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

Version 2.0

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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Version 2.0

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N O T I C E

Marc B. Mandler, Ph.D.
Technical Director
United States Coast Guard
Research & Development Center
1082 Shennecossett Road
Groton, CT 06340-6048

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The R&D Center's technical point of contact is Dr. Carlos Comperatore, (860)-441-2751, email: ccomperatore@rdc.uscg.mil.

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 hours, 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 hours (>12 hr.)
- No opportunities to make up lost sleep
- Poor diet (high fat, sugar, caffeine)
- High workload
- High stress
- Lack of control over work environment or decisions
- Exposure to extreme environment (cold, heat, high seas)
- No opportunity to exercise
- 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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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 of 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.

This guide is structured as follows:

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

Section 2 introduces the CEM program implementation process, and describes the first two tasks in detail: (1) forming a CEM Working Group, and (2) conducting a crew endurance risk assessment.

Section 3 provides detailed information on specific risk factors (stress, fatigue, unpredictable work schedules, etc.), and recommends ways of controlling these hazards. It is recommended that pertinent parts of Section 3 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.

Section 4 describes the final three tasks in the implementation process: (3) developing a CEM plan, (4) deploying a CEM plan, and (5) assessing the effectiveness of a CEM plan.

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.

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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 hours, 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 hours (>12 hr.)
- No opportunities to make up lost sleep
- Poor diet (high fat, sugar, caffeine)
- High workload
- High stress
- Lack of control over work environment or decisions
- Exposure to extreme environment (cold, heat, high seas)
- Little opportunity to exercise
- 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, including:

- Sleep quality and duration
- Biological clock attunement

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

Crew endurance refers to the ability to maintain performance within safety limits while enduring job-related physiological and psychological challenges.

These factors all exert a direct influence on crewmember alertness and performance. When these factors are chronically outside optimal ranges, they become risks or hazards that must be controlled.

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. ATP is found in every cell of the body.

In order to make ATP (energy), we need good nutrition, water, oxygen, and sufficient sleep. Producing energy is one of the main functions of sleep. Studies of the brain have shown that ***seven to eight hours of continuous sleep*** are necessary to restore the energy supplies needed for the brain and body to function well.

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 with which the body's internal energy-producing machinery naturally produces 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. 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.

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.

1.1.4. Keeping Energy Levels High

Adequate sleep, proper nutrition, and regular exercise are essential not only to maintaining good health and fitness, but also to producing the energy our body requires. Sometimes, however, the hectic pace of Coast Guard life tempts us into postponing exercise for another day, into opting for a greasy cheeseburger over a fresh salad. In fact, one of the negative effects of chronic stress and fatigue is to urge us toward taking the easy way out. Instead of giving into this urge, however, we should interpret it as a signal to pamper ourselves with regular exercise, nutritious food, and sufficient sleep.

In a nutshell, here is what each and every one of us needs to do daily to keep our energy levels high:

Personal Guidelines for Maintaining Energy

Encourage crewmembers to:

- ❑ **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 staffing 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 hours (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 carbon monoxide, etc.).

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2. Getting Started

In this section, you will learn:

- The process for implementing a Crew Endurance Management (CEM) program

2.1. CEM Implementation Process

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

Task 1: Form a CEM Working Group

Task 2: Conduct a crew-endurance risk assessment

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

Task 4: Deploy the CEM plan

Task 5: Assess the effectiveness of the CEM plan

2.2. Task 1 – Form a CEM Working Group

The first and most important task 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 tasks in the implementation process. The CEM Working Group:

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

The CEM 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 CEM 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 CEM Working Group, a CEM 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 CEM 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 CEM Working Group member should read this guide ***in its entirety***.

2.3. Task 2 – Conduct a Crew Endurance Risk Assessment

The second task in implementing a successful a CEM program is to identify the specific CE risk factors that are affecting current operations.

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 Assessment Form) to facilitate crew-endurance risk assessments. See next page.

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

If a risk factor is present, the CEM Working Group member should:

1. Check the box next to the risk factor
2. On a scale of 1-7, rate how often the risk occurs per week (e.g., if it occurs three times per week, the CEM 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 CEM 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 CEM Working Group members complete their individual assessments, the individual ratings should be combined to get the average ratings for each risk factor. Plotting these sums (or averages) as a bar chart can 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 underway law enforcement (LE) missions (Figure 2-1A), and for the same crew while in port (Figure 2-1B).

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 CEM Working Group can begin to define the circumstances that expose the unit to the various identified risk factors. In this regard, the CEM 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 ASSESSMENT FORM

Check off all risk factors that pertain to your unit and write in the number of days per week (1-7) that each occurs. 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; **Sec. 3.1**)
- ❑ __ Poor sleep quality (awakenings during the night due to work-related disruptions, ship motion, or noisy environment; **Sec. 3.1**)
- ❑ __ Sleep fragmentation (breaking sleep into multiple rest periods–"naps"–because unable to take a single, 7-8 hour sleep; **Sec. 3.1**)
- ❑ __ Scheduling main sleep period during the day (the human body is designed to sleep at night; **Sec. 3.1**)
- ❑ __ Changing work/rest schedules (rotating between working days and working nights one or more times per week; **Sec. 3.2**)
- ❑ __ Long work hours (exceeding 12 hours per day; **Sec. 3.2**)
- ❑ __ No opportunities to make up lost sleep (napping during the day is not possible; **Sec. 3.1**)
- ❑ __ Poor diet (menu includes frequent fried foods, high fat and sugar content, frequent caffeine consumption; **Secs. 3.3, 3.4**)
- ❑ __ High workload (high physical and-or mental effort requirements; **Sec. 3.4**)
- ❑ __ High stress (caused by extreme environment, high sustained physical or mental workload, rotating work schedules, and-or authoritarian leadership style; **Sec. 3.4**)
- ❑ __ Lack of control over work environment or decisions (workers are isolated and not allowed to contribute in problem identification and resolution; **Sec. 3.4**)
- ❑ __ Excessive exposure to extreme environmental conditions (cold, heat, high seas; **Secs. 3.5-3.7**)
- ❑ __ No opportunity for exercise (not enough time or no equipment/facilities; **Sec. 3.4**)
- ❑ __ Family stress (child and parent care, divorce, finances; **Sec. 3.4**)
- ❑ __ Isolation from family (need to know how family is doing; **Sec. 3.4**)

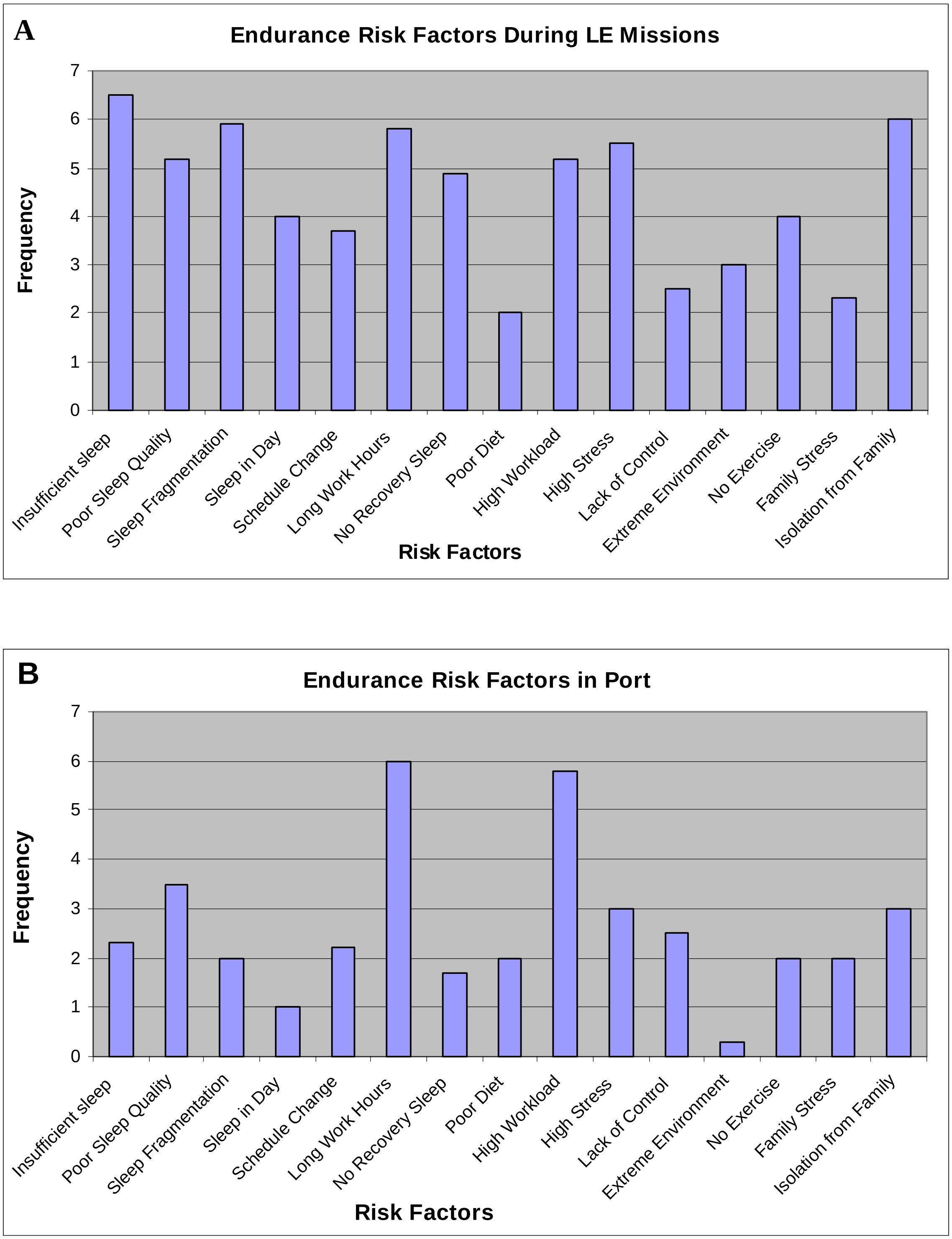


Figure 2-1. Relative Exposure to CE Risk Factors

For example, if the CEM 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 CEM Working Group assessment, it is recommended that CEM 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.

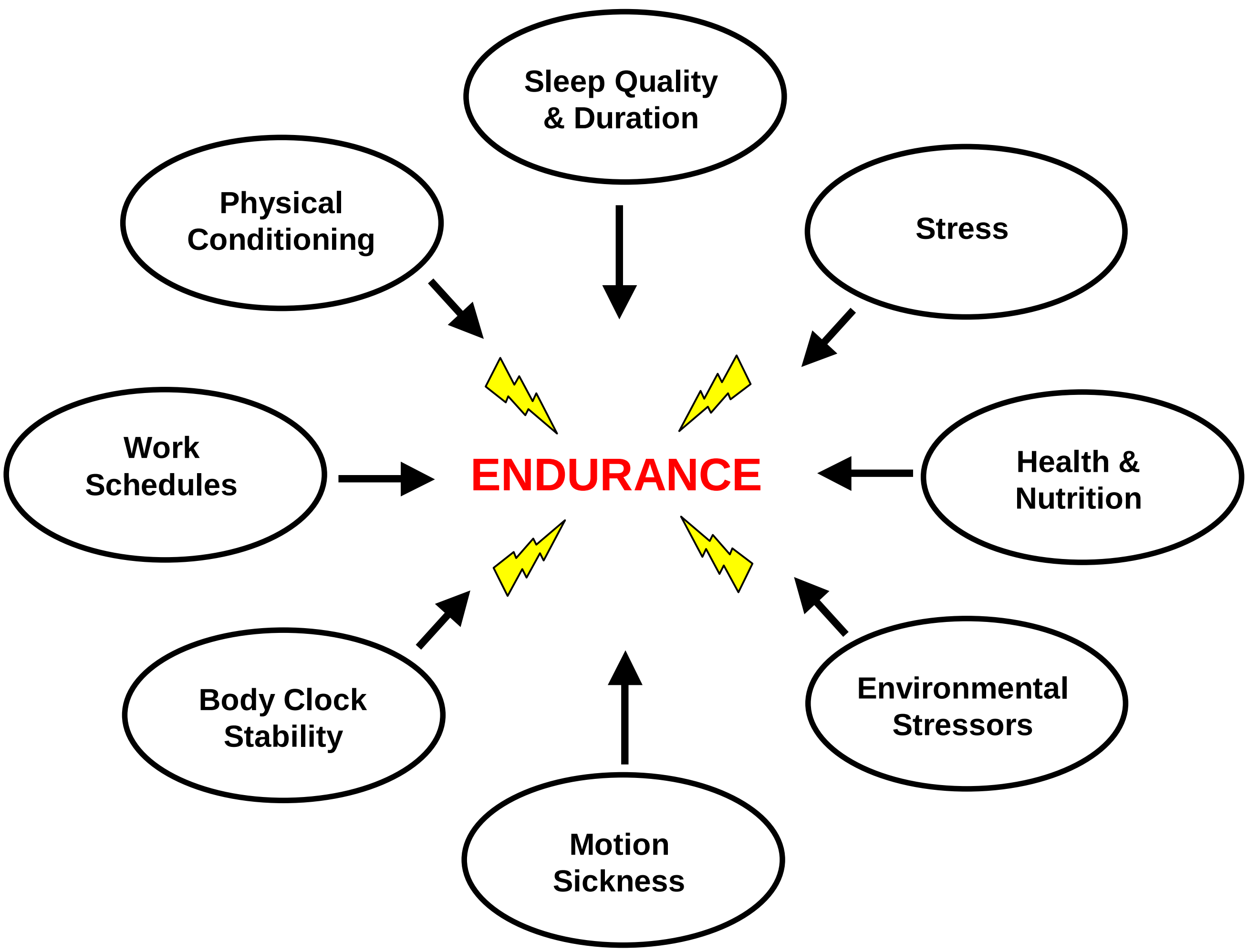
At this point, the CEM Working Group should have a good measure of their unit's exposure to crew-endurance risk. It is time now to learn how to control this risk. This section discusses the major risk factors that affect crew endurance (see the following figure), and offers specific suggestions on how to control these risk factors.

3. Controlling Crew Endurance Risk Factors

This section tells you how to control crew-endurance risk factors in current operations. CEM Working Group members should use this section in regard to completing **Task 3** of the implementation process.

The following risk factors are covered:

- Sleep needs, sleep management, and napping
- Work schedules and how to design them
- Caffeine
- Stress
- Cold stress and prevention
- Heat stress and prevention
- Motion sickness



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SLEEP

3.1. Sleep

In this section 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

3.1.1. Sleep Requirements

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

The body replenishes its energy resources during sleep, and especially during deep 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.

3.1.2. Determining Sleep Debt

You can use the Epworth Sleepiness Scale (see Figure 3-1) 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 (e.g., 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

Evaluate your total score:

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

Figure 3-1. 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.

3.1.3. 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 3-2 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)

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.

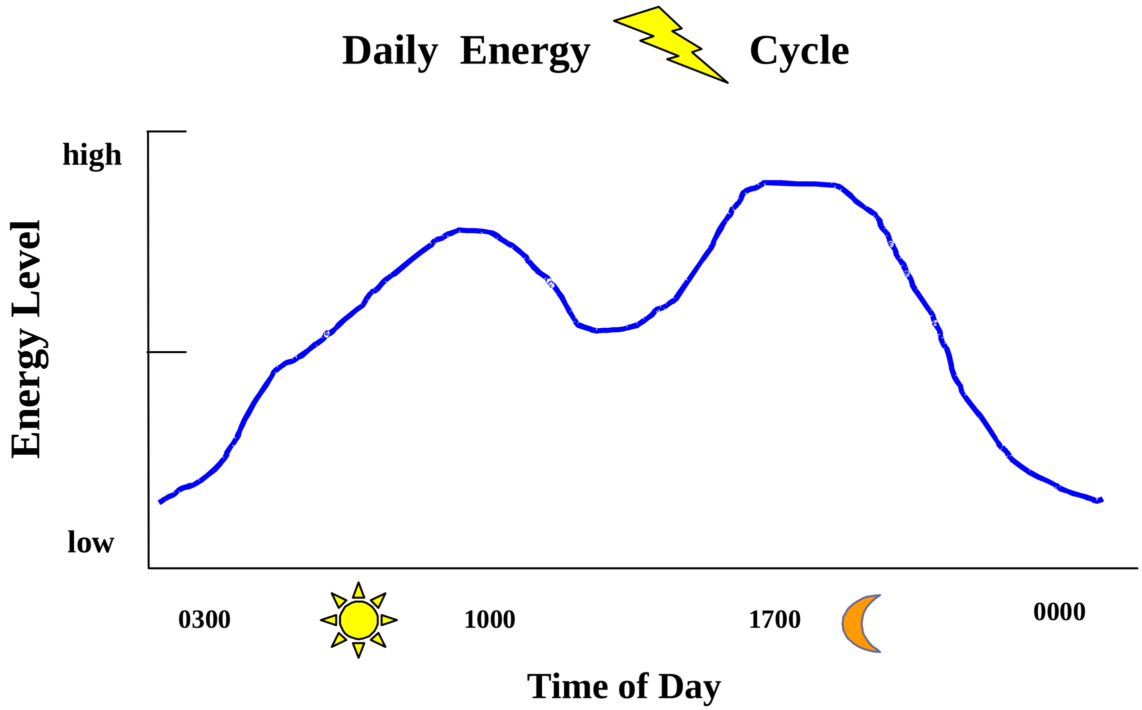


Figure 3-2. Daily Energy Cycle as a Function of Time of Day

3.1.4. 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.

3.1.5. Napping

There are two primary uses of naps:

1. To help personnel adjust to a new, nighttime work schedule
2. 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 3-2). 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.

3.1.5.1 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, and
- They cannot sleep more than four or five hours during the sleep period following the first night work, and
- 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.**

3.1.5.2 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.**

3.1.5.3 Determining a Napping Strategy

Figure 3-3 provides a process for determining if a nap is appropriate, and, when a nap is appropriate, when it should take place.

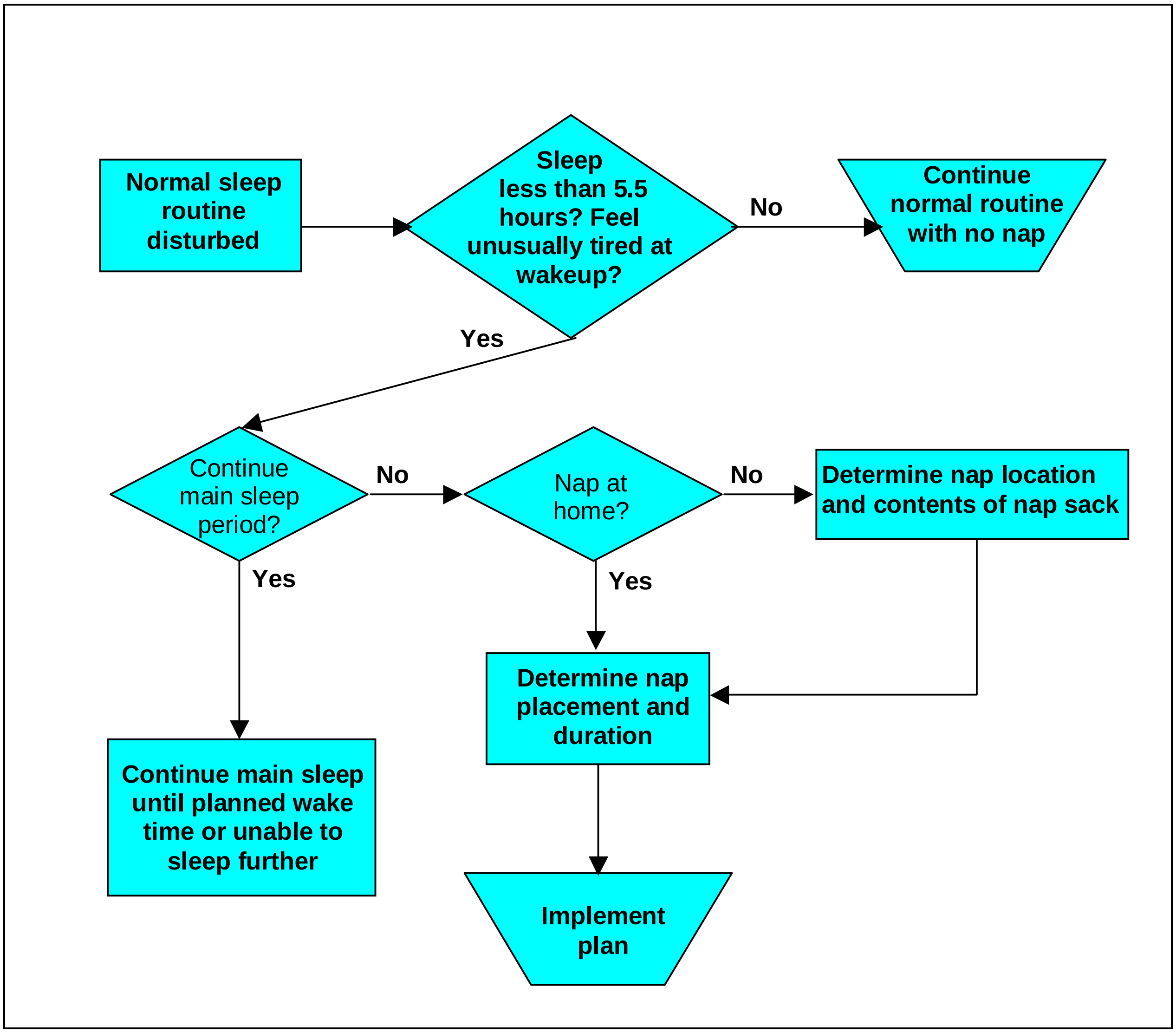


Figure 3-3. Process for determining napping strategy

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

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

3.1.6. Sleep Stages

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

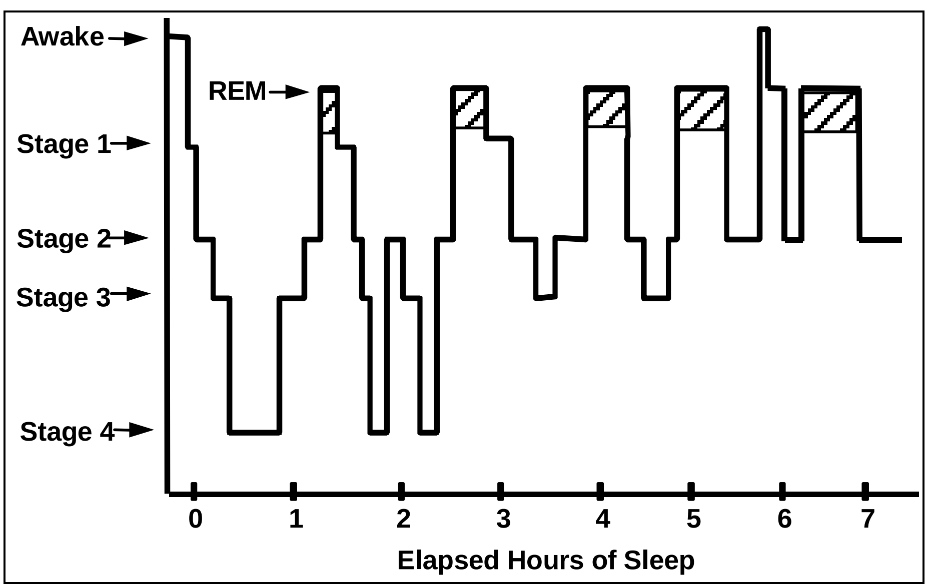
Stage 1 is the transition from awake to asleep. This stage is characterized by a slowing of brain activity. When aroused from this stage, many people believe they were never asleep. After about five to ten minutes of stage 1 sleep, a person progresses to a deeper sleep, stage 2.

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 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.

3.1.7. 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 find yourself having trouble falling or staying asleep, or waking up early or unrefreshed, three of 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, a 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 3-10 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.

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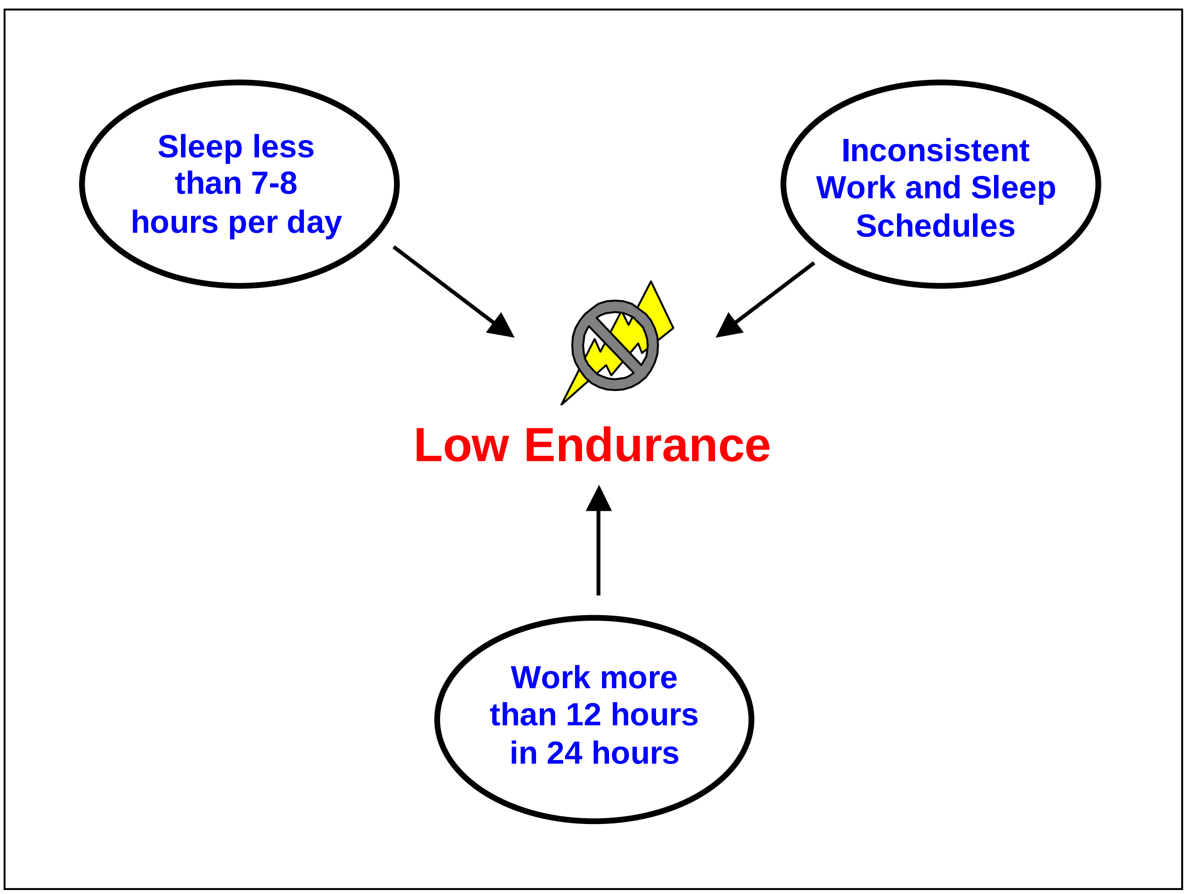
WATCH SCHEDULES

3.2. Watch Schedules

In this section 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



3.2.1. 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 workdays, 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 inconsistent (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**
- **Degraded physical ability**

3.2.2. 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

3.2.3. 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

3.2.4. 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.

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

In the standard three-section (1-in-3) watch rotation (see Table 3-1), 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.

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 3-1) 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.

Table 3-1. 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

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.
- Stand 8-hour watches (to allow a longer daily period for sleeping).

3.2.4.2 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 3-2).

Table 3-2. 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

3.2.4.3 <u>Traditional and Alternative Schedules: 1-in-4</u>

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 may 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 3-3 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.

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.

Table 3-3. 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

Standard 1-in-4 Rotation				Alternate 4-Section Watch			
2000-0000	B	D	B	1500-1800	B	B	B
				1800-2100	C	C	C
				2100-0000	D	D	D

An improved alternative to the 4-section watch schedule is provided on the right half of Table 3-3. 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 3-3)
- Stand 6-hour watches

3.2.4.4 Traditional and Alternate Schedules: 1-in-5

Table 3-4 (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 3-4. 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 3-4 (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 3-2), 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 3-4. 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 3-3) and have one floater

3.2.4.5 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 3-1, 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.

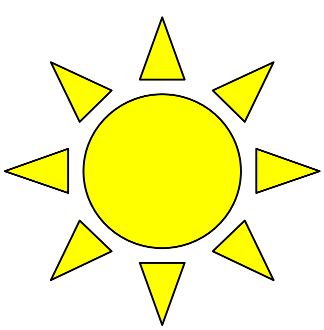
In summary, here are some key recommendations that can help keep personnel alert and adjusted to their work schedules:

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).**

3.2.5. 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 ($\geq$ 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.

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.**

Special Considerations for Partial Adaptation to Night Watch

- ❑ **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 absolutely no interruptions. 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".**

3.2.6. Drugs and Alertness

Many drugs, both over-the-counter (OTC) and prescription, can affect alertness. Most prescription drugs 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 drugs can last up to 24 hours.

Table 3-5 lists popular OTC drugs that can degrade alertness.

Table 3-5. OTC Drugs 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.)

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

Table 3-6. OTC Drugs That Interfere with Sleep

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

CAFFEINE AND READINESS

3.3. Caffeine and Readiness

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

3.3.1. Alertness Boost or Endurance Drain?

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.**

3.3.2. Sources of Caffeine

Table 3-7 lists the most common sources of caffeine.

Table 3-7. OTC Drugs That Induce Sleepiness

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)

3.3.3. 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.**

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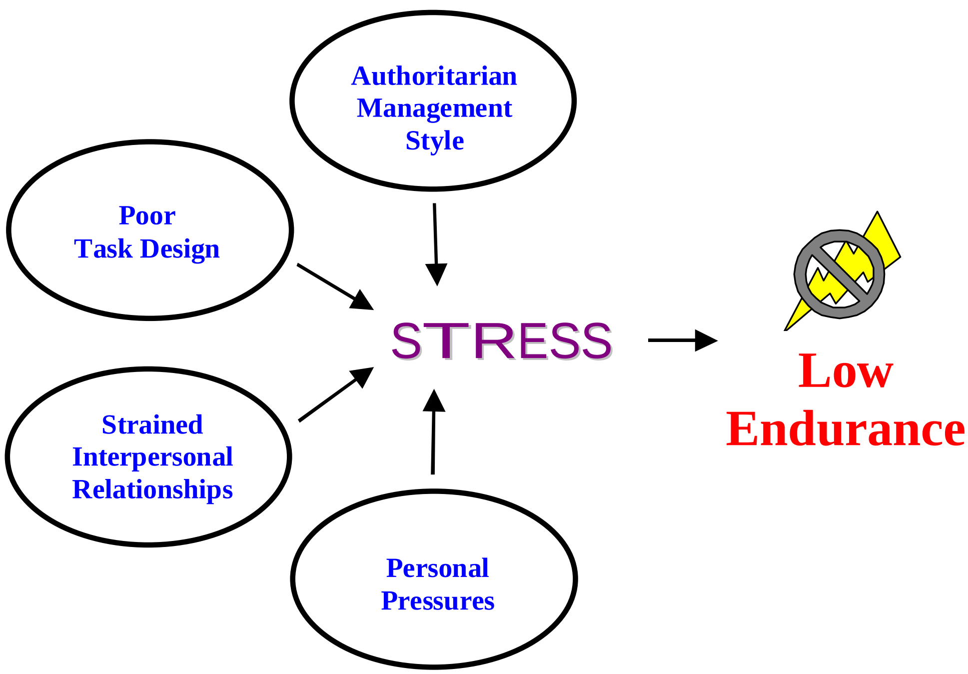
STRESS

3.4. Stress

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



3.4.1. 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 hours
- 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.

3.4.2. 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.

3.4.3. 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.

FACT: The body’s response to stress, whether life-threatening or not, involves energy expenditure and a disruption of energy-producing activities during rest periods. Even during sleep, stress robs the body of needed energy by disrupting the quality and duration of sleep.

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.

3.4.4. 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 optimize the quality of rest periods)
- Provide access to a variety of exercise equipment (free weights, stationary bicycles, rowing machines, etc.).
- Provide access to stress-reducing 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 self-worth, 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, caffeine-free beverages, and avoid the use of 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.

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COLD-RELATED ILLNESS

3.5. 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

3.5.1. 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.

3.5.2. 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

3.5.3. 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.**

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Heat Illness

3.6. Heat 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

3.6.1. 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.

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

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.

3.6.2. 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

3.6.3. 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.**

MOTION SICKNESS

3.7. 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

3.7.1. 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.

3.7.2. 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 3-8).

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 3-8. 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.

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4. Developing, Deploying & Assessing a CEM Plan

This section describes how to develop, deploy, and assess a CEM plan to optimize crew endurance in specific operations.

4.1. Task 3 – Develop a CEM Plan

Before developing a CEM plan to control crew endurance risk factors, the CEM Working Group should have:

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

The risk assessment (for different departments and under different operational conditions) will identify 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 Section 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 the following section.

4.1.1. Assessing Possible 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 embodies a systems approach to understanding crew endurance, and is designed to help CEM Working Groups implement the best possible controls (discussed in detail in Section 3) for reducing or eliminating specific hazards to crew endurance.

There are four factors to consider when selecting controls for improving crew endurance (see Figure 4-1):

- Mission objectives
- Personal endurance plans

- Duty cycles and training
- Collateral duties and environmental attributes

The Crew Endurance Management Model first considers the mission of the unit and identifies those unit variables or characteristics that cannot be modified without having a negative impact on mission effectiveness. The model then considers three layers of potential crew endurance controls.

The first layer of potential crew-endurance controls, the personal endurance plan, encompasses things that individual crewmembers can do to ensure an optimal level of endurance. The second layer, duty cycles and training, encompasses such things as watch schedules, patrol schedules, and sleeping quarters. These variables are under the control of the command staff, and directly support (or detract from) the ability of crewmembers to endure. The third layer, collateral duties, encompasses collateral duty prioritization and scheduling, as well as such environmental variables as exposure to extreme temperatures, ship motion, and noise. These variables are also under the control of the command staff, and tend to be the easiest changes to make, because they have little or no direct impact on mission objectives.

The outer two layers are the most flexible, and will likely be where most improvements are made.

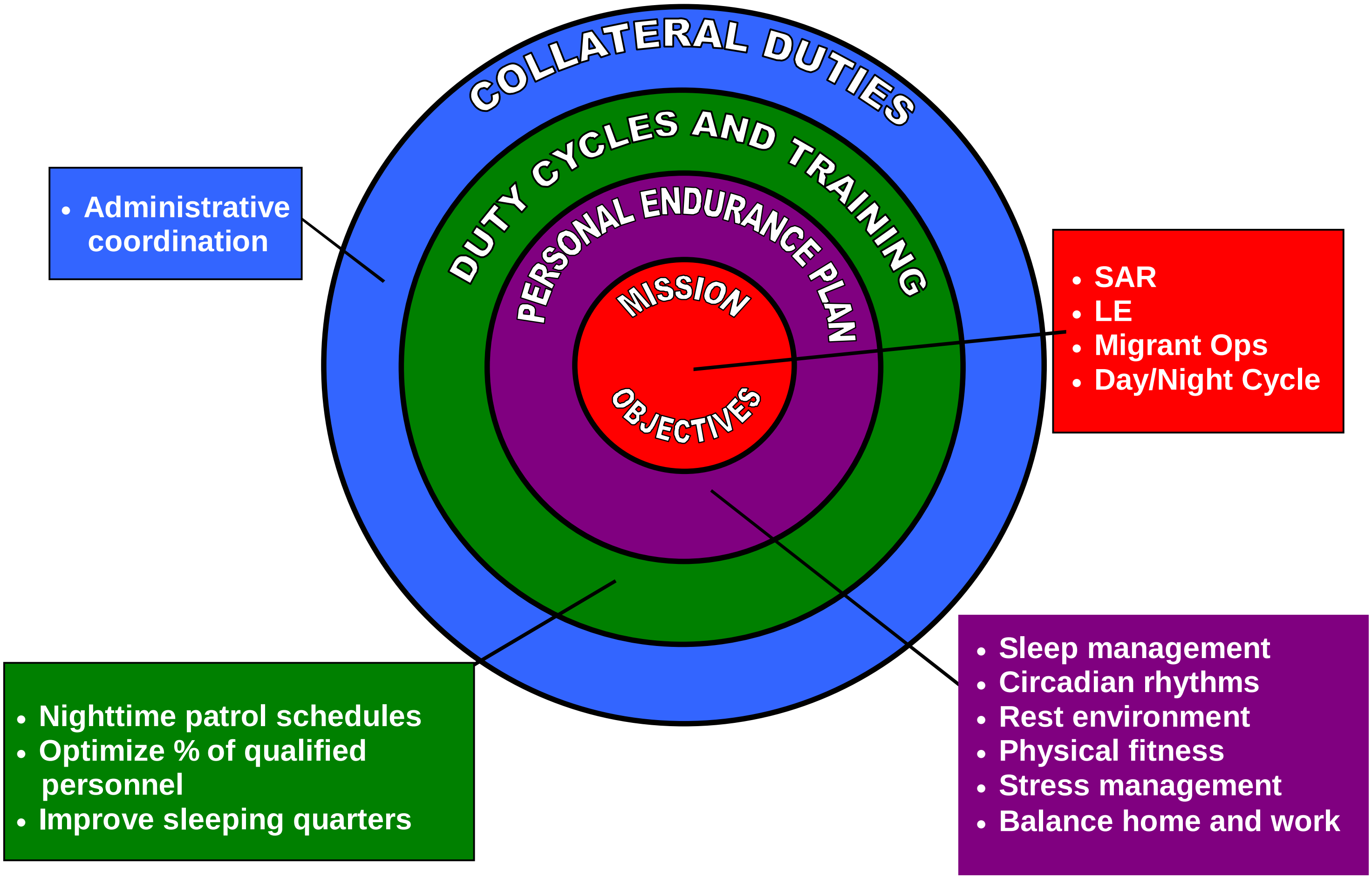

Figure 4-1. Crew Endurance Management Model

4.1.1.1 *Mission Objectives*

As the first layer in the crew-endurance management model, the mission objectives (Search and Rescue, Law Enforcement, Migrant Interdiction, and the like) of a unit are placed at the very center of the model (the bull's-eye in Figure 4-1) to reflect their central importance.

Mission objectives are an external requirement and therefore not subject to be changed by any internal controls put into place under a CEM plan. A successful CEM plan, however, will serve to enhance a unit's overall ability to carry out its missions.

4.1.1.2 *Personal Endurance Plan*

The second layer in the crew-endurance management model consists of personal endurance plans for all members of the unit. Although this layer 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 individualized endurance plans depends heavily on command and department-head support (the outer two layers), as well as on alignment with mission objectives (center layer). 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. Section 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 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.

4.1.1.3 Duty Cycles and Training

The third layer of the crew endurance model consists of duty cycles and training, plus enabling actions, and is controlled by command staff and department heads. The policies and procedures that make up this layer have a direct influence on both crewmembers' personal endurance plans and the unit's overall mission objectives. Good 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 3.3).
- 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 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 3.4.6).
- 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 CEM 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.

4.1.1.4 Collateral Duties and Environmental Aspects

The outer layer of the crew-endurance management model consists of elements that are only indirectly related to mission; however, changes in this area can have profound effects on personal endurance plans, and therefore on a unit's overall crew endurance.

These elements include collateral duties and environmental hazards. Collateral duties should be scheduled around individual sleep schedules. Unavoidable environmental hazards, such as motion sickness and temperature extremes, should be addressed with specific training; for example, on how to avoid or lessen the effects of motion sickness.

4.1.2. Selecting Risk Controls

Developing a CEM plan involves selecting appropriate controls for the risk factors identified in the Crew Endurance Risk Assessment (refer to Section 3). Some controls are relatively easy to implement (especially in the outer layers 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 CEM 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 4-1 is an example.

Table 4-1. Sample CEM 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”. CEM 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 CEM Working Group has developed a complete CEM plan, the CEM 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 CEM 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 CEM 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 CEM 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.**

4.2. Task 4 – Deploy the CEM Plan

Deploying a CEM plan consists of:

- Getting buy-in from all command staff and department heads
- Educating all personnel on (1) the concepts of crew endurance, (2) the risk factors currently affecting operations, (3) the CEM plan for controlling these risk factors, and (4) each crewmember's CEM responsibilities
- Executing the specific terms of the CEM plan
- Monitoring the deployment process to identify and correct any problems

Because human beings are naturally resistant to change, even to change that will benefit them, leaders at all levels of an organization must actively encourage adherence to the terms of a new CEM plan. 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.

Command personnel and department heads create the infrastructure that supports CEM deployment. 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 strategies.

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.

Education is the most important factor in successfully deploying a CEM plan. All personnel *must* understand the basic concepts of crew endurance, at least to the extent of being able to appreciate how the terms of a CEM plan will benefit them.

A particularly effective way of introducing CEM concepts and strategies is to make CEM a topic at unit safety meetings. The basics of CEM can be taught a little at a time at these meetings, and then, later on, the terms of a tentative CEM plan can be introduced and discussed at length. Relevant sections of this guide should be distributed to all personnel previous to these meetings, so they can familiarize themselves with the subject matter to be covered, and so they will have ready references later on to help them implement personal strategies for sleep management, napping, caffeine usage, etc.

The specific terms of a new CEM plan should not be deployed until all personnel have been fully educated, and have agreed to accept the terms of the CEM plan. Depending on the number and types of changes called for, the CEM Working Group might want to phase in the terms of their CEM plan gradually, in order to limit the amount of change personnel would need to deal with at any one time. Remember: Change is stressful!

The CEM Working Group should encourage personnel to provide feedback on any problems they encounter during deployment, so that the CEM Working Group can then fine-tune the CEM plan as necessary to ensure overall success. Once the CEM plan is completely deployed and appears to be running smoothly, the CEM Working Group should allow the unit to stay on the CEM plan for at least 30 days before initiating the evaluation task.

4.3. Task 5 – Assess the CEM Plan

Assessing a CEM plan consists of:

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

4.3.1. Evaluating a CEM Plan

CEM plans should be evaluated periodically to ensure they are working as effectively as possible. The CEM 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 Assessment Form (Section 2.3.2) 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 CEM plan.

Realizing only modest improvements during the initial stages of CEM 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 CEM Working Group should continue to discuss endurance issues with personnel and to identify additional variables that may 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 endurance, will always occur; however, if personnel will acquire good-quality sleep for the majority of each week, this practice alone will go a long way toward providing personnel with the endurance necessary to make it through the rough spots.

4.3.2. 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 CEM 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 Assessment (Section 2.3.2) be performed periodically (every one to two years) 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 CEM 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 tasks will help the CEM 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.

4.4. 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; Dr. Tony Carvalhais, 202-267-2244), or the U.S. Coast Guard Research and Development Center in Groton, CT (Crew Endurance Team, Ms. Pik Kwan Rivera, 860-441-2854).

5. References

Bell, D.S., and Donev, S. (1993). *Curing Fatigue*. Berkley Books, New York, NY.

Brown, G.(1999). *The Energy of Life*. The Free Press, New York, NY.

Caldwell, J. (1996). “Sleep Deprivation”, in Crowley, Newton, Davidson, Lindsey, and Marcum (Eds.), *Leader’s Guide to Crew Endurance*. Fort Rucker, AL: U.S. Army Aeromedical Research Laboratory and U.S. Army Safety Center.

Caldwell, L. (1996). “Stress and Fatigue”, in Crowley, Newton, Davidson, Lindsey, and Marcum (Eds.), *Leader’s Guide to Crew Endurance*. Fort Rucker, AL: U.S. Army Aeromedical Research Laboratory and U.S. Army Safety Center.

Comperatore, C.A. (1996). “The Systems Approach to Crew Endurance”, in Crowley, Newton, Davidson, Lindsey, and Marcum (Eds.), *Leader’s Guide to Crew Endurance* (pp 21-25). Fort Rucker, AL: U.S. Army Aeromedical Research Laboratory and U.S. Army Safety Center.

Comperatore, C. A., Bloch, C., Ferry, C. (1999). *Incidence of sleep loss and wakefulness degradation on a U.S. Coast Guard cutter under exemplar crewing limits*. (CG-D-14-99) Groton, CT: United States Coast Guard Research and Development Center.

Comperatore, C.A., Carvalhais, A., Rivera, P.K. (2000). *Implementation of the U.S. Coast Guard Endurance Management System (CGEMS) at Air Station Miami*. (In progress), United States Coast Guard Research and Development Center, Groton, CT.

Comperatore, C. A., Carvalhais, A., Della Rocco, P., Schaab, B., Bloch, C. (1998). *Development of an endurance management plan for US Coast Guard air stations – phase I*. (CG–D–28–98) Groton, CT: United States Coast Guard Research and Development Center.

Comperatore, C. A., Kirby, A., Bloch, C., and Ferry, C. (1999). *Alertness degradation and circadian disruption on a U.S. Coast Guard cutter under paragon crewing limits*. (CG-D-23-99) Groton, CT: United States Coast Guard Research and Development Center.

Forgey, M.D., William W., Editor. (2001). *Wilderness Medical Society: Practice Guidelines for Wilderness Emergency Care*, Second Edition, The Globe Pequot Press, Guilford, CT.

Schmidt, Helmut S., MD, Schmidt, Markus H., MD. (2001). *Time to get your child’s sleep schedule back on track for the new school year*. Ohio Sleep Medicine Institute, Dublin, OH.

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