

Crew Endurance Management Practices: A Guide for Maritime Operations ADDENDUM



**United States
Coast Guard**

U. S. Coast Guard Headquarters
2100 Second Street SW, Washington, DC 20593-0001

CREW ENDURANCE MANAGEMENT PRACTICES
A Guide for Maritime Operations
Addendum



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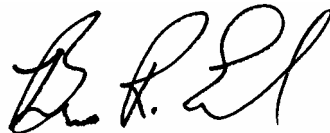
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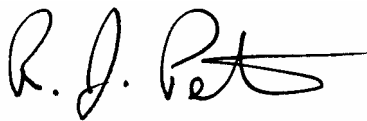
FOREWORD

The original *Crew Endurance Management Practices: A Guide for Maritime Operations* explained the United States Coast Guard's Crew Endurance Management System (CEMS) and the scientific research behind its tools and practices.

Since its publication in 2003, participation and interest in CEMS has grown exponentially. Now, just two years later, the program provides the latest in CEMS updates and information to hundreds in the maritime industry through its website, newsletters, and National Maritime Center-accepted Coaches Training Course.

Our experience in helping companies to implement CEMS has highlighted several areas in which additional information would improve understanding and application. This addendum aims to supplement the original Guide for Maritime Operations in a step-by-step format. All mariners, from trained CEM Coaches to those reading about the system for the first time, can use the addendum to better understand its philosophy and the steps that all companies, regardless of their resources, can do to get started.

While we advocate that any interested parties may utilize the guide and addendum, we recommend that companies should have at least one trained CEMS Coach to help initiate and oversee its CEMS implementation. In any case, the Coast Guard stands ready to assist individual companies or industry workgroups looking to implement CEMS.



CAPT R. J. Petow, Chief
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EXECUTIVE SUMMARY

The original *Crew Endurance Management Practices: A Guide for Maritime Operations* explained the United States Coast Guard's Crew Endurance Management System (CEMS) and the scientific research behind its tools and practices. Since its publication in 2003, participation and interest in CEMS has grown exponentially.

Based upon feedback from the marine industry and experience assisting companies and trained coaches, the Coast Guard has identified a number of areas in which additional information could improve program implementation and overall understanding. This addendum aims to supplement the original Guide for Maritime Operations in a step-by-step format. All mariners, from trained CEM Coaches to those reading about the system for the first time, can use the addendum to better understand its philosophy and the steps that all companies, regardless of their resources, can do to get started.

Section I discusses the philosophy behind CEMS, explaining that while any interested company may implement the program, it should be done so in a systematic way. Section II describes the cyclical five-step process recommended to implement CEMS. Section III guides readers, step-by-step, through the process, providing job aids and recommendations for companies and crewmembers at each stage of implementation. Appendices supplement the checklists by providing detailed information on endurance risk factors, light management, schedule changes, and recommendations for improvement in these areas.

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About This Guide

Purpose of Addendum

The original Guide for Maritime Operations introduced maritime operators to the Crew Endurance Management System, a scientifically-based, systematic way of maximizing crew performance and safety. Though the Guide still serves as a valuable resource, CEMS subject matter experts have since identified a need to publish more intricate details and discussion, such as that presented in CEM Coaches and Experts Training. This addendum provides those necessary additional details to the increasing numbers of vessels and operating companies who continue to adopt Crew Endurance Management practices in ways suiting their own unique situations.

Audience

This addendum is intended to be a supplementary resource for certified CEMS Coaches, Experts, or those interested in learning more about the CEMS program in general. Vessel owners, operators, Coast Guard Officers in Charge, Marine Inspection (OCMI), marine casualty investigators, and others will benefit from the detailed descriptions of risk factors that may affect a vessel's crew. Those implementing CEMS will benefit from guidelines with recommendations on how to address each of these risk factors.

While we advocate that any interested parties may utilize the original guide and addendum, we recommend that companies should have at least one trained CEMS Coach to help initiate and oversee its CEMS implementation. In any case, the Coast Guard stands ready to assist individual companies or industry workgroups looking to implement CEMS.

Contents

Section I discusses the philosophy behind CEMS.

Section II describes the cyclical five-step process used to implement CEMS.

Section III guides readers through the CEMS process, step-by-step, providing job aids and recommendations for companies and crewmembers at each stage of implementation.

Appendix A provides detailed guidance and references to address any of the 15 endurance risk factors an operation may need to manage – individual, environmental, or organizational – as well as poor health, improper drug use, and motion sickness.

Appendix B provides detailed guidance regarding light management.

Appendix C provides detailed guidance regarding schedule changes.

Appendix D lists supporting documents.

How to Use This Guide

It is recommended you approach using this guide as follows:

- First, skim through Section I (*CEM Philosophy*) to address any questions you may have regarding CEMS.
- Next, read the entirety of Section II (*Implementing a CEM Program*) to understand what it takes to start and maintain CEMS on a vessel. Then, use the information, job aids, and recommendations provided in Section III (*CEM, Step by Step*) to initiate the CEMS process on your vessel.
- As your Crew Endurance Work Group decides which factors to address, read the appendices as needed for helpful information and suggestions on endurance risk factors, light management, and/or schedule changes.

- It is recommended that you read the rest of the guide at your earliest convenience, since the information therein can help you to better identify and rank the risk factors most in need of improvement.

SECTION I

CEM Philosophy

I. CEM Philosophy

This section (I) outlines the philosophy behind CEMS.

What CEMS Is – and *Isn't*

The Crew Endurance Management System (CEMS) provides a system of proven practices for managing endurance risk factors that affect operational safety and crewmember efficiency in the maritime industry. The system is, at its heart, a continuous-improvement process which allows an organization to make improvements at a level and pace appropriate to its operation, focusing efforts towards those factors that are most feasibly mitigated and present the greatest possible reduction of risk.

It is important to remember that the Crew Endurance Management System is a cyclical process. A company is not expected to do everything the first time around, nor should they perfect each step in the process before moving forward. We continually emphasize the flexibility of CEMS because we know that each operation is unique, including the amount of time, people, and money it may have available. With some training and genuine effort, any operation can begin an effective CEMS program.

However, just because we say that “anyone can do it” does *not* mean that companies should just fill up a cafeteria tray of CEMS elements that look appetizing. While it is left entirely to the practicing organization to determine how and when to address specific risk factors, there are certain critical elements required by CEMS to ensure an effective implementation scheme. This helps to ensure the consideration of interrelated risk factors in a systematic manner.

This process includes a number of discrete steps which should be completed sequentially, as shown on the next page in Figure 1.

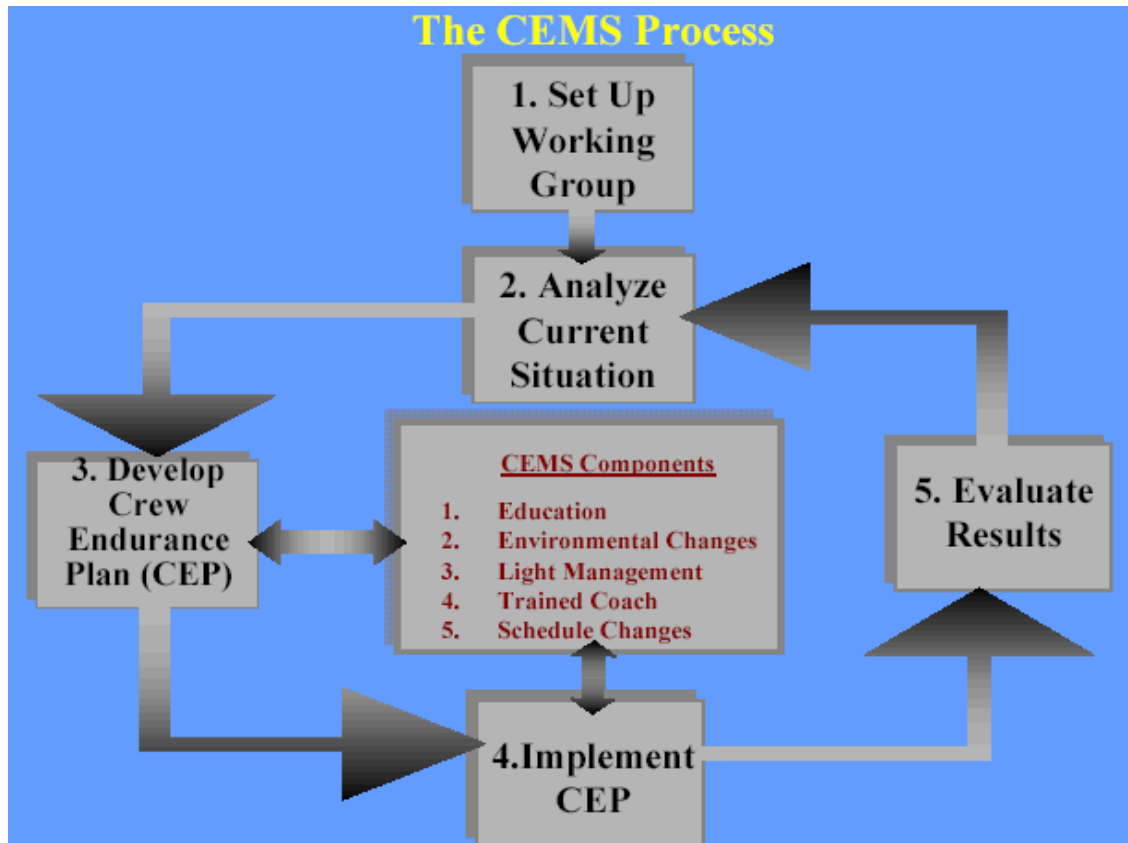


Figure 1. The CEMS Process.

Therefore, the implementing organization should:

- Follow, as closely as is practical, the process described in Section II (*Implementing a CEM Program*).
- Demonstrate consistent, positive progress towards each next step in the process.
- Demonstrate a good-faith effort to address relevant endurance risk factors as much as is practicable.

To do so, there's no need to reinvent the wheel; if the implementing organization has an existing safety management system, it is recommended that CEMS be incorporated into that system rather than be implemented as a stand-alone program. Consequently, some details of the CEMS process may need to be modified to fit within that existing system. The general nature of the CEMS process steps should be sufficiently flexible to allow this to occur.

What if I don't follow the Coast Guard's CEM program?

The CEM process was developed based upon clinical and field research by the Coast Guard Research and Development Center. The research shows that following CEMS results in a measurable change in melatonin levels of the body. Since melatonin is the hormone messenger that tells your body to go to sleep, and since we know following CEM changes the levels of this hormone, we know that the crew will be more alert during critical times of watch. This is one of many reasons why the Coast Guard endorses the CEMS approach.

If you deviate from the CEMS process, we have no guarantee that you will achieve the same results. However, we do know that some deviations usually result in unsatisfactory results. Some may feel that only doing part of CEMS, or doing their own version of CEMS, is adequate. In some cases, doing so might even result in a slight improvement of the situation. But in others, you could be making the situation worse. Either way, there will be no clinical research to back you up.

What parts of the program are "required" to consider this part of the Coast Guard's CEM program?

CEMS is based on science, and our clinical research asserts that if you follow CEMS, you will reduce the risk of an endurance-related accident. The two fundamental requirements of the system that ensure its effectiveness and validity are to (1) follow the CEMS process, as illustrated in Section II (*Implementing a CEM Program*), and (2) ensure an effective means of providing onboard support for your CEMS implementation effort, such as a coach.

What if I can only do some changes right now? Am I still doing CEMS?

The whole concept of CEMS is one of incremental, continuous improvement over time. These improvements should gradually decrease the Crew Endurance risk factors you identify in the assessment phase. Therefore, by jumping in and beginning an education program of awareness of CEMS, or acquiring some certified coaches for your vessels, you are "doing" CEMS! Of course, once you get going, momentum must be maintained, but there is no prescribed rate. The key is to make a good-faith effort to follow the CEMS process and address the risk factors as best as you are able.

You Can Do It!

While it is important to remember that CEMS is not simply a list of factors to check off, it *is* possible to implement the system in a systematic manner that focuses on just one or two steps at a time. Though the guide and addendum may seem like an overwhelming amount of material, remember that you can go through Section III (*CEM, Step by Step*) to find a starting point and branch out from there.

How do I get started?

The first step to getting started is to educate members of the organization and build awareness of why CEMS is important to both individuals and the company. Some companies have accomplished this by sending a person to Coaches Training and having that person come back and do awareness training for others in the company. Other companies have started with broad-based awareness campaigns, which then prompt the decision to send someone to Coaches Training. Both methods have worked well for other companies, and you have the flexibility to choose what's right for you.

If you decide to begin by creating awareness, but do not have someone in your company who is familiar with CEMS, you might consider having a knowledgeable Coach or Expert from another company help you get started. A list of Experts and practicing companies is available on the CEMS website (address in the list below).

Besides this addendum and the original Guide, here are some other resources to get you started. Begin at the point that best fits your level of understanding about CEMS:

- Visit the CEMS website at <http://www.uscg.mil/hq/g-m/cems/index.htm>
- Review the *CEMS: The System* pamphlet (available on the website)
- Talk to a Coast Guard or local industry CEMS Expert (Call U.S.C.G. Headquarters – (202) 267-2997 – to find an Expert in your area)
- Go to Coaches Training (current training opportunities posted on the website)

Once support is obtained, both from the top-down and from the bottom-up, forming a Crew Endurance Work Group (CEWG) is a critical step towards assessing the current endurance risks, developing a plan to address those risks, and deploying the first cut of that plan. This step is detailed in Section II (*Implementing a CEM Program*).

SECTION II

Implementing a CEM Program

II. Implementing a CEM Program

This section (II) describes in detail the five phases involved in the successful incorporation of a CEM program.

- Step I:** Establishment of a Crew Endurance Working Group (CEWG)
- Step II:** Analysis of Current Situation and Identification of Risk Factors
- Step III:** Development of a Crew Endurance Plan (CEP)
- Step IV:** Implementation of the Crew Endurance Plan (CEP). This section also provides details regarding the five necessary components of a CEP: education, environmental changes, light management, trained coaches, and schedule changes.
- Step V:** Evaluation of Results

Step I: Establishment of a Crew Endurance Working Group (CEWG)

*Why do I need a Working Group?
What does it do?
Who needs to be in it?
What training will they need?*

CEWG Duties

The Crew Endurance Working Group (CEWG) is responsible for many critical aspects of implementing a CEM program, including:

- Identifying the relevant endurance risk factors.
- Creating a collaborative network of participants.
- Developing and deploying a specific CEM plan.
- Sustaining vertical alignment of an organization.
- Assessing cycles of continuous improvement.

Although, ideally, it is best to have a distinct CEWG for each vessel, some implementing organizations may find it more practical to establish one CEWG for an entire company.

While there are no specific requirements for how often a CEWG should meet, leaders should ensure that the frequency, content of discussion, and outcomes of meetings by this group are appropriate for meaningful progress. Relevant characteristics of the implementing organization, such as the size and type of operation, should be taken into account when setting the pace, activity level, and goals for the CEWG.

Where an organization combines the function of the CEWG with an existing group, leaders should consider whether this group is actively serving all the purposes of the CEWG as outlined above.

Membership

To be effective, a Crew Endurance Working Group should include or represent all those individuals who stand to be affected by the implementation of a CEM program. A typical CEWG might consist of the following individuals:

- One or two company officers
- The company operations manager
- The captain of the vessel
- The pilot, the bridge personnel, or both
- The department chiefs
- The first mate, the engineer, or both
- One or more deckhands

The composition of the CEWG should enable communication both up and down the organization's hierarchy.

The CEWG will be best served by including at least one Coast Guard Certified Crew Endurance Coach, or an acceptable coach alternative, to facilitate effective communication of CEMS methods and processes. Communication is crucial to identifying and mitigating relevant risk factors, and helps build "vertical alignment."

What is "vertical alignment"?

Several elements are required for a CEWG to build vertical alignment:

- The composition of the CEWG should include or represent varied individuals who stand to be affected by CEMS implementation to enable communication both up and down the organization's hierarchy.
- All members should understand CEMS so that they can better identify and mitigate their fleet/vessel's endurance risk factors.
- All members at all levels of the CEWG should buy into CEMS. Otherwise, it can be easy to stall or undermine progress.
- Finally, communication among all levels and members of the CEWG is crucial. It is important for crewmembers to communicate their experiences with daily risks up through the ranks. It is equally important for those at the upper levels of management to understand how important such risks are, and weigh how important it may be to fund or otherwise support CEMS prevention efforts.

Step II: Analysis of Current Situation and Identification of Risk Factors

What is involved with "Analyzing the Current Situation"?

Once a CEWG has been put together, this analysis becomes its first task. In order to properly assess the current situation and identify relevant risk factors, the CEWG should have at least one member who has had formal training as a Coast Guard Certified Crew Endurance Coach or Expert.

Analyzing the current situation means taking a look at your company's operations and determining what factors may negatively affect the crew's endurance. From there, you can subsequently determine how you want your Crew Endurance Plan to address these risk factors.

Areas for Consideration

The CEWG should consider all relevant risk factors which pertain to individuals and their work/rest environment. Factors considered should include, but not be limited to, those mentioned here. These endurance risk factors are described in further detail in Appendix A.

- 15 Individual Risk Factors as Described in the Decision Support Software Tool

Sleep duration, sleep quality, sleep fragmentation, synchronization with circadian rhythm, change of work/rest schedule (irregular hours), extended work hours, opportunities to make up sleep (nap), diet (types of foods and eating times), workload, work-related stress, opportunities to exercise, sense of control, external environment (including motion sickness), family stress, and isolation from family

- Additional Individual Risk Factors to Consider

Drugs (caffeine, alcohol, and over-the-counter medication), health (general sickness and chronic disease), and other considerations

- Environmental Risk Factors

Work environment – *light intensity conducive to proper light management, noise intensity, temperature, air quality, vessel motion/vibration*

Sleeping environment – *light, noise, temperature, air quality, vessel motion/vibration*

Vessel operating environment – *temperature* (humidity, extreme heat or cold), *marine operating environment* (wind, weather changes, sea state, tides, currents, high and low water), *operational demands* (down time, workload surges, routine vs. dynamic schedule), and *operating policies* (courtesy to crew sleeping off-watch, allowing napping, vessel maneuvering, alternate meal and/or shower times)

Evaluation of Risk Factors

The essential part of this step is to ensure that the organization, through its CEWG, has made a thorough consideration of all risk factors. It is important to note that not all factors will occur with equal frequency for all organizations. CEWGs are strongly encouraged to avail themselves of existing job aids, described on pages 16 and 17, to assist in performing this analysis. These tools are also available on the Crew Endurance Management website, <http://www.uscg.mil/hq/g-m/cems/index.htm>.

Identifying that risk factors are present should not be viewed as an indication of the state of a vessel's safety or an organization's safety program. Such risk factors are present in any 24-hour, 7-day-a-week operation. Organizations that have identified their most prominent risk factors have actually taken the first step to improving safety simply by increasing awareness. Such action should be taken as evidence of an advancing safety culture.

The presence of a risk factor does not necessarily indicate that an organization must address that factor to be considered as practicing CEMS. Simply becoming aware of a risk factor is, in many instances, a significant improvement in the overall safety culture. Some risk factor solutions may be out of the reach of the organization to resolve. In other cases, actions needed to address a risk factor may be inconsistent with the company's operation.

In any case, the implementing organization will have to prioritize which risk factors to address so as to maximize the greatest overall reduction in risk for the least cost. Prioritization of risk factors and determining the best mitigation strategies takes place in Step III of the process.

Scope of Analysis

The risk assessment should take into account the risk factors for each of the vessels being considered by the CEWG. Even if a group of similar vessels doing similar work is being considered, there may be significant differences in the way that the crews on board each vessel live and work. The CEWG should ensure that the risk factors for each individual vessel are identified.

Are there tools to help with this?

Job Aids

People formally certified by the Coast Guard as a Crew Endurance Coach or Expert receive copies of tools developed by the USCG for use in education and risk assessment efforts. These tools are also available on the Crew Endurance Management website, <http://www.uscg.mil/hq/g-m/cems/index.htm>.

- Decision Support Software (DSS) Tool

The Crew Endurance Decision Support Software Tool helps measure the Crew Endurance risk factors currently impacting a particular maritime operation or environment. It asks individual users (crewmembers) to specify their level of exposure to the 15 specific crew endurance risk factors mentioned on page 14 and averages their responses to provide a graphical representation of the overall results. Each user navigates through the same set of assessment screens to rate his or her weekly exposure to a specific risk factor. Before crewmembers do this, it would be helpful for a Crew Endurance Coach or Expert to provide summaries of the risk factors, so there is a clearer understanding of what is involved.

In real time, the tool summarizes the input entered by all users, and provides links to information for the management of specific risk factors. Summary data can be accessed from the tool's "User Management" screen.

It is highly recommended that periodic reassessments be conducted to determine the efficacy of controls implemented to manage the risk factors measured in the initial assessment. A "print/save" function allows users to preserve data for reference during risk factor reassessments.

- Self-Sustaining Workshop (SSW) Tool

The Self-Sustaining Workshop Tool is computer software that enables trainers and operators alike to learn the basics of CEMS in an interactive, self-paced style - an "encyclopedia" of CEMS. Distributed to all members attending Crew Endurance Coaches Training, it is designed to help Crew Endurance Coaches with education efforts within their vessels and companies.

Step III: Development of a Crew Endurance Plan (CEP)

What is required to develop the CEP?

There is no set format for the Crew Endurance Plan. The implementing organization should develop the CEP in a format that is most appropriate to its particular management and operation.

Regardless of the format, the CEP should contain specific recommendations to address those risk factors identified by the CEWG as being the most critical to address. These recommendations will generally fall into two major categories:

- **Operational Recommendations** include changes to policies, practices, or procedures related to vessel operation, and may include:
 - Watches (schedule changes, napping policies).
 - Light management.
 - Time management (shower and meal times).
- **Environmental Recommendations** include changes to the work and rest environment and may include:
 - Shipboard policies (courtesy to off-watch sleepers, avoiding excessive use of throttle).
 - Physical changes (making sleeping areas darker, quieter, and more comfortable, increasing lighting in certain areas of the vessel).

Deciding which risk factors to address and developing appropriate recommendations are two of the most important jobs of the CEWG. Because CEMS is a cyclical, continuous improvement process, the implementing organization should not expect to have to change everything at once. In general, the organization should focus on low-cost, high-return items first, and make a good-faith effort to address each risk factor as much as possible. The CEP should include some discussion as to why the selected recommendations were chosen.

In addition, the CEP should address five CEMS components: education, environmental changes, light management, trained coaches, and schedule changes. With the exception of “trained coaches,” the implementing organization should address the CEMS components in sequence. Accordingly, the degree to which the CEP addresses each component will depend upon where the organization is in the implementation process.

The CEMS component job aid in Section III (*CEM, Step by Step*) can be used as guidance to help develop an organization’s CEP. Some elements to consider from that job aide are summarized here:

Trained CEM Coaches or Acceptable Alternatives:

CEP Elements:

- Describe what duties your coach(es) will fulfill for your vessel(s).
- Describe what qualifications the coach(es) should have, such as Coaches Training certification.
- Determine if the coach(es) will serve one vessel, several vessels, or the entire company.
- Determine how many coaches you will need.
- Describe how your coach(es) will be trained.

Details:

As is more fully described in the next step, on pages 24-25, an onboard coach (or acceptable alternative) is a critical element of a successful CEMS program. Since coaches are trained to be knowledgeable about CEMS and Crew Endurance risk factors, they can provide continuous, **consistent** support for CEMS implementation, supporting their CEWG as well as individuals on the vessel as *the* “go-to” person. They can provide training and education to the rest of the crew, champion the efforts of the CEWG, and help them develop and deploy the resulting CEP.

Education:

CEP Elements:

- Once you have decided upon risk factors to improve, list which crewmembers will need to be educated about them.
- List the topics that will be covered.
- Determine who or what will provide training, how it will be delivered, what training aids might be used, and whether or not the trainer or other educational resource is qualified for that particular topic.
- Describe how often training will be delivered.
- Describe how the training will be tracked.

Details:

What training resources are there for the “education” phase?

Anyone who is interested in CEMS – from company heads, to coaches, to interested crewmembers – will find a wealth of CEMS information in the following sources:

- The CEMS website, <http://www.uscg.mil/hq/g-m/cems/index.htm>
- The AWO/CG (American Waterways Operators/Coast Guard) Executive Level Presentation (on the website)
- CEMS newsletters (on the website)
- The Self-Sustaining Workshop Tool described on page 17
- Training videos from commercial sources

Environmental Changes:

CEP Elements:

- Identify the environmental improvements your group will make.
- Detail plans for the working environment, sleeping environment, *and* the operating environment.

Details:

***What will I have to change about my vessel to do CEMS?
What will I have to change about my operation to do CEMS?
How much do these changes typically cost?***

The choices are yours, dependent upon the risk factors you've identified and the controls the CEWG identified to address them; in other words, they are tailored to your particular operation.

The environmental and operational changes are going to vary in cost depending on what measures you decide to implement. Frequently, crewmembers are able to engineer hand-made modifications at significantly lower costs. Costs may vary from a few hundred dollars to several thousands, depending on the extent of your changes on the first go-around. For example, environmental modifications may range from lower-cost solutions, such as window covers and door baffles, to higher-cost re-fittings of vessel exhaust or air conditioning systems.

Some desirable but expensive improvements may have to wait until the company decides that they are feasible. Depending on your situation, make changes to those areas that will have the most impact, evaluate the results, and then consider other changes that can be made.

Successful environmental changes in the past have included:

- Lightproofing porthole covers in berthing spaces.
- Sound-insulating baffles over cabin door louvers.
- Improving air conditioning.
- Adding air purifiers/carbon monoxide filters.
- Improving mattresses and pillows.
- Increasing access to healthier food choices.
- Adding exercise equipment.
- Making lighting changes in support of the light management plan.

Successful operational changes in the past have included:

- Instituting courtesy policies for sleeping crewmembers (being mindful of two-way radio volume, shutting doors, talking in corridors, TV volume, throttle controls).
- Instituting napping policies.
- Modifying meal times.
- Making watch schedule changes.

Light Management:

CEP Elements:

- Describe how the crewmembers will use light management.
- Determine if there will be an individual plan for each crewmember.
- Describe when the crewmembers should seek and avoid exposure to bright light.
- List changes that will be made to work areas, rest areas, transition areas, and the policies governing these areas.

Details:

Light Management is a highly technical strategy that requires a solid understanding of CEMS. That is why you can find more information on the topic in Appendix B. It can be enacted more effectively if a trained coach or alternative is already in place on a vessel, its crew has been educated, and environmental changes have been implemented.

At that point, the CEWG can evaluate each individual's schedule to determine his or her own optimal plan for light management. Then the CEWG can take into account whether or not changes need to be made to work, rest, and transition areas and the policies surrounding them. Doing so will help support the crewmembers in maintaining their individual plans.

Schedule Changes:

CEP Elements:

- Determine whether or not the crew will change their schedule.
- Describe how the schedule will be changed.
- Describe the watch schedule that will be used.
- Describe how the schedule change supports light management.

Details:

Changing a watch schedule may seem simple, but it is deceptively complex and fraught with pitfalls. That is why you can find more information on the topic in Appendix C. Schedule changes should be evaluated and changed only after coaches, education, environmental changes, and light management have been reasonably attempted. After all, you wouldn't try to get underway without casting off the lines or starting the engine, right? The schedule change should be consistent with previously made efforts and further support them.

How does the CEP fit into all my other plans and documentation? ISO/ISM? RCP?

The CEP may not formally fit into any of your other plans and documentation. However, the process and core elements of the CEP may be smoothly incorporated into other pre-existing plans. The structure of CEMS is very similar to ISM; it establishes practices and guidelines to increase endurance, but leaves the details of the actual plan up to each company/vessel. In any case, the CEP should complement other safety plans.

Are there examples available?

Section III (*CEM, Step by Step*) includes a job aide that may be useful as a template for implementing organizations.

Step IV: Implementation of the Crew Endurance Plan (CEP)

This step is the most important part of the process, yet it can also prove to be the most challenging. Here, the company CEWG and vessel crewmembers make a good-faith effort to address those recommendations identified in the CEP. Some recommendations are easier to implement than others, and some take longer to show results. In general, however, the CEWG should expect to see progress over time.

A CEWG should also be aware that extraordinary events may affect progress. For example, a vessel or company recovering from an extreme

catastrophe, such as a hurricane, may find it difficult to make progress with the recommendations. Instead of becoming discouraged, the group should instead progress as much as could reasonably be expected under the circumstances.

Coaches' Role in Implementation of the CEP

What does a coach really do?

Onboard Support:

On a daily basis, the coach will respond to crewmembers' questions about sleeping problems or difficulties using light management, dietary recommendations, and how to adapt to new watch schedules. A coach also deals with misinformation regarding Crew Endurance, such as disagreements over sleep requirements and the science of CEMS.

Coaches will help troubleshoot crewmembers' personal endurance plans when they experience difficulties using them. For example, one crewmember might go to the coach to say he's not sleeping well on a new watch schedule. The coach would then ask him about his sleep habits and behaviors to see if there was something wrong, and then make suggestions to improve his sleep quality.

The coach, a critical player in the development of the Crew Endurance Plan, understands how the plan addresses various endurance-related risks. The coach also assists with the risk assessment, and is therefore knowledgeable as to which factors most highly affect that vessel's crew. The coach is, therefore, in the best position to champion key elements of the CEP, and to build support amongst onboard crewmembers.

The coach may also conduct periodic (frequency determined by vessel operations) training on specific CEMS topics with the use of the Self-Sustaining Workshop Tool or other training aids.

In this very important way, the role of the coach is to provide **consistent** support for CEMS implementation.

Company Champions:

We recommend that a company should have at least one company champion to help initiate and oversee its implementation effort. Such CEMS advocates help to:

- Build awareness.
- Guide a company and its CEWG(s) through the entire process.
- Train crews and managers.
- Maintain corporate knowledge and understanding of CEMS.

If your company has only one coach, this person would serve as your CEMS Champion.

So you're saying that I MUST have a trained coach on each vessel?

No. Though we recommend that companies should have at least one trained coach to help initiate and oversee its CEMS implementation effort, we realize that this may not be a practical approach for all companies.

If having an onboard coach is not practical, a company should develop an effective alternative approach to providing onboard support for CEMS implementation as part of its safety management system. The Coast Guard stands ready to assist any individual companies or industry workgroups looking to develop acceptable alternatives. If your company has a question about whether or not your approach is appropriate, please contact the Coast Guard at (202) 267-2997.

Where can I get Coaches Training, and how much will it cost?

Several maritime training institutions, maritime academies, and private training companies have been certified to provide CEMS Coaches training. Costs will vary depending on the institution that is offering the training.

Several companies are also conducting their own Coaches Training in-house. These companies have established in-house Coast Guard-trained Experts to train their crews and will open up training to other companies as space is available.

Training descriptions and upcoming classes may be found on the CEMS website at <http://www.uscg.mil/hq/g-m/cems/index.htm>.

What's the difference between a Coach and an Expert?

A Crew Endurance Expert is essentially a trainer for Crew Endurance Coaches. To become an Expert, one must first become certified as a USCG CEMS Coach. Coaches must then attend the more intensive Experts Training and pass both a written and oral examination.

Experts may be located within a particular company, where they will facilitate the two-day Crew Endurance Coaches Training themselves, or within an educational institution, so that the institution provides training to the commercial maritime-at-large.

Can my company have its own Expert or will I have to pay someone else for training?

The choice is yours. If you feel you don't need an Expert on hand, you will most likely have to pay for Coaches Training at an accepted institution. However, industry Experts from operating companies frequently open unfilled slots to outside companies.

Step V: Evaluation of Results

The risk assessment of Step II is repeated here while maintaining an effort to use these results in future iterations of the continuous improvement cycle. This will help to determine the effectiveness of recommendations from the Crew Endurance Plan.

It is also certainly within the scope of each organization to track company-related measures such as:

- Safety improvements and statistics.
- Health and well-being measures.
- Employee turnover.
- Any other subjective measure of implementation.

Once this information has been evaluated, the CEWG can develop an updated set of recommendations for the Crew Endurance Plan.

It is important to look for downward trends in the crew risk assessments. Any increase in risk frequency should be examined to determine if additional methods can be used to reduce risk.

The Decision Support Software Tool described on page 16 may be useful for determining the current status of the organization and to track its progress over time. Computer-based tools for gathering these measures are available from the Crew Endurance Management website at <http://www.uscg.mil/hq/g-m/cems/index.htm>.

SECTION III

CEM, Step by Step

III. CEM, Step by Step

This section (III) provides steps and questions to run through as you develop your CEM program. It also provides related worksheets to help keep track of your improvements. These worksheets are not intended to be all-inclusive, and not every part of the worksheets may apply to your organization. They are intended to be used as a job aid by people with a solid understanding of CEMS, such as a trained Coach or Expert.

Recruiting Trained Coaches or Acceptable Alternatives

These people “in the know” about CEMS will greatly benefit your implementation effort.

Who can serve as a knowledgeable resource about CEMS and Crew Endurance risk factors? Will it be one person for your company, many who will be shared among vessels, or one person for each vessel?

Depending on this variable, go on to decide how many coaches you will need, how you can provide training and education, and how to best supply continuous feedback and coaching to individuals.

You will also need to consider how these CEMS advocates will be trained, via a Coast Guard-approved course (like Coaches and/or Experts Training) or an acceptable alternative.

<p>I. Establishment of a Crew Endurance Work Group (CEWG) <i>See pages 12-13 for more details.</i></p>	
<p>Will you have one CEWG for your company, several who will be shared among vessels, or one CEWG for each vessel?</p>	
<p>List the membership of your CEWG:</p>	<p>Is your membership representative of all levels of organization that will be affected?</p> <p>If not, what representation are you missing?</p> <p>Does the membership support vertical alignment¹?</p>
<p>What level of activity is appropriate for your CEWG? How will the group keep adequate momentum towards identifying problems, deciding upon and implementing solutions, and re-evaluating the results? How often should they meet?</p>	

¹ Description on page 13.

II. Analyzing the Current Situation and Identifying Risk Factors

See pages 14-17 and Appendix A for more details.

Date: _____

For each vessel, evaluate all relevant risk factors, using either the Decision Support Software Tool to record and save your data, or by having your crew fill out the worksheet on the next page.

According to the feedback collected, what factors could use/still use improvement?

Along with the above, consider the general health of your crewmembers, their use of medications, and the environmental risk factors listed on page 15. Add any other concerns to the list above.

Of the listed risks, highlight those that impose the greatest possible endurance risks for your vessel. Read about their implications and recommended changes in Appendix A. Go back and underline which factors could be easily changed based on your vessel's personnel, schedule, and finances.

II. Analyzing the Current Situation and Identifying Risk Factors

Decision Support System Work Sheet - 15 Risk Factors

	HOW MANY DAYS PER WEEK DO YOU EXPERIENCE:	# of DAYS
1	INSUFFICIENT DAILY SLEEP DURATION (less than 7-8 hours of uninterrupted sleep in a 24-hour period)	
2	POOR SLEEP QUALITY (awakenings due to work-related disruptions, vessel motion, or noisy environment)	
3	SLEEP FRAGMENTATION (breaking sleep into multiple naps; cannot schedule 7-8 hours of continuous sleep)	
4	SCHEDULING MAIN SLEEP PERIOD DURING THE DAY (while "day oriented")	
5	CHANGING WORK / REST SCHEDULES (rotating between day and night work / changing watch schedule)	
6	LONG WORK HOURS (more than 12 hours)	
7	NO OPPORTUNITIES TO MAKE UP LOST SLEEP (napping is not possible)	
8	POOR DIET (high fat / fried foods, high sugar content, frequent caffeine consumption, inadequate hydration)	
9	HIGH WORKLOAD (high physical and / or mental effort requirements)	
10	HIGH WORK STRESS (extreme environment, sustained physical / mental workload, rotating work schedules, authoritarian leadership style)	
11	NO OPPORTUNITY FOR EXERCISE (lack of time, or no equipment / facilities)	
12	LACK OF CONTROL OVER WORK ENVIRONMENT OR DECISIONS (not allowed to contribute to problem identification and resolution / lack of participation in decision processes)	
13	EXCESSIVE EXPOSURE TO EXTREME ENVIRONMENTS (cold, heat, high seas, etc.)	
14	FAMILY STRESS (child or parent care, divorce, finances, etc.)	
15	ISOLATION FROM FAMILY (problems maintaining contact with family)	

III. Developing a Crew Endurance Plan (CEP)

See pages 17-23 for more details.

After considering the risk factors in Step II, decide which ones will be addressed in this round of CEMS implementation. Focus on ones that are within your means, yet will reduce the greatest amount of risk. Select as few or as many as you think your CEWG can manage here:

#	Risk Factor	Reason
1		
2		
3		
4		
5		
6		
7		
8		

III. Developing a Crew Endurance Plan (CEP)

See pages 17-23 for more details.

Make sure your plan addresses the five components below:

Coaches

Will there be a trained coach on every vessel or some acceptable alternative? How many coaches will you need, and how will they be trained?

Education

To affect the risk factors chosen, what crewmembers need to be educated? What topics will be covered? Who/what will train them? Is this a qualified source of information? What training aids should be used? How often will training be delivered? How will the training be tracked?

Environmental Changes

To affect the risk factors chosen, what environmental improvements would be most effective? Be sure to consider all areas of the vessel including the working, sleeping, and operating environments. Improvements to consider might include:

*Modify light intensity to support light management.
(see next section for details)*

Reduce noise and vibration levels.

*Improve air quality.
(temperature, humidity, odors, etc.)*

Reduce ship motions.

Modify operational policies such as:

- *Courtesy to those sleeping off watch.*
- *Alternate shower and meal times.*
- *Napping.*
- *Vessel maneuvering/excess throttle.*

Light Management

See also see Appendix B for more details.

To affect the risk factors chosen, will a light management plan be used? Will there be an individual plan for each crewmember?

Will changes be made in support of light management?:

Work Areas	Rest Areas	Transition Areas	Policies
Will light intensity be increased in some areas? Where?	Will lighting be dimmed or reduced in some areas? Where?	How will transition areas be handled?	What vessel policies need to be changed to support these light management practices?
Are green lights to be used?			
Will the crew be exposed to light pre-watch or during watch?			

Schedule Changes

*Complete Only After All Other Steps!
See also see Appendix C for more details.*

Will the schedule be changed in any way?

If so, to what schedule?

Describe how you will make the transition to this schedule change.

Does this schedule support the light management plan, as well as the other changes that have been made? How?

IV. Implementing a Crew Endurance Plan (CEP)

See pages 23-26 for more details.

Deploy the CEP with the help of your Crew Endurance Coach or alternative. There should be some method or person to conduct periodic training sessions, drive the goals of the CEWG, respond to individual questions, troubleshoot crewmembers' personal endurance plans, and, in doing so, provide consistent support for CEMS implementation.

V. Evaluate Results

See page 27 for more details.

As your CEWG collects feedback, continually reassess your vessel's situation and decide if further improvements need to be made. Keep going back to Step II, as necessary, to reconsider factors that may have changed, improved, or taken priority as a result of other changes. You may also wish to collect and document information on safety improvements, statistics, health and well-being measures, employee turnover, or any other subjective measure of implementation.

What information will you collect and document? When will you reevaluate this information to determine your results?

Appendix A

Managing Endurance Risk Factors

Purpose

As described in Step II of implementing a CEM program (see pages 14-17), the CEWG should properly assess the current situation and identify relevant risk factors. After thorough consideration, it can prioritize which risk factors to initially address. To supplement Coaches Training, the following facts, suggestions, and references for each endurance risk factor are provided here.

CEMS mainly considers 15 risk factor categories affecting endurance, which fall under four general areas: sleep/schedules/circadian rhythm, physical stressors, environmental stressors, and personal stressors. These factors are generally accepted within the scientific and medical community as well-established indicators of fatigue.

Please note that all of the following risk factor information is taken from the U.S. Coast Guard's September 2005 Report to Congress on the Crew Endurance Management Demonstration Project, which can be found on the CEMS website in Fall 2005. While suggested references are listed in the bibliography in Appendix D, you will need to review the report if you wish to track down sources for individual facts.

A-1: Sleep, Schedules, and Circadian Rhythm

Sleep Duration

***Refer to this information when considering question #1 of the Decision Support Software:
“How many days per week do you receive insufficient daily sleep (less than 7-8 hours of uninterrupted sleep in one 24-hour period)?”***

Medical research indicates that the average person needs eight hours of uninterrupted sleep per night, or one hour of rest per two hours awake. When a person does not get eight hours, the effect can be devastating to performance. Studies have shown that sleeping less than six hours a night impairs cognitive ability and performance enough to put motor vehicle operators at risk. This is because sleep deprivation causes:

- Daytime drowsiness.
- Feeling overwhelmed, indecisiveness, and a lack of motivation.
- Unconsciously slipping into brief or long episodes of sleep, a reduced ability to handle complex tasks, and a reduction in speed and ability to think logically or critically.
- Impaired memory.
- A reduction in motor skills and coordination.

Everyone who experiences sleep deprivation, from medical personnel and airline pilots to ship crewmembers, are susceptible to these effects. This is particularly of concern for vessel operators working alone; there may be no one immediately available to take control of the vessel, should they fall asleep or lose alertness. Sleep deprivation may also cause memory impairment, which in turn may cause an operator to forget a navigation route, as vessel operators did in Coast Guard accident case files. Finally,

such deprivation could cause crewmembers to experience a loss of motor skills and coordination, consequently impairing their ability to handle equipment.

Sleep Quality

***Refer to this information when considering question #2
of the Decision Support Software:
“How many days per week do you sleep poorly because of
environmental factors such as noise and vibration?”***

Sometimes there are factors that prevent the crew from sleeping or cause their sleep to be disrupted. Occasionally a crew member’s sleep might be disrupted for work-related reasons, such as drills or other operations requiring all hands. Depending upon the weather and sea conditions, the vessel may be subject to motions which can interfere with sleep. For smaller vessels, maneuvering the vessel may cause sudden motions that awaken sleeping crew members. Two common causes of sleep disruption are noise and vibration.

Noise is an environmental stimulant that activates mental and physical reactions in the body, and can disrupt sleep no matter how low that level of sound is. In various studies, scientists have discovered that *any* noise, ranging from a neighbor’s radio or road traffic to aircraft noise, can affect the quality and quantity of sleep a person gets each night. Noise can also affect the ability to fall asleep, causing sleep loss, or it can alter one’s sleep stage or depth of sleep.

Vibration is another environmental factor affecting sleep and fatigue. In extreme cases, whole-body vibrations may be strong enough to create back pain, nausea, loss of balance, motion sickness, discomfort, a change in metabolism, decreased work performance, and fatigue. Because vibration has such extensive effects on performance and physical health, whole-body vibration is considered a major risk factor for many industries.

Depending upon the size, design, and layout of the vessel, crews may experience various degrees of whole body vibration caused by the engine

and other machinery. Clearly, vibrations that are strong enough to cause pain, nausea, and ineffective performance will also impair sleep. However, even lesser vibrations may affect crew members' sleep.

Noise and vibration may keep people awake, keep them from advancing to a more beneficial sleep stage, or wake them up. The risk of being woken up is especially true when people are in certain early stages of sleep, because they can be easily awakened. If the noise and vibration are so strong that they can't get beyond these early stages of sleep, they will never reach the most important sleep stage, REM sleep. Moreover, when noise or vibration disrupts sleep stage or sleep depth, it has the same impact as loss of sleep, because human bodies need to go through all stages and depths of sleep before they can be fully restored. The consequences of poor sleep quality caused by noise or vibration include fatigue, a bad mood, poor health, poor performance, and interference with mental ability.

Sleep Fragmentation

***Refer to this information when considering question #3
of the Decision Support Software:
“How many days per week is your sleep interrupted?”***

Sleep fragmentation is discontinuous sleep, or sleep that is obtained through various short sleep periods, such as naps. A crewmember's sleep may be fragmented because it is interrupted, or their shift schedule only allows brief sleep periods. In any case, sleep fragmentation means that a crew member does not obtain a continuous, uninterrupted period of seven to eight hours of sleep that the human body requires.

The problem with fragmented sleep is that it does not allow the brain and body to fully rejuvenate. This is because the body goes through different sleep cycles over time. Each sleep cycle serves a different purpose for our health. We start in Stage 2, the lightest level of sleep, then advance to Stages 3 and 4, which have physical restorative qualities. Stage 5, or REM sleep, comes last, and is most essential for preparing the mind for optimum

daytime performance. REM sleep helps us with memory and concentration. However, we only get around to the longest REM cycle after the seventh hour of sleep. If we skip the last two hours of sleep, we don't get sufficient REM sleep. When people fragment the eight hours, they, too, break the cycle that eventually leads them to a long REM sleep, and fail to receive the rest they need to perform during the day. Sleep fragmentation is considered as much of a safety risk to Crew Endurance as inadequate sleep.

Sleep fragmentation occurs on board vessels due to relatively short rest periods, having to eat or take care of personal hygiene matters during scheduled rest periods, and other circumstances of shipboard life.

Synchronization With Circadian Rhythms

***Refer to this information when considering question #4
of the Decision Support Software:
“How many days per week do you have to schedule your main
sleep period during the day (while day-oriented)?”***

Circadian rhythms also affect crew alertness. Nearly all human physiological and behavioral functions occur on a rhythmic basis that makes people alert in sunlight and sleepy in night darkness. This is because sunlight suppresses the hormone melatonin. Melatonin is a hormone which makes us sleepy, or unwary. When there is sunlight, the suppression of melatonin allows us to be alert; when there is no sunlight, the melatonin is released and we become sleepy.

This becomes problematic for operators working night shifts, because night workers are sleepy when they need to be awake, and vice versa. They would also normally experience a disruption in circadian rhythm because daylight impairs sleeping during the day by suppressing melatonin. The converse is also true: when it is dark, and night workers are sleepy, they are supposed to work and be alert. Inexperienced shift workers are likely to experience more difficulty with circadian inversion (changing their biological clocks or “shifting the Red Zone,” as we call it in CEMS).

However, for all night workers, a long-term adjustment would require substantial dedication and a strict routine. Until an adequate adjustment is made with the help of countermeasures, such as light management, circadian rhythm disruption is a risk factor.

To counteract the effects of the circadian rhythm change and disruption, vessels are encouraged to use light management, which is further described in Appendix B. Such light exposure has been shown to help night shift workers sleep during the day and make an effective circadian cycle shift from being day-oriented to night-oriented. Because the medical advice is very specific as to when and how these lights should be used, the Coast Guard recommends the use of CEMS Experts to discuss it with the crews.

It is important to note that in a recent study on night shift workers, the use of light alone was found insufficient to induce consistent circadian phase shifts. The research indicated that other adaptations should be made, including keeping a fixed wake/sleep schedule. The Coast Guard agrees, and this is why CEMS considers all risk factors and components in its program. Addressing one risk factor alone is never enough to increase endurance and alertness.

Change in Work/Rest Schedule (Irregular Hours)

***Refer to this information when considering question #5
of the Decision Support Software:
“How many days per week do you experience
changing work/rest schedules?”***

In a 2002 study, the Canadian Marine Safety Directorate identified irregular hours as a top cause of fatigue. “Irregular hours” is the absence of having a regular waking and sleeping time. This absence contributes to circadian disruption, and impairs alertness and good decision-making. Shifting work hours also affects the crew’s ability to sleep. The constant switch of “waking” and “sleeping” hours confuses the body and has an effect similar to that of jetlag.

These results may occur when the person scheduling the shift unknowingly creates a schedule that doesn't allow people time to adjust to a new circadian rhythm, and/or rotates the shifts earlier rather than later, which is harder to adapt to. Either way, the constant schedule changes become a safety risk.

Medical research has shown that shift schedules should last two to three weeks, because it takes people about a week to acclimate to a new circadian rhythm, and once they are adjusted, it is better not to switch shifts again too soon. In addition, when it is time to rotate the shift, it is suggested that they take advantage of the adaptation, and schedule each worker's shift to start at approximately the same time of day or later. The same or later time will work with the body's tendency to advance the clock over time, rather than work against the body the way an earlier shift would.

Extended Work Hours

***Refer to this information when considering question #6
of the Decision Support Software:
“How many days per week do you experience
long work hours?”***

The Center for Disease Control defines extended work shifts as being longer than eight hours, and overtime as being more than forty hours per week. Research has shown that extended shifts of nine hours or more cause more injuries, fatigue, poor health, and errors. A recent study also revealed that offshore oil riggers who worked 12-hour night shifts experienced decreased alertness and response time to challenges of a task. In fact, extended shifts have caused nurses and construction workers to make more errors and suffer car accidents on their way home. According to the nurses, they just didn't have the stamina and mental alertness to deliver the care that patients need.

Workers who work longer hours also have reduced cognitive ability, less energy to exercise, and less ability to plan and prioritize. Finally, workers

with longer working hours may experience more disruption of the circadian system and declines in safety, performance, and productivity.

Shift workers are also vulnerable to fatigue and reduced performance if they work long shifts. The effect that extended hours have on nurses, oil riggers, and drivers will affect vessel operators as well. Long work hours decrease endurance and reduce an operator's ability to be alert, which is why long work hours are a safety risk.

Opportunities to Make Up Sleep (Nap)

*Refer to this information when considering question #7
of the Decision Support Software:
“How many days per week are you unable
to make up lost sleep (napping is not possible)?”*

Shift workers such as crewmembers are most sensitive to sleep disruption, because shift schedules interfere with the biological clock and the ability to sleep.

Naps are an essential countermeasure to fatigue, exhaustion from long shifts, and sleep deprivation. According to sleep experts, whether before an anticipated short night's sleep or after, brief naps improve performance and alertness, and delay fatigue-induced performance degradation. Napping is such a popular solution to driver fatigue that transportation industries in the United States and Canada have recommended napping to airline pilots as an answer to fatigue.

Naps should not last for more than 90 minutes, so they don't disrupt circadian rhythms and cause insomnia. After napping, experts recommend that workers take fifteen minutes between the nap and work so that they are not groggy or disoriented from this “sleep inertia” when they are working.

A work schedule that does not permit naps takes away an opportunity to increase endurance and alertness. Not all crewmembers are able to sleep eight hours a night, and as previously explained, this is a safety risk. Crewmembers that are also unable to make up for this lack of sleep suffer

an additional risk factor, because they are unable to recover from sleep loss. Therefore, the inability to take naps is considered an additional risk factor.

Recommended Follow-Up

If your CEWG identifies any and/or all seven of these sleep, schedule, or circadian rhythm factors as a significant problem, the following can be taken into consideration when devising a CEP. The number(s) following each recommendation correspond to where they can be found in the original Guide for Maritime Operations, where they are described in more detail.

Sleep Recommendations - General:

- Crewmembers should have enough time off to obtain 7-8 hours of uninterrupted sleep per 24-hour period. Strive to sleep at *least* six hours per day. (35, 42, 43, A-10)
- When 7-8 hours of sleep is not possible, compensate for any sleep loss with daily naps of up to 90 minutes in length. Allow 15 minutes between a nap and returning to work to avoid grogginess/disorientation, or sleep inertia. (42)
- Do not nap during the day if you have difficulty sleeping during your normal sleep period. (A-6)
- Provide a comfortable sleeping surface. (36)
- Provide a dark sleeping atmosphere. This may involve tinting windows, installing shutters, or any other method that will prevent sunlight and bright artificial light from penetrating into sleeping quarters. (36)
- Provide and maintain a quiet atmosphere for sleep. If possible, wear earplugs or use a white-noise generator, such as a fan. (36, A-5, A-11)
- Maintain a comfortable temperature of 65-70° F and 60-70% humidity in the sleeping quarters. (36)

- Avoid sudden ship movements that may wake sleeping crewmembers.
- No matter when you sleep, try to wear usual sleep clothes. Use the bed only as a place to sleep. Associating these habits with sleep will allow it to come more easily. (A-5)
- If you cannot fall asleep after 30 minutes in bed, get up for awhile before trying to sleep again. (A-6)
- Work periods should be no longer than eight continuous hours, particularly when prolonged exposures to extreme temperature or humidity levels are involved. In particular, avoid allowing personnel to work more than 12 hours in a 24-hour period. (38, 43, 45)
- Encourage crewmembers to sleep and wake at the same times each day or night to maintain a well-functioning biological clock. (37, A-5)
- Finish physical training no later than one hour before bedtime. (A-5)
- Avoid work schedules that impose frequent changes from daytime to nighttime duty hours. (37)
- When changing to a new work shift, gradually adjust times over a period of days for better performance. (38)
- Please also review recommendations for physical, environmental, and personal stressors, as these areas also affect one's sleep.

Sleep Recommendations – Night Schedule Workers:

- Please also review Appendices B & C, as light management and schedule changes greatly affect one's sleep.
- Environmental light management techniques should be used to adapt crewmembers to night watch. (43)
- For crewmembers working at night, maintain the same work-rest schedule for at least two continuous weeks. (43)
- Provide bright-light exposure during the work period in environments where night vision is not required. (45)

- Avoid bright light for three hours before sleep by avoiding light or wearing wraparound sunglasses (38), or allow crewmembers on any watch ending in the morning hours to retire prior to sunrise. (46)
- Overtime should be scheduled to occur *after* wake-up time. Leisure activities should be scheduled in the evening hours. (46)

When Night Schedule Workers Cannot Use Bright Lights:

- Reduce the duration of the watch. (46)
- Promote exercise in the evening hours. (46)

Read More About It Here:

In the original Guide for Maritime Operations:

- “Managing the Red Zone,” pages 4-6 and 31-46.
- Appendix A, “Sleep Management and Circadian Rhythms,” pages A1-A19.

In the source documents for background material:

- Most sections have a corresponding bibliography in Appendix D.

On the CEMS website at <http://www.uscg.mil/hq/g-m/cems/index.htm>:

- CEMS Newsletters: Vol. I, Issues 1-4, and Vol. II, Issue 1.

A-2: Physical Stressors

General Health

Although this question is not a part of the Decision Support Software, the effects of poor crewmember health, resulting in insufficient energy and an inability to fight illness, should be considered when devising a Crew Endurance Plan.

The crew's physical condition has a large impact on endurance. Physical impact includes diet, workload, extent of exercise, and personal stressors (which are further described in A-5). These factors affect a person's ability to have sufficient energy, the ability to fight sickness, the likelihood of fatigue, the endurance to sustain workplace hardship, and the ability to stay alert.

Diet

***Refer to this information when considering question #8 of the Decision Support Software:
"How many days per week do you have a poor diet?"***

Diet is a factor that can strongly affect a crew's health and endurance. Unfortunately, shift workers have a tendency to eat unhealthfully. Night shift workers, in particular, are prone to weight gain and bad eating habits.

There are basic fundamentals of a good diet that can positively affect an individual's endurance and alertness. In Coaches Training, each coach is taught the fundamentals of maintaining a diet for endurance. Some of those fundamentals are explained here.

Shift workers with long shifts are inclined to drink a lot of coffee to get through the work day. Caffeine shortens total sleep time by preventing sleep, and detracts from time spent in REM sleep, the most important sleep cycle for strengthening learning ability, memory, and daytime performance. This problem exists for anyone who drinks more than three cups (24 oz) per day. Excessive caffeine also causes the body to lose calcium, magnesium, and B vitamins, and impairs iron absorption. Caffeine consumption can also cause dehydration, which is particularly bad when vessels are in an extreme climate, or if an individual on the vessel is seasick. Despite the “kick” that caffeine may give a person, it has many ways of undermining endurance. During training, coaches are informed of the effects of caffeine, and are presented with better beverage options to suggest to the crew.

Some coaches suggest drinking more water. Water makes up a majority of living tissue, and the health of all body systems depends on adequate hydration. It carries nutrients and oxygen to the body’s cells, cushions the body’s joints, dissolves nutrients, and makes nutrients accessible for the body’s use. If a person loses as little as three percent of his or her body weight as water, physical performance starts to suffer. When water loss occurs, a person experiences severe physical and mental stress and performance degradation. Water generates energy and is essential for the body’s cooling and heating systems, enhancing endurance, particularly in extreme climates. Moreover, water provides energy for thinking and may expand the attention span. Finally, it reduces fatigue. Water is the only beverage that will promote endurance by fighting environmental stressors and providing nutrients.

Coaches learn that a high-protein, low-fat diet with well-chosen carbohydrates supports endurance and alertness. Protein is a source of amino acids, an element that is involved in the structure of nutrient carriers, neurotransmitters, and muscle, among other things. Amino acids are essentially responsible for cell regeneration, and 40% of those amino acids must come from our diet. Protein also contains nitrogen, an element needed to repair and build tissue for all bodily functions, and provides nutrients to combat stress. However, some sources of protein may contain tryptophan. This is good for helping the crew to sleep, but not good if the crew needs to stay alert. Most importantly for alertness and decision-making, amino acids run the brain. The neurotransmitters that they help build regulate cognitive and mental performance, as well as emotional states and pain response. For crewmembers, it is very important to

consume high amounts of protein at the beginning of a work shift to obtain the energy and amino acids necessary to do their work, stay alert, and make good decisions.

Carbohydrates can be a good source of energy, including glucose, the only energy source for red blood cells. They also provide fiber, an essential nutrient that decreases risk of coronary heart disease. Fruits and vegetables are common sources of carbohydrates that also contain vitamins, minerals, and other essential nutrients. To prevent constipation, CEMS trainers and coaches recommend that shift workers consume fresh, whole fruits and vegetables rather than getting their nutrients from juice.

Fats are energy sources that are consumed too often. Although fats provide energy and serve other important functions for the body, all Americans (including vessel crews) should reduce their fat intake. Excessive fat intake causes obesity, cardiovascular disease, impaired work performance, and heartburn.

Finally, after the first high-protein meal of the day, it is recommended that shift workers eat lighter meals or snacks. Eating smaller, multiple meals will decrease the risk of obesity and also prevent digestive problems. Because our bodies operate on a circadian rhythm, digestive systems that are not fully entrained to a night shift will more easily digest smaller meals than larger ones during the late night to early-morning hours. It is also important that people eat very little before sleeping, because a lot of food before rest can impede sleep.

In providing diet guidelines, CEMS covers all of the above information. Coaches are taught about the benefits of protein, water, and fresh fruits and vegetables, and potential problems with fats and excessive caffeine. This way, all crewmembers are able to eat for high endurance. It is also important that the crew be given alternate meal times, so that they may eat well before sleep.

Workload

***Refer to this information when considering question #9
of the Decision Support Software:
“How many days per week do you experience high workload (high
requirements of physical and/or mental effort)?”***

An inappropriate workload is another risk factor. Work overload *and* work under-load are *both* considered sources of stress, which is in itself an endurance risk factor. Work overload triggers stress because the individual starts worrying about completing the work on time, and feels too much pressure. If the work is physical, it fatigues the body and makes a crewmember want to sleep. Work underload is a problem because a crewmember may get bored or feel disengaged, causing fatigue. The Decision Support Software focuses on work overload, but underload situations should be a consideration as well.

Opportunities to Exercise

***Refer to this information when considering question #11
of the Decision Support Software:
“How many days per week do you have no opportunity to exercise
(because there’s not enough time or any equipment/facilities)?”***

The inability to exercise is considered a risk factor because it is a circumstance that takes away a crewmember’s ability to increase endurance, enhance sleep, think clearly, and manage stress. Exercise increases physical endurance to sustain stressors such as motion, vibration, and extreme climates, and it also helps one adapt to a new circadian rhythm.

Research has also shown that physical activity enhances cognitive thinking. According to one study, aerobic exercise that is performed for up

to 60 minutes facilitates information processing, and increases decision-making speed. Slow decision-making has contributed to a number of maritime casualties.

Exercise is also known to enhance memory, problem-solving ability, concentration, alertness, and productivity. This is because exercise enhances our ability to use oxygen to obtain energy for work. Exercise can also help crewmembers to fall asleep and sleep well throughout the night. Finally, exercise helps to reduce stress and reset the circadian clock.

Crewmembers benefit from regular exercise. In addition to improving their health and well-being, exercise helps them to sleep, avoid circadian disruption, decrease stress, and increase endurance and alertness. The inability to acquire these benefits is considered a risk factor, because doing so contributes to the kind of good decision-making that prevents accidents.

Sleep Aids, Alcohol, and Over-the-Counter Drugs

Although this question is not a part of the Decision Support Software, the effects of taking sleeping aids, drinking alcohol, and taking over-the-counter drugs either recreationally, to sleep, or to treat medical symptoms should be considered when devising a Crew Endurance Plan.

Crewmembers are usually working in unusual, difficult circumstances. To handle such circumstances, they sometimes adopt habits that ultimately reduce endurance. These habits may include taking sleeping aids and/or taking over-the-counter drugs in order to sleep or to treat various symptoms. Many of these substances suppress REM sleep, which is the most important stage of sleep for replenishing learning ability, memory, and daytime performance.

Many employers prohibit the consumption of alcoholic beverages onboard, and operating a vessel while intoxicated is a violation of federal law¹. Nonetheless, crew members should know that alcoholic beverages also suppress REM sleep and reduce endurance.

¹ 33 Code of Federal Regulation, Part 95.

On other occasions, members of the crew and the pilot may come down with a cold or suffer from allergies. In these cases, they may be inclined to take over-the-counter medicines. Many medicines will make them drowsy. This drowsiness could impair their alertness or make them fall asleep. Some commonly used decongestants that could make them severely drowsy are Actifed, Benadryl, Comtrex, Dimetapp, TheraFlu, and Tylenol.

Other medicines, if taken before bedtime, may keep crewmembers wide-awake while trying to sleep. Sudafed, another commonly used decongestant, contains pseudoephedrine, which, depending upon the individual, may create a stimulatory effect similar to that of caffeine.

CEMS teaches coaches about the side effects of alcohol, sleeping pills, and medicines. The coaches discourage the use of alcohol and sleeping pills, while aiming to enhance sleep in other ways such as reducing the vessel's noise levels. The coaches also teach the crews to be more aware of side effects of over-the-counter medicines, encourage them to consult with doctors, and aim to keep the crew healthy by improving their diet and increasing their amount of sleep time.

Recommended Follow-Up

If your CEWG identifies any and/or all five of these physical stressors as a significant problem, the following can be taken into consideration when devising a CEP. The number(s) following each recommendation correspond to where they can be found in the original Guide for Maritime Operations, where they are described in more detail.

Diet Recommendations:

- Consume a balanced diet¹ of lean proteins, whole, fresh fruits and vegetables, whole-grain carbohydrates, and moderate to low amounts of mono- and poly-unsaturated fats. (35, 42)
- Consume the heaviest meal after waking up from the longest sleep of the day. (42)

¹ In addition to the original guide, extensive information on a balanced diet can also be found in this addendum on pages A13-A15, and in the Dietary Guidelines for Americans 2005 (published by the Department of Health and Human Services and the Department of Agriculture), found at <http://www.healthierus.gov/dietaryguidelines/>

- Eat smaller, lighter meals within four hours of the sleep period, and refrain from eating right before sleeping. Provide nighttime personnel with appropriate meal choices to accommodate this recommendation. (43, 45)
- Adjust meal times so that midnight watch personnel can eat a brunch upon waking, including brewed coffee and breakfast foods, if desired. (45)
- Adapt the mess services to accommodate crewmember needs. This supports both safety *and* morale. (45)
- Modify the daily menu so that meals are balanced. (62)
- Provide a variety of nonalcoholic drinks, and avoid the use of highly sweetened soft drinks. Promote fresh water and fresh fruit or vegetable juices as thirst-quenchers of choice. (62)
- Drink water on a regular schedule, even when not thirsty. Drink *at least* eight, 8-ounce glasses of water per day. This amount will increase depending on your levels of physical activity, perspiration, and work environment. (55)
- Drink extra water when sweating heavily, or if urination becomes less frequent or darker than usual. (55)
- If not obtained through regular salt consumption, replace electrolytes with fruit juices, V-8 juice, bananas, or commercial sports drinks. (55)

Caffeine, Sleep Aids, Alcohol, and Over-the-Counter Drugs:

- Be aware that common sources of caffeine include coffee, tea, chocolate, soft drinks, and medications. (63)
- Use caffeine to boost alertness only when necessary. Crewmembers addicted to caffeine should discontinue use and undergo withdrawal. If withdrawal is not desirable, encourage the crewmember to start by cutting back by one beverage per day. (63)
- If caffeine is needed to maintain alertness during daytime hours, a physician should be consulted to evaluate the possibility of a sleep disorder. (63)

- Avoid all use of caffeine four hours before bedtime. (63, A-5)
- Discourage the use of alcohol and sleeping pills. Instead, attempt to promote better sleep by providing better conditions for sleep. (A-5)
- If the use of over-the-counter medication is required, educate users of possible side effects and encourage them to consult with a doctor. (A-6)
- Captains, department heads, or mates should be warned of crewmembers on medication, especially when their performance will likely be degraded as a side effect.

Workload:

- Train employees to implement time management strategies. (61)
- Implement a nap policy during long work days. (62)
- Carefully consider task design according to the workload and personnel available. (59)
- Allow rest breaks appropriate to tasks.
- Alternate engaging work with monotonous work.
- Provide consistent mental and physical health counseling. (62)

Exercise:

- Train employees to implement a regular exercise program. (61)
- Make a variety of exercise equipment available to crewmembers. (61)
- Allow crewmembers to have their own exercise equipment. (61)
- Provide consistent physical health counseling. (62)
- Finish physical training no later than one hour before bedtime. (A-5)

Read More About It Here:

In the original Guide for Maritime Operations:

- Section IV, “Controlling Stressors,” pages 57-63.

In the source documents for background material:

- Most sections have a corresponding bibliography in Appendix D.

On the CEMS website at <http://www.uscg.mil/hq/g-m/cems/index.htm>:

- CEMS Newsletters: Vol. II, Issues 1 and 2.

A-3: Environmental Stressors

External Environment

***Refer to this information when considering question #13
of the Decision Support Software:
“How many days per week do you experience excessive
exposure to extreme environmental conditions”?***

All mariners are occasionally exposed to extreme environments. The same vessel may operate in extreme climates. Very cold weather conditions may put the crew at risk of hypothermia; very hot conditions may put them at risk of heat illnesses, such as heat exhaustion. However, even when the exposure to extreme is not severe enough to induce illness, extreme temperature conditions can sap a crew's energy and endurance. Depending upon the types of waters in which they operate, the operators of vessels can also be exposed to heavy seas and ship motions. Some crew, particularly those working in machinery spaces, may be subjected to extreme noises or vibrations. Excessive exposure to such environments affects crew endurance.

Cold weather is known to affect human performance. The U.S. Army has found that exposure to cold weather has detrimental effects on cognitive ability. The combined effect of a lowered core body temperature and dehydration contribute to reduced cognitive ability. People exposed to cold weather over a period of time are also inclined to be in a bad mood or unhappy, and try to cope by thinking about other times and places, causing a loss of situational awareness. Between the reduced cognitive ability and distracting elements, cold weather is a performance safety risk that should be guarded against.

The effects of cold weather grow with extended exposure, even to the point of hypothermia. Hypothermia is an illness that results from a lowered core

body temperature. Chronic hypothermia occurs over a long period of time, lasting six hours or longer, and is a consequence of not wearing sufficient clothing to stay warm. Very early in the process of cooling, an individual with hypothermia will experience impaired judgment due to mental incapacity. Specific mild conditions that are still cool enough to induce hypothermia include a combination of wind blowing on exposed skin, temperatures above freezing, and moisture.

For vessel crews, that last condition is the most important. Rain, snow, or spray from the water lands on a person and evaporates. The evaporation uses body heat for vaporization, consequently lowering a person's body temperature. When people get their clothes wet, they lose body heat 25-30 times faster than if they were dry. If there is wind or a breeze, cooling is faster. At that point, chronic hypothermia may set in. Beyond affecting an individual's ability to work, if not treated immediately, hypothermia can lead to death.

Heat illnesses are most often caused by lack of preparation, working in the heat, and not being acclimatized. The effects of heat usually start in the form of dehydration. Dehydration occurs when a person does not drink sufficient fluids to replace those lost through perspiration. Eventually, the body will overheat because there is insufficient water for cooling. This may lead to heat exhaustion, but, at the very least, it will affect the person's physical and mental performance.

Heat exhaustion occurs when the environment and activity level overwhelm the body's adaptive responses. When this happens, an individual's muscular endurance is reduced, and the metabolism starts to burn carbohydrates, which will only provide energy for a few hours. The end result is that the individual will become weak, fatigued, dizzy, exhausted, and/or confused. This causes fatigue-induced poor decision-making.

Motion sickness, or seasickness, is considered a risk factor because it impairs performance, and many medicines to treat it also impair performance. Seasickness is caused by a conflict between the eyes, perceiving that the person is stationary, and the body, feeling motion.

A person who is fatigued is more vulnerable to motion sickness than other people, which is yet another reason why adequate sleep is important. If a person is not already fatigued, seasickness may *cause* fatigue, as well as

symptoms such as feeling like vomiting, feeling dizzy, experiencing visual problems including impaired night vision, and experiencing memory problems.

Seasickness will also have a direct impact on performance. Many crew members take over-the-counter or prescription medicines to prevent seasickness. The problem with taking the medications is that while they may eliminate nausea, they also cause drowsiness, so they do not eliminate the danger that a crewmember or operator may fall asleep or become unaware at the wheel. In fact, the danger of drowsiness is so strong that the FDA advises using caution when taking motion sickness drugs and operating a vehicle.

Coaches are taught about how seasickness medicines may make the crew drowsy. In addition, CEMS informs its coaches that all crewmembers taking seasickness medicines should consult a doctor, and know their side effects before taking it aboard their vessels.

Extreme noise and vibration also have serious effects on crew performance. In 1990, the Department of Transportation Maritime Administration discovered that in a study in which long-distance driving was simulated, people experiencing high levels of noise for four hours performed significantly worse in a simulated emergency situation than people who were not subject to high noise levels. Studies have also shown that whole-body vibration can affect human performance by blurring vision, causing misinterpretation of a situation, fatigue, and accident-prone behavior. Whole-body vibration also compromises alertness of someone operating equipment, especially during a long work shift. Extreme noise and vibration are risk factors because they reduce an operator's situational awareness and ability to prevent accidents.

When an employee works amidst conditions where there are physical stressors such as noise, vibration, ship motions, and extreme temperatures, tolerance for other stressors decrease, as does motivation. This is another reason why these environmental stressors are considered risk factors.

Recommended Follow-Up

If your CEWG identifies environmental stressors as a significant problem, the following can be taken into consideration when devising a CEP. The number(s) following each recommendation correspond to where they can be found in the original Guide for Maritime Operations, where they are described in more detail.

Extremely Cold Climates:

- Be aware that hypothermia due to immersion in cold water takes place much more rapidly than after simply being exposed to cold air. (50)
- Be aware that frostbite occurs at 30° F. (50)
- Provide bed rest and medical attention after first aid. (50)
- Train crewmembers to wear three-layered, warm clothing made of appropriate materials. (51)
- Bring a change of clothing on your shift in case it becomes necessary to change. Before changing into them, take a hot shower. (52)
- Keep the hands, feet, and face covered and warm. Fingers and hands cannot function properly below 59° F. (51, 52)
- Keep the head covered at all times. (52)
- Keep feet well-insulated from cold and dampness using layered socks and insulated boots. (52)
- Keep garments clean, as soiled clothing loses its insulating properties. (52)
- Drink plenty of water and maintain electrolyte balance. (52)
- Provide crewmembers with a heated shelter, local radiant heaters, and/or thermal insulating materials placed over tool handles at environmental temperatures below 30° F. (52)

- Reduce the working pace and allow extra breaks in cold environments, for deck personnel in particular. (52)
- Educate crewmembers on how to endure cold-related risk factors. (52)

Extremely Warm Climates:

- Be aware of the signs of heat stroke, heat exhaustion, heat cramps, heat rash, heat syncope, and heat fatigue, so that prompt action can be initiated. (53, 54)
- Acclimatize crewmembers for work in the heat by having them work for 60-90 minutes each day within the work environment. (55)
- Avoid requiring work when the ambient temperature is 104° F or above. (55)
- Drink water on a regular schedule, even when not thirsty. Drink *at least* eight, 8-ounce glasses of water per day. This amount will increase depending on your levels of physical activity, perspiration, and work environment. (55)
- Drink extra water when sweating heavily, or if urination becomes less frequent or darker than usual. (55)
- If not obtained through regular salt consumption, replace electrolytes with fruit juices, V-8 juice, bananas, or commercial sports drinks. (55)
- Wear loose-fitting clothes that are light in color. (55)
- Seek well-ventilated places. (55)
- Avoid the use of alcohol or other drugs that can impair body temperature regulation, such as melatonin, aspirin, and acetaminophen. (55)

Extreme Noise and/or Vibration:

- Use the American Bureau of Shipping (ABS)'s and the International Maritime Organization (IMO)'s adopted vessel noise standards as guidelines for your own:
 - ABS – 50 db(A) for cabins, staterooms, berthing, medical, dental, first aid, and sanitation spaces; 55 db(A) for dining spaces and most work spaces¹
 - IMO – 60 db(A) for cabins and hospitals; 65 db(A) for mess rooms, recreation rooms, and offices²
- Use the ABS and Department of Defense (DOD)'s vibration standard recommendations as guidelines for your own:
 - ABS and DOD – .5-80 Hz^{3 4}
- Make sleep accommodations the first priority in retro-fitting and new vessel construction.
- Maximize distances and provide buffer spaces between sleeping and machinery spaces.
- Provide room isolation.
- Build resilient mounting of vibrating machinery.
- Build an effective noise barrier around high-noise spaces.
- Use silencers or attenuators on air intake and exhaust.
- Apply sound absorption treatment of accommodation spaces.
- Use low-noise components.

¹ ABS *Guide for Crew Habitability on Ships*, December 2001.

² IMO Resolution A.468 (XII), Chapter 4, adopted November 1981.

³ ABS *Guide for Crew Habitability on Ships*, December 2001.

⁴ Department of Defense Design Standard Criteria: Human Engineering, publication number MIL-STD-1472F.

Motion Sickness:

- If the use of medication is required, educate the user of its possible side effects. (58)
- If possible, avoid assigning seasick crewmembers shipboard work environments. (58)
- Have a medical officer closely supervise crewmembers using medications for motion sickness; do not allow self-administration. (58)
- Captains, department heads, or mates should be warned of crewmembers on motion sickness medication, since their performance will likely be degraded as a side effect. (58)

Read More About It Here:

In the original Guide for Maritime Operations:

- Section IV, “Controlling Stressors,” pages 50-58.

In the source documents for background material:

- Most sections have a corresponding bibliography in Appendix D.

A-4: Personal Stressors

Work-Related Stress and Lack of Control

Refer to this information when considering questions #10 and #12 of the Decision Support Software:

***“How many days per week do you experience high work stress?”
and “How many days per week do you experience lack of control over your work environment or decisions?”***

Work stress is influenced by many characteristics of the work environment. These characteristics include management style, the balance of employee task control against demands of the job, noise and extreme temperatures, isolation, and sustained mental or physical workload.

Stress is a risk factor because it depletes vitamins B and C, which causes a person to be less alert, fatigued, slower to react, slower to think, confused, and unable to concentrate. These symptoms are conditions that impair decision-making and may cause accidents. Therefore, stress creates risk.

Work environment and stress are, to some degree, controlled by the company's culture and a captain's management style. Rigid work practices and tyrannical supervisors induce stress by abusing power, withholding support, and being strict without being open to employee input. Among surveyed stressed employees, some of the most common sources of work-related stress were inadequate supervisor support, ineffective supervisor performance, and ambiguity about what's expected.

Social isolation is another stress factor that affects fatigue. In a situation where employees have the support of their colleagues, they are able to handle stress more easily, and may receive help when overwhelmed. Social support has also been shown to reduce vulnerability to colds by reducing stress hormone release, reducing the sensation of pain, and helping to keep the cardiovascular rate down during stressful situations. A

lack of this support would create additional stress and reduce productivity. A lack of social support would deprive crewmembers of the health-saving benefits of lower heart rates and stronger immunity against colds, and would also deprive them of possible task support.

Research indicates that employees may also become stressed out at work if they have little or no control over accomplishing their tasks. The stress is even worse if the job is very demanding. This is because stress is the mind's way of reacting to an alarming situation, such as an excessive workload. When the brain finds a resolution, it wants to act on that resolution, and not be constrained on how to do it. When there is constraint, there is a certain amount of panic, and logical thinking is cut off. Shift work, such as watch shifts on vessels, is associated with decreased decision latitude and more stress in general. Because vessel work schedules exist in shifts, the crewmembers are likely to be at risk for stress. This risk factor occurs often, but countermeasures can be used to help the crew.

Family Stress and Isolation From Family

***Refer to this information when considering questions #14 and #15 of the Decision Support Software:
“How many days per week do you experience family stress?” and
“How many days per week do you experience isolation from your family?”***

Stress arising from family life is just as distracting and likely to cause fatigue as work-related stress. Being a mariner inherently means traveling and being away from home for extended periods of time. This lifestyle imposes serious strain on crewmembers and their families. Loneliness, isolation, family conflict, and concern about family members provide enough stress to tire and distract any member of a ship's company. That is why family stress and family isolation are considered risk factors.

In 2000, 32% of men and 42% of women said that their paid work was interfering with their family life. Families provide a source of intimacy, support, continuity, satisfaction, and pride. Vessel crewmembers who

leave their homes for extended periods of time miss out on these benefits. In a recent study, families that had a husband with irregular work hours and work during weekends experienced more strain than families with a father who worked during weekdays. Long work hours are also associated with more conflict between work needs and family needs. This conflict is even worse when a spouse must travel for his job. In one report, many men spoke about leaving their work to spend more time with their family, or they regretted the choice of taking a job that took them away from home, because they missed watching their children mature.

Another problem occurs when the absences and re-appearances of a traveling spouse are disruptive to the family, because the family dynamics change as the traveler comes and goes. With each departure and arrival, the family members' perceptions of their roles and household rules change, and this creates family stress. Other problems that arise from the ebb and flow of a traveling spouse are the conflicts that may arise when the spouses don't plan together. If a maritime traveler has made plans without consulting with the spouse, or vice versa, there are likely to be problems at home.

More lengthy problems occur over concern about the family members and the impact the traveler's absence has on the family. While travel is a fact of life, it also makes each spouse feel lonely, because the benefit of mutual support is lost. In some at-home spouses, the feeling is so acute that they become depressed and seek counseling. In fact, spouses of business travelers file more claims for psychological treatment than spouses of non-travelers. Traveling spouses tend to be aware of how the travel affects the at-home spouse. The traveling spouse feels guilty knowing that the at-home spouse feels lonely, misses the traveler, resents running the house alone, and worries about the traveler's safety.

When the couple has children, both spouses worry about how the children are coping. Children tend to miss the traveling parent acutely, and feel vulnerable because the traveling parent is always leaving. They also miss going through their routine with the traveling parent, and they are uneasy because of the unpredictability and uncertainty of a traveling parent's schedule. This maladjustment is expressed through frequent crying, nervousness, clinginess, troubled sleep, argumentative and defiant behavior, and fear and concern over when the traveling parent will return. The traveling parents also feel guilty because they feel they are abandoning their children. This will add to stress amongst the crew on a

vessel. Another problem is finding care for dependants. Even if spouses at home don't work, they still have to run the household, sometimes requiring dependant care. The logistics of ensuring dependant care around-the-clock are difficult, because the care is not always available or affordable.

Another problem with job-related travel is the interference it has with the traveling spouse's ability to help manage the household. If the traveling spouse has any responsibilities that are important to the survival of the family, such as paying the bills, then the departure creates a highly stressful situation. The stress heightens if something goes wrong with anything the traveling spouse is responsible for.

Finally, the return home is often rocky. The family needs to readjust to the traveling spouse's arrival, providing the returning parent with a role in the family and adjusting the at-home parents' role. The traveling parent also needs to renew bonds in his or her relationship with the spouse and children. Knowing this, he or she may be tense about the long absence and return home. During the first few days of the return, the family may want the traveler's attention, while the traveler needs to rest, creating a conflict of needs. Some at-home spouses become difficult with the traveling spouse because they are generally angry, feeling that their needs aren't met. On top of this, the traveling spouse often returns home to a heavy workload of household chores to be done. Those stressful factors, if considered alone and not in conjunction with the joy of seeing loved ones again, can make the traveler stressed about his or her home life. If traveling spouses feel that they are not meeting their families' needs, they may also feel depressed and distressed.

Some traveling spouses lack the knowledge and skill to survive a marriage. For them, traveling may be an excuse to escape family problems. They may choose to be distracted from home life by their work. However, the problems do not go away. They linger on, and get worse from not being dealt with.

For those whose marriages don't survive the stress of travel, divorce is ranked as a top life-stressful event, and heightens work stress. If not kept in check, divorce can take a toll on an employee's health.

The death of a loved one will also cause fatigue. In feeling grief, an individual may experience decreased concentration, sleep deprivation, dehydration, increased distractibility, mental fatigue, and memory loss. All

of these effects will detract from alertness and performance. In fact, many mourners are vulnerable to crises such as accidents.

Stress is clearly a fatigue risk factor. It diminishes the body's defenses against disease and may tire people so they won't engage in healthy habits. One study found that drivers who experienced stressful life events such as personal conflicts, financial difficulties, illness, or bereavement were five times more likely to cause fatal accidents than drivers not subjected to stress.

A commonly recommended measure to reduce family stress is the use of cell phones and e-mail to permit family contact. Research shows that supervisors who are not understanding of family problems contribute to health risk, conflict, and stress, thus draining endurance from crewmembers. By providing adequate family phone time, the company and captain are enabling all family crewmembers to reduce family stress. The time in touch with their family will give them time to plan and reconnect with the family.

Recommended Follow-Up

If your CEWG identifies either or both of these personal stressors as a significant problem, the following can be taken into consideration when devising a CEP. The number(s) following each recommendation correspond to where they can be found in the original Guide for Maritime Operations, where they are described in more detail.

Personal Stressors:

- Make cell phone time available (a common amount is 30 minutes weekly) to all crewmembers. (61)
- Provide shipboard phone use and Internet and e-mail access. (61)
- Implement a consistent stress management program. (61)
- Use relaxation methods to reduce stress at the individual level. (35)
- Train employees, especially those new to their job situation, to implement time-management strategies, a regular exercise program, and relaxation exercises. (61)

- Promote crew participation in problem-solving using a team approach. (61)
- Identify and reduce stressful factors, particularly those involving interpersonal relationships. (61)
- Maintain good communication with crewmembers. (61)
- Provide access to stress-reducing activities, such as implementing nap policies, providing satellite television, and providing consistent mental and physical health counseling. (61, 62)
- Please also review recommendations for physical stressors, as these elements also affect one's stress levels.

Read More About It Here:

In the original Guide for Maritime Operations:

- Section IV, "Controlling Stressors," pages 59-62.

In the source documents for background material:

- Most sections have a corresponding bibliography in Appendix D.

On the CEMS website at <http://www.uscg.mil/hq/g-m/cems/index.htm>:

- CEMS Newsletters: Vol. II, Issue 3.

Appendix B

Light Management

B-1: Light Management

To understand light management, it is important to understand the Red Zone of Human Performance, or the natural nighttime period of lowest energy and performance. The original Guide for Maritime Operations covered the Red Zone and light management on pages 31-46. “Synchronization With Circadian Rhythms” on pages A6-A7 of Appendix A supplements this information. It is highly recommended to send a representative to Coaches Training before setting out to implement light management. The basic principles and recommendations summarized here supplement, but do not replace, the training received at Coaches Training.

How Light Affects Endurance

Our natural circadian rhythms vary in a predictable pattern over the course of each 24-hour period, peaking during daylight hours, and bottoming out during dark nighttime hours. This “Red Zone,” when our mental energy and performance are at their all-time lows, usually lasts from 2100 hours until 0700 hours, with the most critical period spanning from 0300 to sunrise. Because it comes naturally, crewmembers working days and sleeping at night usually don’t have to worry about falling asleep and waking at the proper times.

Switching to a night schedule, however, can be problematic for day-oriented crewmembers. First of all, their performance would suffer because they would be going to work right at the beginning of their Red Zone. To make matters worse, they often work in dimly-lit environments during most of their shift, when they ideally should be getting periods of bright white light (1000 lux) exposure. Light of such intensity suppresses sleep-inducing melatonin, which is produced during the Red Zone for day-oriented individuals. Finally, the end of a night shift usually coincides with sunrise, sending bright-light “wake up” signals to workers heading to bed, making it difficult for them to fall asleep.

How Light Management Can Help

At its most basic, light management is about using light inputs to keep the body awake and alert during watch, and avoiding the same inputs to help it fall asleep afterwards.

To Stay Awake While on Watch:

- If not already working in regular daylight, crewmembers should get exposure to bright lights. This exposure should be 1000 lux¹, or greater, as measured by a light meter at eye level. Ideally, crew members should expose themselves to this light for as long as possible, up until three hours before their normal sleep period.
- Though best results can be obtained by receiving as much exposure as possible during the duration of the work period (conducting normal activities), adequate results may be obtained from exposure times as short as 10-15 minutes per hour. Though longer exposure will be more effective, these short exposures are usually sufficient to alert the body that it is “daytime” by suppressing melatonin.
- Do not stare directly into the light sources.
- Light management will be less effective if practiced in isolation; it should be done in concert with other aspects of a CEMS program. It will also help if you get enough quality sleep, eat the heaviest meal of the day upon waking, exercise before your shift begins, if possible, and keep your diet full of lean protein sources and vegetables while avoiding sugar, white flour, and fatty foods. Avoid eating turkey or dairy products on watch, as they may induce sleep.

¹ Or, alternatively, 300 lux of monochromatic green light, if installed. See “*What about ‘green light’?*” on page B6.

***How do you measure lux?
Is it related to watts or volts?***

Lux is a unit of measurement for light intensity. It does not have an equivalency to the wattage or voltage of a lighting fixture. The only way to be sure of a light level (intensity) is to measure with a light meter at the most frequent position of the eyes in that space.

To Fall Asleep After Watch:

- Light management is also about *limiting* light exposure during periods of sleep/rest. Minimize exposure to daylight/bright white light **three hours before** the end of your pre-sleep watch so that melatonin can be released and start inducing sleep as you get off watch. This may entail dimming lights, avoiding outdoor sunlight, or wearing dark, wraparound sunglasses so that the bright light does not “wake you up.” This is especially the case if the crewmember’s watch ends near or after sunrise.
- You will also fall asleep faster if you eat only small, light meals four hours before going to bed. Sleep-inducing foods such as turkey and dairy products may be eaten at this time. Avoid caffeine three hours before retiring, and avoid exercise one hour before retiring so as not to stimulate the body.
- Finally, proper environmental conditions will help you fall asleep faster. Besides having a comfortable sleep surface, room temperature, and noise and vibration levels, those sleeping during the day will especially need to lightproof their sleeping quarters. This may involve tinting windows, installing shutters, or any other method that will prevent sunlight and bright artificial light from penetrating into the room.

What about “green light”?

There are many instances in the marine environment where bright white light just won't cut it. Mariners need their night vision if standing watch in the pilothouse, and bright lights can be disturbing below decks after hours. This is where green light may be a viable alternative. As studies have shown, monochromatic green lights affect the body clock in similar ways that bright white light (or sunlight) does, but at potentially lower intensities, or brightness. Since the lights are of a lower intensity, night vision can be recovered more quickly than if exposed to white light.

Green light is just one more tool we have to change our circadian rhythms. It acts just like bright white light and sunlight on our brains. It is a "nice to do" for CEM, but not a "need to do." In other words, if monochromatic green light is a part of the Crew Endurance Plan the Working Group suggests and is feasible for your vessel to purchase, go ahead! However, green light is not necessary to implement CEMS. You can still create adequate stimuli to your body clock through the effective use of bright white light.

Keep in mind that, if you *do* decide green light will be part of your Crew Endurance Plan, that any old green light bulb or filter will not do. Studies conducted by the USCG Research and Development Center have determined that *it must be monochromatic green light of a specific frequency and intensity* to affect the body clock.

Installation of green lights should only be undertaken with the assistance of qualified professionals familiar with proper placement of the lights so as to minimize glare or other visual obstructions. Proper placement of the lights is also necessary to ensure effective shifting of the biological clock.

CEM Coaches are trained in how to use a light meter to measure whether light is bright enough to delay sleepiness. Research continues on what frequency and intensity is most effective. Natural sunlight is the best. However, a general rule of thumb is to consider 300 lux of green light equivalent to 1000 lux of white light in terms of its effect upon the biological clock.

Using Light Management to Shift the Red Zone

The only way to fully adapt to night watch schedules is to reset the biological clock so that energy peaks during nighttime. Once adjusted, these workers can use the tips on pages A10-A12 to make the most of their endurance at these times.

But how *do* you reset that clock? Nightshift workers can use light to shift their body clocks so that the Red Zone occurs later in the morning, when they are sleeping.¹ It takes about one day to shift the Red Zone one hour. Therefore depending on how much you need to shift your Red Zone, it may take between 3 and 6 days to become fully adapted to a nighttime schedule.

For example, let's say a crewmember needs to switch his 8-4 work shift from 0600-1400 to 2200-0600. On day one, instead of going to bed at 2100 hours as usual, he could stay up two hours later, retiring at 2300 and staying asleep until 0700 (making sure that the morning sun won't come into his room to wake him). He would also need to block out daylight for some time after waking to effectively delay sunrise even further. This facilitates a further delay of his Red Zone. He would then go about his day, getting the proper amounts of light input (sunlight and bright, greater-than-1000-lux white light) while he's working, and extending his light inputs beyond his normal retiring time as he prepares to go to sleep later each night. This incremental change would ready his body for taking the process a step further.

On day two, this worker would continue this process of artificially extending sunset with bright white light (up to three hours before retiring) and delaying sunrise using light blocking. He would be alert later at night, thanks to his shifted circadian rhythm. He could stay up an additional hour, going to bed at 2400, and waking up at 0800, then going about his day again.

In the same manner, days 3-6 might look like this:

Day	Sleep Time	Wake Time
3	0200	1000
4	0300	1100
5	0500	1300
6	0600	1400

¹ For diagrams showing the process of shifting the Red Zone, please see Figures 7 and 8 in the original Guide for Maritime Operations, on pages 40-41.

As you can see, he shifted his circadian rhythm until the timing allowed him to go to sleep right after his night watch.

Again, it is important to note that this Red Zone shift will only occur if *other* endurance risk factors are being managed. In the case of light management's role here, crewmembers will make a better adjustment if they get bright light exposure when they are supposed to be awake, avoid such exposure three hours before attempting to sleep, and going to sleep in a dark, comfortable, quiet environment.

How does a typical vessel crew perform light management?

Light management is complex and must be tailored to a specific vessel's circumstances and schedule. That's why we include it as part of the two-day Crew Endurance Coaches Training. In this way, CEM Coaches are able to assist crewmembers and their vessels with designing customary light management plans.

Understanding light management is critical to your success with Crew Endurance Management and requires you to understand *when* to time your light exposure, given your particular watch schedule. While it takes training and experience to fully understand the science of light management, the Crew Endurance Guide (pages 39-46) and these recommendations are a good start.

Light Management Considerations for Coaches:

- To keep working crewmembers alert, make sure they get proper exposure to bright white light (1000 lux) or monochromatic green light if they work in a dim environment or at night.¹

¹ Proper exposure is detailed in this section under "How Light Management Can Help" on pages B4-B6.

- Consider where such lights would best be stationed so that crewmembers could easily obtain their benefits – on the mess deck? In the stateroom? In the work environment itself? Will such lights interfere with night vision or other job requirements?
- Consider different lighting policies for different times – a rec room might need bright light in the day, but dimmer light three hours before bedtime, so as to induce melatonin production and sleepiness in its users.
- Once a person has adapted to their new night schedule, be sure to continue using light management. Once you get there, you don't stop!
- Remember, the body clock can only change one hour per day in either direction. Therefore, if you're adapted to a night watch, and for some reason due to operations, miss your light management schedule, all is not lost. Your body clock will only shift back one hour, and if you get back on schedule the next day, you'll be fine. CEMS is not about doing all the right things all of the time, but rather trying to do the best thing most of the time!
- Remember your day workers – light management can be effective for them, too! Three hours prior to their longest sleep period, they should avoid bright light, if possible, and then, upon waking, they should expose themselves to bright light as soon as possible to simulate sunrise.
- Consider different watch schedules for different weeks/seasons. For example, a watch schedule adjusted according to that month's usual sunrise and sunset could allow night workers to end their shifts just before the sun comes up, making it easier for them to head back to their rooms in the dark and fall asleep. For example, rather than a watch schedule following the times of 2400-0600-1200-1800, rotate it back one hour to 2300-0500-1100-1700 so that the person

getting off watch in the morning is not exposed to sunrise and bright light.

- To help crewmembers fall asleep, consider the best ways to help them avoid bright light or daylight in different areas of the vessel. Can night workers appropriately finish their work shifts in dimmer light? Can they use dark, wraparound sunglasses before heading back to their rooms to sleep? Are sleeping quarters and passageways dark enough so as not to stimulate crewmembers going off-watch?
- Consider policies that will allow crewmembers to make the best use of their work and sleep times. For example, allowing night shift crewmembers proper food offerings out-of-schedule will allow them to eat light meals before bedtime. This would also mean that they wouldn't have to wait until after their shift to eat breakfast with the day crew, and they wouldn't have to share a brightly-lit mess hall that would stimulate them before sleeping. Out-of-schedule showers would also allow a night shift worker to head to bed right after the night watch ends, avoiding bright light and noisy stimuli from day shift workers getting up for the day.

What do you mean by “dimmer” light?

When you do not wish to be stimulated by bright white light, you should instead surround yourself with light dimmer than 1000 lux, or dimmer than 300 lux of monochromatic green light.

To take such light measurements, you should use a light meter, as well as common sense, to determine what light levels are operationally safe, yet do not overstimulate the biological clock at inappropriate times.

Lessons Learned From CEMS Practitioners:

In the Coast Guard's Crew Endurance Management Demonstration Project, participating companies worked through the CEMS process and periodically reported on implementation progress and change in level of endurance-related risks. One finding was that older boats

reported they had difficulty getting their lighting circuits up to 1000 lux, but most boats were able to get the public space bright enough by simply re-lamping. Several boats used wraparound sunglasses to block out light input. To dim the lights, rheostats needed to be installed, which proved to be somewhat difficult, as dimmers for fluorescent fixtures require different types of lamp ballast. In addition, care needed to be taken not to ground any of the lighting circuits.

Some of the U.S. Coast Guard's large cutters went to a 100% green light circuit on their mess deck. In addition, by switching over to green lights, all of the ongoing watch was "captured" for at least some proper light exposure prior to taking the watch.

Do I have to have "perfect" light management in place before I can move to the next phase in CEMS ?

Because of human physiology, it is critical to adhere to proper light management practices to ensure that the "Red Zone" occurs when a crewmember is off-watch and resting. However, the operations of the vessel may occasionally interrupt this effort. So long as the vessel and crew make a good-faith effort to adhere to proper light management, they should be able to take the next steps as soon as they believe they are ready.

Appendix C

Schedule Changes

C-1: Schedule Changes

The original CEMS Guide covered elements of schedule changes. You can review concepts on pages 37-39, 43-46, and A15-A19 of the Guide. Please continue below for more recent material on the topic.

***The CEM process says we can't make changes to the watch schedule until the last step, but we're ready to change now!
Why can't we?***

In order for watch schedule changes to be effective and successful, crewmembers need to have a thorough understanding of their behavioral choices and lifestyles that contribute to its success. Organizational policies need to support the many dimensions of successful scheduling. It's also crucial for a coach to be present on the vessel to assist with the mechanics of the schedule and troubleshoot individuals' difficulties in following it. It's for these reasons that education, environmental changes, and light management precede schedule changes in the CEM System. Imagine bypassing these first steps and going straight to the watch schedule change: no one would know why the change was done in the first place, crewmembers would still be working at night while their biological clocks tell them to be asleep, and people might still be using caffeine at the wrong time. The negative possibilities are endless. As you can see, without getting the CEMS machinery working right from the beginning, changing watch schedules first will lead to failed implementation.

What watch schedule will I have to use?

There is no universally prescribed watch schedule to use. The schedule you choose to use is the one that your Working Group determines will most effectively address the endurance risk factors

you've identified. When deciding on a watch schedule, it's important to balance the needs and concerns of your crew and operation with the physiology of the human body. Remember, sleep research indicates that the average human needs 7-8 hours of uninterrupted, quality sleep to adequately recover, both mentally and physically. After you consider your current schedule, you'll need to decide if your crew needs to change it, how they will change it, and, finally, what watch schedule would be best for them to use. Look for the characteristics described below.

What to Look for in a Schedule

If your CEWG has put all other components of CEMS into play, the following can be taken into consideration when devising a CEP. The number(s) following each recommendation correspond to where they can be found in the original Guide for Maritime Operations, where they are described in more detail.

Supports Adequate Quantity and Quality of Sleep:

- Crewmembers should have enough time off to obtain 7-8 hours of uninterrupted sleep per 24-hour period. (35, 42, 43, A-10)
- When a schedule cannot accommodate 7-8 hours of sleep, crewmembers should have enough time off to obtain at least 6.5 hours of uninterrupted sleep, as well as a nap of no less than two hours, per 24-hour period. Also, allow 15 minutes between a nap and returning to work to avoid sleep inertia. (19, 42)
- Overtime should be scheduled to occur *after* wake-up time. Leisure activities should be scheduled in the evening hours. (46)
- Work and activities scheduled near sleeping quarters should be least disruptive when crewmembers may be sleeping.

Consistency:

- Crewmembers working at night should be able to maintain the same work-rest schedule for at least two continuous weeks. (19)
- Schedule rotations from day to night, or night to day, should be minimized in order to avoid circadian rhythm disruption. (19)

Supports Crewmember Health and Well-Being:

- Work periods should be no longer than eight continuous hours, particularly when prolonged exposures to extreme temperature or humidity levels are involved. In particular, avoid allowing personnel to work more than 12 hours in a 24-hour period. (38, 43, 45)
- When changing to a new work shift, allow crewmembers to gradually adjust times over a period of days for better performance. (38)
- Meal times and offerings support crewmembers' ability to eat the heaviest meal of the day upon waking from their longest sleep periods, and smaller meals before they go off watch.
- Scheduled meal times, other daily routines, and recreational activities consider the crewmembers using them to determine whether the atmosphere provided should be stimulating or relaxing.

Supports Light Management:

- Crewmembers coming on watch should receive exposure to daylight or a similar source of bright white light for at least 15 minutes per hour.
- Activities offered when crewmembers are settling down for sleep should be conducted in dim lighting, and support rest.
- Crewmembers coming off watch should either be able to retire to their sleeping quarters in a dark atmosphere, with the help of dark, wraparound sunglasses, or before the sun rises.

- If possible, consider different watch schedules for different weeks/seasons. For example, a watch schedule adjusted according to that month's usual sunrise and sunset could allow night workers to end their shifts just before the sun comes up, making it easier for them to head back to their rooms in the dark and fall asleep.

Pros and Cons of Traditional Watch Schedules for Two-Person Crews

Schedule	Description	Pros	Cons
6-6	Each person works 6 hours on watch followed by 6 hours off, with two watches per 24-hour period.	Traditional watch system for many two-person operations	Doesn't permit a sufficiently long sleep period
5-7	Each person works one 5-hour and one 7-hour watch, the longest watch occurring during the night. Each person also gets one 7- and one 5-hour rest period.	Increases time period available for sleep Longest sleep period at night	Longer 2 nd watch Person with day sleep period must shift Red Zone
8-4	Each person works one 4-hour and one 8-hour watch, the longest watch occurring at night. Each person also gets one 8- and one 4-hour rest period.	Allows for full -8 hours of sleep Reduces need for make-up sleep	Very long 2 nd watch Less personal time or opportunity for make-up sleep

Appendix D

Supporting Documents

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