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COMDTINST 3500.2
30 MAR 2006

COMMANDANT INSTRUCTION 3500.2

Subj: CREW ENDURANCE MANAGEMENT

Ref: (a) Team Coordination Training, COMDTINST 1541.1 (series)
(b) Operational Risk Management, COMDTINST 3500.3 (series)

1. PURPOSE. This Instruction establishes the requirements and the delivery system to support a program, Crew Endurance Management (CEM), to identify and control endurance risk for personnel conducting cutter, boat, aviation, marine inspection and pollution response, security, and command-and-control operations and activities. This program serves all active duty, reserve, Auxiliary, and civilian Coast Guard personnel.

2. ACTION. Area and district commanders; commanders of maintenance and logistics commands; commanding officers of headquarters units; and assistant commandants for directorates, Judge Advocate General, and special staff offices at Headquarters, shall ensure that this Instruction is distributed to the widest extent possible, and that all personnel comply with its provisions. Internet release authorized.

3. DIRECTIVES AFFECTED. The information and requirements established in this Instruction have already been incorporated into, or approved for inclusion in upcoming, changes to references (a) (b) and operational doctrine in Commandants (G-R) and (G-P).

4. BACKGROUND. A ship's endurance can be described by how long it can support operations at sea without replenishing supplies or requiring in-port maintenance. Similarly, crew endurance can be described as a function of physiological and psychological factors that support the ability of crewmembers to perform their jobs safely and effectively. Recent studies of Coast Guard (CG) operations: aboard cutters, at small boat stations, air stations, marine safety units, command centers, and law enforcement units revealed that in excess of 70% of the members studied exhibited signs of compromised endurance. Comparable results have been associated with increased rates of human

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error, performance decrements, cardiovascular disease, hypertension, Type II diabetes, obesity, gastrointestinal disorders, and reduced immune-system resistance. While we might like to believe that we can be Semper Paratus under any condition, this simply is not the case: erratic work/watch schedules, long work hours, insufficient sleep, and exposure to extreme environmental conditions do not allow the human body to replenish physical and mental resources, and leave even the most experienced and dedicated CG member ill-prepared to meet operational challenges and unable to maintain personal health and well-being. While certain foods (e.g., energy bars) are often used to provide a boost of energy, these external sources of energy do not replenish the basic physical and mental resources lost by sleep debt. Only sleep can restore these resources and functions. Fortunately, crew endurance can be managed, and resources are now available to identify and control endurance risk factors.

a. Endurance Risk Assessments. It has long been recognized that long workdays and reduced sleep produces levels of human fatigue that can compromise the health, safety and performance of operators. Mounting concerns from operators and inferred evidence from mishap data prompted research efforts to document and assess the incidence and severity of fatigue in CG operations. These efforts confirmed levels of fatigue that compromise the safety, health, and performance of CG personnel. In addition, factors such as diet, exercise, and stress were identified at levels that compromise the crews' ability to endure operations and maintain alertness and performance. These efforts revealed that many of the CG's traditional work practices do not leverage basic principles of human physiology that are necessary for members to adapt to and endure work environments. Operational field tests that integrated basic fatigue and endurance principles into work practices produced demonstrable improvements in alertness, performance, and general well-being. It was concluded that crew endurance could be maintained and improved if exposure to specific risk factors were managed and controlled.

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

(1) Core Risk Factors.

(a) Insufficient Daily Sleep. It is well established that the human body needs approximately 8 hours of continuous sleep per 24-hour period in order to replenish physical and mental functions. On average, sleep lengths between 7-9 hours are considered within the "normal" range for restoring human physical and mental resources. Sleep lengths outside the 7-9 hour range that are not the result of meeting some external demand (e.g., work schedule or other obligation) may underlie a health problem (e.g., obesity) or sleep disorder (e.g., insomnia).

(b) Poor Sleep Quality. While the continuous 8-hour period of sleep is important, if the quality of sleep is poor, the restorative value of that sleep is reduced. In some respects, the quality of the sleep is as important, if not more important, than how long one sleeps. Sleep environments that are hot, noisy, bright, or that have uncomfortable bedding compromise the quality and restorative value the sleep.

(c) Fragmented Sleep. Sleep is fragmented when the physiological ideal 8-hour sleep period is split into two or more episodes. For example, a person standing the mid-watch typically has one sleep episode before watch and a second sleep episode after watch. In order for sleep to be restorative the brain needs to progress through various sleep stages that restore different physical and mental functions throughout the 8-hour sleep period. When sleep is fragmented, sleep stages are disrupted and energy restoration is compromised.

(d) Main Sleep During the Day. Human physiology is programmed for sleep during night hours (2200 to 0600) and be awake during day hours (0600 to 2200). During these times, specific biochemical activities occur that promote sleep and alertness. Sleep during daylight hours disrupts these biochemical cycles with predictable consequences: loss of attention and alertness, sleepiness, and fluctuations in mood. Adapting to night work requires adjusting the release of biochemicals, but this adjustment can take days, and might not occur at all, depending on how much control members have over their work/home environment.

(e) Changing Work/Rest Schedule. Switching from day to night work produces physiological disruptions very similar to those experienced in 'jetlag'. Standing a watch schedule that rotates from day to night is like crossing multiple time zones every time the schedule rotates. As in jetlag, this 'shiftlag' produces consistent decrements in alertness, performance, and physical and mental functions that can take upwards of one week to recover from.

(f) Long Work Days. Human performance begins to decrease approximately 12 hours after one arises from sleep. After approximately 14 hours of wakefulness, individuals perform at levels compared to someone with a blood alcohol concentration (BAC) of .05. After approximately 26 hours of wakefulness, individuals perform at levels compared to someone with a BAC of .10. These performance levels will vary as a function of type of task, environmental conditions and history of the individual.

(g) No Opportunities to Make Up Sleep. If a sleep period is less than the physiologically ideal 8 hours per, the difference between the actual, say 6 hours, and the ideal, 8 hours, is called a "sleep debt" and must be must be made up at a later time. The body naturally extends normal sleep periods to make up the lost sleep. For most people sleep on weekends is extended for this purpose, to make up for any lost sleep during the workweek. If sleep debt is not paid back, it continues to accumulate until the individual extends their sleep beyond the 8 hour basic need and begins to pay back their accumulated sleep debt. Because human physiology requires that sleep debt be paid back in full, unpaid sleep debt will result in chronic sleep deprivation, and produce decrements in performance, erratic moods, unpredictable behavior and poor health.

(2) Modulating Risk Factors.

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

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

(c) Exposure to Extreme Environments. The body must expend higher amounts of energy to protect itself from extreme conditions. For example, the body uses extra energy to heat itself when cold, and to maintain balance in heavy seas. Sustained exposure to extreme environments requires more energy, and increases the potential for injury and negative health consequences.

(d) Poor Diet. Foods high in carbohydrates, fat and sugar induce drowsiness and promote sleepiness. Potatoes, rice, dairy products, turkey and foods high in sugar can induce a biochemical reaction in the brain that promotes sleepiness. These foods should be avoided during night operations, when sleepiness is already elevated due to circadian rhythms. Vegetables, fruits, whole-grain foods, fish and poultry are healthier and promote alertness.

(e) Lack of Exercise. Exercise promotes sleep and aids in replenishing energy stores. Physically fit individuals burn less energy when performing their job, and replenish energy more efficiently during sleep.

(f) High Stress. Although stress can actually improve performance in the short term, by releasing hormones that prepare an individual to act, these same hormones, sustained at high levels, can actually debilitate and paralyze an individual. Three sources of stress are particularly relevant for CG operations: (1) work stress, (2) family stress, and (3) isolation from family. All three require higher amounts of energy to maintain focus and performance; hence, if they are sustained over long periods, they can compromise endurance. In addition, stress disrupts sleep so that full restoration of physical and mental resources is not possible.

(1) Work Stress. Time pressure, pace of work, volume of work, communication, interpersonal relations, and environmental conditions all contribute to work stress. These sources of stress can degrade endurance and job performance.

(2) Family Stress. Child and parent care, finances, marital problems, conflict with others, and poor support systems are examples of family stress that can compromise endurance. Crewmembers confronting these stressors should be identified and offered support programs.

(3) Isolation from Family. The uncertainty of what is happening to family members, and the inability to be present to comfort or support their activities, is one of the greatest sources of stress for some individuals. Efforts to improve or maintain contact with family (by e-mail or telephone) have been shown to reduce stress and to improve performance.

5. PHILOSOPHY. The conventional approach to ensuring safety and performance at work has been to limit the length of the workday. While this approach has dominated worker safety practices through the use of hours-of-service regulations since the early 1900's, statistical analysis of mishaps, and empirical research on human performance and endurance, suggest that the length of the workday is only a small part of the human endurance equation. This deficiency in the hours-of-service approach has been recognized recently and many organizations are revising their regulations to consider some of the endurance factors mentioned earlier. There is consensus that to truly understand and effectively manage human endurance, one needs to integrate information from the factors described above into how we plan and execute operations. In addition, one size does not fit all. Hours-of-service approaches assume that all operations and environments exert the same demands on human endurance. This assumption, inherent in many prescriptive and regulatory approaches, is false, because endurance risk factors, and exposure to them, often change as a function of operational demands and the environment. To address this deficiency, CEM uses a systems approach to tailor endurance management solutions to operational realities and circumstances. Effective endurance management is a dynamic process. Units or individuals assess their exposure to the endurance risk factors presented above and develop controls that specifically address their exposure to these risks. Successful endurance-management solutions must accommodate the ever-changing operational demands of CG service, the often streamlined resource environment, and the unpredictable nature of CG missions that challenge the endurance limits of CG personnel. To meet these challenges, and live up to the "Semper Paratus" motto, endurance risk must be controlled to ensure mission success and operational readiness.

6. CONCEPT. The CEM process:

a. Advances a risk-based decision-making approach and tools that can be used at all levels of the organization to improve operational effectiveness and readiness by identifying and controlling hazards and improving human performance.

b. Promotes input and support from all levels of the work unit to build ownership in the process and commitment to the risk controls.

c. Uses a systems approach to understand exposure to risk, and promotes systems-oriented solutions to managing risk.

7. PROCESS. Table 1 shows the five steps for implementing a CEM program. Enclosure (1) describes each step of the process, and provides key points, instructions, tools, and examples for completing each step.

Table 1. The 5 steps to implementing a CEM program.

Step 1	Form a CEM Working Group
Step 2	Conduct a crew-endurance risk-factors assessment (RFA)
Step 3	Develop a CEM plan for controlling crew-endurance risk factors
Step 4	Deploy the CEM plan
Step 5	Assess the effectiveness of the CEM plan

8. SCOPE. Endurance challenges are ever-present in CG operations. The target audience for CEM are all CG members who contribute to the overall goal of increasing unit effectiveness: from a motor lifeboat crew working a challenging SAR case, to a cutter boarding team conducting a fisheries inspection, to a helicopter crew executing a hoist, to an electronics technician maintaining a sector high-site antenna, to an acquisition officer purchasing new equipment or services, to a marine safety officer selecting and deploying pollution response resources, to an area staff planning a major operation or exercise. All members of the CG organization depend on endurance to execute their daily tasks in a safe and effective manner.

9. IMPLEMENTATION. CEM principles (e.g., need to sleep 8 uninterrupted hours per day) are physiological realities that will affect the members' ability to perform their jobs safely and effectively, and should be integrated into daily practices and operational doctrine. However, unlike Team Coordination Training (TCT), and Operational Risk Management (ORM), CEM is not intended to be used as a risk management tool before, during, and after each operational evolution. Although CEM can be used to assess risk specific to the operator during evolutions, the intent of this COMDTINST is to evaluate work systems for exposure to specific risk factors that can compromise safety and operational readiness in general. The intent of CEM is not to assess risk during high tempo operations. One should expect high endurance risk during high tempo. However, the ability to respond to and succeed during high tempo depends on how well one manages and promotes endurance during "normal" operations. Managing endurance during "normal" operations, when one has greater control over the operational environment, will promote and ensure that personnel have energy resources to respond to high tempo demands. If endurance risk is high during "normal" operations, the unit will be ill prepared to respond to a high tempo/demand scenario. Therefore, the intent of CEM is to ensure that exposure to endurance risk factors is controlled, and endurance is maintained, during "normal" operations so that the unit will be better prepared to respond to any operational demand. In this capacity, units shall conduct endurance risk-factor assessments as per Enclosure (1) at least once per year, or when operational requirements change, to determine exposure to endurance risk. Enclosure (1) provides a self-paced tool to help members and units to: (1) implement the CEM process, (2) identify exposure to specific endurance risk factors, and (3) explore opportunities to manage and control endurance risk factors. Implementing CEM creates an environment in which every CG member is motivated to manage endurance risk both on- and off-duty. As with TCT and ORM, CEM stresses individual and team concepts for controlling endurance risk in a proactive manner. Units should expect to spend approximately 1-2 hours every quarter on CEM assessments. Additional time may be necessary if exposure to endurance risk is high and

control measures are necessary to implement and evaluate. However, this small investment in time will pay huge dividends in improved safety, health, well-being and operational readiness, and also improve the quality and reduce the time necessary to conduct ORM assessments.

10. CEM PRACTITIONERS. While any unit can implement a basic CEM program using Enclosure (1), specialized training is available for those seeking more advanced CEM applications. A 3-day course introduces the research behind CEM, provides specific instruction on how to identify and control endurance risk, and demonstrates how to implement CEM programs. Upon successful completion of this course, attendees are recognized as Certified CEM Practitioners, and can assist units with implementing CEM programs. A cadre of CG personnel is being trained as certified CEM practitioners to support unit CEM implementation needs. Currently, Safety and Environmental Health Officers (SEHO), Independent Duty (Health Services) Technicians, Maintenance and Logistics Commands Health and Safety Division, and Health Promotion Managers are being certified as CEM practitioners. The CEM practitioners serve as subject-matter-experts to answer questions on CEM, assist field units to conduct endurance risk assessments, and provide referrals to the CG Headquarters program manager for more specialized needs. It is estimated that CEM practitioners will spend approximately 5 hours per month on CEM support. Representatives from field units wishing to attend this specialized training should contact the Office of Safety and Environmental Health (CG-113) at CG Headquarters.

11. MANAGEMENT ROLES AND RESPONSIBILITIES.

a. Commanders, Commanding Officers, and Officers-in-Charge shall:

(1) Establish a CEM working group and empower the CEM process.

(2) Ensure that RFAs are conducted at appropriate intervals.

(3) Select from endurance risk control options developed by the working group.

(4) Eliminate barriers to implementing the CEM process.

(5) Motivate leaders and supervisors to use CEM and support training opportunities.

b. Staff Elements, Department Heads, and Division Officers shall:

(1) Promote and support endurance risk assessments, encourage developing controls for endurance risk, and assist in implementing controls as needed.

(2) Eliminate ineffective controls.

(3) Ensure that those writing doctrine or planning orders apply CEM principles.

(4) Eliminate barriers to implementing endurance-management controls.

c. Supervisors shall:

(1) Apply the CEM process to operations and tasks and encourage its use for off-duty activities.

(2) Elevate endurance risk issues to higher authority for resolution when appropriate.

d. Individuals shall:

(1) Understand, accept, and use CEM principles to control endurance risk.

(2) Apply the CEM process and principles to off-work activities.

(3) Maintain situational awareness of CEM principles that can compromise safety and performance.

12. PROGRAM RESPONSIBILITIES.

a. Commandant shall:

(1) Assistant commandants for directorates and special staff offices at Headquarters shall:

(a) Integrate the CEM process and principles into appropriate doctrinal publications and manuals for all Coast Guard missions and activities.

(b) Incorporate CEM principles into appropriate personal qualification standards publications.

(c) Require program managers to review programs periodically to help field units identify areas and processes for CEM implementation.

(2) Commandant (CG-13) shall:

(a) Continue to use professional development and leadership courses to leverage the findings of the analysis work concerning endurance risk factors. This will provide insight into human performance factors with which leadership cadres can more comprehensively manage their crews and operational requirements.

(b) Consider CEM risk factors when conducting performance gap analyses.

(3) Commandant (CG-113) shall:

(a) Serve as technical advisor on CEM issues.

(b) When practical, incorporate CEM lessons learned into regular safety messages promulgated to the field.

(4) Commandant (G-PCX) shall educate Auxiliary members on the risk factors that affect crew endurance.

b. Area and District Commanders shall:

(1) Ensure that SOPs and/or OPLANs apply CEM in coordinating missions, in the course of normal reviews.

(2) Integrate the CEM process and principles into training and readiness evaluations, and ensure that they are included in readiness evaluation checklists.

(3) Ensure that all exercises and planning efforts consider CEM principles.

(4) Provide CEM program implementation support to the field through Safety and Health Promotion programs.

c. Activity, Sector, and Unit Commanders:

(1) Integrate the CEM process and principles into daily operational, maintenance, and support activities.

(2) Conduct RFAs at appropriate intervals, or when mission/operational requirements change.

(3) Include CEM information in operational briefs, e.g., pre- and post-flight mission briefs; cutter port briefs; and damage-control, navigation, and seamanship training team exercises and briefs.

(4) Include CEM information in appropriate operational notices and plans during the course of normal updates, e.g., cutter organization manuals, Commanding Officer’s Standing Orders, AMIO, helicopter operations, law enforcement, and other operational bills; pulsed counter-narcotics and fisheries enforcement operation planning and execution; and maritime defense zone exercises.

(5) Integrate CEM process and principles into group inspections and Ready-for-Operations procedures.

d. Maintenance and Logistics Commands shall:

(1) Incorporate CEM concepts into unit safety and environmental health programs.

(2) Instruct units in CEM concepts during normal safety and compliance visits.

(3) Provide CEM program implementation support to field units.

13. ENVIRONMENTAL ASPECT AND IMPACT CONSIDERATIONS. Environmental considerations were examined in the development of this Instruction and have been determined to be not applicable.

14. FORMS/REPORTS. None.

PAUL J. HIGGINS /s/
Director of Health and Safety

Encl: (1) Crew Endurance Management (CEM) Process

CREW ENDURANCE MANAGEMENT (CEM) PROCESS

I. CEM Implementation Steps

Successful CEM programs require implementing a 5-step process (Table 1). This enclosure provides instructions for completing each step. Before beginning the implementation process, you should read this enclosure in its entirety.

Step 1	Form a CEM Working Group
Step 2	Conduct a crew endurance risk factors assessment (RFA)
Step 3	Develop a CEM plan for controlling crew endurance risk factors
Step 4	Deploy the CEM plan
Step 5	Assess the effectiveness of the CEM plan

Table 1. The 5 steps for implementing a CEM program.

Step 1 - Form a CEM Working Group

The first and most important step in implementing a successful CEM program is forming a CEM Working Group (WG). The members of the WG serve as local experts on CEM and are responsible for the timely and effective execution of the CEM process. The WG should be composed of members from all departments or functional areas at the unit to ensure that risk factor assessments reflect the concerns and experience of the entire unit, and that risk controls meet the operational reality of the unit. Whereas a small number of unit representatives might be able to make a good first cut at identifying the endurance risk factors affecting all parts of the unit, and potential controls to manage the risk, it is unlikely that they would be able to identify the risk factors affecting every department or group.

If a unit is very small, or if resources are not available to support a WG, one individual who is well versed and experienced in the operations of the unit should be able to identify many of the unit's risk factors. In such a case, it is highly recommended that the sole rater discuss their ratings with other unit members to ensure that the most important risk factors are identified, as well as, to get feedback on the draft CEM plan before it is implemented.

By providing a direct link between the CEM process and the unit members, the WG ensures that everyone in the unit has an opportunity to contribute to the CEM implementation process. This contribution encourages individual ownership in CEM, and will improve the success of any changes that are implemented.

Step 2 - Conduct a crew-endurance risk factors assessment (RFA)

Research on fatigue, and studies of numerous CG platforms and operations, have identified endurance risk factors that can compromise the health, safety, and operational effectiveness of CG crews. The second step in implementing a CEM program is to identify the specific endurance risk factors affecting the unit, and to rate the frequency of exposure. The endurance risk factors are identified and described earlier in this COMDTINST. The RFA output is most useful if each individual in the WG or work unit provides their exposure ratings for each risk factor. However, the RFA can be completed either individually or as group using consensus scores.

If the unit has more than one mission or operational tempo, it is recommended that an RFA be conducted for each mission or tempo, because the respective risk exposures can be different. For example, a unit might have a hectic summer search and rescue (SAR) season but a low-tempo winter season, or a cutter might experience different endurance risks at sea then they do in port. Separate RFAs would identify the risk factors specific to each operational situation, as well as the level of exposure that each situation produces.

A software tool, the Crew Endurance Management System (CEMS), was developed to provide users with all the resources and tools to conduct CEM activities. The CEMS tool is available by going to: http://www.uscg.mil/safety/cem.htm. If you are not able to download a copy of the CEMS tool please contact CG Headquarter's Office of Safety and Environmental Health (CG-113) for a copy of the tool.

To conduct step 2 of the CEM process, open the CEMS tool and select the "Risk Factor Assessment (RFA)" option. The tool leads the user through a series of questions related to the 15 risk factors. The responses to the questions are used to generate an endurance risk profile for a particular environment or a particular user/crewmember. Figure 1 shows one of the questions in the RFA addressing the risk factor insufficient daily sleep duration.

Figure 1. Screen shot from the RFA showing a question from the RFA.

Each screen identifies the risk factor being assessed and provides a brief description. For additional information, the user can click on the *More Information* box located in the upper right left hand corner of the screen. To rate your exposure to the risk factor, the user can click once on the numeric value that best represents the user's exposure to the risk factor, and then click the next button to advance to the next question, or the user can double-click on the numeric value and be automatically advanced to the next question.

When all the questions have been answered, the results are represented in a bar-graph format (Figure 2). These bar-graphs are referred to as 'endurance risk profiles' and represent the user's or unit's exposure to endurance risk. For the core risk factors (described in the paragraph 4.b.(1) of this Instruction), the severity of the risk is categorized by color: **green** indicates an acceptable level of risk exposure (no action is required); **yellow** indicates a moderate level of risk exposure (control measures should be considered); and **red** indicates a high level of risk exposure (control measures should be implemented as soon as possible). While the core factors are physiologically based, modulating factors have strong psychological and experiential influences that make severity thresholds difficult to predict. For this reason, a color-coded severity threshold is not used for the modulating risk factors. It is proposed that modulating risk factors with exposure frequency values greater than 5 will compromise endurance and controls should be considered. It is highly recommended that units look for opportunities to reduce exposure to modulating factors, especially if exposure to core risk factors is high.

It is important to point out that any of the 15 endurance risk factors can degrade performance and compromise operational safety and effectiveness. The simultaneous presence of several risk factors is of great concern, because the negative influence of the whole in such cases is often greater than the sum of the parts. To learn more about each of the risk factors, the user can left-click on the risk factor name to access an online CEM Guide that provides more detailed information on each endurance risk factor. To access all the risk profile screens, the user continues to click the **Next**.

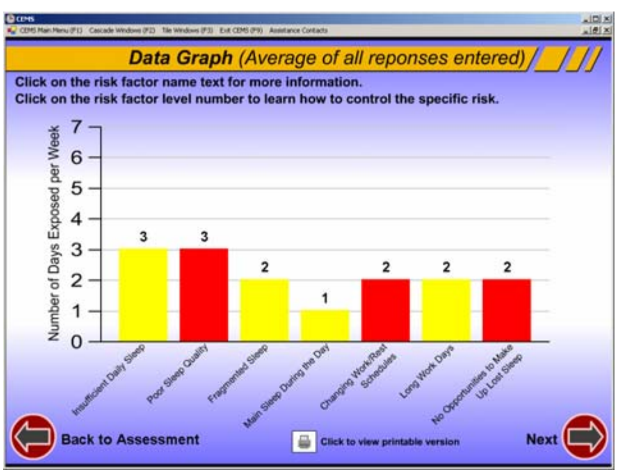

Figure 2. Screen shot showing an RFA endurance risk profile.

As suggested earlier, because exposure to endurance risk factors can vary by operational scenario, an RFA should be conducted to develop a risk profile for each scenario. For example, a cutter might conduct a risk profile for each department under different operational scenarios (dockside, underway, boardings, or night ops), whereas a small-boat facility might conduct a risk profile for B-0 vs. B-1 status, night operations, aviation support, and so forth. The WG would use these separate risk profiles to identify the most at-risk operations, to prioritize risk factors for control, and to develop control strategies specific to the scenarios producing the most risk.

It is recommended that the WG share the risk profiles with the members of the work-unit they represent, so that everyone has an opportunity to contribute to the assessment process. Besides improving the accuracy of the assessments, participation builds ownership in the CEM process and strengthens their commitment to the changes that may occur to control the endurance risk.

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

At this point, the WG should have a good idea of the unit's exposure to crew endurance risk. If the core risk factors are green and modulating factors values above 5, the unit has low exposure to endurance risk, and no further action is required at this time. If the core risk factors show yellow or red, or the modulating factors are above 5 in value, endurance risk is present and the unit must explore options to control the risk.

To manage or control endurance risk, CEM uses a systems approach (CEM Model) that explores control measures at four levels: (1) mission level, (2) personal level, (3) organizational level, and (4) environmental level. Controls for each risk factor are considered at each level of the model. This systems approach not only ensures that all levels of an operational system are considered for controls, it also recognizes that levels interact, and that a fix at one level of the system might affect other levels either in a positive or a negative fashion. The CEM Model is depicted in Figure 3. At the **mission level**, the focus is on the mission requirements or characteristics (e.g., missions at night) that can produce endurance risk, and the question being asked is: can this operational requirement be altered or eliminated without compromising the mission of the organization? The intent is to identify potential operational aspects that are not absolute requirements and if modified or eliminated would not compromise mission readiness or effectiveness. At the **personal level**, the focus is on things that individual crewmembers can do to ensure an optimal level of endurance (e.g., sleep behavior, exercise, diet, etc.). The focus is to recognize physiological requirements and personal behaviors that can influence endurance. At the **organizational level**, the focus is on those variables that are under the control of the command staff, and that directly support (or detract from) the ability of crewmembers to endure. These issues include such things as watch schedules, patrol length, napping policy, and food services. At the **environmental level**, the focus is on berthing and exercise facilities, human-machine interface issues, as well as such environmental variables as exposure to extreme temperatures, ship motion, and noise.

The "corner stone" to the CEM process is education. Throughout the CEM process there is a continuous exchange of information to the user population on what is fatigue and endurance, what factors effect alertness and performance, what are the consequences of certain personal behaviors (i.e., staying-up late to socialize even though they may need to get-up early for work), how does diet and exercise effect endurance and performance, etc. This information is essential to change the attitudes and behaviors of individuals within the personal level, as well as, provide the reasoning and justification for the command to make the necessary changes to the organizational and environmental levels of the CEM model. The CEMS tool provides an education resource library, located in the "Endurance Resources" section of the tool that the WG can use to give this training. With education as a foundation, members are ready to begin exploring opportunities to control endurance risk. The RFA tool used in Step 2 is also used to navigate users through the CEM Model to explore endurance risk control options.

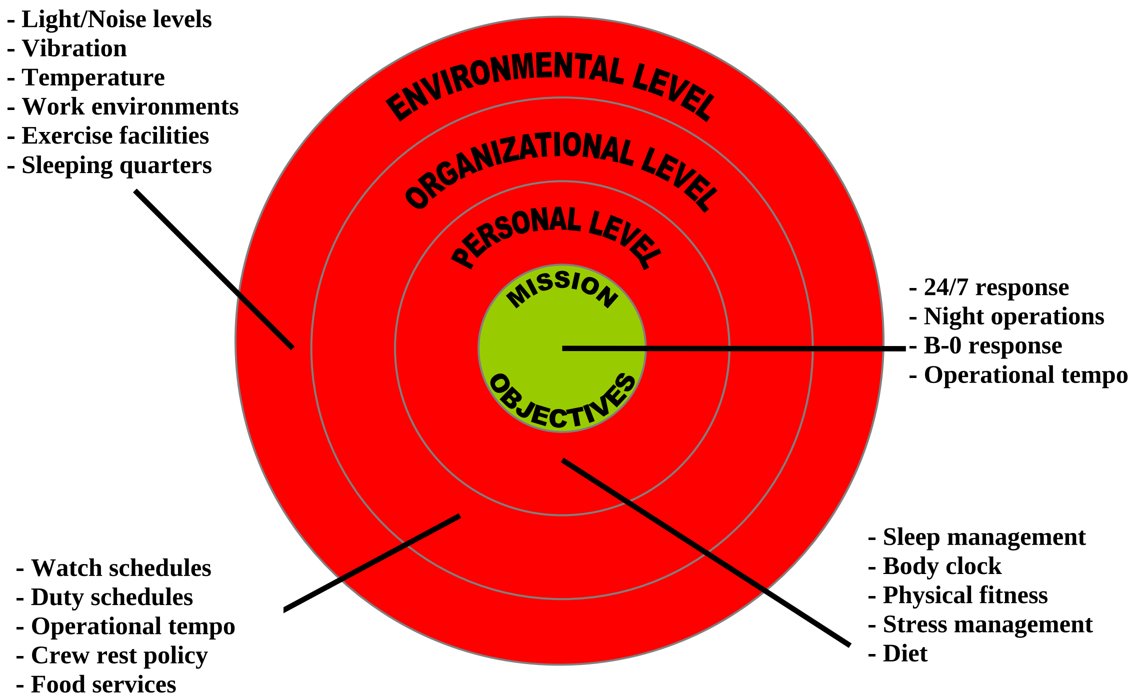

Figure 3. Model of the CEM systems-oriented approach.

Exploring endurance risk factor controls

If you have not completed an RFA (Step 2) please do that now, an endurance risk profile is required to complete Step 3. With the endurance risk profile on the CEM Tool screen, a 'drill-down' approach is used to move the user from general to more specific information related to controlling a particular risk factor. To drill-down for control information, left-click on the colored bar for the risk factor of interest. The CEM Model appears (Figure 4). The user now left-clicks on each of the levels to bring up control information related to this level.

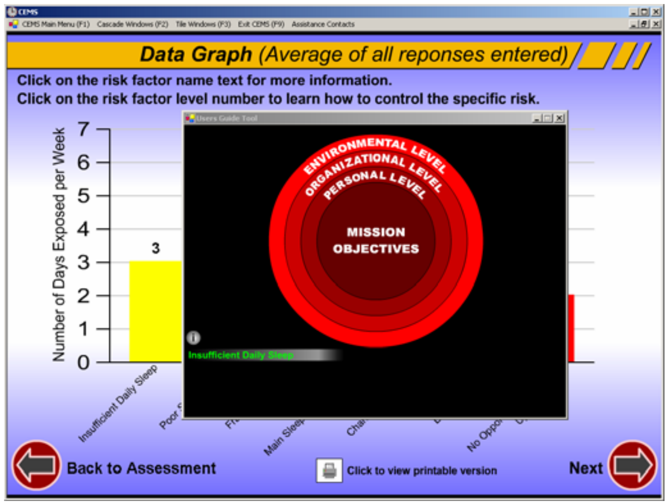

Figure 4. Screen for accessing risk-factor controls by system level.

For example, left-clicking on 'Personal Level' in Figure 4 brings up the list of controls shown in Figure 5. Left-clicking on the **Assess/treat sleep disorder** control brings up information specific to this control (see Figure 6). This process is repeated for each of the four levels composing the CEM Model.

Figure 5. Personal Level controls information related to Insufficient Daily Sleep.

The lower left quadrant of the screen indicates where you are within the RFA and CEM Model so the user can maintain awareness of where they are in the control exploration phase. For figure 6, we know that the risk factor under consideration is "insufficient sleep duration", we are exploring the "personal level" of the CEM Model, and are looking at the "assess/treat sleep disorder" control.

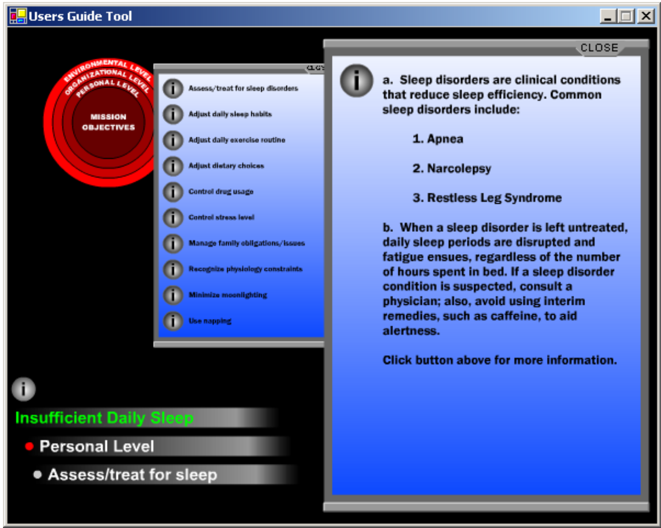

Figure 6. Specific control (Assess/treat sleep disorder) for the Personal Level.

It is recommended that the WG record each potential control and answer the following questions concerning it: (1) What risk factor does it control; (2) Why will it control this risk factor; (3) How will it control this risk factor? The answer to these questions will help the WG determine if and how the control might affect other levels of the system.

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

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

Example - Endurance management plan development

An actual endurance management plan is presented below to illustrate the thoughts, activities, and documentation of one WG executing Step 3 of the CEM implementation process.

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

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

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

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

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

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

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

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

- Create 'pipe free' time periods (prior to 1015 or after 1945) (ST)
- Berthing areas based on watch schedule versus departments (LT)
- Watchstations modify their own watches to meet sleep objectives (LT)
- Weekly berthing area cleanups Friday afternoon versus Sat morning (ST)
- Keep training within core hours of 1015-1600 (ST)
- Authorize Saturday late rack (LT)
- Eliminate 'reveille' and 'taps' pipes (ST)
- Daily berthing cleanups in the afternoon vice morning (ST)
- Adjust length of watches (LT)
- Change lighting – examine research around lighting and sleep patterns (LT)
- Designate 'night workers' (LT)
- Examine boarding/boarding team process (LT)
- Establish 1-3 watch rotations for watchstanders in which their only work is to stand watches. Other qualified personnel are day workers. Rotate through watchstanding/daywork on a 2-week schedule. (LT)
- Examine all hands evolutions (LT)
- Modify crew entertainment options. Separate crew lounges from sleeping areas (LT)
- Increase cross-training (LT)
- Reduce noise in berthing areas (ST/LT)
- Assign people to watches based on personal desires (i.e., acknowledging that some people are 'night people' and some are 'day people') (LT)
- If possible, push to make brief stops for fuel (BSF) into remain overnight (RON) with increased recreational activities and to make up lost sleep (LT)
- Seek ways to improve attitude and morale as ways to increase endurance (LT)
- Examine patrol lengths (LT)
- Balance admin/watchstanding requirements (LT)

This list provided a good starting point for the WG to explore options to control endurance risk. The WG explored the best combination of ideas that would control endurance risk and allow the unit to meet mission needs and responsibilities.

After compiling a list of potential controls, the WG is ready to begin developing a plan for controlling endurance risk. This plan should identify the risk factors, potential controls, and implementation strategy. The what/why/how questions posed earlier will be useful to defend the plan and answer questions from senior cadre members. Getting buy-in from all command staff and department heads is critical to the success of the plan.

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

Note. It is important to recognize that it is not feasible for the CEMS tool to identify all possible controls for each endurance risk factor. The CEMS tool provides the more critical and obvious controls for each risk factor, but users must use their operational experience to supplement the controls with additional options that they have used or considered in the past. Because effective endurance risk control options must accommodate the mission needs, the true expertise for performing this CEM step resides with the unit members who know the operational environment. The CEMS provide an orientation for the risk control process by identifying the types of controls to consider for each level of the CEM system model.

Step 4 - Deploy the CEM plan

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

Successful implementation of CEM plans requires the execution of 5 tasks (**Table 2**).

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

Table 2. The five tasks for implementing a CEM plan.

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

> **Task 1 - Education** is the cornerstone to any CEM plan. The focus should be on disseminating accurate information on the questions of “what is endurance” and “what factors affect endurance”. Education should be directed at all levels of the unit – command, supervisory and crew, and focus on dispelling misconceptions

and misinformation about endurance. Recommended education topics include the physiological need for sleep, how sleep is disrupted, the consequences of disrupted sleep, approaches to promote and protect sleep at work and home, and diet considerations, as well as various personal and work-environment issues, including stress, exercise, alcohol and medication use, and ambient environmental factors.

A particularly effective way of introducing CEM principles and concepts is to make CEM a topic during unit safety training events. The basics of CEM can be taught in this context at a gradual pace. After the training is complete, the CEM plan developed by the WG in Step 3 can be introduced and discussed at length. The CEMS Tool provides all the necessary information and presentation material to conduct the education and training. Simply go into the "Endurance Resources" within the CEMS Tool to access the Education Resource Library and online Guide.

The specific elements of a new CEM plan should not be deployed until all personnel have been educated, and have had an opportunity to comment on the details of the plan. Providing members with the opportunity to comment on the CEM plan will build ownership and improve acceptance of the CEM plan. Depending on the number and type of changes proposed in the CEM plan, it might be useful to implement the changes gradually, or in phases, to minimize the amount of change that personnel must deal with at any one time. Remember, **change is stressful**!

Task 2 - Environmental changes are directed at removing, or minimizing, environmental barriers that can lessen the effects of endurance risk controls. For example, changing work schedules to provide more opportunity for sleep without considering the disruptive effects of environmental factors like noise, light, temperature, and bedding on sleep may result in no improvement to the sleep endurance risk factor. For endurance risk controls to be effective, environmental factors that can also affect the endurance risk must first be controlled. It is important to note that environmental changes are not isolated to the physical environment, but also include organizational and cultural climate.

Task 3 - Light management is essential if endurance-management efforts include physiological adaptation to nighttime schedules. Task 1 should educate members that light is the primary cue to the biological clock that influences circadian rhythms, and that exposure to specific light sources at prescribed times improves alertness and promotes physiological adaptation to nighttime work schedules. The Endurance Resources section of the CEMS Tool provides specific guidance for using light management. If night time work is identified as a risk factor, light management must be considered in the control options.

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

These individuals play a critical role in promoting and advancing endurance management efforts.

Task 5 - Schedule changes are often necessary for aligning human physiology with operational/mission requirements. Many work schedules in use today unwittingly place crewmembers at risk for compromised endurance. However, most of these schedules can be corrected without compromising operational or mission response capabilities, and within staffing constraints. In fact, these schedule modifications improve alertness, health and wellbeing, and operational readiness. A schedule evaluation tool is provided in the Endurance Resources section of the CEMS Tool. This tool should be used to evaluate schedules for elements that increase exposure to endurance risk. A detailed discussion of work schedule issues can be found in the CEM Guide that is part of the Endurance Resource in the CEMS tool.

A cautionary note: There may be a desire to address the 5 tasks in order of convenience, ease, or personal belief for what will fix endurance problems. All too often, WGs focus solely on work schedule issues as the cause of their endurance risk, and discount or ignore the other tasks. Even if work schedules are contributing to endurance risk, implementing changes without first executing the previous 4 tasks increases the likelihood that the changes will fail. Tasks 1-4 creates the environment for change by: 1) educating members on why change is needed, 2) modify the environment to accept/support the change, and establish a support infrastructure to promote and maintain the changes. These tasks have been tested and validated in numerous CG operational environments.

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

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

Step 5 - Assess the effectiveness of the CEM plan

The final step to the CEM program implementation process is to evaluate whether the changes deployed under the CEM plan produced the desired results. Because change is potentially stressful and disruptive to crewmember physiology, and may require conducting operations differently (e.g., reducing the number of pipes including taps and reveille) which can create stress and anxiety in the crew, it is recommended that the CEM plan evaluation be delayed at least 30-60 days to allow personnel ample opportunity to acclimate to the changes. In some instances, the changes enjoy a ‘honeymoon’ period that typically dissipates in 30-60 days. It’s important, therefore, to allow a sufficient period for reality to take hold before beginning any assessment. However, if there is immediate evidence that changes are creating safety or performance concerns, these concerns must be corrected immediately.

By keeping lines of communication open and requesting feedback from unit members, the WG should be able to gather sufficient information to determine how well the CEM plan changes are being received by unit members, and whether endurance risk is reduced. It is common for crewmembers to express or demonstrate negative feelings immediately after changes take effect – as their respective physiologies adapt to the changes – but this negativity should mitigate after 1-2 weeks. If negativity continues, the WG should first ensure that all the elements of the CEM plan have been implemented, and that the 5 tasks for CEM plan deployment have been performed. For example, if schedule changes are made but improvements to berthing areas are not, or if personnel who are placed on a new schedule do not receive a proper regimen of light exposure, the negativity of those affected will not improve.

The CEM plan evaluation begins by repeating Step 2 of the CEM process (Conduct a Risk Factor Assessment) and generating a new endurance risk profile. The WG then compares the profiles from the first assessment (before the CEM plan implementation) with the profile generated after the CEM plan was implemented. The comparison of the profiles will show how the CEM plan changes affected exposure to the 15 endurance risk factors. Depending on results, the WG may decide to modify the CEM plan, create a new CEM plan, or leave things alone. If a new plan or modifications are required, the WG should progress to Steps 3 – 4 of the CEM process to explore and deploy the changes. After the new changes are deployed, the WG would wait another 30 – 60 days and conduct a new evaluation. Again, a new endurance risk profile is generated and compared to the previous profiles to determine whether the changes produced the desired effects. The intent of Step 5 is to provide an opportunity to make strategic ‘course corrections’ at the earliest opportunity. Toward this end, the WG cycles through the entire CEM implementation process to modify, refine, or even replace the current CEM plan in accordance with the results of each follow-up evaluation.

In summary, it should be evident that CEM is not a one-time assessment. Successful CEM initiatives are dynamic and form a continuous feedback loop through the 5-step process. It is highly recommended that units establish a WG to lead and coordinate their CEM activities. The CEMS tool provides all the instruction and resources necessary to identify endurance risk and to systematically and objectively explore strategies to mitigate and control the risk. Anyone, whether or not you are familiar with endurance principles, can use the CEMS tool to manage endurance risk. The CEMS tool offers tutorials to assist you through the resources and tools. These tools and processes have been tested and validated thoroughly in CG operational environments.

In the words of one of the CEM program’s earliest supporters, Vice Admiral Terry Cross, “Use it! It works”!