the human body cannot survive. Similar to breathing, eating, and drinking, sleep provides the body with the energy it requires to maintain physical stamina and mental alertness, to defend against infectious agents, and to recuperate from injuries.

Although sleep has a fundamental role in human survival, it's often misunderstood, overlooked, or disregarded. How often do you hear negative references associated with basic survival functions? Not often, but with sleep, it's common to hear such references as "lazy", "underachiever", and "weak," just to name a few. Also, no one would consider reducing a basic physiological need like breathing, but how often do we voluntarily choose to reduce sleep? In fact, Homo sapiens is the only species in the animal kingdom that chooses to reduce sleep, often with dire consequences.

In this chapter, we discuss the basic sleep needs for humans, and explore opportunities to enhance and promote getting the sleep we require for safety and endurance.

4.2 Sleep Requirements

Human beings, on average, require 7 to 8 hours of uninterrupted sleep daily. During these 7 to 8 hours, the brain cycles through phases of light sleep, deep sleep, and dream sleep, with each cycle lasting about 90 minutes. This 90-minute cycle repeats until the sleep period terminates either naturally or by some form of interruption.

The body replenishes its energy resources during sleep. Therefore, any interruption – due to noise, bright light, sudden movement, or the like – that disrupts the normal sleep cycles will tend to reduce the amount of energy replenishment and thereby to degrade subsequent performance.

FACT: Energy is optimally produced during uninterrupted sleep periods (lasting 7 to 8 hours) that are facilitated by comfortable beds, dark and quiet rooms, and ambient temperatures between 60-75 °F.

Reductions in sleep duration to below 7 to 8 hours per day will result in an accumulation of sleep debt. Sleep debt degrades alertness, decision-making ability, and logical reasoning. Persistent sleep debt increases daytime sleepiness and degrades hand-eye coordination and reaction times.

4.3 Determining Sleep Debt

You can use the Epworth Sleepiness Scale (see Figure 4-1) to determine your current level of sleep debt.

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

0 = Would never doze off

1 = Slight chance of dozing

2 = Moderate chance of dozing

3 = High chance of dozing

____ Sitting and reading

____ Watching TV

____ Sitting, inactive in a public place (for example, a theater or a meeting)

____ As a passenger in a car for an hour without a break

____ Sitting and talking to someone

____ Sitting quietly after a lunch without alcohol

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

____ Total score

Figure 4-1. Epworth Sleepiness Scale

If your score is over 20, you should seek medical advice. If your score is between 6 and 20, you should examine your daily work/sleep schedule for specific conflicts to getting 7-8 hours of uninterrupted sleep per 24-hour period. If your score is 5 or less, you do not have a serious sleep debt, but it would probably be worthwhile to assess your daily work/sleep schedule for ways to improve sleep quality.

4.4 The Biological Clock and Energy Availability

The body's level of immediately available energy varies in a predictable pattern over the course of a 24-hour period. This pattern of available energy is controlled by an internal 'device' referred to as the biological (body) clock. Figure 4-2 shows how energy level normally varies over the course of a day.

The biological clock regulates the daily energy cycle to the effect that alertness:

- Increases after wake-up time
- Peaks in the mid-morning hours
- Dips in the afternoon hours ('post-lunch dip')
- Peaks again in the early evening hours
- Begins to decrease at night
- Reaches its deepest lows in the mid-nighttime to early-morning hours (approximately midnight to 0600) [check this]

The actual occurrence of these peaks and valleys depends on the timing of specific inputs to the biological clock: Wake-up time, bedtime, and exposures to bright light (natural or artificial). As we shall see later, measured exposures to bright light can be used to set (or reset) the body clock for adapting personnel to night work (or back to day work).

FACT: Keeping a regular daily schedule – maintaining consistent work, sleep, and light-exposure times day to day – allows daily energy-replenishment cycles to take place on a consistent basis, thereby making sufficient energy available during normal work periods.

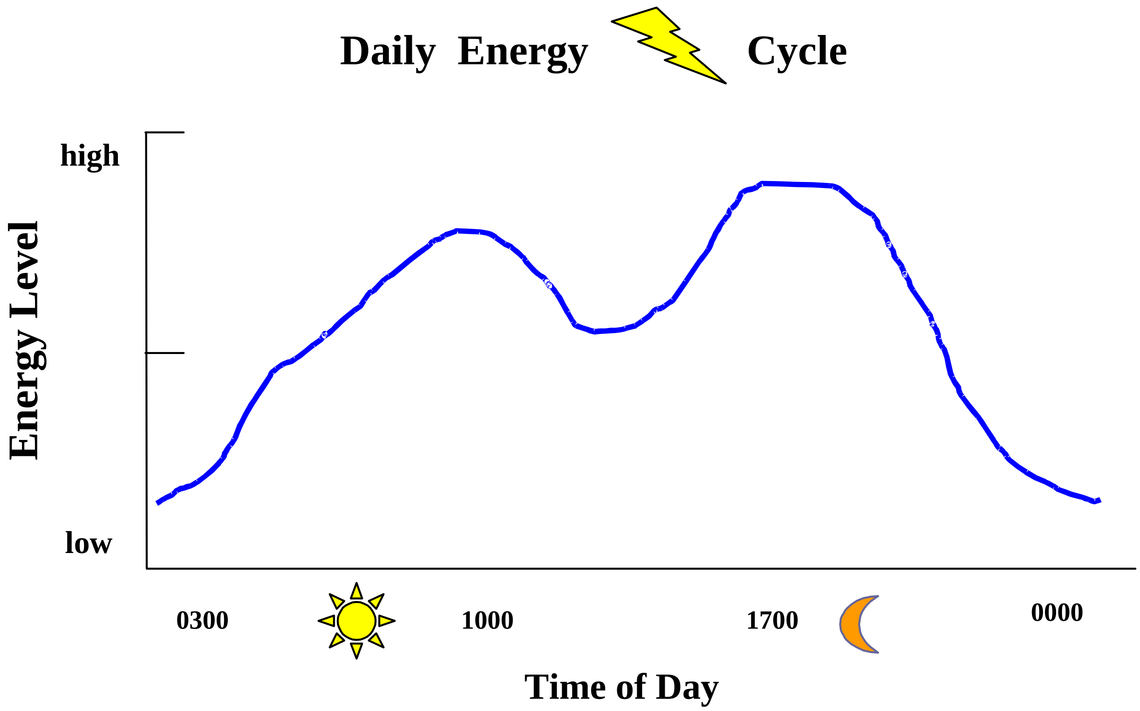


Figure 4-2. Daily Energy Cycle as a Function of Time of Day

4.5 Sleep Stages

Sleep consists of certain brain activities that progress predictably through five distinct stages (see figure below):

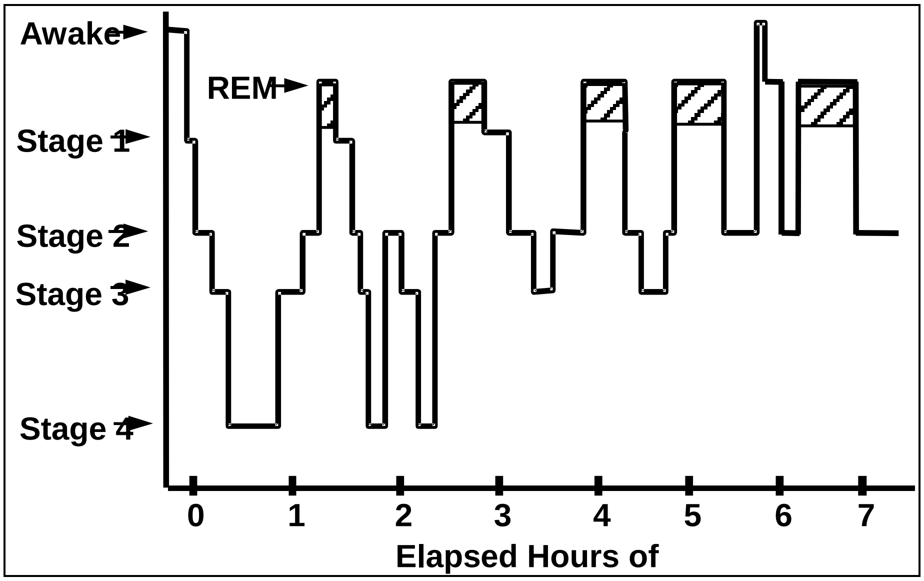
Stage 1 is the transition from awake to asleep. This stage is characterized by a slowing of brain activity. When aroused from this stage, many people believe they were never asleep. After about five to ten minutes of stage 1 sleep, a person progresses to a deeper sleep, stage 2.

Stage 2 is characterized by brain activity slower than that typical of stage 1, and is considered by many to be the true beginning of sleep. Within 10 to 15 minutes, brain activity slows even further and progresses into the deepest sleep, stages 3 and 4.

Stages 3 and 4 are referred to as slow-wave sleep (SWS). It can be very difficult to arouse a person from SWS, and once awake, the person can feel sluggish for several minutes. After 20 to 30 minutes of slow-wave sleep, brain activity reverts briefly back to stage 2 sleep, and is then followed by rapid eye movement (REM) sleep (stage 5).

REM – stage 5 or dream sleep – is characterized by quick eye movements, little or no muscle tone, and very active brain patterns. The first REM period of the night is relatively short, lasting five to ten minutes. After REM sleep, the sleep cycle repeats itself, returning to stages 2, 3, 4, and 5.

Each sleep cycle lasts approximately 90 minutes, with approximately five to six cycles occurring each night. Most SWS occurs during the first half of the sleep period, while most REM sleep occurs during the second half of the period. Overall, stage 2 sleep occupies the majority of the sleep period, followed by REM sleep, and then SWS.



The normal sleep cycle can be disrupted by such factors as schedule changes, frequent awakenings, and medications. Any disruption bringing on full wakefulness will cause the brain to start the sleep cycle from the beginning, with the result that the full cycle might not then be completed, because of time constraints. When chronic disruption occurs, endurance degradation ensues.

4.6 Sleep Management

Achieving 7 to 8 hours of uninterrupted daily sleep is largely a function of good sleep management. The proven principles and practices of good sleep management are summarized in the box on the following page.

Sleep Management

Planning for sleep

- **Daily sleep requirements vary: While the average person requires 7-8 hours of sleep per day, some people need only 5-6 hours, while others need 9-10 hours. If, after sleeping your normal amount, you feel very sleepy during your afternoon (or equivalent) hours, you need more sleep.**
- **Try to sleep (go to bed, get up) at the same time every day, including on days off.**
- **Avoid heavy meals prior to sleep periods, as well as foods and drinks that contain caffeine (for example, coffee, tea, soda, chocolate) four to five hours before bedtime.**
- **Avoid exercise one hour before bedtime – revving up the body at the very time you should be calming it for sleep.**
- **If a sleep aid was taken the previous night, the first and possibly the second night of sleep without medication may be disrupted. However, this disruption should subside within two nights.**
- **Alcohol should never be used to promote sleep. Although alcohol can induce sleep, the overall quality of sleep will be degraded.**

Good sleep habits

- **When needing to sleep outside your usual sleep period (during daytime, for example), prepare as if for a normal sleep period: Wear normal sleep clothes, darken the room as much as possible, keep noise to a minimum, and use a white-noise generator, such as a fan, to mask surrounding noise.**
- **Use bed only as a place to sleep: Do not read, work, or do other similar activities in bed. Associating bed with sleep will eventually allow sleep to come more easily.**
- **If you must stay awake for 24 to 48 hours, do not sleep more than 10 hours in the subsequent sleep period. Sleeping too long can interfere with the normal sleep schedule, and cause significant daytime lethargy. A normal sleep period for an individual is usually sufficient to recover from 24 hours without sleep.**

When personnel cannot fall asleep within 30 minutes, they should not remain in bed awake. They should get up in order to avoid associating wakefulness and anxiety with being in bed. They should remain out of bed, engaged is some kind of passive activity, such as reading, until sleepiness finally develops. Also, personnel who have trouble falling asleep during their normal sleep period should not nap during the day, as napping may delay normal sleep onset.

4.6.1 Personal Choice

Getting sufficient, good-quality sleep is often a matter of the personal choices crewmembers make. Here are some measures crewmembers can take toward ensuring they get sufficient, good-quality sleep:

- Minimizing moonlighting

  Financial pressures can understandably lead CG personnel to working an additional job (moonlighting). However, the sleep and leisure time sacrificed to working additional hours can adversely affect not only personal safety and performance but also the overall quality of personal and family life.

- Getting family support/cooperation for day-sleeping

  Crewmembers needing to sleep when family members are normally awake face a much greater challenge in obtaining adequate sleep than do crewmembers who work and sleep on a normal schedule. In such cases, family members should be asked to enter into some kind of agreement to support the crewmember who must sleep while they are themselves awake.

- Working around family obligations/issues

  CG personnel are often the primary support system for spouses and children. As such, there are added pressures on crewmembers to manage family obligations and issues as they perform their CG missions. Sometimes, for example, crewmembers coming off watch become involved in child care and other household duties or chores instead of going to bed. Therefore, it might sometimes be in everyone’s best interest to organize family life around the work schedule of the crewmember versus the other way around.

4.6.2 Berthing Quarters

Getting adequate sleep is at least partly a function of the conditions in the berthing quarters.

- Controlling climate (temperature and humidity)

  Although external temperatures cannot be controlled, ambient temperatures inside sleeping quarters can be regulated toward optimizing crew endurance:

  - Insulate portholes and windows against drafts
  - Insulate hatches and doors to keep heat out, coolness in

- Provide proper ventilation; crewmembers should be able to open hatches, doors, and portholes for more air
- Locate sleeping areas away from areas that typically radiate or leak heat; for example, avoid placing bunks just above the engine room or the galley
- Use heaters, air conditioners, and fans to control temperature; allow crewmembers to control the thermostat in their quarters; install small fans over bunks

- Controlling noise, fumes, and lighting

  Noise, fumes from the engine room, and bright lights can interfere with crewmember sleep. Specific measures to control these elements include:

  - Installing automatic door hinges to prevent doors from slamming
  - Installing stripping to prevent lockers from vibrating
  - Closing porthole covers to simulate a darkened environment during daytime sleep periods, or conditions where daylight is present for extended periods (as in the case of arctic summers)

- Controlling interruptions

  To help control needless interruptions, the berthing quarters should be declared a quiet zone. In addition, access should be restricted to sleepers only during sleep and nap periods:

- Controlling bedding quality

  To help promote sleep, mattresses and bed covers should be comfortable

- Controlling berthing conditions

  The berthing quarters should be kept clean and as dust-free as possible.

Refer to *The Berthing Guide* in Appendix **1.1.1.1A**.

4.6.3 Organizational Policy

Whenever possible, departmental and vessel-wide policies should be sleep-friendly.

- Curtailing early-morning evolutions

  Early morning all-hands evolutions can disrupt night watchstanders/late sleepers from obtaining their necessary 7-8 hours of uninterrupted sleep.

- Allowing late sleeping after watch and off hours

  Some CG watch/work schedules require crewmembers to work until the early morning hours before being relieved. Personnel on these schedules are often provided little or no opportunity to sleep a minimum of 7 hours. Over time, this inability to obtain adequate sleep results in sleep debt and chronic fatigue. To minimize the impact of these risks, a policy to extend sleep periods to allow crewmembers to obtain a minimum of 7 hours sleep is recommended.

- Curtailing pipes and other shipboard broadcasts

  In around-the-clock operations, there are periods during the night/day (2200-0700, 0400-1000) when crewmembers are asleep. Broadcasting pipes during these periods can disrupt and thereby fragment crewmember sleep.

- Allowing schedule self-selection

  The timing of the human biological clock varies from one person to another. Some people are larks (wake up early and turns in early), while others are owls (wake up late and turn in late). Taking these differences into consideration, it is prudent to allow crewmembers to select watch schedules that are aligned with their body clock rhythms. By allowing self-selection, department heads can maximize the natural performance capabilities of the crewmembers and reduce the risk of alertness decrements associated with body-clock desynchronosis.

- Minimizing/eliminating live watches

  Live watches can strain the human resources of a unit and force the use of extended work periods and/or rotating schedules. These, in turn, can result in fatigue, burn-out, and maladjustment to nighttime schedules. It is important, therefore, for CEM working groups to evaluate the need for live watches in all situations, and, when appropriate, to develop alternative methods for performing the functions of live watches.

- Minimizing participation in outreach programs

  Although outreach activities are valuable to all concerned, they can cause personnel to extend their work periods. In addition, morale can be impacted if participation in these activities is non-voluntary and interferes with personal time-off. Unit policymakers must be aware of these ramifications and plan accordingly.

- Minimizing on-call, B-0 operations, and night ops

  On-call personnel often suffer adverse effect resulting from unmanaged or un-prioritized communications, multi-tasking, and inappropriate use of resources. Unit decision makers must monitor the risks involved with these types of actions and make adjustments, such as assigning non B-0 status personnel to stand nighttime radio watch, to preserve the readiness of response crews.

- Maximize cross-functional training/qualification

  During times of surge ops or high operational tempo, multi-capable personnel within a unit can relieve one another as needed toward minimizing the impact on sleep opportunities of additional duties.

4.7 Napping

There are two primary uses of naps:

- To help personnel adjust to a new, nighttime work schedule

- To help restore energy when personnel are exposed to high-tempo operations for long periods (greater than 12 consecutive hours per day).

Napping is never a substitute for sleep; however, napping can be very helpful in partially restoring the energy level of personnel who do not have time or opportunity for a full sleep period.

Naps should be taken during the afternoon low point in the daily energy cycle in order to coincide with a normal period of sleepiness (see Figure 4-2). Research has shown that a 2-hour nap taken in mid-afternoon (around 1500 hours during the ‘post-lunch dip’) results in greater restoration of alertness than a 2-hour nap taken in the evening (at around 1900 hours, for example, when the energy cycle is on the rise).

Naps should not be taken after midnight. Although it is easier to fall asleep after midnight, it is much harder to wake up: Personnel often feel groggy, and may suffer performance degradations for more than a full hour after waking.

4.7.1 Napping and Change of Work Schedule

When personnel need to shift their work schedule from daytime to nighttime, naps can facilitate adjusting the body clock to the new regimen. Naps are recommended if:

- Personnel rotate from day to night duty, <u>and</u>
- They cannot sleep more than four or five hours during the sleep period following the first night work, <u>and</u>
- The next night is going to be another work period

Napping to Adjust to Night Work

- ❑ **When transitioning to nighttime duty hours, opportunities for naps occur during the following time periods:**
  - **During the mid-afternoon (around 1500 hours, for example)**
  - **During the evening prior to reporting for work: Nap from 1600 to 1900 hours, for example, when reporting for duty at 2100 hours**
- ❑ **When rotating to the night watch, personnel should be encouraged to use naps during time-off to compensate for sleep lost during the transition to nighttime duty hours.**
- ❑ **When transitioning from daytime duty hours to nighttime duty hours later that same day, a nap at 1500 hours can compensate for sleep lost during the assigned sleep period.**
- ❑ **Daytime naps longer than one hour are not recommended if the next sleep period will occur that same night. In this case, naps taken during the day can interfere with the onset and duration of that night's sleep.**

4.7.2 Napping and Continuous Operations

If personnel are subjected to continuous operations, or to very long work periods (greater than 12 hours), napping can help restore dwindling energy levels. Napping during continuous operations can reduce performance impairment but cannot totally alleviate the effects of sleep deprivation.

Individual differences in sleep needs must be considered in determining nap length. Other factors that should be taken into consideration are: whether or not the crewmember has sleep debt, the intended length of the nap, and the time of day.

Command and department heads should allow time for napping, and should provide a quiet, comfortable place for short naps as circumstances permit. In addition, they should educate personnel about the benefits of napping, and should emphasize that naps are not a substitute for sleep.

Napping and Continuous Operations

Pre-existing Sleep Loss

- The best time to nap is *before* significant sleep loss has occurred. Personnel who nap for one to four hours prior to night work will show improved late-night and early-morning performance and alertness compared to those who do not nap. Preventive napping may be better than a nap taken during the sleep-deprivation period.
- Naps do not totally eliminate the energy-cycle dip experienced in the early morning (between 0000 and 0600); however, they do moderate degradation in both cognitive performance and alertness.

Nap Length

- Naps should be one to two hours in length.
- A single two-hour nap during a 24-hour continuous work period can cause performance to be close to pre-sleep-loss levels.
- If longer naps are not possible, several naps of as little as ten minutes each can help personnel endure continuous operations.

Timing of Naps

- It is easier to nap when the energy cycle is at its lowest (approximately 0300 and 1500); more difficult when the energy cycle peaks (around 1000 and 1900).
- Early-morning naps (0000 to 0600, during the energy cycle "low period") are beneficial in restoring alertness and performance. However, post-nap sleepiness will be higher and performance will be lower for an hour or more after awakening from a nap at this time. Therefore, personnel should be awakened from early-morning naps at least an hour before reporting for duty, in order to allow them to fully recover from the nap.
- Naps should be timed such that crewmembers are awakened during an energy rise or peak (between 1000 and 1400, for example, or between 1700 and 2000) in order to minimize post-nap sleepiness. Even so, at least 20 minutes should be allowed for post-nap recovery.

4.7.3 Determining a Napping Strategy

Figure 4-3 provides a process for determining whether napping is needed, and for implementing a napping plan.

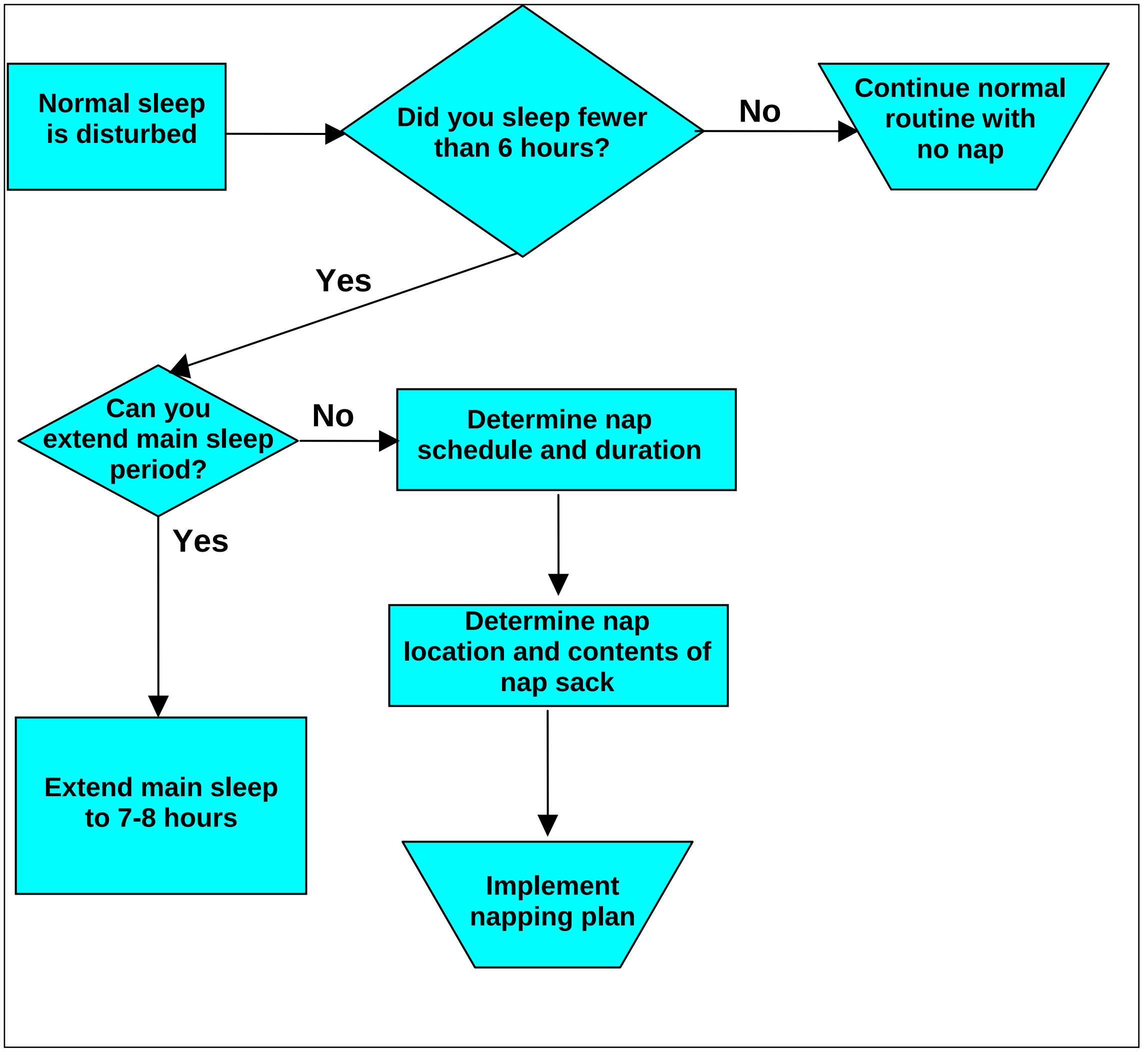


Figure 4-3. Process for determining napping strategy

A nap sack would typically contain some or all of the following items:

- Eye shade
- Ear plugs
- Inflatable neck support
- Pillow
- Blanket
- Portable alarm clock

4.8 Sleep Disorders

Sleep disorders (such as apnea) compromise alertness no matter what other measures might be taken to improve endurance and alertness. Sleep disorders require medical attention.

The following check list can help crewmembers determine if they have a sleep disorder requiring medical attention.

Sleep Disorder Checklist

- ❑ **You are told that you snore loudly and often.**
- ❑ **You are told that you stop breathing or sound as though you are having difficulty catching your breath when asleep.**
- ❑ **You find yourself becoming sleepy or actually falling asleep when performing your daily activities, especially those that are sedentary, like reading, watching TV, and driving.**
- ❑ **You are having trouble falling or staying asleep, or are waking up early or un-refreshed, three or more nights per week**
- ❑ **You experience a nervous, creeping, or tingling feeling in your legs when trying to sleep.**
- ❑ **Your sleep is regularly interrupted due to gastrointestinal distress, need to urinate, acid reflux, pain, night terrors, or an uncontrollable environment (too much light or noise in the room, for example, or an uncomfortable temperature level).**

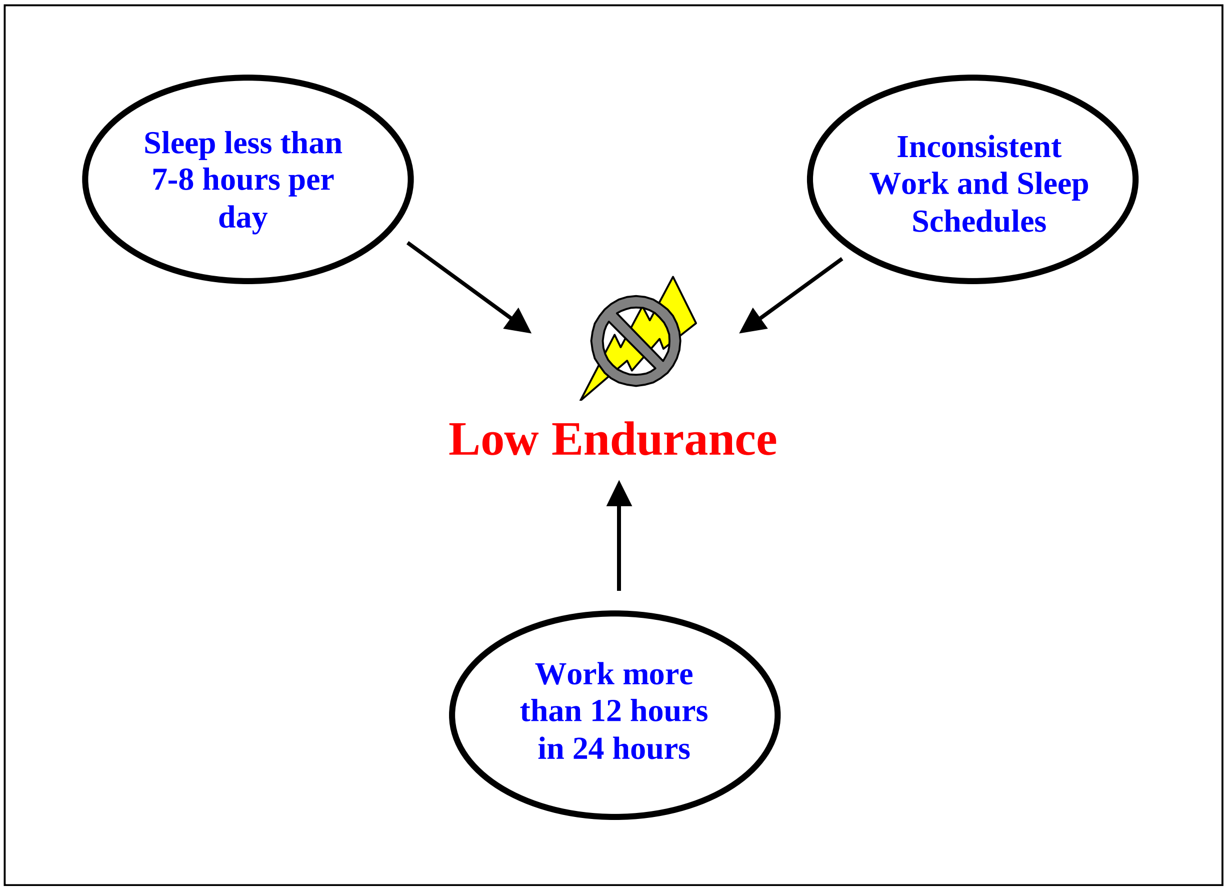
In addition to using this checklist, crewmembers suspecting they might have a sleep disorder should use the Epworth Sleepiness Scale on page 4-3 to determine their level of sleep debt.

If there is any indication of a possible sleep disorder, crewmembers should seek medical advice as soon as possible. They should also avoid using any interim remedies to aid alertness, such as caffeine.

5. Watch Schedules

In this chapter you will:

- Learn how watch schedules can support or degrade endurance
- Understand why working at night can result in jet lag-like symptoms
- See the immediate and long-term performance and health degradations that accompany body clock disruptions caused by poor watch schedules
- Evaluate typical CG watch rotations and consider healthier alternatives
- Learn how to help personnel adapt to night duty



5.1 Introduction

Work and watch schedules have more influence on sleep behavior and ultimately endurance than any other operational factor. In fact, our sleep timing and duration are determined by our work requirements. If you work at night, you have to sleep during the day. This chapter explores how work schedules affect sleep, and presents various options for changing work schedules toward improving sleep without compromising mission effectiveness and readiness.

5.2 How Watch Schedules Can Lead to Poor Endurance

As discussed previously, we can keep our body clock stable by maintaining a routine in which bedtimes, wake-up times, and durations of bright-light exposure stay about the same day to day. When the body clock is stable, endurance is high: personnel will have the energy they need for work and leisure activities, and their bodies will be primed for efficient, restorative energy production during sleep periods. In contrast, watch schedules that impose frequent transitions from daytime to nighttime duty – or that impose changes in wake-up times of as few as two hours – disrupt energy restoration processes and degrade alertness and performance.

For instance, maintaining a summer watch schedule that requires waking up at 0700 on most days of the week, but that requires an earlier wake-up time (0500, for example) on some work days, will send conflicting signals to the biological clock. On the days that earlier wake-up times are required, the earlier exposure to bright light will signal the body clock to advance bedtimes and wake-up times (that is, make them earlier). Conversely, on the days when wake-up time (and exposure to bright light) has been delayed to 0700, the body clock is signaled to delay bedtimes and wake-up times.

These changes in the body clock's timing are important, because they have wide-ranging effects on physiology. Body clock changes affect the normal regulation of physiological functions such as:

- Core body temperature
- Cellular metabolism
- Production and release of hormones and neurotransmitters
- Timing of sleep (energy production)
- Timing of alertness (energy availability)

WARNING! Inconsistent inputs to the biological clock are common when personnel work during nighttime or early-morning hours. When exposed to dim or normal (versus bright) light during night watch, and to daylight after sunrise, personnel will experience sleep problems during the day and performance degradation during nighttime duty hours.

In general, the biological clock requires approximately three days to adjust to a new schedule: to a 2-hour advance in exposure to daylight, for example, due to an earlier wake-up time. And it will only make the adjustment if the new schedule is consistent over the 3-day period. If a change in schedule is <u>in</u>consistent (that is, if the wake-up time and exposure to bright light change every few days, as is the case in many CG watch rotations, the body clock's timing will not only not adjust, it will likely become disrupted in such a way that the physiological functions under its control will no longer occur in a predictable pattern.

FACT: Inconsistent inputs to the body clock can result in:

- **Sleepiness on watch**
- **Paradoxical feelings of fatigue; that is, 'feeling too tired to sleep'**
- **Lack of mental clarity**

5.3 The Problem with the Night Watch

Inconsistent inputs to the biological clock are common when personnel work nighttime shifts. For example, a watch schedule prescribing a 6-hour watch during the night (from 2400 to 0600, for example) can result in jet lag-like symptoms. If night-duty personnel work under normal lighting (in engineering, or in a communications center, for example), or in dim-light environments (on the bridge, for example), exposure to daylight at the end of the watch will set the biological clock to a daytime orientation. This daylight orientation will in turn adjust the body's energy cycle to make energy available during the day, and to prepare the body for sleep at night – precisely the opposite of what is desired for someone on night watch.

FACT: In a daytime orientation, the biological clock predisposes the brain for sleep (not work) during nighttime. Night watchstanders on a daytime orientation, therefore, will inevitably experience fatigue-induced performance degradation during watch.

Studies of the performance of night-shift workers on a daylight body-clock orientation show a consistent reduction in work efficiency – and, in some cases, safety – over time. Some examples:

- Truck drivers have been shown to have twice as many accidents between 0000 and 0200 compared to during the day
- Locomotive operators have an increased probability of missing warning signals when working the night shift

- Night-shift workers perform worse on tasks of vigilance and reaction times compared to day workers
- Aviators flying a flight simulator at night have reduced hand-eye coordination, poorer vigilance and calculation proficiency, and impaired flight performance compared to day fliers

5.4 Insufficient Sleep and Body Clock Disruption

Poorly constructed watch schedules – in particular, those requiring personnel to change their bedtimes and wake-up times two or more times each week – lead to chronic disruptions in the body clock, which in turn lead to an inability both to fall asleep and to achieve sleep of sufficient duration and quality (7-8 hours of uninterrupted per 24-hour period).

The following fatigue symptoms develop and become persistent:

- Sleepiness
- Low energy
- Lack of motivation
- Irritability
- Depression
- Psychosis (in extreme cases)

Possible long-term health effects include:

- Increased incidence of cardiovascular disease (heart attack)
- Gastrointestinal (digestive) disorders
- Sleep disorders

5.5 Promoting Endurance through Sensible Watch Schedules

In order to maintain good crew endurance, it is imperative to keep personnel on as consistent a sleep schedule as possible. Regular, consistent sleep schedules help stabilize the body clock, which in turn enables personnel to be more alert and to perform better on watch.

MANAGEMENT NUGGET: To maintain energy restoration and prevent fatigue, use watch schedules that do not frequently disrupt regular sleep schedules.

Sometimes we do things because ‘that’s the way it’s always been done’. However, what made perfect sense in the past might no longer make as much sense today. In fact, watch schedules are often based more on tradition than on actual need. For example, on cutters, most personnel stand 4-hour watches. But why four hours? Perhaps a longer (or shorter) watch would make more sense, especially for 1-in-4 or 1-in-5 schedules. In some cases, it might no longer make sense to stand watch over the entire 24 hours of each day. Or, it might be possible to reduce the number of personnel standing night watches, thereby freeing up more hands for day duty.

Along these lines, limiting ‘all hands’ evolutions to only those hands actually required, and cross-training personnel for multiple tasks, are two other possible ways of making better overall use of personnel for night watch and day duty.

In assessing current watch schedules, and in designing new ones, the following points should be considered:

- *Is this watch necessary?* – Is it really necessary to have personnel standing this watch 24 hours per day, every day? Are there certain days, certain times of day, or certain types of operations when this watch is not needed?
- *Does everyone need to stand watch?* – How many watchstanders are really needed? Could some current watchstanders be assigned to day work instead of standing watch?
- *Can the watch be consolidated with other duties?* – Can at least some watchstanders complete tasks during watch they would otherwise be required to complete following watch? They could then use the time they would have had to spend on their day work getting sleep.
- *Does the watch need to be 4 hours long?* – Would a different schedule make more sense under current circumstances and conditions?
- *Think about the body clock, rather than just the number of crew, when establishing the watch schedule* – Often the watch schedule (1-in-4 or 1-in-5) is determined by the number of watchstanders available, under the belief that personnel are helped by standing the fewest possible number of watches. In reality, these schedules hurt personnel, because they put personnel on a rotating schedule that the body clock cannot adjust to. Instead, schedules should be designed to support body-clock stability, by allowing personnel to stand watch at the same time each day.

In light of these points, let’s take a fresh look at some watch schedules typically used in the Coast Guard, with an eye toward making possible improvements. We’ll look first at the standard 1-in-3 and 1-in-6 watch schedules. These two schedules are both stable in that watchstanders under these schedules keep the same schedule each day.

Next, we’ll look at the 1-in-4 and 1-in-5 schedules, which are inherently <u>un</u>stable, in that watchstanders under these schedules stand watch at a different time each day, and therefore must shift their sleep period each day.

5.5.1 Traditional Schedules: 1-in-3 and 1-in-6

In the standard three-section (1-in-3) watch rotation (see Table 5-1), there are three duty sections (shown as A, B, and C). On each day, the first duty section (A) is on watch from 0000 to 0400, and again from 1200 to 1600. The second duty section (B) stands watch 0400-0800, and 1600-2000. The third duty section (C) stands watch from 0800 to 1200 and again from 2000 to 2400. Because personnel are on watch at the same times day after day, this schedule supports body-clock stability.

Table 5-1. Standard 3-Section Watch

Standard 1-in-3 Watch			
	Day 1	Day 2	Day 3
0000-0400	A	A	A
0400-0800	B	B	B
0800-1200	C	C	C
1200-1600	A	A	A
1600-2000	B	B	B
2000-0000	C	C	C

However, with only 8 hours off between watches, it is not possible for personnel to obtain 7 to 8 hours of uninterrupted sleep, because they need to use part of the eight hours for meals, showering, personal chores, recreation, and so forth. To compensate, personnel should be encouraged to take a nap during their other off-watch period. Also, personnel on night and early-morning watches (0000-0400 and 0400-0800, respectively) should use the light-management techniques provided at the end of this section to adapt their body clocks properly to nighttime duty.

In regard to the 1-in-3 watch schedule, personnel on the mid (midnight) watch (section A in Table 5-1) will likely experience the most difficulty maintaining endurance. The reason for this likelihood is that these personnel often have day-work duties that preclude their getting a sufficient amount of sleep after coming off watch. As a result, personnel working the mid watch often get a few hours of sleep after the night watch and then try to take a nap in the afternoon. One possible improvement is to absolve the mid watch from day work so they can get their required sleep. An alternative to this (if sufficient personnel are available) is to split the mid watch between two crewmembers, so that one stands watch 0000-0400; the other stands watch 1200-1600.

Some other possible variations to the 1-in-3 schedule are:

- Make standing watch the sole scheduled daily work (to allow more time for sleeping). If it is not possible to do this for all watchstanders, it should at least be done for all personnel standing the midnight watch.

- Reduce the amount of day work, especially for personnel on the midnight watch, so they can get sufficient sleep.
- Split the watch: One crewmember stands the midnight to 0400 watch; another crewmember stands the 1200-1600 watch.

5.5.2 The 1-in-6 Watch Schedule

The standard 1-in-6 watch schedule is the best watch schedule because there is no rotation, and because personnel have lengthy periods in which to get 7 to 8 uninterrupted hours of sleep daily (Table 5-2).

Table 5-2. Standard 6-Section Watch

Standard 1-in-6 Watch			
	Day 1	Day 2	Day 3
0000-0400	A	A	A
0400-0800	B	B	B
0800-1200	C	C	C
1200-1600	D	D	D
1600-2000	E	E	E
2000-0000	F	F	F

5.5.3 Traditional and Alternative Schedules: 1-in-4

When a department has a sufficient number of qualified personnel, it will often go to a 1-in-4 or 1-in-5 watch schedule. While these schedules might at first seem to offer benefits (reduced number of duty hours per day), the 1-in-4 and 1-in-5 schedules are very disruptive to the body clock.

Table 5-3 shows the standard 1-in-4 watch schedule (left half), and an improved 4-section watch (right half). The standard 1-in-4 schedule has personnel working two watches on one day and one watch at a different time on the following day. For example, on the first day, the personnel in section A stand the 0000-0400 watch and the 1600-2000 watch. A sleep period would likely follow the night watch, at about 0430-1200. (Note: One nice thing about the 1-in-4 schedule, as compared to the 1-in-3 schedule, is that there is sufficient off-watch time for a full 7 to 8 consecutive hours of sleep.)

The section A watchstander gets off the evening watch at 2000, but probably would not be able to sleep at this time because of having been awake only ten hours from the end of the previous sleep period. This watchstander's next watch starts at 0800; therefore, using 2300-0700 as a sleep period would allow for sufficient sleep, but only if the watchstander can actually get to sleep. The core problem now is that the wake-up time (and light-exposure time) has been advanced by five hours – a significant advance that can take several days to adapt to. Yet, that very night, this watchstander must switch back to (and be able to maintain alertness during) a 0000-0400 watch.

Table 5-3. Standard and Alternate 4-Section Watch

Standard 1-in-4 Rotation				**Alternate 4-Section Watch**			
	Day 1	Day 2	Day 3		Day 1	Day 2	Day 3
0000-0400	A	C	A	0000-0300	A	A	A
0400-0800	B	D	B	0300-0600	B	B	B
0800-1200	C	A	C	0600-0900	C	C	C
1200-1600	D	B	D	0900-1200	D	D	D
1600-2000	A	C	A	1200-1500	A	A	A
2000-0000	B	D	B	1500-1800	B	B	B
				1800-2100	C	C	C
				2100-0000	D	D	D

This 1-in-4 schedule is like crossing, back and forth, five time zones every day! Personnel on this type of schedule will suffer from chronic body -clock disorganization and flagging alertness levels.

An improved alternative to the 4-section watch schedule is provided on the right half of Table 5-3. In this alternative schedule, there are four watch sections, each section working two 3-hour watches each day. This schedule provides 9 consecutive hours of off-duty time, sufficient for watchstanders to get 7 to 8 consecutive hours of sleep. The hallmark of this schedule is that each watch section stands watch at the same time each day. Thus, personnel can become adapted to a regular schedule, allowing them to be more alert on duty and to get more restorative sleep during sleep periods.

Some other variations to the 1-in-4 are:

- Stand the 1-in-3 watch and split the mid-watch between two watchstanders, one working 0000-0400; the other, 1200-1600
- Stand the 1-in-3 and have one floater who rotates into the watch; for example, for first month, persons A, B, and C stand watch and floater (D) does not; on the second month, D replaces A; on the third month, A replaces B; etc.
- Stand 3-hour watches (in accordance with right side of Table 5-3)
- Stand 6-hour watches

5.5.4 *Traditional and Alternate Schedules: 1-in-5*

Table 5-4 (left half) shows the typical 1-in-5 watch rotation. On most days, personnel have only one 4-hour watch; however, once every five days, they stand two watches. On the surface, this would appear to be a very agreeable watch schedule, with plenty of time to get sleep. Unfortunately, this is not the case. This schedule rotates in the counterclockwise (backward) direction: Each day's watch occurs four hours earlier than the previous day's. Likewise, sleep periods and wake-up times keep shifting.

Table 5-4. Standard and Alternate 5-Section Watch

Standard 1-in-5 Rotation				**Alternate 5-Section Watch**			
	Day 1	Day 2	Day 3		Day 1	Day 2	Day 3
0000-0400	A	B	C	0000-0400	A	A	A
0400-0800	B	C	D	0400-0900	B	B	B
0800-1200	C	D	E	0900-1400	C	C	C
1200-1600	D	E	A	1400-1900	D	D	D
1600-2000	E	A	B	1900-0000	E	E	E
2000-0000	A	B	C				

Take, for example, duty section A in Table 5-4 (left side). On Day 1, watchstanders in section A stand two watches: 0000-0400 and 2000-0000. This schedule gives them a chance to sleep after the first watch, at about 0430-1200. They would probably attempt to sleep after the second watch (the beginning of Day 2) from 0030-0800 or thereabout. Already we see an advance in bedtimes and wake-up times of 4 hours from Day 1 to Day 2. On Day 2, personnel would stand their 1600-2000 watch and sleep 2300-0700 (about a 1-hour advance in wake-up time).

If the section A personnel understood body clocks, they would attempt to keep this same sleep time for the next two days, because their watch schedule would allow it (Day 3 watch is 1200-1600; Day 4 watch is 0800-1200; and section A's Day 4 is the same as C's Day 1). However, because the Day 6 watch starts at 0400, sleep times must advance to about 2000-0330. Watchstanders could take a nap prior to their Day 7 (same as Day 1) 0000-0400 watch; otherwise, they would be awake for over 24 hours before their next sleep opportunity.

It is easy to see how disruptive this schedule is. Although it might be argued that there is plenty of time for watchstanders to take naps, naps are not possible on an arbitrary basis, because of the daily energy cycle (Figure 4-2), which offers only a few low points during normal awake hours. To further complicate matters, when our body clocks are badly disrupted (as is the case with this schedule), our physiological cycles get out of synch also, making it difficult to predict when we would be able to get sound sleep. We often experience heavy fatigue only to find that we are unable get to sleep. This is why it is so important to keep sleep schedules as consistent as possible from day to day: A stable body clock makes energy available when we need it, and allows us to sleep soundly when we go to bed.

One alternative to the 1-in-5 rotation is shown on the right half of Table 5-4. This 5-section watch schedule has one section (A) that works a 4-hour watch at midnight, and four sections (B-E) that stand 5-hour watches. Watch times are consistent from day to day. This schedule provides duty sections C, D, and E with the opportunity to get a full eight hours of sleep at night (that is, to maintain a normal day orientation for their body clocks). Although section A personnel work 0000 to 0400, they can get sound sleep if they go to bed before sunrise (and use dark glasses during times of year the sun rises early). Section B personnel probably have the least desirable schedule of the group, because they would have to go to bed by 2000 in order to obtain 7 to 8 hours of uninterrupted sleep. However, because their schedule is consistent from day to day, they will have better endurance than they would on the traditional 1-in-5 schedule, even if they get only 6 consecutive hours of sleep and take a 1- to 2-hour nap later in the day.

Some other potential variations to the 1-in-5 are:

- Stand the 1-in-3 and have two floaters who rotate into the watch
- Stand the alternate 1-in-4 (right side of Table 5-3) and have one floater

5.5.5 To Rotate, or Not To Rotate? And How Often?

Most personnel do not enjoy standing night watch without at least some degree of rotation. To accommodate this basic reality, rotations should be allowed on a monthly or a biweekly basis (but no more frequently than every 14 days). Schedules should always be rotated in a clockwise direction, so that watchstanders are getting up later rather than earlier for each new watch. For example, in the 3-section watch provided in Table 5-1, section A is on the 0000-0400 watch. If the watch schedule is to be rotated, section A personnel should be switched to the 0400-0800 watch (a clockwise delay in time).

Rotations could be made at noon: The 0800-1200 watch could be extended to 1400 (for a one-time, 6-hour watch), with the next watch working 1400-2000. Thereafter, the watch sections would be on a new 4-hour schedule. Remember: Every time the schedule is changed, it takes about three days for the body clock to readjust. The longer personnel stay on the same schedule, the better adapted they will be.

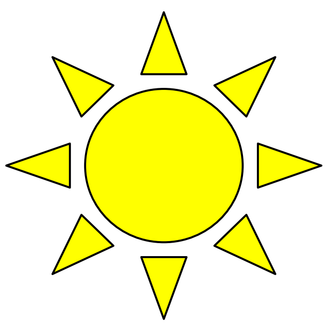
In summary, here are some key recommendations that can help keep personnel alert and adjusted to their work schedules:

Designing Good Watch Schedules

- ❑ **Avoid using frequently rotating duty schedules.**
- ❑ **If you must use rotating schedules, make sure personnel remain on the same schedule for at least two weeks, and that they rotate forward (from 0000-0400 to 0400-0800, for example) rather than backwards (from 0400-0800 to 0000-0400, for example).**
- ❑ **Avoid allowing personnel to work more than 12 hours in any 24-hour period. Count the 24 hours from when personnel wake from their normal (longest) sleep period (not naps).**
- ❑ **Allow for self-selection: Give preference to those who need or want to work nights.**

5.6 Light Management and Adaptation to the Night Watch

Adaptation to nighttime or daytime work requires synchronizing physiological and cognitive resources under the regulation of the biological clock. In order to adapt their biological clock, personnel must be exposed to daylight (or bright artificial light of 1,000 lux or greater) upon awakening and throughout their active periods (that is, during work hours). Light management is critical for proper adaptation to watch/work schedules.



FACT: Daylight or sufficiently bright artificial light (≥ 1,000 lux) is the necessary input to set the body's clock.

MANAGEMENT NUGGET: The only way to fully adapt to night watch schedules is to reset the biological clock so that energy peaks during nighttime. Work must take place under artificial bright lights (1,000 lux or greater), mimicking the effects of daylight. Sleep must take place in a dark, noise-free environment over a period of 7 to 8 uninterrupted hours.

If the use of bright, artificial light is incompatible with the work environment (for example, on the bridge of a cutter, or in the cockpit of a helicopter at night), a specific light and sleep management schedule can be designed to shift the biological clock toward a night orientation.

For specific guidance on using light-management techniques, refer to Appendix B: *Light Management Guide*.

Adapting to Night Watch

- ❑ Adapting to the night watch requires exposure to bright light (of at least 1,000 lux) throughout a watch period. This exposure can be accomplished in most shipboard and shore-side environments (engineering spaces and communications centers, for example). However, where night vision is required (on the bridge, for example), personnel can only achieve partial adaptation to the night watch (see next box, "Special Considerations for Partial Adaptation to the Night Watch").
- ❑ To promote good adaptation to night work, personnel must see daylight or sufficiently bright artificial light (at least 1,000 lux) after they awake from their longest daily sleep period, and as much as possible throughout their awake period. Exposure to daylight provides a critical input that facilitates body-clock adjustment to the sleep/watch schedule.
- ❑ Promote exercise in the evening hours.
- ❑ Provide nighttime personnel with small meals that promote energy and alertness: High protein, low fat, low sugar, low starch, no dairy products, no turkey (dairy and turkey can cause sleepiness). A low-fat diet is particularly important during the first three days after rotation to a night schedule, because gastrointestinal disorders are more likely while the body is trying to adjust to the new schedule.
- ❑ Adjust meal times so that nighttime personnel can eat a brunch upon awakening (at approximately 1300), including brewed coffee and breakfast foods if desired.
- ❑ Always adapt mess services to accommodate personnel needs. Make hot, nutritious meals available at times coordinated with the various watch schedules. Provide access to nutritious snacks or self-serve meals around the clock. These accommodations support both safety and crew morale.
- ❑ Allow for self-selection: Give preference to those who need or want to work nights.

<u>Special Considerations for Partial Adaptation to Night Watch</u>

- ❑ **There are three approaches to reducing fatigue under partial adaptation conditions. The preferred approach is to allow personnel on the 0000-0400 watch (or any other night watch ending in the morning hours) to retire *prior to sunrise*, for 7 to 8 hours of *uninterrupted* sleep. (It is critical that there be no interruptions during the long sleep period.) Daytime work or other duties should be scheduled to occur after wake-up time (from 1400-1800, for example). Leisure time would then take place during the evening hours.**
- ❑ **A second approach to reduce fatigue during the midnight watch is to allow one crewmember to work most of the night by extending the watch duration to 5 or 6 hours (0000-0600, for example). For this to work, the night watchstander must be allowed to retire prior to sunrise and to sleep 7 to 8 uninterrupted hours in a dark, noise-free environment with <u>absolutely no interruptions.</u> Allowing one watchstander to cover the entire night watch avoids need of adapting other personnel to night work. For night work, seek personnel who prefer to work at night.**
- ❑ **A third approach is to reduce the duration of the nighttime watch (to three hours, for example) to minimize the impact of fatigue on safety.**
- ❑ **Unwanted exposure to daylight can be minimized by wearing dark sunglasses. Very dark sunglasses may be ordered from commercial sources. If these are not available, conventional sunglasses will measurably reduce light exposure.**
- ❑ **For exercise and meal recommendations, see the preceding box titled "Adapting to Night Watch".**

5.7 Transitioning to the Night Watch

In regard to transitioning from a day schedule to a night schedule (or vice versa), it is assumed that, prior to switching to the new schedule, the crewmember has been adhering to the current schedule for at least two weeks, and is well adapted. It is further assumed that bright light is not being used in the crewmember's present work environment. (If bright light *is* being used, refer to Section 5.6, *Light Management and Adaptation to the Night Watch.*)

The light-management regimens provided at the end of this section are designed to help personnel rotate to (and from) a night-watch routine:

Table 5-5	Transitioning from a day schedule to a night schedule when the night schedule ends after sunrise.
Table 5-6	Transitioning from a day schedule to a night schedule when the night schedule ends before sunrise.
Table 5-7	Transitioning from a night schedule back to a day schedule.

Exposure to daylight (or to artificial light of at least 1,000 lux) is a necessary input for resetting the body clock and keeping it stable. The regimens in the following tables direct personnel when to seek exposure to daylight and when to avoid it. These regimens assume sunrise at 0500 and sunset at 2000. Of course, the actual times for sunrise and sunset depend on location and time of year; hence, the times used in the regimens will need to be adjusted as circumstances dictate.

The tables use the following symbols:

dl	Exposure to daylight
db	Daylight blocking during free time
wb	Daylight blocking during work time
sb	Daylight blocking during sleep time

During periods of daylight blocking, personnel should avoid exposure to any daylight by staying inside and keeping blinds/curtains closed.

If personnel must be outside (or on the bridge) during these times, they should wear dark sunglasses (sg) to limit exposure to bright sunlight. Note that the symbol in effect changes appropriately from daylight to daylight blocking, or vice versa, during duty-hour transitions.

When personnel are on night watch (Days 4-6 in Table 5-5), they should avoid any exposure whatsoever to early-morning sunlight, lest their body clock, instead of thinking it's almost time for sleep, will be reset back to a daytime orientation. If sunrise occurs before night-watch personnel get off watch, they should wear dark sunglasses.

'Sleep with daylight blocking' periods (sb) begin when personnel get off watch, and extend until early afternoon. When personnel awaken in the afternoon, they should immediately seek exposure to daylight in order to establish the current time-of-day as the beginning of their day. Outdoor activities, such as exercising or taking walks, are encouraged during this time. When naps are indicated, personnel should try to take a nap that is at least two hours in length in order to adequately compensate for anticipated sleep debt.

In all three tables, the current work schedule (before making a transition) should approximate the schedule for Day 1. During the first two days of transition to any nighttime schedule, personnel should reduce their workload between the hours 0400 and 0700 in order to prevent increased risk due to fatigue or sleepiness. During the transition back to a day schedule, personnel should reduce their workload near the end of the work period (after 1500).

Exposure to daylight periods must begin at the earliest time in the indicated range, and end at the latest time. Exposure to daylight should last as long as possible. Normal activities, such as lunch and exercise, should be scheduled to occur within the time range. Note: Continuous exposure to daylight is not required; however, intervals of at least two hours are highly recommended.

As an example, refer to Table 5-5: Day 1 shows a normal daytime duty schedule. A crewmember on this schedule has been working in daylight from 0700-1500, and has been sleeping in darkness from 2200 until about 0600 (the 0600-0700 interval would likely be used for showering, dressing, and eating breakfast). To begin adapting to upcoming night work, this crewmember would begin, on Day 2, blocking daylight until about 1000, effectively delaying sunrise for the body clock. If working indoors, this crewmember would block daylight from all windows; otherwise, the crewmember should wear dark sunglasses until 1000. The crewmember's sleep period would begin at 2200.

On Day 3, this crewmember would begin nighttime duty. Daylight blocking would be used until 1000, at which time exposure to daylight would be sought. A nap of at least one hour would be taken in early evening to help reduce sleepiness during the night watch. Night watch and all collateral duties would encompass the interval from 2000 until about 0700.

Note that work duties are occurring after sunrise; this schedule requires daylight blocking (if working indoors), or the use of dark sunglasses, to prevent exposure to daylight; sleep with daylight blocking occurs from 0700-1400. Upon waking in the afternoon, the crewmember would seek exposure to daylight (dl) in order to help set the body clock to the nighttime orientation. An early-evening nap would help reduce sleepiness while on night watch.

The schedule in Table 5-6 is very similar to the schedule in Table 5-5. The main difference is that in the Table 5-6 schedule the work period ends before sunrise, so that daylight blocking during the work period is not necessary. The same major concepts apply: Blocking daylight during the sleep period, and seeking exposure to daylight upon awaking in the afternoon.

Table 5-7 shows a crewmember who has been on night watch and is transitioning back to a daytime watch. The important points to note here are that on Day 2 there is an extended evening nap prior to the Day 3 mid watch. To help adjust to the upcoming day work schedule, the crewmember should seek exposure to daylight at sunrise and throughout the morning. At 2200, the crewmember's nighttime sleep period begins.

Exposure to daylight is sought as soon as possible after waking on Day 4, and after the day watch is worked; a short nap should be taken if needed (a long nap can prevent getting to sleep at night). Exposure to daylight in late afternoon and early evening is recommended, to help reinforce the new day-watch schedule for the body clock.

Table 5-5. Transition to Night Schedules When Work Ends After Sunrise

	24	01	02	03	04	05 Sunrise	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20 Sunset	21	22	23
Day 1	s	s	s	s	s	s	s	w	w	w	w	w	w	w	w								s	s
Day 2	s	s	s	s	s	sb	db	wb	wb	wb	w	w	w	w	w	w							s	s
Day 3	s	s	s	s	s	sb	db	db	db	db	dl	dl	dl	dl	dl	dl	dl	dl	n	dl	w	w	w	w
Day 4	w	w	w	w	w	sg	sg	sb	sb	sb	sb	sb	sb	sb	dl	dl	dl	dl	n	dl	w	w	w	w
Day 5	w	w	w	w	w	sg	sg	sb	sb	sb	sb	sb	sb	sb	dl	dl	dl	dl	n	dl	w	w	w	w
Day 6	w	w	w	w	w	sg	sg	sb	sb	sb	sb	sb	sb	sb	dl	dl	dl	dl	n	dl	w	w	w	w

Table 5-6. Transition to Night Schedules When Work Ends Prior to Sunrise

	24	01	02	03	04	05 Sunrise	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20 Sunset	21	22	23
Day 1	s	s	s	s	s	s	s	s	w	w	w	w	w	w	w								s	s
Day 2	s	s	s	s	s	sb	db	wb	wb	wb	w	w	w	w	w	w				n	n	n		
Day 3	w	w	w	w	w	sb	sb	sb	sb	sb	sb	sb	sb	dl	dl	dl	dl	dl	dl	dl	w	w	w	w
Day 4	w	w	w	w	w	sb	sb	sb	sb	sb	sb	sb	sb	dl	dl	dl	dl	dl	dl	dl	w	w	w	w
Day 5	w	w	w	w	w	sb	sb	sb	sb	sb	sb	sb	sb	dl	dl	dl	dl	dl	dl	dl	w	w	w	w
Day 6	w	w	w	w	w	sb	sb	sb	sb	sb	sb	sb	sb	dl	dl	dl	dl	dl	dl	dl	w	w	w	w
Day 7	w	w	w	w	w	sb	sb	sb	sb	sb	sb	sb	sb	dl	dl	dl	dl	dl	dl	dl	w	w	w	w

Table Key:

Sleep (s)	Sleep with daylight blocking (sb)	Nap (n)	IF POSSIBLE, WEAR SUNGLASSES (SG)
Work (w)*	WORK WITH DAYLIGHT BLOCKING (WB)	Daylight Blocking (db)	DAYLIGHT OR ARTIFICIAL LIGHT EXPOSURE (DL)

*Daylight exposure expected throughout daytime work hours.

Table 5-7. Transition from Nighttime to Daytime Schedules

	24	01	02	03	04	05 (Sunrise)	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20 (Sunset)	21	22	23
Day 1	w	w	w	w	w	w	sb	sb	sb	sb	sb	sb	sb	sb	dl	dl	dl	dl	dl	dl	n	n	w	w
Day 2	w	w	w	w	w	wb	sb	sb	sb	sb	sb	sb	sb	sb	dl	dl	dl	dl	n	dl	n	n	n	n
Day 3	w	w	w	w	w	dl	dl	n	dl	dl	dl	dl	dl	dl	dl	dl	dl	dl	dl	dl			s	s
Day 4	s	s	s	s	s	s	dl	w	w	w	w	w	n	w	w	w	dl	dl	dl	dl			s	s
Day 5	s	s	s	s	s	s	dl	w	w	w	w	w	n	w	w	w	dl	dl	dl	dl			s	s
Day 6	s	s	s	s	s	s	dl	w	w	w	w	w	n	w	w	w	dl	dl	dl	dl				

Table Key:

Sleep (s)	Sleep with daylight blocking (sb)	Nap (n)	IF POSSIBLE, WEAR SUNGLASSES (SG)
Work (w)*	WORK WITH DAYLIGHT BLOCKING (WB)	Daylight Blocking (db)	DAYLIGHT OR ARTIFICIAL LIGHT EXPOSURE (DL)

*DAYLIGHT EXPOSURE EXPECTED THROUGHOUT DAYTIME WORK HOURS

6. Caffeine & Medications

In this section you will learn:

- Why consuming too much caffeine can be counterproductive
- How to use caffeine effectively as a stimulant
- How to break an addiction to caffeine
- How to manage sleep-altering drugs

6.1 The Stimulant Trap

Chronic stress and insufficient sleep can be extremely damaging not only to crewmember health, but also to operational safety. Both chronic stress and insufficient sleep deplete energy resources and induce fatigue. Thus, crewmembers who are not getting enough sleep, or who are under significant stress, will feel tired, and may seek artificial ways to increase alertness in order to endure job demands. One potentially damaging threat in this situation is the chronic use of stimulant substances, such as caffeine and pseudoephedrine (a chemical commonly found in nasal decongestants).

High doses of such stimulant substances can result in:

- Increased anxiety
- Lack of concentration
- Digestive disorders

In regard to caffeine specifically, some people have a high sensitivity to this common stimulant (found in coffee, soft drinks, chocolate, and some medications) and often experience the symptoms mentioned above even at low doses. In high doses, caffeine can be addictive, and can result in a drain on energy stores rather than in the boost desired. For caffeine to serve as an alertness booster, it must be consumed at *low levels*, and *only when needed*.

Stimulants commonly found in medications, such as pseudoephedrine (widely used in the treatment of allergy and cold symptoms, can also be addictive, and can also lead, as in the case of caffeine, to negative results.

6.2 Caffeine

Caffeine is widely consumed each day in coffee, tea, soft drinks, and chocolate. While caffeine is classified as a stimulant drug, regular use of caffeine can actually degrade endurance by leading to dependency and/or causing gastrointestinal problems. In high doses, caffeine can cause distracting, even debilitating, anxiety (jitters).

For caffeine to be used as an alertness boost, it must be consumed at low levels and only when needed. Because the stimulation effects of caffeine last up to six hours after consumption, personnel should time their consumption of caffeine for when a boost in alertness is most needed, and such that it does not interfere with sleep periods.

Times when caffeine use is most appropriate:

- Midway through the night shift on the first or second day of the work week.
- Mid-afternoon when the afternoon dip in alertness is significant due to inadequate nighttime sleep.

How to Use Caffeine as a Stimulant

- ❑ **Consume at least 32 milligrams of caffeine when needed (see Table 3-8).**
- ❑ **Avoid caffeine within four hours of bedtime.**
- ❑ **Avoid daily use of caffeine as a stimulant.**

6.2.1 Sources of Caffeine

Table 6-1 lists the most common sources of caffeine.

Table 6-1. Common Sources of Caffeine

Source	Serving Size	Milligrams of Caffeine
Coffee		
Regular*	8 oz.	8-150
Decaffeinated	8 oz.	5
Tea		
Brewed**	8 oz.	9-50
Decaffeinated	8 oz.	3-9
Herbal (fruit)***	8 oz.	0
Iced	12 oz.	22-70
Chocolate		

Hot Cocoa	8 oz.	5-8
Milk Chocolate	1 oz.	1-15
Dark Chocolate	1 oz.	5-35
Soft Drinks		
Coca-Cola	12 oz.	46
Pepsi	12 oz.	38
Dr. Pepper	12 oz.	41
Surge	12 oz.	51
Mountain Dew	12 oz.	55
Jolt	12 oz.	71
Sprite	12 oz.	0
7-Up	12 oz.	0

*Depending on roast, method, and whether served with creamer, milk, etc.

**Depending on time steeped and type of tea leaves.

***Most fruit and herbal tea contains no caffeine; there are some exceptions.

Source: *TCRP Report 81*. Washington, DC: National Academy Press (2002)

6.2.2 Breaking an Addiction to Caffeine

As mentioned, personnel should only consume caffeine when a boost in alertness is truly needed. They should not consume caffeine on a daily basis; that is, in response to an addiction.

When personnel are addicted to caffeine, in order to make caffeine an effective alertness booster, they must first break their addiction. Failure to do this will render using caffeine as an alertness booster highly counterproductive, even dangerous.

Withdrawal from caffeine requires complete abstinence from consumption (whether in coffee, tea, soft drink, chocolate, or any other source) for at least two full weeks, and can be associated with some unpleasant, although temporary, side effects, including craving and irritability. It is recommended that personnel intending to detox from caffeine 'buddy up' with a fellow crewmember intending to do the same.

Withdrawal from Caffeine

- Withdraw from daily caffeine use can take two weeks or longer.
- Withdrawal effects may include craving, irritability, headaches, attention deficit, fatigue, and lack of motivation.
- Sleep patterns, however, will likely begin to improve within this period.
- Vigor and alertness after awakening might not be restored until the withdrawal process is complete.
- After withdrawal, use caffeine only when needed to boost alertness.
- If total withdrawal is not possible, reduce the consumption of caffeine to one serving (beverage, pill, chocolate bar) per day.

6.3 Medications

Many medications, both over-the-counter (OTC) and prescription, can affect alertness. Most prescription medications today are packaged with a fact sheet informing the patient of any possible sedating side effects. For OTC drugs, this kind of information is included in the 'fine print' on the label. The sedating effects of OTC medications can last up to 24 hours.

Table 6-2 lists popular OTC medications that can degrade alertness.

Table 6-2. OTC Medications That Induce Sleepiness

Medication Type	Drugs & Brand Names
Allergy Medications (Antihistamines)	Brompheniramine Dimetapp® Allergy, Nasahist B® Chlorphreniramine Chlor-Trimeton® Clemastine Tavist-1®, Tavist-D® Diphenhydramine Benadryl®
Sleep Aids	Diphenhydramine Nytol® liquid

Alcohol	Alcohol Nyquil® liquid
Motion Sickness Tablets	Dimenhydrinate Dramamine® Meclizine Dramamine II®
Pain Medications	Naproxen sodium Aleve® Diphenhydramine (an active ingredient in Tylenol P.M.)

> **WARNING! All medications containing pseudoephedrine warn against chronic use. In fact, most recommend discontinuation after three days of continuous use and always recommend physician supervision.**

Table 6-3 lists OTC medications that can interfere with sleep.

Table 6-3. OTC Medications That Interfere with Sleep

Medication Type	Drugs & Brand Names
Alertness Aids	Caffeine Vivarin®, No-Doz®
Decongestants	Pseudoephedrine Sudafed®
Diet Pills	Caffeine Ephedra Chromium Piccolanate
Tobacco	Nicotine

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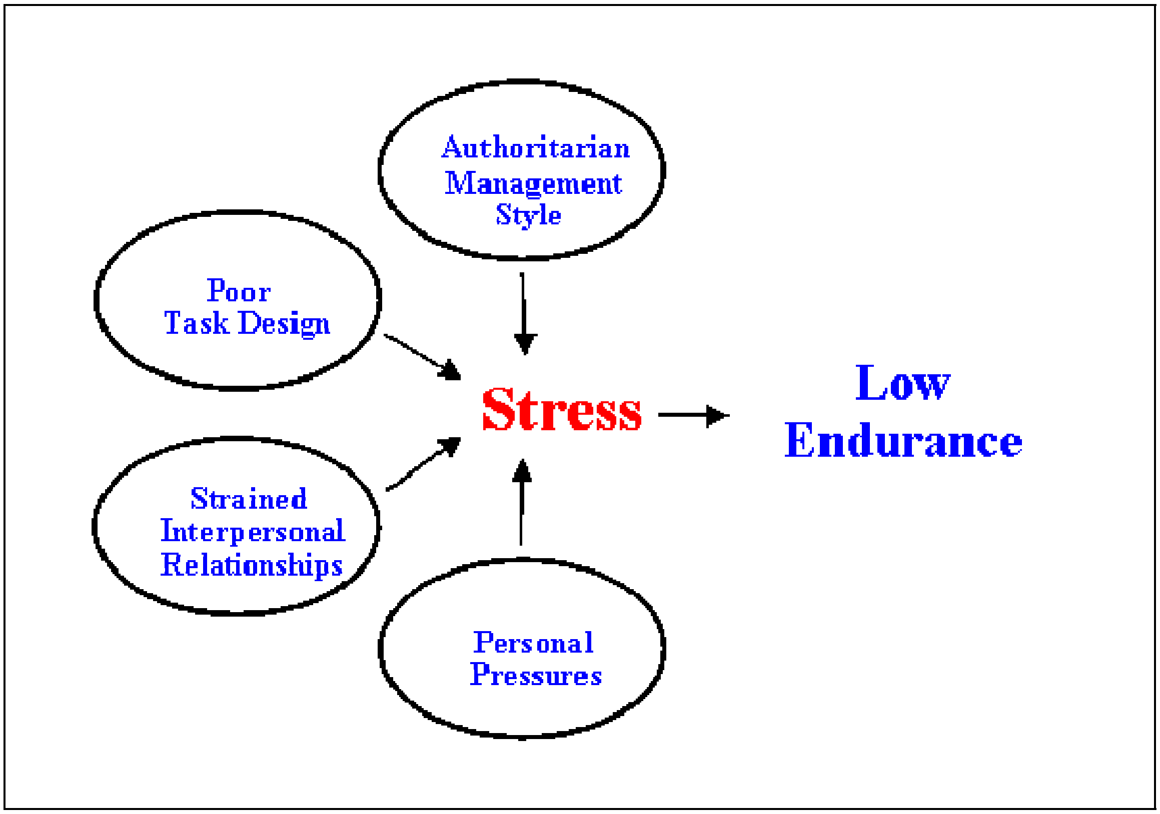
7. Stress

In this section you will learn:

- What contributes to high stress levels
- How stress affects the body
- How stress drains energy and lowers endurance
- How to control stress



7.1 Factors that Increase Stress and Sap Energy

While a little stress actually improves performance, too much stress depletes energy resources, degrades endurance, and distracts personnel from primary tasks. The following factors can increase stress to levels that can compromise crew safety and performance:

An Authoritarian Management Style:

- Lack of participation by workers in decision making
- Poor communication between management and employees
- Lack of family-friendly policies

Poor Task Design:

- High workload
- Infrequent rest breaks
- Long work days
- Shiftwork (work outside normal daytime hours)
- Hectic routine tasks
- Little sense of control

Strained Interpersonal Relationships:

- Lack of support from coworkers and supervisors
- Conflict with others (on or off the job)
- Marital problems and divorce

Personal Pressures

- Work-family conflict
- Child or elder care
- Few friends
- Financial problems
- Continuing education

These factors increase stress levels and drain energy, even during rest periods. Because of the energy-draining effect of stress, personnel need to know how to manage stress.

7.2 What Happens When We Get Stressed

The human response to stress, millions of years old, is sometimes called 'fight or flight'. Whenever humans are stressed, whether physically or psychologically, adrenaline is released into the bloodstream, causing a number of physiological reactions:

- Increased heart rate
- Increased blood pressure
- Shallow, rapid breathing
- Increased blood flow to the muscles
- Increased energy release

Our distant ancestors evolved this adrenaline-induced response – often referred to as the 'fight or flight' response – because, in their environment, most sources of stress required an intense, physical response: Kill an attacker before he/it kills you (fight), or out run a predator to the safety of the nearest tree (flight). Today, most of the stress we experience does not derive from life-threatening situations, and the physiological reactions induced by adrenaline are therefore often inappropriate, and can even be dangerous to our long-term health: For example, chronic stress, the fight-or-flight response it continually induces, is believed to be a major cause of cardiovascular disease. In other words, too much fight-or-flight, instead of saving us from harm, can do us harm. To protect ourselves from such harm, we must learn how to manage stress.

7.3 Stress Decreases Endurance

Chronic stress causes a constant drain on energy stores. Similar to a house leaking heat during winter conditions, crewmembers' bodies leak energy under stressful conditions. The energy used in response to stress reduces the amount of energy personnel have for their work. This means personnel must somehow produce more energy in order to have enough to do their jobs. However, stress inhibits the body's ability to produce the energy needed by interfering with restorative sleep. Thus, by leaking energy through natural responses to stress, and by preventing the body from fully restoring itself through sleep, chronic stress reduces endurance.

In a stressful work environment, crewmembers can be expected to experience frequent bouts of reduced mental concentration and awareness. The use of caffeine and other widely available stimulants, such as pseudoephedrine (used in decongestants), to combat these chronic impairments can result in decreased attention, irritability, and adverse health effects.

Implementing effective stress management techniques and programs is a must-do for effective endurance management. This requirement is particularly relevant in the Coast Guard, where high-tempo operations can provide personnel with little or no opportunity to break away from work-related duties. Under such high-temp conditions, work-related factors such as task design, management style, and interpersonal relationships can easily induce chronic stress if they are not adequately managed.

Identifying and reducing causes of stress, as well as providing access to stress-reducing activities (for example, exercise and recreation), can help control stress and increase endurance. Stress reduction and morale boosters (such as access to cell phones or e-mail to keep in contact with family members) can reap big pay-offs for a relatively small investment.

7.4 How to Control Stress

Education and awareness are important elements of any stress management program. Many CG personnel are not aware of the symptoms and consequences of stress. Compounding the problem is the commonly held belief that stress is an individual problem that must be handled at the individual level. Individual stress affects the entire unit, and people need to be aware of resources available for managing stress.

Command personnel and department heads have a critical role in implementing successful stress-management programs. Components of a stress management program include:

- Identifying stress management resources (for example, wellness programs and financial advice)
- Offering training in stress management, time management, and work planning
- Making time for exercise, recreation, and relaxation
- Promoting participatory troubleshooting and decision making
- Maintaining good working relationships
- Allowing contact with family and friends (for example, cell phones and email)
- Providing nourishing meals

The recommendations in the following box can prove valuable in controlling stress:

STRESS CONTROLS

- ❑ Train new employees, and those recently promoted, to use/engage in:
- ➢ Time-management strategies
- ➢ Regular physical exercise
- ➢ Relaxation exercises (to reduce anxiety, increase concentration, and optimie the quality of rest periods)
- ❑ Provide access to a variety of exercise equipment (free weights, stationary bicycles, rowing machines, etc.).
- ❑ Provide access to stressreducing activities (satellite TV, relaxation training, a nap policy for long work days,mental and physical health counseling).
- ❑ Promote crew participation in problem solving to reduce feelings of alienation, promote feelings of selfworth, and allow crewmembers to become part of a network.
- ❑ Identify and reduce stressors, particularly those involving interpersonal relationships.
- ➢ Maintain good communication with crewmembers
- ➢ Keep in mind that alienation, withdrawal, and lack of participation are signs of stress
- ❑ Modify the daily menu so that meals are balanced and offer plenty of fresh vegetables,fruits, whole-grain breads, and low-fat meats such as turkey, fish, and chicken. Avoid fried foods in favor of broiled, grilled, and baked meals. Good food promotes high morale.
- ❑ Provide a variety of nonalcoholic, caffeinefree beverages, and avoid the useof high-sugar soft drinks. The best drinks are fresh water and fresh fruit juices.
- ❑ Provide access to family and friends through email or cell phones.

8. Environmental Hazards

Environmental hazards include the following illnesses:

- Cold-Related Illness
- Heat-Related Illness
- Motion Sickness

In this section, you will learn how these illnesses affect crew endurance; measures you can take to avoid them, or mitigate their effects; and measures you can take to recover from them.

8.1 Cold-Related Illness

In this section you will learn:

- How exposure to cold temperatures reduces endurance
- How to recognize the symptoms of three cold-related illnesses: frostbite, trench foot, and hypothermia
- How to prevent cold-related illness

8.1.1 Cold Temperatures = Reduced Endurance

Prolonged exposure to cool or cold temperatures causes the body to work harder to maintain its core temperature. This extra work requires that energy resources be shifted to survival needs, thereby making less energy available for work.

Because the skin is an excellent radiator of heat, personnel should be encouraged to wear appropriate clothing in cool and cold weather. As the skin temperature decreases, the temperature within the extremities (hands and feet, for example) decreases as well, reducing muscle dexterity and coordination.

Sensations of tingling and numbness are danger signals that should not be ignored. Continued exposure to cold can lead to hypothermia, characterized by mental confusion and disorientation, and even to death.

WARNING! Cold weather threatens the health and endurance of crewmembers, particularly those working in unprotected areas where exposure to cold spray and air can result in an extreme reduction in body temperature (hypothermia), or in severe frostbite.

8.1.2 Use Common Sense on Deck

A lack of common sense on deck is a primary endurance risk factor. Exposure to cool winds, dampness, and/or cold water – all readily available on the decks of CG cutters and small boats – can lead to cold-related illness. In these environments, crewmembers must be aware of a number of risk factors that can combine to threaten their health and endurance:

- Wet clothing
- Insufficient insulation of body, head, hands, and feet from wind, ocean spray, and cold temperature
- Use of medications that disrupt the body's ability to regulate core body temperature
- Physical exhaustion
- Age: The older we are the greater the danger is of suffering a cold-related illness
- Prolonged exposure in cold, windy, or damp work environments

8.1.3 Cold-Related Illness

Exposure to cold can result in:

- **Frostbite:** Extended exposure to temperatures of 30 °F or lower results in frozen tissue. Fingers, cheeks, nose, and ears are most susceptible. Symptoms of frostbite include sensation of coldness, tingling, stinging, aching, and numbness. Untreated, frostbite can result in amputation or loss of function of the affected area. First aid requires treating tissue with warm water (102-110 °F) as long as there is no chance of the tissue re-freezing. Bed rest and medical attention should follow first aid.
- **Trench foot:** Extended exposure to wet and cold results in damage to the circulatory system in the feet. Symptoms of trench foot include tingling, itching, swelling, and pain. Untreated, trench foot can result in death of skin tissue and ulceration. First aid requires moving the victim to a warm area and treating the affected foot or feet with warm water (102-110 °F) or warm packs. Bed rest and medical attention should follow first aid.
- **Hypothermia:** Environmental air temperatures of 50 °F and below, or water temperatures of 72 °F and below, can induce persistent loss of body heat.

Symptoms of hypothermia include shivering uncontrollably, confusion, carelessness, and disorientation. Untreated, hypothermia can result in death. First aid requires moving the victim to a warm and dry environment, removing wet clothing, offering warm nonalcoholic drinks, and using warm blankets to insulate the body from further exposure. Bed rest and medical attention should follow first aid.

Controlling Cold-Related Endurance Risk Factors

Train crewmembers to:

- ❑ **Wear 3-layered clothing: The outer layer breaks the effects of wind chill. Gore-Tex and nylon materials are best. The middle layer absorbs sweat and insulates the body from the external cold. Wool and synthetic-pile are best for this use. Lastly, the innermost layer must provide ventilation and the escape of perspiration. Synthetic fibers are best for this layer.**
- ❑ **Bring sufficient change of clothing to prevent working with wet garments.**
- ❑ **Keep the head covered at all times. Most body heat is lost when the head is unprotected from cold.**
- ❑ **Keep hands, feet, and face covered and warm. Fingers and hands can't function properly below 59 °F.**
- ❑ **Keep the feet well insulated from cold and dampness. Layered socks and insulated boots are a must.**
- ❑ **Keep garments clean. Soiled clothing looses its insulating properties.**

Provide crewmembers with:

- ❑ **A heated shelter**
- ❑ **Protected work areas**
- ❑ **Radiant heaters**
- ❑ **Thermal insulating materials placed over tool handles at environmental temperatures below 30 °F**
- ❑ **Extra breaks when exposed to cold environments (deck personnel)**
- ❑ **Reduced work pace**
- ❑ **Training sessions on how to endure cold-related risk factors.**

8.2 Heat-Related Illness

In this section you will learn:

- How hot temperatures affect the body and pose an endurance risk
- How to identify the symptoms of heat exhaustion and heat stroke
- How to prevent heat illness

8.2.1 Heat is an Endurance Hazard

Under hot conditions, dehydration and loss of minerals needed to maintain body functions are constant risks to crew endurance. Aboard cutters, exposure to high temperatures on deck is common mostly during the summer months. In engineering spaces, however, exposure to high temperatures is a year-around hazard.

When exposed to heat, the human body normally maintains core temperature (98.6 °F) through sweating. The evaporation of sweat from the skin acts to cool the skin. Prolonged exposure to heat (which can be compounded by strenuous physical activity and/or insufficient intake of water and salt) can overwhelm the body's ability to cool itself, leading to the acute onset of heat illness. Depending on the degree of severity, heat illness is classified as heat exhaustion or heat stroke.

> WARNING! **Heat illness is caused by prolonged exposure to heat and by insufficient fluid intake.**

8.2.2 Heat Exhaustion

Heat exhaustion typically occurs when personnel exercise heavily or work in a warm, humid environment, such that the body sweats heavily. Heavy fluid loss can result in a decreased flow of blood to vital organs, and thereby onset of extreme fatigue. Also, the body is not effectively cooled when high ambient humidity or too many layers of clothing prevent secreted sweat from evaporating.

The symptoms of heat exhaustion are:

- Pale, clammy (cool and moist) skin
- Heavy sweating
- Dilated pupils
- Headache
- Nausea or vomiting
- Dizziness

8.2.3 Heat Stroke

Heat stroke is a life-threatening condition that requires immediate medical attention. Heat Stroke ensues when an overheated body loses its ability to regulate the core body temperature. Unless first aid is given to the victim immediately, core body temperature will continue to rise abated, causing brain damage and eventual death.

The symptoms of heat stroke are:

- Hot, red, dry skin (unless still damp from earlier perspiration)
- Constricted (very small) pupils
- High body temperature (sometimes as high as 105 °F)
- Confusion, disorientation
- Loss of consciousness

EMERGENCY! Should a person exhibit heat illness symptoms, use a cold-water bath or cold wet sheets to lower core body temperature. If the victim is conscious, give one-half glass of water every 15 minutes. Transport the victim to the nearest hospital ER immediately.

WARNING! Crewmembers suffering from any illness involving fever, vomiting, or dehydration will be highly susceptible to heat illness.

Prolonged exposure to heat depletes the body of water and salt. Heat exhaustion is inevitable if crewmembers do not maintain an appropriate amount of water and salt intake during exposures to hot temperatures. Continued exposure to hot temperatures can result in a breakdown of the body's ability to regulate core body temperature. Heat stroke will result when the core body temperature reaches 105-107 °F.

FACT: Heat acclimatization, the process of adapting to consistently hot ambient conditions, can be achieved by engaging in a minimum of 60 to 90 minutes of daily exercise or strenuous work in the heat of the day, for one to two weeks. Adaptation begins to occur within a few days.

How to Prevent Heat Illness

Train crewmembers to:

- ❑ **Drink water often; not wait until they are thirsty.**
- ❑ **Drink extra water if they are sweating, and begin each work period by drinking approximately one pint of water. Water is best consumed in volumes of no more than ½ pint (1 cup) at a time.**
- ❑ **Drink extra water if urination becomes less frequent than normal, or if the urine becomes darker.**
- ❑ **Replace electrolytes with commercial sports drinks that contain 6% glucose and 10-25 mEq/L of sodium. Most commercial sports drinks contain these proportions. Another way to replace electrolytes is through salt obtained from regular meals and snacks.**
- ❑ **Seek well-ventilated places.**
- ❑ **Wear loose-fitting clothes light in color.**
- ❑ **Avoid the use of alcohol or drugs that may impair temperature regulation.**
- ❑ **Acclimate to hot weather as much as possible before working long hours.**
- ❑ **Take rest breaks: Frequent, short exposures vs. long exposures.**
- ❑ **Keep cool by drinking cool fluids or wearing an ice vest.**
- ❑ **Schedule work for cooler times of the day.**
- ❑ **Improve physical fitness.**

8.3 Motion Sickness

This section discusses:

- What causes motion sickness
- How motion sickness affects endurance
- How to control motion sickness
- What medications to take and what the side effects are

8.3.1 Misery and the Adaptation Process

Motion sickness is induced by an internal conflict within the brain. When the body is on a stable platform (firm ground), the brain senses the body's position relative to this unchanging reference (upright, upside down, horizontal, etc.). The sensory pattern formed in the brain becomes coded in memory as a template. When the body is on a moving platform, the sensory pattern formed in the brain regarding the body's position does not, at first, match the existing template. This mismatch creates a series of changes in the body's physiology as the brain tries to create a new reference template. The body experiences these changes as symptoms of motion sickness: cold sweats, yawning, fatigue, dizziness, headaches, nausea, and vomiting.

Fortunately, a new template is ultimately formed, on the basis of the new, ever changing reference, and the symptoms disappear. For CG personnel, this means eventually getting their "sea legs," sometimes, however, not until they've spent several days in misery suffering from the symptoms of motion sickness. Typically, some people adapt to motion more quickly than others, while a few are never quite able to adapt to a level of comfort sufficient for maintaining a normal level of endurance.

WARNING! Motion sickness induces drowsiness and fatigue, thereby degrading performance and increasing the risk to safety. Crewmembers experiencing symptoms of motion sickness should sleep as much as possible, but also should walk about as much as possible to help the brain adapt to the motion being experienced.

8.3.2 Magic Bullets, Performance, and Safety

Medications used to alleviate the symptoms of motion sickness, or to prevent its onset, usually have side effects, such as drowsiness and fatigue. A list of medications and their side effects is provided below (see Table 8-1).

It is recommended that crewmembers receiving medications to mitigate the effects of motion sickness be specifically warned that their performance will likely be degraded. Department heads should exclude any crewmember on medication for motion sickness from any task that might endanger either his/her own safety or the safety of others.

It is strongly recommended that the unit medical officer closely supervise crewmembers using medications for motion sickness. Self-administration of motion-sickness medication is strongly discouraged.

Table 8-1. Medications Commonly Used for Motion Sickness.

MEDICATION	USE	SIDE EFFECT
Scopolamine Patch	Speeds adaptation within 72 hours	Drowsiness Degrades vision
Dramamine	Reduces symptoms	Drowsiness
Antivert	Reduces symptoms	Drowsiness
Phenergan	Reduces symptoms	Drowsiness
Amphetamines	Reduces drowsiness	High blood pressure Disrupts heart rate Addictive
Ephedrine	Reduces drowsiness	High blood pressure Disrupts heart rate Addictive

Note: Scopolamine is the only medication that can speed the process of adaptation.

9. Diet & Exercise

Diet provides the fuel needed by the body for normal function, while exercise helps maintain health.

9.1 Diet

A diet deficient in energy-producing foods can lead directly to degraded stamina, alertness, and concentration. A crewmember trying to operate on the wrong diet is comparable to a vessel trying to run on the wrong type of fuel.

Modest meals consisting of high-protein foods low in fat, sugar, and starch promote wakefulness and alertness.

Certain foods, such as turkey, potatoes, and dairy products, contain a substance known as Tryptophan. This substance triggers the release of melatonin, a sleep-inducing hormone. Ingested at inappropriate times of the day, these foods can degrade crewmember alertness and compromise safety.

9.1.1 Affect on Sleep

What we eat can be a determining factor in sleep quality and duration. Some of the dietary behaviors that can disrupt sleep include:

- Eating heavy or spicy foods just prior to bedtime, which can interfere with sleep by causing heartburn
- Consuming alcohol just prior to bedtime can induce sleep initially, but tends to lead to fragmented sleep
- Consuming caffeine within 4 to 6 hours before bedtime can delay the onset of sleep as well as disrupt sleep

These problems are often exacerbated by conditions common in maritime environments:

- Menus traditionally include large servings of carbohydrates and fried foods.
- On smaller vessels, prepared meals might be limited to one per day.
- On board, the availability of fresh fruits and vegetables might be limited.

9.1.2 Adjustment to Night Work

Proper diet can help crewmembers adjust to nighttime work or watch schedules:

- Eating breakfast soon after waking, regardless of the time of day, can help crewmembers adapt to their work schedule
- Avoiding large meals heavy in sugar and fat can help crewmembers stay awake during watch, and to fall asleep off watch

9.2 Exercise

It has been widely demonstrated through research that exercise is necessary for maintaining health. Exercise helps the body optimize energy usage as well as energy restoration. Exercise promotes weight management and thereby reduces the incidence of obesity-related conditions such as sleep apnea.

Exercise has been shown to increase the efficiency of sleep and increase the body's ability to handle the physiological and psychological effects of stress. It is therefore highly recommended for decision-makers to provide opportunities for crewmembers to exercise.

Section III: Addenda

Section III contains the following appendixes:

- Appendix A: *The Berthing Guide*, a set of guidelines for optimizing crew quarters for sleeping.
- Appendix B: *The Light Management Guide*, a set of guidelines for adapting crewmembers to night work.
- Appendix C: *References*.

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A. Guide to Good Berthing

The berthing environment sets the stage for good restorative sleep. Although people can get used to almost any sleep environment especially when exhausted, certain berthing characteristics can enhance or compromise the restorative value of sleep. To ensure sleep is restorative, berthing environments must be quiet, dark, and cool.

Noise

Although people differ in their sensitivity to noise, a quiet environment, or one with a constant noise source under 45 decibels is most conducive to good restorative sleep. Abrupt noises (that is, slamming doors and “pipes”) disrupt sleep. People can adapt to noise in their sleep environment, but the noise must be constant, not very intense, nor intrusive. Inconsistent and intense noise will disrupt your sleep even is you are not awakened or disturbed by the noise. If your berthing environment is exposed to inconsistent noise levels above 45 decibels, consider the following:

- Remove source(s) of noise (for example, disconnect intercom and provide phones or pagers to alert only necessary personnel)
- Dampen the source of noise (for example, install door stops or rubber stripping on the door frame to reduce noise from slamming)
- Install sound absorbing material (that is, carpeting, heavy curtains, insulated door)
- Use fans or air conditioners to mask the noise
- Use ear plugs, but some people experience discomfort that will disrupt sleep
- Schedule repair and maintenance activities for late morning or early afternoon

Light

Too much light, artificial or natural, will delay falling sleep and disrupt people from staying asleep. To improve sleeping conditions, consider:

- Use heavy dark fabric for curtains
- Use heavy dark fabric to drape over door frame
- Install “hurricane” shutters
- Use eye shades, but some people may experience discomfort that will disrupt sleep

Note: In some situations, light may be used to adapt crews to night operations and promote increased alertness. Therefore, sources of light must be available in the berthing area. To maximize adaptation and alertness, the intensity of the source(s) of light must be greater than 1000 lux. ***Recommend equipping berthing areas, and***

common/recreational areas, with lighting that can attain at least 1000 lux of illumination.

Temperature

Although there are individual preferences, the ideal temperature for sleeping is 65° F. Too hot or too cold can disrupt sleep and even induce nightmares. When possible, allow people to adjust the temperature to their comfort level. In multiple person berthing spaces set temperature at 65° F and provide fans and blankets for members to adjust temperature to their comfort zone.

Humidity

The ideal humidity level is between 60 and 70 percent. Use humidifiers and dehumidifiers to adjust the humidity levels. An added advantage for these units is that they provide a constant hum that can aid in managing disruptive noise.

Colors, Décor, Cleanliness, and Security

The appearance and feel of the sleep environment can soothe people and create a peaceful ambiance that will promote more restful sleep. Specifically,

- Avoid intense and bright colors that arouse people
- Keep area clean and uncluttered
- Exterminate unwanted pests
- Personalize sleep area (that is, photos) to increase comfort
- Ensure area is secure from intruders. People are very vulnerable during sleep and need to feel secure to get restful sleep.

Bedding

One of the most overlooked issues in berthing is bedding. A common attitude is that unless it's distressed and ready for the trash it's fine to use. Nothing could be further from the truth. While the external features of the bedding may look fine, the support feature may no longer do the job. On average, mattresses loose their support and should be replaced approximately every 10 years. Unless the user is small stature, mattresses smaller than "full" size constrain movement and disrupt sleep. Unless berthing space is limited (that is, cutters), "full" size mattresses should be the standard bedding. Uncomfortable bedding will compromise sleep. To improve bedding, consider:

- Clean, cool, and comfortable soft linens
- Cotton sheets are preferred because they are absorbent, making the practical for any climate, and long lasting
- Pillows should be soft enough to conform to the contours of the body

- Mattress should support the contours of the body and allow for free movement
  - Full-size or larger depending on stature of personnel
  - Allow for at least 6 inches of clearance from feet to edge of mattress

Berthing Assessment

Use the checklist attached to rate the quality of your berthing. Answer each question with a "yes" or "no" response. Items marked "no" reveal areas that may compromise sleep. Use the berthing guide provided above to explore possible corrective actions. Remember most of the corrective measures are not very expensive but produce huge returns for sleep, and the endurance of the crew.

Berthing Checklist

	YES	NO
Are sound levels below 45 decibels		
Are sounds consistent and/or gradual (that is, don't hear doors slam shut)		
Can "pipes" be eliminated from berthing spaces		
Is temperature adjustable between 65° and 80° F		
Can temperature be adjusted by occupant		
Is the relative humidity between 60 and 70 percent		
Can light be blocked from entering the space		
Can intensity of artificial light be controlled		
Can lighting source (s) produce at least 1000 lux illumination		
Can personnel feel safe and secure at night		
Can the area be secured if desired		

	YES	NO
Are colors light to provide a feeling of peace and ease		
Is the area clean and free of clutter		
Is mattress less than 10 years old		
Is it even, not sagging, worn, nor stained		
Is it comfortable to lie on		
Is the bed a full size or larger		
Is the mattress 6 inches longer than the sleeper		

Items marked “NO” can compromise sleep. Refer to the Berthing Guide to explore solutions for items marked “NO”. The objective is to attain “YES” responses on all the items.

B. Light Management Guide

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