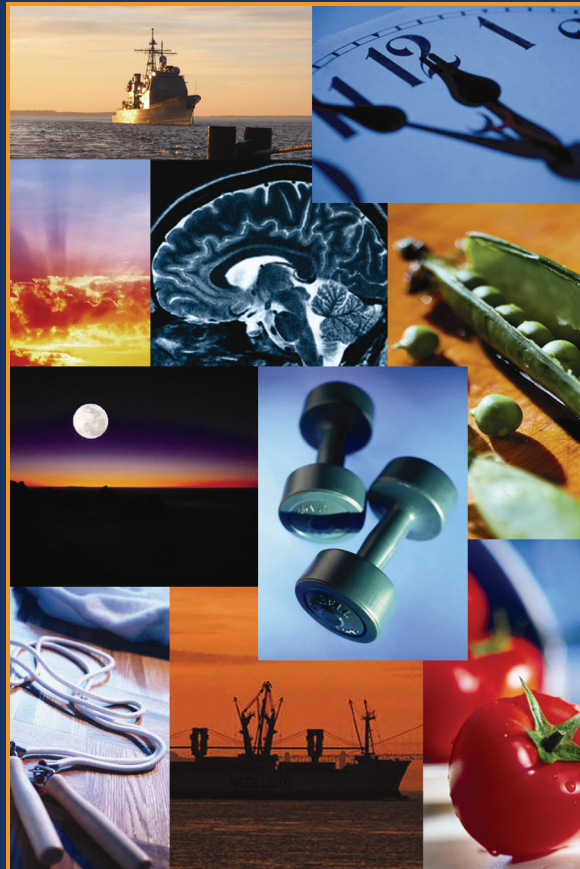




CREW ENDURANCE MANAGEMENT SYSTEM (CEMS)



Awareness Workbook

CREW ENDURANCE MANAGEMENT SYSTEM (CEMS)



AWARENESS WORKBOOK

This document was created and prepared by QSE Solutions for
Pacific Marine Towing Industry Partners



"Working Together to Ensure Competent & Qualified Mariners in the Pacific Marine Towing Industry"

Note to Crewmembers:

Please read this workbook carefully. When you are finished, complete the Review Exercise at the end of this workbook. When you have completed the test, give your answers to your CEM coach. Your answers will be graded and entered in your personnel file.

If you have any questions, please contact your vessel captain or CEM coach.

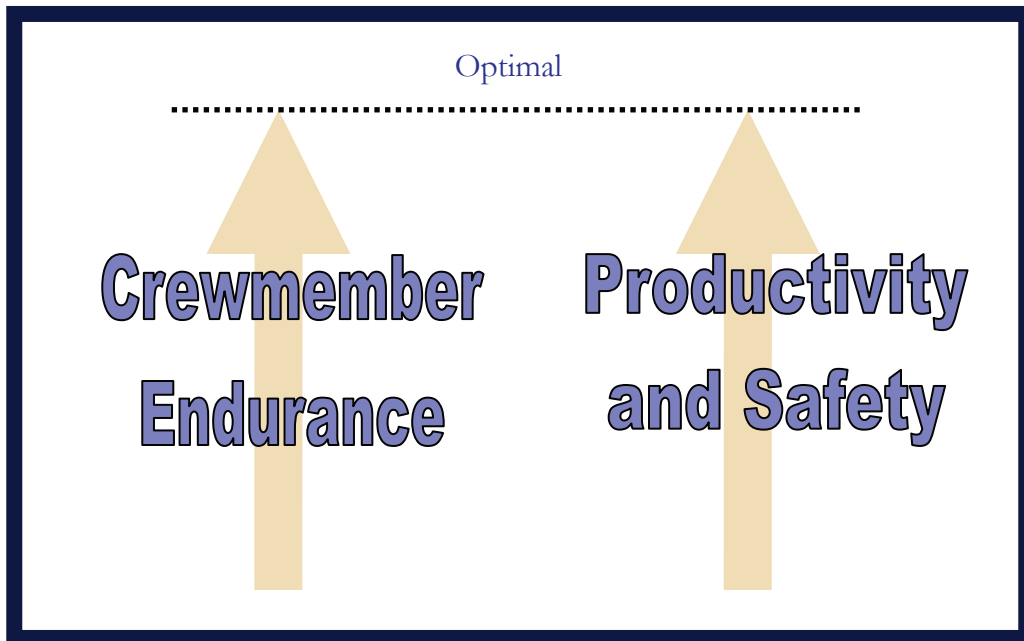


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Welcome

Welcome to Crew Endurance Management System (CEMS) training. The purpose of this workbook is to give you an overview of this system and provide tips on how you can improve your endurance at work and in your personal life.

Marine operations is a challenging industry. Crews are often assigned to jobs in which they are out to sea for days, weeks, or months. As a result, you're immersed in a non-stop environment—24 hours a day, seven days a week. You're also exposed to a variety of risk factors, such as irregular work schedules, heavy workloads, extreme temperatures, and separation from family and close friends. All of these factors can affect your productivity and safety.

CEMS was designed to help you with these challenges. It increases awareness of the factors that impact endurance and how you can notice the warning signs of fatigue. It also helps improve endurance by making simple adjustments to the vessel environment. You'll even improve your own endurance through lifestyle changes in diet and exercise.

If you have any questions or comments about the information in this workbook, please contact your vessel captain or CEM coach.





Introduction

What is CEMS?

The Crew Endurance Management System (CEMS) was developed by the U.S. Coast Guard (USCG). The USCG describes CEMS as “a system of proven practices for managing endurance risk factors that affect operational safety and crewmember efficiency in the maritime industry.” In other words, the system is designed to increase awareness about risk factors affecting endurance and, as a result, help improve conditions that affect endurance. It improves physical stamina and mental alertness.

CEMS focuses on the following issues that affect endurance:

- Awareness and education
- Lifestyle (diet and exercise)
- The vessel’s environment (noise levels, light exposure, air quality, and vessel movement and vibration)
- Company policies
- Watch schedules

Where does CEMS come from?

The system is a product of 25 years of scientific research on sleep. The system, which has been implemented and tested thoroughly by the U.S. Army Special Forces and the USCG Research and Development Center, is a proven method for managing the risk factors affecting endurance. In addition, the system has been implemented at a variety of marine companies since the turn of the millennium.

Although no system can guarantee the elimination of fatigue, the CEMS program is designed to ensure that crew endurance is improved as much as possible based on each vessel’s operating conditions.



How does CEMS affect me?

CEMS is a voluntary program. As part of a CEMS program, your employer should train all of its vessel crews on the system. Vessel crews are expected to follow the guidelines of the program established by the company as well.

To assist in the process, each company has a CEM coach. Your captain has also been trained in the CEMS process. So if you have any questions or concerns, you always have a place to go for answers.





What is endurance?

There are two types of endurance from a marine operations perspective:

1. Vessel endurance, which refers to the length of time a vessel can support operations underway without being replenished or maintained.
2. Crew endurance, which is the ability of a crew to maintain performance within safety limits while coping with job-related challenges. These challenges include environmental, operational, physiological, and psychological factors. Those challenges are also known as *risk factors* or *performance stressors*. These risk factors are described further in the next section.

Risk Factors Affecting Endurance

Four main factors affect a crew's endurance level:

1. Environmental
2. Operational
3. Physiological
4. Psychological

Each of these factors is explained in more detail below.

Environmental Factors

Any external aspects of crew members' surroundings that affect performance are considered environmental factors. These include:

- Light intensity
- Noise
- Weather conditions (temperature extremes, humidity, wind, and changes in weather)
- Sea state (tides, currents, and high and low water)
- Vessel motion and vibration



Operational Factors

These factors refer to the effects of the company's and vessel's policies upon the crew. Examples are:

- Downtime
- Workload surges
- Routine vs. dynamic schedules
- Courtesy to crew sleeping off-watch
- Napping
- Vessel maneuvering
- Alternate meal and/or shower times

Risk Factors that Affect Endurance

- Environmental
- Operational
- Physiological
- Psychological

Physiological Factors

These factors affect the body and its performance. Lack of sleep or irregular sleep, an unbalanced diet, lack of exercise, and shift work can lower endurance.

Psychological Factors

This is the internal state of crew members. Emotions, stress levels, physical conditioning, motion comfort or discomfort, sleep quality and duration, diet, and the biological clock (the stability of the body's internal timing system) all contribute to a crew's internal state.

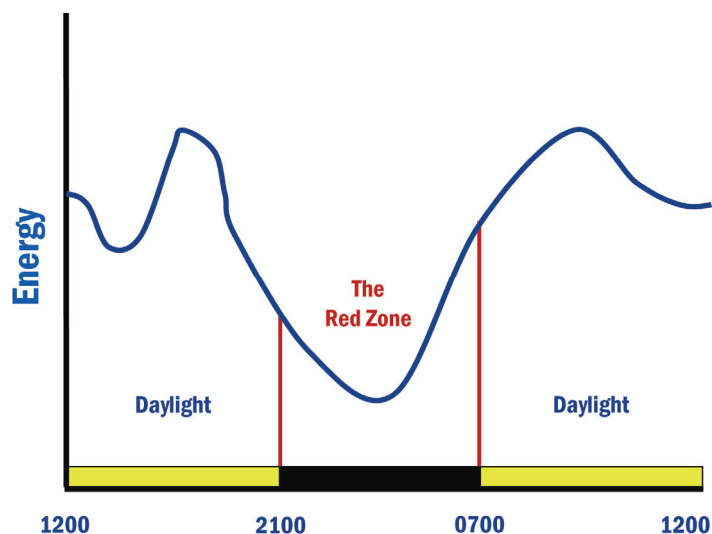
Another critical internal factor affecting endurance is the Red Zone. See the next page for more details.



The Red Zone

The Red Zone is a period of time when your body is not at its peak performance. During this period, your energy is at its lowest level during your body's 24-hour biological cycle.

Here's how it works: Your body's biological clock uses your nervous system and hormones to regulate your energy production schedule. The timing of energy production coincides with the onset of sleep and awakening. Typically your biological clock maintains a sleep-wake schedule synchronized with the daylight hours in your local area. Therefore, your body is naturally programmed to expend energy during the day and sleep at night. On this type of schedule, energy increases after you wake up, peaks mid-morning, dips in the afternoon, peaks again in the early evening, and falls once again as night arrives. Energy is at an all-time low in the middle of the night, which would be considered the Red Zone in this example.



The Red Zone can vary, depending on your work schedule. Other factors that can affect the Red Zone are the times you fall asleep and wake up, and the amount of time you're exposed to light—either natural light or bright artificial light.

Tips for Shifting the Red Zone

When your work hours change from a daytime to nighttime shift, you need to adjust your biological clock to meet the demands of the new schedule. This is known as shifting the Red Zone.

To shift the Red Zone:

- Work in bright light. If your shift is at night, work under artificial light that mimics daylight (at least 1,000 lux).
- Sleep in a dark, quiet environment.
- If you're working at night, expose your eyes to artificial light during the period between sunset and 0200.

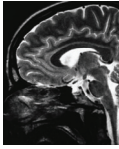


It usually takes about five or six days of consistent light management to shift the Red Zone.

When is your body in the Red Zone?

Your body's Red Zone varies from:

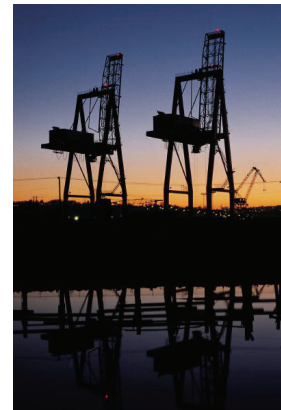
- Your work schedule
- The times you fall asleep and awaken
- The amount of time you're exposed to light
- The intensity of light exposure you receive



The Importance of Sleep

The average person needs eight hours of uninterrupted sleep each night to achieve peak performance. That's one hour of rest for every two hours that you're awake. When you don't receive enough sleep, your cognitive abilities become impaired, which can place you at risk on the job. That's because sleep deprivation causes:

- Drowsiness
- Feelings of being overwhelmed
- Lack of motivation
- Unconscious slips into brief or long periods of sleep
- Reduced ability to handle complex tasks
- Reduction in speed
- Inability to make decisions or think logically or critically
- Memory impairment
- Reduced motor skills and coordination



Causes of Sleep Deprivation

Sleep deprivation can be caused by:

- The quality of sleep—Noise and vibration can prevent crew members from receiving the deep sleep required to rejuvenate the body and boost energy production.
- Sleep fragmentation—Getting regular sleep through shorter periods, such as napping, doesn't allow the brain and body enough time to rejuvenate fully. As a result, the body and mind are not prepared for optimal performance during the work shift.

- Circadian rhythms—Your physical and psychological functions follow a rhythmic pattern, which typically coincides with the hours of daylight. Melatonin, the hormone that makes you sleepy, is suppressed during daylight hours and increases in darkness. Crews assigned to the night shift often encounter *circadian inversion*, because their bodies want to sleep when they're scheduled to work.
- Irregular hours—Constant changes in crew members' work schedules can inhibit sleep, because their circadian rhythms are disrupted. The effects are similar to jetlag.
- Extended work hours—Extended work hours are longer than eight hours in a day or 40 hours in a week. Studies have indicated that shifts of nine hours or more increase injuries, fatigue, health problems, and errors. Other consequences include decreased alertness, slower response times, reduced cognitive abilities, less energy to exercise, and the inability to plan and prioritize.



Tips for Improving Sleep

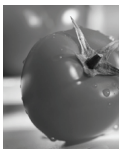
- From seven to eight hours of sleep is recommended. If this isn't possible, your goal should be to sleep at least six hours each day.
- If you can't sleep seven or eight hours, compensate with daily naps of up to 90 minutes. Allow 15 minutes between your nap and returning to work to avoid grogginess, disorientation, or sleep inertia. (Exception: Don't nap if you have trouble sleeping during your normal sleep period.)
- Sleep on a comfortable surface in dark surroundings.
- Sleep in the same place every day and wear the usual sleep clothing. Developing such habits will allow sleep to come more easily.
- If you can't fall asleep after 30 minutes in bed, get up for awhile before trying to sleep again.
- Exercise at least one hour before bedtime.

The Beauty of Sleep

A good night's sleep helps replenish the energy needed to achieve peak performance on the job. For the average person, this equates to eight hours of uninterrupted rest every day.

- If you work the night shift, make sure you're exposed to bright light during your shift to boost your energy levels.
- Don't drink any caffeinated beverages or take medications containing caffeine four hours before bedtime.

Sleep is essential for improving your energy levels, as well as maintaining a healthy diet. Food is converted into fuel, which produces energy. More details about how this works is provided in the next section.



The Importance of a Healthy Diet

Just like diesel fuel gives a vessel the energy it needs to travel the seas, food fuels your body. It gives you the energy you need to survive. The healthier your diet, the more efficiently your body will process food and distribute it for vital functions. In addition, you'll also feel better physically and psychologically. As a result, you'll have more energy, which increases your endurance.

How Energy is Produced

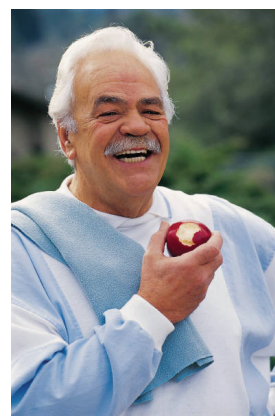
When you eat, your digestive system breaks down food into carbohydrates, proteins, and fats. Then enzymes convert these into energy substrates (glucose or sugar, amino acids, and fatty acids), which are then processed by the cells. The result is *adenosine triphosphate (ATP)*, energy molecules.



The amount of ATP your body manufactures is affected by the types of foods you eat, the amount of water you drink (hydration), oxygen, and the amount of sleep you receive.

Tips for Improving Your Diet

- Eat a balanced diet of lean proteins; whole, fresh fruits and vegetables, whole-grain carbohydrates, and moderate to low amounts of mono- and poly-unsaturated fats.
- Eat your heaviest meal after waking up from your longest sleep of the day.
- Eat smaller, lighter meals within four hours of your sleep period. Heavier meals close to bedtime will keep you awake.
- Don't eat immediately before going to bed. This will hinder sleep.



- Drink water on a regular basis, even if you're not thirsty. Drink at least eight, eight-ounce glasses of water every day. This amount may increase, depending on your levels of physical activity, perspiration, and work environment.
- Drink extra water when sweating heavily, or if urination becomes less frequent or darker than usual.
- Replace electrolytes with fruit juices, V-8 juice, bananas, or commercial sports drinks if you do not receive these through regular salt consumption.
- Avoid drinking any caffeinated beverages (coffee, tea, chocolate, and soft drinks) four hours before bedtime. Also do not take any medications containing caffeine four hours before bedtime.



The Food Balancing Act

Eating a balanced diet of lean proteins, fresh fruits and vegetables, and whole grains gives you the energy you need to maintain peak performance. A balanced diet also helps you feel better physically and psychologically.



The Importance of Exercise

Exercise provides a wide variety of benefits, in addition to improving endurance. It helps you sleep better, allows you to think clearly, manages stress, and enhances your alertness, concentration, and productivity. It also improves your cognitive thinking abilities. The USCG reports that in one research study, aerobic exercise performed for up to 60 minutes facilitates information processing and increases decision-making speed. Slow decision-making has been associated to several marine casualties.



Tips for Implementing an Exercise Program

- Try to get some exercise at least three times per week, even if it's walking for 20 minutes.
- Whenever possible, incorporate a variety of exercises in your program.
- Finish your exercise routine no later than one hour before bedtime.



Handling Environmental Stressors

Environmental stressors are an everyday challenge when you're working aboard a vessel. Climate changes and vessel noise and vibration are the most common environmental stressors you'll experience. All of these can affect endurance. Here are a few tips for coping with these stressors whenever you encounter them.

Handling Extreme Cold

When you're working in extreme cold, always remain aware of the following factors:

- Hypothermia
- Frostbite
- Fingers and hands cannot function properly below 59° F without adequate protection from the elements.

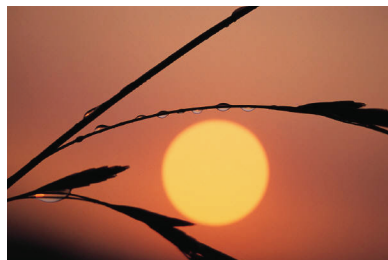


Take care of yourself in these extreme conditions by following these tips:

- Wear three layers of warm clothing.
- Bring an extra set of clothes for your shift in case you need to change. Before changing clothes, take a hot shower.
- Keep your hands, feet, and face covered and warm.
- Always keep your head covered to reduce heat loss.
- Protect your feet from cold and dampness by wearing layered socks and insulated boots.
- Keep your garments as clean as possible. Soiled clothing loses its ability to insulate adequately.
- Drink plenty of water. Dehydration can happen quickly at any temperature extreme—cold or hot.
- Maintain your electrolyte balance by drinking fruit or V-8 juice or eating bananas.
- Work at a slower pace and take frequent breaks when practical.

Handling Extreme Heat

Heat illness is a common threat when working in extreme heat. The main causes of heat illness are lack of preparation, working in the heat, and not being acclimatized. Heat illness usually starts when you're dehydrated. This means that your body is not receiving enough fluids. Heat illness, if left untreated, can lead to heat exhaustion. Symptoms of heat exhaustion are weakness, fatigue, exhaustion, and confusion. Some people suffering from heat exhaustion may experience one of these symptoms or a combination of these.



When you're working in extreme heat, follow these tips to avoid dehydration and heat exhaustion:

- Become accustomed to the climate by working for 60 to 90 minutes each day within the work environment.
- Do not work in temperatures of 104° F or more.
- Drink water on a regular schedule, even you're not thirsty. Drink at least eight, eight-ounce glasses of water every day. The amount of water you drink will increase, depending on your levels of physical activity, perspiration, and work environment.
- Drink extra water when you're sweating heavily, or when urination becomes less frequent or darker than usual.
- Replace electrolytes with fruit juices, V-8 juice, bananas, or commercial sports drinks if you do not receive these through regular salt consumption.
- Wear loose-fitting, light-colored clothing.
- Work in well-ventilated places whenever possible.
- Avoid using alcohol and other drugs that can impair body temperature regulation, such as aspirin and acetaminophen.

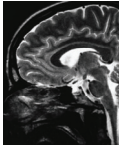


Handling Vessel Noise and Vibration

Here are some tips for handling vessel noise and vibration:

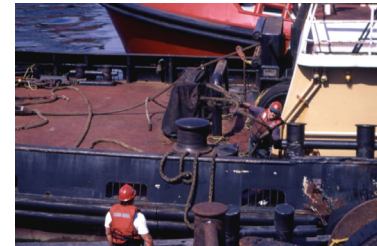
- Wear adequate hearing protection when working in noisy areas.
- Sleep in areas that are buffered from noise.
- When you're performing noisy tasks, be courteous to other crew members who are trying to sleep. Whenever possible, work on the tasks in an area away from the crew's quarters or wait until the crew is awake.
- From seven to eight hours of sleep is recommended. If this isn't possible, your goal should be to sleep at least six hours each day. When you're tired, you're more vulnerable to motion sickness than when you're rested.
- If you're taking medicine for motion sickness, inform your captain. You should always provide this information to your captain in the event of a medical emergency.





Handling Personal Stressors

Your work environment and family situation affect the levels of personal stress. Work-related stress is influenced by the characteristics of your work environment. These include management style, the balance of your control against job demands, noise and extreme temperatures, isolation, and sustained mental or physical workload. The work environment can also affect your family life because of your assigned schedules and the amount of time you travel. Loneliness, isolation, family conflicts, and concern for your family can cause distraction and fatigue.



Tips for Handling Personal Stressors

Here are some tips for handling stress:

- Take advantage of any stress management programs that are available for crews.
- Pursue personal interests when you're not on duty, such as reading good books or taking up a hobby. Thinking about non-work activities when you're off duty will reduce job-related stress.
- Use relaxation methods to reduce stress. Your CEM coach can recommend a variety of relaxation methods that accommodate your lifestyle and schedule.
- Learn and practice good time-management strategies. Contact your CEM coach for suggestions.
- Exercise on a regular basis. Exercise helps reduce stress levels.
- Participate in problem-solving activities using a team approach.
- Maintain good communication with your captain and fellow crew members.
- Identify and resolve stressful factors, particularly in interpersonal relationships.



Glossary

biological clock The mechanism within the brain that regulates physiological and cognitive resources throughout the day. *See also* circadian rhythms.

CEM *See* Crew Endurance Management.

CEM coach The person responsible for monitoring crew member adherence to CEM practices, and for providing guidance and training when needed.

circadian desynchronization A syndrome characterized by symptoms, similar to jet lag, induced by seeing natural or artificial light at inappropriate times of the day.

circadian dip A low point in the normal daily rhythm, or cycle, of body energy and wakefulness. *See also* Circadian rhythms.

circadian rhythms The daily ebb and flow of body energy and alertness over the course of a 24-hour period. *See also* biological clock.

coach *See* CEM coach.

crew endurance The ability to maintain performance within the safety limits while enduring job-related physical, psychological, and environmental challenges.

Crew Endurance Management A system for managing the risk factors that can lead to human error and performance degradation in maritime work environments.

desynchronization *See* circadian desynchronization.

endurance risk factors Factors that can threaten operational and crew member efficiency in the maritime industry. Examples include heavy workloads, sleep debt, and caffeine addiction. *See also* performance stressors.

endurance *See* crew endurance.

Final Common Path A deployment strategy in which a team of onboard coaches monitor crew member adherence to implemented CEM practices, and provide guidance and training when needed. *See also* CEM coach.

insomnia The chronic inability to get to sleep and/or to remain asleep.

light management The practice of using a regimen of controlled light exposures to adapt the body clock for a new sleep-work schedule; that is, to shift the Red Zone. *See also* Red Zone.

lux A standard measurement for light intensity: one lumen per square meter.

maladaptation Shifting into a new sleep-work schedule without adjusting the biological clock.

performance stressors Factors that can have a severe impact on safety and endurance in marine operations either separately or collectively. Examples include motion sickness, psychological stress, and caffeine addiction. *See also* endurance risk factors.

protocol The plan or design for a scientific experiment or treatment.

Red Zone The daily period of lowest energy and alertness, normally occurring between bedtime and sunrise.

risk factors *See* endurance risk factors.

sleep inertia The tendency to feel sleepy and sluggish after awakening.

synergistic Characterized by synergism, the ability of two agents to create an effect neither agent is capable of creating on its own.

stamina *See* crew endurance.

stressors *See* performance stressors.

working group A committee charged with the responsibility for implementing all aspects of a CEM program.

Source: United States Coast Guard. Glossary from Crew Endurance Management Practices: A Guide for Maritime Operations (with edits), January 2003, pp. xv-xviii.



Resources

The following resources provide helpful information about sleep, exercise, and dietary requirements.

Sleep

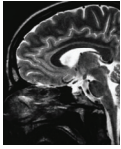
- The Science of Sleep, <http://www.scienceofsleep.net/index.aspx>. This site, developed by Takeda, has extensive information about the biological and psychological aspects of the sleep, including Web links to other resources. The site features an interactive tutorial that describes the sleep-wake cycle, the neurological aspects of sleep, and clinical aspects of sleep. You can also take a quiz to test your knowledge about sleep.
- Sleepnet.com, <http://www.sleepnet.com/>. Since 1995, this site has been providing “everything you wanted to know about sleep but were too tired to ask.” It offers a wealth of information on what hinders sleep and how to improve sleep.

Exercise

- Starting an Exercise Program, http://www.dukehealth.org/tips/tip_20031104203901815. This site, sponsored by Duke University Medical Center, gives practical tips on how to start an exercise program and stick with it.
- Fitness Programs: Ready to get Started?, <http://www.mayoclinic.com/health/fitness/HQ00171>. Another site that provides excellent tips for starting and staying with an exercise program. It’s sponsored by the Mayo Clinic. A separate page on this site offers tips for staying motivated (see <http://www.mayoclinic.com/health/fitness/HQ01543>).

Dietary Requirements

- The Food Guide Pyramid,
<http://www.nalusda.gov/fnic/Fpyr/pyramid.gif>. This image breaks down the U.S. Department of Agriculture's (USDA's) recommended daily allowances of foods in our diets.
- The Food Pyramid-Food Label Connection,
<http://www.fda.gov/fdac/special/foodlabel/pyramid.html#dietary>. Provides suggestions on how to read labels on food in the grocery stores. The site is sponsored by the U.S. Food and Drug Administration (FDA).
- Nutrition Made Easy Index,
<http://www.primusweb.com/fitnesspartner/library/nutrition/nutritn.htm>. Sponsored by the Fitness Jumpsite, this site provides a variety of articles on how improve eating habits. Topics include food cravings, how stress affects nutrition, and tips for eating healthy when you're dining at restaurants.
- Fast Food Nutrition,
<http://www.primusweb.com/fitnesspartner/library/nutrition/nutritn.htm>. This site, sponsored by Helpguide.org, provides tips for eating healthy at fast food restaurants.



References

United States Coast Guard. *Crew Endurance Management Practices: A Guide for Maritime Operations*, January 2003.

United States Coast Guard. *Crew Endurance Management Practices: A Guide for Maritime Operations Addendum*, September 2005.

CEMS Review Exercise

Instructions: Read each question thoroughly and select the best answer by circling either True or False. When you are finished, give your answers to your captain or CEM coach for evaluation.

1. True or False: CEMS stands for Crew Environmental Management System.
2. True or False: CEMS will help you improve your performance levels.
3. True or False: CEMS will help you to become free of fatigue.
4. True or False: Crew endurance is your ability to perform within safety limits while coping with job-related challenges.
5. True or False: Job-related challenges are also known as endurance factors.
6. True or False: The four primary factors that affect a crew's performance level are environmental, operational, psychological, and physiological.
7. True or False: The Red Zone is a restricted area on a vessel.
8. True or False: The Red Zone can be affected by the intensity of the light exposure you receive.
9. True or False: Exposure to light can help you shift your Red Zone.
10. True of False: Getting regular sleep through napping will help you achieve peak performance.
11. True or False: Melatonin is a hormone that keeps you awake.
12. True or False: You can improve your sleep by exercising at least one hour before bedtime.
13. True of False: Food produces energy.
14. True or False: You should eat your heaviest meal just before bedtime to improve your energy levels.
15. True or False: You should drink at least eight, eight-ounce glasses of water every day—even when you're not thirsty.
16. True or False: Not only does exercise improve sleep, it also helps you to think more clearly.
17. True or False: Extreme heat and cold are examples of environmental stressors.
18. True or False: Vessel vibration can help induce sleep.
19. True or False: Stress does not affect endurance.
20. True or False: Isolation improves endurance.

Acknowledgement of training:

I have read and understand the Crew Endurance Management System (CEMS) Awareness Workbook, and have completed and passed the 20-question review exercise.

Employee Signature

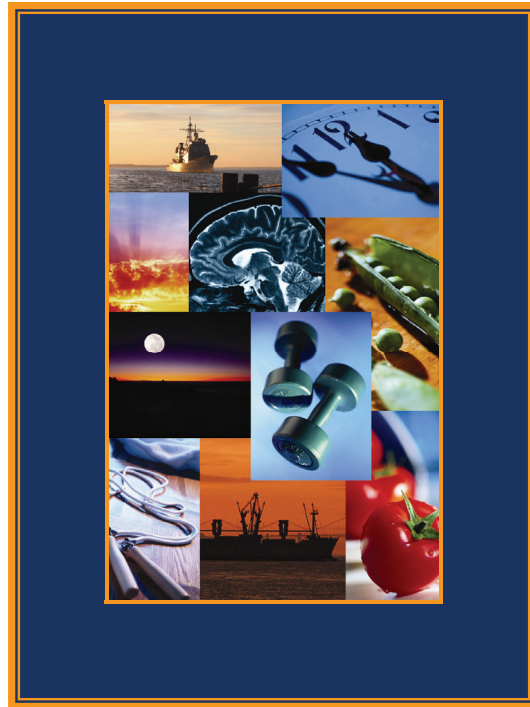
Date

Crew Endurance Management System Training (CEMS)

has completed Crew Endurance
Management System Training

CEM Coach's Signature

Date



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**23112 NE 144th Street
Woodinville, WA 98077
425-788-2713**