

Shattuck, N.L. & Matsangas, P. (2017, March). Comparing the work and rest hours of United States Navy Sailors with existing maritime regulations. Abstract presented at the Tenth International Conference on Managing Fatigue, San Diego, CA.

Comparing the work and rest hours of United States Navy Sailors with existing maritime regulations

Nita Lewis Shattuck, Operations Research Department, Naval Postgraduate School,
nlshattu@nps.edu

Panagiotis Matsangas, Operations Research Department, Naval Postgraduate School,
pmatsang@nps.edu

Problem

Crewmembers in the United States Navy (USN) work long hours with limited opportunities to sleep. Consequently, they are often sleep-deprived (Miller, Matsangas, & Kenney, 2012). Their work schedules are an important contributor to their fatigue levels (Shattuck & Matsangas, 2015; Shattuck, Matsangas, & Brown, 2015). Based on this information, this study has two goals. First, we compare the work and rest patterns of USN crewmembers with existing maritime regulations. Second, we investigate the association between the watchstanding schedule and the level of compliance with existing maritime fatigue regulations.

Method

This retrospective analysis uses data collected from 184 crewmembers of the Reactor Department of the USS NIMITZ (CVN-68) (Shattuck & Matsangas, 2015; Shattuck et al., 2015). In June 2014, participants (n=69) stood watch for 17 days using the 5hr-on/10hr-off schedule. In November 2014, participants (n=115) stood watch for 11 days using the 3hr-on/9hr-off schedule. Sleep was assessed with wrist-worn actigraphy and daily activity logs. Activities were reported as standing watch, other duties (e.g., maintenance, etc.), training, service diversion (e.g., administrative requirements, inspections, etc.), personal time, sleep, and meals.

Information from the activity logs was aggregated into two categories, Work and Rest, by day (midnight to midnight). Work time included watch periods, ship duties, maintenance, training, and service diversion. Rest included personal time, sleep, and meals.

Compliance rates were calculated using provisions from two regulations for seafarers, the Maritime Labour Convention (MLC) (i.e., work ≤ 14 hours/24-hour period, work ≤ 72 hours/7-day period, rest ≥ 77 hours/7-day) (ILO, 2006); and the United States Code (USC) i.e., work ≤ 36 hours/3-day period ("United States Code," 2016). In the absence of specific US Navy regulations, we used the Navy Availability Factor (NAF) criterion (i.e., work ≤ 81 hours/7-day period (*OPNAVINST 1000.16L*, 2015), and the Navy Standard Work Week (NSWW) criterion for sleep ≥ 56 hours/7-day period (*OPNAVINST 1000.16K*, 2007).

The Wilcoxon Rank Sum test was used for statistical comparisons. Post-hoc statistical significance was assessed with the Benjamini–Hochberg False Discovery Rate (BH-FDR) controlling procedure with $q=0.20$ (Benjamini & Hochberg, 1995).

Results

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Participants were predominantly young (25.0 ± 3.72 years of age), male (80%), and enlisted (95%). Crewmembers worked more than 14 hours/day for 21% of their workdays. On a weekly basis, crewmembers worked more than 72 hours for 75% of their 7-day periods, worked more than 81 hours for 53% of their 7-day periods, and rested less than 77 hours for 23% of their 7-day periods. Notably, the total (reported) sleep time was less than 56 hours (or approximately 8-hours/day) for 64% of the 7-day periods. This lack of sleep was also shown objectively by actigraphy data. Crewmembers working on the 5/10 schedule slept on average 6.88 ± 0.93 hours/day, compared to 6.68 ± 0.95 hours of sleep for their 3/9 peers.

As shown in Table 1, the compliance rates differed by watchstanding schedule. Specifically, crewmembers working on the 3/9 were in greater compliance with existing maritime work/rest regulations when compared to their peers on the 5/10 schedule.

Table 1. Non-compliance rates by watchstanding schedule

Regulation	Provision	Non-compliance rate		p-value	Effect size r
		3/9 M%±SD%	5/10 M%±SD%		
MLC	Work≤14hrs/d	13.0±22.2	31.3±15.6	<0.001 ^A	0.541
MLC	Work≤72hrs/7d	52.5±47.1	87.5±28.4	<0.001 ^A	0.399
USC	Work≤36hrs/3d	29.8±35.6	50.3±37.2	<0.001 ^A	0.282
NAF	Work≤81hrs/7d	26.0±40.5	67.3±40.9	<0.001 ^A	0.428
MLC	Rest≥77hrs/7d	6.67±25.3	32.6±39.6	<0.001 ^A	0.419
NSWW (obs.)	Sleep≥56hrs/7d	58.2±47.2	69.6±35.3	0.470	0.077

^A Statistical significant based on the BH-FDR

The overall non-compliance rates by regulation are shown in Figures 1 and 2. Vertical lines denote the standard error.

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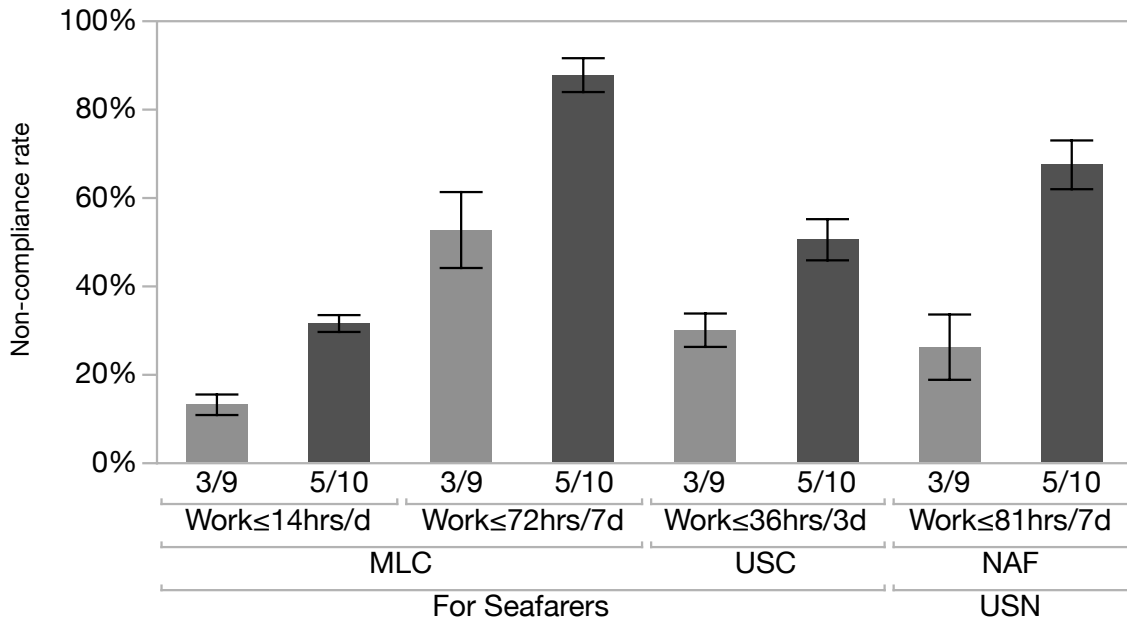


Figure 1: Non-compliance rates by work hours criterion

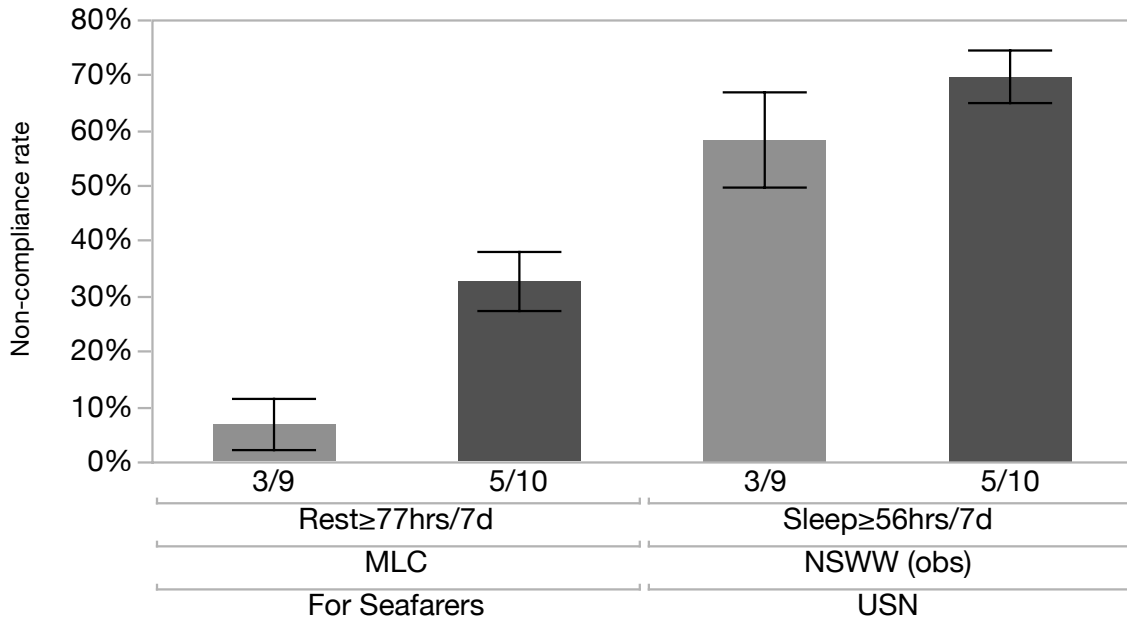


Figure 2: Non-compliance rates by rest/sleep hours criterion

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Discussion

Our results show that crewmembers work long hours, both in terms of daily work, and accumulated work hours per 7-day period. It is notable that crewmembers on the 5/10 schedule worked more than 72 hours for 88% of their 7-day periods. Consequently, it was not a surprise that the non-compliance rates for the criterion of at least 56 hours of sleep per 7-day period was high, reaching 70% for the crewmembers working on the 5/10. Even though the 3/9 was associated with a clear improvement in all the work and rest provisions (non-compliance rates were markedly decreased), some non-compliance metrics were still high.

These results show that crewmembers working at sea have high workloads for extended periods of time. Various inelastic tasks and operational commitments may contribute to increased workload, and, hence, limited opportunities to rest and sleep. It is interesting, however, that the increase in the non-compliance rates from the 3/9 to the 5/10 far exceeds the difference in personnel between the two schedules. Theoretically, a station manned for a 4-section 3/9 schedule needs 25% more personnel than a 3-section 5/10 schedule. On average, however, the non-compliance rates for the 5/10 increased by 140%. The non-compliance rates for the MLC Rest provision showed a 4-fold increase for the 5/10 compared to the 3/9. These findings emphasize the non-linear characteristics of the naval operational environment, and the importance of optimizing shiftwork and work scheduling at sea.

Summary

As part of a multiyear project, multiple studies have been conducted at the Naval Postgraduate School to systematically and empirically assess the work and rest patterns of crewmembers working on U.S. Navy ships. This study compared the compliance of crewmembers' work/rest hours with existing regulations. Overall, non-compliance rates were high, up to 88% of the crew. Results highlight how crewmembers work long hours with limited opportunities to rest. The watchstanding schedules of the crewmembers had a significant impact on the compliance rates. In the absence of specific Navy regulations to manage work and rest schedules, the US Navy should consider using standard maritime regulations that include guidance for optimal management of work/rest/sleep patterns.

Disclaimer

The views expressed in this document are those of the authors and do not reflect the official policy or position of the Department of Defense or the U.S. Government.

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