

UNCLASSIFIED



Force Operational Notes Newsletter

Special Crew Rest Edition

Appendix A: Lessons Learned/Best Practices

Appendix B: Sample Watch Rotations

Purpose

An adequately rested crew is critical to optimal performance. Historically, our submarine culture has not fully appreciated the value of crew rest. When applied and managed properly, crew rest acts as a force multiplier - one that can enhance all aspects of submarine training, maintenance, and operations. The objective of this article is not to prescribe a “one-size fits all” solution for how to manage crew rest; rather, it is to provide Command Teams guiding principles for rest management onboard our submarines. Specifically, the primary objectives of this newsletter are to educate the Submarine Force on the importance of crew rest, discuss how to best manage it, and promulgate best practices that facilitate crew rest and provide an additional margin of safety to all Submarine Force operations.

Background

Submarine mishaps, near misses, and significant events (collectively herein referred to as “mishaps”) occur for a variety of reasons. We typically focus our corrective actions on the direct causes associated with a given mishap, such as proper operation of equipment, procedural compliance, operator and supervisor level of knowledge, and operational skills. While it is clearly necessary to address these deficiencies, it is equally important to identify the underlying conditions that led or contributed to incorrect actions. Lack of adequate rest is an underlying factor in many major mishaps. Our training, organization, and procedures assume watchstanders are alert and able to focus on and accomplish their tasks. Our ability to correctly identify force-wide corrective actions with lasting impact relies on the fundamental assumption of a well-rested crew.

Ensuring adequate crew rest is the responsibility of both the individual and the chain-of-command. Over the past 50 years, submarine watchstanding schedules have not been optimized for crew rest. The most common schedule, 6hrs-On/12hrs-Off (6/12), does

UNCLASSIFIED

not take into account basic principles of human circadian biology. Prior to the early 1960's, the Submarine Force (and many other communities in the U.S. Navy) operated on a 4hrs-On/8hrs-Off (4/8) three-section watch schedule, which aligned with our natural 24-hr circadian rhythm. The 6/12 rotation was introduced at the beginning of the nuclear submarine era, which brought with it increased off-watch duties and longer, more sophisticated watch turnovers. The 12-hour off-watch period afforded by the 6/12

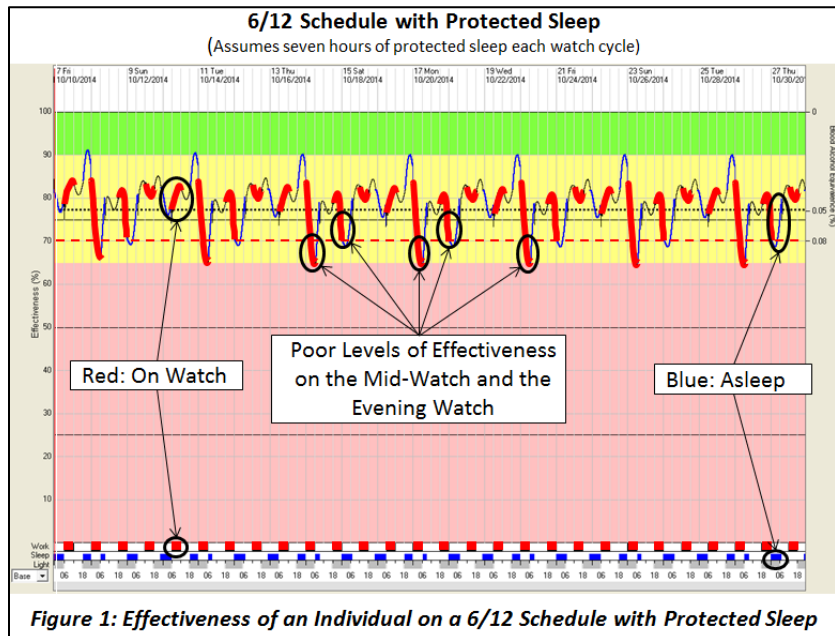


Figure 1: Effectiveness of an Individual on a 6/12 Schedule with Protected Sleep

schedule seemingly provided a better opportunity for individuals to accomplish their work while still receiving adequate rest in a single continuous period of sleep.

If managed carefully, a 6/12 schedule can result in reduced but manageable individual effectiveness (see Figure 1).¹ The risk on the mid-watch and, to a lesser extent, the evening watch, can be mitigated by minimizing activities that would impact dedicated

sleep times. The acceptability of the 6/12 schedule assumes personnel routinely receive 7 hours of sleep per day, which requires a high level of schedule discipline by all hands. More typically, an individual's sleep at sea is not protected, allowing admin, training, maintenance, and "urgent" matters to routinely shorten or interrupt a person's sleep. This results in extreme levels of fatigue and significantly reduced levels of effectiveness over the course of time (see Figure 2 for an example of a poorly managed sleep schedule).

Research tells us that the average person needs about 8 hours of sleep per 24-hr day to function optimally over a long period of time. That sleep should be at the same time each day and as continuous as possible,

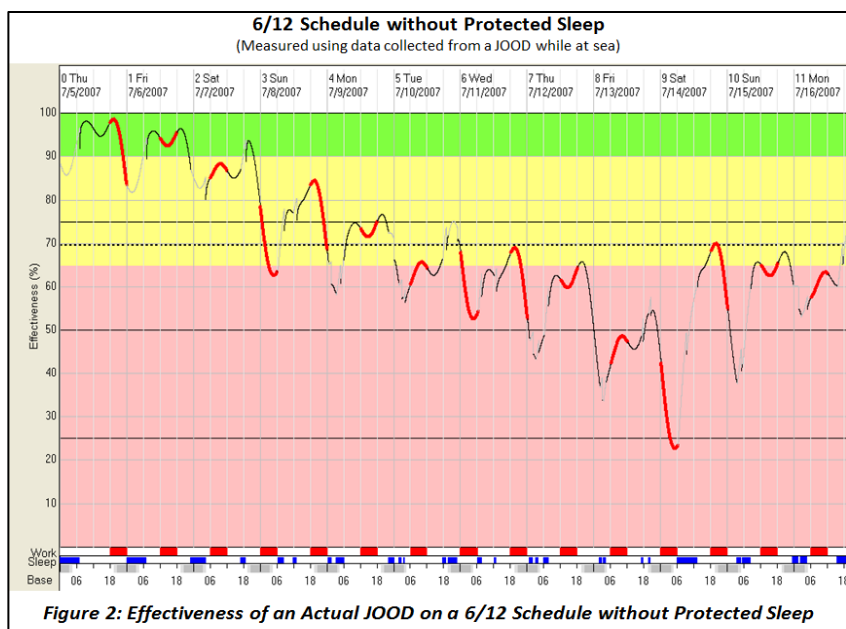


Figure 2: Effectiveness of an Actual JOOD on a 6/12 Schedule without Protected Sleep

although napping can be used to make up for shortfalls. Studies have found that individuals who experience total sleep deprivation (for example, a crewmember who remains awake for a 36-hour period) are more apt to understand the severity of their sleepiness, and, therefore, are more likely to use caution when completing their daily tasks to avoid mistakes. On the other hand, individuals experiencing chronic partial sleep deprivation erroneously believe that they are performing well, when in fact, they are impaired as a result of excessive sleepiness.

It is physically impossible for a person to learn to sleep less per day than their body requires; to stay alert and “get by” if sufficiently motivated. Although a sleep-deprived person can perform well on a simple task for a short period of time, over a period of days, simple decision-making degrades in even the most disciplined and motivated individuals. Regardless of how hard a person may try to stay awake, no amount of safety precautions can prevent a person from falling asleep, experiencing repeated “micro-sleeps”, or making poor decisions once they have accumulated a significant sleep debt. **Put simply, failure to get adequate continuous sleep every day results in overly fatigued personnel who, in a matter of days, function at a deficit similar to being intoxicated.**

Circadian Rhythms

Our bodies are naturally attuned to a 24-hour rhythm that is driven by external cues such as light, mealtimes, etc. Without these cues, our bodies exhibit what is referred to as “free-running” behavior, leading to problems with vigilance and perception, decision-making and judgment, complacency and

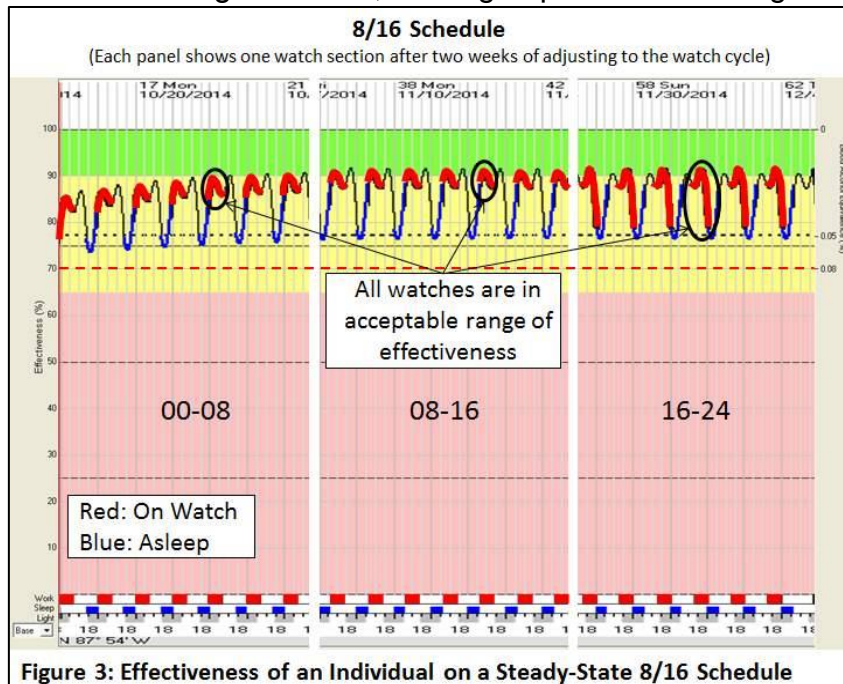


Figure 3: Effectiveness of an Individual on a Steady-State 8/16 Schedule

inaction, learning and memory, as well as mood and health. Numerous studies clearly demonstrate that a 24-hour day enhances individual performance.

In May 2013, 8-hour watches were authorized onboard our submarines. Commands were encouraged to implement watchbills that achieve a 24-hour circadian rhythm and provide 8 hours of protected sleep at the

same time each day. A force-wide review indicates that approximately 60% of the force has tried a circadian-friendly watchbill. Many of those who implemented it experienced positive results in crew performance and morale (see Figure 3). Most commands

UNCLASSIFIED

implemented either a “Straight-8s” watchbill, or an 8-hour rotation that included an 8-hour period commonly referred to as “All Hands Awake.”

Note: The “All Hands Awake” period is established as the time when ship-wide, departmental and/or divisional evolutions and training sessions are scheduled. Much of the crew may not be directly involved in these events, and are allowed to sleep during this period.

Some crews have used a variation of a circadian watchbill that limits the maximum watchstanding duration to 6 hours, eliminating the challenge of standing an 8-hour watch. This watchbill, along with a new example of an 8-hour watchbill, are described in Appendix B.

There is not a “one-size fits all” circadian schedule for every ship and every circumstance; however, **crew rest must be a routine part of our operational process. Supervisors must be aware of the impact that circadian rhythm and continuous sleep have on watch team effectiveness.** Rather than prescribe exactly how to accomplish this, it is more effective to provide commands with guiding principles for crew endurance, best practices, and lessons learned from those who have attempted it.

Guiding Principles

1. Protect sleep. Supervisors and shipmates should place a high priority on protecting the sleep periods of other crewmembers. There are consequences to racking out an individual during their down-time; think ahead to minimize the need to do so. This also applies to your supervisors and command leadership, and may require re-thinking which routine notifications and reports actually require interrupting their sleep.
2. When appropriate, employ a 24-hour circadian rhythm schedule that affords personnel the opportunity to sleep at the same time each day. Over the long-term, when coupled with protected sleep, a 24-hour schedule provides the highest effectiveness across all watch teams. However, the risks associated with the first few days of the midwatch of a 24-hour schedule tend to be higher than those of an 18-hour schedule, so commands should weigh the projected length of the underway against the long-term benefit of a 24-hour schedule when determining which schedule to implement. Note that these same adjustment risks are seen when periodically rotating watch teams (spinning), as discussed below.
3. Understand that more training is not necessarily better training. There is little benefit in training a sleep-deprived person, as research has shown they cannot retain the information.
4. Scientific evidence has shown:

UNCLASSIFIED

-Daily partial sleep deprivation over a period of days/weeks may be worse than staying awake for 24 or more hours straight.

-Recovery from chronic partial sleep deficit may take several days (equalizing with one long sleep period is not sufficient).

-Learning and decision making are impaired even with mild sleep deprivation.

-Your body cannot learn to overcome sleep deprivation.

-Caffeine and energy supplements may temporarily induce sensations of alertness, but they do little to reduce the negative impact of an individual's sleep deficit.

In summary, commands should keep in mind that the overarching goal is to reduce fatigue and improve effectiveness by providing personnel with adequate sleep at the same time every day. Each command retains the flexibility to determine what type of schedule is appropriate at any given time and operational schedule. As the Submarine Force continues to implement circadian and continuous sleep schedules at sea, other innovative approaches and best practices for Crew Rest Management will be discovered and promulgated as part of our Force Improvement Program. Additional lessons learned and feedback are welcome, and should be emailed to: USFF_COMSUBLANT_NFLT_Sub_Lessons_Learned@navy.smil.mil.

Notes

1. The sleep graphs in this newsletter illustrate an individual's predicted effectiveness under various watchbill and sleep parameters, and were developed using the Fatigue Avoidance Scheduling Tool (FAST) program.

Accident risk is inversely related to FAST predicted effectiveness scores. Studies have shown that human factors-related accidents are 65% more likely to occur with predicted effectiveness scores of 50 or less, and that scores below 70 are associated with increased fatigue-related errors. These studies have also shown that human factors-related accidents that occur when an individual's effectiveness level is less than 77 are two and a half times more costly than similar accidents that occur when an individual's effectiveness level is greater than 90.

Effective FON Messages:

1. Appendix A: 03-12 through 04-12, 03-13 through 05-13, and 01-14 through 06-14.
2. Appendix B: 06-12 through 07-12, 01-13 through 10-13, and 01-14 through 04-14.

Approved,

CAPT Chris Harkins

CSL Training, Tactical Development, Doctrine & Operational Safety (N7)

CAPT David Kirk

CSP Training, Tactical Development, Doctrine & Knowledge Management (N7)

Appendix A: Lessons Learned/Best Practices

1. Strive to achieve an extended sleep period for every crew member at the same time every day.
2. Achieving 8 hours of continuous sleep may not be practical. The deciding factor is the length of watches; specifically, the time off between watches. If unable to achieve 8 hours of uninterrupted sleep, an individual can compensate for the sleep loss with daily naps. Every minute of napping adds to the alertness of an individual once fully awake. However, naps greater than 30 minutes but less than 2 hours in length can result in a person feeling groggy for a short period after waking. Therefore, ensure sufficient time is taken to fully awaken before performing activities that require alertness after naps of this length.
3. Commands that spin in a circadian schedule should carefully manage the risk associated with these shifts. Every spin has the same effect as “jet lag” and may take several days to recover from, depending on the direction of the shift. Medical research indicates that the rotation to a new schedule works best when sleep time moves in a direction that requires personnel to go to sleep later than they previously did (like traveling westward), rather than sooner. Many boats make the shifts during the weekend by temporarily shifting to 6-hour watches for one day before returning to 8-hour watches, but this results in an “eastward” vice “westward” rotation, which can drastically affect watchstander effectiveness. Bottom line: the impact on fatigue by changing sleep schedules must be taken into account whenever a new watch rotation is adopted. When spinning, aim to remain in the new routine for at least 3 weeks.
4. Consider the amount of required watch-preparation time, and the time at which it occurs, when estimating sleep opportunities. Do not perform wakeups unnecessarily early; foster efficiency in watch-preparation/turnover processes.
5. Seek high quality sleep.
 - a. When not assigned the mid-watch, your protected sleep should be during normal nighttime hours. This is especially important if the ship is on a 6/12 schedule to allow for better quality of sleep and to support all-hands training and supervisor management events during the day.
 - b. Avoid caffeine within 6 hours of sleeping; refrain from eating a heavy meal or exercising right before bedtime; refrain from doing things that shorten your sleep period, such as playing games on a tablet late at night, or setting an alarm clock to awaken early with the intention of automatically pressing the snooze button. When feasible, avoid bright lighting prior to going to bed, as it will phase-delay actual sleep time by suppressing melatonin, causing you to lie wide awake in your rack. Similarly, lighting in berthing areas should be kept low at all times.
6. The single biggest concern with eight-hour watches is the likelihood for watchstanders to have fatigue and hunger set in over the course of a watch. A short

UNCLASSIFIED

break during the middle of watch can mitigate some of these concerns. In addition, a number of boats have made snacks available to their watchstanders during these breaks. However, additional watch reliefs add risk, so these transitions must be managed just like any other watch relief.

7. Meal Management. A watchbill that uses 8-hour watches presents several challenges in meal management. Meals are usually served once every eight hours, and meals can become a source of irritation when watch teams find themselves eating “dinner” for “breakfast” for two weeks at time, or if they miss out on dinner for a 3-week period. Some crews rotate their meals so that a different type of food is served for a given meal hour. Others have opted to provide a second type of meal at each setting, such as a breakfast option at dinner. One SSN that recently utilized 8-hour watches for an entire deployment without spinning rotated their meals every two weeks.

The most important aspect of meal management for circadian schedules is advanced preparation. Deploying without accounting for a circadian schedule can lead to an unexpected depletion in food stores. Initiatives to provide snacks and meal variety can rapidly counter the inventory benefits of serving one less meal per day. Close supervision of the development and implementation of a meal plan supportive of the circadian schedule is critical.

8. Organizations should prepare for change before implementation. Buy-in by the majority is critical to success. The science showing the performance of overly tired personnel to be significantly impacted is irrefutable. The Naval Submarine Medical Research Laboratory (NSMRL, the principal source of scientific information contained herein) study titled “Implementation of the 24-hour Duty Cycle aboard U.S. Submarines: Initial Guidance for the ‘All-Hands Awake’ Watchbill” is available on the CSL website at: <http://cfo.fleetforces.navy.smil.mil/csl/n7/Shared%20Documents/Forms/Descriptive.aspx>

This study provides specific rationale for the use of 8-hour watches. It also includes a thorough discussion of the underlying fundamentals of circadian rhythm and continuous sleep, as well as providing a detailed description of a way to rotate watches in a “westward” vice “eastward” direction. Its sister document, “Scientific rationale for the ‘All-Hands Awake’ 24-hour Watchstanding Schedule,” by NSMRL is also available at the same location.

UNCLASSIFIED

Appendix B: Sample Watch Rotations

Two creative approaches to circadian watchbills, both proven successful on submarines, are discussed on the following pages.

Hybrid 8s Watchbill

The Hybrid 8s watchbill is a three section, 24-hour watchbill using 8-hour watches that mixes the two basic 8-hour rotations. The Hybrid 8s combines a Straight 8s watchbill for the crew with an All Hands Awake watchbill for supervisors. As depicted in Figure 4 below, the Straight 8s watchbill has all sections with dedicated sleep periods during their on-coming time, and their off-going time is available for maintenance, cleaning, training, qualifications etc. As shown in Figure 5, the “All Hands Awake” model has one section with a dedicated sleep period on-coming, one section with a dedicated sleep period off-going, and one section that sleeps four hours after watch and four hours before watch, creating one 7-8 hour period where all hands could be awake if the ship’s training schedule requires it.

	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1	Watch								Training, Maint and Quale								Sleep							
2	Sleep								Watch								Training, Maint and Quale							
3	Training, Maint and Quale								Sleep								Watch							

Figure 4: Crew Schedule on Hybrid 8s

	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
	All Hands Awake Period																							
1	Watch								Training, Maint and Quale								Sleep							
2	Sleep				Training, Maint and Quale				Watch								Training, Maint and Quale				Sleep			
3	Sleep								Training, Maint and Quale								Watch							

Figure 5: Supervisor Schedule on Hybrid 8s

In the Hybrid 8s plan, the crew is on a Straight 8s schedule, and most of the ship supervisors (except EOOWs and EWSs) are on an All Hands Awake rotation. This Hybrid 8s watchbill alleviates many concerns. For example, off-going personnel are available for maintenance and other evolutions, supervisor sleep is protected so they can be utilized during the normal workday, and competition for finite assets like computers and physical fitness equipment is reduced. This watchbill also addresses the primary concerns of both parties involved: deck plate sailors, who often want the normal routine of oncoming sleep, watch, off-going maintenance/training/personal time (Straight 8s model); and the supervisors, who want to get a guaranteed 7-8 hours of sleep at the same time every day so they can be awake for the necessary meetings, operational planning and crew management during the day, without accumulating sleep deficit (All Hands Awake model).

UNCLASSIFIED

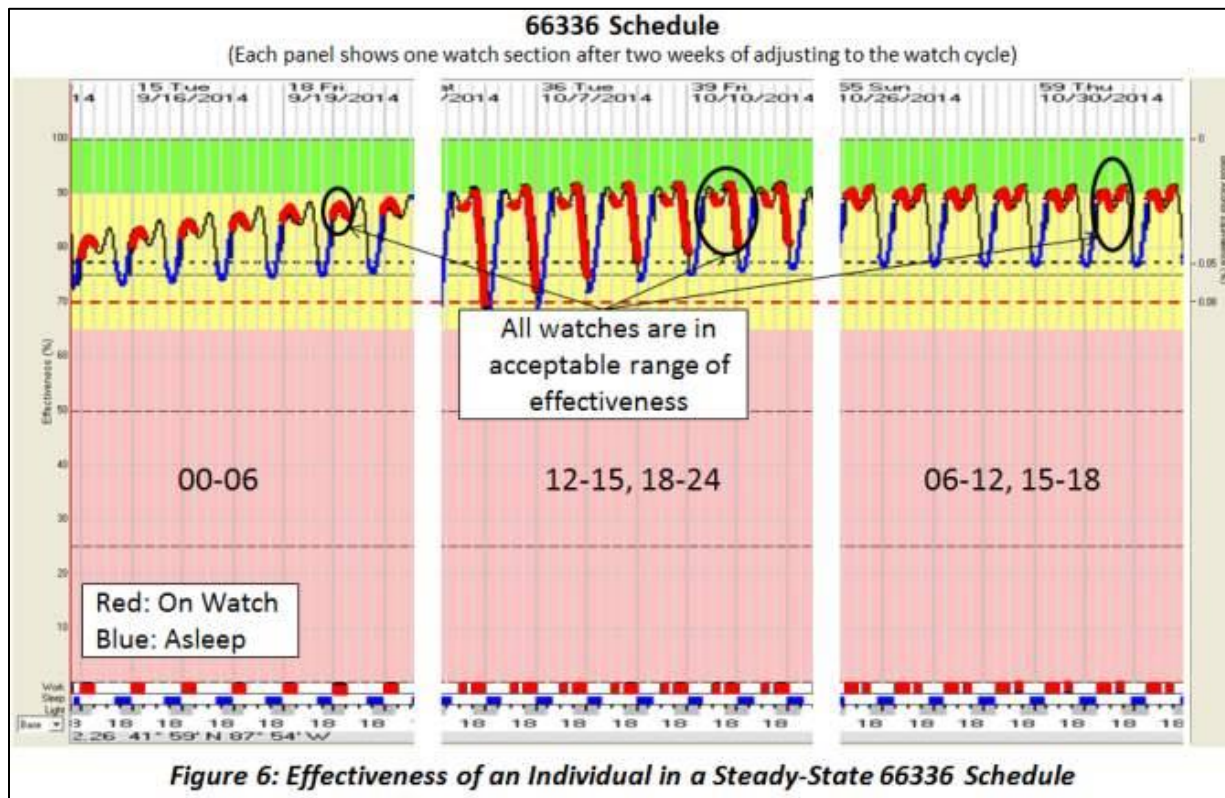
The Commanding Officer of the boat that initiated the Hybrid 8s watchbill observed, "The crew was the best rested crew on deployment I have seen in my 19 years of service, especially the officers. They were able to accomplish so much more than normal...and they were still getting good sleep."

Modified 6s Watchbill

The Modified 6s watchbill (6-6-6-3-3 or 6-6-3-3-6) is a three-section watch bill that limits the maximum length of a watch to 6 hours while still achieving a 24-hour schedule. The midnight, morning, and afternoon (or evening) watches are 6 hours long. The remaining 6-hour block is split into two 3-hour watches.

Note that in order to achieve circadian rhythm, this is not a straight 1-2-3 rotation. Mid-watch personnel only stand the mid-watch, and the other two sections cover the rest of the 24-hour period. The resulting daily 6-6-3-3-6 watchbill would look like this (see Figure 6):

- 0000-0600: Section 1
- 0600-1200: Section 2
- 1200-1500: Section 3
- 1500-1800: Section 2
- 1800-2400: Section 3



UNCLASSIFIED

Despite the utilization of 6-hour watches in this watchbill, seven hours of continuous sleep can be scheduled for each section. For example:

Section 1 Sleep: 1600-2300

Section 2 Sleep: 2200-0500

Section 3 Sleep: 0100-0800

The Modified 6s watchbill has been found effective in addressing concerns about the frequency of meals and watchstander fatigue that can occur over 8 hours of intense ship operations.

*As a reminder, engineering watchbills that provide less time between watches than the length of the watch previously stood require the Engineer's express permission. A watchbill signed by the Engineer will meet this requirement for Modified 6s.