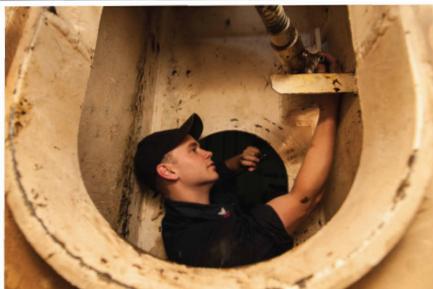




Version 2.0

NPS CREW ENDURANCE HANDBOOK

A Guide to Applying Circadian-Based Watchbills





Photographer: MCSN Drace Wilson

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This Handbook is dedicated to the men and women who serve in the United States Navy.

All photos used for the the *Crew Endurance Handbook Version 2.0* are public domain and can be found at www.dvidshub.net

Cover Photos:

Sailor At Work (Taken 05.15.2015)
Trincomalee, Sri Lanka Arrival (Taken 08.23.2018)
Unrep-Sep 4 (Taken 09.03.2018)
Maintenance, USS BATAAN (Taken 04.20.2020)
Makin Island Underway (Taken 10.12.2020)
Nimitz Sailors Wave Farewell (Taken 11.20.2020)

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SN Darren Newell
MC1 Harry Andrew D.Gordon
PO3 Charles DeParlier



Executive Summary



The most effective weapon system on a warship is a well-rested crew.

A circadian-based watchbill and supporting schedule will result in a more effective and resilient crew. Crewmembers will be more likely to have the reserve strength needed to face unexpected challenges and overcome obstacles if they get the proper rest.

Commands should pursue this goal single-mindedly, using every resource available to them to provide crewmembers with protected sleep opportunities at the same time each day.

Only with adequate rest will the crew be maximally effective and alert. Just like a degraded and non-functioning combat system, a sleep-deprived crew will not perform up to its potential—and poses a significant risk to the mission.

This Handbook...

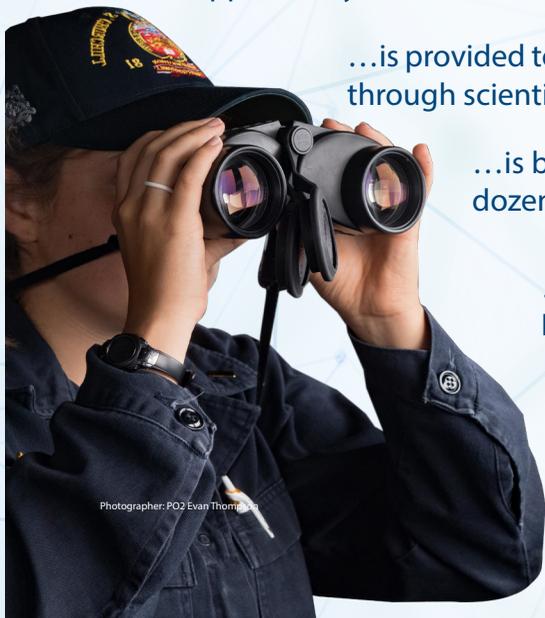
... is built upon the idea that a ship's crew must be well-rested to achieve the most effective operational performance. Building a ship's schedule that optimizes Sailor performance and well-being for all personnel is an important goal that commands must pursue.

...is not meant to be overly prescriptive. Because all ships (and crews!) are different, describing the precise steps to reach crew endurance is impossible. This handbook provides commands with guiding principles for attaining crew endurance—based on best practices shared by actual fleet sources and supported by the latest scientific evidence.

...is provided to commanders and their staff to share some of the valuable lessons learned through scientific investigation and trial and error by other Naval commanders.

...is based on data collected over the last 20+ years from hundreds of Sailors on dozens of ships.

...is a work in progress! Please share the lessons you learn with the Crew Endurance Team so that we can continue improving this handbook.



Photographer: PO2 Evan Thompson

www.nps.edu/crewendurance



WHAT IS CREW ENDURANCE?

The ability to maintain optimal warfighting performance while enduring job-related physical, psychological, and environmental challenges.

WHY DOES IT MATTER?

Operational effectiveness depends on crew endurance. If crewmembers are overly fatigued, mission accomplishment, performance, and safety are in jeopardy. Morale suffers. Chronic sleep debt has long-term physical and mental health consequences, and degrades human performance.

HOW CAN IT BE IMPROVED?

One method with proven results is the use of circadian-based watchbills. Numerous shipboard studies have shown how a circadian watchbill and schedule can improve operational readiness, enhance productivity, reduce stress, and improve morale, especially over a long deployment.



Photographer: PO2 James Hong

Sleep is a Weapon.
A Clear Mind is a Combat Edge.

WHAT IS A CIRCADIAN-BASED WATCHBILL?



“Circadian-based watchbill” is the term used for a work and rest schedule that conforms to a 24-hour day, allowing individuals to work, eat, and sleep at approximately the same time each day.

A circadian-based watchbill aligns with the naturally-occurring 24-hour rhythm in humans which drives all biological processes, down to the cellular level. It enables personnel to perform at their best.

When you combine the number of hours spent **on watch** with the number of hours **off watch** (whether doing other work, eating, or sleeping), a circadian-based watch system always add up to 24 hours. The central characteristic of a circadian- based watchbill is that individuals **go to bed and awaken around the same time each day.**



Work, eat, and sleep at the same time each day.

HOW CAN I SET UP A CIRCADIAN-BASED WATCHBILL?



Photographer: Michael S. Murphy

Light management is key to a successful circadian transition.

The human body needs time to adjust to any change in the biological day and night. Motivation and effort are simply not enough to maintain alertness at night. Moving the circadian clock requires planning and takes time. If you want crewmembers to be alert for night shiftwork, you must start days in advance to help them shift their circadian clocks.

When you change time zones (either traveling east or west), the hours of daylight also change. A good rule of thumb is that for every hour of time change, it takes about a day for your circadian rhythm to adjust – and this calculation assumes light exposure occurs at the appropriate times!

Jet lag and “shift lag” (rotating to a different shift) have similar effects. The same process is necessary for adapting to night shiftwork but in the case of night shiftwork, the hours of daylight have not changed. Therefore, you need to trick the body into believing that a time zone change has occurred – by managing the body’s exposure to light.

HOW SHOULD I ROTATE SHIFTS?

Generally, watch sections should rotate forward, lengthening the day by an hour or two. Staying up later and sleeping in an hour longer is generally easier than going to bed and waking up an hour earlier.

HOW OFTEN SHOULD SHIFTS BE ROTATED?

The short answer is as infrequently as possible! Once you have adjusted to your schedule, try to stick to it! We recommend that you stay on the same rotation for at least 3 weeks—even longer if possible. Some ships report sticking to the same rotation for the entire deployment, or they rotate with port visits.

Remember that each time the crew shifts to new sleep and work hours, risks will increase. This increased risk will remain until the crew members (and especially night watchstanders) have fully adjusted to their new schedule.



Photo courtesy of the USS Ronald Regan (CVN 76)

Just like crossing over multiple time zones, rotating to a new shift *confuses* the circadian system and increases risk!

HOW SHOULD I TRANSIT TIME ZONES?



Photo courtesy of the U.S. Navy

When transiting time zones, it is generally better to adjust the clock by one hour per day. Try to avoid making large adjustments to the ship's local time.

When possible, ships should advance the clock during the day and turn back the clock at night. If advancing the clock during the day is not possible, remember that advancing the clock at night will result in an hour less sleep for shift workers. Plan to give the crew extra rest -- either the day before or on the following day -- to reduce risk.

When adjusting the clock, the timing of watch relief can be adjusted half an hour earlier than normal so that the extra hour of watch is spread over two watch sections.

When sailing in groups, ships should coordinate time changes as a group. To stay aligned, the CSG/SAG commander should consider issuing guidance for when and how these changes should happen.

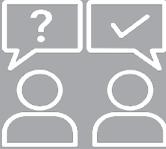
HOW CAN SHIPBOARD ROUTINES SUPPORT CIRCADIAN-BASED WATCHBILLS?

Establish mandatory “protected” sleep periods for each watch section, allowing crew members to sleep in, away from scheduled meetings, training, drills, etc. Maximize protected sleep for night watchstanders.



Hold admin meetings between 0800 or 0900 and 1600.

Hold quarters later in the day, perhaps before lunch.



Consider midday Quarters/ Officers-call.

Eliminating reveille allows early morning watchstanders (“late sleepers”) to sleep in.



Eliminating taps and moving evening prayer to lunchtime allows night watchstanders to continue sleeping.



Meal hours need to cover turnover times, ideally an hour on either side of turnover.

Hold Ops/Intel briefs in the afternoon.



Midrats should include a healthy “midnight snack” for night watch teams.

GUIDING PRINCIPLES FOR CREW ENDURANCE



Focus on having alert and engaged watchstanders.

Learn and understand the effects of good sleep practices.

Use the 24-hour circadian rhythm to set the foundation.

Build a stable daily schedule including the watchbill that maximizes rest opportunities at the same time each day.

One size does not fit all—consider tradeoffs.

Get supporting analysis on your schedule before you make a final decision.



ADM John M. Richardson (Ret.)

Former CNO and Chief of Naval Reactors

REAL WORLD CONSEQUENCES OF VIOLATING GUIDING PRINCIPLES

...had bad experiences on "my ship" because I/we:

Didn't ask for feedback from watchstanders and other crew!

Ignored "off-duty time" by calling off-watch personnel while they are sleeping!

Wouldn't delegate duties of CO/XO to Department Heads!

Tried to apply the same watch template to all situations!

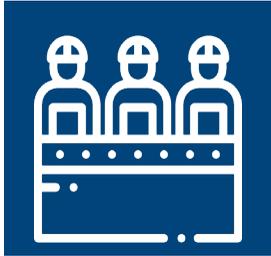
Required the night watch teams to attend morning quarters!

The 1MC announcements kept waking me up!

Refused to allow Department Heads to delegate to principal assistants!

TEN FACTORS TO CONSIDER WHEN CHOOSING THE RIGHT WATCHBILL

THESE FACTORS WILL HELP DETERMINE WHICH WATCHBILL WILL WORK BEST ON YOUR SHIP!



1. Manning

(Quals/Fit/Fill levels)

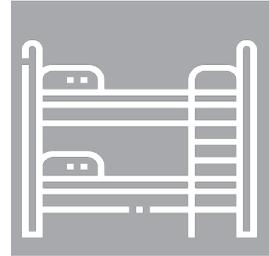


2. Ship daily routines

(e.g., work from 0900-1600)

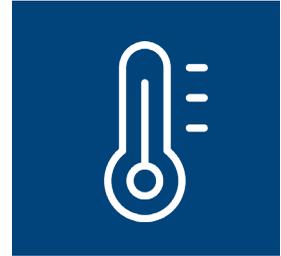


3. Meal hours may need to be extended



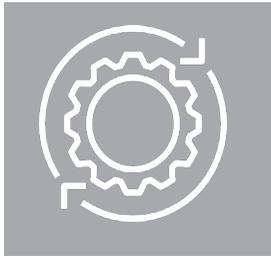
4. Berthing arrangements

(Berth watch teams together)



5. Heat stress limits

(PHEL curves)



6. OPTEMPO



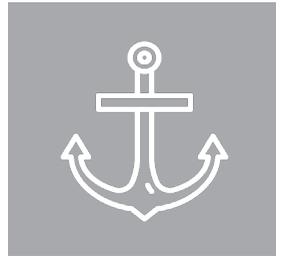
7. Time drills, briefs, debriefs to avoid disrupting sleep.



8. Watchteam SOP for "crisp" turnover.

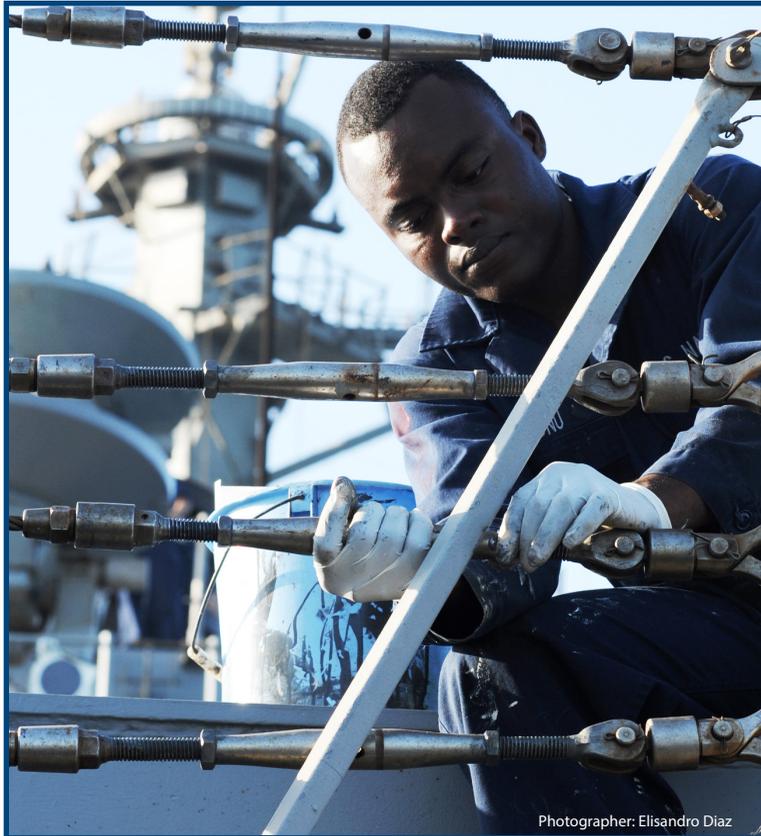


9. Watchteam cohesion



10. Frequency of special evolutions like unreps, flight ops, sea & anchor, and boarding parties.

WHAT ARE THE LIMITATIONS OF CIRCADIAN-BASED WATCHBILLS?



Research conducted by the *Crew Endurance Team* at the Naval Postgraduate School over the past two decades has demonstrated that circadian-based watchbills are superior to non-circadian watchbills. Crewmembers prefer them and their performance and alertness levels are improved. Implemented properly, circadian-based watchbills can help reduce the negative effects of occupational stress on the crew—but they are not a panacea that can fix everything!

A Sailor's watchbill is a major determinant of their daily schedule, mood, overall well-being, and performance. Operational requirements will always affect the ship's schedule—and events will often pop up that cannot be anticipated. In addition, some Sailors are overtasked, working long hours with limited opportunities to sleep as required by their biological clock. These issues and others cannot be addressed by a watchbills alone but must be addressed at the ship, command, or the Navy senior leadership level.

TEMPLATES FOR CIRCADIAN-BASED WATCHBILLS



A Watchbill Template Helps You *GO CIRCADIAN* on Your Ship.

Over the next several pages, we present basic templates for some circadian-based watchbills. For each watchbill, we show a diagram with a notional workday routine for each watch section and for the ship as a whole. The watchbill diagrams split the daily routine into watch/work periods, protected sleep periods, and personal time. The bottom row on each watchbill template shows an example daily routine of the ship.

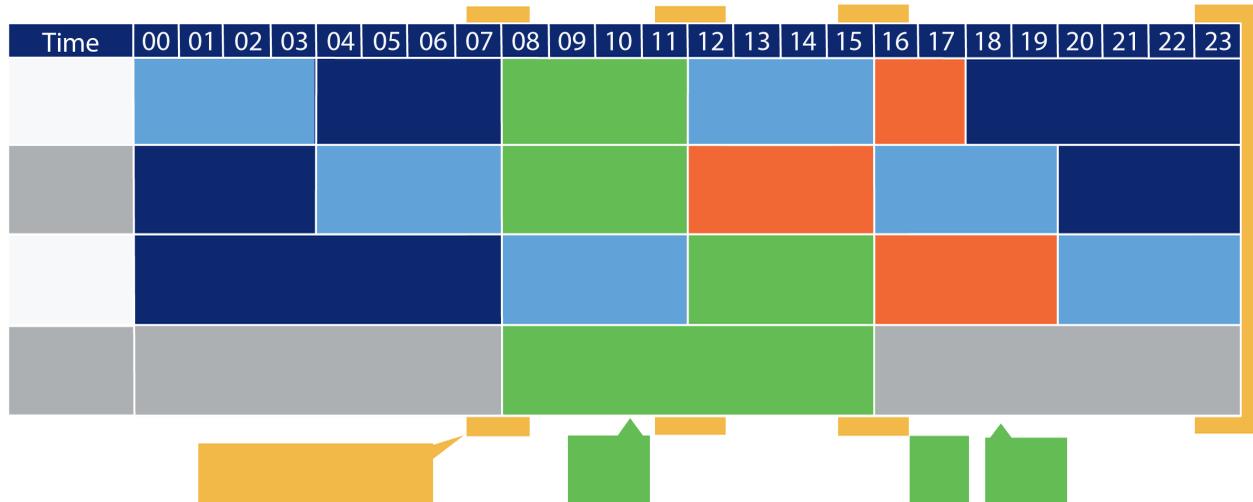
TEMPLATES

Protected Sleep periods (Dark Blue)

No meetings or routine training events. Consider scheduling UNREPS/Flight Ops, etc., around these periods.

Watch (Light Blue)

The watch time on the template does not include the extra time required for pre-watch tour and turnover.



Shipwide Work Period (Green)

May vary slightly by division or based on tasking.

Messing & Berthing Adjust around meal times
Ops Brief Hold in the afternoon

Personal Time (Orange)

May need to be tailored by division

Meal times (Amber)

Adjusted to cover turnover times 1.5 - 2 hour duration

BLOOD ALCOHOL EQUIVALENCE AND HOURS OF WAKEFULNESS

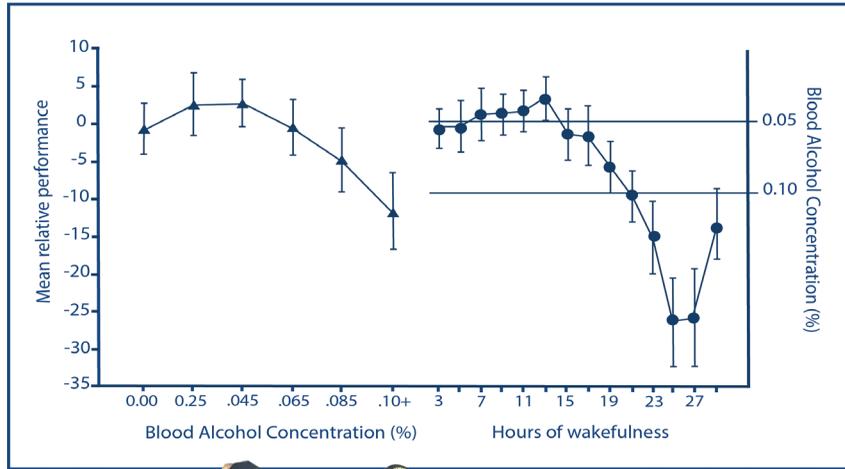


Diagram used with permission
Lamond and Dawson 2002



Multiple blood alcohol equivalence studies show the relationship between blood alcohol concentration (BAC) and hours of wakefulness.

The results show:

- **Staying awake for 18 hours is the equivalent of a BAC of 0.05%**
- **Staying awake for 24 hours is equivalent to a BAC of 0.10 %, higher than the legal limit for driving in all 50 states**

When an individual gets too little sleep or sleep is disrupted, predicted effectiveness drops. These drops in predicted effectiveness are related to alertness and reaction times and are associated with increased risk.

Predicted effectiveness has also been equated with blood alcohol concentration. **Blood Alcohol Equivalence** is shown on the right axis with the criterion level indicated on the FAST© diagram.

You'd never want your crew reporting for duty drunk and the same thing goes for sleep deprivation!

WATCHBILLS: THE GOOD, THE BAD, AND THE UGLY

The watchbills on the following pages are divided into three categories that we call the GOOD, the BAD, and the UGLY.

GOOD CIRCADIAN WATCHBILLS

3 SECTION

4 hrs-on/8 hrs off

8 hrs-on/16 hrs off

4 SECTION

3 hrs-on/9 hrs off

3/3/3/15

6 hrs-on/18 hrs off

5 SECTION

6/5/5/4/4

6/6/4/4/4

Two watchbill principles, borne out in scientific studies, tell us that in general:

- **Shorter watches are better than long watches**
- **More watch sections are better than fewer watch sections**

Of course, these two principles can be carried to extremes and can then backfire. For example, having an extremely short watch doesn't allow the watchteam to develop situational awareness. Similarly, too many team members may make it hard to be a cohesive watch team. In these extreme cases, the time taken up by watch turnover will expand, maintaining situation awareness becomes challenging, and operational effectiveness and crew performance will suffer!

BAD NON-CIRCADIAN WATCHBILLS

3 SECTION

"Five and Dime"
5 hrs-on/10 hrs off

"Classic Submarine
Schedule"
6 hrs-on/12 hrs off

4 SECTION

5 hrs-on/15 hrs off

UGLY CIRCADIAN WATCHBILLS

2 SECTION

6 hrs-on/
6 hrs off

7/5/5/7

12 hrs-on/
12 hrs off

THE GOOD WATCHBILLS



Photographer: Jacob Moore

For our list of Good watchbills, we have included two 3-section watchbills, three 4-section watchbills, and for those who have won the *manning lottery*, we also have the two 5-section watchbills. Some variant of each of these watchbills has been observed on operational ships and/or submarines.

So why do we classify them as “Good” and who exactly are these watchbills good for? They are good for the crew because they provide for sleep and work at the same time each day, which enables circadian entrainment and stabilization to occur. They are also good for the command, because crewmembers are more alert and attentive!

3 SECTION

4 hrs-on/8 hrs off

8 hrs-on/16 hrs off

4 SECTION

3 hrs-on/9 hrs off

3/3/3/15

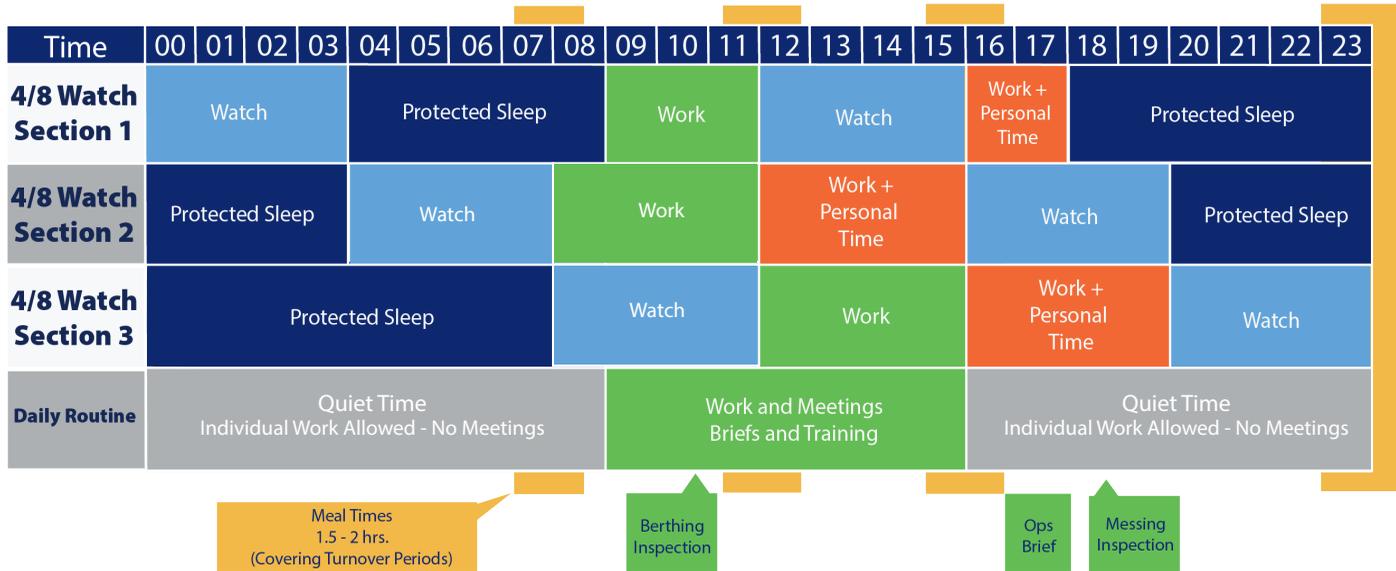
6 hrs-on/18 hrs off

5 SECTION

6/5/5/4/4

6/6/4/4/4

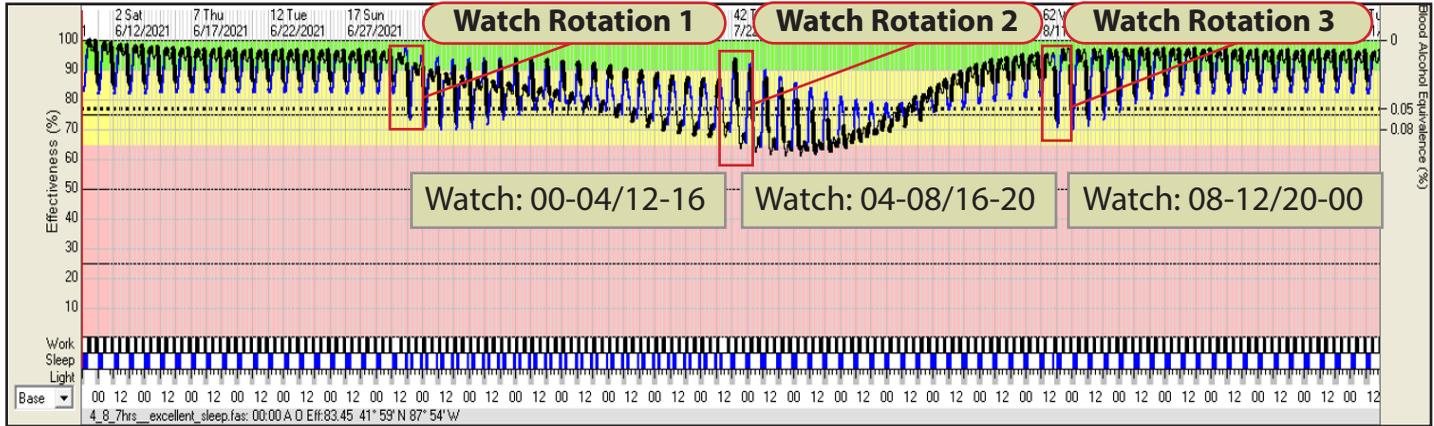
THE 4/8 CIRCADIAN WATCHBILL



PROS: Sailors in Watch Section 1 get three extra hours of sleep to compensate for night shiftwork.

CONS: Sailors in Watch Section 1 must split up their sleep rather than getting one long sleep opportunity. Meals are served every four hours rather than every six hours and dinner is early. Mid-rats are required for Sailors who are sleeping during normal dinner hours. The OPS brief is held after the early dinner.

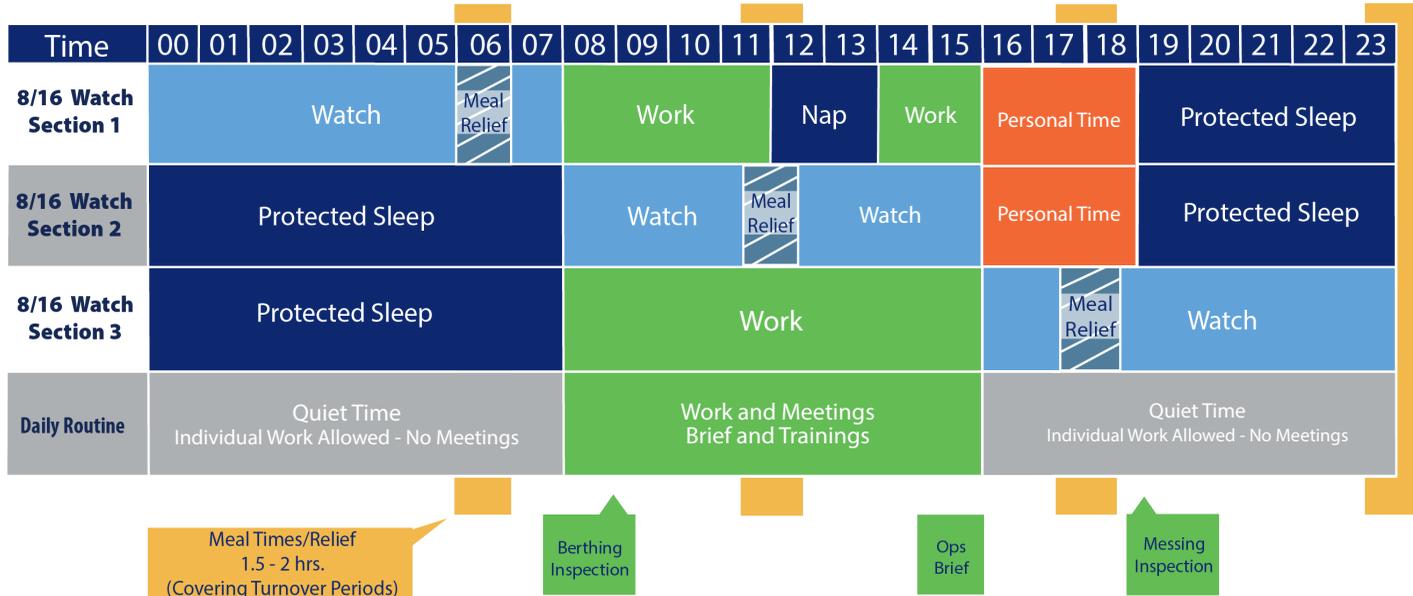
THE 4/8 FAST© SCHEDULE DIAGRAM



This watchbill requires three watch sections. Teams stand the same two 4-hour watches each day. When rotating to a new shift, each shift rotates forward.

The FAST© diagram shows how predicted performance will change over the course of a 12-week period when rotating every three weeks. The rotations are accompanied by a predictable drop in performance as the crew adjusts to the changes in work and rest patterns. This drop in performance is why it is important to rotate as infrequently as possible. We recommend staying on the same schedule for three weeks or longer—or align the rotation with port visits.

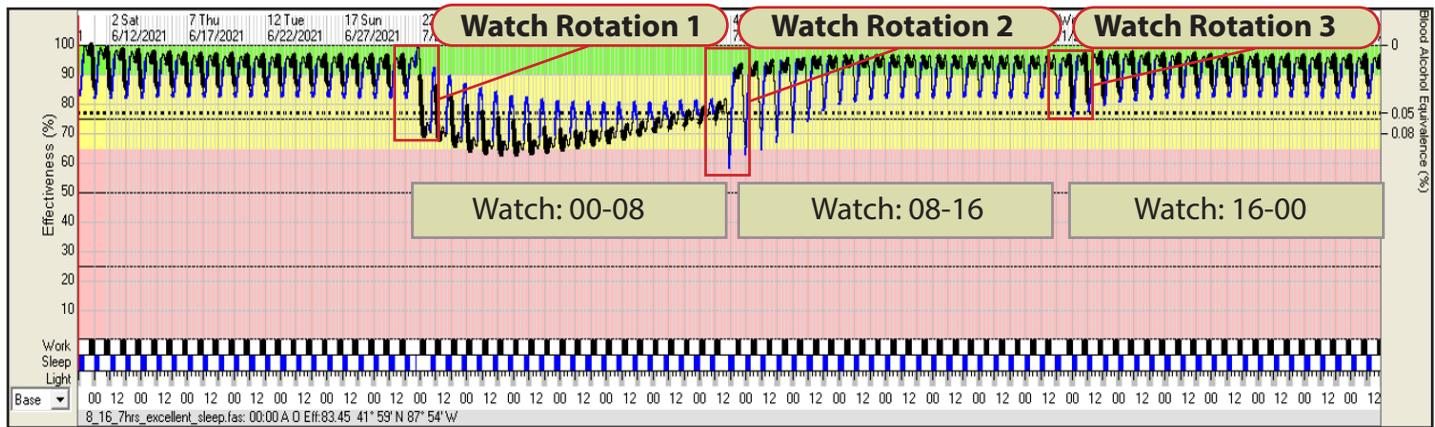
THE 8/16 CIRCADIAN WATCHBILL



PROS: Because the watchbill is fixed, watchstanders stand watch and sleep at the same time each day.

CONS: Eight hours is a LONG time to stay alert on watch. For individuals standing watch topside, sunlight exposure can wreak havoc on their circadian rhythms.

THE 8/16 FAST© SCHEDULE DIAGRAM



This watchbill requires three watch sections. Teams stand the same 8-hour watch each day. Shift rotations are extremely hard on this schedule but is used frequently on submarines, and may work best without any rotations at all. In some submarines, crews report rotating the meals rather than the watches. For example, breakfast may be served at noon or 1800 rather than 0600.

This FAST© diagram shows how predicted performance will change over the course of a 12-week period, when rotating every three weeks. The rotations are accompanied by a predictable drop in performance as the crew adjusts to the changes in work and rest patterns. This drop in performance is why it is important to rotate shifts as infrequently as possible. We recommend staying on the same schedule for three weeks or longer—or align the rotation with port visits.

THE 3/9 CIRCADIAN WATCHBILL

Time	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
3/9 Watch Section 1	Watch		Protected Sleep				Work			Watch		Work		Work + Personal Time		Protected Sleep								
3/9 Watch Section 2	Protected Sleep		Watch		Work + Personal Time		Work					Watch		Protected Sleep										
3/9 Watch Section 3	Protected Sleep				Watch		Work					Work + Personal Time		Watch		Protected Sleep								
3/9 Watch Section 4	Protected Sleep								Watch		Work					Work + Personal Time		Watch						
Daily Routine	Quiet Time Individual Work Allowed - No Meetings								Work and Meetings Briefs and Training								Quiet Time Individual Work Allowed - No Meetings							

Meal Times
1.5 - 2 hrs.
(Covering Turnover Periods)

Berthing Inspection

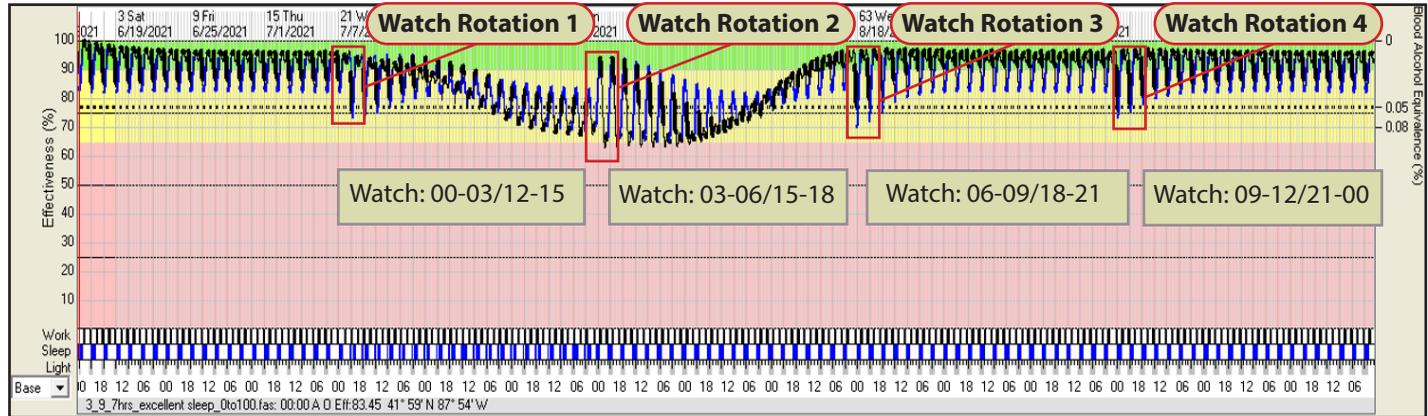
Ops Brief

Messing Inspection

PROS: Shorter watches ensure watchstanders are more alert. Sailors in three of the four Watch Sections have the opportunity for a single sleep period of seven hours or more. Meals are served every six hours.

CONS: More frequent watch turnovers may require a more diligent turnover process. Split sleep is required for Watch Section 1.

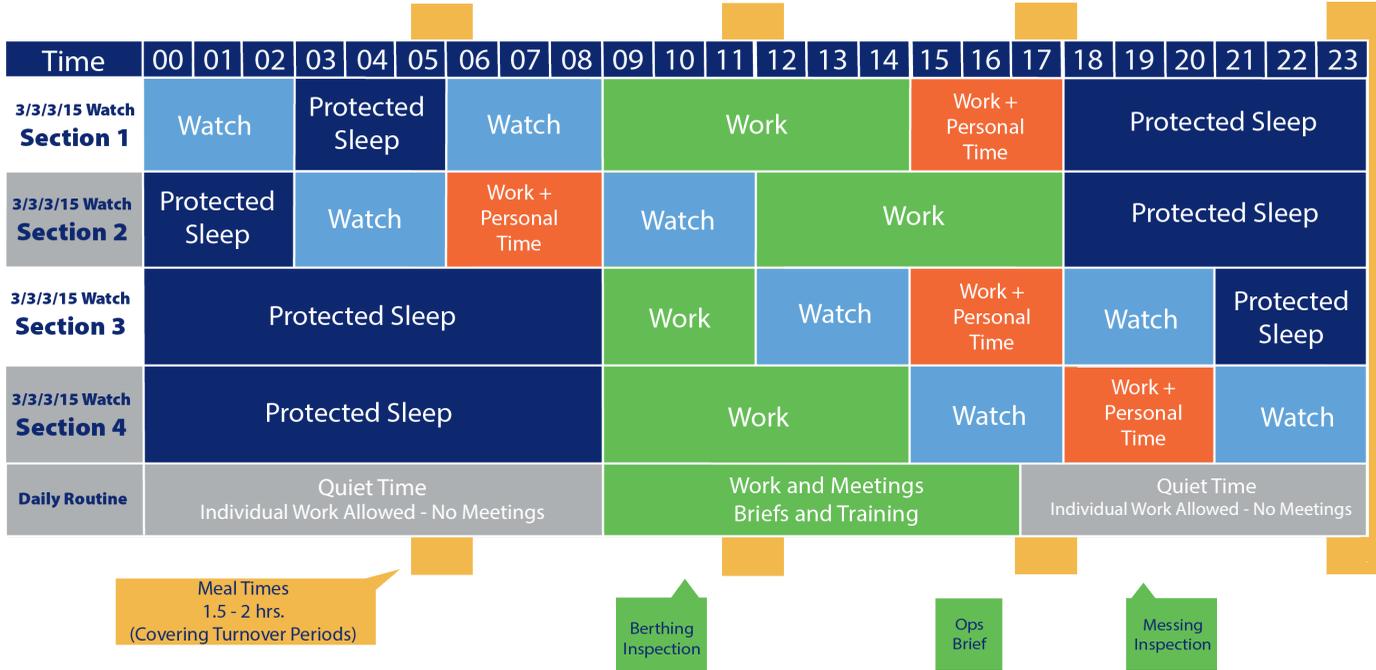
THE 3/9 FAST© SCHEDULE DIAGRAM



This watchbill requires four watch sections. Teams stand the same two 3-hour watches each day for a total of six hours of watch per day.

When rotating to a new shift while underway, each shift rotates forward by three hours. This FAST© diagram shows how predicted performance will change over the course of a 15-week period when rotating every three weeks. The rotations are accompanied by a predictable drop in performance as the crew adjusts to the changes in work and rest patterns. This drop in performance is why it is important to rotate as infrequently as possible. We recommend staying on the same schedule for three weeks or longer—or align the rotation with port visits.

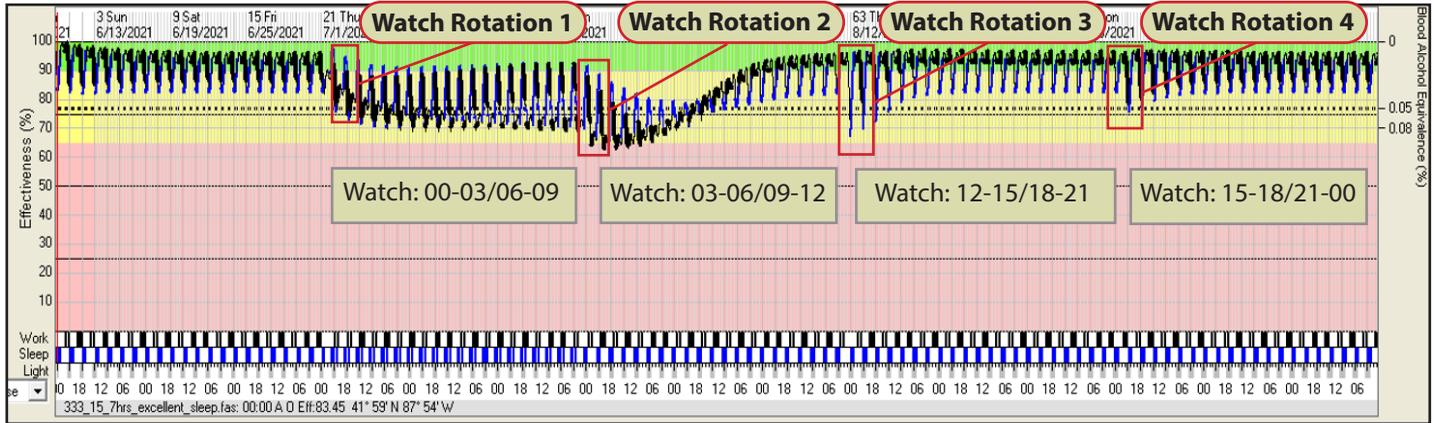
THE 3/3/3/15 CIRCADIAN WATCHBILL



PROS: Each sailor stands watch for two 3-hour periods which are three hours apart.

CONS: The 3-3-3-15 may not be as useful for Sailors whose duties demand a high level of situational awareness in ship operations because of the 15-hour off watch period. Split sleep is required for Watch

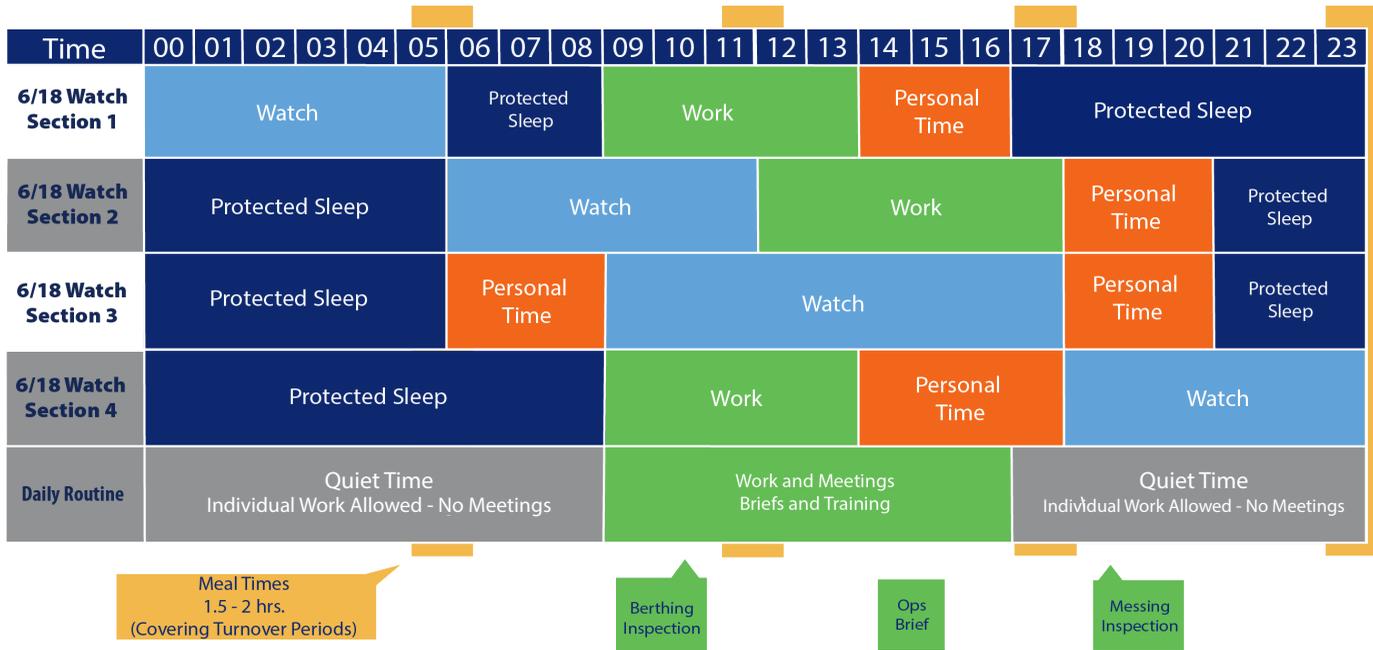
THE 3/3/3/15 FAST© SCHEDULE DIAGRAM



This watchbill requires four watch sections. Teams stand the same two 3-hour watches each day for a total of six hours of watch per day. The two watches are three hours apart allowing for a 15-hour off watch period after the second watch.

When rotating to a new shift while underway, each shift rotates forward by three hours. This FAST© diagram shows how predicted performance will change over the course of a 15-week period when rotating every three weeks. The rotations are accompanied by a predictable drop in performance as the crew adjusts to the changes in work and rest patterns. This drop in performance is why it is important to rotate as infrequently as possible. We recommend staying on the same schedule for three weeks or longer—or align the rotation with port visits.

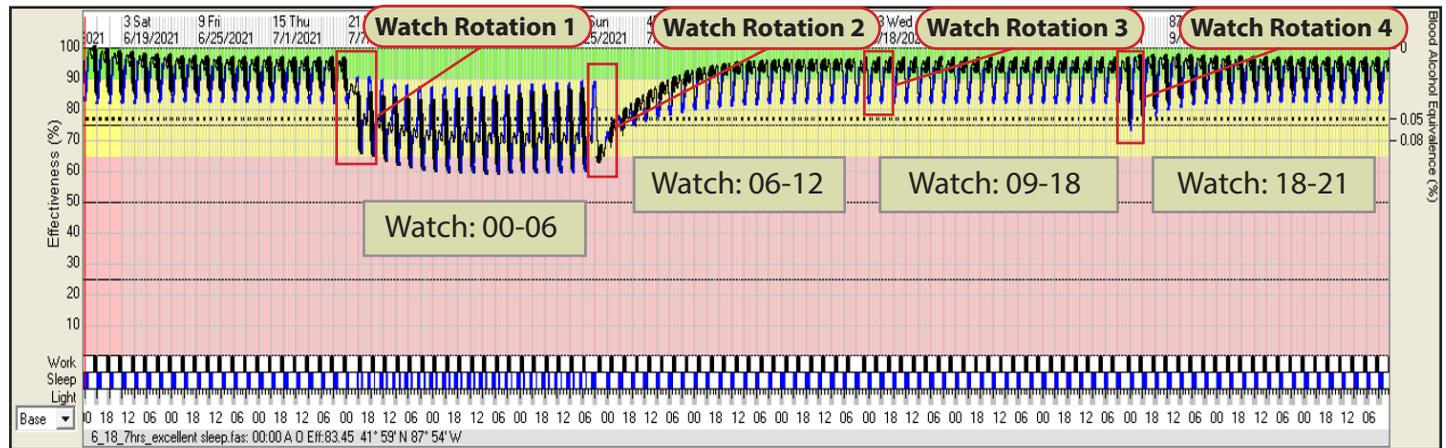
THE 6/18 CIRCADIAN WATCHBILL



PROS: Sailors in Watch Section 1 have split two extra hours of sleep to compensate for sleep loss due to night shiftwork. Sailors in all sections sleep in one contiguous period. Meals are served every six hours.

CONS: Watches are six hours long, which may be too long for duties requiring continuous attention or when working in hot environments.

THE 6/18 FAST© SCHEDULE DIAGRAM



This watchbill requires four watch sections. Teams stand the same watch each day for a total of six hours of watch per day. This watchbill may be ideal for CSG/ESG staff watch rotation battle rhythm.

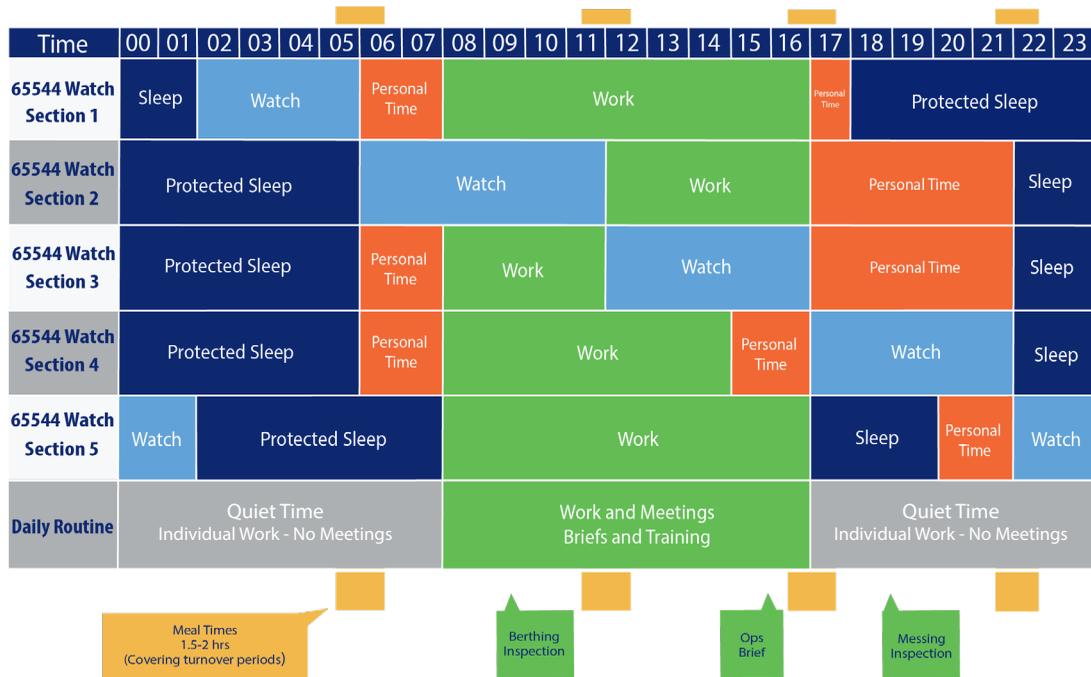
When rotating to a new shift while underway, each shift rotates forward by six hours, a significant challenge for the circadian system. This FAST© diagram shows how predicted performance will change over the course of a 15-week period, when rotating every three weeks. The rotations are accompanied by a predictable drop in performance as the crew adjusts to the changes in work and rest patterns. This drop in performance is why it is important to rotate as infrequently as possible. We recommend staying on the same schedule for three weeks or longer—or align the rotation with port visits.

THE 6/5/5/4/4 CIRCADIAN WATCHBILL

PROS: Sailors get significant time off watch for other duties and for personal time.

CONS: It may not be as useful for Sailors whose duties demand a high level of situational awareness due to the 14-16-hour off watch period. This watchbill requires five watch sections. Teams stand one watch each day. The three “day shifts” from (0600 to 2200) are longer (5-6 hours in duration) than the two “night” shifts (4 hours) from 2200 to 0600.

When rotating to a new shift while underway, each shift rotates forward. However, rotations should be as infrequent as possible. We recommend staying on the same schedule until port call.



THE 6/6/4/4/4 CIRCADIAN WATCHBILL



PROS: Sailors get significant time off watch for other duties and for personal time.

CONS: It may not be as useful for Sailors whose duties demand a high level of situational awareness due to the 14-16-hour off watch period. This watchbill requires five watch sections. Teams stand one watch each day. The two “day shifts” (from 0600 to 1800) are longer (6 hours in duration) than the three 4-hour “night” shifts (from 1800 to 0600).

When rotating to a new shift while underway, each shift rotates forward. However, rotations should be as infrequent as possible. We recommend staying on the same schedule until port call.

THE BAD WATCHBILLS

Three BAD watchbills are listed here to remind you of the schedules you should avoid even though the Navy has been guilty of using them many times in the past! We classify them as BAD because when you use them, you are setting yourself and your crew up for BAD outcomes...poor sleep, lapses in attention, and BAD moods...in short, it is not going to be that great Navy day that you want for your crew. The BAD watchbills we identified are:



a.) 5 hrs on/10 hrs off, a.k.a. "5 and dime" (15-hr day with 9 hours of jetlag per day)

b.) 5 hrs on/15 hrs off (20-hr day with 4 hours of jetlag per day)

c.) 6 hrs on/12 hrs off (18-hr day with 6 hours of jetlag per day)

The 6/12 schedule was used by the Submarine Force for over four decades before being replaced recently with the circadian-based 8/16.



It is hard to get healthy sleep when you are forced to sleep at different times of the day and night. When you miss out on sleep, you are less capable of controlling impulsive behavior, more prone to taking risks, and your judgment is degraded. With less sleep, it's harder for you to pay attention, react to signals, or remember important information. In many ways, sleep deprivation resembles what happens when you drink too much alcohol.

...AND THE UGLY WATCHBILLS

Sometimes manning levels and Fit/Fill rates are such that only a 2-section watchbill is possible. The number of crewmembers—or the number with the right qualifications—means you just cannot have anything other than a 2-section watch.

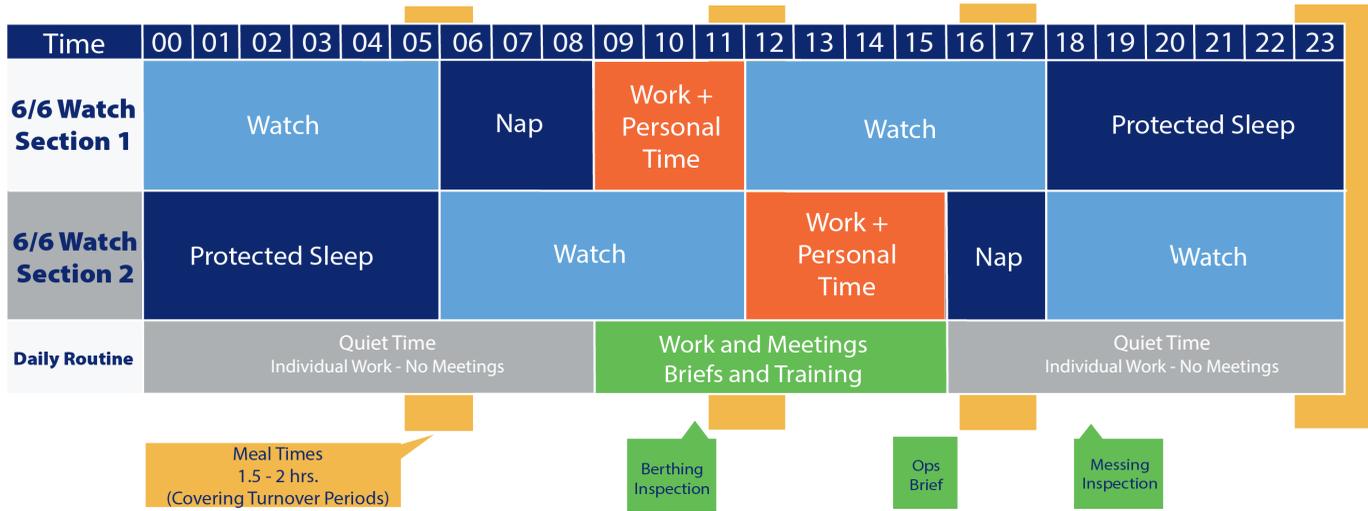
It doesn't matter how you look at it, working "Port and Starboard" means 12 hours of watch EVERY day. These schedules are technically "circadian" because they allow crew members to work and sleep at the same time each day. In this respect, they have an advantage over the three non-circadian BAD watchbills. For your crew, the "Port and Starboard" situation may be unavoidable, but it can be just plain UGLY--especially for night watchstanders.

For this reason, providing protected sleep periods for those crewmembers who are working between **2200-0600** is vital. The three "Port and Starboard" schedules on the next few pages illustrate the challenges posed by these ugly watchbills.



Photo courtesy of the US Navy

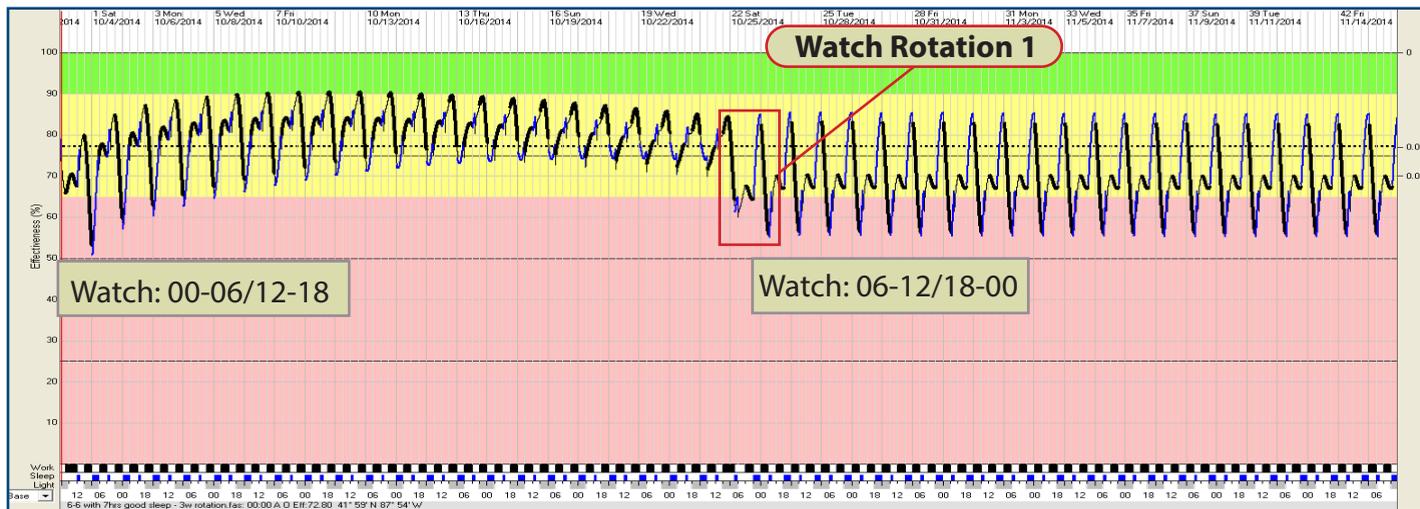
THE 6/6 CIRCADIAN WATCHBILL



PROS: Only two qualified watchstanders are required to cover 24-hours of watch.

CONS: Watchstanders never have adequate time off for rest. Even in the best of circumstances, they will have poor sleep because of the disruptions and timing (sleeping during the day).

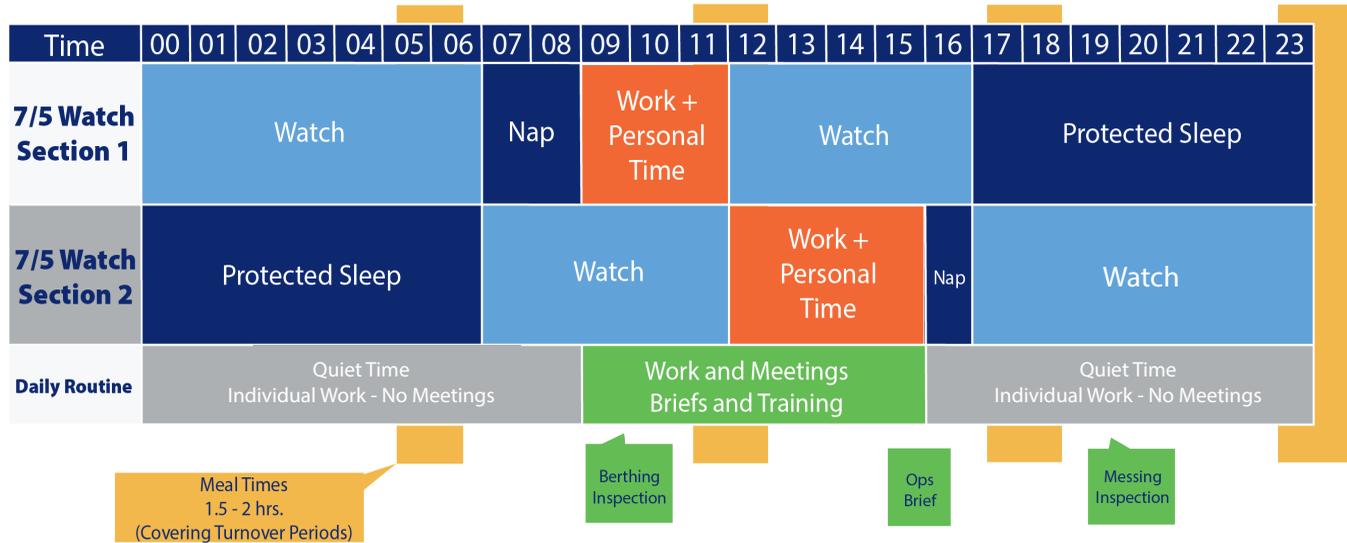
THE 6/6 FAST© SCHEDULE DIAGRAM



This watchbill requires two watch sections. Teams stand the same two 6-hour watches each day. The two watches are six hours apart.

Rotating shifts is challenging on this schedule. Because the Sailors will already have a sleep debt, the added burden from the six-hour rotation makes it extremely hard to mitigate risk when using this watchbill.

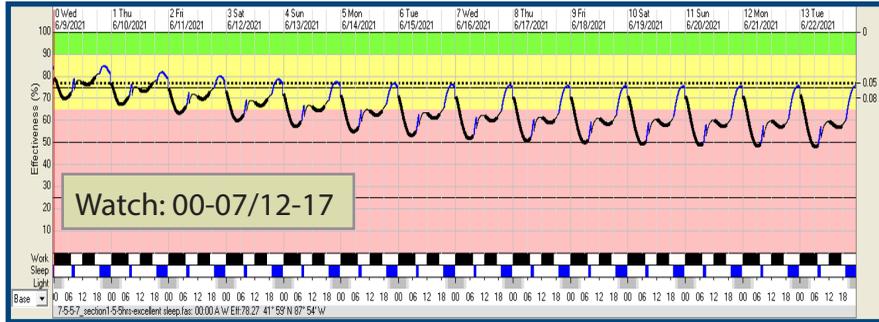
THE 7/5/5/7 CIRCADIAN WATCHBILL



PROS: Only two qualified watchstanders are required to cover 24-hours of watch.

CONS: Watchstanders never have adequate time off for rest. Even in the best of circumstances, they will have poor sleep because of the disruptions and timing (sleeping during the day).

THE 7/5/5/7 FAST© SCHEDULE DIAGRAM

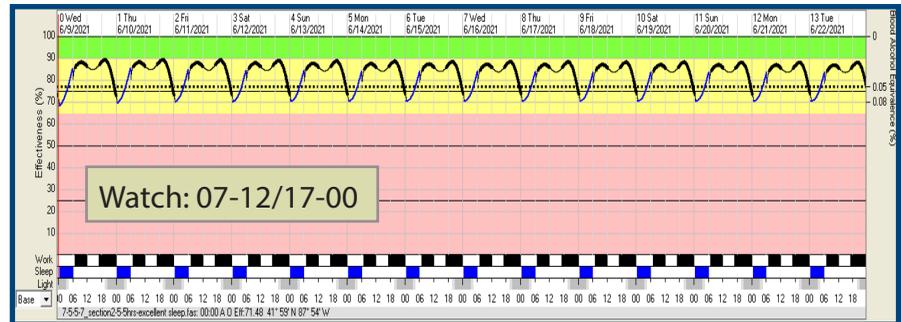


Requires two watch sections.

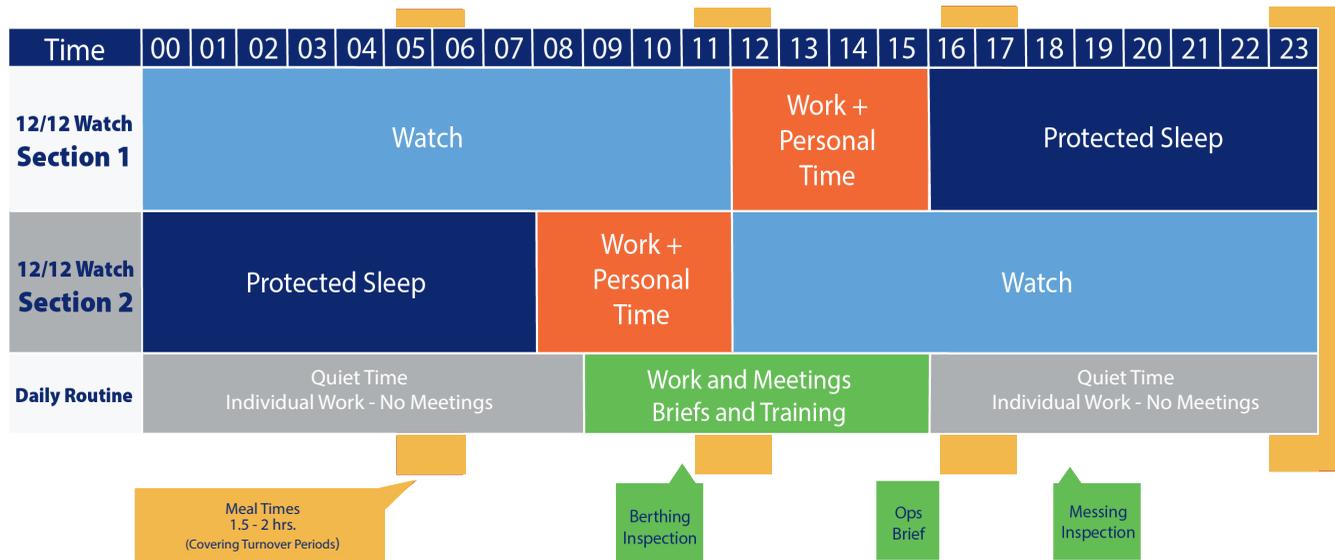
Teams stand the same 5 and 7 hour watches each day. The two watches never allow adequate sleep in a single sleep opportunity.

Rotating shifts is challenging on this schedule.

Because the Sailors will already have a sleep debt, the additional burden from rotating 5 to 7 hours make it extremely hard to mitigate risk.



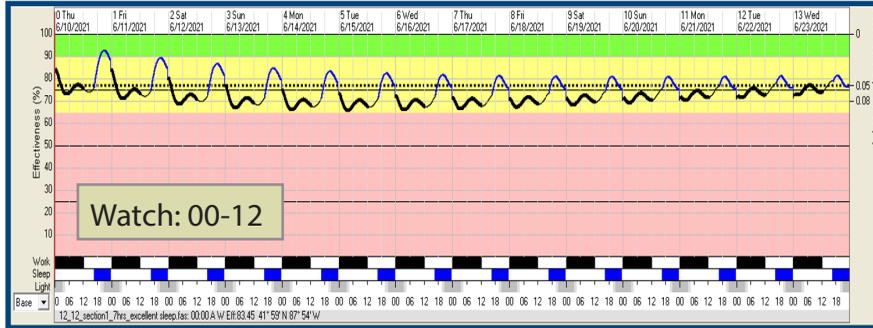
THE 12/12 CIRCADIAN WATCHBILL



PROS: Only two qualified watchstanders are required to cover 24-hours of watch.

CONS: This 12-hour watchbill is not as useful for watches that require continuous focused attention or high levels of cognitive effort.

THE 12/12 FAST© SCHEDULE DIAGRAM

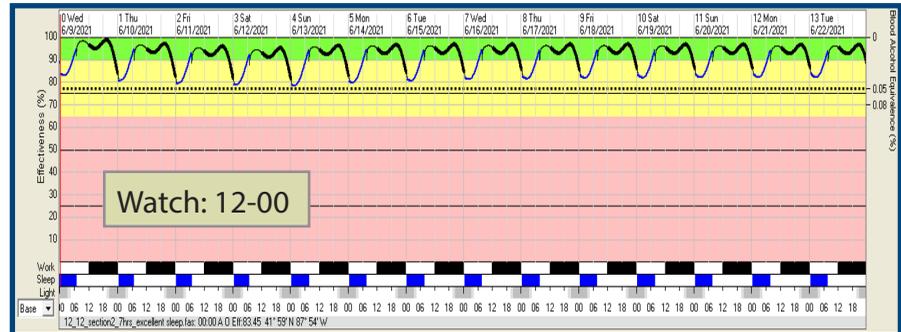


Requires two watch sections.

Teams stand the same 12-hour watch each day.

Rotating shifts is challenging on this schedule.

Adjusting to a 12-hour time shift is difficult under the best of circumstances.



COMBINING WATCHBILLS ACROSS A COMMAND

Certain situations may require the simultaneous use of more than one watchbill in a command. Sometimes this challenge arises because the manning level in a department is insufficient or perhaps the characteristics of the watch do not support crewmembers working a long shift. In those situations, you may be forced to use more than one watchbill for the command.

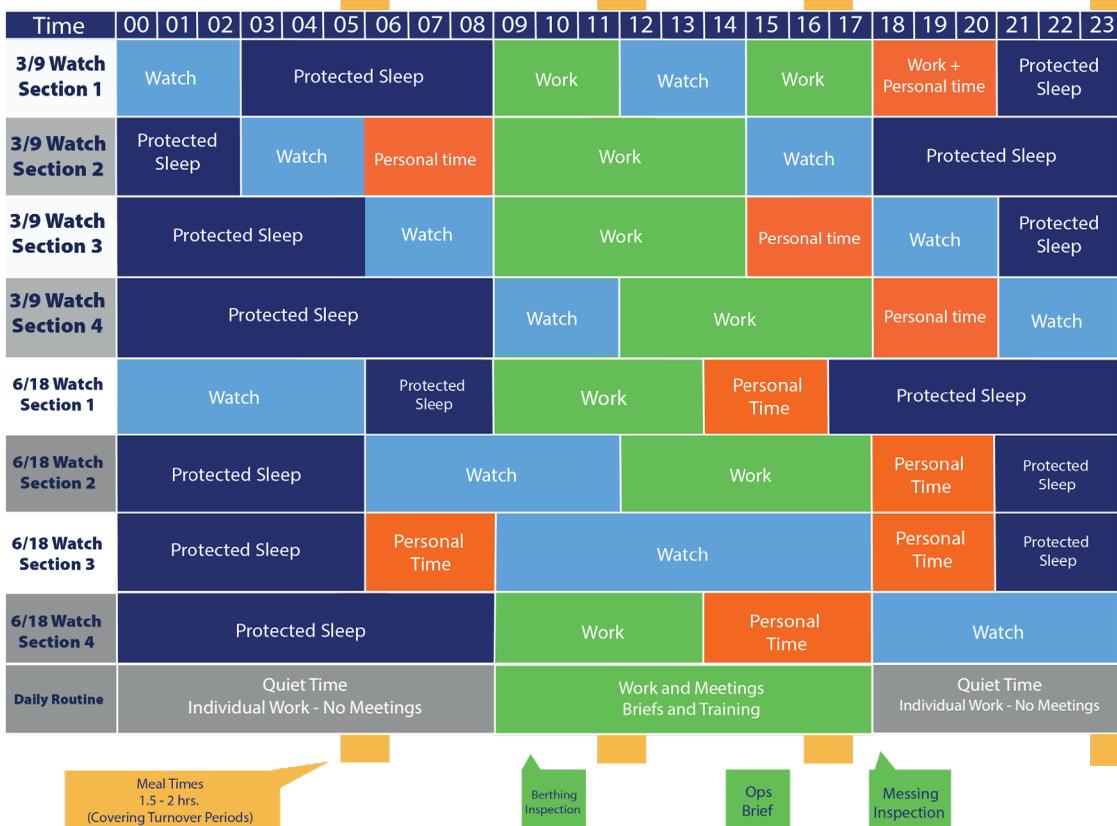
Combining two 4-section circadian-based watchbills (such as the 3/9 and 6/18) has been frequently reported as being useful and fairly easy to implement ship-wide. Engineers and others working in hot spaces can use the 3/9 to avoid busting PHEL limitations while department heads and khaki may prefer standing a longer shift like the 6/18 to help maintain situational awareness. In the diagram on the facing page, these two watchbills are shown together atop the ship's daily schedule. As you can see, meals and other ship-wide activities still align well. Similarly, the 4/8 and 8/16 watchbills can be combined across a command.

Combination of 3 and 4-section watchbills can be more challenging, however, especially with the need to align meals and meetings, trainings, and drills.

ASSIGNMENT TO BERTHING SPACES AND "BATTLE BERTHING"

Another best practice is the allocation of berthing spaces to crewmembers who stand watch for the same hours. When this procedure is followed, less noise inside the berthing spaces facilitates better sleeping conditions for crewmembers. Note that this decision does not preclude "battle berthing" (distributing the members of the same department across the ship) because it is not limited to berthing crewmembers from the same department.

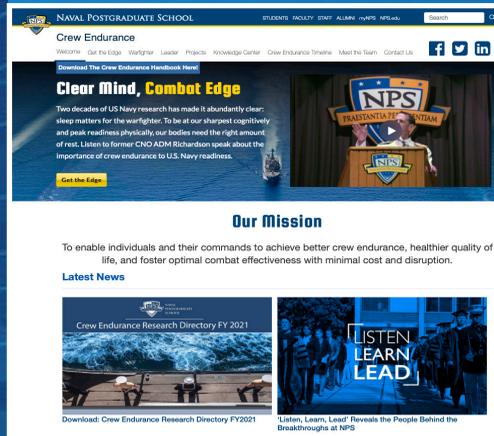
SOME BEST PRACTICES



ABOUT THE NPS CREW ENDURANCE TEAM

Over the past two decades, the NPS Crew Endurance Team has dedicated itself to improving the performance and quality of life of US Navy Sailors and other military service members. The team is led by Dr. Nita Lewis Shattuck and consists of NPS faculty, staff members, postdoctoral fellows, and volunteers. Essential to the Crew Endurance Team are the incredible active duty military graduate students who have helped us collect objective data on the work and rest patterns of thousands of military members in scores of locations.

From the deckplates of Navy warships to the White House, from Boot Camps and Military Service Academies to US Embassies around the world, we continue to build an understanding of the issues faced by today's military. In this Handbook, we use what we have learned to present best practices to guide leaders as they develop schedules to support the health and effectiveness of their crews and organizations.



The screenshot shows the NPS Crew Endurance website. At the top, it says "NAVAL POSTGRADUATE SCHOOL" and "CREW ENDURANCE". Below that is a navigation menu with links for "Home", "About Us", "Research", "Education", "Outreach", "Contact Us", and "FAQ". The main content area features a large banner with the text "Clear Mind, Combat Edge" and a sub-headline "Two decades of US Navy research has made it abundantly clear: sleep matters for the warfighter. To be at our sharpest cognitively and peak readiness physically, our bodies need the right amount of rest. Listen to former CNO ADM Richardson speak about the importance of crew endurance to U.S. Navy readiness." Below the banner is a section titled "Our Mission" with the text "To enable individuals and their commands to achieve better crew endurance, healthier quality of life, and foster optimal combat effectiveness with minimal cost and disruption." There is also a "Latest News" section with two articles: "Crew Endurance Research Directory FY 2021" and "Listen, Learn, Lead! Reveals the People Behind the Breakthroughs at NPS".

FOR MORE INFORMATION

Visit our Crew Endurance Website—a central resource for Commanders and their staff to identify and implement policies, procedures, and watch rotations proven to reduce fatigue levels. This site offers tools, resources, and instructions for implementing more effective watch rotations and improving Crew Endurance.



Visit us at www.nps.edu/crewendurance



ABOUT THE AUTHORS



Dr. Nita Lewis Shattuck is a Professor in the Operations Research Department at the Naval Postgraduate School in Monterey, California where she leads the Crew Endurance Team. She received her Ph.D. in Behavioral Sciences from the University of Texas School of Public Health. Dr. Shattuck teaches courses in human factors engineering and human systems integration, directs thesis research, and pursues her research interests in human fatigue in operational settings, individual and team performance, and decision-making. As the leader of the NPS Crew Endurance Team, Dr. Shattuck studies ways to improve the lives of military personnel.



Dr. Panagiotis Matsangas is a Research Assistant Professor in the Operations Research Department at the Naval Postgraduate School, Monterey, California. He is a retired Commander in the Hellenic Navy. Dr. Matsangas received his Ph.D. in Modeling, Virtual Environments, and Simulation (MOVES) from the Naval Postgraduate School and also holds a graduate degree in Operations Research. His research interests are in the area of human performance, mathematical modeling of human behavior, and behavioral statistics with an emphasis in military and naval operational environments.

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We received unwavering support and guidance from CAPT John Cordle, USN, Ret., CAPT Chuck Good, USN, Ret., former CNO ADM John Richardson, USN, Ret., and VADM Tom Rowden, USN, Ret.

Special thanks to the COs and leadership of the many ships who have allowed us to study their crews.

And finally, to the Sailors of the US Navy, thank you for allowing us to get a glimpse into your lives of service. You inspire us to continue looking for ways to improve your lives.



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NPS CREW ENDURANCE HANDBOOK

A Guide to Applying Circadian-Based Watchbills (Version 2.0)



NAVAL POSTGRADUATE SCHOOL

