Investigation report

S3/2004M

Factors contributing to fatigue and its frequency in bridge work

Translation of the original Finnish report

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SUMMARY

In accidents suffered by modern vessels investigated by the Accident Investigation Board, it was detected that, in a significant number thereof, fatigue had contributed to the alertness of the navigating personnel. When analysing the events, there were signs that indicated that work shift arrangements had affected the problem detected. The Accident Investigation Board sent a questionnaire to Finnish officers in order to establish the effects of different factors.

A very representative reply was obtained to the questionnaire, and the analysis produced results which describe the problem well. The questionnaire consisted of two parts: coded questions and open questions. The results from both parts led to the issuing of recommendations. The recommendations paid attention to an unprejudiced consideration of work-time arrangements, attending to adequate rest periods, observance of the strain of port work, development of the job description of the lookout, detection and reporting of symptoms of fatigue, the quality of the nourishment of the watch personnel as well as the air quality on the bridge.

As a whole, the study gave a picture of responsible and safety-oriented bridge personnel.

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BACKGROUND FOR THE STUDY

In many maritime accidents investigated by the Accident Investigation Board at the end of the 20th and at the beginning of the 21st centuries, the direct cause of the accident or a factor contributing thereto had been the falling asleep of the watch officer or a decrease in alertness due to fatigue. The International Maritime Organisation [1] has more and more frequently had the fatigue of watch officers on their agenda. The problem is well-known and recognised, but the issue has been approached from the view of individual accidents. At the beginning of the 21st century, inter alia in Great Britain and Sweden, the fatigue of watch officers has become a subject of more extensive studies.

As the problem is known and recognised, the Accident Investigation Board decided to start preparing a safety report. For the report, a questionnaire was sent, with the help of the Finnish Ships' Officers' Association, to its members in charge of navigation.

The goal was to study the condition of seafarers, the frequency of fatigue as well as the effects of shift systems and other background factors on alertness. In addition, the aim was to establish the effects of the physical condition, overweight and other health factors of seafarers on alertness and fatigue. The aim was also to find ways to control the decreasing of alertness and to prevent unintentional dozing-off.

The safety report and the related questionnaire have drawn up by the experts of the Accident Investigation Board: LL.D., Neurology Markku **Partinen**, Professor Mikko **Härmä,** psychologist/airline pilot Matti **Sorsa** and Major (Ret.) Pertti **Siivonen**. Its contents were specified with the help of the Executive Manager and Deputy Executive Manager of the FSOU to suit seafarers. The questionnaires were translated into Swedish by Harriet **Björkqvist**. The section of the report "Manning on the bridge after the Second World War - rules and practices" was written by an expert of the Accident Investigation Board, Jukka **Häkämies**.

The work has been led by Investigator Risto **Repo** and coordinated by Administrative Director Pirjo **Valkama-Joutsen** from the Accident Investigation Board.

[1] International Maritime Organisation.

The work has taken longer than planned, partially due to the extent of the material and partially due to the other tasks of the members of the working group. During the drawing up of the report, new international research and articles have been published on the fatigue of seafarers. They have been used as sources and reference material at the final stage of the writing of the report.

1 INTRODUCTION

1.1 Review of the observations of the Accident Investigation Board

In 1997–2003 the Accident Investigation Board investigated 10 accidents (Appendix 3) where the state of alertness has had either a clear or apparent causal relationship to the accident. In five cases, the person keeping watch had fallen asleep against his will and the vessel had continued its journey and got into an accident. In the rest of the cases, the investigation revealed clear indications to the effect that the lowered state of alertness had contributed to the lack of observations, which had caused the accident. In seven cases, the 6/6 watch system was observed, in two cases the 4/8 watch system and a mixed system of 6/6 + 4/4 was observed onboard one vessel. The clear majority of the one watch system in all the cases studied had an effect on the framing of the questions used in the study.

1.2 Manning

The ship's captain bears overall responsibility for the safety of the vessel and the appropriate arrangement of the bridge watch. The masters have traditionally stayed shorter or longer periods on the bridge, especially during poor weather conditions, in narrow or densely-trafficed passages as well as upon approaching the port either as support for the watch officer and guiding him or by assuming the navigation responsibility from the watch officer.

The role of a pilot as a participant to bridge watch has not been handled in this connection. Finnish passenger ships have already for a long time applied the line pilot system in short-distance traffic. In the system, the bridge has two navigators at all times and, in this connection, the watch keeping on passenger ships is not examined in more detail.

In traffic including frequent calls to ports, the master cannot necessarily at any stage of his work shift sleep longer than a few hours at a time. This is due to the frequent and short calls to ports, during which the master is primarily in charge of the manoeuvering of the ship.

The manning should be such that the work and rest period regulations can be observed. Smaller ships are still navigated in the waters of Western Europe so that the deck officers comprise only the master and one mate. The relatively wide-scope questionnaire launched by the Swedish Maritime Administration at the beginning of the 21st century indicated that accidents occur on these ships more than on the average[2]. A similar accident process has been established also in Finland on the basis of the accidents studied. In most cases, the cause has been the lowered state of alertness of the watch officer. The uncertainty of the jobs, the increased workload during the short stays in port, the different mother tongues and cultural differences of the crew as well as the high average age[3] of the crew onboard are factors which have to be observed.

1.3 Sleep/wake phase and its regulation

In addition to physical health, sleep has an effect on all three sub-areas of psychological functioning: action, cognition and emotion. Through brain energy metabolism, sleep has an effect on the maintenance of perception as well as on the guidance and assessment of one's own actions in new and complex situations. A 24-hour uninterrupted wake period or a one-week-long 3 to 4 hour daily sleep deprivation corresponds to the effects of intoxication where the alcohol level is approximately 1 per mill.

Weakening of the cognitive function may lead to erroneous action, casualties or accidents. Sleep also has an effect on memory by strengthening the memory imprints created while awake as well as by moulding the memory imprints into a form facilitating perception. The effect of inadequate sleep on emotions is mainly manifested as a weakening of one's self control as well as an increase in irritability and melancholy, but sometimes also as an euphoric state of mind.

A person needs some 7 to 8 hours of sleep daily in order to keep active and maintain his functional and working ability. The feeling of sleepiness at night - and sometimes also during the day - is the way for our brain to tell that is it tired and needs sleep. Our activity is the highest in late morning and early evening and the lowest in the small hours as well as in early

[2] Sjöfartsinspektionen 2003, C. Lindquist
[3] In 2000 in the EU States, two-thirds of the crew members were over 40 years old and 40 % belonged to the group of over 50-year-olds. (Database STC Group, 2004)

afternoon. After a meal, fatigue increases especially if the meal has contained a lot of fast carbohydrates or if it has been especially heavy. The alteration of sleep and active phases is closely linked to the other circadian variations. Besides the time of the day, our alertness during the working hours is affected by the length and quality of the preceding sleep, the wake time, nutrition and the working environment, for example, monotony of work and temperature of the environment.

A person is most likely to fall asleep at night and least likely to fall asleep in late morning. Another natural period of fatigue is between 3 and 5 in the afternoon. The afternoon fatigue period is also referred to as "post-lunch dip". Afternoon fatigue is, however, not only due to loading caused by work or to lunch, but our alertness follows, in addition to the 24-hour rhythm, also a 12-hour rhythm.

The syncronization of the inner clock and the inner phase of the sleep-wake rhythm vary considerably between people. Individual differences in the circadian rhythms are mainly genetic and the genes regulating the rhythm have already been detected. One strongly genetic characteristic is so-called morningness or eveningness. Morning persons have an earlier sleep-wake rhythm: they wake up earlier than evening people and go to bed in the evening earlier than the evening people. As a result of ageing, people have more evening sleepiness, i.e., they become morningness types.

The phase of the circadian rhythm, i.e., the time of the inner clock, has a strong effect on our alertness, our ability to fall asleep and maintain sleep. The phase of the circadian rhythm also affects the structure of sleep, especially the occurrence of deep sleep and REM, or rapid eye movement, sleep. The wake time does not have much effect on the length of sleep, but its length depends more on the time one goes to bed. If we go to bed at the right time compared to the phase of our inner rhythm, we are likely to sleep well and long. For most people, the best bedtime is between 9 and 11 in the evening, when the inner body temperature is dropping. Our sleep phase will, however, be at its shortest if we go to bed in the morning between 9 and 11, for example, due to a night shift.

1.4 Connection between work-time arrangements and accidents and alertness

The watch systems affect the sleep-wake rhythm of those working on the bridge. During the night watch, a person is, by nature, sleepier than during the day-time watch. On the other hand, the rest period between the watches and the time of the day affect the possibilities to recover from sleep deprivation. In addition to the watch system, alertness is also affected by the overall working time and the conditions of bridge work[4].

Several studies have indicated that marine accidents take place more often at night than during the day[5]. Raby and McCallum[6] studied the role of fatigue in the material covering 98 marine accidents. According to the researchers, fatigue was a contributing factor in approximately one-quarter of the accidents. The researchers found that accidents caused by fatigue were connected with a wake period longer than normally, typically of at least 24 hours, and symptoms of fatigue. The accidents were often also connected to a long total working time during the preceding 24–72-hour period.

Most studies indicate that, relatively taken, most accidents take place in the small hours or early in the morning. The differences between the different studies derive from the differences between the times examined. In the material of Folkard[5], comprising 127 vessels most collisions took place early in the morning. According to Berger's study, 45 % of the collisions of vessels take place between midnight and 6 a.m. Accidents caused by steering errors complied with the circadian variation so that they occurred mostly between 4 a.m. and 10 a.m. and, on the other hand, between 4 p.m. and midnight[7]. In material involving 100 head-on collisions and groundings, most incidents took place between 11 p.m. and 4 a.m. Also according to material covering 65 groundings, more incidents took place in the small hours than during the day[8].

[4] Collins et al. 2000
[5] Folkard 1997, Berger 1987, Smith and Owen 1989, MAIB 2004
[6] Raby M, McCallum MC. Procedures for investigating and reporting fatigue contributions to marine casualties, 1997
[7] Smith ja Owen 1989
[8] MAIB 2004: Bridge Watchkeeping Safety Study

Alertness and the cognitive functions were the weakest in the small hours, for example in watches starting at 4 a.m.[9] Watch officers and masters sleep less than the crew: for 30 %, the length of sleep was under four hours a day[10]. Also according to Sanquist[11], watch officers sleep less than the ship's other crew, approximately 6.6 hours a day. Sleep gotten at night is better in quality than sleep gotten during the day[11]. Although there is a clear on connection between alertness and accidents on the general level and although also marine accidents seem to follow the circadian rhythm of alertness, the connection between the ships' watch systems and accidents and alertness has been studied very little. Although it would seem that more accidents take place at night during the 6/6 watch system than during the 4/8 watch system[8], the earlier studies have not been able to indicate clear differences in alertness or sleep between the 6/6 and 4/8 watch systems[12].

1.5 The bridge and its ergonomies

Along with technology aiming at improving safety, the nature of bridge work has changed from task-oriented to supervision-oriented. This has, for its part, lead to as compact and ergonomic planning of the work stations as possible. The comfortableness of the seat of the work station, the reliability of the technical equipment, the monotonous sound world and the tiring isothermal air conditioning are typical of a modern bridge. When we combine the said factors with working hours that suit poorly the human wake rhythm, we have an environment which weakens the state of alertness.

[9] Condon 1986
[10] Parker 1997
[11] Sanquist 1996
[12] Sanquist 1996, Donderin 1995

2 DESCRIPTION OF THE INVESTIGATION

Different parties, maritime organisations and many other actors agreed that the problem has to be examined thoroughly as an entity and not only through individual incidents.

The use of special expertise was found necessary when, during a relatively short period of time, accidents came repeatedly subject to investigation involving, as a clear contributing factor, the weakened alertness of the watch officer. International investigation reports showed that the problem is global and growing.

All the navigator members of the Finnish Ships' Officers' Association, altogether 1501 persons, were sent material which comprised a personal questionnaire as well as a work and sleep diary form. The forms were drawn up by the experts invited to join the investigation. The open questions of the questionnaire were drawn up at the Accident Investigation Board and they were specified with representatives of the Finnish Ships' Officers' Association.

The goal of the questionnaire was to clarify the sleeping habits of persons acting as watch officers in different watch systems, the occurrence of possible sleeping disorders as well as symptoms of fatigue. Opinions free in form on the working environment of a watch officer were requested on the same form.

If the recipient did not consider that he/she belonged to the target group (active watch officers), he was requested to return the mailed cover letter in order to clarify the accuracy of the response rate. The investigators received 290 returns. Altogether 185 completed questionnaires were returned, and so that the total response rate was 31.6.

The response rate can be deemed satisfactory taking into consideration the target group.

The personal questionnaire and the data in the sleep diaries were coded on the basis of the instructions of the said investigators and the investigators analysed the results, on the basis of which parts 3.1 and 3.2 of this report have been drawn up. The answers to open questions are handled in part 3.3.

3 RESULTS

3.1 Questionnaire

Questionnaire on sleep and alertness disorders

The aim of the numeral part of the questionnaire was to clarify the sleeping habits of those acting as watch officers and the occurrence of sleep disorders and fatigue symptoms.

Description of the questionnaire material

Altogether 185 persons responded to the questionnaire. The median age was 40 years (variation between 22 and 64 years). Of the respondents, 21.1 % were under 30 years of age and 27 % were over 50 years of age.

The median body mass index (BMI = kg/m^2)[13] of the respondents was 25.8 kgm^{-2} (average 26.4, variation between 19.1–39.4). Of the respondents, 61.6 % were overweight (BMI > 25) and 15.1 % were obese (BMI > 30 kgm^{-2}). Of those under 30 years of age (N = 39 respondents), 4 were obese (10.3 %), of the 30 to 49-year-olds (N = 80 respondents) 16 (16.7 %) and of the over 50-year-olds (N = 50) altogether 8 persons (16.0 %) were obese.

The most common watch type (161 responses) during the past 5 years had been 4/8 (N = 68, 42.2 %). The next common type was 6/6 (N = 41, 25.5 %). The most usual watch type of 3.7 % (N = 6) had been the 12/12 system. Of the respondents, two were working the 4/4 watch system and 44 did other types of shifts. These systems were typically either a mix of the 6/6 and 4/8 systems or ones where the master does for example one 4-hour shift between 6–10 p.m. and, in addition to that, there are 4 and 6-hour shifts (5/6, 4/6 system, etc.)

[13] The body mass index was calculated in order to gain information on the possible effect on fatigue of this factor

Methods in the questionnaire

The questionnaire form used was a form[14] tailored from the Skogby Sleep Clinic questionnaire[15]. The form is based on a validated Nordic sleep questionnaire[16]. The original form was supplemented with questions on seafaring experience, watch shifts and marine accidents. The form has altogether 58 questions measuring different issues. The Epsworth sleepiness scale (ESS) measuring the likelihood of dozing off is included in the form. In this study, the score 11 or higher (ESS > 10) was considered as a deviating ESS score.

The other sum variable measuring fatigue and excessive sleepiness used was the Skogby Excessive Daytime Sleepiness scale (SEDS) of the Skogby Sleep Clinic.

The SEDS is formed by summing up the values of the following questions of the form: question 31 (do you feel sleepy), question 32 (do you feel sleepy during the day), question 33 (compulsory tendency to fall asleep during working hours), question 34 (compulsory tendency to fall asleep during free time) and question 42 (more tired than friends or colleagues). The SEDS value varies between 5 and 25. A value of 15 or more is considered a deviating value (SEDS > 14). Tables 1 and 2 do show also the occurrences of certain significant sleep disorders. A sleep disorder was classified as significant if the person suffers therefrom at least 3 days a week.

Results of the questionnaire study

The material displayed in the two following tables has been arranged first by age group and thereafter according to the watch systems. The material has thereafter been examined analytically. Finally, multivariable models based on the material are used to explain the different sleepiness scales to explain falling asleep as a watch officer.

[14] Form as Appendix 1.
[15] Markku Partinen / Rinnekoti-Säätiö
[16] Partinen and Gislason 1994

Table 1. Description of the study subjects and occurrence of sleep disorders according to the age group.

	under 30 year-olds	**30-49 year-olds**	**50 year-olds or older**
No. of respondents (N)	38	93	47
BMI median (mean±SD)	24.5 (25.0±3.0)	26.1 (26.6±3.2)	26.3 (27.2±3.9)
Clearly morning types	5.1 %	10.4 %	22.9 %
Morning types	20.5 %	30.2 %	45.8 %
Evening types	74.4 %	58.4 %	35.4 %
Clearly evening types	38.5 %	34.4 %	12.5 %
Difficulties falling asleep = 3 days a week	7.7 %	12.5 %	16.7 %
Awakening = 3 times during the sleep	57.9 %	56.4 %	62.5 %
Awakening too early = 3 times a week	5.1 %	17.7 %	14.9 %
Tired during the day = 3 times a week	26.3 %	26.3 %	33.4 %
ESS > 10; irregular dozing	5.1 %	14.1 %	26.2 %
SEDS > 14; irregular fatigue and sleepiness	5.4 %	19.6 %	27.1 %
Compulsory nodding off during the working hours = 3 times a week	0 %	2.2 %	6.3 %
Nodded off while working as the watch officer during the past 5 years	15.4 % (N = 6)	22.1 % (N = 21)	13.3 % (N = 6)
Marine accident during the past 5 years	15.8 % (N = 6)	15.0 % (N = 14)	4.3 % (N = 2)
Suspected sleep apnea, likely sleep apnea	0	8.8 % (N = 8)	19.0 % (N = 8)
Restless legs symptoms = 3 times a week	8.6 %	7.2 %	22.2 %

BMI = Body Mass Index kg/m^2; SD = standard deviation

Table 2. Description of the study subjects and occurrence of sleep disorders according to the watch system.

	6/6 watch system	**4/8 watch system**	**Other watch system**
No. of respondents (N)	41	68	52
Age median (mean±SD)	45 (45.1±9.8)	33 (36.9±9.8)	42.5 (42.9±12.3)
BMI median (mean±SD)	26.8 (27.2±3.3)	25.4 (26.3±3.6)	25.9 (26.3±3.2)
Clearly morning types	9.8 %	10.4 %	17.6 %
Morning types	31.8 %	29.8 %	33.3 %
Evening types	53.7 %	61.2 %	51 %
Clearly evening types	31.7 %	28.4 %	25.5 %
Difficulties falling asleep ≥ 3 days a week	14.6 %	10.5 %	17.6 %
Awakening ≥ 3 times during the sleep	65 %	58.2 %	46 %
Awakening too early ≥ 3 times a week	19.5 %	16.4 %	12 %
Tired during the day ≥ 3 times a week	34.1 %	31.8 %	20 %
ESS > 10; irregular dozing	18.9 %	12.3 %	12.2 %
SEDS > 14; irregular fatigue and sleepiness	31.7 %	15.6 %	10 %
Compulsory nodding off during the working hours ≥ 3 times a week	7.3 %	1.5 %	2 %
Nodded off while working as the watch officer during the past 5 years	9.8 %	28.4 %	14 %
Suspected sleep apnea, likely sleep apnea	15.8 %	3.3 %	10.6 %
Restless legs symptoms ≥ 3 times a week	20.6 %	9.5 %	7.3 %
Marine accidents during the past 5 years	15 % (N = 6)	13.6 % (N = 9)	6.0 % (N = 3)

BMI = Body Mass Index kg/m^2; SD = standard deviation

Examination

Morningness was statistically significantly ($P < 0.001$) more common in the older age groups and eveningness in the younger age groups. This fits in well with several studies where the eveningness of the young is often found to change to morningness along with ageing. Symptoms of fatigue (SEDS > 14; $P = 0.037$) and sleep disorders increase along with ageing. Both suspected sleep apnea and restless legs symptoms increase especially along with ageing (Table 1).

Of the watch types, the 6/6 system was statistically significantly connected to symptoms of fatigue. This was clearly shown when measured with the Skogby SEDS scale. In the 6/6 system, 31.7 % of the respondents complained about fatigue and sleepiness, in the 4/8 system, 15.6 % and in other systems, 10 % ($P = 0.022$).

In the reported cases of nodding off during the watch, there were, however, no statistically significant differences nor in the marine accidents reported by the respondents themselves although did a watch system other than the 6/6 or 4/8 system seem slightly better in this respect (Table 2).

Fatigue and nodding off at work

Fatigue and also accidental nodding off were common. Of the respondents, 40.6 % had been close to nodding off during the watch at least once during the past 5 years. Altogether 17.6 % had nodded off at least once during watch. Near-miss cases resulting from fatigue had occurred at least once to 19.7 % ($N = 36$) and at least twice to 10.9 % ($N = 20$). Of the respondents, 45.3 % reported that they had been in a marine accident at least once in their lifetime. At least one of the respondents reported that fatigue had been the cause of the accident.

State of alertness is known to be one of the factors affecting attentiveness and observation as well as other functioning. Symptoms of fatigue were very common and, in correlated to that, we could assume that fatigue had most likely been at least a contributory factor in more than one marine accident.

Occurrence of fatigue at different times of the day

The respondents evaluated the occurrence of fatigue in 4-hour phases on the scale 1 (*not at all tired*) to 10 (*cannot stay awake*) at different times of the day (Figure 1).

Fatigue was most common between 4 and 7 in the morning (scale median = 6), the second common in the small hours at 1–4 a.m. (median = 5). The next common occurrence of fatigue was between 7 and 10 a.m. (median = 3) and between 10 p.m. and 1 a.m. (median = 3). Fatigue was least common between 10 a.m. and 10 p.m. (median = 2).

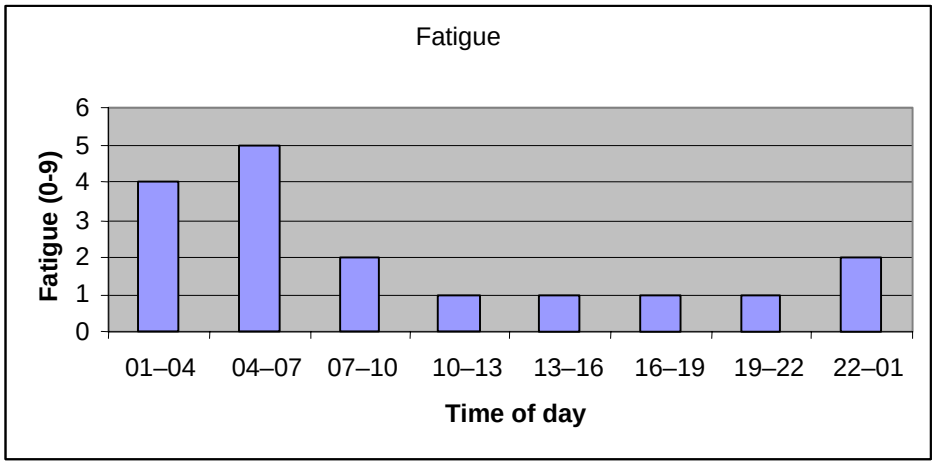


Figure 1. Occurrence of fatigue at different times of the day.

Logistic regression analysis[17]

In the first model, the regressand used was the value 15 or bigger of SEDS. The model included age, Body Mass Index (BMI), total sleep time (TST), the watch system (the comparison system was other than the 6/6 or 4/8 system), morningness/eveningness (the comparison type was the

[17] **Regression analysis** is used to study the effects of one or several explanatory variables on a variable being explained. It may be used for example to try and answer the question whether the length of education has an effect on the size of the salary and if so, how strong this effect is. A special advantage of a regression analysis is that it can be used to study the effects of several explanatory variables on one variable being explained at the same time. In that case, the results will indicate the role of an individual explanatory variable when the effects of other effective factors on the variable to be explained have been observed.

mixed form, i.e., neither morningness or clearly eveningness) as well as suspicion of obstructive sleep apnea syndrome (OSAS).

Logistic regression model 1 of fatigue.

The regressand is a SEDS value of over 14 explaining fatigue and drowsiness.

Parameter	Odds Ratio	95 % upper limit	95 % lower limit
AGE	1.040	1.093	0.990
BMI	0.938	1.077	0.816
TST	0.777	1.192	0.507
MORNINGEVENING_morn	0.201	0.764	0.053
MORNINGEVENING clearly evening	1.251	3.625	0.431
OSAS	5.715	24.590	1.328
WATCH SYSTEM 4/8	2.203	7.804	0.622
WATCH SYSTEM 6/6	3.974	13.443	1.174

According to this model, the strongest risk factor explaining fatigue is sleep apnea (OSAS) OR[18] = 5.7 (95 % confidence interval 1.3–24.6). The morningness types experienced significantly less fatigue than the mixed types. The odds ratio (OR) of the morningness type compared to the mixed type is 0.2 and the 95-percent confidence interval is 0.05–0.76. It is thus a factor protecting from the occurrence of fatigue. Also the 6/6 watch system increased fatigue compared to other than the 6/6 or 4/8 system (OR 4.0, 95-percent confidence interval 1.2–13.4).

Age, weight and the daily TST did not significantly explain day-time fatigue measured with SEDS.

In the other model, the regressand measuring day-time fatigue was the value 11 or higher on the Epsworth scale (ESS). The explanatory variables were the same variables as in model 1 above. As indicated in model 2 below, only age was a factor slightly increasing the occurrence of fatigue.

[18] Odds Ratio, OR.

The watch systems did not explain the ESS value nor did the suspected sleep apnea.

Logistic regression model 2 of fatigue.

The regressand is a value of ESS of over 10 explaining fatigue.

Parameter	Odds Ratio	95 % upper limit	95 % lower limit
AGE	1.063	1.124	1.006
BMI	0.926	1.098	0.782
TST	0.843	1.284	0.554
MORNINGEVENING_morn	1.561	5.718	0.426
MORNINGEVENING clearly evening	2.882	10.853	0.765
OSAS	0.351	3.391	0.036
WATCH SYSTEM 4/8	1.497	5.584	0.401
WATCH SYSTEM 6/6	1.951	7.279	0.523

In the end, the effects of different factors on dosing off when acting as a watch officer were studied. The logistic regression model was supplemented also with ESS and SEDS. As model 3 indicates, the Skogby sleepiness variable SEDS was a statistically significant risk factor explaining the dozing off as a watch officer even also the Epworth scale was included in the model.

Logistic regression model 3.

The regressand was dozing off as a watch officer during the past five years.

Parameter	Odds Ratio	95 % upper limit	95 % lower limit
AGE	0.986	1.044	0.931
BMI	0.983	1.148	0.841
MORNINGEVENING_morn	0.667	2.535	0.175
MORNINGEVENING clearly evening	1.042	3.263	0.333
ESSGT10_0	0.381	1.390	0.105
TST	0.909	1.418	0.582
OSAS	1.438	10.110	0.205
WATCH SYSTEM 4/8	1.535	4.606	0.512
WATCH SYSTEM 6/6	0.246	1.265	0.048
SEDS >14_”yes”	4.817	15.956	1.454

As the ESS and SEDS measure partially the same issue, they were studied more in two different models. In model 4, the SEDS was excluded and the ESS included.

Logistic regression model 4.

The regressand is dozing off as a watch officer during the past five years.

Parameter	Odds Ratio	95 % upper limit	95 % lower limit
AGE	0.994	1.047	0.944
BMI	0.951	1.105	0.818
MORNINGEVENING_morn	0.568	1.888	0.171
MORNINGEVENING clearly evening	0.949	2.807	0.321
ESSGT10_0	0.333	1.127	0.098
K35TST	0.865	1.323	0.566
OSAS	1.692	10.063	0.285
WATCH SYSTEM 4/8	1.760	5.085	0.609
WATCH SYSTEM 6/6	0.402	1.785	0.091

The value 11 or bigger on the Epworth scale was not a significant risk factor. In model 5, the ESS was excluded and the SEDS included.

Logistic regression model 5.

The regressand is dozing off as a watch officer during the past five years.

Parameter	Odds Ratio	95 % upper limit	95 % lower limit
AGE	0.987	1.044	0.933
BMI	0.967	1.126	0.831
MORNINGEVENING_morn	0.630	2.365	0.168
MORNINGEVENING clearly evening	1.256	3.766	0.419
TST	0.866	1.331	0.564
OSAS_1	1.663	9.652	0.287
WATCH SYSTEM 4/8	1.801	5.337	0.608
WATCH SYSTEM 6/6	0.257	1.270	0.052
SEDS >14 ”yes”	5.569	17.993	1.724

The Skogby sum variable SEDS measuring fatigue is a very significant risk factor explaining dozing off when acting as a watch officer (OR = 5.6, 95-percent confidence interval 1.7–18.0).

We can see from the questionnaire that symptoms of fatigue and sleep disorders increase with ageing. Age was, however, not an independent risk factor, when also the BMI, the TST, morningness/eveningness and the watch system were taken into account. The symptoms of fatigue increasing with ageing are significantly connected partially to increasing weight and to sleep apnea. Sleep apnea is the strongest risk factor explaining fatigue. Also the 6/6 watch system increases fatigue when measured with the Skogby SEDS scale.

When considering nodding off during the watch, no watch system was a statistically independent explanatory risk factor nor was morningness/eveningness or sleep apnea. However, SEDS measuring fatigue was an independent risk factor.

The answers indicate that individual characteristics have a significant effect on the occurrence of day-time fatigue and also on the probability for nodding off during a watch. The SEDS scale can be used to assess the individual risk. However, the use of the Epworth sleepiness scale does not, according to this study, provide help in assessing such risk.

3.2 The work and sleep diary study

The main goal of the work and sleep diary study was to examine variations in alertness and the factors contributing thereto during different shifts and shift systems.

The detailed goals of the diary study were:

1. *to describe the practical implementation of watches and work time in different watch systems;*

2. *to explain variations in alertness and the factors contributing thereto in different watches and watch systems;*

3. *to explain the effects of length of sleep/naps on the maintenance of alertness in different watches*[19]*.*

Description of the material

Altogether 92 persons participated in the work and sleep diary study. At the time of filling in the diary, 31 of them worked in the 6/6 watch system and 40 in the 4/8 watch system. The participants comprised also one person working in the 4/4 system and one in the 12/12 system. In addition, 19 answered that they worked in "another" watch system. These systems were typically either a mix of the 6/6 and 4/8 systems or ones where the master does for example one 4-hour shift between 6–10 p.m. and, in addition to that, there are 4 and 6-hour shifts (5/6, 4/6 system, etc.).

In the sleep diaries of the 92 persons covering one week, there were altogether 2850 entries regarding alertness[20]. Table 1 provides a

[19] The material did not provide enough answers to make conclusions on the effect of naps on alertness. Therefor the significance of naps is not handled herein on the basis of the response material.

[20] KSS, Karolinska Sleepiness Scale

description of the persons working in the different watch systems. Those working in the 6/6 system were, on the average, c. ten years older than the others. Among those working in "another watch system" there were fewer so-called morning types.

Table 3. Participants of the work and sleep diary study according to the watch system. In addition, the participants of the diary study comprised one person working in the 4/4 system and one in the 4/12 system. The table presents the median and its range is in brackets.

	6/6 watch system	**4/8 watch system**	**Other watch system**
No. of studied persons	31	40	19
Age (median)	45 (27–63)	33 (25–60)	39.5 (25–64)
Body Mass Index BMI	26.8 (21.9–35.9)	25.4 (21.4–38.1)	25.8 (20.5–39.4)
Morning types (%)	35	28	11
Clearly evening types (%)	29	33	32
Watch experience (months)	100 (6–500)	40 (5–438)	60 (0–440)
Watch experience/alone (months)	32 (0–200)	18 (0–250)	17.5 (0–200)

Methods

A one-week work and sleep diary was sent along with the questionnaire. A corresponding diary has been used previously i.a. in a study concerning railway engineers and remote controllers[21]. For a period of one week, the beginning and end times of all watches and other work, alertness in watch at two-hour intervals as well as the times of falling asleep and waking up were collected in the diary. Also noddings off at different times of the day were asked to be entered in the diary.

[21] Härmä et al. 2003

Alertness during the watch was asked to be assessed according to the modified[22] Karoliska Sleepiness Scale (KSS):

1 *extremely alert*
2 *alert*
3 *neither sleepy nor alert*
4 *sleepy but no effort to remain awake*
5 *very sleepy, an effort to stay awake (fighting sleep)*

The data of the sleep diary were combined with the questionnaire enabling the diaries to be grouped according to the watch systems. The material was also supplemented with background variables from the questionnaire. As the statistical model, the linear multivariate model[23] suitable for repeated measurements was used. The variation in alertness during the watches was explained by means of individual differences, age, morningness/eveningness and the probability for nodding off[24], the watch system (6/6, 4/8 or other), the time of the day (at two-hour intervals), the awake time as well as the length of sleep.

Results

The implementation of work shifts and working times in different watch systems.

Of those working in 6/6 and 4/8 watch systems, the average beginning and end times of the shifts, the lengths of the watches, the time between shifts and the amount of other work before each watch are presented in Table 2. There is considerable variation in the beginning and end times of the watches, but they are in compliance with the traditions of seafaring. In the 6/6 system or in systems closely resembling it, some of the watches are shorter than normal and therefore the average length of the watches was under six hours. In the 4/8 system, the watches of the first mates and chief mates were, on the average, prolonged over four hours. In addition to

[22] In the original KSS scale, the descriptions of the alertness levels are the same, but the scale is from 1 to 9. The scale used has been modified to correspond to the original KSS scale (1 = 1, 2 = 3, 3 = 5, 4 = 7 and 5 = 9). The intermediate alertness levels (2, 4, 6 and 8) were omitted, and so the scale is rougher than the original.
[23] Mixed model, Brown and Prescott 1999
[24] Epworth index

watch duty, so-called other work was performed most often by the chief mates in the 4/8 system.

Table 4. *A description of the 6/6 and 4/8 watch systems. The average beginning and end times of the watches, the lengths of watches and the times between them. The watches are classified according to their beginning time to the closed possible group (in the 6/6 system: at 6, 12, 18 and 24; and in the 4/8 system: at 04, 08, 12, 16, 20 and 24). The decimals in the Table are a result of the coding of the beginning and ending times of work times in the material (if the end of one 6/6 watch has been prolonged by half an hour or an hour, its effect on the end time of all 6/6 watches is one or two minutes).*

	6/6	**6/6**	**4/8**	**4/8**	**4/8**
	a	b	a	b	c
	"master/ chief mate"	"chief mate/ 1st mate"	"1st mate"	"chief mate"	"2nd mate"
beginning of watch (at)	00.11 11.99 **24.00/12.00**	06.17 17.94 **06.00/18.00**	00.00 12.01 **00.00/1200**	04.01 16.01 **04.00/16.00**	08.02 20.09 **08.00/20.00**
end of watch (at)	06.89 18.00	11.55 22.74	04.25 16.56	08.32 20.49	11.94 23.86
length of watch (h)	5.30+1.52 5.61 +1.06	5.39 + 1.56 4.80 +1.67	4.25 +0.38 4.55 +0.86	4.31 +0.81 4.48 +0.94	3.92 +0.98 3.76 +0.54
time between watches (h)	5.04 +1.88 5.16+2.47	5.16 + 2.2 4.16 + 2.52	5.87 +1.95 6.41 +2.55	6.07 +3.40 3.95 +3.16	5.35 +4.43 5.49 +2.95
other work preceding watch (h)	0.58 + 1.64 0.48 +1.28	0.61 + 2.9 1.39 + 2.65	1.63 + 3.04 0.96 + 2.58	2.02 + 3.66 2.76 + 3.60	2.10 + 5.57 1.00 + 1.84

Variation in alertness in different watch systems and watches

The average variation in alertness according to the time of the day is indicated in Figure 2. Figure 3 shows the variation in alertness according to the 6/6 and 4/8 watch systems and the watches therein.

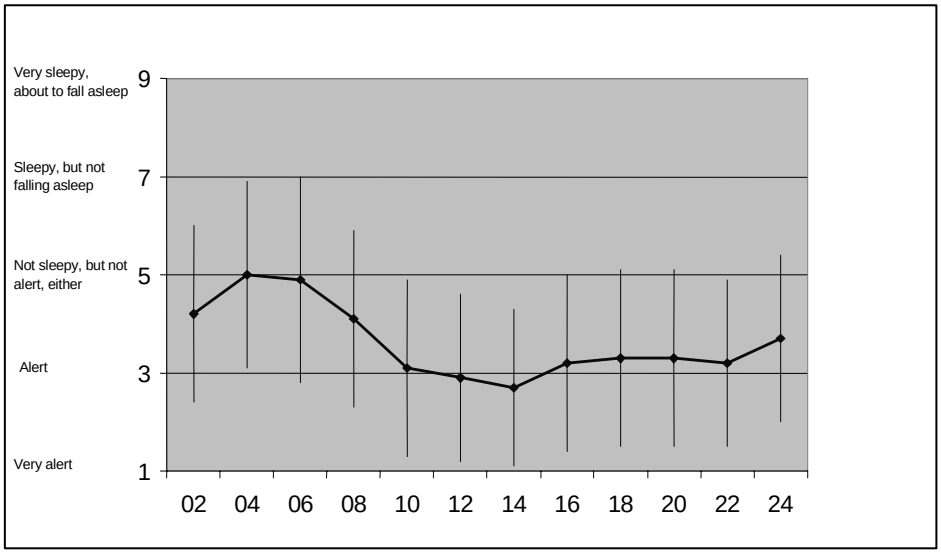


Figure 2. State of alertness (KSS) according to the time of the day on the basis of one-week measurements (N = 90). Altogether 2850 KSS observations; 139–313 observations per each hour. The vertical beams indicate the ranges of the observations.

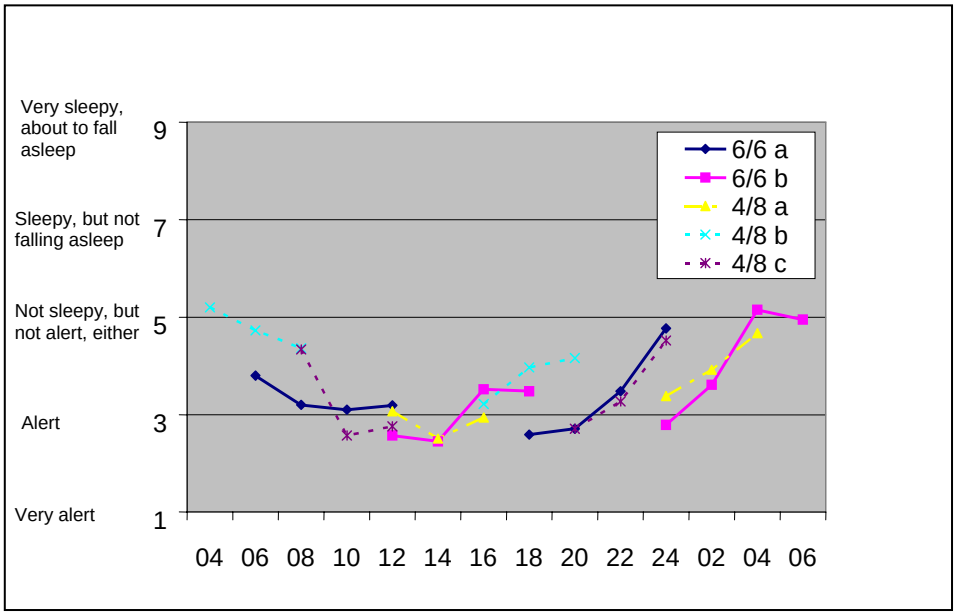


Figure 3. Variation in alertness in the different watches of the 6/6 (N = 31) and 4/8 (N = 40) watch systems (cf. the names of the watches and their times in more detail in Table 4).

Sleepiness is strongest at 04–06 in the morning and least at 12–14 in the afternoon (Figure 3). The differences in sleepiness were relatively slight between the watch systems if the individual differences within the watch systems were not simultaneously taken into consideration (cf. Figures 3 and 4). During the watches, sleepiness mainly increased towards the end of the watch in shifts starting after noon but decreased during the watch in shifts that started at 04 and 06.

Multivariate model

In order to study the variations in alertness in different shifts, a multivariate model was formed to study the effects of the following factors on alertness:

- age (20–29, 30–49 or 50–62 years)
- morningness-eveningness (morning type, a so-called mixed type or clearly evening type)
- probability for nodding off (Epworth scale)

- the starting time of the watch (classified at two-hour intervals)
- the watch system (either 6/6, 4/8 or "other")
- length of sleep (classified in 1 to 7 hours) and
- time spent awake (0, 1, 2, 3 and 4 hours or more).

The following factors affected the variation of alertness in the watch (Table 5): *the time of the day, the time spent awake and the length of sleep.* The shift system and individual factors did not have an independent effect on alertness, but they did have a combined effect thereon (their statistical combined effects were significant in the multivariate model). Thus the effects of the shift system (6/6, 4/8 or other) on alertness depended on both the time of the day and various individual factors[25]. The length of sleep did not, however, have any significant effects in combination with the watch system and the time of the day.

Table 5. Linear multivariate model on individual, shift system and sleep factors having an effect on alertness in the watch (KSS). N = 85.

Variable	**Degrees of Freedom**	**F**	**p <**
age	2.76	0.98	0.3792
morningness-eveningness	2.76	0.45	0.6395
nodding-off tendency	2.76	1.59	0.2115
time of day	11.246	6.78	0.0001
time spent awake	4.162	9.20	0.0001
length of sleep	6.226	12.96	0.0001
shift system	2.76	0.44	0.6477
age*time*shift system	59.246	2.39	0.0001
morningness/eveningness*time*shift system	63.246	2.16	0.0001
nodding-off*time*shift system	62.246	1.80	0.0009

The combined effects of the shift system and individual characteristics found can be interpreted as follows:

[25] age, morningness-eveningness and the probability for nodding off

- in the 4/8 system, the 50–62 year-olds were sleepier than the 30–49 year-olds both at night and in the afternoon. In the 6/6 system, the age group did not correspondingly affect on alertness (Figure 4)

- in the 6/6 system, the persons with a high probability for nodding off according to the questionnaire were more tired at night than the persons with a low probability for nodding off. In the 4/8 system, the probability for nodding off did not correspondingly affect on alertness at night

- the evening types were mainly more tired than the morning types. However, in the 4/8 system, the evening types were more alert in the evening than the morning types.

As a conclusion we can state that, according to the work and sleep diary study, the factors having a significant effect on alertness were the time of day, the time spent awake and the length of sleep so that alertness was at its lowest in watches taking place at night and in the early hours, when staying awake for a long time and in situations where the preceding sleep time had been shorter than normally. In addition, the watch system and the individual characteristics had combined effects on alertness so that *special risk groups regarding alertness at night were the 50–62 year-olds in the 4/8 system and in the 6/6 system both the evening types and persons with a high probability for nodding off.*

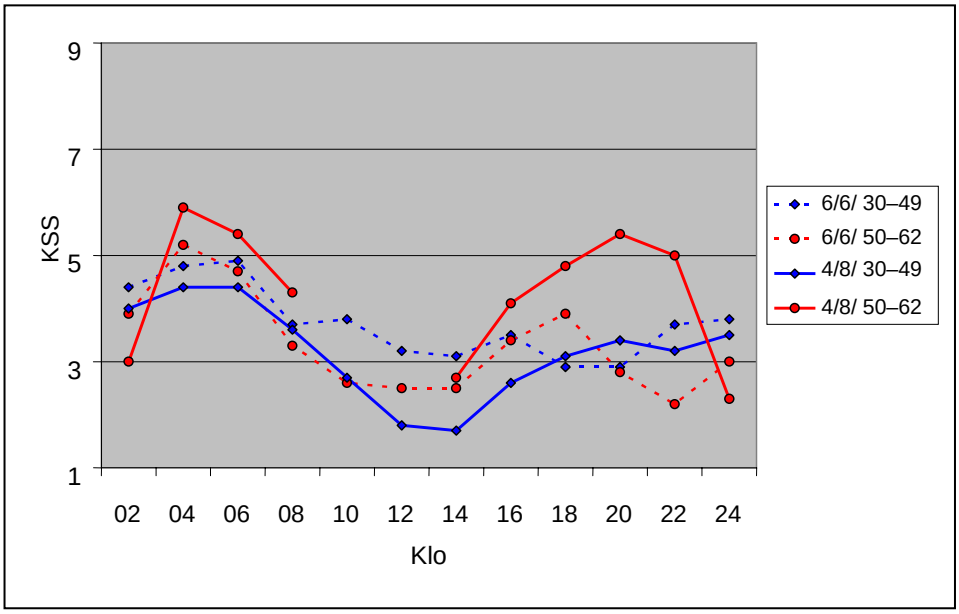


Figure 4. Variation in sleepiness (KSS) among the ageing (50–62 year-olds, red) and the middle-aged (30–49 year-olds, blue) watch officers in the 6/6 (broken line) and 4/8 system (continuous line).

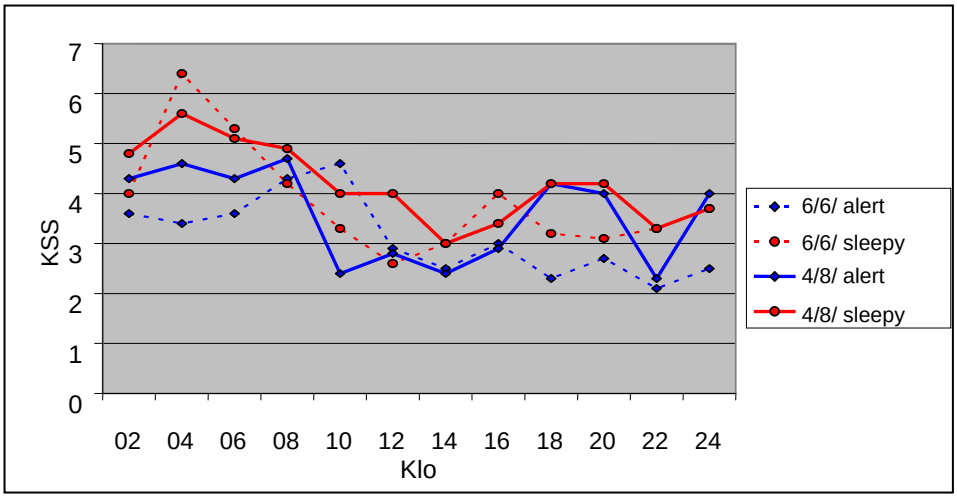


Figure 5. Variation in sleepiness (KSS) among watch officers with a high probability for nodding off (ESS 10–15, red) and alert watch officers (ESS 1–4, blue) in the 4/8 (continuous line) and the 6/6 systems (broken line).

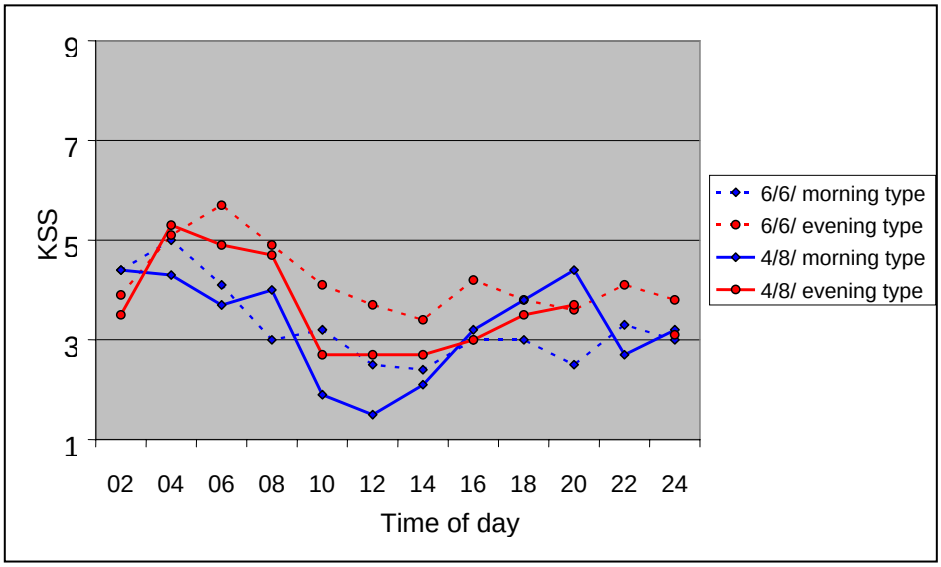


Figure 6. Variation in sleepiness (KSS) among evening-type (red) and morning-type (blue) watch officers in the 4/8 (continuous line) and the 6/6 systems (broken line).

3.3 Free-form responses

This is mainly a study of comments made more than five times.

1. "In what way does the deckhand acting as your lookout participate in the watch duty with you?"

Of the 195 forms that were returned, this free-form question was answered by 173 persons. This shows that the issue is of importance to the respondents. Most of the forms - altogether 112 - stated that the lookout is a kind of a living warning system that keeps the navigator awake in the difficult hours of the night. Typically the responses were of the type: "Just keeps the lookout and chats, makes coffee, does what he is told to do."

Of the respondents, 24 felt that they received actual help in navigation (13.8 % of the respondents). Their responses can be described as follows: "Uses the other radar, acknowledges alarms, discusses actively."

Of the respondents, 13 considered that the situation depended mainly on the person often referring to the difference between old and young lookouts.

Of the respondents, 11 felt that the lookout was very passive. "Nodding off, dreaming in some corner, tidying up, making fire rounds." These responses reflected a more or less belittling attitude towards the role of the lookout.

Examination

The role of the lookout in bridge duty is a typical indication of the long history of seafaring. Before the era of the radar, continuous visual lookout was necessary. On the other hand, almost anyone who had good eyesight and adequate vocal resources was capable of the task. Along with modern technology, navigation in poor weather conditions has become based on the radar, but it has not been considered necessary to teach the deckhands the use of the radar. This is the case despite the fact that the basic education level of the present deckhands has risen to a completely other level than before the era of the radar and this would enable active monitoring of navigation from the other radar and also otherwise a full-bodied participation in the management of the situation.

The underuse of the resources of the lookout is most likely due to professional and union-related reasons. There, however, hardly are rational reasons for an emotional underestimation of the skills and role of deckhands during an era of small crews, when the maintenance of the alertness of the navigators is a critical safety issue in merchant shipping.

2. "Which improvements would you make on the bridge with regard to the maintenance of alertness?"

The questions relating to the general improvement of the working environment received 96 answers in free form. It is be considered a significant observation that *most* of the answers dealt with tidal air: "Good air-conditioning would facilitate concentration" (27 responses, thus nearly 30 %); "There should be a possibility to go outdoors" (22 responses).

In addition to better breathing air, the wishes dealt with more refreshments (refrigerator, music, coffee, fruit on the bridge - 22 responses), which can be anticipated.

With regard to the chairs on the bridge, the opinions were divided in an interesting manner: Some of the respondents (9 persons) wished that the chair could be better for the back, not too hard. On the other hand, six respondents felt that it would be best to navigate standing up.

The general ergonomics received some comments: ergonomic working positions, the adjustment of the lighting of the equipment and the control of alarm sounds - altogether nine responses. Two respondents expressed a wish for a bright light lamp.

Examination

We can consider the very extensive criticism relating to the breathing air on the bridge as a finding of this study. The finding is very clear; the need for good-quality tidal air has not adequately been observed in the design of bridges. Also the possibility to adjust the air temperature would be important. In modern ships, the breathing of outdoor air while in watch is not easy.

3. General views regarding the manner in which the working conditions should be developed so that the working ability and alertness would remain good

The responses to this free-form question (148 responses) were mainly linked to one system-related issue, the manning (69 responses). Many respondents stated as follows: "The system dates back to the times when the voyages were long. The present busy-rhythm work with loading and unloading, i.e., the additional burden from dock work, should be taken into consideration."

Thirty respondents stated clearly that there should be one more mate on board the ship especially to ease the work load of the chief mate. This clearly refers to the burden of dock work, which especially falls on the chief mate.

Of the respondents, 22 requested changing the watch system from 6/6 to 4/8.

A weekly rest period, when one could sleep off any fatigue, was requested by 10 respondents.

In addition to the watch system, the respondents drew attention to the use of the off-watch period and wished for a gym etc. for recovery (13 respondents).

The placement of cabins in a peaceful area was requested by 12 respondents. Seven respondents paid attention to the development of the contents of the work so that it would be less numbing. On the other hand, the additional duties of the mates (salvage equipment, maps, radios, etc.) are a problem as the sleep is interrupted.

4 ANALYSIS

4.1 On development of bridge manning

The number of navigators has decreased during the last 30 years. Long work weeks on ships are more frequent than earlier. The lookout and the helmsman can be used to assist the mate less than before as deck manning has especially been the target of cuts. Bridge watch is more and more often the duty of the mate alone.

The development trend in Finland after the Second World War as well as the effect of the STCW Convention of the IMO on the development of bridge manning is described in detail in Appendix 2.

4.2 Significance of alertness on operative capacity

The effects of decreased alertness caused by fatigue on the capacity of the seafarer are a significant safety factor. The operative significance in bridge work lies in the fact that the level of alertness of the brain of a tired navigator is no longer up to the standard of the work. The work is by nature mostly passive supervision, where the number of stimuli is small. The stimuli often appear at long intervals, but they often require immediate attention and measures. Typical situations are the start of turns as well as evasive movements caused by other traffic.

The said situations require well-timed and exact observation, interpretation and understanding of the situation as well as an ability to take the required measures on the basis of correct decisions.

The decrease in alertness caused by fatigue has an effect on all these sub-factors of performance.

Observation means perceiving and filtering of stimuli by guiding attentiveness. Stimuli received by the sensory organs and successfully filtered by the brain are subjected to interpretation so that their significance in each situation can be assessed. A single light or signal obtains its operative content only after interpretation. The interpretation is based on the models of corresponding stimuli in the memory of the seafarer and

their significance. A successful interpretation gives rise to a realisation, for example, of another ship in the fairway or of side buoyage of the fairway. A signal produced automatically of e.g. the approach of a turning point also requires interpretation and understanding. A tired person fails to observe stimuli or cannot always ponder their significance adequately. There is significant worsening in the memory function. Also the reaction speed may slow down in an operatively significant manner. This results in a shortage of situation awareness, which may be critical with a view to the required decision-making.

Not all situations requiring decision-making are unambiguous in the steering of a ship. In complex situations where there are too many or too few stimuli there is a need for considerably vigilant readiness to process the information, which a tired brain cannot do within the framework of time available.

The navigator has to move from decision-making to a physical activity such as the handling of the automatic steering of the ship. When transferring to action, a tired person may experience slowness of initiative, which may typically cause a delay for example in starting a turn.

Fatigue also affects the communication atmosphere on the bridge. A tired person is easily irritable and often unwilling to communicate. Even if there is help available for navigation on the bridge, it is possible that it is not fully used. Alertness lowered by fatigue thus deteriorates the BRM behaviour[26], which has an effect clearly decreasing the safety level.

In extreme cases, fatigue may lead to uncontrollable dozing off. Dozing off is usually preceded by a series of micro-sleep, ice-fishing, which the person is conscious of but to which he is too tired to react. Dozing off does therefore not come as a surprise to the person.

Some people suffer from a clinically significant and diagnosable problem such as a temporary stoppage of breathing during sleep (sleep apnea). Identifying these persons and their transfer to other tasks in seafaring has to be considered a clear safety issue.

[26] Bridge Resource Management

With regard to alertness, the effects of ageing and other individual differences in performance should be taken into consideration. Most often there are noticeable changes that cause a slowing down of data processing and the initiation of action. With ageing, also individual differences become more apparent. The working memory gets burdened easier and the alertness necessary in bridge work decreases. There is no reason to exaggerate the effects of age on persons selected to navigation work as the ability to outline entities and through that to predict situations develops through experience. Ageing also helps in solving complex problems.

As a comparison we should note that the investigation of traffic accidents[27] has taught us that inter alia the following factors have an effect on performance:

- long-term staying awake, over 21 hours
- working in the small hours
- working in the afternoon (1–3 hours after lunch)
- a nightly sleep of less than 5–6 hours
- sleep apnea.

If a person is subject to more than one of the risk factors, the risk of a false measure and an accident caused by fatigue naturally grows.

Due to the risk of sleep apnea especially those who are overweight and who almost always snore in sleep should seek an examination in order to get a possible sleep apnea diagnosed and treated. Sleep apnea can be treated and with efficient treatment the daytime fatigue caused by it may also be remedied.

Recently an increasing amount of evidence has been acquired to the effect that especially fast-digesting carbohydrates are detrimental. Fast-digesting carbohydrates increase one's weight and they also cause fatigue. The nutrition of seafarers should be supplemented with slow-digesting and fibre-rich carbohydrates (vegetables, root vegetables, fruit, whole-grain

[27] VALT

products, rye) and inter alia pure sugar, raffinated wheat, sodas and beer. For example potato starch is fast digesting should be avoided.

4.3 Dock work and other work outside the watch duty

A reference was made earlier in this report to work performed onboard the ship other than the watch duty. What is most significant is the supervision of loading and unloading work when docked. The planning and supervision of the loading traditionally ties the chief mate for the whole duration of the loading. Most of European ports work in three shifts and after the mooring of the ship, the unloading/loading starts immediately. What is also typical is that in the same port part of the load is unloaded in one berth, after which the vessel moves to a second and even to a third berth. The mooring and unmooring work of the vessel ties all the deck officers and deckhands.

Various functional and document inspections relating to navigation as well as audits in practice require being prepared for an inspection at each visit to a port. This means an essential increase in the workload of the deck officers and it is thus off their rest periods. The stevedores expect the master to have a piloting right in as many ports of the traffic as possible. The masters often willingly acquire piloting rights, because the piloting increases their income. The following is an example told by the master of a Finnish feeder-container vessel with piloting rights in the Elbe and Weser Rivers.

"The vessel leaves the Kiel Canal at Brunnsbuttel and the master acts as the watch officer and pilot. After 3 hours the vessel moors in Bremerhafen, with a 2-hour loading in the first berth, after which the vessel moves to another berth, where the unloading continues for 2 hours, after which the vessel sails towards Hamburg. The master alone acts as the pilot and the watch officer, and the voyage up the river takes 5 hours. After mooring, the unloading in Hamburg takes 4 hours until the vessel moves for loading to another berth. After 3 hours the vessel moves to a third berth, where the loading takes 5 hours. After the loading, the master acts as the watch officer and pilot for the 3-hour voyage to Brunnsbuttel, where he can rest after passing the lock.

The more efficient use of loading and unloading periods the ISM and ISPS procedures and various inspections (the authorities, stevedores, the

shipping company, the classification society) is likely to cause the deck officers of an ordinary vessel most likely continuously the work input of one person. This fact has not so far been sufficiently taking into account in evaluating the manning. This is confirmed by the answers to the open questions in the questionnaire. The so-called *other work* can be clearly seen for example in the Fatigue Forum web site of the Nautical Institute (UK)[28].

4.4 The role of the lookout, legislation. STCW-95 and the Decision of the Ministry of Transport 1257/1997

A new Decree on the manning of ships and certificates (1256/1997) was issued as well as new regulations on watchkeeping (Decision of the Ministry of Transport 1257/1997)[29]. The instructions on watchkeeping emphasise more and more the advance planning of the journey, the correct use of the bridge equipment and compliance with safe routines. Lookout is, relatively speaking, discussed less.

The purpose of the lookout and the duties of the lookout have in the decision been defined in the traditional manner as making visual and auditory observations. The utilisation of the capacity of the lookout in the use of the bridge equipment is not required or encouraged by the provision. The watchkeeping decision concentrates on the watch officer. The assessment of the composition of the watch and the arrangement of the lookout provided for in section 9 includes 13 points, none of which directly refers to fatigue or alertness. The instructions are of several pages in length.

The MAIB[30] presents in a safety report relating to fatigue in 2004 that the lookout on vessels is heavily underused and even underestimated. The training of lookouts and their effective use with regard to all the bridge equipment would enable real co-operation. This, for its part, would help in the maintenance of alertness and also in the management of fatigue. Watch officers have not been trained in the full utilisation of lookouts. The said safety report presents three recommendations, two of which relate to an increasingly better and more efficient use of lookouts.

[28] Reference: July 2007. URL: http://www.nautinst.org/fatigue/search.htm
[29] FMA Bulletin No 2/19 January 1998
[30] Marine Accident Investigation Branch, UK

4.5 Vessel as a working and living environment

Vessels as a working and living environment have been studied a lot during the past decades. The studies have concentrated on **noise and motion**. These factors are essential with regard to alertness. The bridge as a working place has been handled in legislation only slightly. *"The design of the bridge … should take into account factors with an effect on the safety of the working environment and the health of the worker*[31]*."* Concrete requirements are the prevention of risks leading to falling or tripping, glare prevention, stepless adjustment of meter displays and the protection of the lookout post against the weather.

The noise values of the accommodation premises of sailors are in Finland regulated in the so-called Accommodation Decree[32]. In accordance with the regulations issued under this Decree, a constant noise of at most 60dB and a temporary noise of 65 dB(A) is allowed in sleeping cabins. In winter, the maximum limit is 10 dB(A) higher due to the noise caused by ice. It was found in a significant British study[33] that a noise of 65 dB(A) has a negative effect on the quality of sleep. In order to enable good sleep quality, the accommodation premises shall be placed so that inter alia the noise from the aft machinery and propellers as well as the loading and unloading work do not sound disturbing.

Motion, swelling, is a significant loading factor as it affects the person as a whole by impairing the ability of an individual to handle information. The constant swinging of the vessel, for its part, causes a load on the body and thus also increases fatigue.

No special attention has been paid to **the quality of breathing air** on the bridge. The recommendations concentrate on the quality and temperature of the air in the *accommodation premises*. With regard to bridge design, there are no separate instructions relating to air quality. The provisions on the ventilation of accommodations may be applied to the ventilation of bridges. Special attention should be paid to the quality of air on the bridge as nowadays the bridges are closed. The responses relating to the need to

[31] Decision of the Council of State on the Working Environment on a Vessel. 417/81, § 25 and 26.
[32] Decision 981 issued on 27 October 1977 on the basis of Decree on the Accommodation Premises of the Crew on Vessels (518/1976), which forms the basis for Safety Order and Instruction No. 37; The Labour Protection Board.
[33] Seafare Fatigue: Cardiff Research Programme 2006, Smith, Allen & Wadsworth

improve the conditions on the bridge most often related to the need for *fresh air*.

Fatigue Management Plan as part of the ISM system

A comprehensive management plan of alertness and fatigue is needed for seafaring[34]. The cornerstone of such a plan is training, which gives the seafarer a possibility to manage the systems of the workplaces as well as his personal life better than at present.

The support of the people who make the decisions and decide on the use of resources has to be obtained for this plan. The division of responsibility must be made clear in fatigue management. The will and expectations of those in charge must be made clear. Any feedback from the ships must be taken into consideration. When a special factor causing fatigue is recognised, the issue must be studied thoroughly and objectively. After a study of the issue, measures have to be taken.

Alternative watch systems

The study indicated that the 6/6 system operating with a smaller manning clearly increased symptoms of fatigue compared to the 4/8 system. The alertness of watch officers clearly varied with the time of day so that in the small hours the alertness was at its lowest. According to the work and sleep diary study, alertness in the small hours was lowest in the 6/6 system in persons who experienced a general tendency for nodding off or who, as for their individual characteristics, were so-called evening persons. The results do not encourage the use of the 6/6 system, but either the 4/8 system or other alternative watch systems are more recommendable with regard to alertness and accident risk.

Actually, according to the results, a significant part of the respondents worked in another watch system than a 6/6 or a 4/8 system.

When trying to manage the fatigue and to improve the alertness of the crew, it is useful to study new watch systems without prejudice. An alternative to be considered is the use of a flexible 4/8–8/4 system, guaranteeing a one-hour continuous rest period without additional costs.

[34] Safety Alert nro 13m January 2007, Fatigue management plan

In the system, onboard vessels with two navigators, the master and one mate distribute their work periods daily so that each works for one 8-hour and one 4-hour period. The continuous work period of eight hours is, as such, against the work hour Directive, but, none the less, worth considering because this will guarantee one proper period making a sufficiently long sleep possible.[35] This will compensate the excessively long work period and it is therefore also possible *vis-á-vis* the work hour Directive.

An example of systems of three watch officers is the flexible watch system onboard the tankers of Ocean Shipholdings[36], which has been used successfully since 1988. It consists of a series of two and six-hour watches. Each person has the watch daily for a two-hour and a six-hour period for example from midnight until six in the morning and again from eight to ten. Then he is free until the following midnight if there is no other work. The next mate has the watch from six to eight and from noon till six in the evening. Correspondingly, the third watch officer has the shifts from ten in the morning till noon and in the evening from six till midnight. This systems ensures that each has sufficient rest and it also allows the daily overtime work allowed by the STCW. A transfer to this system was carried out voluntarily in the company. No vessel has wanted to return to the old system. This shows that the new system is better than the earlier one with regard to the abilities of the watch officer.

Nutrition

The questionnaires didn't find out the eating habits of the respondents, but the importance of the nutrition to health and alertness is clear. The investigators want to pay seafarer's attention to the importance of the varied nutrition. The nutrition should be based on slowly digested carbohydrates and those containing plenty of fibres[37].

[35] TNO Report (20834/11353) Fatigue in the Shipping Industry 2005, Hoofddorf, The Netherlands
[36] Safety Alert nro 13m, January 2007
[37] http://www.hsph.harvard.edu/nutritionsource/pyramids.html#pyramid, July 2007

Development outlook

The amount of traffic is increasing in all sea areas, especially in those used by Finnish vessels. Statistically it is clear that also the accident risks will increase. The risk management systems utilise the possibilities allowed by new technology, which, in part, results in increased automation on the bridge.

Because of the automation, the work becomes more supervisory in nature than before. Supervisory work makes it difficult to maintain a state of alertness especially when one is working alone and in the small hours and very early in the morning. Maintaining a high alertness requires at least a continuous six-hour sleep once a day.

In addition, special attention has to be paid to the work-hour arrangements, nutrition, quality of breathing air and manning.

The amount of port work and other administrative work has to be taken into account when deciding on the manning and the work-hour arrangements.

5 CONCLUSIONS

Observations

The percentage of responses to the questionnaire was good and the willingness to fill in the questionnaire and the sleep/work diary indicates that the seafarers consider the fatigue problem to be important.

Of those who responded to this study, 17 % had fallen asleep at least once while holding watch. Over 40 % had been near nodding off during watch at least once during the past 5 years. Close-by incidents due to fatigue had happened at least once to c. 20 % of the respondents. If the watch officer experienced symptoms of fatigue, this increased the risk of nodding over fivefold.

Symptoms of fatigue were, in turn, most **increased** by sleep apnea (risk over fivefold), the 6/6 watch system (about double the risk compared to other work time models) and eveningness. Age and weight did not directly explain fatigue symptoms, but they increased the risk of getting sleep apnea.

The most important factors affecting alertness during a watch were the time of day (at night alertness especially between 4–6 a.m. was lower than during the day), the length of the previous sleep period (the shorter, the lower the alertness) and the time since the person had last woken up (the longer, the more tired). The effects of the watch system (6/6, 4/8 or another) on alertness were dependent on individual factors (age, morningness-eveningness and likeliness to nod off) so that the special risk groups with regard to night-time alertness were in the 4/8 system those from 50 to 62 years and in the 6/6 system both morning persons and persons with a generally high tendency to nodding off.

As a summary of the results relating to **the watch systems** we can say that the study shows that the 6/6 system increases the likeliness of symptoms of tiredness and therefore also the possible risk of nodding off compared to other watch systems. The research results do not encourage the use of the 6/6 system; instead, either the 4/8 system or other

alternative watch systems are more recommendable with regard to alertness and the risk of falling asleep.

According to the study, age did not alone explain fatigue symptoms or the falling asleep of the watch officer. It is likely that fatigue risks relating to age were largely due to the more general occurrence of sleep apnea in the older age groups. Excess weight and especially waist fatness combined with snoring every night and possibly noticed breathing gaps during sleep refer to possible sleep apnea. Sleep apnea is a well-known cause of day time fatigue and it is also related to a significant decrease in the state of alertness. Attention shall be paid to the weight control and nutrition of seafarers.

Questions measuring fatigue can predict fatigue and the tendency to nod off also during work. For this purpose an easy-to-use tool should be developed.

For example the SEDS index can be used to identify a risk group in health inspections. If the SEDS is higher than 14, the risk for nodding off has increased and so may also be the risk of sleep apnea.

The total working time of a seafarer and especially the uneven stress caused by visits to ports are significant factors which were not sufficiently taken into account in the questionnaire. However, they were clearly evident for example in the open-ended questions. The amount of total working hours was also discussed when examining the history of legislation.

The lack of fresh breathing air came out as a significant factor. This was a new observation; no studies or literature references about it can be found. At present this matter has not received sufficient attention either at the level of legislation or in the planning of the bridges.

The use of the lookout as a support of the watch officer turned out to be largely deficient. The provisions do not emphasise the full use of the resources of the lookout, which, however, would help to maintain the state of alertness of the watch officer.

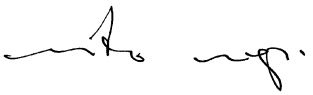
The study strengthened the results of numerous international studies in the last few years regarding the importance of fatigue to maritime safety. The special features of Finnish maritime traffic, narrow fairways, winter

conditions and short-cycled traffic with short voyages were seen also in bridge fatigue. In addition, a significant part of the work is done during the dark hours and in difficult weather conditions. A lot of information is available and the possibilities to apply it exist.

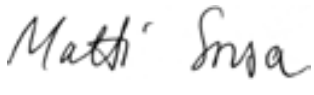
6 RECOMMENDATIONS

1. The BRM practices of the bridges have to be improved in at least two ways:
   - A system has to be created making it possible and encouraging a person to speak out the fatigue that he experiences.
   - The whole input of the lookout has to be made part of bridge work. The resources of the lookout have to be fully utilised.
2. An unbiased examination of work-hour arrangements has to be made without the weight of traditional systems. In this connection, sufficient and high-quality rest has to be ensured.
3. Attention will have to be paid to the quality of air on the bridges. The availability of fresh air should be guaranteed. With regard to new constructions this is not a matter of cost.
4. Port work and other work has to be taken into account when making decisions on the manning and the arrangement of the work.
5. Those working as watch officers have to have a sufficient amount of sleep each day. Untreated sleep apnea has to be taken into account as a maritime risk factor. In the occupational health care of seafarers, attention shall be paid to finding and treating sleep apnea and fatigue symptoms.

Helsinki 11.10.2007



Risto Repo

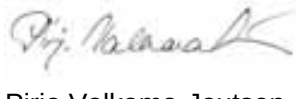


Matti Sorsa

Markku Partinen

Mikko Härmä

Pertti Siivonen



Pirjo Valkama-Joutsen

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Helsinki 30 November 2004 COVER LETTER

Dear recipient,

the Accident Investigation Board has, in the last few years, investigated numerous maritime accidents in which one of the factors affecting the event has been the lowering of the functioning ability of a lonely watch officer, sometimes even nodding off in watch. There are explaining background factors for the lowering of functioning ability. These may include work time arrangements, external conditions, bridge arrangements, the ergonomics of equipment, personal health and many other matters. The situation in Finland does not differ from other European countries. The reasons for the fatigue and the lowering of the functioning ability have been studied in Finland especially in road traffic, in the railways and in uninterrupted shift work in the industry.

The Accident Investigation Board has now launched a study on navigation, the purpose of which is to obtain a realistic idea of the work of the watch officer in present navigation. The other goals include finding tools to identify fatigue, tools to manage it, methods for bridge co-operation, information for occupational healthcare units and material for making manning decisions.

The Investigation Group includes Doctor Markku Partinen from Rinnekotisäätiö, Research Professor Mikko Härmä from the Finnish Institute of Occupational Health, Psychologist, civil pilot Matti Sorsa and, as representatives of the Accident Investigation Board, Captain Risto Repo and Major (Ret.) Pertti Siivonen.

This questionnaire has been sent to all the members of the Finnish Ships' Officers' Association with navigator qualifications. We have received the addresses from the office of the Association. Our target group includes all those working as watch officers in their present jobs. If you consider that you are not part of the target group but work in different tasks, we ask you only to send back this cover letter in the enclosed envelope. This way we can obtain as reliable a picture as possible of the reply percentage of those belonging to the target group.

We ask you to answer the appended questionnaire and to fill in the appended sleep diary while onboard. You have time to reply until the middle of March 2005. When you have filled in the questionnaire and the sleep diary, please send them back in the enclosed envelope. The postage has been paid.

The questionnaire is fully anonymous. The envelopes or questionnaires have no codes or markings which would make it possible to identify a person who has or has not answered.

The results of the study will be published and they will be available also at our web site www.onnettomuustutkinta.fi.

Thanking you for our participation in advance

On behalf of the Investigation Group Risto Repo

Appendix 1/2 (12)

MARITIME SLEEP - questionnaire

The questions of the questionnaire are important for the study to succeed. Please answer the questions by circling the alternative that best describes your situation and/or by filling in the missing parts. Some of the questions resemble each other quite a lot. However, please answer all the questions. We will handle the information in confidence. The answers will only be available to the investigators. The results will be handled so that individuals cannot be identified.

PERSONAL DATA

Date of filling in the questionnaire ____/____ 200__.

1. Year of birth _____
2. Height _____ cm
3. Current weight _____kg
4. At the age of 20, I weighed c. _____ kg
5. At the age of 30, I weighed c. _____ kg
6. The thickness of my neck is about _____ cm (notify by giving the result measured around the Adam's apple [lower part of the neck] or alternatively you can estimate the thickness of your neck by deducting 1–2 cm from the size of your dress skirt/depending on how tight a shirt you usually wear). The thickness of my neck notified above has been

   1. measured 2. evaluated from a shirt

My seafarer experience

7.
   a. I started at the sea when I was _____ years old
   b. I have been working as a watch office for _____ years

---

8. What kind of watch shifts have you had most in the year (during the last 5 years)?

   a. 4 –4
   b. 6 – 6
   c. 4 – 8
   d. 12 – 12
   e. other, what?
   f. what is your watch shift at present?

---

9. I have been a watchman during my life for an estimated _____ months, from that without a lookout/another navigator for _____ months

---

10. During your entire life, have you been close to falling asleep <u>in watch</u>?

    1. Never
    2. Yes, sometimes
    3. Yes, many times

How many times altogether? I have almost fallen asleep in watch c. _____ times

---

11. Have you been close to falling asleep <u>in watch</u> during the last five years?

    1. Never
    2. Yes, sometimes
    3. Yes, many times

    How many times altogether? During the past five years I have almost fallen asleep c. _____ times

---

12. During your entire life, have you ever fallen asleep <u>in watch</u>?

    1. Never
    2. Yes, sometimes
    3. Yes, many times

    How many times altogether? I have been near falling asleep in watch about _____ times

---

13. Have you fallen asleep <u>as a watch officer</u> during the last five years?

    1. Never
    2. Yes, sometimes
    3. Yes, many times

    During the past five years, I have fallen asleep as the watch officer c. ____ times.

---

14. In how many marine accidents have you been involved on board a vessel **during your entire seafaring career?**

    Altogether c. _____ times during my life,
    of which _____ times when acting as the watch officer.

---

15. In how many marine accidents have you been involved on board a vessel **during the past five years?**

    Altogether c. _____ times,
    of which _____ times when acting as the watch officer.

---

16. Have you ever been in a maritime accident due to falling asleep or strong fatigue (do you yourself think, that a momentary nodding off or fatigue would have been a cause for the accident)?

    1. Never
    2. Yes, once
    3. Twice
    4. 3–4 times
    5. At least 5 times

Give a short description of such an event: _____

16a. Have you ever been in a close-by situation due to falling asleep or strong fatigue?

1. Never
2. Yes, once
3. Twice
4. 3–4 times
5. At least 5 times

---

17. Which time of the day do you feel is to most tedious when considering fatigue in your present watch system? At what time of day does fatigue bother you most when in watch?

In watch I am usually most tired at about

0. 01 – 04 in the morning	1	2	3	4	5	6	7	8	9	10
1. 04 – 07 in the morning	1	2	3	4	5	6	7	8	9	10
2. 07 – 10 in the morning	1	2	3	4	5	6	7	8	9	10
3. 10 – 13 before noon	1	2	3	4	5	6	7	8	9	10
4. 13 – 16 afternoon	1	2	3	4	5	6	7	8	9	10
5. 16 –19 afternoon	1	2	3	4	5	6	7	8	9	10
6. 19 – 22 in the evening	1	2	3	4	5	6	7	8	9	10
7. 22 – 01 in the late evening	1	2	3	4	5	6	7	8	9	10

Scale: 1 = I am not at all tired, 10 = I cannot stay awake

---

18. Do you feel that you can influence your watch times, the watch system? Yes/No
If not, why not? _____

---

19. What, in your opinion, would be the most suitable length of a rest period after a watch?

1. 4 hours
2. 6 hours
3. 8 hours
4. 12 hours

HEALTH DATA

20. How do you estimate your own working ability at the moment in relation to the physical requirements of your work?

    1. Very good
    2. Fairly good
    3. Moderate
    4. Fairly poor
    5. Very poor

---

21. How do you estimate your own working ability at the moment in relation to the mental requirements of your work?

    1. Very good
    2. Fairly good
    3. Moderate
    4. Fairly poor
    5. Very poor

---

22. Please evaluate whether you can, with regard to your working ability, to work in a job corresponding to your present job in two years

    1. I most likely can
    2. Fairly likely I can
    3. I am not sure
    4. It is fairly unlikely that I can
    5. It is very unlikely that I can

QUESTIONS RELATING TO SLEEPING AND DISTURBANCES IN SLEEP

23. Have you had difficulties in falling asleep during the past three months?

    1. Never or less than once a month
    2. Less than once a week
    3. 1–2 days a week
    4. 3–5 days a week
    5. daily or nearly daily

---

24. How often have you woken up during sleep (in the middle of your rest) during the past three months?

    1. Never or less than once a month
    2. Less than once a week
    3. 1–2 times a week
    4. 3–5 times a week
    5. Every time or almost every time

25. If you usually wake up during sleep/rest, how many times have you, on the average, woken up during the past three months otherwise than waking for work?

    1. I don't usually wake up middle of the sleep
    2. Once
    3. Twice
    4. 3–4 times
    5. At least 5 times

26. How often have you woken up too early and not been able to fall asleep again during the past three months?

    1. Not once or less than once a month
    2. Less than once a week
    3. 1–2 days a week
    4. 3–5 days a week
    5. daily or nearly daily

28. **QUESTION REGARDING YOUR WORKING ENVIRONMENT IN WATCH**

1. Are you sitting down all the time?

2. Do you have to get up from your chair due to a navigational task?

3. Can you navigate while standing up?

4. Do you have the possibility to go outdoors for fresh air?

5. Can you adjust the temperature on the bridge?

What improvements would you make on the bridge with regard to the maintenance of alertness if you could?

In what way does the deckhand acting as your lookout participate in the watch duty with you?

29.1. Have you had strange sensations (tingling, hot flashes, feeling of cold, pain, creeping or other sensations or feeling of restlessness in our legs (especially in your feet, calves and legs) so that you have felt that you must move your limbs?

1. No 2. Yes

29.2. Do you sometimes have an almost irresistible urge to move your legs (and / or arms)?

1. No 2. Yes

29.3. Do the sensation symptoms referred to above (questions 29.1 and 29.2) increase when you are sitting down or lying inactively?

1. No 2. Yes 3. Not applicable

29.4. If you have strange sensations in your legs and you move your limbs or start walking, do the sensations ease? In other words, does moving the limbs / walking ease the symptoms?

1. No, it does not 2. Yes, it does 3. I have no sensations or sensory disturbances in my limbs

29.5. Do the above sensation symptoms (questions 29.1 and 29.2) worsen when you go to bed?

1. No 2. Yes 3. Not applicable

29.6. How often have you felt the said (point 29.1) sensations or the feeling of restless legs during the past 3 months?

1. Never or less than once a month
2. Less than once a week
3. 1-2 evenings/nights a week
4. 3-5 evenings/nights a week
5. Every evening/night or nearly every evening/night

Appendix 1/8 (12)

USE OF MEDICINES

30.a. Have you taken prescription sleep medication during the past 3 months?

1. Not once or less than once a month
2. Less than once a week
3. 1-2 days a week
4. 3-5 days a week
5. daily or nearly daily

Which sleep medication?:

_____
_____
_____
_____
_____

30 b What other prescription medicines are you taking or have taken during the past 3 months?

_____
_____
_____
_____
_____
_____

OTHER QUESTIONS RELATING TO THE SLEEP-WAKE PERIOD AND ALERTNESS (with regard to the past three months)

31. Do you feel tired?

1. Never or less than once a month
2. Less than once a week
3. 1-2 days a week
4. 3-5 days a week
5. daily or nearly daily

---

32. Do you feel drowsy during the day?

1. Never or less than once a month
2. Less than once a week
3. 1-2 days a week
4. 3-5 days a week
5. daily or nearly daily

---

33. Have you experienced a compelling need to nod off during work shifts? (Have you felt that you cannot help falling asleep?)

1. Not once or less than once a month
2. Less than once a week
3. 1-2 days a week
4. 3-5 days a week
5. daily or nearly daily

---

34. Have you experienced a compelling need to nod off in free time? (Have you felt that you cannot help falling asleep?)

1. Not once or less than once a month
2. Less than once a week
3. 1-2 days a week
4. 3-5 days a week
5. daily or nearly daily

---

35. How many hours do you sleep on the average during a day including a nap?

On the average, I sleep c. _____ hours and _____ minutes in a day.

---

36. Are you a morning type or an evening type?

1. I am clearly a morning type and sleepy in the evening
2. I am somewhat of a morning type and sleepy in the evening
3. I cannot say
4. I am somewhat of an evening type and sleepy in the morning
5. I am clearly an evening type and sleepy in the morning

---

37. How often do you take **a nap** in addition to the main sleep?

1. Never or less than once a month
2. Less than once a week
3. 1-2 days a week
4. 3-5 days a week
5. daily or nearly daily

---

38. Do you snore in your sleep? (Ask others if you are not sure)

1. Once a month or more rarely
2. Less than once a week
3. 1-2 nights a week
4. 3-5 nights a week
5. Every night or nearly every night

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39. What is your snoring in type? (What have others said)

1. I do not snore
2. I snore quietly and evenly
3. I snore evenly but fairly loudly
4. I snore evenly but so loudly that it can be heard even in the next room
5. I snore very loudly and unevenly (at times I have breathing gaps when nothing is heard and at times a wheezing type of snoring is heard). It is very difficult for others to sleep in the same room.

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40. Have you or have other people noticed that you have had pauses in breathing (apnea, stops in breathing) while you sleep?

1. Never or less than once a month
2. Less than once a week
3. 1-2 nights a week
4. 3-5 nights a week
5. Every night or nearly every night

41. If you snore at least 1 - 2 times a week, how many years have you snored? (What have others said)

I have been snoring for about _____ years.

I was about _____ years old when I started snoring

42. In your opinion, are you more tired during the day than your friends or co-workers?

1. No, I am clearly more alert
2. No, I am somewhat more alert
3. I cannot see a difference
4. Yes, I am slightly more tired
5. Yes, I am clearly more tired

43. How many hours of sleep do you need in a day (how many hours would you sleep if you could sleep as long as you wanted)? In other words how long a sleep do you need to be alert and in good working condition on the following day?

I need about _____ hours and _____ minutes of sleep per day.

44. How fast do you usually fall asleep at bedtime?

1. in over 40 minutes
2. in 31-40 minutes
3. in 21-30 minutes
4. in 10-20 minutes
5. in less than 10 minutes

45. How likely are you to doze off or fall asleep in the following situations, in contrast to feeling just tired? This refers to your usual way of life in recent times. Even if you have not done some of these things recently, try to work out how they would have affected you. Use the following scale to choose the most appropriate number for each situation.

Scale (alternatives):

0 = no chance of dozing
1 = slight chance of dozing
3 = moderate chance of dozing
4 = high chance of dozing

Situation	Estimate on the chance of dozing: no chance	slight chance	moderate chance	high chance
- Sitting and reading	0	1	2	3
- Watching TV	0	1	2	3
- Sitting inactive in a public place (e.g. a theater or a meeting)	0	1	2	3
- As a passenger in a car for an hour without a break	0	1	2	3
- Lying down to rest in the afternoon when circumstances permit	0	1	2	3
- Sitting and talking to someone	0	1	2	3
- Sitting quietly after a lunch without alcohol	0	1	2	3
- In a car, while stopping for a few minutes in traffic	0	1	2	3

46. Do you smoke?

1. no, I have never smoked
2. I have quit smoking
3. yes, I smoke

47. During a day I smoke cigarettes/cigars/the pipe

1. 0-5 cigarettes / 1-2 cigarillos / 1-2 pipes
2. 6-10 cigarettes / 3-4 cigarillos cigars / 3-4 pipes
3. over 10 cigarettes / over 5 cigarillos / over 5 pipes

48. How often do you drink alcohol?

1. I don't drink any alcohol at all
2. Once a month or more rarely
3. 2-4 times in a month
4. 2-3 times a week
5. at least 4 times a week

49. How much alcohol do you drink in a week on an average?

_____ bottles of ordinary beer, _____ bottles of strong beer,
_____ bottles of wine, _____ bottles of spirits.

50. How much coffee, tea and different cola or energy drinks do you drink daily on an average?

I drink daily or almost daily an average of:
_____ cups of coffee, _____ cups of tea, _____ bottles of cola/energy drinks.

Finally, we ask you to write freely about how you feel that your work conditions should be developed in order for your working ability and alertness to stay good. You can write also other comments. If necessary, continue on the other side of the paper.

_____
_____
_____
_____
_____
_____

WE ASK TO FILL THIS IN IF YOU WANT US TO CONTACT YOU OR IF YOU ARE WILLING TO PARTICIPATE IN A POSSIBLE FURTHER STUDY

Name _____
Address _____
Telephone, home: _____
Telephone, work: _____
Gsm: _____

Thank you for your participation. Put the questionnaire and your sleep diary (if you had the energy to keep it) in the appended return envelope and mail it. The postage has been paid.

Appendix 2. Review on the manning of the bridge after the Second World War

1. History

After the war, the best vessels had been given to the Soviet Union as war reparations. Navigation started with old vessels. The Maritime Working Hours Act of 1924 was not applied to mates. The Act was in force until 1961. The collective agreement concluded in 1949 gave working hour provisions for mates. The number of mates was regulated by a Decree in 1949 (D 141/1949). The number of the crew was not a problem. Short-distance traffic frequently used a 2-watch system.

The International Rules on the Prevention of Collision at Sea of 1960 (Rules of the Seas, enacted in Finland by Decree D 569/1964) warn against neglecting the lookout and against measures violating good maritime practice. Sufficient lookout was an important means to prevent accidents for centuries.

In the first years of the 1960s Finnish navigation experienced a growth. Numerous new vessels were being constructed throughout the decade. A new Decree on officers was enacted in 1964 (D 522/1964). The Decree still only allowed the use of two mates in European traffic onboard vessels below 3,500 grt. Under collective agreements their number was, however, three with the exception of vessels under 500 grt, whose size grew through interpretation of vessel measurement rules (so-called “paragraph vessels”). Deckhands were agreed upon with the labour union and there was still enough crew for lookout and handling the helm. The 1961 Maritime Working Hours Act (A 409/1961) was applied. The “paragraph vessels” had a crew of 12-14, the slightly bigger cargo vessels in traffic in the North Sea had a crew of 25 and the vessels in ocean traffic had a crew of 30-45 depending on the age and technology of the vessel.

In the early 1970s, even some of the bigger vessels (over 1,600 grt) sailed with two mates even though a large number of mates graduated from the big age classes. The Swedish labour markets with their higher wages attracted Finnish officers.

The passenger-ferry traffic started growing. Also the size of the other tonnage increased and Finnish tankers and bulk carriers appeared also in tramp shipping in ocean traffic.

However, in the 60s and the 70s the vessels usually stayed in port for several days. Because shift work was not yet common in ports, the times in port allowed a longer rest period.

The minimum wage provisions of the Employment Contracts Act of 1970 for land started indirectly to raise also the wages of shipboys, ordinary seamen and galley personnel. Also the officers associations became active on the wage front. The new Maritime Working Hours Act entered into force in 1976 (A 296/1976). Demands to compensate weekend work with better alternating systems increased. The demands were backed up by strikes and by the 1980s the wages on Finnish vessels were close to the Swedish level. In one decade wages had become a significant cost factor in international competition.

However, alternating systems were introduced, which shortened the period served onboard and thus the total annual working hours even if the work weeks onboard could increase as the crews became smaller.

The instructions on bridge watch were somewhat specified in the renewed Rules of the Seas in 1972 (Finnish Treaty Series 30/1977). There is a new renewed instruction on the lookout in Rule 5, according to which “every vessel shall at all times maintain a proper look-out by sight and hearing as well as by all available means appropriate in the prevailing circumstances and conditions so as to make a full appraisal of the situation and of the risk of collision”. The new rules also contained instructions on the use of the radar. The rules entered into force in 1977.

2. The STCW 1978 Convention

At the beginning of the 1980s there were still enough crew members for the bridge watch. Radar equipment had developed in the 1970s and in 1978 the IMO adopted the ARPA radar requirement for biggest vessels, which entered into force at the beginning of the 1980s. At the same time, since the beginning of the 1970s, the IMO also handled issues relating to training, certificates and watch keeping. The STCW 1978 Convention adopted in 1978 has, in addition to issues relating to training, also regulations relating to watch keeping.

In 1981 the Assembly of the IMO adopted Resolution A. 481 (XII) *Principles of safe manning*. The Resolution explains the principles of safe manning and recommends the introduction of a manning certificate granted by the flag administration.

At the same time the Finnish maritime authorities gave instructions on the composition and tasks on the bridge watch by enacting a Decree on Watch Keeping Onboard a Vessel (D 666/1981). The Decree defined *a qualified watchman and a qualified watchman keeping the watch alone*, who had to have six months of experience in tasks relating to deck watch. The Decree contained instructions on the watch arrangements of the deck department, the composition of the deck watch and the lookout. The Decree complies with the contents of the STCW 1978 Convention. The Convention entered into force internationally in 1984.

Upon the entry into force of the STCW Convention, also a new Decree was given on the manning of the vessel and the qualifications of the crew (D 250/1984). For the first time, the Decree has tables not only on the minimum number of officers but also on the minimum number of the crew. It also has provisions on the manning certificate to be given to a vessel. At first an attempt was made to grant the certificates in the Manning Committee on a tri-partite principle. The attempt failed. Later on, the National Board of Navigation/the Finnish Maritime Authority has decided on the certificates on the basis of statements issued by the organisations. In the next few years the Decree was amended several times inter alia to implement EU provisions.

The total numbers of the crew have been steadily decreasing until the last few years. The older regular line tonnage was out-flagged in full in 1980s and the Finnish tonnage was at its lowest in 1987 (0,84 mill. gross). The development was similar in all the West European countries at the time. The majority of Finnish ocean traffic disappeared and little by little the Finnish tonnage consisted of cargo ferries in traffic in the Baltic and the North Sea. The tanker-vessel tonnage decreased, but the number and size of passenger ferries increased.

In the early 1990s, there were discussions in the IMO on bridge watch-keeping without a lookout. The IMO studied the equipment that would make it possible. Temporary instructions were issued in circular MSC Circ. 566. In addition to efficient radar equipment, the bridge was equipped with a so-called dead man's alarm, which would wake up the master if the mate in watch failed to acknowledge the alarm at the intervals set. The arrangement was tried out in several West European countries. The trial in Finland stopped short. According to the circular files of the IMO, numerous countries have notified that they have stopped the practice in the early 21st century. The majority of the member states considered the practice to violate the reformed provisions on watch keeping.

3. Amendments of the STCW Convention in 1995

The contents of the STCW Convention were amended and the international supervision of the level of training increased by amendments in 1995. The amendments entered into force on 1 January 1998. The amendments also increased provisions on rest periods relating to watch keeping in the hope that they would have an effect on the extensively reported problem of fatigue relating to work onboard vessels.

Also in Finland, the Working Hour Acts were amended to comply with the provisions on rest periods (Act on the Amendment of the Maritime Working Hours Act 942/1997).

At the end of the 1990s, the Maritime Inspection of the Finnish Maritime Authority conducted inspections relating to rest periods on numerous Finnish vessels which had two mates and where the master participated in

the watch keeping usually for 4 hours a day. The rest period provisions were not violated, but the weekly working hours of the mates were long and especially the working hours of the chief mates were close to the maxima allowed.

Mid-size ships have crews of 10-12 people and there is no facilitation in sight for the workload of the mates. Increased shift work in ports, the increase in vessel size, the faster loading and unloading and, as the newest, the additional work due to the Security Code[38] have maintained the load.

On the bridge, electronics have been supplemented with GMDSS radio equipment, Ecdis maps, the VDR, the AIS, surveillance cameras, ISPS alarms and, on closed bridges, by hearing lookout equipment ("elephant ears"). It is not easy to utilise the ordinary seaman to participate in the watch as an assisting team member because the use of the equipment requires training.

4. Evaluation of the development

All that explained above must, of course, be evaluated against the background that **the master of the vessel has overall responsibility for the security of the vessel** and the proper arrangement of watch keeping on the bridge. The masters have traditionally stayed shorter or longer periods on the bridge, especially during poor weather conditions, in narrow or crowded passages as well as upon approaching the port either as support for the watch officer and guiding him or by assuming the navigation responsibility from the watch officer.

The role of the pilot as a participant in bridge watch has not been handled in this connection.

The vessels complying with this SOLAS Convention have to have a manning certificate granted by the flag state. The manning should be confirmed so that international provisions on rest period regulations can be observed. In the provisions valid in Finland and in the practice prevailing here, ensuring safe watch keeping is one of the main principles in strengthening the manning.

Finnish passenger ships have already for a long time applied the line pilot system in short-distance traffic. The basic training level of line pilots has improved in the last few decades. In the system, the bridge has two navigators at all times and, in this connection, the watch keeping on passenger ships is not examined in more detail. However, a problem has emerged: during his shift, the master does not, in any context, have a longer continuous period of sleep of more than a few hours. This is due to

[38] ISPS code, International Ship and Port Facilities Security Code.

the frequent sailing in and out of ports, during which the master is primarily in charge of the manoeuvering of the ship.

Smaller ships are still navigated in the waters of western Europe so that the deck officers comprise only the master and one mate. The relatively wide-scope questionnaire launched by the Swedish Maritime Administration at the beginning of the 21st century indicated that accidents occur on these ships more than on the average. A similar proneness to accidents has been established also in Finland on the basis of the accidents studied. In most cases, the cause has been the lowered state of alertness of the watch officer.

The uncertainty of job security, the increased workload during the short stays in port, the numerous languages and cultural differences of the crew as well as the high average age of the crew onboard are factors which have to be observed.

Appendix 3. Accidents indicating fatigue investigated by the Accident Investigation Board in 1997 -2003.

Vessel	Date	Place	Weather	Watch system	Start of the watch	Time of nodding off	Grounding	Watch crew
SPOVEN	8.11.2003	Degerö (h)	Visibility under 50, fog	-	09.30	did not fall asleep	14.40	master + master
PAMELA	23.4.2003	Södertälje	good visibility, wind 5 m/s	6/6	01.30	did not fall asleep	2:27	chief mate + master
BIANCA	31.3.2003	Gävle (h)	clear, at times snow, wind 12 m/s	6/6	23.00	03.40-03.55	04.04	chief mate + lookout
STEEL-BOARD	1.1.2002	Kvarken (h)	fairly good, wind 8 m/s	6/6	06.00	c. 06.50	7.18	chief mate
CINDY	17.9.2001	Prästkärrpp	calm, clear	6/6	17.40	did not fall asleep	22.51	master + chief mate
PAMELA	2.10.2001	Kihti	clear, wind 10 m/s	6/6	00.00	did not fall asleep	03.05	chief mate
JANRA	23.12.2000	Northern Baltic (½ h)	clear, visibility over 25 km	4/8	00.00	did not fall asleep (own idea)	03.07	second mate
PAMELA	3.8.1998	The Archipelago Sea	clear, good visibility, wind 1-2 m/s	-	23.50	03.30	03.35	master
NAJADEN	12.7.1997	Coast of Estonia (h)	half cloudy, wind 3 Bf	4/8	00.00	00.10	03.20	mate
SOFIA	12.5.1997	Öresund (h)	good + 10 degrees	6/6+ 4/4+ 4	00.00	5.08–5.45	05.55	mate