

Fatigue at sea

Lützhöft, M., Thorslund, B., Kircher, A., Gillberg, M.

Result and recommendations for managing fatigue in watch systems onboard

This document presents the main results and recommendations from the project Fatigue at sea. It is meant as a living document, where mainly columns should be filled in with suggestions of who should take action to enforce these recommendations, and how this is to be done.

Main results

The following is suggested by the results of questionnaires and diaries:

- Mates in the three-watch system are more satisfied with their working times and working situation.
- Mates in the two-watch system are sleepier than the mates in the three-watch system, especially in the early morning and afternoon.
- Most mates think they need at least eight hours of sleep per day, independent of watch system.
- All mates are less sleepy and less stressed at home, independent of watch system.

The following is suggested by the results of EOG, KSS and reaction time tests:

- Although no statistical difference is found, all tendencies in the results point in the same direction: officers in the 6x6 system are more tired than the officers in the 4x8 system.
- The highest KSS ratings show that all work performed over and above the six hours lead to very high sleepiness levels and should be avoided.
- KSS values are highest on night shifts.
- 5.6 % of all scorings are 7 (out of 9) and above. This means that during 83 hours participants were tired. During 39 hours they were very tired, staying awake with effort or fighting sleep.
- 82 % of the very high KSS values (above 7) is from ships with the 6x6 system.
- The sleepest participants work two-shift.
- Reaction times are longer for all participants after a night shift.
- Variation in reaction time is higher for two-shift which suggests that they are more unfocused.

- Actiwatch data show that participants sleep approximately six to seven hours per 24 hours independent of shift system.
- The sleep on the two-watch ships is divided into two sleeps, very few of which is longer than approximately 4.5 hours. The only watch in the 4x8 system which approaches these low levels seems to be the 04-08/16-20 watch.
- Sleep quality is low and can probably be classified as disturbed, for both shift systems according to Actiwatch results.
- Non-Swedish participants rate their sleepiness (KSS) significantly lower but also have significantly longer reaction times after the night watch, which is contradictory.

The following conclusions may be drawn from the interview study:

- Most Swedish shipping companies do not think fatigue is a problem (during normal conditions) – but would address it if they found it necessary.
- Most would consider fatigue monitoring equipment and believe that the crew would accept it.
- All would install equipment if insurance premiums were lowered (say 30 %)

General conclusions

Working more than 2x6 hours per 24 hours should be avoided since this lead to very high levels of sleepiness. There should always be two persons on the bridge during watch keeping. This conclusion indicates difficulties with a continued use of the two-watch system on ships with only two nautical officers.

A mutual effort with commitment on all levels is a prerequisite in order to accomplish a change and an improvement. A survey of existing recommendations shows that most of them are directed to the ship and to individuals onboard. Only seldom do the recommendations address the shipping company or other land-based organisations or authorities. A selection of recommendations is presented below, with columns showing what stakeholders can and should do.

There are individual differences between people, which means that not all need the same amount of sleep. The recommendations, however, are of a general nature. One example is that older, more experienced officers are better at staying awake, at judging their fatigue levels and at judging and compensating for any possible performance decrement due to fatigue, than young people are. On the other hand it is more difficult for older people to sleep during the day

It is also important to have a systematic approach when considering recommendations. Some people onboard might experience a change to the worse, e.g. the cook steward if watch and meal times are changed or a mate who gets a few hours watch during the night, but the crew as a whole will be more alert.

Technical solutions are available that wake a sleeping person but do not prevent an officer on watch from becoming tired or assist in decision making when the personal capacity is impaired due to fatigue or being newly awakened. Equipment that gives off a warning when someone is too tired or is falling asleep is under development, for example motion detectors or cameras, but the equipment will not make sure that thoroughly rested personnel is available to take over. This has to be controlled at an organizational level. If watch keeping can be upheld with rested personnel an investment in technical solutions is obsolete.

Recommendation	Onboard	Onshore (Shipping company, DP)	National authorities and administrations	Internationally	Others, explanations etc.
Use SWP: Sleep Wake Predictor.	To develop watch systems. Planning ordinary and extraordinary voyages. Planning exercises on hours that disturb as little and as few as possible.	Planning size and competence of the crew. Possibly also for calculation of safety level for insurance and classification purposes.	Can support authorities at Port and Flag State Controls, enabling solid documentation if, for example, a ship is to be detained in order to let the crew rest before the voyage is resumed. This is not a long-term solution but rather a way of highlighting the problem. Can be used for prevention and investigation of accidents.		SWP should be a mandatory publication onboard. Will be available on internet.
The off duty period on the 6x6 watch system must be		Possible to do paper work ashore? Planning arrival and	Co-ordinate administration, info, inspections and controls.		

<p>reserved for sleep and rest.</p>		<p>departure. Co-ordinate software for e.g. basic ship information (avoid redundant form-filling). Co-ordinate vetting. Review of what is necessary at moorings etc.</p>	<p>Investigate the need for crew and solutions for e.g. mooring and other tasks demanding many crew members.</p>		
<p>Two persons on watch (on the bridge at the same time) gives both physical support (keep each other awake) and mental (two tired persons make better decisions than one person alone).</p>	<p>Introduce the concepts “Challenge” and “Closed-loop communication”. Challenge and question to make sure the situation is correctly understood. Repeating order and actions give a possibility to control both a person’s actions and state. Decision making, troubleshooting. It is important to make sure the look-out have interesting</p>	<p>Resources for personnel and competence. BRM, and involve all hands onboard, not only the officers.</p>	<p>Safe manning. Take into consideration the certificates and total manning. Pilotage fees can have an effect.</p>		<p>BRM necessary A pilot reinforces the bridge team.</p>

	tasks and that the person's competence is utilized in the forming of a bridge team.				
Education on all levels.	For everybody onboard	Mandatory	Mandatory		
It takes five to six days to adjust to a new shift.	Scheduling. Plan relieving, overlap, travels and adjustment of ship time. Take into consideration watch system and biorhythm at time zone change.	Scheduling. Plan relieving, overlap, travels. Relieved person should not drive long distances.			"24 hours per time zone" is needed to adjust after a long journey.
6x6 watch system. It is better to change watch at 03-09-15-21, than at 00-06-12-18. If it is necessary to rotate the watch, it should be moved forward.	Meals; content and timing needs planning. Heaviest meal after the longest period of sleep.	Educational responsibility for the whole crew. Responsible for adequate information.			The alertness of the ship as a whole is increased. Verified in the Swedish Royal Navy with SWP during mine sweeping operation.
Designing the sleeping environment.	Knowledge. Personal sleeping equipment, dark curtains and good bunk. Can noise from e.g.	Information, economic support.	Make demands		Where is the cabin situated? Is it dark, quiet and cool enough (17-21 °C)? Consider furnishing and equipment.

	cargo operations be reduced?				
Strategic sleep. Half an hour can make a big difference.	Sleep close to the watch. A siesta is better than sleeping in. Sleep the same time every day if it is shorter than eight hours (“anchor sleep”).				19-22.30 a lot better than 20-22.30 Level of sleep 7/9.
Fatigue management included in ISM	Report non-conformities.	Responsible for implementation.	Make legal claims. Report non-conformities at audits.		
Chain of responsibility in transport sector			The (Swedish?) Transport Agency?		Have previously been done in Australia, for instance.
Individual solutions when assigning watch.	Individualize, take the personal characteristics into consideration.				Risk: Alertness, increased safety – poorer health in the long term.
Health ○ Food ○ Exercise ○ Stimuli ○ Light ○ Socially (and at home)	Mainly on board	Support			
“Caffeine nap” 10-15 min. Drink a large cup of	Can be used when needed, even during a watch if possible.	Support in composing procedures and supply competence.	Recommendation?		The aim is to increase the alertness. Can it be

coffee and lay down for 15 min. The caffeine and the nap have an interacting effect.	This need to be supported with personnel and routines on how to assess if the situation permits a caffeine nap.	Information.			done during time in locks, for instance? Recommended also when leaving the ship, if one has to drive a car after not getting enough sleep.
Nap < 45 or > 90 minutes.	“Scheduled nap” on the off-duty watch. Allow time for waking up.				Including the master and the chief engineer. Remember that a person straight out of bed is not sharp.

More information and further reports are available at www.vti.se/fatigueatsea
 Questions and comments can be directed to Margareta Lützhöft margareta.lutzhof@chalmers.se