FATIGUE OFFSHORE: PHASE 2

THE SHORT SEA AND COASTAL SHIPPING INDUSTRY

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SUMMARY

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EXECUTIVE SUMMARY

We are carrying out a research programme to investigate seafarers' fatigue and the first phase of the research was concerned with specific comparisons between offshore oil support shipping and the offshore oil industry. The overall objectives of the research are: to predict worst case scenarios for fatigue, health and injury; develop best practice recommendations appropriate to ship type and trade; and produce advice packages for seafarers, regulators and policy makers. This topic has been investigated using a variety of techniques to explore variations in fatigue and health as a function of the voyage cycle, crew composition, watchkeeping patterns and the working environment. Results from the first project can be summarised as follows:

- The literature review has confirmed the absence of information on seafarers' fatigue. It is essential, therefore, that further research is conducted on this topic.
- The present research shows that this is feasible and the long term programme of research funded by HSE on health and safety on installations provides a good model for the future direction of the work.
- The analyses of injury data show that better reporting systems are necessary and collaboration is now needed to develop and validate new systems.
- Our survey questionnaire is a useful tool for providing initial descriptions of potential problems and can now be used as a screening tool providing justification of more detailed investigations.
- The onboard measurements of performance show that features of work offshore (e.g. shift system; noise) may have an impact on safety via the creation of worker fatigue. These methods can now be applied to the assessment of other ships and to make recommendations about suitable working practices.

The second phase of the research examined seafarers' fatigue in the short-sea shipping sector (passenger ferries – both traditional and fast ferries; freight ro-ro's; and near sea tankers). In addition to collecting new data a further literature review was undertaken and secondary analyses of the first phase data carried out. Both the survey and studies aboard ship were completed successfully and the main features of the study and results can be summarised as follows:

- The survey was carried out using three samples: (a) a sample of NUMAST members working in short sea shipping (b) a sample who also participated in the workplace testing, and (c) other employees of the companies participating in the research. Information from these three samples allowed us to examine whether the companies involved in the research were representative of seafarers in general, and whether the crews who participated in the workplace testing were representative of the company. The results showed that the onboard sample, respondents from the participating companies and the NUMAST sample were very similar. It is impossible to determine whether the sample as a whole is generally representative of all seafarers but the absence of differences in our various sampling frames suggests that there are no selective biases due to our methods of data collection. Indeed, the similarity of our different samples has important implications for interpretation of our onboard testing in that there was no evidence to suggest that the companies we studied were unrepresentative or that there was a bias in the selection of the specific ships studied.
- Detailed analyses of the content of the survey showed that it provides good measures of job characteristics that might potentially lead to fatigue. In addition, the questionnaire measures perceived fatigue at work, fatigue after work and general

levels of fatigue. Health-related behaviours and health outcomes are also measured using established questionnaires.

- The detailed profile of specific features of the person's job has allowed us to examine associations between job characteristics, perceived fatigue and health and safety. These analyses have adjusted for demographic factors and for negative affectivity (the tendency to perceive or report negative aspects of the environment or self). Overall, the study represents the most sophisticated approach to the topic adopted so far.

- Initial analyses compared the present sample with the results from Phase 1 of the project. Many results were very similar. Indeed, the results obtained here confirm that long working hours and disturbed sleep are frequently reported. In addition, 16% of the sample had been involved in a fatigue related incident and 92% had received no training in recognizing or dealing with fatigue. This demonstrates that the potential for fatigue at sea is high, that it may influence operational efficiency and that little is done about providing guidance about fatigue.

- The Phase 2 participants reported higher levels of fatigue and poorer health than the sample studied in the previous project. Following this our analysis strategy was to try to identify factors associated with reported fatigue in the present phase. Ship type was found to be important, with those on ferries reporting higher levels of fatigue. This finding held up across ferry types and was not due to one specific type of ferry (e.g. the high speed ferries). Job type was found to have little effect on reported fatigue even though different job categories (e.g. marine versus non-marine) were associated with different work schedules.

- Analyses were conducted to determine which job characteristics were associated with fatigue. Variables relating to working hours, especially "Do you consider your working hours to present a danger to your personal health and safety?", were the strongest predictors of fatigue. The sleep variables were also significant predictors of fatigue but not to the same extent as working hours. Job demands and perceived stress at work were also important, although these factors had selective effects and cannot be considered equivalent. Additional predictors of fatigue were support at work, age, vibration/motion, the physical working environment, having to stand watch, and increased use of caffeine at sea. From these analyses it was apparent that a number of factors influence fatigue, and the best predictor was the combined effect of these potentially negative job characteristics. This confirms the results from the secondary analyses of the Phase 1 data. Indeed, the combined effects approach not only predicted fatigue but also health status. In contrast, accidents at work were largely related to the physical working environment.

- Assessment aboard ship involved collection of data from 177 participants from seven ships in the short sea shipping industry. Subjective reports were recorded in logbooks and objective measures obtained using actimetry (to measure sleep) and computerised assessment of performance before and after work.

- The results from the logbooks confirmed that seafarers report poorer sleep than onshore controls. Ship type was found to relate to a number of differences but some of these (e.g. sleep variables) could be better accounted for by working hours rather than ship *per se*. However, physical effort and job demands were higher on the passenger ferries than the tankers and these results did not reflect between ship variation in work schedules. No differences were found between marine and non-marine crew. However, officers reported their jobs to be more demanding and stressful (but also more interesting) than did the ratings. Analyses of the survey data revealed no difference between reported health of officers and ratings which suggests that the positive aspects of the officers' jobs (e.g. greater control) may act as a buffer against the high demands.

- Length of tour and the working week were important factors. Job stress increased over the seven days that the seafarers were studied. However, other potential problems decreased with length of tour (e.g. sleep improved further into the tour and there appeared to be habituation to noise). Such findings confirm results from the survey which suggested that longer tours were associated with less fatigue. Fatigue was predicted by the logbook variables of job effort, sleep and work satisfaction. Again, the combined effects of potential negative work characteristics were found to be a good predictor of negative outcomes. The final issue considered was whether measures taken from the logbook were associated with the survey data. There was support for the view that the time period we examined was representative of the "job in general" although some of the associations were modest.

- Results from the performance tasks, mood ratings and sleep recording showed significant differences between the present sample and those tested in Phase 1 of the project. Those tested in Phase 2 had slower reaction times, were less accurate and reported a more negative mood. They also slept for a shorter time although they were less likely to wake up during sleep. These differences between the two samples did not reflect any single factor. Indeed, they either reflect the combined influence of a number of different factors or some basic difference between the ships studied in the two phases (e.g. voyage cycle time).

- Objective measurements of noise exposure and motion were obtained aboard ships. Conclusions about the effects of motion are restricted due to the small number of ships with any significant motion (just the tankers). The effects of noise varied over time and this may reflect habituation. However, it is also apparent that our future measurement of noise must pay more attention to the frequency of the noise as changes in this may underlie some of the variation in the effects of noise intensity reported here.

In summary, the present project has extended research on seafarers' fatigue by conducting a further review of the literature, further analyses of our existing database and collecting new data from short-sea shipping. The methods were again found to be applicable to the topic and collaboration with NUMAST and four companies, and, of course, the willingness of the seafarers to participate in the study, has meant that we have been able to collect further extensive information. Four main findings emerge from the project. First, the survey has confirmed that the potential for fatigue is often present at sea and that fatigue may be a factor in reducing operational efficiency. Furthermore, guidance on recognizing and dealing with fatigue at sea is rarely provided. Secondly, fatigue is best predicted by exposure to a combination of potential hazards. This has important implications for audits, suggesting that it is inappropriate to focus on individual factors such as working hours. This "combined effects" approach is very similar to that being adopted by HSE to improve the management of stress at work. The third major result is that those studied in this project reported higher levels of fatigue and ill health than those in the first phase of the research. This difference between the two samples was confirmed by the onboard measurement of performance and mood. Finally, while the project has extended our knowledge of the area there is still a strong need to assess the impact of certain factors in larger samples (e.g. motion) and to use more sophisticated methodologies to examine other issues (e.g. the need to assess the impact of noise of different frequencies). There are also other variables, such as voyage cycle time, that potentially may lead to fatigue but which we have not been able to study in the present project. Phase 3 of the research will not only enable us to extend the research to other types of shipping but will allow us to modify our approach to consider factors implicated but not addressed by the earlier studies.

1. BACKGROUND

1.1 Phase 1 of the Research

Concern with seafarer fatigue is widely evident among maritime regulators, insurers, ship owners, trade unions and welfare agencies. We are carrying out a research programme to investigate this topic and the first phase of the research was concerned with specific comparisons between offshore oil support shipping and the offshore oil industry. The overall objectives of the research are: to predict worst case scenarios for fatigue, health and injury; develop best practice recommendations appropriate to ship type and trade and produce advice packages for seafarers, regulators and policy makers. This topic has been investigated using a variety of techniques to explore variations in fatigue and health as a function of the voyage cycle, crew composition, watch keeping patterns and the working environment. The methods involve:

- A review of the literature
- A questionnaire survey of working and rest hours, physical and mental health
- Physiological assays assessing fatigue, rhythm adjustment and cardiovascular risk
- Instrument recordings of sleep quality, ship motion, and noise
- Self-report diaries recording sleep quality and work patterns
- Objective assessments and subjective ratings of mental functioning
- Analysis of accident and injury data

1.1.1 The literature review

The purpose of this literature review was to identify existing research into fatigue, health and injury rates among employees engaged in exploration, production and support roles in the offshore oil industry. Although the contribution of fatigue to occupational injuries has been extensively researched in other industries, findings cannot automatically be applied to the offshore industry. This is because of the unique combination of conditions offshore workers have to cope with, including motion, extreme weather, noisy working conditions and demanding work and rest patterns. The offshore oil industry has gone through major economic, structural and technological changes in recent years, leading to reduced manning of installations and ships, increased automation, increased workload and decreased job security (e.g. Collinson, 1998; NUMAST, 1992). This has put increased pressure on both seafarers and installation workers who often feel they have to work extra hours and shifts in order to keep their jobs.

More research has been carried out amongst installation workers than seafarers, although even the installation research is not extensive. The main findings of the installation research show:

- Tours exceeding 2 weeks, with shift durations over 8 hours and including night shifts all appear to have serious implications for workers in terms of increased injury rates.
- Environmental factors are related to adverse subjective and objective health outcomes.
- Elevated levels of self-reported anxiety, perceived risk and workload, dissatisfaction with shift schedules, living conditions and sleep problems are evident and reflected in formal health and absenteeism records.
- Performance and alertness levels are affected by rotating shift schedules.
- Circadian adaptation to nightshifts, especially for fixed shift schedules, may occur.
- Adverse physiological changes related to tour lengths exceeding 1 week may be present.

Seafarer research indicates that:

- Collision risk is greatest during the early hours of the morning, suggesting a circadian influence. Fatigue has been proposed as a contributory factor.
- Seafarers report elevated levels of anxiety, perceived work load, dissatisfaction with shift schedules and sleep problems.
- Environmental factors are related to sleep disturbances, fatigue and stress.
- Motion adversely affects cognitive and psychomotor performance.
- Circadian adaptation can only be partially achieved at best on 4-on/8-off shift systems.

The literature also highlights an important difference between installation workers and seafarers:

- Installation workers show circadian adaptation to night shifts while seafarers do not.
- Injury reporting is more detailed for the installations than on support vessels.

Unfortunately, direct comparisons between installation workers and seafarers cannot be made since there have been few studies of seafarers, and these few have been limited and focused on different aspects of work patterns and the working environment. Furthermore, injury studies of seafarers have paid little attention to factors such as hours-into-shift, days-into-tour, job area, risk perception, personality characteristics, and time of day of the incident.

However, on installations and vessels alike, reporting of accidents needs to be more formal and systematic with enough detail to enable investigation of the underlying causes of accidents and make comparisons between the different aspects of the offshore oil industry. One of the major problems for both industries is the lack of exposure data, which makes it impossible to calculate accurate accident rates.

Studies to date have tended to focus on one sector of the offshore oil industry, namely installations, and when this is coupled with methodological differences between studies it fails to give an accurate picture of the offshore oil industry as a whole. Sample sizes also tend to be very small which makes it hard to draw firm conclusions. Future research needs to encompass the range of factors that affect offshore workers because it is the combination of them that make the offshore oil industry unique.

1.1.2 The survey

Although a number of studies have been conducted into stress and health offshore, they rarely refer to fatigue explicitly, or do not identify sufficient factors necessary to determine whether fatigue can have an impact on workers. Furthermore, the majority of surveys carried out in this area have exclusively examined offshore installations.

There is some evidence that psychosocial stressors unique to the offshore environment do impact upon mental health (Parkes, 1997; 1998), yet other studies have either failed to examine the psychological state of participants, or concluded that they were no more affected than their onshore counterparts (Gann et al., 1990; Parker et al., 1998). However, it is apparent from the self-reported data that increased workload, excessive work hours, poor quality or lack of sleep and feelings of boredom and isolation all contribute to stress, poor mental health and fatigue offshore (Parkes, 1997; Parker et al, 1997; 1998).

The current survey was therefore designed to identify all aspects of the working environment that may lead to fatigue, and affect the health and general well-being of personnel employed in all sectors of the offshore oil industry. By drawing comparisons between installation workers and seafarers, it was hoped that risk factors inherent in these diverse occupations could be identified.

The aims of the survey were:

- To assess the work and rest patterns of seafarers and offshore installation workers
- To assess the extent to which working hours, shift patterns and time spent offshore are associated with fatigue, injuries, and poor physical and mental health of crewmembers
- To assess the impact of time spent offshore on leave time

The questionnaire (33 pages) was designed to encompass all aspects of an offshore worker's life, and assessed the nature of tours of duty, work and rest patterns, fatigue and sleep, health-related behaviours and general health and well-being. It was divided into the following three sections:

1. Offshore: included questions relating specifically to work patterns, and subjective measures of attitudes towards work.
2. On leave: included subjective measures of health and well-being, and health related behaviours such as eating, drinking, smoking and exercise.
3. Measures of well-being**:** included a number of standardised scales of well-being, such as the General Health Questionnaire (GHQ), the Profile of Fatigue-Related Symptoms (PFRS), the Cognitive Failures Questionnaire (CFQ) and the MOS Short Form Health Questionnaire (SF-36).

The questionnaire was distributed to the home addresses of members of the seafaring officer's union, NUMAST and the installation worker's union, MSF. Secondly, questionnaires were distributed by visiting researchers to seafarers aboard offshore oil support vessels operating in the UK sector. A short version of the questionnaire was sent to a group of onshore workers, as a control for items specifically relating to fatigue. Results were also compared with normative data from three other sources: a sample of onshore workers currently participating in a study of workplace stressors, a random sample of the working population taken from the Welsh Health Survey (1998), and data from the Bristol Health and Safety at Work Study (1999).

The main findings were:

Although exposed to similar working environments, the results demonstrate a number of important differences in work patterns between the two groups of offshore workers. Seafarers for example, are more likely to work fixed shifts and longer tours of duty than installation personnel. However, both groups work considerably longer hours per week than a comparison group of onshore workers.

Both samples demonstrate similar mean age, although socio-economic differences do exist between the populations of seafarers and installation personnel studied. Largely as a result of targeting methods, the majority of the seafarers surveyed were officers, whereas the majority of installation respondents were classified as manual workers. (The effects of these differences in socio-economic status were statistically controlled).

A number of significant findings emerged from the analyses, which highlight the potential impact of demanding work schedules and lack of sleep. These can be summarised as follows:

- Installation workers report that they are generally worse off in terms of psychological well-being compared to either seafarers, or a comparison group of onshore workers (when age, gender and socio-economic status are controlled for)
- Rotating shift patterns (e.g. changing from day to night work, or vice versa) impact negatively on mental health
- Long work hours are associated with increased reports of emotional distress
- Perceptions of fatigue tend to be highest amongst personnel who also report psychological, somatic and cognitive difficulties
- Cognition and physical and mental well-being are negatively influenced by insufficient or poor quality sleep
- There is evidence to suggest that offshore working patterns also have a negative effect on well-being during the early stages of leave

Although detrimental effects of long hours and shift systems employed offshore are reflected in fluctuations of standardised measures of well-being, seafarers actually seem to be better off in terms of physical and mental health than the majority of onshore workers. Installation workers on the other hand, tend to fare much worse than seafarers, and (in some cases) than onshore workers.

It is evident therefore, that the majority of offshore personnel feel that current working patterns and practices are in some ways detrimental to their health and safety. However, a number of issues require further clarification: firstly, to what extent current shift systems are responsible for the apparently poorer health of installation personnel, and secondly, to what extent self-selection and medical screening buffer the influence of difficult working conditions. Similarly, cross-sectional surveys cannot explore long-term health impacts of working conditions (because of "healthy worker" effects) and longitudinal research designs are needed to address this topic.

1.1.3 Analysis of injury databases

Two datasets, containing injury-related information from support vessels were analysed in terms of temporal and environmental factors. Dataset 1 was obtained from a large multinational oil company, and dataset 2 from the MCA. Unfortunately, there were several problems inherent to both datasets, namely lack of exposure information and large amounts of missing data within significant temporal and environmental variables.
Nonetheless, incidents were examined in terms of time of day, hours into shift, days into tour and motion (inferred from sea state and wind force). Further analyses were conducted specifically examining injury severity (i.e. fatalities, serious injuries) and injury type (i.e. burns/scalds, strains/sprains) in terms of the above temporal and environmental factors, in order to see if this would add to information gained from total incidence analyses.
Although the two datasets deal in the main with different injury types (the majority of incidents detailed in dataset 1 are relatively minor, whereas in dataset 2 they are, for the most part, major) they generate a very similar pattern of results. In both cases, injury frequency demonstrates a time of day effect (incidence is higher between 0900-1600 hours) although there is no evidence that fatigue is a causal factor. Injuries do not peak significantly during any time periods associated with natural circadian troughs (i.e. post lunch or in the early hours of the morning). However, some evidence is presented to suggest that sleep inertia (or unfamiliarity with the work or type of work being carried out at this time) impacts upon injury frequency, as injury rates are highest in the first few hours of a shift. Regarding days into tour, (it was only possible to analyse information from dataset 1 in this instance) it seems that injury occurrence is greatest in the first week. However, it should be noted that database 1 contains a limited amount of data regarding fatalities and major injuries.
Regarding environmental factors, accidents seem more likely to occur in calm conditions. This counter intuitive finding probably reflects of work patterns: it is likely that greater proportions of personnel are exposed to potential incidents in calm conditions since they are working in places unavailable in adverse weather conditions.
Analyses of temporal factors in terms of injury severity and accident and injury type, failed to yield additional information to that provided by overall incidence rates. In conclusion, the data analyses provide little evidence for a major role of fatigue in offshore accidents. This does not mean that fatigue plays no part, rather it shows that it is impossible to determine the impact of fatigue from data with inadequate reporting specifications.

1.1.4 Logbooks

Logbooks were completed by 58 onshore day workers and 42 offshore workers doing day work. The results showed that the two groups differed significantly on a number of sleep variables. Offshore workers slept for a shorter time, woke up more often during the night, had greater difficulty falling asleep, and were less likely to consider that they had a deep sleep or enough sleep. Although these differences are statistically significant the magnitude of the effects are small. Offshore workers also considered their jobs to be less physically demanding than the onshore sample.
Comparisons were then made between different offshore groups. These analyses compared 31 installation workers and 29 seafarers. 42 were day workers and 18 night workers. 25 were in the first week of their tour of duty and 35 were in either their second or third week offshore. The results showed that installation workers felt less alert at the start of the day. Those working nights reported lower alertness at the end of the working day even though they perceived their job to be less physically demanding. Day workers starting their tour of duty

awoke more frequently than those in their second or third week of the tour. The reverse was true for night workers. Sleep duration was reduced for the first night offshore, especially for installation workers on nightshifts. The alertness levels at the end of the first day were lower for seafarers than for installation workers, with the reverse pattern being present on days 6 and 7. Physical effort was perceived by the day workers to decrease over the week whereas night workers perceived it to increase.
43 volunteers completed the weekly log while they were on leave. 22 were installation workers and 21 seafarers. 34 had worked day shifts before leave and 9 had worked nights. Of these 43 participants 22 had just started their leave and 21 were on their second week of leave. The results showed clear evidence that sleep duration and alertness were abnormal at the start of leave.

1.1.5 Assessments aboard ship

Initial analyses of onboard measures of performance, alertness and sleep suggest that fatigue offshore is not a general problem present at all times in all personnel. However, certain job characteristics, such as working at night, are associated with reduced alertness and impaired performance. Noise exposure was also found to be associated with sleep problems and impaired performance. Further research is now required to determine whether this finding is observed across a range of ship types. In addition, it is essential to examine situations where combinations of potentially harmful factors are present. At the moment we may have information about "best practice" rather than average or poor practice.

1.1.6 Recommendations

The literature review has confirmed the scant study of and data on seafarers' fatigue. It is essential, therefore, that further research is conducted on this topic. The present project shows that this is feasible and the long-term programme of research funded by HSE on health and safety on installations provides a good model for the future direction of the work. The analyses of injury data show that better reporting systems need to be implemented and collaboration is now needed to develop and validate new systems. Our survey questionnaire is a useful tool for providing initial descriptions of potential problems and can now be used as a screening tool providing justification of more detailed investigations. The onboard measurements of performance show that features of work offshore (e.g. shift system; noise) may have an impact on safety. These methods can now be applied to the assessment of other ships and to make recommendations about suitable working practises. The research has shown that the effects of offshore work on quality of life while on leave requires further investigation.

1.2 A Further Review of the Literature

The purpose of this literature review was to update the initial phase review of the literature on fatigue, health and injury rates among seafarers. This was done by identifying research carried out in the intervening period, or research not covered in the initial review, that is relevant to phase two of the project. More research has been added to the sparse literature in the intervening time, although this remains an underdeveloped area in comparison to research on other transport industries, highlighting the need for further research, such as that undertaken in this project. The literature reviewed here reaffirms the high risk involved in seafaring work and the influence of increased technological complexity and decreased manning on the modern seafaring industry.
Roberts, (2002) reports that seafaring remains the most hazardous of all occupations in Great Britain, with seafarers being 26.2 times more likely to have a fatal accident at work compared with other British workers. Although the number of work-related deaths has decreased in recent decades, in relative terms seafaring remain as hazardous as before. Glen and

McConville's (2001) comparison of officers' employment profiles and voyage patterns across organisation type, company nationality, flag of registry, and ship type in the period 1998-99 appears to show that ship type is a key issue, and suggests that ship type and associated voyage cycles act as a proxy for variables which make different employment demands on seafarers.

1.2.1 Noise

Szczepanski and Otto, (1995) measured noise on merchant ships of 3 types during routine sea voyages and found that the equivalent noise levels calculated for engine crew members exceeded the accepted hygienic norm by 1-2 dB. Audiometric examinations at the beginning and end of a voyage were performed with engine room and deck crew seafarers. They found statistically significant differences of temporary shift of the hearing threshold, more pronounced in the engine room crew. This indicates that exposure to onboard noise varies with employment role.

1.2.2 Motion

Wertheim, (1998) argued that performance decrements associated with working in a moving environment can be expected to occur as a result of general factors or as a result of specific impairment to particular human skills. General effects happen when simulated or real environmental motion reduces motivation (due to motion sickness), increases fatigue (due to increased energy requirements), or creates balance problems. Specific effects of moving environments on task performance may only be expected through biomechanical influences on particular skills such as perception (interference with oculomotor control) or motor skills (such as manual tracking). No evidence was found for a direct effect of motion on performance in purely cognitive tasks. Wertheim, Kemper and Heus, (2002) analysed previous studies on physical fatigue during simulated ship movements, and found that the apparent exhaustion of subjects after experimentation suggests that the traditional index of physical workload underestimates workload in a moving environment. This paper reports on three tests performed with a ship motion simulator and onboard a ship at sea, confirming this hypothesis. Thus additional factors need to be taken into account when addressing physical fatigue in moving environments.

Stevens and Parsons, (2002) point out that current minimisation of ship crews now more than ever requires all persons onboard to be fully capable of conducting their duties. Seafarers are almost constantly exposed to motion as a result of weather and sea conditions, and the physiological, biomechanical, and psychological responses to motion can quickly reduce crew efficiency even when on a stable platform. Additionally, emergency situations may become more threatening in a situation where only a portion of the crew is able to respond effectively. As ship design evolves and crew sizes decrease, greater emphasis must be placed upon the human factor in order to ensure safety and efficiency during both routine and emergency operations.

1.2.3 Fatigue and related issues

Howarth, Pratt and Tepas, (1999) examined a sample of shift workers, and found that neither the observed differences between on and off-duty sleep problems nor the correlation between sleep disturbance and sleep length were significant. Although results were found to confirm previous findings that shift work reduces sleep length on workdays, caution is advised before extrapolating further in terms of labelling shift workers as having 'disturbed sleep' or 'sleep disorders'. Thus it is important to distinguish between length of sleep and 'sleep disorders' when addressing issues of fatigue in seafarers.

Marsden, and Leach, (2000) investigated the effects of alcohol, caffeine, and an alcohol/caffeine mixture on performance in maritime problem solving tests and found that alcohol impaired performance accuracy. The same finding was produced by Howland, Rohsenow, Cote, Siegel and Mangione, (2000). They found that performance of deck officer cadets in simulated merchant ship handling was significantly impaired by these doses of alcohol. In the Marsden and Leach study caffeine was found to selectively enhance performance, although neither alcohol nor caffeine had any significant effect on the speed of problem-solving.

Fatigue becomes a major issue when people are acutely exposed to multiple stressors, with evidence of significant impairments in terms of cognitive performance in such situations.. Lieberman, Tharion, Shukitt-Hale, Speckman and Tulley, (2002) found that cognitive task performance and mood were adversely affected in Navy SEAL trainees tested after 72 hours of sleep deprivation and continuous exposure to other stressors. Caffeine, in a dose-dependent manner, mitigated many adverse effects of exposure to multiple stressors, significantly improved task performance and self-report fatigue. Therefore, even in the most adverse circumstances, moderate doses of caffeine can improve cognitive function. When cognitive performance is critical and must be maintained during exposure to severe stress, administration of caffeine may provide a significant advantage. This may be a useful finding in terms of coping with fatigue at sea.

1.2.4 Health and accidents

Akerstedt and Haraldsson, (2001) imply that official statistics strongly underestimate prevalence of fatigue related accidents in transportation, and that a reasonable estimate, based on research, lies between 10 and 20% for accidents on the road, in the air and at sea. They propose the main causes are disturbed sleep, working when circadian alertness is low, (night work, early morning work) sleep/wake disorders (including sleep apnoea) or social obstacles to sleep. Proposed countermeasures include strategic use of napping and caffeine (as above).

Roberts and Hansen, (2002) found that the relative risk of mortality due to accidents at work was 23.9 times higher among seafarers than for all workers in Great Britain during the period studied between 1st January 1986 and 31st December 1995. On the basis of official mortality files the authors conclude that many of the fatal accidents at work were caused by hazardous working practices. In many instances, therefore, accidents could arguably have been prevented, with further extension of this conclusion to a number of off-duty accidents and drownings. In an earlier paper Roberts (2000) examines the relative risk to British seafarers of having a fatal accident whilst serving on a foreign vessel in comparison to working in the British fleet. Studying the same time period between 1986 and 1995, British seafarers serving on foreign vessels were found to be at greater risk of mortality through work-related accidents, suicides and unexplained disappearances at sea.. Jensen, Laursen, and Sorensen, (2001), from a sample of over 1000 seafarers from five countries, found that 8.7% of the seafarers reported that they had been injured during their latest tour of duty, nearly half of which were account for by falls and slips.

Hansen and Pedersen, (1996) had previously noted an unusual mortality pattern among seafarers and, as above, found that while active as seafarers, accidents at the workplace explained almost half the deaths. However, seafarers continued to have a higher risk than the general population of fatal accidents into older age. Accidents ashore and diseases related to lifestyle factors such as drinking and smoking made a major contribution to the observed excess mortality. The results indicate that people in occupations with a high risk of fatal accidents at the workplace also seem to have a high risk of accidents away from the workplace after leaving the occupation. Hansen and Jensen, (1998) examined a cohort of almost 7,000 female seafarers and found that in the whole cohort there were fewer deaths from natural causes than expected but an excess risk of death due to lung cancer and heart disease, which probably reflects high tobacco consumption. There was an excess risk of fatal accidents and suicide especially among female seafarers entering traditional male jobs, who had a high risk of fatal accidents, not only at sea but also ashore. Hemmingsson, Lundberg, Nilsson and Allebeck, (1997) also found that seamen had increased relative risks of mortality, even after controlling for background variables. Even so, health-related selection was only partly able to explain the increased relative risks faced by seamen found in this study. The occupation itself remains a strong risk indicator, even after controlling for a large number of selection factors.

Thomas, Parker, Horn, Mole, Spiro, Hooper, and Garland, (2001) examined U.S. Navy rates and causes of accidents among deployed crewmembers aboard submarine patrols between 1997 and mid 1999. Results showed that rates of accidents and injuries decreased with increasing age and duration of military service, but that particular roles were associated with higher accident and injury rates. They propose focused safety training to reduce rates among younger, less experienced crewmembers and those working in higher-risk areas of the submarine. Hansen, Nielsen and Frydenberg, (2002) also found that age was a major risk factor, in this case for accidents causing permanent disability. Change of ship and the first period aboard a particular ship were also identified as risk factors, and the most serious accidents happened while walking about the ship, and while on deck. It was possible to clearly identify work situations and specific risk factors for accidents aboard merchant ships. Most accidents happened while performing daily routine duties, and therefore they proposed that preventive measures should focus on workplace instructions for all functions.

Bloor, Thomas and Lane, (2000) argue that in that past thirty years the shipping industry has been transformed by technological and economic changes. They indicate that closer monitoring is required to address the gap between best and worst industry practice, and the impact this has on seafarers' health and safety. Nielsen, (2001) found that there is little reliable, comparable statistical data on seafaring health and safety issues for the past twenty years and suggests that a better subdivision of accident causes and types would be necessary to monitor trends in rates, and to improve the legislation and work practices which could lead to reduction of these accident and fatality rates. MacGillivary, (1998) suggested that the most dangerous risk to seafarers is not from collisions, explosions, slippery decks or falling cargo, but from social conditions onboard. It was suggested that the root cause of ship-based accidents is human error, caused by a variety of factors, such as sub-standard training or low morale. Improving social conditions is proffered as a way to improve safety at sea.

1.3 Further Analyses of the Phase 1 Data

McNamara and Smith (in press – see Appendix 1) proposed that it is the unique combination of factors to which offshore workers are exposed that impacts negatively on well-being. Median splits of potential stressors and fatigue-related variables (e.g. noise, working hours, shift type) were summed to create a ‘total fatigue indicators’ score. Total fatigue indicators demonstrated a linear effect on depression, cognitive failures, social functioning, lack of/poor quality sleep, fatigue, and the home-work interface. No significant effects were observed for injury frequency, prescribed medication or smoking and alcohol consumption. The results suggest that exposure to a combination of stressors has a significantly greater negative effect on fatigue and health than any of these factors in isolation.

Wellens, McNamara, Ellis and Smith (in press – see Appendix 1) analysed data from the seafarers on board support vessels for the North Sea oilrigs to assess the impact of noise and nightwork. Noise exposure was found to be associated with increased subjective alertness but also with slower reaction times. Those working night shifts showed a large drop in alertness over the course of work and became slower at tasks requiring more difficult responses. There were some interactions between noise and shift, such as more lapses of attention (very long response times) but fewer incorrect responses in the noise/nightwork condition.

These two sets of analyses suggest that it is important to continue to examine combined effects of different factors in the next phase of the project.

2. PHASE 2

The programme of research had two elements, a questionnaire survey and workplace studies. Identical procedures were used to those developed in the first phase of the research which allowed comparison between the phases. The survey was carried out using three samples:
(1) a sample of NUMAST members working in short sea shipping (2) a sample who also participated in the workplace testing, and (3) other employees of the companies participating in the research. Information from these three samples allowed us to examine whether the companies involved in the research were representative of seafarers in general, and whether the crews who participated in the workplace testing were representative of the company.
Ship type was of major interest in this phase of the research and the main comparison was between ferries (conventional passenger, fast ferries, freight ro-ro's) and near-sea tankers.

3. THE SURVEY

3.1 Aims of the Survey

The aim of the second phase of the project was to extend the research from the offshore oil support industry (phase 1) to short sea coastal shipping. The direct continuation of methods allowed assessment of the degree to which seafarers can be considered a homogeneous group. Through this examination of a cross section of the seafaring industry is it possible to form a comprehensive picture of the extent, causes and consequences of fatigue at sea.
The specific aims from the first phase of the project therefore remain:

- To identify characteristics of the work environment which are likely to impact upon fatigue and general health.
- To develop an applied theoretical framework from which direct recommendations can be made and tested.

3.2 Sample

Two techniques were used to administer the survey to seafarers. First, the questionnaire was sent out in a mail shot to the officers union NUMAST and four individual shipping companies. Secondly, the questionnaire was completed by participants recruited as part of the onboard study. The ships involved with onboard testing represented the same four companies targeted with the mail shot (see appendix 2 for all descriptive statistics). Characteristics of the mail shot sample are described below.

Mail shot sample
The number of questionnaires sent out and response rates are shown in table 1 below.

Table 1: Mail shot response rates

Company	**Number of Questionnaires Sent**	**Number of Questionnaires Received**	**Response Rate** (%)
NUMAST	2740	539	19.7
Ferry Co.1	650	137	21.1
Ferry Co.2	110	35	31.8
Tanker Co.1	110 Polish / 90 English	30	15.0
Tanker Co.2	250	48	19.2

As can be seen from Table 1 response rates were relatively low, however these rates were approximately comparable (the slight exception being the high response rate from Ferry Co.2) across organisations which reduces the possibility of any selective group bias.

Mail shot demographic information
The mail shot sample had a mean age of 44.99 (range 17- 66, SD=9.72). This is high due to the large proportion of NUMAST respondents in this sample. NUMAST respondents represent officers and those in senior positions. In terms of education, 54.7% of respondents reported completing GCSE's / 'O' levels, which again may be skewed by the large number of officers in the sample. In terms of marital status, 5.1% reported being divorced which is relatively low compared to the phase 1 onshore control sample (7.9%). The number who reported being single was 12.5%.

The Onboard sample

Data were collected from 177 participants from seven ships within the short sea shipping industry. These ships included 3 small oil tankers, 2 passenger ferries, a freight ferry, and a fast ferry. Details of the vessels and the participants recruited from each are shown in appendix 3.

Participants

Demographics

177 participants were recruited, as compared with an onboard sample of 144 workers from the offshore oil support industry in phase one.

Participants in phase 2 were generally younger than those in phase 1. This may be due in part to the bias introduced by the comparatively young crew on the fast ferry (see table 2).

Table 2: Mean ages of crew of different ships

Group	N	Mean	SD
Phase 1	144	41.31	9.82
Pipe Layer	18	40.78	10.14
Dive support vessel	81	42.04	8.63
Shuttle tanker	19	38.84	12.85
Supply Vessel	12	44.00	8.16
Standby/supply Vessel	14	38.86	12.51
Phase 2	177	36.07	11.40
Freight Ferry	27	39.11	10.45
Tankers	24	41.83	12.67
Passenger Ferries	71	37.28	9.90
Fast ferry	55	30.49	11.07

There were more mixed nationality crews in phase 2, with only 63.8% (n=113) of crews being from the UK, in comparison to 91.2% (n=134) in phase 1. Other nationalities in phase 2 included Spanish (20.3%, n=36), Polish (13.0%, n=23, and Canadian (2.8%, n=5). The survey questionnaire, daily questionnaires and instructions for the performance tests were translated into Spanish and Polish.

Marine versus Non-marine crew

There were similar numbers of marine and non-marine crew in the phase 1 and 2 samples, with 65.5% of the sample being marine crew in phase 1, and 72.3% in phase 2.

Length of tour

The typical tour length was shown to differ between the two phases, with the majority of participants in phase 1 (68.3%, n=99) working 4 weeks on/4 weeks off tours, in comparison to phase 2 in which 1 week tours were most common (34.4%, n=61) (see table 3). However, again this was skewed by tour length on the fast ferry, which never exceeded seven days.

Table 3: Tour length

Tour length	Phase 1	Phase 2
1 week	----	34.4% (n=61)
2 weeks	2.8% (n=4)	15.3 (n=27)
3 weeks	4.1% (n=6)	6.2% (n=11)
4 weeks	68.3% (n=99)	3.4% (n=6)
5 weeks	6.9% (n=10)	0.6% (n=1)
6 weeks	2.1% (n=3)	1.1% (n=2)
7 weeks	9.0 (n=13)	----
8 weeks	6.9 (n=10)	10.2% (n=18)
8+ weeks	----	29.0% (n=51)

Phase 1 and phase 2 participants were tested at a similar stage into the tour, with the highest proportion of volunteers being tested in week 1 (43.7% in phase 1, and 48.0% in phase 2) (see table 4).

Table 4: Weeks into tour at testing

Weeks in tour	Phase 1	Phase 2
week 1	43.7% (n=62)	48.0% (n=85)
week 2	26.1% (n=37)	13.0% (n=23)
week 3	16.2% (n=23)	6.8% (n=12)
week 4	4.2% (n=6)	5.6% (n=10)
week 5	2.1% (n=3)	4.0% (n=7)
week 6	1.4% (n=2)	4.5% (n=8)
week 7	5.6% (n=8)	3.4% (n=6)
week 8	0.7% (n=1)	5.1% (n=9)
week 8+	----	9.6% (n=17)

3.3 Survey Content

Basic survey content

The questionnaire used in the survey was identical to that used in phase one of the project (see Appendix 2) and consists of three sections:

Offshore: Questions in this section refer specifically to time spent offshore, encompassing measures of work and rest patterns, and subjective measures of attitudes towards work.

On leave: Questions in this section relate to time spent on leave/at home and include subjective measures of health and well-being, fatigue, sleeping patterns, and health-related behaviours such as eating, drinking, smoking and exercise.

Life in general: Questions in this section are designed to measure incidence of accidents and injuries, and general health and well-being, using a number of standardised scales such as the General Health Questionnaire (GHQ), the Profile of Fatigue Related Symptoms (PFRS), the Cognitive Failures Questionnaire (CFQ), and the MOS Short Form Health Questionnaire (SF-36).

Combined factors derived from the survey

Within the survey are sections which contain a number of questions that essentially measure the same underlying construct, although addressing the issue from slightly different angles. In these instances it is advantageous to calculate a combined factor score that reflects consistency across items and therefore a more reliable measure. This procedure also reduces the number of comparisons required, therefore creating a more concise final picture, and reducing the number of chance effects. In order to identify which questions are tapping the same construct, factor analysis was conducted on specific sections within the questionnaire. Sections that were chosen for factor analysis represent areas of specific interest in terms of addressing the central aims of the project. Therefore the factors identified fall into two distinct categories:

1. Fatigue symptom factors
2. Potential fatigue risk factors

Fatigue symptoms factors

Individual items loading on each factor are shown below:

General fatigue symptoms

- General question: To what extent do you experience the following symptoms of fatigue whilst at sea?
    Confusion,
    Lethargy
    Depression
    Tension
    Loss of concentration

Fatigue at work

Which of the following responses best describes your **typical state** during work?
Options: Sleep / Somewhat sleepy / Somewhat alert / Alert / Very alert
About how often do you feel **tired** at work?
Options: Never / Less than once a month / Once or twice a month / Once a week / Two or three times a week / About everyday
About how often do you feel **sleepy** at work?
Options: Never / Less than once a month / Once or twice a month / Once a week / Two or three times a week / About everyday

Fatigue after work

On a normal work day, how **physically tired** do you usually feel at the end of the working day?
Options: Not at all / A little / Quite a bit / Extremely
On a normal work day, how **mentally tired** do you usually feel at the end of the working day?
Options: Not at all / A little / Quite a bit / Extremely
On a normal work day, how **tense** do you usually feel at the end of the work day?
Options: Not at all / A little / Quite a bit / Extremely

Potential risk factors for fatigue

Disruptive working hours
Do you work at night?
Options: Often / Sometimes / Seldom / Never-almost never
Do you do shift work?
Options: Often / Sometimes / Seldom / Never-almost never
Do you have to work long and/or unsociable hours?
Options: Often / Sometimes / Seldom / Never-almost never

The physical environment
Does your job ever expose you to breathing fumes, dusts or other potentially harmful substances?
Options: Often / Sometimes / Seldom / Never-almost never
Does your job ever require you to handle or touch potentially harmful substances or materials?
Options: Often / Sometimes / Seldom / Never-almost never
Do you ever have to work tasks that leave you with a ringing in your ears or a temporary feeling of deafness?
Options: Often / Sometimes / Seldom / Never-almost never
Does the level of back ground noise in your work disturb your concentration?
Options: Often / Sometimes / Seldom / Never-almost never

Vibration and Motion
Does the level of vibration in your workplace affect you performance?
Options: Often / Sometimes / Seldom / Never-almost never
Do you experience feelings of nausea brought on by motion effects?
Options: Often / Sometimes / Seldom / Never-almost never

Job Demands
I have constant time pressure due to a heavy workload
Options: No / Yes (not at all) / Yes (somewhat) / Yes (rather) / Yes (very distressed)
I have many interruptions and disturbances in my job
Options: No / Yes (not at all) / Yes (somewhat) / Yes (rather) / Yes (very distressed)
I have a lot of responsibility in my job
Options: No / Yes (not at all) / Yes (somewhat) / Yes (rather) / Yes (very distressed)
I am often under pressure to work overtime
Options: No / Yes (not at all) / Yes (somewhat) / Yes (rather) / Yes (very distressed)

Job insecurity
I have experienced or expect to experience an undesirable change in my work
Options: No / Yes (not at all) / Yes (somewhat) / Yes (rather) / Yes (very distressed)
My job promotion prospects are poor
Options: No / Yes (not at all) / Yes (somewhat) / Yes (rather) / Yes (very distressed)
My job security is poor
Options: No / Yes (not at all) / Yes (somewhat) / Yes (rather) / Yes (very distressed)
I am treated unfairly at work
Options: No / Yes (not at all) / Yes (somewhat) / Yes (rather) / Yes (very distressed)

Support at work
I receive the respect I deserve from my superiors and colleagues
Options: Yes / No (not at all) / No (somewhat) / No (rather) / No (very distressed)
I experience adequate support in difficult situations
Options: Yes / No (not at all) / No (somewhat) / No (rather) / No (very distressed)
Considering all my efforts and achievements, I receive the respect and prestige I deserve at work
Options: Yes / No (not at all) / No (somewhat) / No (rather) / No (very distressed)

Sleep quality

- General question: How often do you?

Have difficulty falling asleep?
Options: Not at all / A little / Quite a bit / Almost always
Have difficulty in staying asleep
Options: Not at all / A little / Quite a bit / Almost always
Wake up during sleep
Options: Not at all / A little / Quite a bit / Almost always
Have restless or disturbed sleep
Options: Not at all / A little / Quite a bit / Almost always

- General question: How much do any of the conditions below disturb your sleep?

Noise
Options: Not at all / A little / Quite a bit / Almost always

In order to facilitate direct between-phase comparisons, parallel factor analysis was conducted on the phase 1 database. All the factors previously specified were found to be comparable in the phase 1 database with similar loadings in relation to individual questions. Identical factors were therefore calculated within the phase 1 database.

3.4 Areas of comparison

When addressing the central aims of the project three key areas of comparison emerge:

Self-reported levels of fatigue
Most important of all it is necessary to obtain a measure of how fatigued the respondents actually feel. For this purpose four separate scales were used. Three of the measures were derived factors as detailed above – General Fatigue symptoms, Fatigue at work and Fatigue after work. The fourth measure was the fatigue sub-scale taken from the Profile of Fatigue Related Symptoms (PFRS) section within the questionnaire. For all analyses these four fatigue scales were therefore used to assess actual levels of fatigue.

Levels of exposure to potential fatigue causing factors
These measures account for the largest proportion of the questionnaire and cover a spectrum of factors that may potentially predict fatigue and/or health outcomes. The derived factors described above (numbers 4 to 10) are examples of such predictor variables.

Health status as an indicator of the potential consequences of fatigue
The questionnaire includes comprehensive assessment scales that evaluate various aspects of physical and mental health. The key scales of interest when focusing upon health are the General Health Questionnaire (GHQ) and the Short Form Health Survey (SF-36). These are used to assess possible health outcomes, particularly in relation to reported levels of fatigue.

4 HOW REPRESENTATIVE ARE THE SAMPLES?

4.1 The Mail Shot and Onboard Samples

It was necessary to assess how representative the onboard sample was of seafarers in general before any valid analysis could be conducted. This was assessed by comparing characteristics of the onboard sample with the mail shot sample which represented a larger cross section of the seafaring community.
Differences between the mail shot sample and the onboard sample were considered in terms of the survey as a whole, and more directly in terms of the three key areas of interest; levels of fatigue, exposure to fatigue risk factors and health status.

4.1.1 General findings

Comparisons revealed that the onboard sample could be considered equivalent to the mail shot sample in terms of all key variables. Some differences were found between the two groups (e.g. the mail shot sample had a higher average age), however these differences were accounted for by the higher percentage of officers in the mail shot sample. Example comparisons from the three key areas of interest are shown in Tables 5 to 12.

Self-reported levels of fatigue

Table 5: General symptoms of fatigue (factored from 5 questions)

	General fatigue
Mail shot	Mean=1.42 (n=674 , S.E = 0.03)
Offshore testing	Mean=1.48 (n=119 , S.E = 0.08)

(1=Low fatigue, to 5=high fatigue)

Table 6: Fatigue during work (factored from 3 questions)

	During work fatigue
Mail shot	Mean=3.74 (n=768 , S.E = 0.03)
Offshore testing	Mean=3.73 (n=137 , S.E = 0.08)

(1=Low fatigue, to 5=high fatigue)

Table 7: Fatigue after work (factored from 3 questions)

	After work fatigue
Mail shot	Mean=2.46 (n=773 , S.E = 0.02)
Offshore testing	Mean=2.43 (n=138 , S.E = 0.05)

(1=Low fatigue, to 5=high fatigue)

Levels of exposure to fatigue

Table 8: How many hours a day do you work on additional duties?

	Mail shot (%)	**Offshore testing** (%)
None	35.3	38.0
1-2 hrs	32.5	29.3
3-5 hrs	21.6	12.0
>5hrs	10.6	20.7

Table 9: How much sleep do you feel you get at sea?

	Mail shot (%)	**Offshore testing** (%)
Too little	13.0	14.1
?	32.5	28.1
Enough	52.5	54.8
?	1.8	3.0
Too much	0.3	---

Table 10: General quality of sleep (factored from 5 questions)

	Quality of sleep
Mail shot	Mean=2.34 (n=726 , S.E = 0.02)
Offshore testing	Mean=2.26 (n=129 , S.E = 0.06)

(1=good quality sleep, to 5=poor quality sleep)

Health status

Table 11: General health status

	Mail shot (Mean)	**Offshore testing** (Mean)
Physical functioning	**89.4** (n=769 , S.E = 0.53)	**90.2** (n=132 , S.E = 1.24)
Role-physical	**83.5** (n=777 , S.E = 1.03)	**80.9** (n=132 , S.E = 2.49)
Bodily pain	**75.0** (n=790 , S.E = 0.81)	**76.1** (n=140 , S.E = 1.95)
General health	**67.0** (n=770 , S.E = 0.68)	**66.7** (n=137 , S.E = 1.65)
Vitality	**59.4** (n=768 , S.E = 0.70)	**61.7** (n=136 , S.E = 1.61)
Social functioning	**81.9** (n=779 , S.E = 0.81)	**77.5** (n=138 , S.E = 2.12)
Role-emotional	**82.1** (n=780 , S.E = 1.14)	**78.1** (n=134 , S.E = 2.87)
Mental health	**73.0** (n=769 , S.E = 0.61)	**69.6** (n=135 , S.E = 1.63)

(lower scores represent poorer functioning)

Table 12: Profile of fatigue related symptoms (PFRS) fatigue scale

	Mail shot	**Offshore testing**
Profile of fatigue related symptoms (PFRS) fatigue scale	Mean=28.9 (n=769 , S.E = 0.50)	Mean=31.5 (n=138 , S.E = 1.30)

(a higher score represents higher levels of fatigue)

4.2 Conclusions

The offshore sample was found to be broadly representative in terms of all key variables. There was evidence of marginal differences between the two groups, however these differences were generally selective and not indicative of any underlying group differences. For example:

- the offshore sample had a slightly higher level of mental health and social functioning problems.
- in contrast to the other fatigue scales, the PFRS fatigue scale indicated slightly higher levels of fatigue in the offshore sample.

4.3 Assessing the 'Best Ship' Possibility

In addition to assessing how representative the onboard sample was of seafarers in general, it was necessary to assess the extent to which the ships studied were representative of their respective companies in general. Whilst the possibility of companies providing only their best ships was limited due to researcher selection of certain vessels, nevertheless the best ship possibility had to be addressed.

4.3.1 General results

Trends within companies' onboard samples were generally found to match trends within companies' mail shot samples, with no consistent picture concerning which group was more fatigued. Therefore whilst comparisons were limited due to small onboard sample sizes, there was little evidence to support the 'best ship' idea. Examples illustrating this are shown in Tables 13 to 19.

<u>Self-reported levels of fatigue</u>

Table 13: General symptoms of fatigue (factored from 7 questions)

Company	**Mail shot** (Mean)	**On board** (Mean)
Ferry Co.1	1.41(n=113 , S.E = 0.06)	1.56 (n=80 , S.E = 0.10)
Ferry Co.2	1.07 (n=34 , S.E = 0.12)	1.44 (n=23 , S.E = 0.20)
Tanker Co.1	0.91(n=24 , S.E = 0.17)	0.73 (n=8 , S.E = 0.19)
Tanker Co.2	1.17 (n=39 , S.E = 0.12)	1.63 (n=8 , S.E = 0.33)

(1=Low fatigue, to 5=High fatigue)

Table 14: Fatigue during work (factored from 3 questions)

Company	**Mail shot** (Mean)	**On board** (Mean)
Ferry Co.1	3.71 (n=130 , S.E = 0.08)	3.84 (n=92 , S.E = 0.10)
Ferry Co.2	3.29 (n=34 , S.E = 0.16)	3.75 (n=25 , S.E = 0.14)
Tanker Co.1	3.26 (n=30 , S.E = 0.16)	3.22 (n=12 , S.E = 0.23)
Tanker Co.2	3.29 (n=47, S.E = 0.16)	3.21 (n=8 , S.E = 0.22)

(1=Low fatigue, to 5=High fatigue)

Table 15: Fatigue after work (factored from 3 questions)

Company	**Mail shot** (Mean)	**On board** (Mean)
Ferry Co.1	2.35 (n=130 , S.E = 0.05)	2.45 (n=93 , S.E = 0.07)
Ferry Co.2	2.25 (n=35 , S.E = 0.10)	2.49 (n=25 , S.E = 0.13)
Tanker Co.1	2.24 (n=29 , S.E = 0.09)	2.31 (n=12 , S.E = 0.21)
Tanker Co.2	2.20 (n=47 , S.E = 0.10)	2.17 (n=8 , S.E = 0.18)

(1=Low fatigue, to 5=High fatigue)

Levels of exposure to fatigue

Table 16: Do you regularly have the opportunity to gain 6 hours rest in every 24 hr period?

	Yes (%)
Ferry Co.1 mail shot	62.4
Ferry Co.1 onboard	75.3
Ferry Co.2 mail shot	80.0
Ferry Co.2 onboard	69.2
Tanker Co.1 mail shot	82.8
Tanker Co.1 onboard	83.3
Tanker Co.2 mail shot	85.4
Tanker Co.2 onboard	75.0

Table 17: Gene ral quality of sleep (factored from 5 questions)

Company	Mail shot (Mean)	On board (Mean)
Ferry Co.1	2.25 (n=122 , S.E = 0.06)	2.25 (n=84 , S.E = 0.08)
Ferry Co.2	2.28 (n=33 , S.E = 0.13)	2.33 (n=26 , S.E = 0.11)
Tanker Co.1	2.19 (n=28 , S.E = 0.13)	2.20 (n=11 , S.E = 0.23)
Tanker Co.2	2.29 (n=45 , S.E = 0.10)	2.23 (n=8 , S.E = 0.16)

(1=good quality sleep, to 5=poor quality sleep)

Health status

Table 18: General health status

	Physical Functioning (Mean)	General Health (Mean)	Mental Health (Mean)
Ferry Co.1 mail shot	89.4 (n=134, S.E = 1.68)	65.3 (n=132 , S.E = 1.79)	71.5 (n=129 , S.E 1.67)
Ferry Co.1 onboard	90.1 (n=87 , S.E = 1.69)	65.1 (n=91 , S.E = 2.15)	66.7 (n=89 , S.E = 2.09)
Ferry Co.2 mail shot	93.2 (n=34 , S.E = 1.41)	75.9 (n=35 , S.E = 2.57)	79.2 (n=34 , S.E = 2.29)
Ferry Co.2 onboard	89.6 (n=26 , S.E = 2.06)	69.2 (n=26 , S.E = 3.82)	71.2 (n=26 , S.E = 3.42)
Tanker Co.1 mail shot	91.2 (n=30 , S.E = 3.39)	71.3 (n=27 , S.E = 3.60)	75.5 (n=30 , S.E = 3.85)
Tanker Co.1 onboard	95.0 (n=12 , S.E = 1.74)	72.3 (n=12 , S.E = 3.77)	82.7 (n=12 , S.E = 2.67)
Tanker Co.2 mail shot	87.7 (n=47 , S.E = 2.55)	67.2 (n=46 , S.E = 3.67)	73.5 (n=47 , S.E = 2.94)
Tanker Co.2 onboard	85.0 (n=7 , S.E = 6.07)	68.0 (n=8 , S.E = 4.04)	76.5 (n=8 , S.E = 6.11)

(lower scores represent poorer functioning)

Table 19: Profile of fatigue related symptoms (PFRS) fatigue scale

	Profile of fatigue related symptoms (PFRS) fatigue scale (Mean)
Ferry Co.1 mail shot	29.6 (n=127, S.E = 1.21)
Ferry Co.1 onboard	34.4 (n=93, S.E = 1.62)
Ferry Co.2 mail shot	23.7 (n=35, S.E = 1.87)
Ferry Co.2 onboard	28.7 (n=25, S.E = 2.74)
Tanker Co.1 mail shot	20.8 (n=30, S.E = 1.63)
Tanker Co.1 onboard	21.5 (n=12, S.E = 3.24)
Tanker Co.2 mail shot	27.6 (n=47, S.E = 2.39)
Tanker Co.2 onboard	22.6 (n=8, S.E = 4.00)

(high score=high fatigue)

4.4 Conclusions

There was little evidence to support the ‘best ship’ idea with the ships studied appearing broadly representative of their respective companies as a whole.

4.5 How representative are the companies of the industry?

The final question to address was whether the actual companies studied could be considered representative of seafaring companies sampled via the NUMAST survey. For this comparison all data from the four companies studied, both from the mail shot and offshore testing, was separated from the rest of the survey. Each company was then individually compared with the 'rest of survey' group. In these comparisons the 'rest of survey' group was therefore used to represent a broad range of different seafaring companies.

4.5.1 General findings

Trends within the company samples were generally found to match trends within the rest of the survey. Some broad between group differences, however, were as follows:
Levels of Fatigue
The 'rest of survey' group showed highest levels of fatigue, with the participating ferry companies showing higher fatigue than the tanker companies.
Exposure to fatigue related factors
There was evidence of the tanker companies working different types of work/leave schedule.
Many non-fatigue related differences between the groups could be understood in terms of the higher percentage of officers in the mail shot sample. Tanker company 1 stood out as the most distinct group from the rest of the survey. This difference could potentially be explained by the fact that Tanker company 1 was purely a tanker company, whilst ferry and passenger companies accounted for a large proportion of the rest of the survey.
Example comparisons on the three key areas of interest are shown in Tables 20 to 27.

<u>Self-reported levels of fatigue</u>

Table 20: General symptoms of fatigue (factored from 7 questions)

Company (Mean)	**Rest of survey** (Mean)
Ferry Co.1 **1.47** (n=193 , S.E = 0.05) Ferry Co.2 **1.22** (n=57 , S.E = 0.11) Tanker Co.1 **0.86** (n=32 , S.E = 0.14) Tanker Co.2 **1.25** (n=47 , S.E = 0.12)	**1.49** (n=464 , S.E = 0.04)

(1=Low fatigue, to 5=High fatigue)

Table 21: Fatigue during work (factored from 3 questions)

Company (Mean)	**Rest of survey** (Mean)
Ferry Co.1 **3.76** (n=222 , S.E = 0.06) Ferry Co.2 **3.49** (n=59 , S.E = 0.11) Tanker Co.1 **3.25** (n=42 , S.E = 0.13) Tanker Co.2 **3.28** (n=55 , S.E = 0.14)	**3.85** (n=527 , S.E = 0.04)

(1=Low fatigue, to 5=high fatigue)

Table 22: Fatigue after work (factored from 3 questions)

Company (Mean)	**Rest of survey** (Mean)
Ferry Co.1 **2.39** (n=223 , S.E = 0.04)	
Ferry Co.2 **2.35** (n=60 , S.E = 0.08)	
Tanker Co.1 **2.26** (n=41 , S.E = 0.09)	**2.55** (n=532, S.E = 0.02)
Tanker Co.2 **2.19** (n=55 , S.E =0.09)	

(1=Low fatigue, to 5=high fatigue)

Levels of exposure to fatigue

Table 23: What is the work / leave system onboard?

	4 weeks on / 4 off (%)	**2 weeks on / 2 off (%)**	**1 week on / 1 off (%)**	**Other (%)**
Ferry Co.1	3.9	38.4	6.5	51.3
Ferry Co.2	18.3	---	31.7	50.0
Tanker Co.1	2.6	5.1	---	92.3
Tanker Co.2	---	---	---	100.0
Rest of survey	2.8	31.8	22.4	43.0

Table 24: Do you regularly have the opportunity to gain 10 hours rest in every 24 hr period?

	Yes (%)
Ferry Co.1	61.2
Ferry Co.2	59.0
Tanker Co.1	55.0
Tanker Co.2	52.7
Rest of survey	62.8

Table 25: General quality of sleep (factored from 5 questions)

Company (Mean)	**Rest of survey** (Mean)
Ferry Co.1 **2.25** (n=206 , S.E = 0.05)	
Ferry Co.2 **2.30** (n=59 , S.E = 0.09)	**2.38**
Tanker Co.1 **2.19** (n=39 , S.E = 0.12)	(n=498 , S.E = 0.03)
Tanker Co.2 **2.28** (n=53 , S.E = 0.09)	

(1=good quality sleep, to 5=poor quality sleep)

Health status

Table 26: General health status

	Physical functioning (Mean)	General health (Mean)	Mental health (Mean)
Ferry Co.1	89.7 (n=221 , S.E = 1.21)	65.2 (n=223 , S.E = 1.37)	69.6 (n=218 , S.E = 1.31)
Ferry Co.2	91.7 (n=60 , S.E = 1.21)	73.1 (n=61 , S.E = 2.22)	75.7 (n=60 , S.E = 2.02)
Tanker Co.1	92.3 (n=42 , S.E = 2.47)	71.6 (n=39 , S.E = 2.72)	77.5 (n=42 , S.E = 2.88)
Tanker Co.2	87.3 (n=54 , S.E = 2.34)	67.4 (n=54 , S.E = 3.17)	73.9 (n=55 , S.E = 2.65)
Rest of survey	89.3 (n=524 , S.E = 0.57)	66.6 (n=530 , S.E = 0.78)	72.8 (n=529 , S.E = 0.70)

(lower scores represent poorer functioning)

Table 27: Profile of fatigue related symptoms (PFRS) fatigue scale

	Profile of fatigue related symptoms (PFRS) fatigue scale (Mean)
Ferry Co.1	31.6 (n=220 , S.E = 0.99)
Ferry Co.2	25.8 (n=60 , S.E = 1.60)
Tanker Co.1	21.0 (n=42 , S.E = 1.47)
Tanker Co.2	26.9 (n=55 , S.E = 2.13)
Rest of survey	29.6 (n=530 , S.E = 0.61)

(High score= High Fatigue)

4.6 Conclusions

There was little evidence to suggest that the companies studied were not broadly characteristic of companies sampled by NUMAST. Therefore any differences between the groups appeared to directly reflect sample composition differences. Certainly one factor of potential importance appeared to be ship type.

5 A COMPARISON OF PHASE ONE AND PHASE TWO

5.1 Reason for the comparison

In order to establish whether the phase one and phase two samples were comparable, analyses were conducted on the variables assessed in both phases. These included all those assessed by the survey, some of the sleep variables from the log books, as well as the performance data and objective sleep measures. In this way it is possible to ascertain whether results from phase 1 can legitimately be generalised to phase 2.
The next section considers the survey data.

5.2 Survey Data

- The two samples were broadly comparable in terms of most variables (see Table 28).
- Key differences:
  a) Phase 2 participants reported slightly higher levels of fatigue.
  b) Phase 2 participants had consistently lower levels of general health.
  c) There was evidence of different work / leave schedules between the two phases.

Examples of these differences are shown in Tables 29 to 35.

<u>Fatigue-related issues</u>
Table 28 shows key variables from the two phases. For all questions there are very similar responses from the two samples.

Table 28 : A comparison of survey responses from Phases 1 and 2

		Phase 1	Phase 2
1	Working > 85 hours a week	49%	45.7%
2	Consider working hours to be a danger	43.5%	52.6%
3	No opportunity to have 6 hours uninterrupted sleep	43.5%	52.6%
4	Poor quality sleep	47.4%	52.8%
5	Split sleep	49.8%	56.4%
6	Involved in a fatigue related incident	11%	16%
7	No training in recognising fatigue or dealing with it	92.2%	91.7%
8	Performance impaired when on leave	46.4%	44.8%
9	Working hours increased over last 10 years	47.4%	59%
10	Desirable changes:		
	Extra manning	57.6%	58.9%
	More leave	24.7%	37.6%
	Tougher laws	29.5%	36.9%
	Less paperwork	39.5%	31.4%

Self-reported levels of fatigue

It can be seen from the three tables below that self reports of actual fatigue are slightly higher in phase two.

Table 29: General symptoms of fatigue (factored from 7 questions)

	General Fatigue
Phase 1	Mean=1.39 (n=494 , S.E = 0.04)
Phase 2	Mean=1.43 (n=793 , S.E = 0.03)

(1=Low fatigue, to 5=High fatigue)

Table 30: Fatigue after work (factored from 3 questions)

	Fatigue after work
Phase 1	Mean=2.35 (n=559 , S.E = 0.03)
Phase 2	Mean=2.46 (n=911 , S.E = 0.02)

(1=Low fatigue, to 5=High fatigue)

Table 31: Fatigue during work (factored from 3 questions)

	Fatigue during work
Phase 1	Mean=3.63 (n=550 , S.E = 0.04)
Phase 2	Mean=3.74 (n=905 , S.E = 0.03)

(1=Low fatigue, to 5=High fatigue)

This pattern of results remained the same when GHQ, age, education and socio-economic class were co-varied in the analysis.

Levels of exposure to factors which may lead to fatigue

Having seen above that self reports of actual fatigue are slightly higher in phase two, it may prove instructive to look at self reports of exposure to factors that may induce fatigue. The following tables show different work/leave schedules between the phases and more frequent reports of too little sleep in phase two, although sleep quality is almost equivalent between the two phases.

Table 32: What is the work / Leave system onboard?

Schedule	**Phase 1** (%)	**Phase 2** (%)
4 weeks on / 4 weeks off	66.7	3.9
2 weeks on / 2 weeks off	1.3	28.3
1 week on / 1 weeks off	0.2	16.7
Other	31.9	51.0

Table 33: How much sleep do you feel you get at sea?

	Phase 1 (%)	**Phase 2** (%)
Too little	5.9	13.0
?	30.2	32.5
Enough	62.8	52.5
?	0.7	1.8
Too much	0.4	0.3

Table 34: General quality of sleep (factored from 5 questions)

	Quality of sleep
Phase 1	Mean=2.28 (n=997 , S.E = 0.02)
Phase 2	Mean=2.32 (n=855 , S.E = 0.02)

(1=good quality sleep, to 5=poor quality sleep)

This pattern of results again remained the same when GHQ, age, education and socio-economic class were co-varied in the analysis.

Health status

Phase two participants consistently reported lower levels of general health, as reflected by the various scales outcomes represented below, and also by scores on the SF-36 scales and the Profile of Fatigue Related Symptoms scale.

Table 35: General health status

	Phase 1 (Mean)	**Phase 2** (Mean)
Physical functioning	**90.0** (n=556 , S.E = 0.67)	**89.6** (n=901 , S.E = 0.49)
Role-physical	**87.9** (n=536 , S.E = 1.14)	**83.1** (n=909, S.E = 0.95)
Bodily pain	**77.9** (n=559 , S.E = 0.87)	**75.1** (n=930 , S.E = 0.74)
General health	**70.4** (n=557 , S.E = 0.73)	**67.0** (n=907 , S.E = 0.63)
Vitality	**64.0** (n=558 , S.E = 0.76)	**59.7** (n=904 , S.E = 0.64)
Social functioning	**84.9** (n=554 , S.E = 0.87)	**81.2** (n=917 , S.E = 0.76)
Role-emotional	**88.3** (n=527 , S.E = 1.17)	**81.5** (n=914 , S.E = 1.06)
Mental health	**74.8** (n=555 , S.E = 0.70)	**72.5** (n=904 , S.E = 0.58)

(lower scores represent poorer functioning)

Table 36: Profile of fatigue related symptoms (PFRS) fatigue scale (Mean)

	Phase 1	**Phase 2**
Profile of fatigue related Symptoms (PFRS) *fatigue Scale*	Mean=25.4 (n=553 , S.E = 0.53)	Mean=29.3 (n=907 , S.E = 0.47)

(a higher score represents higher levels of fatigue)

This pattern of results remained the same when GHQ, age, education and socio-economic class were co-varied in the analysis.

5.3 Conclusions

Participants in phase two reported slightly higher levels of fatigue, greater exposure to factors that may induce fatigue, and poorer reported health. Neither demographic variables such as socio-economic status and age, nor GHQ scores, nor sample composition (i.e. officers/rating proportions, and marine/non marine crews), nor nationality, were sufficient to explain why phase two had poorer outcomes in these areas. However, it is still possible that these differences may not be due to the issues addressed above, but rather the combined effects of other factors that change considerably between the two phases. These factors relate to issues such as ship type, job type, shift patterns, length of tours, and days into tour, which are addressed in the following sections.

6 SHIP TYPE

An analysis of the impact of ship type was considered extremely important in order to establish the conditions that induce fatigue. Analyses were conducted in order to establish whether the work issues faced by seafarers are homogenous across ship types, or whether there are significant differences in exposure variables between the different types of vessel. Within this area of investigation any significant findings have clear applied relevance.

6.1 General Findings

- Passenger vessel respondents were shown to have slightly higher levels of fatigue and poorer alertness than the tanker respondents.
- Different patterns of work/leave and watch/duty schedules were found for the passenger vessel types as against tankers/dredgers/other.
- No clear pattern of results emerged in terms of sleep and health variables.
- Ships were found to differ in terms of a number of variables that could potentially lead to fatigue. It is, of course, extremely unlikely that ship type in itself determines the observed variations. Far more likely is the permutation of factors and, especially, operational variations in voyage cycles.

6.2 Results from the Survey

The vessels appeared to fall into two groups as follows :

Table 36: Ship division

Passenger carrying	Non-passenger
Passenger	Tanker
High speed Passenger	Dredger
Freight*	Other

Within these categories the largest differences were found between 'passenger'/'high speed passenger' and 'tanker'. In contrast to the onboard sample, a number of different short-sea vessels types were reported within the survey. It was therefore necessary to form vessel categories in order to manage the data and form useful conclusions. Five ship divisions were made, into which most respondents naturally fell (Passenger, High speed passenger, Freight, Tanker and Dredger). Any unclear cases were put into a sixth 'other' category. The ship type comparisons were based on the same areas previously used to analyse the survey: self reported fatigue, exposure to potential fatigue risk factors and health status (see Tables 37 to 42).

* [Whilst some pure freight ferries do not carry passengers, most freight ferries accommodate passengers in some form. In many instances within the survey the same vessel has actually been classed differently by different respondents as freight or passenger].

Self-reported levels of fatigue

The only consistent finding across all fatigue scales was that the passenger/high speed passenger vessels showed higher levels of fatigue than the tankers, (as shown in table 37 below).

Table 37: Fatigue after work (factored from 3 questions)

Vessel	**Fatigue after work** (Mean)
Passenger	**2.57** (n=363 , S.E = 0.03)
High speed Passenger	**2.57** (n=79 , S.E = 0.07)
Freight	**2.37** (n=189 , S.E = 0.05)
Tanker	**2.32** (n=147 , S.E = 0.05)
Dredger	**2.39** (n=61 , S.E = 0.06)
Other	**2.36** (n=62 , S.E = 0.07)

(1=Low fatigue, to 5=high fatigue)

This pattern of results remained the same when GHQ, age, education and socio-economic class were co-varied in the analysis.

Levels of exposure to fatigue

Different watch/duty schedules were present on the ships. This difference was most noticeable in terms of a broad tankers/dredgers/other vs. passenger split as shown in table 38 below. A high percentage of the passenger respondents reported working 12 on/12off shifts in contrast to a noticeably high percentage of tanker/dredger/other respondents working flexible shifts ('as required').

Table 38:What is your typical watch/duty schedule?

	12on/ 12off (%)	**6on/ 6off (%)**	**4on/ 8off (%)**	**4on/ 4off (%)**	**As required (%)**	**Other (%)**
Passenger	36.0	12.1	1.9	0.5	3.5	46.0
H.speed passenger	56.6	2.4	---	---	---	41.0
Freight	30.6	35.8	2.6	---	6.2	24.9
Tanker	13.8	22.1	13.8	---	15.9	34.9
Dredger	6.6	21.3	3.3	1.6	23.0	44.3
Other	21.0	19.4	19.4	---	16.1	24.2

A difference in work/leave schedules was found between tankers/dredgers/other and the passenger ships (see table 39). The passenger respondents frequently reported working short schedules of either one or two weeks, in contrast to the tanker/dredger/other vessels where shifts were difficult to categorise due to the large number of variations (illustrated by high numbers in the 'other' category).

Table 39: What is the work/leave system onboard?

	4 weeks on, 4 off (%)	2 weeks on, 2 weeks off (%)	1 week on, 1 off (%)	Other (%)
Passenger	3.5	41.4	23.5	31.6
H.speed passenger	---	2.4	45.8	51.8
Freight	6.3	43.2	12.5	38.0
Tanker	2.7	---	1.4	95.9
Dredger	---	27.9	3.3	68.9
Other	11.5	9.8	1.6	77.0

Health status

As can be seen in table 40 below, no consistent health status differences were observed between the different vessel types. However, the PFRS fatigue scale again highlights the difference in fatigue levels found between the tanker respondents, and those from passenger / high speed passenger vessels (see table 41).

Table 40: General health status

Vessel	General Health (Mean)	Physical Functioning (Mean)	Mental Health (Mean)
Passenger	66.74 (n=362 , S.E = 0.90)	90.07 (n=357 , S.E = 0.64)	71.97 (n=359 , S.E = 0.85)
High speed Passenger	68.51 (n=81 , S.E = 2.46)	88.31 (n=80 , S.E = 2.22)	72.05 (n=78 , S.E = 2.14)
Freight	67.19 (n=188 , S.E = 1.49)	89.29 (n=183 , S.E = 1.26)	70.02 (n=186 , S.E = 1.39)
Tanker	66.63 (n=145, S.E = 1.62)	88.84 (n=147 , S.E = 1.22)	74.49 (n=148 , S.E = 1.50)
Dredger	63.76 (n=59 , S.E = 2.36)	90.74 (n=61 , S.E = 1.04)	76.26 (n=61 , S.E = 1.78)
Other	69.45 (n=60 , S.E = 2.20)	90.08 (n=61 , S.E = 1.82)	74.82 (n=61, S.E = 2.07)

(lower scores represent poorer functioning)

Table 41: Profile of fatigue related symptoms (PFRS) fatigue scale (Mean)

Vessel	Profile of fatigue related symptoms (PFRS) fatigue Scale (Mean)
Passenger	31.3 (n=364 , S.E = 0.80)
High speed Passenger	33.0 (n=79 , S.E = 1.68)
Freight	29.3 (n=185 , S.E = 0.95)
Tanker	25.8 (n=148, S.E = 1.13)
Dredger	26.9 (n=59 , S.E = 1.55)
Other	23.8 (n=61 , S.E = 1.26)

(high score = high fatigue)

The pattern of results shown in tables 40 and 41 remained the same when GHQ, age, education and socio-economic class were co-varied in the analysis.
In addition to the analyses reported above, it was considered that ship based differences may actually reflect disproportionate marine/non-marine crew representation within vessels. Therefore passenger vs. tanker differences could arguably just reflect marine vs. non-marine differences through the fact that tankers are exclusively marine crewed, whilst passenger vessels have a high proportion of non-marine crew. Further analysis was conducted excluding the non-marine crew in order to construct a more equivalent comparison. Across measures the pattern of results remained broadly the same suggesting that ship based differences cannot be accounted for in terms of a marine/non-marine explanation. Covarying GHQ, education, socio-economic status and age could not account for these effects either.
Ship type may therefore be a useful contributory factor in understanding fatigue at sea. However this factor may represent the combined effect of several specific variables (e.g work schedules/voyage cycle patterns) that effectively distinguish the different vessels on a practical level. In the present survey ship type was confounded with many other pertinent variables, such as work leave schedules, working hours, job status and work security. Thus in order to understand and address the between ship type differences above, it is important to disentangle what is actually responsible for them, i.e. whether it is some variable highly correlated with ship type rather than ship type itself, or the combined effects of many different variables associated with ship type. The combined effects hypothesis is examined later but the next section considers one specific type of ship, fast ferries, to determine whether this should be considered a distinct category.

6.3 High speed passenger ferries – A distinct category?

Additional analyses were conducted in order to establish whether it is justified to consider the high speed passenger craft as significantly distinct from all other vessels. Certainly in many respects high speed craft are distinct in terms of many working patterns, however these differences may simply be of the same magnitude as differences found between other vessel types, e.g. freight ferries relative to tankers.
In order to assess the distinctiveness of high speed passenger craft, comparisons were made with respondents from traditional passenger ferries, representing the most similar sample group. If only marginal differences were found between these two groups then separate high-speed vessel analysis would appear unjustified. Comparisons were made across the spectrum of survey questions in order to give a global impression of group differences. Findings were structured around four key areas: demographics, fatigue, health and work.

6.3.1 Demographics

Three significant demographic differences were found between the high speed and traditional ferry respondents. First, the high speed ferry respondents were in general younger which may be accounted for by the large numbers of customer service crew. Secondly, the high speed vessels were found to have a higher percentage of women in the crew which could again arguably be traced to back to the proportion of customer service crew involved. Finally, there were reported to be fewer nationalities on the high speed vessels.

6.3.2 Fatigue

No significant differences in reported fatigue were found between the high speed and traditional ferries.

6.3.3 Health

No health status differences were found between the high speed and traditional passenger ferries.

6.3.4 Working practices

As might be expected, a number of differences were found in relation to working patterns and practices. For example, significant differences were found in relation to: work/leave systems, watch/duty schedules, working hours, number of port calls and sleeping patterns. Of possibly more interest is the fact that the high speed passenger respondents reported generally better work security and lower job demands relative to the traditional passenger ferry respondents.

6.4 Conclusions

Data from the survey were used in order to assess whether high speed ferries can be considered an entirely distinct group relative to other craft. Comparisons with conventional passenger ferries showed that in most crucial respects the high speed ferries are actually extremely similar. Analysis was further conducted between the marine crew on both types of vessel, and between the non-marine crew on both vessels, with similar results as might be expected. This therefore suggests that amongst the varied spectrum of vessel types, high speed craft do not necessarily warrant any isolated analysis.

7 JOB TYPE

In order to establish whether job type had any influence on levels of fatigue and performance in seafarers, officers' and ratings' reports of fatigue, exposure to fatigue related factors, health, work difficulties, and job stress were compared. All data were also further analysed using a marine crew vs. non-marine crew split (N.B marine crew were classified as trained seafarers, and non-marine as those with no formal seafaring qualifications).

7.1 General Findings

- Officers and ratings reported similar levels of fatigue and comparable health status.
- Whilst differences were found between marine and non-marine crew in terms of potential fatigue predictors (e.g. working hours), these differences appeared to have little impact in terms of reported levels of fatigue or related health status.

7.2 Results from the Survey

Within the survey a basic officers vs. ratings comparison was conducted (N.B The simplicity of this division necessitated certain non-explicit cases to be categorised into one group or another, e.g. stewards and bosuns were classified as ratings, and engineers as officers). Marine and non-marine crew were also distinguished.

Self-reported levels of fatigue
Officers and ratings reported similar levels of fatigue as shown in tables 42 and 43 below.

Table 42: General symptoms of fatigue (factored from 7 questions)

	General fatigue
Officers	Mean=1.44 (n=601 , S.E = 0.03)
Ratings	Mean=1.40 (n=119 , S.E = 0.08)

(1=Low fatigue, to 5=high fatigue)

Table 43: Fatigue after work(factored from 3 questions)

	Fatigue after work
Officers	Mean=2.49 (n=672 , S.E = 0.02)
Ratings	Mean=2.38 (n=144 , S.E = 0.05)

(1=Low fatigue, to 5=high fatigue)

This pattern of results remained the same when GHQ, age, education and socio-economic class were co-varied in the analysis. The marine and non-marine crew were also found to have comparable levels of fatigue, again co-varying for GHQ, age education and socio-economic class.

Levels of exposure to fatigue

Slight differences were evident in terms of officer and ratings exposure to fatigue risk factors (See tables 44-47), however it appears the slight exposure differences had little impact in terms of actual levels of reported fatigue, or related health status.

Table 44: What are your present average daily working hours?

	Officers (%)	**Ratings** (%)
<8 hrs	0.9	1.4
8-12 hrs	37.2	57.1
12-15 hrs	56.8	40.1
15-18 hrs	4.9	1.4
>18 hrs	0.3	---

Table 45: How many hours a day do you work on additional duties?

	Officers (%)	**Ratings** (%)
None	34.2	45.5
1-2 hrs	34.7	16.8
3-5 hrs	22.9	10.9
>5hrs	8.2	26.7

Table 46: General quality of sleep (factored from 5 questions)

	Quality of sleep
Officers	Mean=2.37 (n=643 , S.E = 0.02)
Ratings	Mean=2.27 (n=131 , S.E = 0.06)

(1=good quality sleep, to 5=poor quality sleep)

Table 47: What is the work / leave system onboard?

	Officers (%)	**Ratings** (%)
4 weeks on/ 4 off	3.8	3.4
2 week on/ 2 off	33.9	8.8
1 week on/ 1 off	18.3	10.2
Other	44.0	77.6

The pattern of results shown in tables 44 to 47 remained the same when GHQ, age, education and socio-economic class were co-varied in the analysis.

A number of differences were found between the marine and non-marine crew in terms of a range of potential fatigue predictors e.g. daily work hours, watch/duty schedules. These differences are hardly surprising, however, in view of the fact that marine and non-marine crew have quite distinct roles onboard a vessel. The significance of these differences lies solely in their impact upon the specific outcomes of interest, i.e. in terms of fatigue and health scores.

Health status

Officers and ratings showed similar results in terms of self-reported health status (See table 48). Table 49 again illustrates the comparable levels of fatigue found with officers and ratings.

Table 48: General health status

	Officers (Mean)	**Ratings** (Mean)
Physical functioning	**89.9** (n=669 , S.E = 0.47)	**89.8** (n=139 , S.E = 1.70)
Role-physical	**83.1** (n=672 , S.E = 1.11)	**82.8** (n=145 , S.E = 2.40)
Bodily pain	**74.7** (n=685 , S.E = 0.84)	**75.8** (n=148 , S.E = 2.12)
General health	**66.4** (n=669 , S.E = 0.70)	**69.1** (n=144 , S.E = 1.79)
Vitality	**59.0** (n=666 , S.E = 0.72)	**62.8** (n=147 , S.E = 1.81)
Social functioning	**81.7** (n=676 , S.E = 0.86)	**80.3** (n=145 , S.E = 2.04)
Role-emotional	**82.1** (n=674 , S.E = 1.22)	**79.3** (n=146 , S.E = 2.68)
Mental health	**73.0** (n=668 , S.E = 0.63)	**70.7** (n=145 , S.E = 1.69)

(lower scores represent poorer functioning)

Table 49: PFRS fatigue Scale

	Officers	**Ratings**
Profile of fatigue related symptoms (PFRS) fatigue scale	Mean=**28.89** (n=673 , S.E = 0.53)	Mean=**29.98** (n=143 , S.E = 1.25)

(a higher score represents higher levels of fatigue)

This pattern of results shown in tables 48 and 49 remained the same when GHQ, age, education and socio-economic class were co-varied in the analysis. The marine and non-marine crew were also found to have comparable health status, again co-varying for GHQ, age education and socio-economic class.

7.3 Conclusions

The comparison between officers and ratings suggests that the magnitude of the effect of job type may be marginal. A marine/non marine split did not yield any more significant findings. Covarying GHQ, education, socio-economic status and age did not change the results.

8 FATIGUE REGRESSION ANALYSIS

Regression analysis was conducted as a means of clarifying the relative importance of various factors already identified as useful in predicting fatigue. This allowed more precise interpretation of the findings, incorporating the fact that certain fatigue risk factors will be more predictive of fatigue than others. Regression analysis also highlights the inter-correlation of predictive variables, thus further facilitating the development of a more comprehensive picture of seafarers' fatigue.

The analyses detailed below focus specifically on the prediction of fatigue outcomes. For these analyses, fatigue is always assessed in terms of the four fatigue scales identified from the survey (General fatigue symptoms at sea; Fatigue at work; Fatigue after work; and the Profile of Fatigue Related Symptoms (PFRS) fatigue scale).The potential fatigue risk factors used to predict the four fatigue scales were also taken from the survey.

8.1 General Findings

- Variables relating to working hours, in particular 'Do you consider your working hours to ever present a danger to your personal health and safety?', had the most predictive power across the four main fatigue outcomes,.
- Job demands and job stress were frequently found to be useful in predicting fatigue, although these two concepts were not interchangeable.
- As would be expected sleep variables proved useful in predicting fatigue, although not to the same extent as working hours.
- Support at work, number of fatigue related incidents, age, vibration/motion, and physical environment issues were also found to be useful additional factors in predicting fatigue outcomes.

8.2 Specific Results

8.2.1 General symptoms of fatigue

Table 50 illustrates the order in which predictors were identified as useful in predicting the factor 'General symptoms of fatigue at sea'. Correlated variables are also shown. As table 50 shows, the variable identified as most predictive of general fatigue symptoms was 'Working hours which may present a personal health and safety danger'. Therefore as would be expected, there was found to be a relation between potentially dangerous working hours and reported levels of fatigue. The second most predictive variable selected was 'Job Demands'. As would be expected, high fatigue was related to pressure at work. Correlations were also found between this factor and seven other variables. Three of the correlated factors support a relationship between long working hours and job demands as might be expected (Hours worked per week, Hours worked per day, Longest continuous duty). There was also a correlation with the factors 'Physical environment issues', 'Disruptive working hours', 'Work insecurity' and 'Vibration and motion'. Therefore whilst job demands are useful in predicting fatigue, the actual construct and correlated attributes of job demands appear to be quite complex.

The third variable selected was 'Age'. The direction of the relationship suggests that older seafarers are slightly less fatigued than younger ones. Additionally, the correlation with 'Average time to fall asleep' suggests that older seafarers get to sleep quicker than younger ones.

The working hours / fatigue relationship was supported by the fourth variable selected in the analysis ('Working hours which may present a danger to ship operations').

The fifth variable to be selected as predictive was 'Length of stay onboard between leave'. This suggests longer stays onboard between leave are less fatiguing than shorter tours. This might be accounted for in terms of the adjustment associated with changing between work and leave. Shorter onboard stays inevitably involve more frequent work / leave adjustments. There was also found to be a correlation between 'Length of stay onboard between leave' and 'Nationality/Citizenship'. Non-UK citizens were generally found to work longer tours of duty.

The sixth variable selected was 'How stressful do you find your job?'. As would be expected, high job stress was found to be associated with high levels of fatigue.

A final variable that was not selected, but was nearly significant was 'Vessel Comparison' (p=0.053). This variable may also have potential use in accounting for differences in fatigue and its independence from the other variables suggests that the ship differences observed earlier do not merely reflect other factors such as differences in working hours or job demands.

Table 50: Stepwise regressions flow chart- General fatigue symptoms

Variable selection order (order of predictive power)	Variables identified as highly related to the selected variable (Pearson correlations shown)
(1) Working hours which may present a personal health and safety danger	
(2) Job Demands	- How many hours do you work each week? (r=.227, p<0.01) - How many hours do you work each day? (r=.283, p<0.01 - Longest period of continuous duty (r=.218, p<0.01) - Factor: Physical environment issues (r=.298, p<0.01) - Factor: Disruptive Working hours (r=.207, p<0.01) - Factor: Work Insecurity (r=.363, p<0.01) - Factor: Vibration and Motion (r=.304, p<0.01)
(3) Age	- Work/Leave schedule (n/s) - Average time to fall asleep (r=-.196, p<0.01)
(4) Working hours which may present a danger to ship operations	
(5) Length of stay on board between leave	- Nationality/Citizenship (r=.491, p<0.01) -Do you get the opportunity to get at least 6 hours uninterrupted sleep? (n/s)
(6) How stressful do you find your job?	
(7) Vessel Comparison (approaching significance p=0.053)	

8.2.2 Fatigue at work

Table 51 below illustrates the order in which predictors were identified as useful in predicting the factor 'Fatigue at work'. Correlated variables are also shown. Again the variable 'Working hours which may present a personal health and safety danger' was selected by the analysis as most useful, this time in terms of predicting fatigue at work.

The second variable selected as predictive was 'Do you get enough sleep?'. Therefore as would be expected, a higher level of fatigue was found to be associated with a shorter duration of sleep. 'Do you get enough sleep?' was also found to correlate with four other variables. The correlation with 'Age' shows that older seafarers generally get more sleep. The correlation with 'Working hours which may present a danger to ship operations' suggests that dangerous working hours are related to low amounts of sleep as would logically be expected.

Finally, correlations with 'Physical environment issues' and 'Vibration and Motion' suggest that dangerous working conditions, onboard vibration and ship motion all contribute towards low sleep duration.

The third variable to be selected as predictive was 'Length of stay onboard between leave'. This again showed that longer stays onboard between leave are less fatiguing than shorter stays onboard between leave. This variable was also found to correlate with 'vessel comparison', 'Work/leave schedule', 'Do your shifts start at different times of day/night?' and 'How many hours do you work each week?'. These four correlated variables are understandably related. Different tour lengths, work/leave schedules, and working hours are arguably all centrally related to the variable 'Vessel Comparison'.

The fourth variable to be selected as predictive was 'Disruptive working hours'. As would be expected, disruptive working hours were found to be associated with high levels of fatigue.

The fifth variable to be selected was 'How stressful do you find your job?'. Unsurprisingly this was found to be correlated with job demands. High stress / job demand was associated with high fatigue as would be expected.

The final variable to be selected was 'Hours spent on additional duties'. A slight association was found between high fatigue and a low number of hours spent on additional duties. This may reflect an effect of fatigue on the willingness to do extra work.

Table 51: Stepwise regressions flow chart- Fatigue at work

Variable selection order (order of predictive power)		**Variables identified as highly related to the selected variable (Pearson correlations shown)**
(1)	Working hours which may present a personal health and safety danger	
(2)	Do you get enough sleep?	-Age (r=.100, p<0.01) -Working hours which may present a danger to ship operations (r=-3.57, p<0.01) -Factor: Physical environment issues (r=-.209, p<0.01) -Factor: Vibration and motion (r=-.211, p<0.01)
(3)	Length of stay onboard between leave	-Vessel Comparison (r=.398, p<0.01) - Work/Leave schedule (r=.448, p<0.01) -Do your shifts start at different times of day/night? (r=.106, p<0.01) -How many hours do you work each week? (r=-.131, p<0.01)
(4)	Disruptive work hours	
(5)	How stressful do you find your job?	-Factor: Job demands (r=.399, p<0.01)
(6)	Hours spent on additional duties	

8.2.3 Fatigue after work

Table 52 illustrates the order in which predictors were identified as useful in predicting the factor 'Fatigue after work'. Correlated variables are also shown.

Table 52: Stepwise regressions flow chart- Fatigue after work

Variable selection order (order of predictive power)	Variables identified as highly related to the selected variable (Pearson correlations shown)
(1) Job demands	
(2) Working hours which may present a personal health and safety danger	-Working hours which may present a danger to ship operations (r=.660, p<0.01) - Number of awakenings during sleep period (r=.192, p<0.01)
(3) Length of stay onboard between leave	- Work/Leave schedule (r=.448, p<0.01) - Hours spent on additional duties (r=.197, p<0.01) - How many hours do you work each day? (r=-.183, p<0.01) - How many hours do you work each week? (r=-.131, p<0.01)
(4) How stressful do you find your job?	
(5) Vessel Comparison	

The variable found to be most predictive of fatigue after work was job demands. As would be expected, higher job demand was associated with higher levels of fatigue.

The second variable to be selected was 'Working hours which may present a personal health and safety danger'. As previously found, a relationship was identified between potentially dangerous working hours and high levels of fatigue. A correlation was again also found between 'Working hours which may present a personal health and safety danger' and 'Working hours which may present a danger to ship operations', confirming earlier results.

Interestingly a correlation was also found between 'Working hours which may present a personal health and safety danger' and 'Number of awakenings during sleep period'. Those who work potentially dangerous working hours are likely to wake up a greater number of times during a typical sleep period.

The third variable to be selected was 'Length of stay onboard between leave'. This again suggests longer stays onboard between leave are less fatiguing than shorter stays onboard between leave. This variable was also found to correlate with 'Work/leave schedule', 'Hours spent on additional duties', 'How many hours do you work each week?' and 'How many hours do you work each day?' These four correlated variables are obviously related. Different tour lengths will be associated with different working hour patterns and shift systems. For example, on a fast ferry with no cabins a split shift will not be not feasible because the crew will have nowhere to retreat during down-time. On a tanker, however, a more varied and flexible shift system suits the nature of the work. These two types of vessel are also naturally associated with different lengths of tour which demonstrates how inter-related many of the critical variables are.

The fourth variable to be selected was 'How stressful do you find your job?'. As expected, high job stress was related to a high level of fatigue. Interestingly this variable was selected as significant separate from the related variable job demands. This, therefore, suggests that the concepts of 'job demand' and 'stress' are not entirely interchangeable.

The final variable to be selected was 'Vessel Comparison'. Reported fatigue was also associated with vessel type, with higher levels of fatigue being reported on the passenger carrying craft compared to tankers/dredgers/other type vessels.

8.2.4 The PFRS fatigue scale

Table 53 shows the order in which predictors were identified as useful in predicting the PFRS fatigue score. Correlated variables are also shown.

Table 53: Stepwise regressions flow chart- PFRS Fatigue scale

Variable selection order (order of predictive power)	**Variables identified as highly related to the selected variable (Pearson correlations shown)**
(1) Working hours which may present a personal health and safety danger	
(2) Vessel Comparison	- Work/Leave schedule (r=.283, p<0.01) - How many hours do you work each week? (n/s) - Length of stay onboard between leave (r=.398, p<0.01) - Factor: Work insecurity (r=-.161, p<0.01) - Factor: Support at work (r=-.093, p<0.01)
(3) Average time to fall asleep	- Age (-.196, p<0.01)
(4) Job demands	- How many hours do you work each day? (r=.283, p<0.01) - Number of fatigue related incidents (r=.194, p<0.01) - Do you get enough sleep? (r=-.277, p<0.01) - How stressful do you find your job? (r=.399, p<0.01 - Factor: Vibration and Motion (r=.304, p<0.01)
(5) Length of stay onboard between leave	
(6) How stressful do you find your job?	
(7) Age	

As with the other fatigue measures, the variable 'Working hours which may present a personal health and safety danger' was found to be the best predictor of the PFRS fatigue scores.

The second variable to be selected was 'Vessel comparison' suggesting again that vessel type may be important when evaluating seafaring fatigue. Vessel type was correlated with the variables 'Length of stay onboard between leave', 'Work/leave schedule' and 'How many hours do you work each week?' as would be expected- different vessels have quite different working schedules. There were also correlations between vessel type and the 'support at work' and 'work insecurity'. No conclusive pattern of results can be drawn from the 'support at work' correlation, however the correlation with 'work insecurity' is quite interesting. Those on the passenger carrying craft (passenger ferries, high-speed ferries and freight ferries) reported significantly higher job insecurity than those on tanker/dredger/other vessels (as shown by an independent samples t-test (t=6.64, p<0.01). This suggests a further dimension that could potentially be considered when examining differences between ships, although job insecurity is almost certainly linked to the market conditions present at the time of the survey.

The third variable was 'Average time to fall asleep'. As would be expected, taking longer to fall asleep was found to be associated with higher levels of fatigue. This variable was correlated with 'Age'. This suggests that older seafarers get to sleep quicker than younger ones which may reflect habituation to sleeping at sea.

The fourth variable was job demands. As would be expected, high fatigue was related to high job demands at work. Five other variables were found to be correlated with job demand: 'How many hours do you work each day?', 'Number of fatigue related incidents', 'Do you get enough sleep?', 'How stressful do you find your job?' and 'Vibration and Motion'. These

correlations are understandable and further suggest that job demand in itself is a multi-dimensional construct.
The fifth variable to be selected was 'Length of stay onboard between leave', again showing longer stays onboard to be less fatiguing than shorter stays onboard between leave.
The sixth variable to be selected as predictive was 'How stressful do you find your job?'. High job stress was again found to be associated with high levels of fatigue as would be expected.
The final variable to be selected as predictive was 'Age'. The direction of the relationship again suggests that older seafarers are slightly less fatigued than younger ones

8.2.5 Additional predictors

Subsequent to the regression analyses three more variables were identified as especially useful in terms of predicting fatigue, as detailed below.

1. Do you stand watch? Yes/No

Those respondents who reported standing watch were found to be significantly more fatigued than those who reported being watch-free as might be expected (general symptoms of fatigue scale, p=0.01). This result remained when co-varying for GHQ, age, education and socio-economic class.

2. Whilst at sea do you increase your use of caffeine?

Those respondents who reported increasing their use of caffeine were found to be significantly more fatigued than those who did not report an increase whilst at sea. This result was found to be significant across all four fatigue scales, co-varying for GHQ, age, education and socio-economic class. Therefore whilst caffeine is used as a means of alleviating fatigue symptoms, the actual act of increasing caffeine consumption conversely appears as symptomatic of fatigue. This result was found to be very reliable, with a dose response across the five points on the scale employed, as shown in table 54 below (means shown are adjusted for covariates).

Table 54: Fatigue level by increased use of caffeine

Question: To what extent do you increase your use of caffeine whilst at sea? (1=very to 5=not at all).

	1	2	3	4	5
General Fatigue symptoms (Mean)	1.74 (n=134 , S.E.= 0.06)	1.59 (n=140, S.E.= 0.06)	1.35 (n=111, S.E.= 0.06)	1.35 (n=108, S.E.= 0.06)	1.20 (n=221, S.E.= 0.05)
Fatigue at work (Mean)	3.95 (n=143, S.E.= 0.07)	3.90 (n=141, S.E.= 0.07)	3.72 (n=114, S.E.= 0.08)	3.69 (n=111, S.E.= 0.08)	3.66 (n=220, S.E.= 0.06)
Fatigue after work (Mean)	2.65 (n=144, S.E.= 0.05)	2.54 (n=144, S.E.= 0.05)	2.40 (n=114, S.E.= 0.05)	2.41 (n=109, S.E.= 0.05)	2.38 (n=219, S.E.= 0.04)
PFRS fatigue scale (Mean)	34.69 (n=146, S.E.= 1.02)	30.02 (n=146, S.E.= 1.00)	28.55 (n=112, S.E.= 1.15)	28.41 (n=108, S.E.= 1.18)	26.87 (n=223, S.E.= 0.83)

(Higher scores indicate higher levels of fatigue)

3. In the past five to ten years have your working hours increased, decreased or remained the same?

Those respondents who reported their working hours increasing over the past five to ten years were found to be significantly more fatigued than those who reported their working hours decreasing or staying the same. Those who reported their working hours decreasing were found to be the least fatigued as might be expected. This result was found to be very reliable across the four fatigue scales, co-varying for GHQ, age, education and socio-economic class (see table 55 below. NB. means adjusted for covariate effects).

Table 55: Fatigue level by work hours increase over five to ten years

Question: In the past five to ten years have your working hours increased, decreased or remained the same?

	Decreased	Remained the same	Increased
General Fatigue symptoms (Mean)	1.22 (n=66, S.E.= 0.09)	1.23 (n=232, S.E.= 0.05)	1.54 (n=413, S.E.= 0.03)
Fatigue at work (Mean)	3.47 (n=74, S.E.= 0.10)	3.62 (n=255, S.E.= 0.05)	3.89 (n=471, S.E.= 0.04)
Fatigue after work (Mean)	2.33 (n=74, S.E.= 0.06)	2.37 (n=257, S.E.= 0.04)	2.55 (n=472, S.E.= 0.03)
PFRS fatigue scale (Mean)	27.52 (n=74, S.E.= 1.40)	28.03 (n=258, S.E.= 0.75)	30.44 (n=478, S.E.= 0.55)

(Higher scores indicate higher levels of fatigue)

These additional predictor variables highlight how certain factors can be of relatively more use than others in terms of understanding fatigue outcomes. In terms of practical application to the workplace, therefore, a framework incorporating differential risk weightings would appear most appropriate.

8.3 Age or length of service accountable for trends observed in older seafarers ?

There is some evidence throughout this report that older seafarers are less fatigued and exhibit fewer fatigue related symptoms than younger ones. This general pattern of better coping among older seafarers requires explanation – is it due to age, or the fact that older seafarers are more experienced in and used to life at sea? It was found that Age and Years at Sea are, as would be expected, highly correlated (0.77, $p<0.001$), and so it is difficult to disentangle their effects. Partial correlations to determine their independent effects indicate that their effects are too highly correlated to address separately. Both Age and Years at Sea were entered in a regression as predictors for variables correlating with both.

8.3.1 Age

Age is a better predictor of:
- Time required to adjust to life onboard ship after a period of leave
- Fatigue at work,

Older seafarers take less time to adjust to life onboard and are less tired at work. This may indicate that older seafarers are less susceptible to errors and accidents, since they show fewer adjustment effects and score lower on job fatigue.

8.3.2 Years at sea

Years at sea is a better predictor of:
- Do your working hours present a danger to the safe operation of the ship?
- Usual stay onboard between leave

Seafarers with longer service records are less likely to consider their working hours present a danger to safe operation of ship and have shorter stays onboard. As such it seems that they perceive their working hours as less detrimental for safety.
We can see from the above that the independent effects of each are not significantly large or disparate. Although these variables may be seen to have slightly different levels of impact on other, correlated variables, they are so intertwined and highly correlated as to be almost interchangeable, and as such the relative importance of each independently of the other is minimal within this dataset. In addition, it is important not only to consider age and experience but to evaluate these in the context of the marital-family cycle (e.g. younger seafarers may be more affected by marital-family influences).

8.4 Conclusions

Questions addressing working hours proved to be the most useful in predicting fatigue across the four scales. In particular one question proved especially predictive: 'Do you consider your working hours to ever present a danger to your personal health and safety?'. The results also showed that work / leave schedules need to be addressed when looking at seafarers fatigue. These two areas are closely tied to the more global comparison of ship type. Ships differ in terms of self-reported fatigue, which in turn reflects specific factors that actually define the various ships at the operational level.
Job demands and job stress were frequently found to be useful in predicting fatigue, however evidence was found that these two concepts are not interchangeable. Additionally, job demand was found to be a complex construct with multiple correlates. As would be expected sleep variables proved to be useful in predicting fatigue, although not at the same level as working hours. Other areas to be considered are support at work, number of fatigue related incidents, age, vibration/motion, and physical environment issues. These could be useful as additional factors when attempting to predict fatigue at sea. Similarly, standing watch, increased use of caffeine at sea, and changes in working hours must be considered. Finally, it should be noted that the effects of all of these variables have been considered in analyses that have adjusted for demographic factors and negative affectivity. This sophisticated approach is sadly lacking in research on fatigue and has certainly never been previously applied to the issue of seafarers' fatigue.

9 ACCIDENTS AND INJURIES

The relationship between fatigue and accidents/injuries was assessed using data from the survey.

9.1 Accident Prevalence

The first area of interest concerned basic accident prevalence rates. In order to assess accident levels one specific question was identified as useful;

'Have you had any accident, injury or poisoning, needing hospital treatment or a visit to casualty in the past 3 months? Yes □ No □

From the survey sample 5.9% (n=54) of respondents reported having an accident requiring hospital treatment in the past 3 months. Further details concerning the nature of the accidents reported are shown in tables 56 and 57.

Table 56: Type of injury

Type of injury	% of accident reporting respondents
Break or fracture	24.1 (n=14)
Poisoning	5.2 (n=3)
Head injury	3.4 (n=2)
Cut or puncture	12.1 (n=7)
Burn	3.4 (n=2)
Other	51.7 (n=30)

Table 57: Place accident occurred

Place	% of accident reporting respondents
In the home	38.5 (n=20)
In traffic	3.8 (n=2)
At work (in port)	28.8 (n=15)
At work (at sea)	19.2 (n=10)
Somewhere else	9.6 (n=5)

Tables 56 and 57 above provide a tentative indication of accident circumstances, however conclusions are extremely limited due to analysis within a small sub-sample of respondents. In order to draw any valid conclusions a specific sample of accident-involved individuals would have to be enlisted. This would enable a more in-depth analysis of circumstances specifically conducive to an accident at sea.

9.2 Accidents and Fatigue

The next area considered was whether self-reports of fatigue are related to accident likelihood. In order to assess the impact of fatigue on accident likelihood, respondents were divided into two groups on the basis of their response to the specific question detailed above. Levels of fatigue in those who reported being involved in an accident in the past 3 months were therefore compared to those who were not involved in an accident. Comparisons were again made across the four fatigue scales previously discussed: General fatigue symptoms, Fatigue at work, Fatigue after work and the PFRS Fatigue scale.

Table 58 shows fatigue scores for the accident and non-accident involved groups.

Table 58: Fatigue levels (mean) by accidents

Fatigue scale	Accident	Non-accident
General fatigue symptoms	1.59 (n=41, S.E=0.13)	1.41 (n=731, S.E=0.03)
Fatigue at work	3.82 (n=52, S.E=0.14)	3.74 (n=827, S.E=0.03)
Fatigue after work	2.56 (n=52, S.E=0.07)	2.46 (n=832, S.E=0.02)
PFRS Fatigue scale	30.04 (n=53, S.E=1.93)	29.12 (n=832, S.E=0.49)

(High score= High fatigue)

As table 58 above shows, the accident group consistently reported higher levels of fatigue. Whilst none of the accident/non-accident fatigue differences were found to reach significance, the pattern of results nevertheless supports a possible link between fatigue and accident likelihood. This pattern of results, however, overlooks the important distinction between accidents at home and the work place. The fatigue scales focus upon time at sea and therefore arguably only analysis of accidents at work is warranted, and indeed relevant to the general line of investigation. Table 59 therefore shows fatigue levels specifically for those respondents who reported involvement in a work related accident.

Table 59: Fatigue levels (mean) by accident at work

Fatigue scale	Work accident	No accident
General fatigue symptoms	1.53 (n=21, S.E=0.17)	1.41 (n=728, S.E=0.03)
Fatigue at work	3.68 (n=25, S.E=0.19)	3.74 (n=824, S.E=0.03)
Fatigue after work	2.47(n=25, S.E=0.11)	2.46 (n=829, S.E=0.02)
PFRS Fatigue scale	28.96 (n=25, S.E=2.76)	29.09 (n=829, S.E=0.49)

(High score= High fatigue)

As table 59 shows, the picture that emerges from those involved solely in work-based accidents is less consistent than when work and home-based accidents are considered as one. Certainly conclusions are extremely limited when the sample of accident involved respondents is reduced down to only those involved in work-based incidents, however no consistent trend emerges. Most noticeably those involved in accidents at work did not generally report higher levels of fatigue than the non-accident involved group. Beyond this tentative observation, the only other conclusion is that work based accidents rates are very rare.

9.3 Accidents and Fatigue Predictors

The next area to consider was whether factors potentially predictive of fatigue are associated with accidents. This analysis was conducted in order to understand how fatigue predictors, fatigue and accident likelihood are inter-related. In order to test the link between potential fatigue predictors and accident likelihood a series of logistic regression analyses were conducted.

A series of potential fatigue predictors (listed below) were used in the analyses:
Officer ratings split.
Industrial vs. passenger type vessels.
What is the work/leave system onboard?
On a typical day, what is your watch/duty schedule?
Do your shifts begin at different times of the day/night?
Average daily working hours.
Average hours worked per week.
Do you have the opportunity to gain 10hrs rest in every 24hr period?
Do you regularly have the opportunity to gain at least 6hrs uninterrupted sleep?

Typically, what is your longest period of continuous duty?
Do your working hours ever present a danger to your personal health and safety?
Do your working hours ever present a danger to the ships operations?
How long is your usual stay onboard between leave?
In a typical 24hr period, how many sleep periods do you have?
How much sleep do you feel you get?
How long on average does it take you to get to sleep?
How many times do you wake during a typical sleep period?
Can you screen light out in your cabin?
How stressful do you find your job?
Job Demands.
Physical environment issues.
Disruptive working hours.
Work insecurity.
Vibration and Motion.
Support at work.
General quality of sleep.

Only one variable was found to be significantly predictive of accidents at work, which is perhaps unsurprising in view of the low accident-at-work prevalence rate. The factor 'Physical environment issues' (p=.031) represents exposure to breathing fumes, handling harmful substances and high levels of noise. Those respondents who reported high exposure to negative environmental based factors were found to be at a higher risk of having an accident at work as might be expected. In support of this view, those who reported having an accident *outside* work in the past three months were found to have the same level of exposure to environmental based factors as the non-accident involved group, as shown in table 60.

Table 60: Level of exposure to environmental factors by accident involvement

Involved in an accident?	Level of exposure to negative environmental factors
No	2.44 (n=834, S.E.=0.03)
Yes, outside work	2.41 (n=32, S.E. =0.15)
Yes, within work	2.56 (n=25, S.E. =0.15)

(High score=High exposure to negative factors)

As table 60 shows, those respondents who reported having an accident in work were more likely to have a high level of exposure to negative environmental based factors. This result therefore supports an approach involving the direct use of potential fatigue predicting factors in helping to predict accident likelihood, rather than necessarily using intermediary fatigue measures. The association between the physical working environment and accidents is not unique to seafarers but has been observed in large scale studies of onshore workers (e.g. the Bristol Stress and Health at Work study – Smith et al., 2000). However, it is often the physical environment in combination with other job characteristics that produces the greatest risk. The next section uses this combined effects approach to address issues that have already been examined in univariate analyses.

10 COMBINED EFFECTS

In phase 1 of the project a combined effects approach was introduced. Rather than focusing upon the predictive power of individual factors, the combined effects approach stipulates that multiple factors must be considered in terms of their summed effect on an individual. This approach proved extremely useful within phase 1 and the same technique was extended to the phase 2 data.

In phase 1 potentially important stressors were identified from questions within the survey questionnaire:

Number of working hours per week; shift schedule; night work; unsociable hours; breathing fumes/harmful substances; touching/handling harmful substances; ringing in the ears; background noise; vibration; motion sickness; time pressures; work disturbances; work responsibility; overtime pressure; work changes; promotion prospects; job security; & treatment at work.

Median splits were conducted on each variable. Therefore on each stressor subjects scored either 1 (high exposure to stressor) or 0 (low exposure to stressor). The median split scores were then summed to create a 'total negative factors score' for each individual. A quartile split was then conducted on this composite variable, producing four separate groups ranging from very high to very low risk in terms of the summed number of stressors identified. The phase 1 analysis detailed thus far was therefore replicated exactly in phase 2.

10.1 General Findings

- Fatigue and health outcomes were more accurately predicted by calculating the combined effect of a number of potential fatigue related factors. This confirms findings from phase 1 and emphasises the importance of the combined effects approach in understanding seafaring fatigue

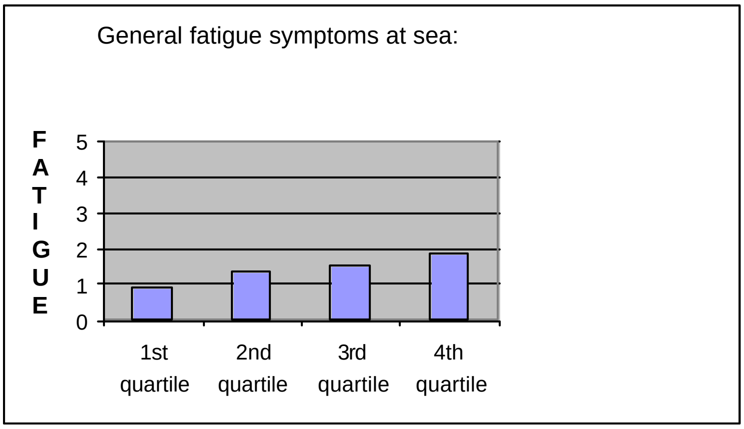
10.2 Combined Effects as Predictive of Fatigue Measures

The four quartile groups were compared in terms of the four measures of self-reported fatigue:

1. General Fatigue

The four quartile groups were compared in terms of general fatigue using an ANCOVA , co-varying for age, education and socio-economic status. The quartile groups were found to be significantly different in terms of this fatigue variable ($p<0.01$), as shown in figure 1 .

Figure 1: Combined effects quartile groups compared on general fatigue

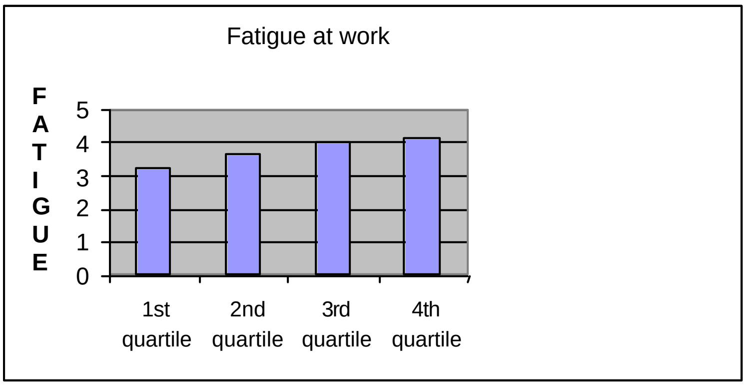


(a high score represents high fatigue)

2. Fatigue at work

The four quartile groups were compared in terms of fatigue at work using an ANCOVA, co-varying for age, education and socio-economic status. The quartile groups were found to be significantly different in terms of this fatigue variable ($p<0.01$), as shown in figure 2.

Figure 2: Combined effects quartile groups compared on fatigue at work

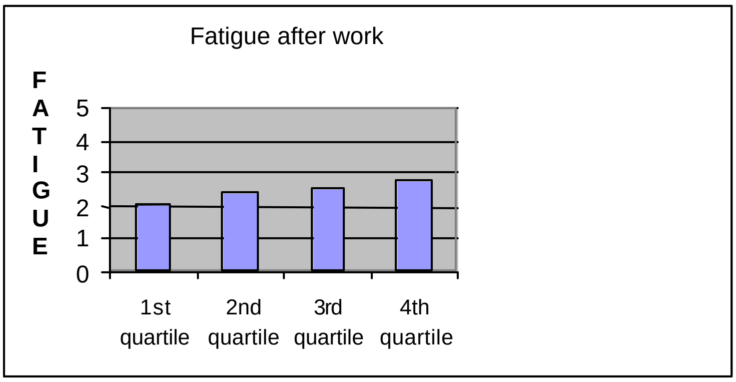


(a high score represents high fatigue)

3. Fatigue after work

The four quartile groups were compared in terms of fatigue after work using an ANCOVA, co-varying for age, education and socio-economic status. The quartile groups were found to be significantly different in terms of this fatigue variable ($p<0.01$), as shown in figure 3.

Figure 3: Combined effects quartile groups compared on fatigue after work

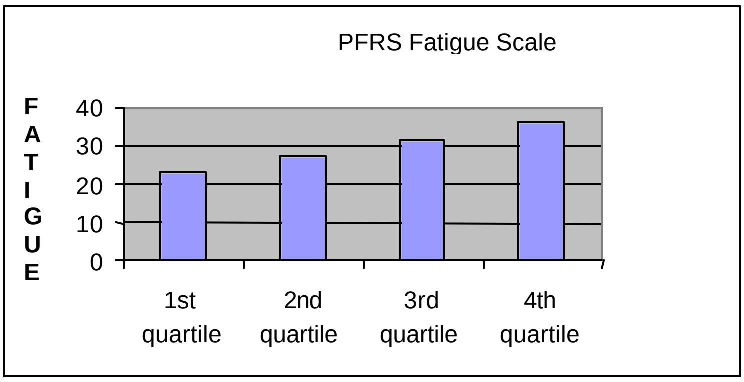


(a high score represents high fatigue)

4. PFRS Fatigue scale

The four quartile groups were compared in terms of the PFRS fatigue scale using an ANCOVA , co-varying for age, education and socio-economic status. The quartile groups were found to be significantly different in terms of this fatigue variable ($p<0.01$), as shown in figure 4.

Figure 4: Combined effects quartile groups compared on PFRS Fatigue scale



(a high score represents high fatigue)

All of the above effects remained when GHQ was co-varied.

10.3 Combined Effects as Predictive of Health

Whilst a direct link has been identified between fatigue predictors and self-reported levels of fatigue, the issue of negative health outcomes has not been explored. By-passing the intuitive mediating position of fatigue, can the combined effects approach directly predict actual health outcomes?

General Conclusion

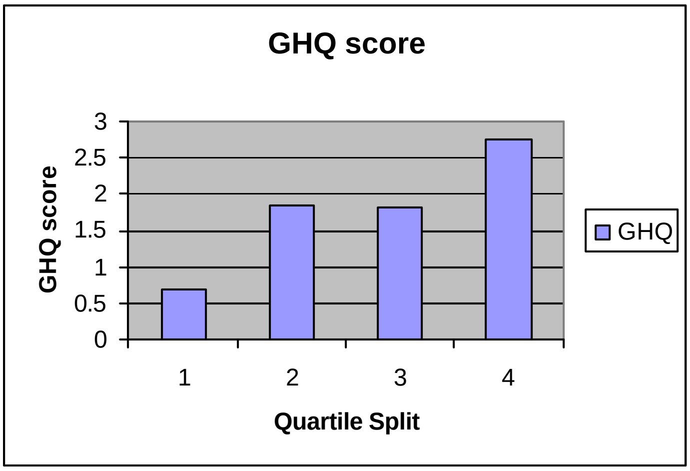
The quartile groups differed significantly on all health measures (9 comparisons $p<0.0001$, 1 comparison $p<0.01$), thus the combined effect of potentially negative factors proved extremely useful in predicting health.

Two examples are given below to illustrate the general trend. The first is the 'General Health Questionnaire' (GHQ) and the second is the 'General Health scale', a subscale of the Short Form Health Survey (SF-36).

General Health Questionnaire (GHQ)

The four quartile groups were compared in terms of scores on the General Health Questionnaire using an ANCOVA , co-varying for age, education and socio-economic status. The quartile groups were found to be significantly different in terms of this health variable ($p<0.01$), as shown in Figure 5.

Figure 5: General Health Questionnaire (GHQ) score by quartile split

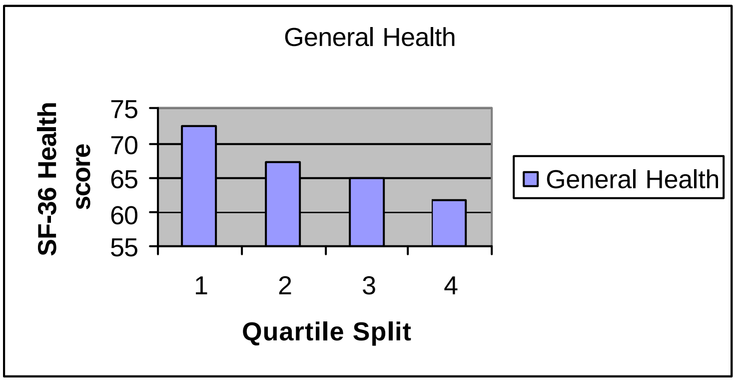


(A high GHQ score indicates poorer mental health)

Short-Form Health Questionnaire: General Health Score

The four quartile groups were compared in terms of scores on the general health score from the Short-Form Health Questionnaire using an ANCOVA, co-varying for age, education and socio-economic status. The quartile groups were found to be significantly different in terms of this health variable ($p<0.01$), as shown in Figure 6.

Figure 6: Short-Form Health Questionnaire (SF-36) General health score by quartile split



(A low score indicates poorer health)

The pattern of results remained the same when GHQ was co-varied in the analysis.

10.4 Conclusions

We have seen from the analyses run on the survey that using a combined effects approach it is possible to directly predict both fatigue and health outcomes using a set of stressor variables derived from the survey as in phase one. This analysis highlights the usefulness of a combined effects approach, emphasising that health and fatigue factors may be more usefully evaluated in terms of the sum of the factors influencing them, represented in this model by the variable of total negative combined effects score. Thus, the data from this phase supports interpretation of the health and fatigue data in terms of a total negative score on combined effects.

11 RELATIVE PREDICTIVE VALUE OF SUBJECTIVE PERCEPTIONS VERSUS OBJECTIVE WORKLOAD ON FATIGUE

In order to address this issue, variables measuring objective and subjective job demand were entered into a regression analyses of the four primary fatigue scales to assess their relative predictive value. These variables were:

Objective	Subjective
Hours on additional duties	Working hours present a danger to self
Contract hours per day	Working hours present a danger to operations
Daily hours	Job demands
Weekly hours	
6 hours sleep	
Longest duty (hrs)	
Working hours	
Time between leave	

11.1 General Fatigue Symptoms at Sea

General fatigue at sea, seems to be best predicted by perception of working hours and the actual average working hours:

- Do you consider your working hours to ever present a danger to your personal health and safety ($p < 0.001$)
- How many hours on average work per day ($p=0.040$)

11.2 Fatigue at Work

Fatigue at work follows a similar pattern, primarily predicted by subjective perceptions of working hours, but also by actual average working hours:

- Do you consider your working hours to ever present a danger to your personal health and safety ($P < 0.005$)
- How many hours on average do you work each day ($p=0.004$)
- How many hours on average do you work each week ($p=0.035$)

11.3 Fatigue after Work

It seems that the best predictor of fatigue after work is the composite variable job demand, composed of the following items: I have constant time pressure due to heavy workload; I have many interruptions and disturbances in my job; I have a lot of responsibility in my job; I am often under pressure to work overtime. Thus it seems that while during work fatigue is best predicted by working hours, post work fatigue is best predicted by perceived job demands ($p < 0.001$)

11.4 Conclusions

It is apparent that subjective perceptions predict fatigue better than objective job demand. It is worth noting that the fatigue scales used here are based on subjective self reports. As such it is perhaps unsurprising that self-reported job demands should predict self report fatigue better than objective indicators.

12 BENCH-MARKING: THE RELATIVE BENEFITS OF POSITIVE CHANGES TO IDENTIFIED FATIGUE RISK VARIABLES

While the earlier analyses suggested that it the combined effects of different factors that is crucial, it is clearly not the case that all variables have an equal impact. Analyses were conducted in order to assess which factors it would be most beneficial to control in order to decrease the incidence of fatigue among seafarers.

<u>Predictor variables</u>
Age;
Working hours present a danger to safe operations of ship;
Working hours present a danger to self;
Job demands;
How stressful is work;
Usual stay on board between leave
Hours additional duties;
How much sleep on average
Disruptive working hours;
Length of time taken to fall asleep

<u>Outcome variables</u>
General fatigue symptoms at sea
Fatigue at work
Fatigue after work
PFRS Fatigue Scale

Each of the outcome variables was dichotomised by median split, into high and low categories. Logistic regression was then used to determine which variables contributed to which types of fatigue issues, and to what extent. This information was obtained from the odds ratio. The odds ratio is a way of comparing whether the probability of a certain event is the same for two groups. If the odds ratio is one, the issue is equally likely in both groups, if greater than one it is more likely in the high fatigue group and if less than one it is less likely in the high fatigue group.

12.1 General Fatigue

In order to minimise general fatigue those variables that are most important to control are *job demands and stress, and working hours perceived as dangerous.* Table 61 shows that those who perceive their working hours to present a danger to themselves (Dangself) or the safe operation of the ship (Dangoper), and those experiencing high job demands (Jobdeman) and stress (Jobstres) are likely to be in the high fatigue group, while those who are older are likely to be in the low fatigue group. Variables not included in the model due to lack of effect are:
'hours of additional duty'; 'how long is your usual stay onboard between leave? '; 'how much do you sleep?; 'are your working hours disruptive?'; and 'how long does it take you to get to sleep?'. As such these are not the key variables to address in terms of general fatigue

Table 61: Variables predicting general fatigue at sea

	Variable	Odds Ratio	95% C.I.	Significance
1	Dangoper	4.227	2.487-7.184	.000
2	Dangself	2.252	1.339-3.786	.002
3	Jobdeman	2.060	1.515-2.802	.000
4	Jobstres	1.433	1.116-1.840	.005
5	Age	0.958	0.937-0.979	.000

12.2 Fatigue at Work

Variables most important in terms of levels of fatigue at work are again those relating to job demands and working hours perceived as dangerous (see Table 62). Results indicate that again those who perceive their working hours to present a danger to themselves or the safe operation of the ship, and those experiencing high job demands (though not job stress, see below) are likely to be in the high fatigue group, while those who sleep more are likely to be in the low fatigue group.

Table 62: Predictors of fatigue at work

	Variable	Odds Ratio	95% C.I.	Significance
1	Dangself	2.618	1.550-4.421	.000
2	Dangoper	1.641	1.001-2.688	.049
3	Jobdeman	1.477	1.132-1.926	.004
4	HMSleep	0.406	0.300-0.549	.000

Variables not included in the model due to lack of effect are:
'age'; 'hours of additional duty '; 'how long is your usual stay onboard between leave';'are your working hours disruptive '; 'is your job stressful' and 'how long does it take you to get to sleep'.

12.3 Fatigue after Work

Table 63 again shows that job stress or job demand and the perception that their working hours present a danger to themselves (though not to the safe operation of the ship, see below) places seafarers in the high fatigue group and thus these are the key variables related to post-work fatigue. Once more those who sleep more are likely to be in the low fatigue group.

Table 63: Fatigue after work

	Variable	Odds Ratio	95% C.I.	Significance
1	Jobdeman	2.917	2.029-4.194	.000
2	Dangself	2.712	1.579-4.659	.000
3	Jobstress	1.814	1.370-2.403	.000
4	Longstay	0.991	0.982-1.001	.070
5	HMSleep	0.652	0..445-0.955	.028

Variables not included in the model due to lack of effect are:
'age'; 'hours of additional duty'; 'do you consider your working hours to present a danger to the safe operation of the ship'; 'are your working hours disruptive'; and 'how long does it take you to get to sleep'

12.4 Profile of Fatigue Related Symptoms

It is clear from table 64 that those who perceive their working hours to present a danger to themselves, experience high job demands and stress and take longer to fall asleep are likely to be in the high fatigue group. Those who sleep more are again likely to be in the low fatigue group.

Table 64: Profile of fatigue related symptoms

	Variable	Odds Ratio	95% C.I.	Significance
1	Dangself	2.917	1.384-3.208	.001
3	Jobstress	1.814	1.206-1.871	.000
4	Jobdeman	0.991	1.072-1.827	.013
5	Longslep	0.927	1.004-1.020	.003
6	Longstay	0.652	0.985-1.000	.065
7	HMSleep	0.608	0.452-0.817	.001
8	Age	0.423	0.963-1.001	.058

Variables not included in the model due to lack of effect are:
'hours of additional duty '; 'do your working hours present a danger to the safe operation of the ship'; and 'are your working hours disruptive'

12.5 Conclusions

In order to reduce fatigue among seafarers it would be most beneficial to focus on controlling to optimum levels working hours which are perceived to present a danger to themselves/the ship, as well as job demands and stress, since these appear to have an impact across different types and manifestations of fatigue.

13 THE INTERACTIVE IMPACT OF SLEEP AND WORK HOURS ON PHYSICAL FUNCTIONING

The individual effects of sleep and work hours on physical functioning have been documented in the regressions. However it may be important to analyse their combined impact, in order to assess whether they have an interactive effect on seafarers' physical well-being and level of functioning.

13.1 Variable used in statistical modelling

Physical functioning was assessed by the survey using the SF 36 Health Survey (Ware, Snow, Kosinski & Gandek, 1993) which measures generic health concepts. It provides a profile of standardised scale scores, two of which are relevant here:

PF - physical functioning:
Examines the extent to which health limits physical activities such as self-care, walking, climbing stairs, bending, lifting and moderate and vigorous exercises
RP - role physical functioning:
The extent to which physical health interferes with work or other daily activities, including accomplishing less than wanted, limitations in the kind of activities or difficulty in performing activities.

Work hours and sleep were also assessed using the survey, by those variables listed.
Work Hours
How many hours a day do you work on additional duties?
What hours of work are required by your contract per day?
What hours of work are required by your contract per week?
What are your present average daily working hours?
How many hours, on average, do you work each week?
Typically, what is your longest period of continuous duty?
Do you consider your working hours to ever present a danger to your personal health and safety?
Do you consider your working hours to ever present a danger to the safe operations onboard your ship?

Sleep
How much sleep do you feel you get?
What is your ideal sleep length?
On average, how long does it take you to get to sleep?
Quality of sleep (Factored from following variables
- Have difficulty in falling asleep
- Have difficulty in staying asleep
- Wake up during sleep
- Have restless or disturbed sleep
- How much does noise disturb your sleep?)

13.2 Sleep and Work Hours on SF-36 Physical Functioning

All variables were dichotomised in order to conduct the analysis. Each working hours variable was then put into an ANCOVA analysis with each of the sleep variables individually in order to identify the interactive effect upon physical functioning. Age, education, socio-economic class and GHQ were co-varied in all analyses.
Only one interaction was found to be significant in terms of explaining differences in physical functioning, as shown in table 65 below (p=0.002).

Table 65: Interactive effect of ideal sleep length and longest duty on physical functioning

Longest period of continuous duty	What is your ideal sleep length?	Physical functioning score (mean)
<13 hrs	<8 hrs	89.61 (n=285, S.E= 0.73)
	8+ hrs	90.66 (n=255, S.E= 0.80)
13 hrs +	<8 hrs	91.98 (n=121, S.E= 1.12)
	8+ hrs	87.30 (n=134, S.E= 1.06)

(a low physical functioning score indicates poorer health)

As table 65 above shows, a marginal interactive effect was shown between ideal sleep length and longest period of continuous duty. The table shows that potentially longer shifts of work are only a health issue when coupled with the conflicting requirement for a long sleep period. In this particular instance the individual's health is more likely to be detrimentally effected.

13.3 Sleep and Work Hours on SF-36 Role Physical Functioning

Identical analyses were conducted using the second outcome measure, role physical functioning. Again only one interaction was found to be significant, as shown in table 66 below:

Table 66: Interactive effect of ideal sleep length and longest duty on role physical functioning

Do your working hours present a personal danger?	What is your ideal sleep length?	Role Physical functioning score (mean)
No	<8 hrs	88.25 (n=231, S.E= 1.84)
	8+ hrs	91.04 (n=194, S.E= 1.96)
Yes	<8 hrs	79.49 (n=209, S.E= 1.92)
	8+ hrs	73.59 (n=224, S.E= 1.89)

(a low physical functioning score indicates poorer health)

As table 66 above shows, an interactive effect was shown between ideal sleep length and potentially dangerous working hours as might be expected. Health status is shown to suffer as the result of working hours which could potentially present personal danger, however the biggest detriment is shown when this is coupled with the conflicting requirement to get 8 or more hours sleep.

13.4 Conclusions

The purpose of this analysis was to assess the combined impact, if any, of work hours and sleep in terms of an interactive effect on seafarers' physical well-being and level of functioning. Whilst only a limited number of interactions were found to be significant, the results nevertheless again highlight how factors cannot be considered in isolation when addressing issues surrounding seafarers' fatigue. In particular the analyses highlight the important interaction between environmental and personal factors. For example, working 18 hours a day is much less of problem for someone who requires 4 hours sleep a night compared to someone who requires 8 hours sleep or more to function properly. That is not to say the person who requires 4 hours sleep a night should work longer, instead such interactions provide a platform for understanding circumstances that could contribute towards a worse case scenario.

14 THE RELATIONSHIP BETWEEN HEALTH RELATED BEHAVIOURS AND FATIGUE

Using measures taken from the survey, the relationship between fatigue and health related behaviours was explored. Analyses were conducted to establish how seafarers may react to experiencing fatigue within the work place. In terms of health related behaviours three central areas were focused upon: caffeine, nicotine and alcohol.

14.1 Caffeine

It has already been shown that increased caffeine consumption is associated with reports of greater fatigue (see section 9.2.5).

14.2 Nicotine

Analyses were conducted to determine whether smoking may be used as means of alleviating the symptoms of fatigue at sea. In the first set of analyses a simple smokers/non-smokers split was made, comparing the groups in terms of levels of fatigue. Both groups were found to be comparable, with no significant fatigue based differences found. Analysis then focused only on the smokers.

In the first analysis respondents were compared in terms of the number of cigarettes smoked per day, however no significant fatigue differences were found. The next analysis looked at whether they smoked more cigarettes at sea, on leave, or approximately the same amount during both periods. In this final analysis it was found that those who smoked more cigarettes whilst at sea were significantly more fatigued than those in the alternative two groups. This result was found across all four fatigue scales, co-varying GHQ, age, education and socio-economic class (see table 67).

Table 67: Fatigue level by period of most cigarette smoking

	More on leave	The same	More at sea
General Fatigue symptoms (Mean)	1.43 (n=19, S.E.=0.23)	1.34 (n=65, S.E.=0.10)	1.62 (n=119, S.E.=0.08)
Fatigue at work (Mean)	3.39 (n=24, S.E.=0.20)	3.48 (n=72, S.E.=0.11)	3.90 (n=140, S.E.=0.07)
Fatigue after work (Mean)	2.31 (n=24, S.E.=0.15)	2.34 (n=73, S.E.=0.76)	2.60 (n=142, S.E.=0.05)
PFRS fatigue scale (Mean)	24.81 (n=26, S.E.=1.89)	27.61 (n=74, S.E.=1.55)	33.35 (n=141, S.E.=1.31)

(Higher scores indicate higher levels of fatigue)

As table 67 shows, those who reported smoking more cigarettes whilst at sea also reported the highest levels of fatigue. This result parallels the caffeine result discussed previously, with the same causal implications. The only reliable conclusion, therefore, is that increased cigarette smoking at sea can be used as a potential indicator of high fatigue levels.

14.3 Alcohol

Analyses were conducted in order to determine whether alcohol may be used as means of coping with the symptoms of fatigue at sea, for example as an aid in helping to wind down after work Only one question was deemed useful in terms of assessing alcohol consumption, as detailed below:

Do you consume alcohol whilst at sea?

1. No
2. Yes, Hardly ever
3. Yes, Some weeks
4. Yes, Most weeks
5. Yes, Every week

On two of the fatigue scales a significant difference was found between those who drink at sea and those who do not, with the drinkers appearing less fatigued. This result, however, was confounded with ship type. The majority of those who reported drinking at sea were from the tankers, in comparison to the passenger vessels where only a small percentage of respondents reported drinking. The tanker respondents reported lower levels of fatigue relative to the passenger craft, which can therefore account for the apparent effects of alcohol . Even the ship based difference may be seen as unreliable, however, based on the actual definition of drinking 'alcohol whilst at sea'. For example, a crew member on a high speed ferry would only class drinking 'whilst at sea' as quite literally drinking whilst onboard ship, which is taboo. Any drinks on land when home for the evening would therefore not be included within their understanding of the definition. In contrast, however, a tanker respondent might class 'whilst at sea' as their time spent on a tour of duty. This would include time in port and on land. Any drinking whilst in port would therefore still be understood as being 'at sea' in the sense that he/she is not on leave. Unfortunately due to this definitional issue little can therefore be concluded concerning the use of alcohol as a fatigue coping strategy.

14.4 Conclusions

Despite issues of the direction of causality, it is apparent that to some extent caffeine and cigarettes use reflect symptoms of fatigue at sea. Seafarers are not therefore merely passive subjects when exposed to fatigue related factors, instead active steps are taken in order to combat the problem, even if only short term. This makes *relative* consumption of caffeine and cigarettes potentially usefully as an indicator of fatigue.

15 CONCLUSIONS FROM THE SURVEY

Detailed analyses of the content of the survey showed that it provides good measures of job characteristics that might potentially lead to fatigue. In addition, the questionnaire measures perceived fatigue at work, fatigue after work and general levels of fatigue. Health-related behaviours and health outcomes are also measured using established questionnaires. The detailed profile of specific features of the person's job has allowed us to examine associations between job characteristics, perceived fatigue and health and safety. These analyses have adjusted for demographic factors and for negative affectivity (the tendency to perceive or report negative aspects of the environment or self). Overall, the study represents the most sophisticated approach to the topic adopted so far.

In the present study we have also examined the issue of whether the samples studied are representative of seafarers. The results showed that the onboard sample, respondents from the participating companies and the NUMAST sample were very similar. It is impossible to determine whether the sample as a whole is generally representative of all seafarers but the absence of differences in our various sampling frames suggests that there are no selective biases due to our methods of data collection. Indeed, the similarity of our different samples has important implications for interpretation of our onboard testing in that there was no evidence to suggest that the companies we studied were unrepresentative or that there was a bias in the selection of the specific ships studied.

Initial analyses compared the present sample with the results from Phase 1 of the project. Many results were very similar although there were clear differences in the work/leave schedules in the two phases. Phase 2 participants also reported higher levels of fatigue and poorer health. Following this our analysis strategy was to try to identify factors associated with reported fatigue in the present phase. Ship type was found to be important, with those on ferries reporting higher levels of fatigue. This finding held up across ferry types and was not due to one specific type of ferry (e.g. the high speed ferries). Job type was found to have little effect on reported fatigue even though different job categories (e.g. marine versus non-marine) were associated with different work schedules.

Analyses were conducted to determine which job characteristics were associated with fatigue. Variables relating to working hours, especially "Do you consider your working hours to present a danger to your personal health and safety?", were the strongest predictors of fatigue. The sleep variables were also significant predictors of fatigue but not to the same extent as working hours. Job demands and perceived stress at work were also important, although these factors had selective effects and cannot be considered equivalent. Additional predictors of fatigue were support at work, age, vibration/motion, the physical working environment, having to stand watch, and increased use of caffeine at sea. From these analyses it was apparent that a number of factors influence fatigue, and the best predictor was the combined effect of these potentially negative job characteristics. This confirms the results from the secondary analyses of the Phase 1 data. Indeed, the combined effects approach not only predicted fatigue but also health status. In contrast, accidents at work were largely related to the physical working environment.

The next section considers results from the onboard testing and a major issue was whether similar effects to those found in the survey were obtained.

16 ASSESSMENT OF FATIGUE ABOARD SHIP

The onboard section of the study assessed fatigue on seven vessels in the short sea shipping industry. In parallel with the survey aims, a key focus was to assess similarities in relation to the offshore oil support industry, as surveyed in phase one of the project.
In order to assess fatigue onboard the vessels a mixture of objective measurements and subjective reports were used.

16.1 Sample

Data were collected from 177 participants from seven ships in the short sea shipping industry. These ships included 3 small oil support tankers, 2 passenger ferries, a freight ferry, and a fast ferry. Details of the vessels and the participants recruited from each are shown in appendix 3.
Demographics
In the second phase 177 participants were recruited, as compared with an onboard sample of 144 workers from the offshore oil support industry in phase one.
Participants in phase 2 were generally younger than those in phase 1. This may be due in part to the bias introduced by the comparatively young crew on the fast ferry (see table 68).

Table 68: Age of volunteers from different ships

Group	N	Mean	SD
Phase 1	144	41.31	9.82
Pipe Layer	18	40.78	10.14
Dive support vessel	81	42.04	8.63
Shuttle tanker	19	38.84	12.85
Supply Vessel	12	44.00	8.16
Standby/supply Vessel	14	38.86	12.51
Phase 2	177	36.07	11.40
Freight	27	39.11	10.45
Tankers	24	41.83	12.67
Passenger Ferries	71	37.28	9.90
Fast ferries	55	30.49	11.07

There were more mixed nationality crews in phase 2, with only 63.8% (n=113) of crews being from the British Isles, in comparison to 91.2% (n=134) in phase 1. Other nationalities in phase 2 included Spanish (20.3%, n=36), Polish (13.0%, n=23, and Canadian (2.8%, n=5). The questionnaires, daily questionnaires and instructions for the performance tests were translated into Spanish and Polish.
Marine versus non-marine crew
There were similar levels of marine and non marine crew in the phase 1 and 2 samples, with 65.5% of the sample being marine crew in phase 1, and 72.3% in phase 2.
Length of tour
The typical tour length was shown to differ between the two phases, with the majority of participants in phase 1 (68.3%, n=99) working 4 weeks on/4 weeks off tours, in comparison to phase 2 in which the majority worked 1 week tours (34.4%, n=61 - see table 69). However, again this was skewed by tour length on the fast ferry, which never exceeded seven days.

Table 69: Tour length

Tour length	Phase 1	Phase 2
1 week	----	34.4% (n=61)
2 weeks	2.8% (n=4)	15.3 (n=27)
3 weeks	4.1% (n=6)	6.2% (n=11)
4 weeks	68.3% (n=99)	3.4% (n=6)
5 weeks	6.9% (n=10)	0.6% (n=1)
6 weeks	2.1% (n=3)	1.1% (n=2)
7 weeks	9.0 (n=13)	----
8 weeks	6.9 (n=10)	10.2% (n=18)
8+ weeks	----	29.0% (n=51)

Phase 1 and phase 2 participants were tested at a similar stage into the tour, with the highest proportion of volunteers being tested in week 1 (43.7% in phase 1, and 48.0% in phase 2 – see table 70). In terms of phase two, this again may have been skewed by those from the fast ferry who only worked 7 day tours.

Table 70: Weeks into tour at testing

Weeks in tour	Phase 1	Phase 2
week 1	43.7% (n=62)	48.0% (n=85)
week 2	26.1% (n=37)	13.0% (n=23)
week 3	16.2% (n=23)	6.8% (n=12)
week 4	4.2% (n=6)	5.6% (n=10)
week 5	2.1% (n=3)	4.0% (n=7)
week 6	1.4% (n=2)	4.5% (n=8)
week 7	5.6% (n=8)	3.4% (n=6)
week 8	0.7% (n=1)	5.1% (n=9)
week 8+	----	9.6% (n=17)

16.2 Procedure

The specific procedures for the onboard testing are outlined in the phase 1 report. A brief outline, however, is given below.

Participants initially completed a familiarisation session in which they ran through a shortened version of the performance tasks. Information about the participant's rank, work area, tour length, shifts worked, smoking habits, and nationality was recorded on recruitment sheets. Participants were then given a recruitment booklet and a sleep watch (numbers dictating) and asked to wear this during the sleep period prior to the shift they were tested on. They were also asked to give a saliva sample when they awoke, before brushing their teeth or smoking.

Participants came to be tested before, or at the beginning of their shift, completing both the relevant section of the log book, and performance tasks. At the end of their shift participants returned and repeated the performance tasks, completed the relevant section of the log books, and gave a saliva sample. Prior to the test session on day 7 (or as close to the seventh day as possible) participants were again given a sleep watch for the sleep period prior to testing and provided a saliva sample. The test procedure on day 7 was the same as outlined for day 1.

16.3 Logbooks

The questionnaire consisted of four sections, before and after work on the first and final day of their performance testing, typically with an intervening period of 5-7 days. The questionnaires were completed by the participants during their performance testing sessions. Participants recorded food intake, medication, breaks, caffeine consumption, smoking, sleep, symptoms of fatigue and perception of work related issues.

The Questionnaires
The "before work day one" questionnaire included a description of the research aims and a consent form. Apart from this, the two "before work" questionnaires, i.e. day one and day seven, were identical. Likewise both the day one and day seven after work questionnaires contain identical sections. All sections within the daily questionnaires refer to the day of testing, or in the case of sleep and alcohol the day before testing. However, at the end of the day seven there was an additional 'Work in General' section which was completed after work on the final day of testing.

* *'Before work' questionnaires*
Sleeping and eating questionnaire:
Examines alcohol consumption, sleep, breakfast, caffeine consumption, medication and smoking (see appendix 4).

* *'After work' questionnaires*
Daytime health-related behaviours questionnaire:
This looks at lunch, other breaks, caffeinated drinks, medication, smoking, workload, daily workplace hazards, and work environment.
On day seven, a work in general section was included relating to overall issues rather than those encountered on the testing day. These were about type of work, about the position at work, about consistency and clarity at work, job involvement, and support at work (see appendix 4)

Factors derived from the data
The hazards and work in general sections of the after work questionnaires were analysed using factor analysis, in order to derive factors underlying the individual variables being measured in these sections. The factors and variables from which they are derived are shown below. These factors were used to facilitate more succinct analysis of influences of fatigue exposure variables on seafarers.

Day 1:

<u>Factor One: Work Environment</u>
The work environment was very noisy today
I was exposed to breathing fumes, dusts or other potentially harmful substances.
I handled or touched potentially harmful substances or materials
I was left with a ringing in my ears or a temporary feeling of deafness.
My concentration was disturbed by the level of background noise in the workplace.
I felt that the air temperature was too hot/cold to work effectively .
<u>Factor Two: Job Effort</u>
I felt I had too much work to do today
Did you find your job required a lot of effort today?
How stressful did you find your job today?
Did you find your job demanding today?

Factor Three: Support, control and satisfaction
Did you have a choice in deciding what you did at work or how you did your work? Did you feel satisfied with what you did at work today?
I felt that I had good support from my fellow workers if I needed it today
I felt that management were supportive and would listen to me if I needed their help today.

Day 7

Factor One: Work Environment
The work environment was very noisy today
I was exposed to breathing fumes, dusts or other potentially harmful substances
I handled or touched potentially harmful substances or materials
I was left with a ringing in my ears or a temporary feeling of deafness
My concentration was disturbed by the level of background noise in the workplace
I felt that the air temperature was too hot/cold to work effectively
Factor Two: Job Effort
I felt I had too much work to do today
Did you find your job required a lot of effort today?
How stressful did you find your job today?
Did you find your job demanding today?
Factor Three: Support, control and satisfaction
Did you have a choice in deciding what you did at work or how you did your work? Did you feel satisfied with what you did at work today?
I felt that I had good support from my fellow workers if I needed it today
I felt that management were supportive and would listen to me if I needed their help today

Work in General (after work day 7 only)

Factor One: Work in General
I have to work very fast
I have enough time to do everything I need to do at work
My tasks are such that others can help me if I do not have time
I have the possibility of learning new things through work
My job requires me to take the initiative
Others take decisions concerning my work
Do you get sufficient information from line management?
Do you get consistent information from line management?
Does your job provide you with a variety of interesting things to do?
How often do you get help and support from your colleagues?
How often are your colleagues willing to listen to your work-related problems?
How often do you get help and support from your immediate superiors?
How often is your immediate superior willing to listen to your problems?
Factor Two: Decision latitude
I have a choice in deciding how I do my work
I have a choice in deciding what I do at work
I have a great deal of say in decisions about my work
I have say in my work speed
My working time can be flexible
I can decide when I take a break
Factor Three: Work Difficulty/Intensity
I have to work very intensively
My work demands a high level of skill/expertise
Do different groups demand things from you that you think are hard to combine?
Factor Four: Control
I can take my holidays more or less when I wish

I have a say in choosing who I work with
I have a great deal of say in choosing my work environment
Factor Five: Monotony
I have to do the same thing over and over again
Is your job boring?

16.4 Comparison of Phase One and Phase Two

In order to establish whether the phase one and phase two samples were comparable, analysis was conducted on variables assessed in both phases.

16.4.1 General findings

- No significant differences were found between the two samples in terms of the logbook sleep variables. Other conclusions were limited due to changes in the logbook format between phases.

16.4.2 Specific results

This comparison is limited in that the daily questionnaires used in phase one and phase two differ somewhat. However, some of the variables, notably those relating to sleep, remained the same and so the analysis was conducted in terms of these. In phase one, seafarers reported more sleep problems than onshore workers. In a comparison of phase one and phase two seafarers, no significant differences were found between the two samples, as indicated by the descriptives presented in the table below.

Table 71: Comparison of phase one and phase two sleep variables

	Phase One Onshore	Phase One Offshore	Phase Two Offshore
Sleep Duration (hrs)	6.97 (n=51, S.E.= 0.13)	6.38 (n=45, S.E.= 0.13)	5.75 (n=128, S.E.= 0.17)
Number of awakenings	1.19 (n=51, S.E.= 0.14)	1.80 (n=41, S.E.= 0.22)	1.72 (n=118, S.E. = 0.17)
Ease of falling asleep	3.81 (n=51, S.E.= 0.12)	3.32 (n=48, S.E.= 0.14)	3.31 (n=134, S.E. = 0.09)
Enough sleep	3.08 (n=48, S.E.= 0.14)	2.62 (n=47, S.E.= 0.12)	2.79 (n=133, S.E. = 0.09)
Deep sleep	3.70 (n=50, S.E.= 0.12)	3.22 (n=46, S.E.= 0.12)	3.34 (n=134, S.E. = 0.09)
Physical demand	4.37 (n=52, S.E.= 0.20)	3.83 (n=47, S.E.= 0.16)	3.71 (n=132, S.E. = 0.12)

Key: ease of falling asleep, sufficient sleep, deep sleep (1 = least, 5 = most). Physical demand (1 = least, 7 = most).

Although phase two participants do report shorter sleep durations, in general the two samples appear to be comparable in terms of sleep variables since no significant differences were identified. Therefore we can surmise that the phase two sample, as with the offshore sample of phase one, suffers from poorer sleep than the onshore control sample of phase one.

This pattern of results remained the same when potential differences in GHQ, age, socio-economic status were taken into account, since these did not vary significantly between the two phases. There were demographic differences by phase in terms of sex, education, and numbers of marine/non-marine subjects, although since none of these significantly predict sleep variables, such differences are unlikely to impact on the above conclusion.

16.5 Conclusions

Since the phase two sample is comparable to the phase one offshore sample in terms of sleep variables assessed by the daily questionnaires, they may be considered to likewise suffer from poorer sleep than an onshore control sample from phase 1.

17. SHIP TYPE

The analyses of the survey data demonstrated that ship type was an important variable. This issue was examined further by considering the logbook data.

17.1 General Findings

- Ships were found to differ in terms of a number of variables that could potentially lead to fatigue (e.g. sleep variables).
- Multivariate analyses showed that some of the effects attributed to ship type could be better interpreted in terms of other factors that varied with ship type (e.g. working hours). However, certain effects, such as perceived effort and demand did appear to be associated with ship type rather than correlated attributes.

17.2 Specific Results

The different ships were compared in terms of a number of logbook variables in order to identify between-ship fatigue exposure differences. An ANOVA was performed and significant differences by ship type were identified on sleep items and various other variables that were assessed. Table 72 below presents a representative sample of these differences:

Table 72: Representative sample of variables differing by ship type

*Approaching significance	Freight Ferries	Passenger Ferries	Fast Ferry	Tankers
Sleep duration day one (p=0.063*)	5.05 hrs, n=27, S.E. = 0.35	5.28hrs,n=66, S.E. = 0.18	5.96hrs,n=54, S.E. = 0.28	5.70hrs,n=24, S.E. = 0.26
Sleep duration day seven (p = 0.011)	5.64 hrs, n=20, S.E. = 0.32	5.37hrs,n=50, S.E. = 0.26	6.74hrs,n=37, S.E. = 0.36	6.29hrs,n=22, S.E. = 0.40
Enough sleep day one (p = 0.003)	2.81, n=26, S.E. = 0.22	2.54, n=68, S.E. = 12	2.89, n=53, S.E. = 0.13	3.46, n=24, S.E. = 0.23
Enough sleep day seven (p = 0.023)	2.87, n=23, S.E. = 0.25	2.41, n=49, S.E. = 0.15	2.85, n=39, S.E. = 19	3.27, n=22, S.E. = 0.25
Physical Effort day one (p = 0.000)	3.95, n=22, S.E. = 0.28	4.10, n=67, S.E. = 0.17	4.83, n=53, S.E. = 0.20	3.13, n=22, S.E. = 0.33
Physical demand day one (p = 0.014)	3.68, n=22, S.E. = 0.30	3.79, n=67, S.E. = 0.16	4.09, n=53, S.E. = 0.21	2.91, n=23, S.E. = 0.34

As table 72 above shows, a number of between-vessel differences were identified in terms of fatigue exposure variables. This pattern of results remained the same when GHQ, age, education and socio-economic class were co-varied in the analysis, and obtained across both marine and non-marine crew. This therefore again supports the value of considering ship type when examining seafaring fatigue.

Further analysis was required, however, in order to establish whether ship type *per se* was the crucial factor, or whether it was the constellation of characteristics associated with ship type that combine to actually produce apparent between vessel differences.

Multivariate analysis

Multivariate regression analysis was conducted in order to tease apart the relative independent predictive power of vessel type. As a first step the following three variables were identified as potentially confounded with vessel type (N.B. these variables were adopted from the survey based on a combined survey / logbook database):

Work / leave schedule
Average hours worked per week
Length of stay onboard between leave

The potential confounding variables, as well as ship type, were entered into regressions to predict those fatigue exposure differences previously attributed to ship type alone. It must be noted first, however, that in a number of analyses no significant predictors were found, highlighting how group differences (e.g. by ship type) are not necessarily indicative of any causal relationship. Table 73 shows the results of the multiple regression analysis which was conducted using a step-wise technique.

Table 73: Ship-type multiple regression analysis

Variable to be predicted	Variables selected through step-wise analysis - in order of predictive power
Sleep duration, before day 7	How many hours do you work each week?
Number of awakenings, before day 7	1. How many hours do you work each week? 2. Ship type
Enough sleep, before day 1	Ship type
Enough sleep, before day 7	How many hours do you work each week?
Physical effort, after day 1	Ship type
Physical demand, after day 1	Ship type

As table 73 shows, a number of effects previously attributed to ship type may actually be more appropriately understood in terms of other variables which are closely related. In particular, working hours appear more useful in terms of predicting a number of sleep variables, whilst the concept of ship type holds firm in terms of predicting specific work variables (physical effort, physical demand). The pattern of results shown in table 73 remained when GHQ, education, socio-economic class, education and marine/non-marine were also entered into the analysis.

It may therefore be necessary to look beyond the more global concept of ship type when looking at between-group differences, towards specific factors that effectively define and characterise ships. These more specific factors can then be used to build up a more sophisticated profile of seafarers' fatigue.

17.3 Conclusions

The results confirm that ship type may be a useful contributory factor in understanding fatigue at sea. However this factor may represent the combined effect of several specific variables and some of these can be seen to be responsible for effects attributed initially to ship type.

In order to effectively address those at-work issues which have detrimental effects on seafarers' health and well being, it may be necessary to tailor approaches to reducing the incidence of these exposure variables by ship type. This was certainly the case with regard to sleep variables, although the effect of ship type on perceived effort and demand did not appear to reflect other factors such as working hours.

18 JOB TYPE

The logbook data were further analysed using a marine crew vs. non-marine crew split (N.B marine crew were classified as trained seafarers, and non-marine as those with no formal seafaring qualifications). Approximately one third of the onboard sample in the study consisted of non-marine crew (n=49), and therefore a comparison of the effect of working offshore for those who did not traditionally work in the industry and those who did was seen as potentially interesting.

18.1 General Findings

- There were no differences between marine and non-marine crew.
- Although officers reported higher levels of job difficulty and stress they were more likely to report their job as interesting.
- Despite the increased levels of job stress in officers, there was little impact on actual reported levels of health (see survey).

18.2 Specific Results

Although significant differences were very few, consistent patterns were found on fatigue exposure variables by job type. Officers were found to report slightly shorter sleep duration, more awakenings during sleep, as well as higher levels of job stress (see table 74)

Table 74: Officers vs. Ratings on selected fatigue exposure variables

	Officer	Rating
Sleep duration	5.38 (n=62, S.E. = 0.14)	5.75 (n=109, S.E. = 0.09)
No. of Awakenings	1.94 (n=62, S.E = 0.27)	1.62 (n=103, S.E. = 0.16)
How stressful job today	1.80 (n=45, S.E = 0.15)	1.31 (n=86, S.E = 0.10)

Analysis revealed evidence of higher levels of decision latitude and work flexibility among officers. Further, officers were more likely to report that they found their jobs interesting than ratings (see table 75 below).

Table 75: Officers vs. Ratings on selected work related variables

	Officer	Rating
Say in work decisions	2.65 (n=52, S.E = 0.20)	2.30 (n=89, S.E = 0.13)
Job requires initiative	3.06 (n=53, S.E = 0.20)	2.56 (n=89, S.E = 0.15)
Work time flexible	2.56 (n=52, S.E = 0.15)	2.21 (n=89, S.E = 0.12)
Job provides interesting things to do	2.66 (n=53, S.E = 0.19)	2.34 (n=89, S.E = 0.12)
May learn new things through work	2.51 (n=53, S.E = 0.18)	2.27 (n=89, S.E = 0.14)

(Higher scores represent items which are affirmed)

Analyses showed that the differences reported above were not attributable to GHQ, age, education or socio-economic status, although they did moderate some officer/rating differences not reported. This analysis was also run for a marine/non-marine split, and the differences on fatigue exposure variables assessed by the logbooks were generally not significant, and formed no coherent pattern to indicate that this distinction is an important factor in seafarers' fatigue.

18.3 Conclusions

The comparison between officers and ratings revealed very few differences. Similarly, a marine/non marine split did not yield any more findings. The two areas that suggested effects of job type were sleep, with officers reporting less sleep and more interruptions, and job demand, with officers reporting higher levels of work stress and job difficulty. Co-varying job type with GHQ, education, socio-economic status and age did not alter these effects.
These findings could have important ramifications as officers generally have greater responsibility for the safety of vessel and crew, and therefore any fatigue-induced errors may have greater potential impact, such as in the worst case scenario the loss of a vessel. However these higher perceived demands appear to have little actual impact, since officers and ratings showed similar results in terms of self-reported health status (see survey results). It may well be, however, that the positive aspects of officers' job characteristics buffer against the effects of poorer sleep and higher work intensity.

19. NOISE AND MOTION

In order to examine the influence of noise and motion on workers aboard ship, associations between self reported measures of these factors and perceived fatigue were examined.

19.1 General Findings

- Subjective measures of noise and motion were not found to influence any of the sleep variables.
- Subjective measures of noise and motion were similarly not found to predict any of the fatigue outcomes.

19.2 Specific Results

Findings from the logbook were consistent with the survey data, as no significant relationships were identified between self-reported motion and noise on the four general fatigue outcomes. These fatigue outcomes included measures of sleep.

19.3 Conclusions

Surprisingly noise did not affect any of the measures of sleep, which may explain its lack of influence on the self report fatigue measures as examined in the log books and survey. This may be due to the type of noise onboard vessels in the present study, as noise levels were generally consistent, with few rapid changes in noise, or loud unexpected noises (in contrast to Phase 1). Unfortunately this hypothesis cannot be addressed within the current study.

20 DAYS INTO TOUR, AND THE CUMULATIVE EFFECT OF THE WORKING DAY

The purpose of this analysis was to yield information about changes over discrete periods of time in seafarers' stress, fatigue and performance levels. This was done in order to assess the impact of shipboard work, both as a function of shift, and as a function of time into tour. The period of analysis matched the period of the performance testing onboard, i.e. typically 5-7 days, and the analysis itself had two layers. Firstly, the aim was to reveal any fatigue and performance related differences there may be as a result of a working period – that is to uncover what, if any, effect the working day and the working week have on self-reports of fatigue, work-related variables, and objectively measured performance and sleep. Secondly, these effects over the working day and week effect were analysed as a function of time into tour, to assess whether longer tours mitigated or exacerbated these effects.
Approximately forty subjects (the fast ferry sample) were excluded from this analysis since their entire tour was only 6-7 days long, and it was felt that including them would bias the data set, by confounding ship type with tour length.

20.1 General Findings

- Levels of job stress and job effort appear to be negatively influenced by the cumulative effect of the working week.
- Habituation to noise levels onboard ship seems to occur fairly consistently as a function of time into tour.
- Sleep appears to improve further into tour, which may help account for the relatively low levels of fatigue in this sample.

Key differences shown on the first fortnight vs after two weeks analysis:

First fortnight of tour:

- Physical effort significantly lower at the end of the working week
- General health is reported as being significantly worse at the end of the working week

After first two weeks of tour:

- Almost no change in sleep across the working week
- Physical effort significantly higher at the end of the working week
- Weather becomes more of an issue across the working week, despite no change in actual weather conditions
- Support from fellow workers, self-regulation of own work, and work satisfaction are all affirmed more highly at the end of the working week for this sub-sample

20.2 Specific Results

For the logbook data the working day was not used as a period of analysis, since the before and after work questionnaires differed from each other, but were essentially the same from day one to day seven. Hence there were no similar items from this measure to compare between the beginning and end of shift, although there were identical items to compare between the beginning and end of the working week. As well as examining the effect of the working week, a grouped analysis was also conducted between those within the first fortnight of their tour of duty, and those more than two weeks into tour.

Analysis 1: Changes from Day 1 to Day 7
Overall, statistically significant differences were found indicating increasing sleep time over the work period. That is to say, participants went to bed/sleep earlier, got up later, slept longer

and affirmed more highly that they had more sleep than usual on day seven, as indicated by the list below.

- Went to bed/ sleep: Later day 1
- Got up: Later day 7
- Sleep duration: Longer day 7
- More sleep than usual: More day 7

Further analysis revealed increased affirmation of items relating to self perceived job stress and effort from day one to day seven. That is to say participants indicated that they felt more pressured in relation to work issues on day seven than they did on day one of testing, again displayed in the list below.

- Felt had too much work to do today: More day 7
- Job stressful: More day 7
- Job Effort (factor): More day 7

There was also evidence across the sample as a whole of possible habituation to noise over the working week, since although we know from the objective measures that actual noise levels did not change significantly over the testing period, the participants level of affirmation of perceived noise levels decreased from day one to day seven, as shown below

- Noise levels: Higher day 1

<u>Analysis 2: Time into tour</u>
Having conducted the initial analysis and found significant differences as a function of the working week, another analysis was carried out to see if this effect varied as a function of time into tour. The sample was split into approximately equal groups depending on whether the testing interval was within the first fortnight of tour (49%, n=66), or whether it fell after the first two weeks of tour (51%, n=69). This split was deemed appropriate firstly because it yielded approximately equal sample sizes, and since a fortnight was not regarded as a long time into tour by the seafarers.

First fortnight of tour
In this section of tour, increasing sleep time over the work period was again identified, although participants no longer reported more sleep than usual over the work period.

- Went to bed/ sleep: Later day 1
- Woke/Got up: Later day 7
- Sleep duration: Longer day 7

Increased perception of job effort over time again came out as significant, although the effect for job stress is not found for this sub-sample.

- Felt had too much work to do today: higher day 7
- Job effort (factor): Higher day 7

General findings within this sub-sample indicate that self-reports of health worsen over the testing interval, although physical effort is seen to decrease over the same period

- General health: Worse day 7
- Physical effort: Less day 7

After second week of tour
The changes in sleep variables as a function of the working week are, for the most part, no longer evident after the first two weeks of tour, with the minor exception that participants are less likely to affirm that they had less sleep than usual at the end of the testing interval than on day one of testing.

- Less sleep than usual: Higher day 1

This sub-sample is identical to those within the first fortnight of tour in terms of perception of job effort, which again increased significantly over time, although again no effect for job stress was found for this sub-sample.

- Felt had too much work to do today: More day 7
- Job Effort (factor): More day 7

In terms of environmental influences, the habituation to noise effect holds up for this sub-sample, although we see an effect in the opposite direction for weather. That is, although we have no record of weather deteriorating significantly over the work period, the extent to which participants in this sub-sample report it as problematic increases significantly across the testing period.

- Weather: Worse day 7
- Noise: Less day 7

Finally, in contrast to those in their first fortnight of tour, participants show an increase in self-reported physical effort from day one to day seven of testing. It is interesting to note that many general items that did not show a significant difference over the working week for the overall sample attain significance for this sub-sample who was further into their tour. These include increase affirmation of support from fellow workers, ability to self regulate their work, and work satisfaction

- Physical effort: Higher day 7
- Support from fellow workers: Higher day 7
- Decide what to do at work: Higher day 7
- Work satisfaction: Higher day 7

20.3 Conclusions

The logbooks provide evidence that the cumulative effect of working, both across days and weeks, may influence levels of fatigue and performance. Across the working week, job stress was found to increase which may indicate that over longer periods, seafaring work has a detrimental effect on individual well being.

There is also some evidence from the daily questionnaires that seafarers' sleep improves as a function of time into tour. Although an actual improvement in sleep was not recorded by the objective measures (see subsequent section), no impairment in sleep was identified either so at the very least these do not contradict the logbook findings. Also, generally habituation to noise levels onboard was observed as a function of days into tour.

It can be seen from the logbook data that any cumulative effects over the testing interval varies as a function of weeks into tour, with some evidence of habituation, and some evidence of cumulative negative effects of time at sea, e.g. fewer effects of noise are observed further into tour, whereas the subjective impact of motion increases.

This "first fortnight/after second week of tour" split is supported by the manifest differences between the two sub-samples. For example, from day one to day seven of the first fortnight of tour, there is a significant increase in self reported work stress and lack of sleep, and even though physical effort decreases over the seven day period, general health is reported as worse. After the first fortnight of the tour there are fewer negative day one-day seven differences. Again, general health was found to be worse on day 7. Stress is mostly the same and sleep appears stable over a week long period after the first fortnight of the tour. There are some indications that longer tours may be better in that there is higher affirmation of receiving support from fellow workers, self-regulation of work and work satisfaction further into tour.

Thus we can see from the above analyses that there are differential effects over the work period depending on how far into their tour the seafarers are. These differences are not due to demographic or GHQ differences since the samples do not differ significantly on these. Indeed, such effects may even indicate that in some ways longer tours are actually less detrimental in terms of fatigue and work related exposure variables than shorter ones. This is supported by findings from the survey, indicating that the longer the tour, the lower the fatigue as measured by the PRFS scale, and the fatigue at/after work factors.

Note: Voyage cycles (or ship activity cycles - frequency of port turnaround, time at anchor/in port etc), may account for some of the effects observed. However, it is not possible within this data set to disentangle the effects of voyage cycle from those relating to ship type. Controlling for ship type by running within ship analyses cannot address this, since variance within ships is confounded with job type. Thus within this database voyage cycle is inextricably confounded with other variables and so it is not possible to isolate any independent effects it may have.

21. FATIGUE REGRESSION ANALYSIS

In parallel with the survey analysis reported in the previous section, regression analysis was conducted on the logbook data as a means of clarifying the relative importance of various factors already identified as useful in predicting fatigue.
Fatigue risk factors identified from the daily questionnaires were entered into regression analyses predicting the four fatigue scales identified from the survey (General fatigue symptoms at sea; Fatigue at work; Fatigue after work; and the Profile of Fatigue Related Symptoms (PFRS) fatigue scale). Due to the fact that fatigue predictors were taken from the logbooks, conclusions are limited to the onboard sample.

21.1 General Findings

- The primary predictor from the daily questionnaires appeared to be job effort on the first day of testing.
- Sleep on the night prior to the first day of testing was found to be related to the factor 'general symptoms of fatigue', as well as 'fatigue at work'.
- Work satisfaction after work on the final day of testing was found to be related to the PFRS fatigue scale.

21.2 General Fatigue Symptoms at Sea

The logbook regressions were on a smaller scale than the survey and therefore the number of predictors identified in any one analysis were limited.
Three variables were identified as predictive of general fatigue symptoms:
1. Mental effort day one
2. Sleep duration day one
3. Work satisfaction day one

It therefore appears that perceived job effort at the beginning of the work period and general symptoms of fatigue as reported by seafarers are very much interlinked. Actual sleep duration is also significant here, with longer sleep leading to fewer general symptoms of fatigue. Work satisfaction also plays a role.

21.3 Fatigue at Work

Three variables were identified as predictive of fatigue at work:
1. Less sleep day one
2. Job effort day one
3. Less sleep day seven

It is interesting to note that, differently from general fatigue symptoms, it is relative amounts of sleep rather than objective amount of sleep that has most effect on fatigue at work. That is to say tiredness at work is more a matter of whether seafarers have less sleep than usual rather than the amount of time they actually sleep, with sleep time variables not achieving significance. Job effort as measured on the first day of testing also proves significant.

21.4 Fatigue after Work

Only one logbook variable was identified as predictive of fatigue after work:

1. Mental effort day seven

Here we see that by the end of the work period, the effects of sleep duration appear to have lost their influence over tiredness, with work related mental effort proving the most immediate influence on fatigue after work

21.5 PFRS Fatigue Scale

Only one logbook variable was identified as predictive the PFRS fatigue scale:

1. Work satisfaction after day seven.

Work satisfaction after work on the final day of testing is most predictive of seafarers' profile of fatigue related symptoms.

21.6 Conclusions

The primary predictor from the daily questionnaires of the four main fatigue outcomes was job effort on the first day of testing. Thus self-report measures of fatigue are here closely linked with self-reports of how effortful seafarers perceive their jobs to be. This ties in with the results from the survey in terms of the predictive power of job demand and job stress. Unsurprisingly we also see that sleep the night prior to the first day of testing affects general symptoms of fatigue, as well as fatigue at work in the offshore population studied. This is coherent with the moderate predictive effect of sleep identified in the survey. Furthermore, work satisfaction as measured after work on the last day of testing is related to the profile of fatigue related symptoms measured by the survey.

Further regressions were carried out co-varying age, education, GHQ, socio-economic class and marine vs. non-marine. Although these variables were, as expected, found to be predictive of fatigue, in general the pattern of results remained the same despite their influence.

22. COMBINED EFFECTS

In phase 1 the combined effects approach was only applied to the survey, however in phase 2 the technique was extended to the logbook database. The same combined effects score calculated using survey stressors was applied to the logbook database in order to test its extended predictive power. Whilst the survey data were analysed in terms of the combined effect of stressors upon fatigue and health status, the logbook analysis complemented this analysis by considering the combined effect of stressors upon particular job characteristics (e.g. job effort).

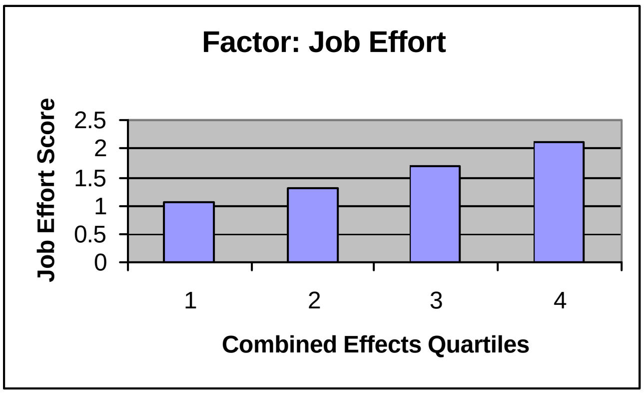
22.1 General Findings

- The extension of the combined effects approach to the logbook data supports the cumulative negative effects hypothesis, with high levels of exposure to potentially negative work characteristics being associated with greater perceived strain.

22.2 Daily Questionnaires

The onboard sample was divided into quartiles on the basis of the combined effects score taken from the survey. These quartile groups therefore ranged from very low to very high risk in terms of the summed number of stressors identified. The quartile groups were then compared in terms of a number of logbook factors in order to assess whether exposure to a large number of stressors was related to the logbook outcome measures. Between-quartile differences were then analysed in a series of ANOVAs. Figure 7 shows an example of a significant between-quartile differences found for the logbook outcome variables.

Figure 7 Job Effort by negative job characteristics quartile split



As can be seen from figure 7 above, the amount of self-reported job effort, as measured by a combination of variables, increases as the combined number of stressors increase. An ANOVA revealed the between quartile differences in job effort to be significant ($p<0.001$).

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22.3 Conclusions

The relationship between the combined stressors score and a number of logbook variables provides further evidence of the use of the combined effects approach.

23 THE RELATIONSHIP BETWEEN SURVEY AND LOGBOOK MEASURES

It was considered important to examine the extent to which measures from the logbooks correlated with similar measures taken from the survey. Whilst the logbooks capture a small snapshot of the seafarers existence, the survey deals with a global evaluation of the seafarers life. Examining the cross-correlation between these perspectives therefore enables a consideration of the extent to which the data taken from the logbooks is typical or representative of the seafarer's life in general.

23.1 General Findings

A large number of the survey and logbook measures were found to correlate. This suggests that to some extent results from the specific period of time spent onboard can be generalised in terms of a broader work perspective. Specific correlation analyses are detailed below. All correlations were focused around areas of key interest in terms of the central themes of the project

23.2 Survey Fatigue Scores and Logbook Variables

The most important issue was to examine whether any of the logbook variables were related to the four fatigue scales calculated from the survey. A large number of correlations were found to be significant, with a division in terms of those relating to *sleep* or *work*. Table 76 summarises a representative sample of significant correlations, with an indication of how to interpret the results.

Table 76: Logbook variables correlated with the survey fatigue scales

	Sleep Variables (Logbook)	Pearson's r value	Work variables (Logbook)	Pearson's r value
High fatigue (survey) associated with:	Difficulty falling asleep	0.23	High mental effort	0.26
	Difficulty rising	0.25	High mental demand	0.27
	Insufficient sleep	0.28	Bad work environment	0.23
	Shallow sleep	0.25	High job effort	0.29
	More sleep than usual	-0.27	Low self-determinedness	0.17
			Not far into tour	0.20
			No decision when to take breaks	-0.36

(N.B Where statements above represent more than one variable, average correlation values are shown)

As table 76 shows, an intuitive pattern of results emerges from the significant correlations found between the logbooks and survey, although it should be noted that most of the correlations are modest.

23.3 Survey Work Factors and Logbook Work Factors

Factor scores taken from the two datasets represent a large spectrum of questions in a concise and manageable form. Correlating between factors is therefore a useful means of identifying inter-database relationships. The second set of analyses focused on work-related factors, and factors associated with the work environment. Six factors were taken from the survey (job demands, physical environment issues, disruptive working hours, work insecurity, vibration and motion and support at work) along with four variables (physical effort, physical demand, mental effort, mental demand) and three factors (work environment, job effort and work satisfaction) from the logbooks. Out of all the survey-logbook combinations, around 44% of correlations were found to be significant. These correlations were further found to be in the expected direction, e.g. high support at work (survey) was found to be related to high work satisfaction (logbooks). This analysis therefore again highlights the validity of considering the logbook data as suitably representative of the seafarers' general working patterns.

23.4 Survey Sleep Measures and Logbook Sleep Measures

Two key variables from the survey were used to assess sleep - *quantity* and *quality* of sleep. A high degree of correlation was found between these two survey measures of sleep and measures taken from the logbooks, as shown in table 77.

Table 77: Survey sleep measures correlated with logbook sleep measures

	Good general quality of sleep (survey)	**Pearson's r value**	**High quantity of sleep (survey)**	**Pearson's r value**
(Logbook correlates)	Easy to fall asleep	0.31	Easy to rise	0.18
	Sufficient sleep	0.30	Sufficient sleep	0.38
	Deep sleep	0.31		
	Non-interrupted sleep	0.29		

(N.B Where statements above represent more than one variable, average correlation values are shown)

As table 77 above shows, all correlations were found to be in the direction that would be expected.

23.5 Survey Motion and Logbook Motion

No significant correlations were found. This is unsurprising given that the survey addresses *motion sickness* whilst in the logbooks *subjective vessel motion ratings* were recorded.

23.6 Survey Noise and Logbook Noise

Measures of noise exposure from the survey and logbooks were found to be highly correlated, with nearly 80% of survey-logbook relationships proving significant.

23.7 Combined Effects

A correlation was calculated between the survey combined effects summed negative score and all logbook variables. Significant correlations from this analysis can be interpreted in one of two ways. First, a correlation could represent the <u>impact</u> of negative work stressors e.g. a high summed negative score might be highly correlated with disturbed sleep. Secondly, however, the correlation may represent <u>similarity</u> between the logbook variable and a number of the constituent combined effects variables addressing similar work characteristics. In this instance a significant correlation might also be expected. Acknowledging the two possible interpretations, a number of significant correlations were found, as detailed below.

High summed negative score associated with:	Low sleep sufficiency (r=-0.22)
(N.B Where statements represent more than one variable, average correlation values are shown)	High physical effort (r=0.26)
	High physical demand (r=0.22)
	High mental effort (r=0.19)
	High mental demand (r=0.22)
	High environmental noise (r=0.35)
	High motion (r=0.22)
	A negative work environment (r=0.42)
	High job effort (r=0.40)

A simple combined effects score was also calculated on the basis of a number of variables taken from the logbooks (physical effort, physical demand, mental effort, mental demand, weather, motion and noise). The process for deriving this new summed negative score was identical to that used previously for the survey data. The summed negative score was then entered into correlation analyses with measures of fatigue and health taken from the survey. Interestingly a significant correlation was found between the logbook combined effects score and the survey factors 'fatigue at work' and 'fatigue after work'. A high negative summed score was also found to be significantly related to one of the survey health scores (SF-36 bodily pain subscale).

Finally, a correlation was calculated between the survey combined effects score and the logbooks combined effects score. Perhaps unsurprisingly the correlation was found to be highly significant ($p<0.001$), although the magnitude was quite small.

23.8 Conclusions

A relatively large number of significant correlations were found between time-specific logbook measures and more general measures employed in the survey. Whilst to a certain extent this may reflect the fact that the survey questionnaire was generally completed in the same week as the logbooks, the correlations nevertheless support the generalisation of results beyond the window of time examined in the onboard investigation.

24. CONCLUSIONS FROM THE LOGBOOKS

Logbooks were completed by 177 participants from seven ships in the short sea shipping industry. The information obtained from the logbooks was more sophisticated than in phase 1 and not only covered sleeping, eating, drinking, medication use and smoking but also the work environment, job demands and support, control and job satisfaction.

The results showed that there were no differences between the phase 1 and phase 2 sleep variables. This confirms that seafarers report poorer sleep than onshore controls. Ship type was found to relate to a number of differences but some of these (e.g. sleep variables) could be better accounted for by working hours rather than ship *per se*. However, physical effort and job demands were higher on the passenger ferries than the tankers and these results did not reflect between ship variation in work schedules.

No differences were found between marine and non-marine crew. However, officers reported their jobs to be more demanding and stressful (but also more interesting) than did the ratings. Analyses of the survey data revealed no difference between reported health of officers and ratings which suggests that the positive aspects of the officers' jobs (e.g. greater control) may act as a buffer against the high demands.

Noise and motion were found to have little effect but length of tour and the working week were important factors. Job stress increased over the seven days that the seafarers were studied. However, other potential problems decreased with length of tour (e.g. sleep improved further into the tour and there appeared to be habituation to noise). Such findings confirm results from the survey which suggested that longer tours were associated with less fatigue.

The next set of analyses examined associations between the logbook variables and reports of fatigue (from the survey). Fatigue was predicted by job effort, sleep and work satisfaction. Again, the combined effects of potential negative work characteristics were found to be a good predictor of negative outcomes.

The final issue considered was whether measures taken from the logbook were associated with the survey data. There was support for the view that the time period we examined was representative of the "job in general" although some of the associations were modest.

The next section reports results from the objective measures taken aboard ship.

25. ASSESSMENT OF PERFORMANCE AND MOOD ABOARD SHIP

25.1 Performance and mood

The same performance tests and mood ratings were used as in Phase 1. A brief outline of the tasks and what is measured is given in the following section.

Visual Analogue Mood Scales

Mood was assessed using an 18 item computerised visual analogue mood rating scale (after Herbert, Johns and Dore, 1976). Three main factors were derived from the scale: alertness, hedonic tone, and anxiety.

Variable fore-period simple reaction time task

In this task a box appears in the centre of the screen, and at varying intervals (from 1-8 seconds) a target square appears in the centre of the box. Average reaction times are calculated for each minute, and for the task overall.

Focused attention task (Broadbent et al. (1986, 1989)

In this task target letters (either A or B) appear in the centre of the screen. Participants are required to respond by pressing the same letter as marked on the response box, as quickly and accurately as possible. Distracters may also be presented either side of the letter, for example A's, B's, or asterisks. Three blocks of 64 target letters are presented with rest breaks in the middle. From this task a number of factors are measured:

- Mean reaction time
- Momentary lapses of attention – errors, occasional long RTs
- Focusing of attention (whether attention is focused or set to a wide angle – the "Eriksen effect")
- Speed of encoding of new information (the difference between responses to the same stimulus as the previous trial and responses that are different and require more processing).

Categoric search task (Broadbent et al. (1986, 1989)

The categoric search task is similar to the focused attention task, both in how the participant responds and how the task is presented on the screen. The major difference is that the participant does not know in which of two possible locations the target will appear. Again participants are required to respond to target letters (either A or B) by pressing the same letter as marked on the response box, as quickly and accurately as possible. However, these letters may be presented either in the centre, or the far left, or the far right of the screen, with or without distracters (numbers). Again, three blocks of 64 target letters are presented with rest breaks in the middle. From this task a number of factors are measured:

- Mean reaction time
- Momentary lapses of attention – errors, occasional long RTs
- Speed of encoding of new information (the difference between responses to the same stimulus as the previous trial and responses that are different and require more processing).
- Reaction times for compatible and incompatible responses (compatible – stimulus on same side of screen as hand of response; incompatible – stimulus on opposite side of screen).
- Effects of spatial uncertainty (if a target can occur in two locations which are widely separated then RTs are slower than if the two locations are close together).

- The place repetition effect – when you don't know which of two locations a target will appear in, then you are quicker if the target occurs in the same place as a previous trial than if it occurs in a different location.

Factor analyses confirm that these tests measure a number of different functions:

1. Speed of response in the choice reaction time tasks (both mean reaction time and number of long responses).
2. Accuracy of responding in choice reaction time tasks
3. Simple reaction time
4. Focusing of attention (the extent to which attention is set to a wide angle or focused on the central visual field – the Eriksen effect).
5. Stimulus-response compatibility
6. Speed of encoding of new information
7. Mood – alertness, hedonic tone, anxiety

Analyses were conducted on these measures obtained before and after work on days 1 and 7. In addition, change scores were calculated over the day and over the week.

25.2 General findings

The sample studied in Phase 2 had slower reaction times, were less accurate and reported a more negative mood than those tested in Phase 1. These differences were found at all times but did not show up in the change scores. These results were found for all ships, although numerically those on the fast ferry had the worst performance, and were not modified by temporal factors (shift timing and length, days into tour), job type or nationality.

25.3 Specific results

Analyses of covariance were carried out comparing the Phase 1 and 2 samples and covarying age. Table 78 shows the variables where significant differences were found. It can be seen that these differences were restricted to four factors – simple reaction time, choice reaction time speed, choice reaction time accuracy and mood. The differences were significant at all times but there were no significant effects in the change scores (see Table 79) suggesting that it was not the nature of the work that was having an effect. Tables 80 to 84 show specific examples of these effects and in all cases those in Phase 2 are slower, less accurate and have a more negative mood. Many of the impairments (e.g. lapses of attention – occasional long responses, errors; slow simple reaction time) are greater than 10%, which is the effect size that one typically gets in low alertness states.

Separate analyses compared the type of ship studied in phase 2 with the phase 1 sample. All ships were found to be significantly different from phase 1, with the fast ferries showing the biggest numerical difference.

Table 78: Performance variables where significant differences were found between phase 1 and 2. These variables are grouped into 7 factors identified by factor analysis (The shaded boxes indicate the variables that were found to be significant and the double border indicate the significant factors)

	Factor	*Variables in factor*	*Session 1*	*Session 2*	*Session 3*	*Session 4*
1	**Reaction time measures**	Mean reaction time on the focused attention task to the target presented alone or with asterisk (ms)	Sig	Sig	Sig	Sig
		Mean reaction time on the focused attention task to targets when distracters are present, whether they agree/disagree (ms)	Sig	Sig	Sig	Sig
		Mean reaction time on the focused attention task to targets presented alone (ms)	Sig	Sig	Sig	Sig
		Mean reaction time on the categoric search task to targets presented alone or with asterisk (ms)	Sig	Sig	Sig	Sig
		Categoric search, Mean reaction time to targets in blank compatible conditions (ms)	Sig	Sig	Sig	Sig
		Number of long responses on the focused attention task (> 800 ms)	Sig	Sig	Sig	NS
		Number of long responses on the categoric search task (> 1000 ms)	Sig	Sig	Sig	Sig
2	**Accuracy measures**	Number of errors on the focused attention task	Sig	Sig	Sig	NS
		Number of errors on the categoric search task	NS	NS	Sig	NS
		Mean accuracy on the focused attention task to targets presented alone or with asterisk	Sig	Sig	Sig	Sig
		Mean accuracy on the focused attention task to targets with distracters present	Sig	Sig	NS	Sig
		Mean accuracy on the categoric search task to targets presented alone or with asterisk	Sig	Sig	Sig	Sig
3	**Simple reaction time**	Mean overall reaction time on the simple reaction time task (ms)	Sig	Sig	Sig	Sig
4	**Mood measures**	Alertness	NS	Sig	Sig	Sig
		Hedonic tone	Sig	Sig	Sig	Sig
		Anxiety	Sig	Sig	Sig	Sig
5	**Speed of Encoding**	Mean reaction time taken to encode new information on the focused attention task (ms)[1]	NS	NS	NS	NS
		Mean reaction time taken to encode new information on the categoric search task (ms)	NS	NS	NS	NS
6	**Compatibility**	The effect of compatibility of the target position and response key on reaction time on the categoric search task (ms)[2]	NS	NS	NS	NS
7	**The Eriksen effect**	Mean reaction time taken to focus attention on the focused attention task (ms) (The Eriksen effect)[3]	NS	NS	NS	NS

[1] The difference between alternations and repetitions; the higher the score the greater the slowing of responses when processing a new stimulus.
[2] The difference between incompatible and compatible presentations in a) near/blank, b) far/blank, c) near/digit and d) far/digit conditions; the lower the score the faster the responses in compatible compared to incompatible target presentations.
[3] The difference between disagreeing stimuli presented near to and far from the target; the greater the score the more focused the attention

Table 79: Performance variables where significant differences were found between phase 1 and 2 change scores across day 1, day 7, and the working week. These variables are grouped into 7 factor identified by factor analysis (The shaded boxes indicate the variables which were found to be significant and the double border indicate the significant factors)

Factor	*Variables in factor*	*Day 1 change(%)*	*Day 7 change(%)*	*Day 1-7 change(%)*
Reaction time measures	Mean reaction time on the focused attention task to the target presented alone or with asterisk (ms)	NS	NS	NS
	Mean reaction time on the focused attention task to targets when distracters are present, whether they agree/disagree (ms)	NS	NS	NS
	Mean reaction time on the focused attention task to targets presented alone (ms)	NS	NS	NS
	Mean reaction time on the categoric search task to targets presented alone or with asterisk (ms)	NS	NS	NS
	Categoric search, Mean reaction time to targets in blank compatible conditions (ms)	NS	NS	NS
	Number of long responses on the focused attention task (> 800 ms)	NS	NS	NS
	Number of long responses on the categoric search task (> 1000 ms)	NS	NS	NS
Accuracy measures	Number of errors on the focused attention task	NS	NS	NS
	Number of errors on the categoric search task	NS	NS	Sig
	Mean accuracy on the focused attention task to targets presented alone or with asterisk	NS	NS	NS
	Mean accuracy on the focused attention task to targets with distracters present	NS	NS	NS
	Mean accuracy on the categoric search task to targets presented alone or with asterisk	NS	NS	NS
Simple reaction time	Mean overall reaction time on the simple reaction time task (ms)	NS	NS	NS
Mood measures	Alertness	NS	NS	NS
	Hedonic tone	NS	NS	NS
	Anxiety	NS	NS	NS
Speed of Encoding	Mean reaction time taken to encode new information on the focused attention task (ms)[1]	NS	NS	NS
	Mean reaction time taken to encode new information on the categoric search task (ms)	NS	NS	NS
Compatibility	The effect of compatibility of the target position and response key on reaction time on the categoric search task (ms)[2]	NS	NS	NS
The Eriksen effect	Mean reaction time taken to focus attention on the focused attention task (ms) (The Eriksen effect)[3]	NS	NS	NS

[1] The difference between alternations and repetitions; the higher the score the greater the slowing of responses when processing a new stimulus.
[2] The difference between incompatible and compatible presentations in a) near/blank, b) far/blank, c) near/digit and d) far/digit conditions; the lower the score the faster the responses in compatible compared to incompatible target presentations.
[3] The difference between disagreeing stimuli presented near to and far from the target; the greater the score the more focused the attention

Table 80: Mean reaction time on the focused attention task to the target presented alone or with asterisk (ms) (S.E. in parentheses)

	Phase 1	Phase 2
Mean reaction time (ms)		
Day 1 before shift	489.4 (5.9)	505.8 (5.7)
Day 1 after shift	474.7 (6.1)	487.5 (5.7)
Day 7 before shift	469.7 (8.3)	489.2 (5.7)
Day 7 after shift	453.3 (7.3)	477.6 (5.9)

Table 81: Mean number of long responses on the categoric search task (S.E. in parentheses)

	Phase 1	Phase 2
Mean number of long responses (> 1000 ms)		
Day 1 before shift	5.65 (0.56)	8.61 (0.67)
Day 1 after shift	4.90 (0.57)	7.78 (0.66)
Day 7 before shift	2.84 (0.59)	7.43 (0.70)
Day 7 after shift	2.95 (0.66)	6.41 (0.67)

Table 82: Mean number of errors on the focused attention task (S.E. in parentheses)

	Phase 1	Phase 2
Mean number of errors		
Day 1 before shift	3.06 (0.32)	4.59 (0.43)
Day 1 after shift	3.47 (0.34)	4.92 (0.43)
Day 7 before shift	2.78 (0.44)	4.44 (0.43)
Day 7 after shift	3.30 (0.47)	4.91 (0.45)

Table 83: Mean overall reaction time on the simple reaction time task (ms) (S.E. in parentheses)

	Phase 1	Phase 2
Mean reaction time (ms)		
Day 1 before shift	315.9 (5.3)	356.2 (5.0)
Day 1 after shift	319.1 (5.4)	362.9 (5.0)
Day 7 before shift	333.3 (9.7)	371.6 (5.9)
Day 7 after shift	333.8 (10.0)	379.9 (5.9)

Table 84: Mean alertness score (S.E. in parentheses – high scores=greater alertness)

Alertness	Phase 1	Phase 2
Day 1 before shift	262.39 (5.64)	244.18 (4.82)
Day 1 after shift	261.77 (5.71)	239.81 (4.87)
Day 7 before shift	259.71 (8.79)	240.42 (5.09)
Day 7 after shift	272.29 (8.50)	238.28 (5.30)

25.4 Effects of other factors on performance and mood

Analyses of covariance were carried out to determine whether job type and temporal factors (shift type and duration, days into tour) had effects on the performance and mood of the phase 2 sample. These results are summarized in Tables 85 to 96. None of these factors had major effects on performance and mood, and they certainly cannot account for the differences observed between the two phases.

Further analyses considered specific factors that might have had acute effects (e.g. precise time of testing, whether in port or at sea, caffeine and meals) but these had negligible effects. Similarly, there were few significant correlations between the sleep variables and performance and mood.

Table 85: Performance variables (raw scores at e ach test session) where significant differences were found between job types. These variables are grouped into 7 factor identified by factor analysis (The shaded boxes indicate the variables which were found to be significant and the double border indicate the significant factors)

	Factor	*Variables in factor*	*Session 1*	*Session 2*	*Session 3*	*Session 4*
1	**Reaction time measures**	Mean reaction time on the focused attention task to the target presented alone or with asterisk (ms)	NS	NS	NS	NS
		Mean reaction time on the focused attention task to targets when distracters are present, whether they agree/disagree (ms)	NS	NS	NS	NS
		Mean reaction time on the focused attention task to targets presented alone (ms)	NS	NS	NS	NS
		Mean reaction time on the categoric search task to targets presented alone or with asterisk (ms)	NS	NS	NS	NS
		Categoric search, Mean reaction time to targets in blank compatible conditions (ms)	NS	NS	NS	NS
		Number of long responses on the focused attention task (> 800 ms)	Sig	NS	NS	NS
		Number of long responses on the categoric search task (> 1000 ms)	Sig	NS	Sig	NS
2	**Accuracy measures**	Number of errors on the focused attention task	NS	NS	NS	NS
		Number of errors on the categoric search task	NS	NS	NS	NS
		Mean accuracy on the focused attention task to targets presented alone or with asterisk	NS	NS	NS	NS
		Mean accuracy on the focused attention task to targets with distracters present	NS	NS	NS	NS
		Mean accuracy on the categoric search task to targets presented alone or with asterisk	NS	NS	NS	NS
3	**Simple reaction time**	Mean overall reaction time on the simple reaction time task (ms)	NS	NS	NS	NS
4	**Mood measures**	Alertness	NS	NS	NS	NS
		Hedonic tone	NS	NS	NS	NS
		Anxiety	NS	NS	NS	NS
5	**Speed of Encoding**	Mean reaction time taken to encode new information on the focused attention task (ms)[1]	NS	NS	NS	NS
		Mean reaction time taken to encode new information on the categoric search task (ms)	NS	NS	NS	NS
6	**Compatibility**	The effect of compatibility of the target position and response key on reaction time on the categoric search task (ms)[2]	NS	NS	NS	NS
7	**The Eriksen effect**	Mean reaction time taken to focus attention on the focused attention task (ms) (The Eriksen effect)[3]	NS	NS	NS	NS

[1] The difference between alternations and repetitions; the higher the score the greater the slowing of responses when processing a new stimulus.
[2] The difference between incompatible and compatible presentations in a) near/blank, b) far/blank, c) near/digit and d) far/digit conditions; the lower the score the faster the responses in compatible compared to incompatible target presentations.
[3] The difference between disagreeing stimuli presented near to and far from the target; the greater the score the more focused the attention

Table 86: Performance variables (change scores across day 1, day 7, and the working week) where significant differences were found between job types (phase 2 only) These variables are grouped into 7 factors identified within factor analysis (The shaded boxes indicate the variables which were found to be significant and the double border indicate the significant factors)

Factor	*Variables in factor*	*Day 1 change(%)*	*Day 7 change(%)*	*Day 1-7 change(%)*
Reaction time measures	Mean reaction time on the focused attention task to the target presented alone or with asterisk (ms)	NS	NS	NS
	Mean reaction time on the focused attention task to targets when distracters are present, whether they agree/disagree (ms)	NS	NS	NS
	Mean reaction time on the focused attention task to targets presented alone (ms)	NS	NS	NS
	Mean reaction time on the categoric search task to targets presented alone or with asterisk (ms)	NS	NS	NS
	Categoric search, Mean reaction time to targets in blank compatible conditions (ms)	NS	NS	NS
	Number of long responses on the focused attention task (> 800 ms)	NS	NS	NS
	Number of long responses on the categoric search task (> 1000 ms)	NS	NS	NS
Accuracy measures	Number of errors on the focused attention task	NS	NS	NS
	Number of errors on the categoric search task	NS	NS	NS
	Mean accuracy on the focused attention task to targets presented alone or with asterisk	NS	NS	NS
	Mean accuracy on the focused attention task to targets with distracters present	NS	Sig	NS
	Mean accuracy on the categoric search task to targets presented alone or with asterisk	NS	NS	NS
Simple reaction time	Mean overall reaction time on the simple reaction time task (ms)	NS	NS	NS
Mood measures	Alertness	NS	NS	NS
	Hedonic tone	NS	NS	Sig
	Anxiety	NS	NS	NS
Speed of Encoding	Mean reaction time taken to encode new information on the focused attention task (ms)[1]	NS	NS	NS
	Mean reaction time taken to encode new information on the categoric search task (ms)	NS	NS	NS
Compatibility	The effect of compatibility of the target position and response key on reaction time on the categoric search task (ms)[2]	NS	NS	NS
The Eriksen effect	Mean reaction time taken to focus attention on the focused attention task (ms) (The Eriksen effect)[3]	NS	NS	NS

[1] The difference between alternations and repetitions; the higher the score the greater the slowing of responses when processing a new stimulus.
[2] The difference between incompatible and compatible presentations in a) near/blank, b) far/blank, c) near/digit and d) far/digit conditions; the lower the score the faster the responses in compatible compared to incompatible target presentations.
[3] The difference between disagreeing stimuli presented near to and far from the target; the greater the score the more focused the attention

Table 87: Performance variables (raw scores at each test session) where significant differences were found between different nationalities groupings (phase 2 only). These variables are grouped into 7 factor identified by factor analysis (The shaded boxes indicate the variables which were found to be significant and the double border indicate the significant factors)

	Factor	*Variables in factor*	*Session 1*	*Session 2*	*Session 3*	*Session 4*
1	**Reaction time measures**	Mean reaction time on the focused attention task to the target presented alone or with asterisk (ms)	NS	NS	NS	Sig
		Mean reaction time on the focused attention task to targets when distracters are present, whether they agree/disagree (ms)	NS	NS	NS	NS
		Mean reaction time on the focused attention task to targets presented alone (ms)	NS	NS	NS	Sig
		Mean reaction time on the categoric search task to targets presented alone or with asterisk (ms)	NS	NS	NS	NS
		Categoric search, Mean reaction time to targets in blank compatible conditions (ms)	NS	NS	NS	NS
		Number of long responses on the focused attention task (> 800 ms)	NS	NS	NS	NS
		Number of long responses on the categoric search task (> 1000 ms)	NS	NS	NS	NS
2	**Accuracy measures**	Number of errors on the focused attention task	NS	NS	NS	NS
		Number of errors on the categoric search task	NS	NS	NS	NS
		Mean accuracy on the focused attention task to targets presented alone or with asterisk	NS	NS	NS	Sig
		Mean accuracy on the focused attention task to targets with distracters present	NS	NS	NS	NS
		Mean accuracy on the categoric search task to targets presented alone or with asterisk	NS	NS	NS	NS
3	**Simple reaction time**	Mean overall reaction time on the simple reaction time task (ms)	NS	NS	NS	NS
4	**Mood measures**	Alertness	NS	Sig	NS	NS
		Hedonic tone	NS	NS	NS	NS
		Anxiety	NS	NS	NS	NS
5	**Speed of Encoding**	Mean reaction time taken to encode new information on the focused attention task (ms)[1]	NS	NS	NS	NS
		Mean reaction time taken to encode new information on the categoric search task (ms)	NS	NS	NS	NS
6	**Compatibility**	The effect of compatibility of the target position and response key on reaction time on the categoric search task (ms)[2]	NS	NS	Sig	NS
7	**The Eriksen effect**	Mean reaction time taken to focus attention on the focused attention task (ms) (The Eriksen effect)[3]	Sig	NS	NS	NS

[1] The difference between alternations and repetitions; the higher the score the greater the slowing of responses when processing a new stimulus.
[2] The difference between incompatible and compatible presentations in a) near/blank, b) far/blank, c) near/digit and d) far/digit conditions; the lower the score the faster the responses in compatible compared to incompatible target presentations.
[3] The difference between disagreeing stimuli presented near to and far from the target; the greater the score the more focused the attention

Table 88: Performance variables (change scores across day 1, day 7, and the working week) where significant differences were found between nationality groupings (phase 2 only) . These variables are grouped into 7 factor identified by factor analysis (The shaded boxes indicate the variables which were found to be significant and the double border indicate the significant factors)

Factor	*Variables in factor*	*Day 1 change(%)*	*Day 7 change(%)*	*Day 1-7 change(%)*
Reaction time measures	Mean reaction time on the focused attention task to the target presented alone or with asterisk (ms)	Sig	Sig	NS
	Mean reaction time on the focused attention task to targets when distracters are present, whether they agree/disagree (ms)	NS	Sig	Sig
	Mean reaction time on the focused attention task to targets presented alone (ms)	Sig	NS	NS
	Mean reaction time on the categoric search task to targets presented alone or with asterisk (ms)	NS	NS	NS
	Categoric search, Mean reaction time to targets in blank compatible conditions (ms)	NS	Sig	NS
	Number of long responses on the focused attention task (> 800 ms)	Sig	NS	NS
	Number of long responses on the categoric search task (> 1000 ms)	NS	NS	NS
Accuracy measures	Number of errors on the focused attention task	NS	Sig	NS
	Number of errors on the categoric search task	NS	Sig	NS
	Mean accuracy on the focused attention task to targets presented alone or with asterisk	NS	Sig	NS
	Mean accuracy on the focused attention task to targets with distracters present	NS	Sig	NS
	Mean accuracy on the categoric search task to targets presented alone or with asterisk	NS	NS	NS
Simple reaction time	Mean overall reaction time on the simple reaction time task (ms)	NS	NS	NS
Mood measures	Alertness	NS	NS	NS
	Hedonic tone	NS	NS	NS
	Anxiety	NS	NS	NS
Speed of Encoding	Mean reaction time taken to encode new information on the focused attention task (ms)[1]	NS	NS	NS
	Mean reaction time taken to encode new information on the categoric search task (ms)	NS	NS	NS
Compatibility	The effect of compatibility of the target position and response key on reaction time on the categoric search task (ms)[2]	NS	NS	NS
The Eriksen effect	Mean reaction time taken to focus attention on the focused attention task (ms) (The Eriksen effect)[3]	NS	NS	NS

[1] The difference between alternations and repetitions; the higher the score the greater the slowing of responses when processing a new stimulus.
[2] The difference between incompatible and compatible presentations in a) near/blank, b) far/blank, c) near/digit and d) far/digit conditions; the lower the score the faster the responses in compatible compared to incompatible target presentations.
[3] The difference between disagreeing stimuli presented near to and far from the target; the greater the score the more focused the attention

Table 89: Performance variables (raw scores at each test session) where significant differences were found between shift hour groupings (phase 2 only) . These variables are grouped into 7 factor identified by factor analysis (The shaded boxes indicate the variables which were found to be significant and the double border indicate the significant factors)

	Factor	*Variables in factor*	*Session 1*	*Session 2*	*Session 3*	*Session 4*
1	**Reaction time measures**	Mean reaction time on the focused attention task to the target presented alone or with asterisk (ms)	NS	NS	NS	NS
		Mean reaction time on the focused attention task to targets when distracters are present, whether they agree/disagree (ms)	NS	NS	NS	NS
		Mean reaction time on the focused attention task to targets presented alone (ms)	NS	Sig	NS	NS
		Mean reaction time on the categoric search task to targets presented alone or with asterisk (ms)	Sig	NS	NS	NS
		Categoric search, Mean reaction time to targets in blank compatible conditions (ms)	NS	NS	NS	NS
		Number of long responses on the focused attention task (> 800 ms)	NS	Sig	NS	NS
		Number of long responses on the categoric search task (> 1000 ms)	NS	NS	NS	NS
2	**Accuracy measures**	Number of errors on the focused attention task	NS	NS	NS	NS
		Number of errors on the categoric search task	NS	NS	NS	Sig
		Mean accuracy on the focused attention task to targets presented alone or with asterisk	NS	NS	NS	NS
		Mean accuracy on the focused attention task to targets with distracters present	NS	NS	NS	NS
		Mean accuracy on the categoric search task to targets presented alone or with asterisk	NS	NS	NS	NS
3	**Simple reaction time**	Mean overall reaction time on the simple reaction time task (ms)	NS	NS	NS	NS
4	**Mood measures**	Alertness	NS	NS	NS	NS
		Hedonic tone	NS	NS	NS	NS
		Anxiety	NS	NS	NS	NS
5	**Speed of Encoding**	Mean reaction time taken to encode new information on the focused attention task (ms)[1]	NS	NS	NS	NS
		Mean reaction time taken to encode new information on the categoric search task (ms)	NS	NS	NS	NS
6	**Compatibility**	The effect of compatibility of the target position and response key on reaction time on the categoric search task (ms)[2]	NS	NS	NS	NS
7	**The Eriksen effect**	Mean reaction time taken to focus attention on the focused attention task (ms) (The Eriksen effect)[3]	NS	NS	NS	NS

[1] The difference between alternations and repetitions; the higher the score the greater the slowing of responses when processing a new stimulus.
[2] The difference between incompatible and compatible presentations in a) near/blank, b) far/blank, c) near/digit and d) far/digit conditions; the lower the score the faster the responses in compatible compared to incompatible target presentations.
[3] The difference between disagreeing stimuli presented near to and far from the target; the greater the score the more focused the attention

Table 90: Performance variables (change scores across day 1, day 7, and the working week) where significant differences were found between shift hour groupings (phase 2 only) . These variables are grouped into 7 factor identified by factor analysis (The shaded boxes indicate the variables which were found to be significant and the double border indicate the significant factors)

Factor	*Variables in factor*	*Day 1 change(%)*	*Day 7 change(%)*	*Day 1-7 change(%)*
Reaction time measures	Mean reaction time on the focused attention task to the target presented alone or with asterisk (ms)	NS	NS	NS
	Mean reaction time on the focused attention task to targets when distracters are present, whether they agree/disagree (ms)	NS	NS	NS
	Mean reaction time on the focused attention task to targets presented alone (ms)	NS	NS	NS
	Mean reaction time on the categoric search task to targets presented alone or with asterisk (ms)	NS	NS	NS
	Categoric search, Mean reaction time to targets in blank compatible conditions (ms)	NS	NS	NS
	Number of long responses on the focused attention task (> 800 ms)	NS	NS	NS
	Number of long responses on the categoric search task (> 1000 ms)	NS	NS	NS
Accuracy measures	Number of errors on the focused attention task	NS	NS	NS
	Number of errors on the categoric search task	NS	NS	NS
	Mean accuracy on the focused attention task to targets presented alone or with asterisk	NS	NS	NS
	Mean accuracy on the focused attention task to targets with distracters present	NS	NS	NS
	Mean accuracy on the categoric search tas k to targets presented alone or with asterisk	NS	NS	NS
Simple reaction time	Mean overall reaction time on the simple reaction time task (ms)	NS	NS	NS
Mood measures	Alertness	NS	NS	NS
	Hedonic tone	NS	NS	NS
	Anxiety	NS	NS	NS
Speed of Encoding	Mean reaction time taken to encode new information on the focused attention task (ms)[1]	NS	NS	NS
	Mean reaction time taken to encode new information on the categoric search task (ms)	NS	NS	NS
Compatibility	The effect of compatibility of the target position and response key on reaction time on the categoric search task (ms)[2]	NS	NS	NS
The Eriksen effect	Mean reaction time taken to focus attention on the focused attention task (ms) (The Eriksen effect)[3]	NS	NS	NS

[1] The difference between alternations and repetitions; the higher the score the greater the slowing of responses when processing a new stimulus.
[2] The difference between incompatible and compatible presentations in a) near/blank, b) far/blank, c) near/digit and d) far/digit conditions; the lower the score the faster the responses in compatible compared to incompatible target presentations.
[3] The difference between disagreeing stimuli presented near to and far from the target; the greater the score the more focused the attention

Table 91: Performance variables (raw scores at each test session) where significant differences were found between single and split shift groups (phase 2 only) . These variables are grouped into 7 factor identified by factor analysis (The shaded boxes indicate the variables which were found to be significant and the double border indicate the significant factors)

	Factor	*Variables in factor*	*Session 1*	*Session 2*	*Session 3*	*Session 4*
1	**Reaction time measures**	Mean reaction time on the focused attention task to the target presented alone or with asterisk (ms)	NS	NS	NS	NS
		Mean reaction time on the focused attention task to targets when distracters are present, whether they agree/disagree (ms)	NS	NS	NS	NS
		Mean reaction time on the focused attention task to targets presented alone (ms)	NS	NS	NS	NS
		Mean reaction time on the categoric search task to targets presented alone or with asterisk (ms)	NS	NS	NS	NS
		Categoric search, Mean reaction time to targets in blank compatible conditions (ms)	NS	NS	NS	NS
		Number of long responses on the focused attention task (> 800 ms)	NS	Sig	NS	NS
		Number of long responses on the categoric search task (> 1000 ms)	NS	NS	Sig	NS
2	**Accuracy measures**	Number of errors on the focused attention task	NS	NS	NS	NS
		Number of errors on the categoric search task	NS	NS	NS	NS
		Mean accuracy on the focused attention task to targets presented alone or with asterisk	NS	NS	NS	NS
		Mean accuracy on the focused attention task to targets with distracters present	NS	NS	NS	NS
		Mean accuracy on the categoric search task to targets presented alone or with asterisk	NS	NS	NS	NS
3	**Simple reaction time**	Mean overall reaction time on the simple reaction time task (ms)	NS	NS	Sig	NS
4	**Mood measures**	Alertness	NS	NS	Sig	NS
		Hedonic tone	NS	NS	Sig	NS
		Anxiety	NS	NS	NS	NS
5	**Speed of Encoding**	Mean reaction time taken to encode new information on the focused attention task (ms)[1]	NS	NS	NS	NS
		Mean reaction time taken to encode new information on the categoric search task (ms)	NS	NS	NS	NS
6	**Compatibility**	The effect of compatibility of the target position and response key on reaction time on the categoric search task (ms)[2]	NS	NS	NS	NS
7	**The Eriksen effect**	Mean reaction time taken to focus attention on the focused attention task (ms) (The Eriksen effect)[3]	NS	NS	NS	NS

[1] The difference between alternations and repetitions; the higher the score the greater the slowing of responses when processing a new stimulus.
[2] The difference between incompatible and compatible presentations in a) near/blank, b) far/blank, c) near/digit and d) far/digit conditions; the lower the score the faster the responses in compatible compared to incompatible target presentations.
[3] The difference between disagreeing stimuli presented near to and far from the target; the greater the score the more focused the attention

Table 92: Performance variables (change scores across day 1, day 7, and the working week) where significant differences were found between single and split shift groups (phase 2 only). These variables are grouped into 7 factor identified by factor analysis (The shaded boxes indicate the variables which were found to be significant and the double border indicate the significant factors)

Factor	*Variables in factor*	*Day 1 change(%)*	*Day 7 change(%)*	*Day 1-7 change(%)*
Reaction time measures	Mean reaction time on the focused attention task to the target presented alone or with asterisk (ms)	Sig	Sig	NS
	Mean reaction time on the focused attention task to targets when distracters are present, whether they agree/disagree (ms)	NS	Sig	NS
	Mean reaction time on the focused attention task to targets presented alone (ms)	NS	Sig	NS
	Mean reaction time on the categoric search task to targets presented alone or with asterisk (ms)	NS	NS	NS
	Categoric search, Mean reaction time to targets in blank compatible conditions (ms)	NS	Sig	NS
	Number of long responses on the focused attention task (> 800 ms)	NS	NS	NS
	Number of long responses on the categoric search task (> 1000 ms)	Sig	NS	NS
Accuracy measures	Number of errors on the focused attention task	NS	NS	NS
	Number of errors on the categoric search task	NS	NS	NS
	Mean accuracy on the focused attention task to targets presented alone or with asterisk	NS	NS	NS
	Mean accuracy on the focused attention task to targets with distracters present	NS	NS	NS
	Mean accuracy on the categoric search task to targets presented alone or with asterisk	NS	NS	NS
Simple reaction time	Mean overall reaction time on the simple reaction time task (ms)	NS	NS	NS
Mood measures	Alertness	NS	Sig	NS
	Hedonic tone	NS	NS	NS
	Anxiety	NS	NS	NS
Speed of Encoding	Mean reaction time taken to encode new information on the focused attention task (ms)[1]	NS	NS	NS
	Mean reaction time taken to encode new information on the categoric search task (ms)	NS	NS	NS
Compatibility	The effect of compatibility of the target position and response key on reaction time on the categoric search task (ms)[2]	NS	NS	NS
The Eriksen effect	Mean reaction time taken to focus attention on the focused attention task (ms) (The Eriksen effect)[3]	NS	NS	NS

[1] The difference between alternations and repetitions; the higher the score the greater the slowing of responses when processing a new stimulus.
[2] The difference between incompatible and compatible presentations in a) near/blank, b) far/blank, c) near/digit and d) far/digit conditions; the lower the score the faster the responses in compatible compared to incompatible target presentations.
[3] The difference between disagreeing stimuli presented near to and far from the target; the greater the score the more focused the attention

Table 93: Performance variables (raw scores at each test session) where significant differences were found between day or night shift groups (phase 2 only). These variables are grouped into 7 factor identified by factor analysis (The shaded boxes indicate the variables which were found to be significant and the double border indicate the significant factors)

	Factor	*Variables in factor*	*Session 1*	*Session 2*	*Session 3*	*Session 4*
1	**Reaction time measures**	Mean reaction time on the focused attention task to the target presented alone or with asterisk (ms)	NS	NS	NS	NS
		Mean reaction time on the focused attention task to targets when distracters are present, whether they agree/disagree (ms)	NS	NS	NS	NS
		Mean reaction time on the focused attention task to targets presented alone (ms)	NS	NS	NS	NS
		Mean reaction time on the categoric search task to targets presented alone or with asterisk (ms)	NS	NS	NS	NS
		Categoric search, Mean reaction time to targets in blank compatible conditions (ms)	NS	NS	NS	NS
		Number of long responses on the focused attention task (> 800 ms)	NS	NS	NS	NS
		Number of long responses on the categoric search task (> 1000 ms)	NS	NS	NS	NS
2	**Accuracy measures**	Number of errors on the focused attention task	NS	NS	NS	NS
		Number of errors on the categoric search task	NS	NS	NS	NS
		Mean accuracy on the focused attention task to targets presented alone or with asterisk	NS	NS	NS	NS
		Mean accuracy on the focused attention task to targets with distracters present	NS	NS	NS	NS
		Mean accuracy on the categoric search task to targets presented alone or with asterisk	NS	NS	NS	NS
3	**Simple reaction time**	Mean overall reaction time on the simple reaction time task (ms)	NS	NS	NS	NS
4	**Mood measures**	Alertness	NS	NS	NS	NS
		Hedonic tone	NS	NS	NS	NS
		Anxiety	NS	NS	NS	NS
5	**Speed of Encoding**	Mean reaction time taken to encode new information on the focused attention task (ms)[1]	NS	NS	NS	NS
		Mean reaction time taken to encode new information on the categoric search task (ms)	NS	NS	NS	NS
6	**Compatibility**	The effect of compatibility of the target position and response key on reaction time on the categoric search task (ms)[2]	NS	NS	NS	NS
7	**The Eriksen effect**	Mean reaction time taken to focus attention on the focused attention task (ms) (The Eriksen effect)[3]	NS	NS	NS	NS

[1] The difference between alternations and repetitions; the higher the score the greater the slowing of responses when processing a new stimulus.

[2] The difference between incompatible and compatible presentations in a) near/blank, b) far/blank, c) near/digit and d) far/digit conditions; the lower the score the faster the responses in compatible compared to incompatible target presentations.

[3] The difference between disagreeing stimuli presented near to and far from the target; the greater the score the more focused the attention

Table 94: Performance variables (change scores across day 1, day 7, and the working week) where significant differences were found between day or night shift groups (phase 2 only). These variables are grouped into 7 factor identified by factor analysis (The shaded boxes indicate the variables which were found to be significant and the double border indicate the significant factors)

Factor	*Variables in factor*	*Day 1 change(%)*	*Day 7 change(%)*	*Day 1-7 change(%)*
Reaction time measures	Mean reaction time on the focused attention task to the target presented alone or with asterisk (ms)	NS	NS	NS
	Mean reaction time on the focused attention task to targets when distracters are present, whether they agree/disagree (ms)	NS	NS	NS
	Mean reaction time on the focused attention task to targets presented alone (ms)	NS	NS	NS
	Mean reaction time on the categoric search task to targets presented alone or with asterisk (ms)	NS	NS	NS
	Categoric search, Mean reaction time to targets in blank compatible conditions (ms)	NS	NS	NS
	Number of long responses on the focused attention task (> 800 ms)	NS	NS	Sig
	Number of long responses on the categoric search task (> 1000 ms)	NS	NS	NS
Accuracy measures	Number of errors on the focused attention task	NS	NS	NS
	Number of errors on the categoric search task	NS	NS	NS
	Mean accuracy on the focused attention task to targets presented alone or with asterisk	NS	NS	NS
	Mean accuracy on the focused attention task to targets with distracters present	NS	NS	NS
	Mean accuracy on the categoric search task to targets presented alone or with asterisk	NS	NS	NS
Simple reaction time	Mean overall reaction time on the simple reaction time task (ms)	NS	NS	NS
Mood measures	Alertness	NS	NS	NS
	Hedonic tone	NS	NS	NS
	Anxiety	NS	NS	NS
Speed of Encoding	Mean reaction time taken to encode new information on the focused attention task (ms)[1]	NS	NS	NS
	Mean reaction time taken to encode new information on the categoric search task (ms)	NS	NS	NS
Compatibility	The effect of compatibility of the target position and response key on reaction time on the categoric search task (ms)[2]	NS	NS	NS
The Eriksen effect	Mean reaction time taken to focus attention on the focused attention task (ms) (The Eriksen effect)[3]	NS	NS	NS

[1] The difference between alternations and repetitions; the higher the score the greater the slowing of responses when processing a new stimulus.
[2] The difference between incompatible and compatible presentations in a) near/blank, b) far/blank, c) near/digit and d) far/digit conditions; the lower the score the faster the responses in compatible compared to incompatible target presentations.
[3] The difference between disagreeing stimuli presented near to and far from the target; the greater the score the more focused the attention

Table 95: Performance variables (raw scores at each test session) where significant differences were found between days into tour groupings (phase 2 only). These variables are grouped into 7 factor identified by factor analysis (The shaded boxes indicate the variables which were found to be significant and the double border indicate the significant factors)

	Factor	*Variables in factor*	*Session 1*	*Session 2*	*Session 3*	*Session 4*
1	**Reaction time measures**	Mean reaction time on the focused attention task to the target presented alone or with asterisk (ms)	NS	NS	NS	NS
		Mean reaction time on the focused attention task to targets when distracters are present, whether they agree/disagree (ms)	NS	NS	NS	NS
		Mean reaction time on the focused attention task to targets presented alone (ms)	NS	NS	NS	NS
		Mean reaction time on the categoric search task to targets presented alone or with asterisk (ms)	NS	NS	NS	NS
		Categoric search, Mean reaction time to targets in blank compatible conditions (ms)	NS	NS	NS	NS
		Number of long responses on the focused attention task (> 800 ms)	NS	Sig	NS	NS
		Number of long responses on the categoric search task (> 1000 ms)	NS	NS	NS	NS
2	**Accuracy measures**	Number of errors on the focused attention task	NS	NS	NS	NS
		Number of errors on the categoric search task	NS	NS	NS	NS
		Mean accuracy on the focused attention task to targets presented alone or with asterisk	NS	NS	NS	NS
		Mean accuracy on the focused attention task to targets with distracters present	NS	NS	NS	NS
		Mean accuracy on the categoric search task to targets presented alone or with asterisk	NS	NS	NS	NS
3	**Simple reaction time**	Mean overall reaction time on the simple reaction time task (ms)	NS	NS	NS	NS
4	**Mood measures**	Alertness	NS	NS	NS	NS
		Hedonic tone	NS	NS	NS	NS
		Anxiety	NS	NS	NS	NS
5	**Speed of Encoding**	Mean reaction time taken to encode new information on the focused attention task (ms)[1]	NS	NS	NS	NS
		Mean reaction time taken to encode new information on the categoric search task (ms)	NS	NS	NS	NS
6	**Compatibility**	The effect of compatibility of the target position and response key on reaction time on the categoric search task (ms)[2]	NS	NS	Sig	NS
7	**The Eriksen effect**	Mean reaction time taken to focus attention on the focused attention task (ms) (The Eriksen effect)[3]	NS	NS	NS	NS

[1] The difference between alternations and repetitions; the higher the score the greater the slowing of responses when processing a new stimulus.
[2] The difference between incompatible and compatible presentations in a) near/blank, b) far/blank, c) near/digit and d) far/digit conditions; the lower the score the faster the responses in compatible compared to incompatible target presentations.
[3] The difference between disagreeing stimuli presented near to and far from the target; the greater the score the more focused the attention

Table 96: Performance variables (change scores across day 1, day 7, and the working week) where significant differences were found between days into tour groupings (phase 2 only) . These variables are grouped into 7 factor identified by factor analysis (The shaded boxes indicate the variables which were found to be significant and the double border indicate the significant factors)

Factor	*Variables in factor*	*Day 1 change(%)*	*Day 7 change(%)*	*Day 1-7 change(%)*
Reaction time measures	Mean reaction time on the focused attention task to the target presented alone or with asterisk (ms)	Sig	Sig	Sig
	Mean reaction time on the focused attention task to targets when distracters are present, whether they agree/disagree (ms)	NS	NS	NS
	Mean reaction time on the focused attention task to targets presented alone (ms)	Sig	NS	Sig
	Mean reaction time on the categoric search task to targets presented alone or with asterisk (ms)	NS	NS	NS
	Categoric search, Mean reaction time to targets in blank compatible conditions (ms)	NS	NS	NS
	Number of long responses on the focused attention task (> 800 ms)	Sig	NS	NS
	Number of long responses on the categoric search task (> 1000 ms)	NS	NS	NS
Accuracy measures	Number of errors on the focused attention task	NS	NS	NS
	Number of errors on the categoric search task	NS	NS	NS
	Mean accuracy on the focused attention task to targets presented alone or with asterisk	NS	NS	NS
	Mean accuracy on the focused attention task to targets with distracters present	NS	NS	NS
	Mean accuracy on the categoric search task to targets presented alone or with asterisk	NS	NS	NS
Simple reaction time	Mean overall reaction time on the simple reaction time task (ms)	NS	NS	NS
Mood measures	Alertness	NS	NS	NS
	Hedonic tone	NS	NS	NS
	Anxiety	NS	NS	NS
Speed of Encoding	Mean reaction time taken to encode new information on the focused attention task (ms)[1]	NS	NS	NS
	Mean reaction time taken to encode new information on the categoric search task (ms)	NS	NS	NS
Compatibility	The effect of compatibility of the target position and response key on reaction time on the categoric search task (ms)[2]	NS	NS	NS
The Eriksen effect	Mean reaction time taken to focus attention on the focused attention task (ms) (The Eriksen effect)[3]	NS	NS	NS

[1] The difference between alternations and repetitions; the higher the score the greater the slowing of responses when processing a new stimulus.
[2] The difference between incompatible and compatible presentations in a) near/blank, b) far/blank, c) near/digit and d) far/digit conditions; the lower the score the faster the responses in compatible compared to incompatible target presentations.
[3] The difference between disagreeing stimuli presented near to and far from the target; the greater the score the more focused the attention.

25.5 Correlations between performance and mood scores and data from the survey and logbooks

There were few significant correlations between variables from the survey and the performance and mood scores. However, levels of fatigue reported in the survey were correlated with lower alertness and less accurate performance. The logbook ratings of demand and effort were significantly correlated with changes in mood over the course of the working day and also with changes in simple reaction time. Those who reported greater demand and mental effort during the working day showed a greater decrease in alertness and greater slowing of reaction time over the course of the day.

25.6 Conclusions

Analyses of the performance and mood data showed that the Phase 2 sample had slower reaction times, were less accurate and reported a more negative mood than the Phase 1 sample. This is consistent with the greater fatigue and ill health reported in Phase 2. However, consideration of a number of job characteristics failed to identify variables responsible for the poorer performance and mood. This suggests two likely possibilities. First, the differences reflect characteristics of the sample that were not measured (e.g. motivation – interest in the research). Secondly, a major difference between the two phases is the voyage cycle time. All of those in Phase 2 were regularly in and out of port whereas those in Phase 1 spent most of the study period at sea. This issue will be pursued in the third phase of the project.

26. SLEEP

26.1 Measures

As in Phase 1, sleep was measured using actiwatches. This was done for the sleep period prior to the first performance testing sessions on days 1 and 7. Sleep recording was carried out for most participants except those on the fast ferry (only 14 had their sleep recorded). As those on the fast ferry slept at home rather than aboard ship this was not considered a major problem. Factor analysis of the actiwatch variables revealed that they were measuring 6 things:

1. Fragmented sleep
2. Activity
3. Sleep duration
4. Wake up time
5. Sleep start time
6. Length of periods asleep

26.2 General findings

Compared to Phase 1, the volunteers in Phase 2 slept for a shorter duration but were asleep for a greater percentage of this time (and hence had less activity during the sleep period). The larger number of participants working split shifts can at least in part, explain the shorter sleep duration in Phase 2. However, a number of other factors had specific effects on sleep and the differences between the two phases probably reflect the combined influence of several variables.

26.3 Differences between Phase 1 and Phase 2

Table 97 shows the significant differences between the two phases. Those in Phase 1 slept for longer but had greater activity showing that they were asleep for a lower percentage of the time than those in Phase 2. Specific examples of the effects are shown in Tables 98 and 99.

Table 97: Sleep variables for which significant difference were found between phase 1 and 2 for day 1, day 7, and changes in sleep across days. These variables are grouped into 6 factors identified by factor analysis (The shaded boxes indicate the variables which were found to be significant, and the double border indicate the significant factors)

	Factor	*Variables in factor*	*Day 1*	*Day 7*	*Day 1-7 change %*
1	**Restlessness**	*The number of immobile phases of 1 minute*- The number of immobile phases where duration was only 1 minute	NS	Sig	NS
		Percentage Immobility phases of 1 minute- The percentage immobility phase of 1 minute as a proportion of the total number of immobility phases. This value is also termed the fragmentation index	NS	NS	NS
		Fragmentation index- The sum of the time spent moving and the percentage immobility phases of 1 minute. This is used as an indicator of 'restlessness'.	NS	NS	NS
2	**Activity measures**	*Actual sleep percentage*- Actual sleep time as a percentage of the overall observed period	Sig	Sig	NS
		Actual wake percentage- Actual wake time as a percentage of the overall observed period	Sig	Sig	NS
		Total activity score- the total number of activity counts between sleep start and sleep end	Sig	Sig	NS
		Mean activity score- The average value of the activity counts per epoch over the assumed sleep period.	Sig	Sig	NS
3	**Sleep durations**	*Assumed sleep*- the difference between sleep end and sleep start.	Sig	Sig	NS
		Actual sleep time– the amount of sleep as determined by algorithms (excluding any wake time)	Sig	Sig	NS
		Time in bed- the difference between the bed time and get up time	Sig	Sig	
		Number of minutes immobile- The total number of minutes where a score of zero was recorded during the assumed sleep period	Sig	Sig	NS
4	**End times of sleep periods**	*Analysis end*- the time the researcher set as the end of analysis	NS	NS	
		Sleep end- inputted get up time	NS	NS	
		Get up time- the end of the sleep period as determined by the researcher	NS	NS	
5	**Start times of sleep periods**	*Analysis start*- the time the researcher set as the start of analysis	NS	NS	
		Bed time- inputted bed time	NS	NS	
		Sleep start- the start of the sleep period as determined by the researcher	NS	NS	
6	**Measures of sleep bouts**	*Mean sleep bout time*- Total sleep duration divided by the number of sleep bout	NS	Sig	
		Mean length of immobile phases- Total duration of immobile phases divided by the number of immobile phases	NS	NS	NS

Table 98: Mean total activity scores (S.E. in parentheses)

	Phase 1	Phase 2
Mean total activity score		
Day 1	5418.84 (289.03)	3282.29 (216.46)
Day 7	6558.63 (580.41)	3832.36 (383.96)

Table 99: Mean time in bed (hours) (S.E. in parentheses)

	Phase 1	Phase 2
Mean time in bed (hours)		
Day 1	6.44 (0.15)	5.59 (0.16)
Day 7	6.41 (0.20)	5.61 (0.19)

26.4 Effects of other factors on sleep

Further analyses were carried out to examine the effects of ship type, nationality, job type and working hours on sleep. These effects are summarised in tables 100 to 106. Ship type was found to influence time of going to sleep, getting up and sleep duration. This is not surprising given the different work schedules found across ships. Similar effects on the timing of sleep were also found as a function of job type. Nationality also influenced sleeping patterns although the effect of this variable was found to change across days, which suggests that it may reflect differences specific to certain time periods rather than nationality per se. Length of shift had an initial effect on disturbed sleep but this was not observed later in the study period. Working split shifts also had a significant effect on when sleep occurred and the duration of it, as did the timing of shifts (day v night). Days into tour had little effect apart from influencing activity during sleep at the end of the study period. Overall, none of these factors produced detrimental effects on all aspects of sleep and the differences between Phases 1 and 2 reflect a combination of differences rather than a major influence of any one variable.

Table 100: Sleep variables for which significant difference were found between ship types (phase 2 only) for day 1, day 7, and across the working week. These variables are grouped into 6 factors identified by factor analysis (The shaded boxes indicate the variables which were found to be significant, and the double border indicate the significant factors)

	Factor	*Variables in factor*	*Day 1*	*Day 7*	*Day 1-7 change %*
1	**Restlessness**	*The number of immobile phases of 1 minute*- The number of immobile phases where duration was only 1 minute	NS	NS	NS
		Percentage Immobility phases of 1 minute- The percentage immobility phase of 1 minute as a proportion of the total number of immobility phases. This value is also termed the fragmentation index	NS	NS	NS
		Fragmentation index- The sum of the time spent moving and the percentage immobility phases of 1 minute. This is used as an indicator of 'restlessness'.	NS	NS	NS
2	**Activity measures**	*Actual sleep percentage*- Actual sleep time as a percentage of the overall observed period	NS	NS	Sig
		Actual wake percentage- Actual wake time as a percentage of the overall observed period	NS	NS	Sig
		Total activity score- the total number of activity counts between sleep start and sleep end	NS	NS	NS
		Mean activity score- The average value of the activity counts per epoch over the assumed sleep period.	NS	NS	NS
3	**Sleep durations**	*Assumed sleep*- the difference between sleep end and sleep start.	Sig	NS	Sig
		Actual sleep time– the amount of sleep as determined by algorithms (excluding any wake time)	NS	Sig	Sig
		Time in bed- the difference between the bed time and get up time	Sig	NS	
		Number of minutes immobile- The total number of minutes where a score of zero was recorded during the assumed sleep period	Sig	NS	Sig
4	**End times of sleep periods**	*Analysis end*- the time the researcher set as the end of analysis	NS	Sig	
		Sleep end- inputted get up time	NS	Sig	
		Get up time- the end of the sleep period as determined by the researcher	NS	Sig	
5	**Start times of sleep periods**	*Analysis start*- the time the researcher set as the start of analysis	Sig	Sig	
		Bed time- inputted bed time	Sig	Sig	
		Sleep start- the start of the sleep period as determined by the researcher	Sig	Sig	
6	**Measures of sleep bouts**	*Mean sleep bout time*- Total sleep duration divided by the number of sleep bout	NS	NS	
		Mean length of immobile phases- Total duration of immobile phases divided by the number of immobile phases	NS	NS	

Table 101: Sleep variables for which significant difference were found between job types (phase 2 only) for day 1, day 7, and across the working week. These variables are grouped into 6 factors identified by factor analysis (The shaded boxes indicate the variables which were found to be significant, and the double border indicate the significant factors)

	Factor	*Variables in factor*	*Day 1*	*Day 7*	*Day 1-7 change %*
1	**Restlessness**	*The number of immobile phases of 1 minute*- The number of immobile phases where duration was only 1 minute	NS	NS	NS
		Percentage Immobility phases of 1 minute- The percentage immobility phase of 1 minute as a proportion of the total number of immobility phases. This value is also termed the fragmentation index	NS	NS	NS
		Fragmentation index- The sum of the time spent moving and the percentage immobility phases of 1 minute. This is used as an indicator of 'restlessness'.	NS	NS	NS
2	**Activity measures**	*Actual sleep percentage*- Actual sleep time as a percentage of the overall observed period	NS	Sig	Sig
		Actual wake percentage- Actual wake time as a percentage of the overall observed period	NS	Sig	Sig
		Total activity score- the total number of activity counts between sleep start and sleep end	NS	Sig	NS
		Mean activity score- The average value of the activity counts per epoch over the assumed sleep period.	NS	NS	NS
3	**Sleep durations**	*Assumed sleep*- the difference between sleep end and sleep start.	NS	NS	NS
		Actual sleep time– the amount of sleep as determined by algorithms (excluding any wake time)	NS	NS	NS
		Time in bed- the difference between the bed time and get up time	NS	NS	
		Number of minutes immobile- The total number of minutes where a score of zero was recorded during the assumed sleep period	NS	NS	NS
4	**End times of sleep periods**	*Analysis end*- the time the researcher set as the end of analysis	Sig	NS	
		Sleep end- inputted get up time	Sig	NS	
		Get up time- the end of the sleep period as determined by the researcher	Sig	NS	
5	**Start times of sleep periods**	*Analysis start*- the time the researcher set as the start of analysis	Sig	NS	
		Bed time- inputted bed time	Sig	NS	
		Sleep start- the start of the sleep period as determined by the researcher	Sig	NS	
6	**Measures of sleep bouts**	*Mean sleep bout time*- Total sleep duration divided by the number of sleep bout	NS	NS	
		Mean length of immobile phases- Total duration of immobile phases divided by the number of immobile phases	NS	NS	NS

Table 102: Sleep variables for which significant difference were found between nationality groupings (phase 2 only) for day 1, day 7, and across the working week. These variables are grouped into 6 factors identified by factor analysis (The shaded boxes indicate the variables which were found to be significant, and the double border indicate the significant factors)

	Factor	*Variables in factor*	*Day 1*	*Day 7*	*Day 1-7 change %*
1	**Restlessness**	*The number of immobile phases of 1 minute*- The number of immobile phases where duration was only 1 minute	NS	NS	NS
		Percentage Immobility phases of 1 minute- The percentage immobility phase of 1 minute as a proportion of the total number of immobility phases. This value is also termed the fragmentation index	NS	Sig	Sig
		Fragmentation index- The sum of the time spent moving and the percentage immobility phases of 1 minute. This is used as an indicator of 'restlessness'.	NS	Sig	Sig
2	**Activity measures**	*Actual sleep percentage*- Actual sleep time as a percentage of the overall observed period	NS	Sig	NS
		Actual wake percentage- Actual wake time as a percentage of the overall observed period	NS	Sig	NS
		Total activity score- the total number of activity counts between sleep start and sleep end	Sig	Sig	Sig
		Mean activity score- The average value of the activity counts per epoch over the assumed sleep period.	NS	Sig	Sig
3	**Sleep durations**	*Assumed sleep*- the difference between sleep end and sleep start.	Sig	NS	NS
		Actual sleep time– the amount of sleep as determined by algorithms (excluding any wake time)	Sig	NS	NS
		Time in bed- the difference between the bed time and get up time	Sig	NS	
		Number of minutes immobile- The total number of minutes where a score of zero was recorded during the assumed sleep period	Sig	NS	NS
4	**End times of sleep periods**	*Analysis end*- the time the researcher set as the end of analysis	NS	NS	
		Sleep end- inputted get up time	NS	NS	
		Get up time- the end of the sleep period as determined by the researcher	NS	NS	
5	**Start times of sleep periods**	*Analysis start*- the time the researcher set as the start of analysis	NS	Sig	
		Bed time- inputted bed time	NS	NS	
		Sleep start- the start of the sleep period as determined by the researcher	NS	NS	
6	**Measures of sleep bouts**	*Mean sleep bout time*- Total sleep duration divided by the number of sleep bout	NS	NS	
		Mean length of immobile phases- Total duration of immobile phases divided by the number of immobile phases	NS	NS	NS

Table 103: Sleep variables for which significant differences were found between shift hour groupings (phase 2 only) for day 1, day 7, and across the working week. These variables are grouped into 6 factors identified by factor analysis (The shaded boxes indicate the variables which were found to be significant, and the double border indicate the significant factors)

	Factor	***Variables in factor***	***Day 1***	***Day 7***	***Day 1-7 change %***
1	**Restlessness**	*The number of immobile phases of 1 minute*- The number of immobile phases where duration was only 1 minute	Sig	NS	NS
		Percentage Immobility phases of 1 minute- The percentage immobility phase of 1 minute as a proportion of the total number of immobility phases. This value is also termed the fragmentation index	Sig	NS	NS
		Fragmentation index- The sum of the time spent moving and the percentage immobility phases of 1 minute. This is used as an indicator of 'restlessness'.	Sig	NS	NS
2	**Activity measures**	*Actual sleep percentage*- Actual sleep time as a percentage of the overall observed period	NS	NS	NS
		Actual wake percentage- Actual wake time as a percentage of the overall observed period	NS	NS	NS
		Total activity score- the total number of activity counts between sleep start and sleep end	NS	NS	NS
		Mean activity score- The average value of the activity counts per epoch over the assumed sleep period.	NS	NS	NS
3	**Sleep durations**	*Assumed sleep*- the difference between sleep end and sleep start.	Sig	NS	NS
		Actual sleep time– the amount of sleep as determined by algorithms (excluding any wake time)	NS	NS	NS
		Time in bed- the difference between the bed time and get up time	Sig	NS	
		Number of minutes immobile- The total number of minutes where a score of zero was recorded during the assumed sleep period	NS	NS	NS
4	**End times of sleep periods**	*Analysis end*- the time the researcher set as the end of analysis	NS	NS	
		Sleep end- inputted get up time	NS	NS	
		Get up time- the end of the sleep period as determined by the researcher	NS	NS	
5	**Start times of sleep periods**	*Analysis start*- the time the researcher set as the start of analysis	NS	NS	
		Bed time- inputted bed time	NS	NS	
		Sleep start- the start of the sleep period as determined by the researcher	NS	NS	
NS 6	**Measures of sleep bouts**	*Mean sleep bout time*- Total sleep duration divided by the number of sleep bout	NS	NS	
		Mean length of immobile phases- Total duration of immobile phases divided by the number of immobile phases	NS	NS	NS

Table 104: Sleep variables for which significant differences were found between single and split shift groups (phase 2 only) for day 1, day 7, and across the working week. These variables are grouped into 6 factors identified by factor analysis (The shaded boxes indicate the variables which were found to be significant, and the double border indicate the significant factors)

	Factor	***Variables in factor***	***Day 1***	***Day 7***	***Day 1-7 change %***
1	**Restlessness**	*The number of immobile phases of 1 minute*- The number of immobile phases where duration was only 1 minute	NS	NS	NS
		Percentage Immobility phases of 1 minute- The percentage immobility phase of 1 minute as a proportion of the total number of immobility phases. This value is also termed the fragmentation index	NS	NS	NS
		Fragmentation index- The sum of the time spent moving and the percentage immobility phases of 1 minute. This is used as an indicator of 'restlessness'.	NS	NS	NS
2	**Activity measures**	*Actual sleep percentage*- Actual sleep time as a percentage of the overall observed period	NS	NS	NS
		Actual wake percentage- Actual wake time as a percentage of the overall observed period	NS	NS	NS
		Total activity score- the total number of activity counts between sleep start and sleep end	Sig	Sig	NS
		Mean activity score- The average value of the activity counts per epoch over the assumed sleep period.	NS	NS	NS
3	**Sleep durations**	*Assumed sleep*- the difference between sleep end and sleep start.	Sig	Sig	NS
		Actual sleep time– the amount of sleep as determined by algorithms (excluding any wake time)	Sig	Sig	NS
		Time in bed- the difference between the bed time and get up time	Sig	Sig	
		Number of minutes immobile- The total number of minutes where a score of zero was recorded during the assumed sleep period	Sig	Sig	NS
4	**End times of sleep periods**	*Analysis end*- the time the researcher set as the end of analysis	Sig	NS	
		Sleep end- inputted get up time	Sig	NS	
		Get up time- the end of the sleep period as determined by the researcher	Sig	NS	
5	**Begging times of sleep periods**	*Analysis start*- the time the researcher set as the start of analysis	Sig	Sig	
		Bed time- inputted bed time	Sig	Sig	
		Sleep start- the start of the sleep period as determined by the researcher	Sig	Sig	
6	**Measures of sleep bouts**	*Mean sleep bout time*- Total sleep duration divided by the number of sleep bout	NS	NS	
		Mean length of immobile phases- Total duration of immobile phases divided by the number of immobile phases	NS	NS	NS

Table 105: Sleep variables for which significant difference were found between day or night shift groups (phase 2 only) for day 1, day 7, and across the working week. These variables are grouped into 6 factors identified by factor analysis (The shaded boxes indicate the variables which were found to be significant, and the double border indicate the significant factors)

	Factor	*Variables in factor*	*Day 1*	*Day 7*	*Day 1-7 change %*
1	**Restlessness**	*The number of immobile phases of 1 minute*- The number of immobile phases where duration was only 1 minute	NS	NS	NS
		Percentage Immobility phases of 1 minute- The percentage immobility phase of 1 minute as a proportion of the total number of immobility phases. This value is also termed the fragmentation index	NS	NS	NS
		Fragmentation index- The sum of the time spent moving and the percentage immobility phases of 1 minute. This is used as an indicator of 'restlessness'.	NS	NS	NS
2	**Activity measures**	*Actual sleep percentage*- Actual sleep time as a percentage of the overall observed period	Sig	Sig	NS
		Actual wake percentage- Actual wake time as a percentage of the overall observed period	NS	NS	NS
		Total activity score- the total number of activity counts between sleep start and sleep end	NS	NS	NS
		Mean activity score- The average value of the activity counts per epoch over the assumed sleep period.	NS	NS	NS
3	**Sleep durations**	*Assumed sleep*- the difference between sleep end and sleep start.	Sig	NS	Sig
		Actual sleep time– the amount of sleep as determined by algorithms (excluding any wake time)	Sig	NS	Sig
		Time in bed- the difference between the bed time and get up time	Sig	NS	
		Number of minutes immobile- The total number of minutes where a score of zero was recorded during the assumed sleep period	Sig	NS	Sig
4	**End times of sleep periods**	*Analysis end*- the time the researcher set as the end of analysis	Sig	Sig	
		Sleep end- inputted get up time	Sig	Sig	
		Get up time- the end of the sleep period as determined by the researcher	Sig	Sig	
5	**Start times of sleep periods**	*Analysis start*- the time the researcher set as the start of analysis	NS	NS	
		Bed time- inputted bed time	NS	NS	
		Sleep start- the start of the sleep period as determined by the researcher	NS	NS	
6	**Measures of sleep bouts**	*Mean sleep bout time*- Total sleep duration divided by the number of sleep bout	Sig	NS	
		Mean length of immobile phases- Total duration of immobile phases divided by the number of immobile phases	Sig	NS	Sig

Table 106: Sleep variables for which significant difference were found between days into tour groupings (phase 2 only) for day 1, day 7, and across the working week. These variables are grouped into 6 factors identified by factor analysis (The shaded boxes indicate the variables which were found to be significant, and the double border indicate the significant factors)

	Factor	*Variables in factor*	*Day 1*	*Day 7*	*Day 1-7 change %*
1	**Restlessness**	*The number of immobile phases of 1 minute*- The number of immobile phases where duration was only 1 minute	NS	NS	NS
		Percentage Immobility phases of 1 minute- The percentage immobility phase of 1 minute as a proportion of the total number of immobility phases. This value is also termed the fragmentation index	NS	NS	NS
		Fragmentation index- The sum of the time spent moving and the percentage immobility phases of 1 minute. This is used as an indicator of 'restlessness'.	NS	Sig	NS
2	**Activity measures**	*Actual sleep percentage*- Actual sleep time as a percentage of the overall observed period	NS	Sig	NS
		Actual wake percentage- Actual wake time as a percentage of the overall observed period	NS	Sig	NS
		Total activity score- the total number of activity counts between sleep start and sleep end	NS	Sig	NS
		Mean activity score- The average value of the activity counts per epoch over the assumed sleep period.	NS	Sig	NS
3	**Sleep durations**	*Assumed sleep*- the difference between sleep end and sleep start.	NS	NS	NS
		Actual sleep time– the amount of sleep as determined by algorithms (excluding any wake time)	NS	NS	NS
		Time in bed- the difference between the bed time and get up time	NS	NS	
		Number of minutes immobile- The total number of minutes where a score of zero was recorded during the assumed sleep period	NS	NS	NS
4	**End times of sleep periods**	*Analysis end*- the time the researcher set as the end of analysis	NS	NS	
		Sleep end- inputted get up time	NS	NS	
		Get up time- the end of the sleep period as determined by the researcher	NS	NS	
5	**Start times of sleep periods**	*Analysis start*- the time the researcher set as the start of analysis	NS	NS	
		Bed time- inputted bed time	NS	NS	
		Sleep start- the start of the sleep period as determined by the researcher	NS	NS	
6	**Measures of sleep bouts**	*Mean sleep bout time*- Total sleep duration divided by the number of sleep bout	NS	NS	
		Mean length of immobile phases- Total duration of immobile phases divided by the number of immobile phases	NS	NS	NS

26.5 Conclusions

Analyses of objective measures of sleep using actimetry showed further differences between the present project and the earlier research. The sample studied in this project had shorter sleep periods but were asleep for a larger percentage of time than those in Phase 1. This largely reflects the different work schedules in the two phases and most aspects of the working hours profile (shift length, timing, split versus single shift etc) had an influence on some aspect of sleep. Again, this emphasises the importance of considering combinations of work characteristics rather than focusing on individual variables. The analyses conducted so far have not considered two important aspects of the working environment – noise and motion – and these are examined in the next section.

27. EFFECTS OF NOISE AND MOTION

27.1 Measurement of noise and motion

Noise
As in phase 1 noise was measured using CEL-460 dosimeters (for a detailed outline of the specifications of the dosimeters, and the operating procedure see the phase 1 report). In this phase, the dosimeters were set to record consecutive blocks of 1 hour data continuously throughout the stay on the vessel. Two dosimeters were used in parallel; one was located on the vessels bridge, and the other was located in the researchers' cabin (N.B. there were no cabins on the fast ferry as the crew slept on land therefore no noise measurements were recorded for the cabin on this vessel). A number of measures were recorded by the dosimeters, including the equivalent sound level (Leq), the sound exposure level (SEL), the average sound level (Lavg), and the time weighted average level (TWA). The amount of time that the noise level exceeded certain defined decibel levels was also recorded. These values were obtained for specific time periods which included: an hour period around the time of testing for all of the four tests, during the work shift on day 1 and day 7, during the sleep period on day 1 and 7, for the entire duration the researcher was onboard the vessel, and for the time between the end of shift on day 1 and the start of shift on day 7. Noise levels were not recorded on the freight ferry because of equipment problems.

Motion
The motion of the vessel was measured continuously throughout the duration of the visit on the vessel using the Seatex MRU H.2 (for a detailed outline of the specifications of this unit, and the operating procedure see the phase 1 report). However, the units of measurement that were recorded were adjusted within the second phase following discussion with the Institute of Sound and Vibration. The sampling rate was changed to a third of a second. As in phase 1, pitch, roll and heave, were recorded (in degrees). However the surge, sway, and yaw measures were replaced by accelerations in the pitch, roll, and heave dimensions (metres/second). The motion-recording unit was located in the researcher's cabin on all the vessels in stage 2.

Once these data were collected, four measurements were obtained for the 6 motion vectors measured across certain time periods: Mean position (a non-normalised average score), the maximum negative displacement (the minimum score for the normalised value), the maximum positive displacement (the maximum score for the normalised value), and the Root Mean Squared (RMS) displacement (the standard deviation of the values). The time periods during which these measurements were obtained included: an hour period around the time of testing for all of the four tests, during the work shift on day 1 and day 7, during the sleep period on day 1 and 7, and for the time between the end of shift on day 1 and the start of shift on day 7.

Motion was only recorded on the tankers as it was minimal on the ferries (due to the stabilisers).

27.2 General findings

Noise levels were comparable to those recorded in Phase 1 but the type of noise was rather different (a predominance of low frequency background noise with occasional louder higher frequency noises). The effects of noise varied over time. On the first day high acute noise exposure was associated with impaired performance although high exposure over the course of the day was correlated with improved performance. The effects on day 7 also differed from day 1 and the variation in effects of noise may reflect either habituation or the extent to which the noise consisted of sounds of different frequencies. Exposure to low frequency noise may cause fatigue and the presence of noise of higher frequencies may counteract these effects. Future measurement

of noise needs to consider exposure to noise of different frequencies rather than just the intensity of the noise.
Motion was minimal on the ferries and it was only objectively measured on the tankers. No effects of acute or longer term motion on performance, mood or sleep were found but these findings should be treated with caution due to the limited number of ships studied and the small sample size.

27.3 Noise levels

Noise levels were fairly consistent across ships and time periods with an average Leq of about 65 dBA and maximum levels of individual noise events about 100 dBA. Details of the noise exposures on the different ships at different times are shown in Appendix 5. These results are very similar to those obtained in Phase 1. However, the nature of the noise was rather different on the ships studied in this project, with low frequency noise being the dominant "background" noise, which was combined with occasional louder higher frequency noise. Low frequency noise often leads to fatigue and it could be an important factor in the higher levels of fatigue reported by the Phase 2 sample.

27.4 Correlations between noise levels and performance and mood

Acute exposure
On the first test session noise exposure was correlated with simple reaction time (r=0.26), with reaction times being slower for those exposed to higher levels of noise. This effect was also observed at the end of the first day (r=0.23) but was not found for the seventh day, which suggests some habituation to noise. Indeed, higher noise exposure was associated with greater alertness at the start of day 7 (r=0.21).
Daily noise exposure and changes in performance and mood
Those exposed to higher levels of noise on day 1 showed less slowing of simple and choice reaction time over the day but this effect was reversed on day 7. This effect of noise on day 7 was also seen in reported alertness, with high noise exposure being associated with a greater decrease in alertness over the day (r=-0.26).
Noise exposure over the week and changes in performance and mood
High noise exposure over the course of the study period was associated with a greater increase in alertness and faster simple reaction time. This may reflect the fact that the louder noises were of a higher frequency and counteracted the fatiguing effect of the quieter low frequency noises. This hypothesis clearly requires further test but if correct it would suggest that it is not necessarily noise intensity that needs to be reduced but exposure to the lower noise frequencies.

27.5 Correlations between noise exposure and sleep.

Those exposed to higher noise levels in their cabins went to bed later and started to go to sleep later. However, noise had no effect on sleep latency, activity or fragmentation of sleep. Indeed, on day 7 those exposed to higher noise levels spent more time immobile during their sleep (r=0.41). The absence of effects of noise levels on sleep probably reflects the fairly constant levels of exposure, which permit rapid habituation. Low frequency noise also decreases alertness, which may also help promote sleep.

27.6 Motion

These results must be treated with caution given that motion data were only collected on the tankers. Details of the amount of motion are shown in Appendix 5.

27.7 Correlations between motion and performance, mood and sleep

There was little evidence of any associations between the nature and extent of the motion and performance, mood and sleep. This may reflect the limited sample size and the small number of tankers studied.

27.8 Conclusions

Objective measurements of noise exposure and motion were obtained aboard ships. Conclusions about the effects of motion are restricted due to the small number of ships with any significant motion (just the tankers). The effects of noise varied over time and this may reflect habituation. However, it is also apparent that our future measurement of noise must pay more attention to the frequency of the noise as changes in this may underlie some of the variation in the effects of noise intensity reported here.

28. ASSESSMENT ABOARD SHIP: CONCLUSIONS

Results from the performance tasks, mood ratings and sleep recording showed significant differences between the present sample and those tested in Phase 1 of the project. Those tested in Phase 2 had slower reaction times, were less accurate and reported a more negative mood. They also slept for a shorter time although they were less likely to wake up during sleep. These differences between the two samples did not reflect any single factor. Indeed, they either reflect the combined influence of a number of different factors or some basic difference between the ships studied in the two phases (e.g. voyage cycle time).

29. OVERALL CONCLUSIONS FROM THE PROJECT

This phase of the research has extended the investigations to consider ferries (fast ferries, conventional passenger ferries, and freight ro-ro's) and near-sea tankers. A further review of the literature has been conducted and secondary analyses of the previous project have suggested methods for assessing fatigue.

The programme of new data collection had two elements, a questionnaire survey and workplace studies. Identical procedures were used to those developed in the first phase of the research which allowed comparison between the phases. The methods used were again found to be very acceptable and the project has collected extensive data, both from surveys and also aboard ship.

29.1 The survey

The survey was carried out using three samples:

(1) a sample of NUMAST members working in short sea shipping (2) a sample who also participated in the workplace testing, and (3) other employees of the companies participating in the research. Information from these three samples allowed us to examine whether the companies involved in the research were representative of seafarers in general, and whether the crews who participated in the workplace testing were representative of the company. Detailed analyses of the content of the survey showed that it provides good measures of job characteristics that might potentially lead to fatigue. In addition, the questionnaire measures perceived fatigue at work, fatigue after work and general levels of fatigue. Health-related behaviours and health outcomes are also measured using established questionnaires. The detailed profile of specific features of the person's job has allowed us to examine associations between job characteristics, perceived fatigue and health and safety. These analyses have adjusted for demographic factors and for negative affectivity (the tendency to perceive or report negative aspects of the environment or self). Overall, the study represents the most sophisticated approach to the topic adopted so far.

The results showed that the onboard sample, respondents from the participating companies and the NUMAST sample were very similar. It is impossible to determine whether the sample as a whole is generally representative of all seafarers but the absence of differences in our various sampling frames suggests that there are no selective biases due to our methods of data collection. Indeed, the similarity of our different samples has important implications for interpretation of our onboard testing in that there was no evidence to suggest that the companies we studied were unrepresentative or that there was a bias in the selection of the specific ships studied.

Initial analyses compared the present sample with the results from Phase 1 of the project. Many results were very similar. Indeed, the results obtained here confirm that long working hours and disturbed sleep are frequently reported. In addition, 16% of the sample had been involved in a fatigue related incident and 92% had received no training in recognizing or dealing with fatigue. This demonstrates that the potential for fatigue at sea is high, that it may influence operational efficiency and that little is done about providing guidance about fatigue.

The Phase 2 participants reported higher levels of fatigue and poorer health than the sample studied in the previous project. Following this our analysis strategy was to try to identify factors associated with reported fatigue in the present phase. Ship type was found to be important, with those on ferries reporting higher levels of fatigue. This finding held up across ferry types and was not due to one specific type of ferry (e.g. the high speed ferries). Job type was found to have little effect on reported fatigue even though different job categories (e.g. marine versus non-marine) were associated with different work schedules. Analyses were conducted to determine which job characteristics were associated with fatigue. Variables relating to working hours, especially "Do you consider your working hours to present a danger to your personal health and safety?", were the strongest predictors of fatigue. The sleep variables were also significant predictors of fatigue but not to the same extent as working hours. Job demands and perceived stress at work were also important, although these factors had selective effects and cannot be considered equivalent. Additional predictors of fatigue were support at work, age, vibration/motion, the physical working environment, having to stand watch, and increased use of caffeine at sea. From these analyses it was apparent that a number of factors influence fatigue, and the best predictor was the combined effect of these potentially negative job characteristics. This confirms the results from the secondary analyses of the Phase 1 data. Indeed, the combined effects approach not only predicted fatigue but also health status. In contrast, accidents at work were largely related to the physical working environment.

29.2 Assessment aboard ship

Data were collected from 177 participants from seven ships in the short sea shipping industry. Subjective reports were recorded in logbooks and objective measures obtained using actimetry (to measure sleep) and computerised assessment of performance before and after work.

29.2.1 Logbooks

The information obtained from the logbooks was more sophisticated than in phase 1 and not only covered sleeping, eating, drinking, medication use and smoking but also the work environment, job demands and support, control and job satisfaction.

The results from the logbooks confirmed that seafarers report poorer sleep than onshore controls. Ship type was found to relate to a number of differences but some of these (e.g. sleep variables) could be better accounted for by working hours rather than ship *per se*. However, physical effort and job demands were higher on the passenger ferries than the tankers and these results did not reflect between ship variation in work schedules. No differences were found between marine and non-marine crew. However, officers reported their jobs to be more demanding and stressful (but also more interesting) than did the ratings. Analyses of the survey data revealed no difference between reported health of officers and ratings which suggests that the positive aspects of the officers' jobs (e.g. greater control) may act as a buffer against the high demands.

Length of tour and the working week were important factors. Job stress increased over the seven days that the seafarers were studied. However, other potential problems decreased with length of tour (e.g. sleep improved further into the tour and there appeared to be habituation to noise). Such findings confirm results from the survey which suggested that longer tours were associated with less fatigue. Fatigue was predicted by the logbook variables of job effort, sleep and work satisfaction. Again, the combined effects of potential negative work characteristics were found to be a good predictor of negative outcomes. The final issue considered was whether measures taken from the logbook were associated with the survey data. There was support for the view that the time period we examined was representative of the "job in general" although some of the associations were modest.

29.2.2 Objective measures

Results from the performance tasks, mood ratings and sleep recording showed significant differences between the present sample and those tested in Phase 1 of the project. Those tested in Phase 2 had slower reaction times, were less accurate and reported a more negative mood. They also slept for a shorter time although they were less likely to wake up during sleep. These differences between the two samples did not reflect any single factor. Indeed, they either reflect the combined influence of a number of different factors or some basic difference between the ships studied in the two phases (e.g. voyage cycle time).

Objective measurements of noise exposure and motion were obtained aboard ships. Conclusions about the effects of motion are restricted due to the small number of ships with any significant motion (just the tankers). The effects of noise varied over time and this may reflect habituation. However, it is also apparent that our future measurement of noise must pay more attention to the frequency of the noise as changes in this may underlie some of the variation in the effects of noise intensity reported here.

29.3 Summary

The present project extended research on seafarers' fatigue by conducting a further review of the literature, further analyses of our existing database and collecting new data from short-sea shipping. The methods were again found to be applicable to the topic and collaboration with NUMAST and four companies, and, of course, the willingness of the seafarers to participate in the study, has meant that we have been able to collect further extensive information. Four main findings emerge from the project. First, the survey has confirmed that the potential for fatigue is often present at sea and that fatigue may be a factor in reducing operational efficiency. Furthermore, guidance on recognizing and dealing with fatigue at sea is rarely provided. Secondly, fatigue is best predicted by exposure to a combination of potential hazards. This has important implications for audits, suggesting that it is inappropriate to focus on individual factors such as working hours. This "combined effects" approach is very similar to that being adopted by HSE to improve the management of stress at work. The third major result is that those studied in this project reported higher levels of fatigue and ill health than those in the first phase of the research. This was confirmed by the onboard measurement of performance and mood. Finally, while the project has extended our knowledge of the area there is still a strong need to assess the impact of certain factors in larger samples (e.g. motion) and to use more sophisticated methodologies to examine other issues (e.g. the need to assess the impact of noise of different frequencies). There are also other variables, such as voyage cycle time, that potentially may lead to fatigue but which we have not been able to study in the present project. Phase 3 of the research will not only enable us to extend the research to other types of shipping but will allow us to modify our approach to consider factors implicated but not addressed by the earlier studies.

APPENDICES

1. Publications from the project
2. Descriptive statistics of the whole survey sample, shown in the questionnaire format
3. Vessels and participants recruited
4. Logbook layout, content and descriptive statistics
5. Descriptive statistics for objective measures of noise and motion

APPENDIX 1: PUBLICATIONS FROM THE PROJECT

Personalfuhrung (2003), 2, 46-52

SEAFARERS' FATIGUE, HEALTH AND SAFETY

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SUMMARY

The present paper reviews findings from a project on fatigue in ships working in the offshore oil industry. The results show that long working hours, varying shift patterns, reduced manning and problems with motion and noise are often present. These factors are often associated with perceptions of reduced safety. Combinations of these factors are also associated with impaired health. A review of the literature and analyses of accident data show that we have little knowledge of the extent to which the potential for fatigue leads to reduced safety. Analyses of onboard measures of performance, alertness and sleep suggest that fatigue offshore is not a general problem present at all times in all personnel. However, certain job characteristics, such as working at night, are associated with reduced alertness and impaired performance. Further research is now required to determine whether this view holds up across a range of ship types. This is currently in progress, with interest focusing on short sea shipping (ferries and tankers). Our next project will extend the research to consider fishing vessels, mini-bulkers, long haul tankers, containerships and cruise ships.

BACKGROUND

Global concern with the extent of seafarer fatigue is widely evident everywhere in the shipping industry. Maritime regulators, ship owners, trade unions and P&I clubs are all alert to the fact that in some ship types, a combination of minimal manning, sequences of rapid turnarounds and short sea passages, adverse weather and traffic conditions, may find seafarers working long hours and with insufficient recuperative rest. A long history of research into working hours and conditions and their performance effects in manufacturing and process industries as well as in road transport and civil aviation has no parallel in commercial shipping. Given the absence of research on offshore fatigue we are carrying out a research programme which generally aims to:

- Predict worst case scenarios for fatigue, health and injury
- Develop best practice recommendations appropriate to shiptype and trade
- Produce advice packages for seafarers, regulators and policy makers

Specifically, the programme aims to provide advice on:

- incidence and effects of fatigue in terms of specific ship types and voyage cycles

- optimal shift patterns and duty tours to minimise fatigue
- identification of at risk individuals and of factors which affect fatigue/quality of rest
- significance of patterns of work and rest, and patterns of health and injury, in terms of seeking to improve health and safety of seafarers on board ship
- suggested ameliorative/preventative procedures for minimising the effects of fatigue
- appropriate guidance for seafarers on fatigue avoidance

The research involves field studies using a battery of techniques to explore variations in fatigue and health as a function of the voyage cycle, crew composition, watchkeeping patterns and the working environment. The methods used include:

- A review of the literature
- A questionnaire survey of working and rest hours, physical and mental health
- Physiological assays assessing fatigue, rhythm adjustment and cardiovascular risk
- Instrument recordings of sleep quality, ship motion, and noise
- Self-report diaries recording sleep quality and work patterns
- Objective assessments and subjective ratings of mental functioning
- Analysis of accident and injury data

The first phase

The first phase of the project has operationalised the central themes of the programme so that they can be applied to specific issues of current concern (see Smith & Lane,2001). This involved studies of short sea shipping supporting the offshore oil industry (shuttle tankers, offshore supply vessels, anchor handlers, daughter craft and diving support vessels). Our interest in this type of shipping comes from recent research by SIRC which has analysed mortality data and found supply vessels to have major problems. Fatigue on oil platforms is currently being investigated in a parallel project supported by the Health & Safety Executive, and this allows comparison between the ships and the offshore installations.

The next section considers whether fatigue-related factors are present in our study population.

The NUMAST survey

The current survey was designed to provide information on aspects of the offshore working environment that may influence fatigue, performance efficiency and health. Details of the survey are given in Cole-Davies (2001) and McNamara (2001). The questionnaire was sent to 1600 members of NUMAST and 563 questionnaires were returned. The mean age of the sample was 43.8 years (s.d. 9.6) and 79% were marine officers.

Working hours and shifts

Over 50% reported that they worked in excess of 85 hours per week. 66.9% worked for a tour of 4 weeks and most worked fixed shifts (84.4%) both during and between tours of duty. The three most common shifts were 12 hours on/12 off (41.4%). 6 hours on/6 off (22.4%) and 4 hours on/8 off (18.1%).

These results confirm that these seafarers work long hours and have shift patterns which may lead to fatigue.

Sleep

Nearly a quarter of the sample (24%) reported that they had difficulty falling asleep and 44.6% reported that they often woke during sleep. Noise often disturbed sleep (36.6%) as did motion (44.9%). Split sleep periods were also common (45.6%).

Overall, these confirm that problems with sleep are common in this sample.

Reduced manning and other problems

One of the questions asked about measures to reduce fatigue. 66.1% reported that extra manning was necessary; 32.8% stated that more leave was desirable; and 53.5% suggested that there should be less paperwork.

The next section considers the extent to which the above working practices are related to perceptions of reduced safety and to time to adjust to onshore leave (a major concern of the respondents).

Perceptions of safety, working hours and sleep.

1. Working hours

Long working hours were significantly associated with increases in perceived job stress, reduced safety, poor concentration, fatigue and number of fatigue-related incidents experienced. In addition, those working the longest hours experienced more problems adjusting to onshore leave.

2. Shifts

Those workings 12 hour shifts were more likely to report problems adjusting to leave. Those working 6 hour shifts reported more problems sleeping.

3. Sleep

Poor sleep was significantly associated with perceptions of compromised safety and increases in physical and mental fatigue.

Measures of health

Despite the presence of many factors which lead to fatigue the seafarers generally reported good physical and mental health. Sick leave was very low (91% reported no sick leave in the last 12 months compared to only 39% of an onshore sample) and scores from well established measures of mental and physical health (e.g. the GHQ, SF-36) showed little indication of impaired health. Similarly, use of medication was very low (29.6% of seafarers use OTC medication compared to 73.1% of onshore workers who report regular use of analgesics alone). Use of medication offshore was associated with more fatigue related incidents and problems adjusting to leave.

Recent analyses (McNamara & Smith, in press) have examined associations between combinations of hazards and health. The results show that individuals exposed to the greatest combination of negative factors report the most health problems.

ACCIDENTS AND ERRORS

The incidence of accidents requiring medical attention was higher than that observed in onshore groups (3% of the seafarers reported an accident in the last 3 months). This higher incidence may reflect the general working environment. Indeed, standard measures of the frequency of human error (e.g. the cognitive failures questionnaire) show no differences between offshore and onshore groups.

A COMPARISON WITH THE EXISTING LITERATURE AND OTHER DATABASES

Fatigue, health and injury among seafarers: an overview of the literature

Collins, Matthews and McNamara (2000) have reviewed the existing literature on fatigue, health and injury among seafarers. This review shows that while there is substantial documentation on the potentially disastrous consequences of fatigue at sea, there is little hard evidence of such effects, especially in short-sea shipping. Brown (1989) reviewed the literature on hours of work, fatigue and safety at sea and while he found little objective evidence of the effects of fatigue, he did find substantial reporting of personal experiences of fatigue. These reflected long periods of continuous duty, limited opportunities for sleep and rest and poor organisation of duty, rest and sleep periods within the 24-hour cycle. Changes in the working practices of seafarers may also contribute to health and safety problems (Parker et al., 1995; Pollard et al., 1990).

Research on fatigue and accidents at sea is limited. This largely reflects accident reporting systems which provide little information on the presence or absence of fatigue-related factors. A few recent studies have attempted to resolve such problems and provide the strongest evidence for a link between accidents at sea and fatigue. Raby and McCallum (1997) found that hours on duty and hours worked in the last 3 days were associated with accidents that could be attributed to fatigue. Phillips (1998) found fatigue to be a contributory factor in only 8% of collisions and groundings. However, this may reflect the lack of usage of the term fatigue in the incident reports. A more detailed analysis found that behaviours consistent with fatigue were more frequently described in the reports (e.g.

attentional failures, perceptual limitations, and failures to act appropriately). Research on performance efficiency and human error at sea is almost non-existent. What research there has been suggests that factors known to influence performance onshore (e.g. time of day) also have effects offshore. Motion may also influence performance although less is known about motion and cognition than about the peripheral fatigue produced in moving environments (Smith, 2001). Although the literature on fatigue and accidents at sea is inconclusive, it is clearly the case that excessive hours are worked on ships (Wigmore, 1989; NUMAST, 1990; and Sanquist et al., 1996). Reduced sleep at sea is also frequently reported (Sanquist et al., 1996), although the quality of sleep need not be reduced (Parker et al., 1997; Reyner & Baulk, 1998). Indeed, the major factors influencing sleep at sea appear to be shift type, noise (especially alarms) and bad weather. There is little evidence of cumulative effects of fatigue, with several studies showing no decline in alertness with length of tour (Torsvall et al., 1987; Donderi et al., 1995).

Other research has investigated the associations between fatigue and health in seafarers. These results suggest that different findings emerge depending on whether one considers physical or mental health. For example, Parker et al. (1997) found that seafarers reported more physical health problems but appeared to be more psychologically robust than the onshore groups studied. Indeed, mental health problems in seafarers were restricted to those who were working the longest hours. Other research by Parker et al. (1998a,b) has shown that Great Barrier Reef pilots reported good health and little fatigue but that their health-related behaviours and physiological state indicated potential problems (e.g. 30% were smokers; 56% categorised as obese).

Overall, the existing literature confirms our finding that hours of work are a problem offshore. There is little evidence of associations between fatigue and accidents offshore and the next section considers an analysis of two accident databases.

Fatigue and accidents in short-sea shipping

We have analysed two datasets containing accident-related information (see McNamara, Collins & Cole-Davies, 2001). Dataset 1 consisted of records obtained from a multinational oil company, and dataset 2 was provided by the MCA and covered incidents reported to the MAIB. Both datasets included incidents occurring between 1989-1999. Both datasets gave details of injuries incurred by personnel working on offshore oil support vessels. Unfortunately however, the datasets did not include identical information; dataset 1 was primarily concerned with relatively minor injuries, whereas dataset 2 dealt mainly with major injuries.

Some modifications were made to each dataset in order that only personnel working on merchant vessels were included in the analyses. Dataset 1 was modified to exclude all personnel working on installations, and in dataset 2, incidents occurring aboard fishing and passenger vessels were excluded.

There were however, a number of problems inherent within both datasets. Largely as a result of inadequacies in original incident reporting systems, it was not possible to gain estimates of exposure rates, and large amounts of potentially useful data about temporal and injury severity variables were defined as missing (see Table 1).

Table 1: Percentage of Missing Data

Variable	Dataset 1 (n=7169)	Dataset 2 (n=4145)
Injury severity	84.0%	43.5%
Hours into shift	87.9%	70.5%
Hour of accident	28.4%	49.9%
Days into tour	86.6%	99.5%
Sea state	44.9%	73.3%
Accident type	n/a	47.7%
Injury type	84.1%	63.4%

Dataset 1

Age of crewmembers in dataset 1 ranged from 18 to 67 years, with the highest incident rate occurring in those aged 34-44 years (50%). Recorded injuries extended over 108 different occupations. Contractors accounted for the greatest number of injured workers (27.7%) followed by marine personnel (23%).

The most common incident area was the open deck (accounting for 53.8% of total accidents). With regards to body part, arms were the most frequently injured (34.6% of incidents) followed by legs (20% of total incidents).

Dataset 2

Accidents were most frequent in the 30-50 age group (56.8% of the total).

56.6% of the sample consisted of ratings, 35.3% of masters/cadets/officers, and just 8.2% of catering staff/stewards. One-third (33.4%) of the accidents reported in dataset 2 were classified as collisions/contacts, 25.5% as strandings/groundings and 22.9% as machinery faults. 29.3% of incidents were classified as slips/trips or falls.

Accident Distribution as a Function of Time of Day and Hours into Shift

The majority of incidents were found to occur between the hours of 09:00-16:00, an effect found to be independent of whether personnel were on or off duty. Incident frequency was significantly greater during the first four hours of a shift. Although time of day effects were evident from these analyses, they do not correspond to natural troughs in circadian rhythms.

Accident Distribution as a Function of Days into Tour

Accident frequency was found to be greatest at the beginning of a tour, specifically during the first tour week, and then declined steadily over the course of a tour. Again, when examined in terms of on and off-duty incidents, the same pattern was evident for both groups.

Accident Distribution as a Function of Sea State

Accident distribution was found to differ significantly as a function of sea state. More specifically, a greater proportion of incidents occur in calm conditions (i.e.

low – moderate wind force, and calm seas). This finding may simply be a reflection of work patterns: in other words, it is more than likely that a greater proportion of personnel are exposed to potential incidents in calm conditions, as they are more likely to be working.

Injury Severity and Accident and Injury Type

Re-analysis of temporal and environmental variables in terms of injury severity and incident type provided no further information on the possible role of fatigue in accident causation.

In summary, these results have replicated some previous findings: for example, Jeong (1999) found the greatest number of accidents to occur in the first 2 hours of the day shift and Forbes (1997) demonstrated that there are significantly more injuries during the first seven days of a tour. Other findings, such as accidents being more likely to occur at night (Williamson & Feyer: 1995) have not been replicated. Other issues, such as variation in injury severity as a function of time into shift, could not be examined due to inadequacies inherent within reporting systems.

It is important to acknowledge that the absence of a link between accidents and fatigue indicated by these results does not mean that fatigue has no impact: rather that it is not possible to determine from data of this type. Information regarding days into tour and hour into shift was often missing, and no exposure rate information was available. Therefore, if the role of fatigue in accident causation is to be accurately estimated, it is vital that reporting systems are standardised across the industry and information relating to days into tour, hours into shift, injury severity and exposure levels is recorded. This view agrees with the recommendation put forward by Brown (1989) and we intend to pilot new methods of collecting such data in our future project.

The next section covers some onboard data collection.

ASSESSMENT OF FATIGUE ONBOARD SHIP

In this part of the research we have assessed fatigue onboard ship using a variety of objective indicators and subjective reports. The objective measures have included:

- Sleep recording using actimeters
- Measurement of salivary cortisol (a good indicator of stress and fatigue)
- Reaction times, errors and lapses of attention (before and after work).

Subjective reports of alertness, hedonic tone (happiness, sociability) and anxiety have been recorded before starting and after completing work. Logs have been completed providing information on sleep patterns, workload and alertness.

Data has been collected from over 150 volunteers from 7 different ships. The first analyses compared the offshore group with 113 onshore workers (performance/subjective mood). Similarly, sleep from 94 onshore volunteers was compared with the offshore group. Cortisol levels before and after work are also presented.

A comparison between offshore and onshore samples

Sleep

Actimeters were used to record one night's sleep in both the onshore and offshore groups. Table 2 shows that the duration of sleep offshore is slightly shorter for the seafarers. Other aspects of sleep show no differences between the groups. This suggests that global statements about the sleep of seafarers may be inappropriate – one needs to consider factors such as the nature of the shift worked.

Table 2: Comparison of offshore and onshore samples

(Scores are the means, s.d.s in parentheses)

	Onshore (N = 94)	Offshore (N = 90)
Duration (hours)	7.14 (1.3)	6.50 (1.3)
% Actual sleep	91.1 (5.3)	90.3 (3.63)
% Immobile	90.4 (5.57)	91.0 (3.29)
% Sleep efficiency	89.3 (6.77)	88.6 (4.63)

Subjective alertness
Visual analogue scales were used to assess alertness both before and after work. Table 3 shows that the seafarers did not differ from the onshore group.

Table 3: Alertness, simple reaction time, lapses of attention: Comparison of offshore and onshore samples
(Scores are the means, s.d.s in parentheses)

	Onshore (N = 113)	Offshore (N = 162)
Alertness[1]:		
Before work	245 (67)	260 (69)
After work	257 (55)	261 (66)
Simple RT: (msecs)		
Before work	313 (48)	316 (62)
After work	325 (61)	322 (69)
Long responses:		
Before work	3.8 (8.9)	4.6 (10.1)
After work	2.7 (7.1)	3.5 (9.0)

[1] High Scores = more alert

Performance
Speed of responding was assessed using a simple reaction time task. Lapses of attention were measured using a focussed attention task. Both tasks were completed before and after work. Table 3 shows there were no differences between the seafarers and the onshore group.

Cortisol
Salivary cortisol assays were carried out on pre- and post work samples from 50 volunteers. These were compared with samples from 42 onshore workers. The offshore sample showed a much smaller difference between pre and post work levels (means : 7.1 and 5.7 nmol) than the onshore group (means: 9.8 and 5.9 nmol) which probably reflects the greater incidence of shiftwork offshore.

The above results show that a single assessment will not show large differences between seafarers and those working onshore. In a second series of analyses we have examined these measures on two days one week apart. Generally, performance and mood appears to be consistent over time suggesting that the absence of effects in the above analyses does not reflect the fact that only a single day was sampled.

The absence of effects in the above analyses should not be taken to mean that the methodology is insensitive to the nature of the job. In a study conducted on offshore installations we have shown that performance and alertness are reduced after a 12-hour night shift for the first few days of the tour. After this pre and post-work differences largely disappear suggesting that adaptation has occurred. The next section examines the effect of nightwork in the present sample to determine whether similar effects are apparent.

The offshore sample: working hours, days into tour and occupation

In the following analyses sleep, alertness and performance were considered as a function of shift, days into the tour and occupation (marine versus non-marine crew). Occupation had little effect with no obvious differences being apparent between marine and non-marine crew (although a more detailed classification of jobs is clearly still required). Nightwork was associated with lower alertness and slower reaction times after work (see Table 4).

Table 4: Effects of shift on alertness and reaction time

(Scores are means, s.d.s in parentheses)

	Day Shift (12 hours) (N = 49)	Night Shift (12 hours) (N = 22)
Alertness:		
Before work	248 (70)	252 (60)
After work	257 (61)	219 (60)
Choice reaction time: (msecs)		
Before work	487 (75)	487 (73)
After work	463 (68)	492 (93)

Days into tour interacted with nightwork and the results confirmed our previous research showing that those doing nightwork at the start of a tour are most likely to have impaired performance, especially at the end of the shift (see Table 5).

Table 5: Effects of days into tour in night workers doing 12 hour shifts

(Scores are the means, s.d.s in parentheses)

	Less than 5 days into tour (mean length = 3 days)	More than 5 days (mean length = 18 days)
Choice reaction time: (msecs)		
Before work	471 (75)	492 (78)
After work	494 (97)	478 (99)
Percentage of errors:		
Before work	5.6 (3.3)	2.5 (2.6)
After work	7.2 (5.9)	2.7 (3.0)

Further analyses (Wellens, McNamara, Ellis & Smith, in press) have shown that potential hazards such as noise and nightwork have largely independent effects on performance. This issue is receiving further attention in later phases of the project.

CONCLUSIONS FROM PHASE 1

The present project has aimed to determine the nature and extent of fatigue in seafarers on ships involved with the offshore oil industry. A review of the literature showed that there is little information on this topic and we have found that analyses of accident data do not clarify the impact of fatigue. A survey of fatigue offshore suggests that it is selective, and may reflecting working practices such as the hours worked and the duty shifts. This view is confirmed by our initial analyses of data collected onboard ship. It is quite likely that we have been studying ships that adopt “best practice” and we have little information on the impact of combinations of factors that may lead to greater fatigue. Future research must consider a wider range of situations and ships as single snapshots may not reflect what can occur. The variation in life onboard ship can be clearly seen from the following quote:

“The life of a shipmaster has been described as hours of boredom punctuated by moments of terror” (Lowell, 1998).

At the moment we know little about either of the extreme conditions that may be the major causes of fatigue. An extended programme of research is now necessary to develop our knowledge of seafarers fatigue so that informed decisions about working practices can be made.

PHASE 2

In this phase of the research we have investigated fatigue in ferry and tanker crews. The same methodology has been used as in Phase 1 and the report on the project will be available in 2003.

PHASE 3

This will continue to examine fatigue in a wider range of shipping (fishing; mini-bulkers; long-haul tankers; containerships and cruise ships). The research will also examine the interface between ships and installations/ports. Specifically, the impact of fatigue on collision awareness and other aspects of risk perception will be investigated. In depth analyses of certain jobs (e.g. possible problems of multi-tasking on the “one man bridge”; the impact of fatigue on tasks done by nonmariners in offshore rescue) will be carried out. The development of fatigue and the after-effects of tours of duty on fatigue during leave will also be investigated. Information obtained from the three phases of the project will be used to provide an appraisal of some of the main published guidance on fatigue for the maritime sector and to assess the impact of EU working time regulation offshore.

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Noise disturbed sleep aboard ships and on oil installations

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Abstract

In contrast to other transport industries little is known about fatigue offshore. One factor that is thought to contribute to fatigue offshore is noise disturbed sleep. A large scale survey was conducted to determine the prevalence of noise-disturbed sleep in the UK offshore oil industry (oil installations; ships supporting these installations - support vessels, dive support ships). Questionnaires were returned from nearly 1,000 workers in this industry. Over 30% of the respondents reported that noise frequently disturbed their sleep. The possible impact of this noise-disturbed sleep on health and safety will be discussed.

1. Introduction

Mounting concern with seafarer fatigue is widely evident among maritime regulators, insurers, ship owners, trade unions and welfare agencies. We are carrying out a research programme to investigate this topic and the first phase of the research was concerned with specific comparisons between offshore oil support shipping and the offshore oil industry [1]. The overall objectives of the research are: to predict worst case scenarios for fatigue, health and injury; develop best practice recommendations appropriate to ship type and trade; and produce advice packages for seafarers, regulators and policy makers. This topic has been investigated using a variety of techniques to explore variations in fatigue and health as a function of the voyage cycle, crew composition, watchkeeping patterns and the working environment. The methods involve:

- A review of the literature
- A questionnaire survey of working and rest hours, physical and mental health
- Physiological assays assessing fatigue, rhythm adjustment and cardiovascular risk
- Instrument recordings of sleep quality, ship motion, and noise
- Self-report diaries recording sleep quality and work patterns
- Objective assessments and subjective ratings of mental functioning
- Analysis of accident and injury data

A long history of research into working hours and working environment and their performance effects in manufacturing and process industries as well as in road transport and civil aviation has no parallel in commercial shipping. The present paper reports results about the prevalence of noise-disturbed sleep aboard ship and on offshore oil installations.

There has been considerable research on the effects of noise exposure (on land) on sleep.

There is evidence of both objective and subjective sleep disturbance by noise [2,3]. There is some evidence that noise effects on sleep may habituate over time, but research also suggests that small deficits may persist for years [4]. This often leads to greater use of sleeping pills in high noise areas. Noise not only affects sleep but may have after-effects the following day [5]. This could provide a possible mechanism for the effects of noise on psychosocial well-being. Noise exposure during sleep is considered to increase awakening or cause shifts from deeper to lighter sleep stages [6]. Noise during the day may also reduce REM sleep [7] which shows that noise can influence sleep in several different ways.

The present article reports results from a survey carried out with seafarers and those working on installations. One of the general aims was to determine the extent to which sleep disturbances were reported. Sleep problems may be especially prevalent in this group because they are exposed to a number of factors known to influence sleep (shiftwork, motion and noise). Perceived consequences of sleep disturbances are also reported here.

2. Method

2.1. The survey

The questionnaire itself was divided into the following three sections:

Offshore: Questions in this section refer specifically to time spent offshore, encompassing measures of work and rest patterns, perceptions of the working environment and subjective measures of attitudes towards work.

On leave: Questions in this section relate to time spent on leave/at home and include subjective measures of health and well-being, fatigue, sleeping patterns, and health-related behaviours such as eating, drinking, smoking and exercise.

Life in general: Questions in this section are designed to measure incidence of accidents and injuries, and general health and well-being, using a number of standardised scales such as the General Health Questionnaire, the Profile of Fatigue Related Symptoms, the Cognitive Failures Questionnaire, and the MOS Short Form Health Questionnaire.

2.1.1 The sample

The questionnaire was distributed to members of the seafaring officers union, NUMAST and to members of the installation workers union, MSF. The questionnaires were accompanied by a letter from a union official, detailing the importance of the research.

2.1.2 Comparison Groups

The major aim of the research was to compare seafarers and those working on installations. In addition, comparisons were made with onshore samples. A short version of the questionnaire was sent to a group of onshore workers, as a control for items specifically relating to fatigue. Further comparisons (e.g. on general health measures) were made using three additional sources, detailed in Table 2. Unless stated in the text the onshore comparison group refers to the third sample (N = 93).

Table 1: Survey Response Rates

Target Group	Sent	N returned	% returned
NUMAST	1600	563	35.2
MSF	1800	388	21.6
Control	93	71	76.3*

***All subjects in the control group were paid £5 on completion of the questionnaire

Table 2: Comparison Groups of Onshore Workers

Study	Study Type	N	Variables used (for comparison)
Bristol Health and Safety at Work Study (1999)	General population: survey of occupational health and safety: work stress	7071	General Health Questionnaire Scores, Socio-economic status
The Welsh Health Survey (1998)	General population: survey of physical and mental health, use of health services	29, 874	SF – 36 Short Form Health Survey, Work-related accidents
Combined Effects of Occupational Hazards (2000-2002)	Examination of workplace stressors, collection of psychosocial, cognitive and physiological data	93	General Health Questionnaire, Profile of Fatigue-related Stress, Cognitive Failures, Socio-economic status

No specific attempt was made to match the onshore and offshore samples. Crucial variables (e.g. age, socio-economic status) were covaried in the analyses. Demographic and occupational variables are shown in Tables 3 and 4.

As is evident from Table 3, seafarers and installation workers are fairly similar in terms of mean age, although minimum age is higher in the latter group. The onshore group by comparison, demonstrate lower mean age than either group of offshore workers.

Table 3: Age Range

Group	N	Minimum	Maximum	Mean	SD
Seafarers	555	17	64	43.75	9.55
Installation workers	385	24	62	45.59	7.82
Onshore workers	68	17	68	39.18	12.29

Table 4: Distribution of Job Type (Seafarers and Installation Workers only)

Occupation	Seafarers (%)	Installation Workers (%)
Marine officers	79.0	-
Marine crew	4.1	4.4
Divers/dive support staff	3.0	-
Project management	1.8	23.7
Technicians	1.2	62.9
Drillers/roughnecks	0.9	3.4
Stewards/catering staff	2.8	0.5
Missing/not specified	7.2	5.1

3.Results

3.1 Disturbed sleep

Initial analyses focused on disturbed sleep (see Table 5). As Table 5 demonstrates, offshore workers report significantly greater difficulty in falling asleep than onshore workers. They are also more likely to wake during sleep, or report restless/disturbed sleep than the control group. However, confusion/disorientation on waking is reported by a marginally greater proportion of controls than either installation workers or seafarers. Furthermore, investigation of noise and motion as detrimental to sleep would seem worthwhile, given the significant proportions of offshore workers reporting environmental factors as disturbing to their sleep (N.B. motion is obviously less of a factor on installations, as the majority are fixed platforms).

Table 5: Disturbed Sleep (quite a bit/always)

	Seafarers (%)	Installation Workers (%)	Onshore Workers (%)
How often do you:			
Have difficulty falling asleep	24.0	26.3	13.0
Wake during sleep	44.6	49.5	37.6
Have restless/disturbed sleep	43.4	43.3	31.8
Wake up confused/disorientated	6.2	8.2	10.1
How often do the following disturb your sleep:			
Noise	36.6	32.2	15.9
Motion	44.9	4.4	-

The next set of analyses examined associations between sleep parameters and operational efficiency and safety.

3.2 Sleep Quantity and Perceived Risk

Of respondents who report too little sleep, 70.5% of installation workers, 67.2% of seafarers and 46.9% of onshore workers felt that that working patterns seriously compromise personal safety. A similar pattern of results was observed for operational safety.

3.3 Sleep Quantity and Fatigue

Lack of sleep was significantly related to perceptions of physical and mental fatigue amongst both seafarers and installation workers.

3.4 Sleep Quantity and Fatigue Indicators

Confusion was significantly related to insufficient sleep amongst installation workers only. However, poor concentration was significantly related to sleep quantity amongst both groups of offshore workers.

3.5 Sleep Quality and Fatigue Indicators

Confusion was significantly associated with poor quality sleep amongst seafarers and installation workers. Poor concentration was also found to be significantly related to sleep quality amongst both groups.

5. Conclusion

The results from the present study suggest that noise may frequently disturb the sleep of those on ships and on oil installations. Sleep disturbance also appears to be related to reduced operational efficiency and possibly compromises safety. Other recent research [8, 9] has shown that other types of transport noise also disturb sleep and this noise-induced sleep disturbance is associated with reports of health problems. Noise offshore may be a great problem as sleep is often disturbed by other factors such as shiftwork and motion. The present study examined subjective reports. Other research involving objective measurement of noise, sleep and performance [10] has confirmed that high noise exposure is present on ships and that this is associated with disturbed sleep and impaired performance. Further research is extending the present study by considering other types of vessel in the short sea shipping sector.

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The research described in this article is supported by the UK Maritime and Coastguard Agency, the UK Health and Safety Executive, NUMAST and MSF. We would also like to acknowledge the contribution made by the ship and installation owners who have participated in the research.

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Objective measurement of the effects of noise aboard ships on sleep and mental performance

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Abstract
In contrast to other transport industries little is known about fatigue offshore. One factor that is thought to contribute to fatigue offshore is noise disturbed sleep. This has been confirmed in a large scale survey. The aim of the present study was to objectively measure noise and examine its impact on performance efficiency and sleep. Noise exposure was monitored on all the ships using dosimeters. It was possible to relate these measures to the sleep, mood and performance scores of 62 of the volunteers. Interest focuses on two main noise parameters - the Leq values (a measure of average noise exposure over a 12 hour time period) and the peak noise (Sel) values. The mean Leq value was 63 dB with a range from 55-72 dB. The mean Sel value was 112 dB with a range from 104-121 dB. Correlations with the mood and performance data confirmed many of the known effects of noise. High levels of noise were associated with increases in alertness but slower reaction times, greater focusing of attention and more lapses of attention. Noise levels were also associated with sleep disturbance, with sleep efficiency being lower when noise levels were high and sleep latency being longer. These results confirm that noise levels onboard these ships may impair performance and disturb sleep.

1. Introduction
Global concern with the extent of seafarer fatigue and the potential environmental costs is widely evident everywhere in the shipping industry. Maritime regulators, ship owners, trade unions and P & I clubs are all alert to the fact that in some ship types, a combination of minimal manning, sequences of rapid turnarounds and short sea passages, adverse weather and traffic conditions, and the nature of the working environment may find seafarers working long hours and with insufficient recuperative rest. In these circumstances fatigue and reduced performance may lead to environmental damage, ill-health and reduced life-span among highly skilled seafarers who are in short supply. A long history of research into working hours and conditions and their performance effects in manufacturing and process industries as well as in road transport and civil aviation has no parallel in commercial shipping. With a few exceptions, maritime research on work patterns and conditions has been conducted aboard, or in simulations of warships.

Our research has aimed to look at combinations of factors that may induce fatigue [1]. In the present article the focus is on noise. There is considerable evidence that noise may impair performance [2,3,4] and of associations between noise and accidents [2]. Similarly, there has been considerable research on the effects of noise exposure (on land) on sleep. There is evidence of both objective and subjective sleep disturbance by noise [5,6]. There is some evidence that noise effects on sleep may habituate over time, but research also suggests that small deficits may persist for years [7]. This often leads to greater use of sleeping pills in high noise areas. Noise not only affects sleep but may have after-effects the following day [8]. This could provide a possible mechanism for the effects of noise on psychosocial well-being. Noise exposure during sleep is considered to increase awakening or cause shifts from deeper to lighter sleep stages [9]. Noise during the day may also reduce REM sleep [10] which shows that noise can influence sleep in several different ways.

A recent study [11] has shown that noise disturbed sleep is frequently reported by seafarers. This sample also reported that disturbed sleep is associated with reduced operational efficiency and possibly compromised safety. In the part of the research reported here we have assessed fatigue aboard ship using a variety of objective indicators and subjective reports. The objective measures have included:

- Sleep recording using actimeters
- Measurement of salivary cortisol (a good indicator of stress and fatigue)
- Reaction times, errors and lapses of attention (before and after work).

Subjective reports of alertness, hedonic tone (happiness, sociability) and anxiety have been recorded before starting and after completing work. Logs have been completed providing information on sleep patterns, workload and alertness.

2. Method

Data has been collected from over 150 volunteers from 7 different ships. Noise exposure was monitored on certain ships (dive support ships and supply ships) using dosimeters. It was possible to relate these measures to the sleep, mood and performance scores of 62 of the volunteers.

2.1 Measurement of noise

The noise levels on the vessels were recorded using CEL–460 Dosimeters, which log noise data over a specific period. This unit consist of two parts, the recording unit and the microphone. Each dosimeter was calibrated using the CEL-282 Acoustic calibrator. The dosimeters were set to run for approximately 24-hour periods in different locations across the vessel. These included the following areas: accommodation, bridge, salon, dive control, daughter craft, hospital, lounge. Once these 24-hour periods had elapsed the data was then downloaded to an IBM compatible computer, into the CEL SoundTrack db10 programme.

2.2 Measurement of performance and mood

2.2.1 Visual analogue mood scales

Mood was assessed both pre and post performance using 18 computerised visual analogue mood rating scales [12]. Each of the 18 bipolar scales comprised of a pair of adjectives for instance, drowsy - alert or happy - sad. Participants were instructed to move the cursor from a central position anywhere along the horizontal rule, towards either extreme of the scale, until the cursor was at a position representative of their mood state at that exact time. These 18 scales were presented successively. Three main factors were derived from these scales; alertness, hedonic tone and anxiety.

2.2.2Variable fore-period simple reaction time task

In this task a box was displayed in the centre of the screen and at varying intervals (from 1-8 seconds) a target square would appear in the box. As soon as they detected the square participants were required to press a response key using the forefinger of their dominant hand only. This task lasted for approximately 3 minutes. A measure of mean reaction time was recorded for each minute of performance on the basis of the number of trial completed per minute. A total mean reaction time is also calculated from the total number of trials completed during the whole test. Responses below 200 ms and greater than 750 ms are eliminated from the calculation of these variables.

2.2.3 Focused attention task

This choice reaction time task, developed by Broadbent et al. [13,14], measures various aspects of selective attention. In this task target letters appeared in upper case A's and B's in the centre of the screen. Participants were required to respond to the target letter presented in the centre of the screen ignoring any distracters presented in the periphery as quickly and as accurately as possible. The correct response to A was to press a key with the forefinger of the left hand while the correct response to B, was to press a different key, with the forefinger of the right hand. Prior to each target presentation three warning crosses were presented on the screen, the outside crosses were separated from the middle one by either 1.02 or 2.60 degrees. The crosses were on the screen for 500 ms and were then replaced by the target letter. The central letter was either accompanied by 1) nothing, 2) asterisks, 3) letters which were the same as the target or 4) letters which differed from the target. The two distracters presented were always identical and the targets and accompanying letters were always A or B.

Participants were given ten practice trials followed by three blocks of 64 trials. In each block there were equal numbers of near / far conditions, A or B responses and equal numbers of the four distracter conditions. The nature of the previous trial was controlled. This test lasted approximately 3 minutes. In this task several aspects of choice responses to a target were measured. The global measures of choice reaction time that were assessed were mean reaction time, accuracy of response (percent correct) and lapses of attention (reaction times > 800 msecs). In addition a measure of selective attention was recorded e.g. the Erikson effect. This provides a measure of focusing of attention, describing the effect of spatial interference caused by disagreeing stimuli placed near to or far from the target upon reaction time and accuracy of response to the target. If attention is focused, then a big difference between near and far distractor conditions should be found. If attention is set to a wide angle then this difference should be reduced. A more specific aspect of choice response was measured recording choice reaction time and accuracy with which new information was encoded i.e., the difference in reaction time and accuracy of response between conditions when the target is alternated from the previous trial and when the target is repeated from the previous trial.

2.2.4 Categoric Search Task

This task was also developed by Broadbent et al. and is similar to the focused attention task previously outlined. Each trial started with the appearance of two crosses either in the central positions occupied by the non-targets in the focused attention task i.e., 2.04 or 5.20 degrees apart or further apart, located towards either left and right extremes of the screen. The target letter would then appear in place of one of these crosses. However, in this task participants did not know where the target would appear. On half the trials the target letter A or B was presented alone and on the other half it was accompanied by a distracter, in this task a digit (1-7). Again the number of near/far stimuli, A versus B responses and digit/blank conditions were controlled. Half of the trials led to compatible responses (i.e., the letter A on the left side of the screen, or letter B on the right) whereas the others were incompatible. The nature of the preceding trial was also controlled. In other respects (practice, number of trials, etc.) the task was identical to the focused attention task. This task also lasted approximately 3 minutes. As in the focused attention task several aspects of choice responses to a target were measured. The global measures being choice reaction time, accuracy of response and lapses of attention (reaction times > 1000 msec). A more specific aspect of choice response was measured, recording choice reaction time and accuracy with which new information was encoded. In addition specific aspects of selective attention were measured. For each of these variables outlined below, mean reaction time and accuracy were calculated. A measure of response organisation was recorded. This refers to the effect of compatibility of the target position and the response key upon reaction time and accuracy. A further measure of place repetition was taken which refers to the effect of target location (i.e., the target appearing in the same or a different place on successive trials). A measure of spatial uncertainty was also taken which describes the extent to which not knowing the location of the target (in near or far locations) hinders both reaction time and accuracy.

2.3 Measurement of sleep

Sleep data was recorded using the Actiwatch® Activity Monitoring System by Cambridge Neurotechnology. This system consisted of two parts: An actiwatch, which measured motion using a piezo-electric accelerometer giving measurements of intensity, amount and duration of movement. The watch also includes a ‘Event Marker’ button which allows the user to mark certain points in time, for example when they woke up. This information is stored in the Actiwatch unit, similar in appearance to an electronic wristwatch, which can record information for a period of up to 83 days. Subjects were asked to wear the Actiwatch on their non dominant hand during the sleep periods prior to the test sessions.

The second part to the system is the Reader/Interface connecting cable and software. This allows the Actiwatch to be programmed to run for different periods of time, with subject information, and for data to be downloaded and stored from the watch.

The sleepwatch analysis software uses an algorithm based on level of movement in any 5-second period and the preceding and following periods to give a value of asleep or awake for that period. A global measure of number of hours sleep per night was derived, this was the difference between sleep onset and awakening, not taking into account any wakening during the night. Using this variable and the sleep/wake data from the actiwatch software, measures for actual sleep time, sleep efficiency and immobility as percentages and total activity and sleep fragmentation index as totals were derived.

3.Results

Interest focuses on two main noise parameters – the Leq values (a measure of average noise exposure over a 12 hour time period) and the peak noise (Sel) values. The mean Leq value was 63 dB with a range from 55-72 dB. The mean Sel value was 112 dB with a range from 104-121 dB. These results suggest that the environment on the ships is moderately noisy with occasional noises (e.g. alarms) of very high intensity. Measures taken on consecutive days were highly correlated (Leq: $r=0.82$; Sel: $r=0.7$) suggesting the noise levels on the ships are consistent.

Correlations with the mood and performance data confirmed many of the known effects of noise. High levels of noise were associated with increases in alertness ($r=0.5$) but slower reaction times, greater focussing of attention and more lapses of attention (all r's > 0.25, all p's < 0.05). Noise levels were also associated with sleep disturbance, with sleep efficiency being lower when noise levels were high ($r=-0.32$) and sleep latency being longer ($r=0.26$). These results confirm that noise levels onboard these ships may impair performance and disturb sleep.

5. Conclusion

In contrast to other transport industries little is known about fatigue offshore. Noise disturbed sleep is thought to contribute to fatigue offshore and this has been confirmed in a large scale survey [11]. The aim of the present study was to objectively measure noise and examine its impact on performance efficiency and sleep. Noise exposure was monitored on all the ships using dosimeters and it was possible to relate these measures to the sleep, mood and performance scores of the volunteers. Interest focused on two main noise parameters - the Leq values (a meaure of average noise exposure over a 12 hour time period) and the peak noise (Sel) values. Correlations with the mood and performance data confirmed many of the known effects of noise. High levels of noise were associated with increases in alertnes but slower reaction times, greater focusing of attention and more lapses of attention. Noise levels were also associated with sleep disturbance, with sleep efficiency being lower when noise levels were high and sleep latency being longer. These results confirm that noise levels onboard these ships may disturb sleep and impair performance.

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THE COMBINED EFFECTS OF FATIGUE INDICATORS ON HEALTH AND WELL-BEING IN THE OFFSHORE OIL INDUSTRY

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Abstract

Offshore workers are exposed to a unique combination of factors that may impact negatively on well-being. This paper describes results from a survey of fatigue, health and injury amongst seafarers and installation personnel working in the UK sector of the offshore oil industry. Potential stressors and fatigue-related variables (e.g. noise, working hours, shift type) were considered in terms of their combined effects on subjective outcome measures. Median splits of these variables were summed to create a 'total fatigue indicators' score. A quartile split of this variable was entered into a series of ANCOVA, co-varying for age, education and socio-economic status (SES) and stratifying for occupational group (i.e. seafarers or installation personnel). Total fatigue indicators demonstrated a linear effect on depression, cognitive failures, social functioning, lack of/poor quality sleep, fatigue, and the home-work interface. Effects were more pronounced amongst installation personnel than seafarers. This is possibly due to fundamental differences in shift systems between the two groups of offshore workers, as discussed. No significant effects were observed for injury frequency, prescribed medication or smoking and alcohol consumption. Results suggest that exposure to a combination of stressors has a significantly greater negative effect on health than any of these factors in isolation.

Key words: psychology, occupational medicine, epidemiology.

Introduction

The purpose of the present paper is to describe a survey that was carried out to determine the extent of fatigue and poor health offshore. The term 'offshore' refers in this instance, to all personnel employed in the UK sector of the offshore oil industry, who work tours of duty between two and four weeks in length, either on installations or on support and supply vessels. It was hoped that this might provide some indication, not just of injury likelihood, but of chronic problems that may occur as a result of working in an offshore environment.

Extreme weather conditions, noisy working environments and demanding work and rest patterns may all contribute to fatigue and poor health offshore (Parkes 1997, 1998). Furthermore, major economic, structural and technological changes have taken place within the industry in recent years, often resulting in reduced manning, increased workload and job insecurity (e.g. Collinson 1998). All of these factors, either alone or in combination, may have a negative impact on the health and well-being of offshore workers.

A number of studies of stress and health offshore have been undertaken in recent years, yet fatigue is rarely examined specifically. Furthermore, surveys are for the most part limited to offshore installation personnel. What is apparent from the self-reported data however, is that increased workload, long hours, poor quality or lack of sleep and boredom do indeed contribute to poor mental health and fatigue offshore (Parkes 1997, Parker et al. 1997). However, some studies have failed to demonstrate significantly poorer levels of health amongst installation personnel, and have therefore concluded that they are no worse off than their onshore counterparts (Gann et al. 1990).

The current survey was designed to identify all aspects of the working environment that may impact on the health and general well-being of personnel employed in all sectors of the offshore oil industry. By drawing comparisons between installation workers and seafarers, it is hoped that risk factors inherent in these diverse occupations can be reduced, and in some cases eliminated.

Previous research (e.g. Smith et al. 2000, 2001) has shown the relationship between exposure to one or more occupational hazards (e.g. Noise, shift work) and poor health to be linear. In light of this, the purpose of the analyses described was to examine the impact of workplace factors in combination, as individuals in an offshore environment are likely to be exposed to a number of negative factors at any one time.

Materials and Methods

Survey Content

The main aim of the survey was to assess the work and rest patterns of seafarers and offshore installation workers. More specifically, to assess the extent to which working hours, shift patterns and time spent offshore are associated with fatigue, accidents and injuries, and poor physical and mental health of crewmembers. The questionnaire was designed to encompass all aspects of life offshore. It was divided into the following three sections:

1 **Offshore:** included questions relating specifically to work patterns, and subjective measures of attitudes towards work.

2 **On leave:** included subjective measures of health and well-being, and health related behaviours such as eating, drinking, smoking and exercise.

3 **Life in general:** included a number of standardised scales of well-being, such as the General Health Questionnaire (GHQ: Goldberg 1972), the Profile of Fatigue-Related Symptoms (PFRS: Ray 1991), the Cognitive Failures Questionnaire (CFQ: Broadbent et al. 1982) and the MOS Short Form Health Questionnaire (SF-36: Ware et al. 1993).

Participants/Procedure

The questionnaire was distributed to the home addresses of members of the seafaring officer's union, NUMAST and the installation worker's union, MSF. Secondly, questionnaires were distributed to seafarers onboard offshore oil support vessels operating in the UK sector, by visiting researchers. A short version of the questionnaire was sent to a group of onshore workers, as a control for items specifically relating to fatigue. Results were also compared with normative data from three other sources (see Table 1): a sample of onshore workers who participated in a study of workplace stressors, (Smith et al. 2001), a random sample of the working population taken from the Welsh Health Survey (The National Assembly for Wales 1998), and data from the Bristol Health and Safety at Work Study[1] (Smith et al. 2000).

Table 1 provides details of control groups used for comparison.

[1] All three control groups served as comparative norms for scores on the health and well-being scales (e.g. GHQ, CFQ, SF-36).

Table 1: Control Groups for Comparison

Study	N	Variables for comparison
Bristol Health & Safety at Work Study (2000)	3220	GHQ, SES
The Welsh Health Survey (1998)	8092	SF – 36,Work-related Accidents
Combined Effects of Occupational Hazards (Smith et al. 2001)	93	GHQ, PFRS, CFQ, SES

Table 2 shows the relative response rates from each of the populations targeted

Table 2: Population Response Rates

Target Group	Sent	N returned	% returned
NUMAST	1600	563	35.2
Offshore support	-	53	-
MSF	1800	388	21.6
Short version (control)	93	71	76.3

Results

Potential stressors and fatigue related variables (e.g. High levels of noise, long working hours and rotating versus fixed shifts) were considered in terms of their combined effects on outcome measures (i.e. Subjective reports of physical and psychological health).[2]

Statistical Methods

Median splits of potential stressors were examined in pairs[3], and summed to create a 'total fatigue indicators score'.[4] These comprised

[2] ANCOVA were carried out on offshore groups only. N in onshore control group was deemed insufficient.

[3] Where 1=low exposure, 2=high exposure.

'number of hours worked per week', and the following working hours and physical hazards variables: night work, shift work, unsociable hours, breathing fumes/harmful substances, touching/handling harmful substances, ringing in the ears, background noise, vibration and motion sickness[5].

Median splits of the following items relating to job demand[6] were also included: 'I have constant time pressure due to a heavy workload', 'I have many interruptions and disturbances in my job', 'I have a lot of responsibility in my job', 'I am often under pressure to work overtime', 'I have experienced or expect to experience an undesirable change in my work', 'my job promotion prospects are poor', 'my job security is poor' and 'I am treated unfairly at work'. Shift schedule was split into two categories (i.e. 'fixed or rotating') as was shift length (i.e. 'long' versus 'short'). These items were also included in the 'total fatigue indicators score'.

A quartile split of this composite variable was then entered into a series of analyses of co-variance (ANCOVA) co-varying for: age, education and socio-economic status (SES) and stratifying for occupational group (i.e. Seafarers or installation personnel).

Descriptive Statistics

Descriptive statistics for age are shown in Table 3.

Table 3: Age Range

Group	N	Mean	SD
Seafarers	555	43.75	9.55
Installation workers	385	45.59	7.82
ControlGroup	68	39.18	12.29

Frequency distributions for marital status and education are shown in Table 4 below.

Table 4: Marital Status and Education

	Seafarers (%)	Installation Workers (%)	Control Group (%)
Divorced	5.7	3.6	7.9
Single	11.2	4.4	-
Min 5 GCSE'S	54.2	54.4	-

[4] Taking GHQ as an example, cross-tabs show the distribution of high and low scores to be comparable across all variables within the total score.

[5] Responses to all working hours and physical hazards variables were scored from 1-4: 1=never, 2=seldom, 3=sometimes, 4=often.

[6] Taken from Siegrist's Effort-Reward Imbalance Model (1996). 1=Not at all distressed, 4=Very distressed.

With regards occupation, over 3/4 of the seafaring sample comprises senior personnel, as opposed to approximately 20% of installation workers. This is not surprising however, as seafarers were contacted almost exclusively via the officers' union.

Shift Systems and Hours of Work

Table 5 shows descriptive statistics for the various shift systems and hours worked by all personnel.

Table 5: Shift Systems and Work Hours

	Seafarers (%)	Installation workers (%)	Control Group (%)
4 week schedule	65.7	0.8	-
2 week schedule	1.2	78.1	-
12-hr shifts	41.4	87.5	-
Fixed shifts	75.1	48.5	-
> 60 hrs week	93	93.3	5.8
3-5 hrs overtime	24.5	17.8	9.8
2-3 days to adjust	50.1	43.6	-

Shift Systems

There are several major differences in the work and leave systems reported by seafarers and installation workers. For example, the most common work/leave cycle for seafarers is the 4 weeks-on, 4 weeks-off cycle. However, less than 1% of workers on offshore installations work this system. Over 3/4 of installation personnel work a 2 weeks-on, 2-weeks off schedule. Furthermore, seafarers appear more likely than installation personnel to work fixed shifts.

Work Hours

There are also significant differences in work hours within these shift systems: more than twice as many installation respondents as seafarers work 12-hour shifts. As the nature of seafaring often demands personnel to 'keep watch', 6 hours-on, 4-off and 4-on, 8-off systems are common (see Table 6).

Table 6: Work Hours/Duty Schedule

Duty Schedule	Seafarers (%)	Installation Workers (%)
12 hrs on, 12 off	41.4	86.9
6 hrs on, 6 off	22.4	12.4
4 hrs on, 8 off	18.1	-
4 hrs on, 4 off	0.2	-

However, despite these differences in shift patterns between the two offshore groups, both report significantly higher weekly hours than onshore workers. It is also evident (see Table 5) that offshore personnel tend to do more hours of overtime per day than onshore workers (N.B. mean additional daily hours are higher still in the seafaring group than amongst installation workers).

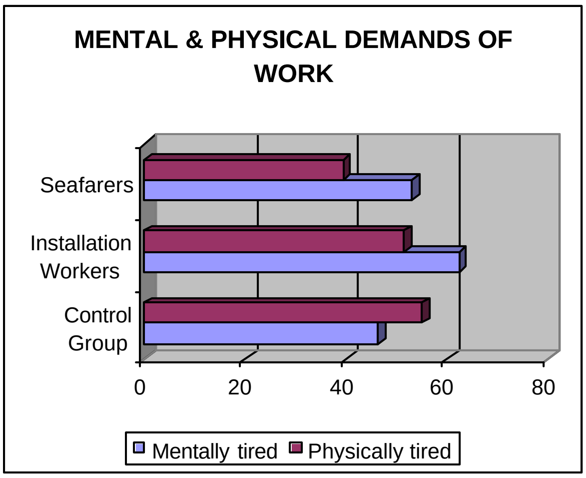
Adjustment to Shift Systems and Work Hours

A significant proportion of respondents in both offshore groups report feeling 'below par' on returning to their vessel/installation after a period of leave, although this is more marked in the case of installation workers (reported by 44.6% as opposed to 25.2% of seafarers). Furthermore, approximately half of all respondents felt that adjusting to life offshore took at least 2-3 days. Perhaps of more concern, is the fact that 45.1% of seafarers and 63.7% of installation workers felt their performance to be affected during this period of adjustment.

Mental and Physical Fatigue

Figure 1 below depicts the proportion of workers in each group who report feeling tired at the end of their working day.

Figure 1: Mental & Physical Demands of Work (very/extremely tired)



As is evident from the graph, those who work in an offshore environment are more likely to report feeling mentally tired at the end of the working day than onshore workers. This pattern is reversed for physical tiredness.

Fatigue–Related Incidents

The percentage of respondents who report being involved in at least one fatigue-related incident is highest amongst installation workers (reported by 12.9% of respondents, as compared to 6.6% of seafarers and 10.1% of controls). However, the proportion of respondents reporting involvement in
3-4 fatigue-related incidents is very similar across all three groups.

Further Analysis: ANCOVA

Where pairs of stressors are examined in combination, there is evidence to suggest that exposure to two hazards results in poorer well-being than exposure to a single hazard. However, this was not the case for all combinations studied. If we take GHQ scores as an example of a typical outcome variable, there were no additive effects of background noise and night work (main effect of noise: $F [1, 849] = 15.34$, $p<.0001$), background noise and unpredictable hours (main effect of noise: $F [1 ,845] = 15.26$, $p<.0001$) night work and exposure to hazards (main effect of hazards: $F [1, 848]= 5.78$, $p<.02$), night work and level of responsibility (main effect of responsibility: $F [1, 848] = 30.35$, $p<.0001$) and night work and unfair treatment (main effect of unfair treatment: $F [1, 849] = 48.65$, $p<.0001$).

However, additive effects were observed for the following example pairings: 'long/unsociable working hours' and noise (WRKHRS $F [1, 842] = 17.56$, $p<.0001$; NOIS $F [1, 842] = 8.76$, $p<.0001$) and shift schedule and time pressure (SHIFT $F [1, 789] = 4.27$, $p<.04$; TIME $F [1, 789] = 29.68$, $p<.0001$). Table 7 shows the means for each group.

Table 7: ANCOVA Means for GHQ[7]

Low noise/Low hours	Low Noise/High hours	High Noise/Low hours	High noise/High hours
1.13 (2.22)	1.51 (2.34)	1.66 (2.56)	2.55 (3.15)
Fixed shift/Low pressure	**Rotating shift/Low pressure**	**Fixed shift/High pressure**	**Rotating shift/High pressure**
1.14 (2.21)	1.54 (2.34)	2.08 (2.80)	2.99 (3.33)

[7] SD shown in brackets below mean.

The means in Table 7 suggest a linear relationship between combinations of hazards and mental health. In order to further test this, and to determine whether greater variance in well-being could be explained, a 'total fatigue indicators score' was calculated across all possible hazards.

Total Fatigue Indicators Score

Significant effects of the composite fatigue indicators score were found on virtually all subjective measures of health and well-being, including mental health (GHQ Score $F [1, 739] = 35.38$, $p<.0001$), cognitive failures (CFQ $F [1, 723] = 29.62$, $p<.0001$), fatigue (PFRS fatigue $F [1, 732] = 43.37$, $p<.0001$), physical functioning (SF-36 physical functioning $F [1, 735] = 5.55$, $p<.0001$), social functioning (SF-36 social functioning $F [1, 732] = 36.32$, $p<.0001$), job stress ($F [1, 732] = 53.38$, $p<.0001$), life stress ($F [1, 737] = 7.17$, $p<.0001$), lack of sleep ($F [1, 735] = 25.66$, $p<.0001$), poor quality sleep ($F [1, 739] = 34.31$, $p<.0001$), physical ($F [1, 745] = 31.32$, $p<.0001$) and mental fatigue ($F [1, 744] = 38.93$, $p<.0001$), and aspects of the home-work interface, including: 'problems at work make you irritable at home' ($F [1, 728] = 9.55$, $p<.0001$) and 'job takes up too much energy' ($F [1, 731] = 34.65$, $p<.0001$). Means and standard deviations for representative outcome measures are shown in Table 8.

Table 8: ANCOVA Descriptive Statistics

Outcome	1st[8]	2nd	3rd	4th
GHQ	0.59 (1.28)	1.25 (2.09)	2.22 (2.75)	3.17 (3.44)
CFQ	32.50 (11.85)	36.62 (11.79)	40.40 (1320)	44.13 (13.65)
SF-36 Social Functioning[9]	92.41 (14.14)	88.24 (17.67)	80.10 (22.16)	72.62 (22.68)
Poor quality sleep	1.97 (0.75)	2.36 (0.83)	2.55 (0.86)	2.80 (0.88)
Job stress	1.95 (0.78)	2.40 (0.94)	2.64 (0.90)	3.08 (0.95)
Physical fatigue	2.08 (0.62)	2.32 (0.65)	2.50 (0.66)	2.72 (0.68)
Mental fatigue	2.22 (0.66)	2.55 (0.67)	2.77 (0.64)	2.93 (0.71)
Problems at work=irritable at home	1.32 (0.50)	1.53 (0.60)	1.76 (0.60)	1.67 (0.65)

[8] Numbers refer to quartiles.
[9] A high score means good social functioning: in all others cases a high score demonstrates a negative outcome.

Injuries and Health-Related Behaviours

No significant effects were observed for injury frequency, use of prescribed medication or smoking and alcohol consumption.

Covariates

Installation workers were significantly worse off on the following outcomes: GHQ (Occupational Group: $F [1, 711] = 25.28$, $p<.0001$), SF-36 social functioning ($F [1, 709] = 10.46$, $p<.001$), PRFS fatigue ($F [1, 709] = 11.94$, $p<.001$), physical fatigue ($F [1, 720] = 6.42$, $p<.01$), mental fatigue ($F [1, 720] = 13.02$, $p<.0001$), job stress ($F [1, 708] = 4.42$, $p<.04$), life stress ($F [1, 712] = 8.25$, $p<.004$), lack of sleep ($F [1, 720] = 25.07$, $p<.0001$), 'problems at work make you irritable at home' ($F [1, 704] = 30.18$, $p<.0001$) and 'job takes up too much energy' ($F [1, 704] = 37.69$, $p<.0001$).

Functioning on the following measures was found to deteriorate with age: CFQ ($F 1, 706] = 6.52$, $p<.01$), SF-36 physical functioning ($F [1, 712] = 24.99$, $p<.0001$) and physical fatigue ($F [1, 720] = 5.09$, $p<.01$). Low socio-economic status was associated with increased life stress ($F [1, 712] = 4.51$, $p<.03$), mental fatigue ($F [1, 720] = 3.95$, $p<.05$) and 'problems at work make you irritable at home' ($F [1, 704] = 4.81$, $p<.03$). Low educational status negatively influenced mental fatigue only ($F [1, 720] = 4.18$, $p<.04$).

Summary of Findings

These results suggest that physical and psychosocial hazards in the offshore environment combine additively to produce a linear effect on a wide range of health and well-being outcome measures. Furthermore, this effect is more marked when a range of stressors are combined additively (as opposed to studying pairs of hazards). They do not however, appear to demonstrate these effects on health-related behaviours or injury frequency. The pattern of significance demonstrated by the covariates suggests that installation workers are worst off on the majority of outcome measures (as compared to both seafarers and onshore norms), and not surprisingly, that cognitive ability and physical functioning deteriorate with age.

Discussion

These results clearly demonstrate that exposure to a combination of workplace stressors has a significantly greater negative impact on subjective measures of health and well-being than any one 'hazard' in isolation. Furthermore, installation workers appear even worse off in terms of well-being than their seafaring counterparts. This may be explained in part by the differences in shift systems between the two groups: installation workers tend to work fast rotating as opposed to fixed shifts, which have previously been demonstrated to be the most detrimental shift pattern in terms of health and performance (e.g. Wilkinson 1992). This idea requires further clarification however: future research in the area might therefore wish to investigate this issue.

There are a number of problems inherent in the type of methodology used in this study. It is not possible to determine causal relationships from a cross-sectional survey. Although the results suggest that working in an offshore environment is detrimental to health, the possibility that poor health may lead to a more negative perception of working patterns cannot be ruled out. Individual differences such as negative affectivity may create reporting biases amongst those who seem to be most affected. These difficulties could be overcome in future by employing longitudinal or intervention studies, although an approach of this nature might prove difficult to implement from a practical point of view. Co-varying for negative affectivity may provide a more suitable alternative (see Smith et al. 2001).

As part of an ongoing research project examining fatigue and health amongst the seafaring population (Smith et al. 2001), onboard studies of the relationships between working patterns and objective performance, sleep and physiological parameters are currently being carried out. It is hoped that as a result, a clearer picture of the effects of life offshore on the workforce will emerge, in order to enable policy makers and commercial organisations to follow a common standard of best practice.

The current research highlights the potential for fatigue in an offshore environment. Although it was not clear in this instance what the consequences of this might be in terms of injury and accident causation, future research should seek to examine this link as the environmental, financial and personal costs of such a causal relationship are potentially devastating. It is already clear that a revision of working practices within the industry would greatly improve the well-being of the workforce.

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ARCHIVES OF COMPLEX ENVIRONMENTAL STUDIES, IN PRESS

COMBINED EFFECTS OF SHIFT WORK AND OCCUPATIONAL NOISE EXPOSURE ON PERFORMANCE TASKS IN A SEAFARING POPULATION.

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Abstract

This study was undertaken to compliment a cross-sectional survey of the combined effects of self-reported workplace stressors. Data were collected from seafarers on board support vessels for the North Sea oilrigs as part of a project on offshore fatigue. These data could also be used specifically to address whether there were any cognitive effects associated with working in loud noise at night that were different to working in loud noise during the day, low noise at night or low noise during the day. The participants were 62 male workers from 3 different vessels. Their mean age was 40.3 years. Individuals were from a range of different jobs onboard the vessels. There were two between-subjects factors (day/night shift and noise exposure) and one within-subjects factor (test session). Workers were asked to complete a battery of computer tests both before (Pre-shift) and after (Post-shift) their shift on one day. Four tests were presented using laptop computers. These tests were visual analogue mood scales, a simple variable fore-period reaction time, and categoric search and focused attention choice reaction time tasks. The mood scales were presented at the beginning and end of the testing session. Occupational noise exposure (L_{eq}) was measured over a two-day period using a dosimeter. Workers were categorised into day/night workers by their shift pattern. Regression analyses distinguishing noise exposure, day/night shift and their interaction were performed on the data from each test session and the change score between the start and end of the shift. Noise exposure was associated with a more positive mood but also with slower reaction times. Those working night shifts showed a large drop in alertness over the course of work and became slower at tasks requiring more difficult responses. There were also a limited number of interactions between noise and shift, such as more lapses of attention (very long response times) but fewer incorrect responses in the noise/nightwork condition. The findings suggest that these techniques may provide valuable information about the possible combined effects of occupational stressors in situ. The present analyses are based only on a small number of night workers and further consideration of effects of potential confounding influences must also be undertaken. **Key words:** psychology, occupational medicine, epidemiology.

Introduction

There has been previous research on a large number of workplace hazards. These include those arising from the psychosocial environment as well as those due to working hours and physical agents. For the most part the nature and effects of these are considered in isolation. This is not often representative of the real-life situation where employees are likely to be exposed to multiple hazards (e.g. noise, shiftwork, organic solvents). There is limited information on the combined effects of these hazards on health and performance efficiency. Indeed, there have not even been any systematic reviews of the existing literature, no attempt to produce a coherent framework for studying these factors, and a dearth of studies using multi-methods to investigate the topic. However, in many industries it is crucial to consider the combinations of factors the worker is exposed to (Smith and Mackay, 2001). This is particularly true for seafarers as high lighted by the following quote:

"Global concern with the extent of seafarer fatigue and the potential environmental costs is widely evident everywhere in the shipping industry. Maritime regulators, ship owners, trade unions and P & I clubs are all alert to the fact that in some ship types, a combination of minimal manning, sequences of rapid turnarounds and short sea passages, adverse weather and traffic conditions, may find seafarers working long hours and with insufficient recuperative rest. In these circumstances fatigue and reduced performance may lead to environmental damage, ill-health and reduced life-span among highly skilled seafarers who are in short supply. A long history of research into working hours and conditions and their performance effects in manufacturing and process industries as well as in road transport and civil aviation has no parallel in commercial shipping" (Smith, Lane and Bloor, 2000).

A recent study has investigated combined effects of workplace stressors on seafarers' health (McNamara and Smith, 2002). They found that it was the combination of work-related factors that influenced (self-reported) health in seafarers. However, the extent to which this environment, and the combination of specific factors within this environment, has a measurable impact on performance has not been investigated. This may to some extent reflect the difficulties encountered in measuring occupational performance. One method that has been used to examine this topic is to use interpolated artificial tasks to make inferences about changes in performance over the day. This approach has been used successfully to examine the effects of fatigue and noise (Broadbent, 1979), working hours (Monk and Folkard, 1985) and workload (Parkes, 1995). Similarly, such measures are sensitive to health-related behaviours (e.g. ingestion of caffeine – Brice & Smith, 2001) and health status (e.g. upper respiratory tract illnesses - Smith et al., 2000).

The present study investigated single and combined effects of occupational stressors aboard ship. Stressful aspects of offshore work are represented in the present investigation by two factors, both which were objectively measured (a) time of shift and (b) noise level[1]. These were chosen for a number of reasons:

1. The independent performance effects of noise (see Smith and Jones, 1992 for a review) and time of day effects (see Smith, 1992 for a review) are well known.
2. The performance effects of noise and circadian variation have been previously studied in the laboratory (Smith and Miles, 1986, 1987(a) and 1987(b)), thereby offering an opportunity to compare effects. These studies showed that noise and nightwork had selective effects on performance. Indeed, even where the two factors influenced the same dependent variable (e.g. alertness), effects were independent not interactive.
3. To complement studies of the associations of self-reported occupational noise exposure and exposure to temporal stressors with physical and mental health outcomes (Smith et al., 2001).

[1] it is acknowledged that many more factors would have an influence

4. These measures could be easily taken without interfering with the ongoing work of the volunteers.

Materials and Methods

Sample

62 working volunteers from various occupations on-board 3 vessels serving the offshore oil industry.

Measures

Participants were required to complete a battery of computerised performance and mood tasks on a laptop computer, in the same order, before and after work on one day of their shift.

Mood: Ratings of mood were taken using visual analogue mood scales. Participants were presented with 18 scales comprising a pair of adjectives anchored at either end of a linear scale – e.g. drowsy – alert. Participants were asked to move the display pointer, using the keys on a response box, to a position on the scale that was representative of their mood. Three main factors were then extracted from the results: alertness, anxiety and hedonic tone.

Simple Reaction Time (SRT): A white frame was displayed in the centre of the screen and at varying intervals (1-8 seconds) a solid white square appeared inside the frame. Participants were asked to press a response key as soon as they detected the solid square. This task lasted approximately 3 minutes. Mean reaction times were calculated for the test as a whole, as well as for each minute of the task.

Focused Attention (Broadbent et al., 1989): Target letters (A's or B's) were presented at random intervals in the centre of the screen. The target stimulus was shown on its own, with an asterisk on either side, or with a letter either side. Participants were required to ignore any distracters presented in the periphery and respond to the target stimuli only. This task measures mean reaction time, accuracy of response (percent correct), lapses of attention (occasional long responses), the Eriksen effect (which measures the focusing of attention) and speed of encoding information (i.e. reaction time differences between conditions when target is alternated/repeated from a previous trial).

Categoric Search (Broadbent et al., 1989): This task is similar to the focused attention task outlined above. Prior to the presentation of the target letter, two crosses were shown either in the centre of the screen or towards the extreme left and right of the screen. The target letter, again either A or B, then appeared in place of one of these crosses. For half the trials the target letter was presented alone and for the other half it was accompanied by a distracter digit. Reaction time, response accuracy, lapses of attention, spatial uncertainty (i.e. the extent to which knowing the target location affects accuracy and reaction time), speed of encoding and effect of target location (i.e. difference in reaction times between targets presented in different/same location) were measured. In addition, trials differed in stimulus-response compatibility (on some trials the stimulus appeared on the same side of the screen as the hand with which the response had to be made [compatible condition], on others it appeared on the opposite side of the screen.

Noise

Noise was measured using dosimetry. Noise was measured in dB(A) and the 'equivalent continuous' level (L_{eq}) is quoted.

Timing of Shift

Timing of shift was defined by usual shift pattern. The length of the shift was 12 hours, from 18:00 – 6:00 for night workers and 6:00 – 18:00 for day workers.

Analysis

66 stepwise regression analyses were carried out in SPSS v10 with the mood and performance measures as dependent variables. Noise exposure (L_{eq}) was included in the regression model as a continuous predictor variable, and shift type (day or night) as a categorical predictor variable. Therefore the two between-subjects factors were (a) objectively measured noise exposure and (b) day/night shift. The interaction of the two predictors was also included in the model.

Results

Demographics

The sample consisted of 62 men working in different capacities aboard vessels associated with the offshore oil industry. The mean age of the sample was 40.3 years (SD = 9.41), with the youngest 21 years old and the oldest 58 years old. The majority were British/Irish (83.9%), with a smaller number being European (12.9%) and 'other' (3.2%) respectively. Participants held an array of occupational roles aboard the vessels (Table 1).

Table 1: Range of occupations within sample

Job title	N (percentage)
Marine officers	9 (14.5%)
Non-marine crew (i.e. divers)	13 (21.0%)
Marine crew (i.e. steward, cook, medic)	37 (59.7%)
Missing	3 (4.8%)

Of the 62 workers, 53 (85.5%) were day workers and only 9 (14.5%) were night workers. The night workers were marginally older (41.3 years old) than day workers (40.1 years old) on average. Also, unsuprisingly, night workers were drawn from a specific subset of occupations onboard the vessels, exclusively from the non-marine crew.

Aside from differences in occupations of day and night workers, there were also significant differences in the organisation of their work. The majority of both day- and night- workers worked 28 day tours of duty, however amongst the day workers there were more people working tours of duty both shorter (14 – 21 days) and longer than this (30 – 56 days).

Also, at the time of testing, night workers generally had been on tour for less time ($\leq$ 14 days), whereas a substantial proportion of day workers had been on tour $\geq$ 15 days.

On average, day workers were exposed to slightly greater noise (Table 5), as would be expected given the greater general activity on board during the day.

Table 5: Noise exposure by shift time

	Noise (Leq) at time 2			
	Mean	SD	Min	Max
Day shift	62.06	6.49	55.20	72.50
Night shift	57.94	4.58	55.20	69.30

For the tabulated comparisons of means in the results, objectively measured noise exposure was split into high ($\geq$59 dB(a)) and low (<59 dB(a)) noise exposure. For the analyses presented below this meant that there were considerably unequal cell sizes (Table 6).

Table 6: Categorisation of workers by noise exposure and day/night shift

	Day workers	Night workers
<59 dB(a)	22	6
$\geq$59 dB(a)	31	3

Mood and Performance Results

Results are tabulated according to the type of effect observed (a) main effects of noise, (b) main effects of shift and (c) interaction between noise and shift.

Noise exposure

There were a considerable number of main effects of noise. These effects are summarised in the tables below, grouped by the test. Where there were main effects of noise, the effect was almost always present both pre- and post-shift. This suggests that the effects were chronic, not reflecting exposure to noise over the shift but more general, longer term, exposure[2].

Mood

Noise had a significant effect on mood (table 7). Increased noise was assoicated with increased reported alertness and increased hedonic tone (i.e. more ‘happiness’). There was also a main effect on post-shift reported anxiety, which decreased.

Simple reaction time

There was an increased post-shift mean reaction time on the simple reaction time task for those exposed to the higher noise levels (table 8). Given that this was not apparent pre-shift this could reflect an acute effect of noise exposure.

Table 7: Mood

		< 59 dB(A)	≥ 59 dB(A)
Pre-shift alertness*	F (1, 60) = 9.7, p<.01; ß =.376, t =3.114, p<.01	mean=237.3 s.d.=51.9 n=28	mean=291.2 s.d.=61.7 n=33
Post-shift alertness*	F (1, 60) = 19.43, p<.001; ß =.498, t =4.408, p<.001	mean=235.2 s.d.=50.2 n=28	mean=287.9 s.d.=62.5 n=33
Pre-shift hedonic tone**	F (1, 60) = 11.99, p≤.001; ß =.411, t =3.462, p<.01	mean=186.7 s.d.=40.8 n=28	mean=222.0 s.d.=48.4 n=33
Post-shift hedonic tone**	F (1, 60) = 16.54, p<.001; ß =.468, t =4.067, p<.001	mean=181.5 s.d.=39.6 n=28	mean=218.7 s.d.=49.0 n=33
Post-shift anxiety***	F (1, 60) = 5.43, p<.05; ß =.290, t =2.329, p <.05	mean=85.7 s.d.=16.9 n=28	mean=100.2 s.d.=25.6 n=33

* high scores = greater alertness
** high scores = more positive mood
*** low scores = greater anxiety

Table 8: Simple reaction time (msecs)

		< 59 dB(A)	≥ 59 dB(A)
Post-shift reaction time	F (1, 61) = 5.14, p<.05; ß =.281, t =2.268, p<.05	mean=288.6 s.d.=49.5 n=28	mean=314.4 s.d=56.4 n=34

Focused attention task

On the focused attention tasks, there were a number of significant noise effects (table 9). Mean reaction time was greater on both pre- and post-shift measures, as were the number/percentage of long reponses made. Also there was a significant main effect of noise on both pre- and post-test Eriksen effect measures, suggesting less focused attention in those exposed to higher noise levels.

Categoric search task

The analyses of the data from the categoric search task confirmed that noise exposure was associated with slower reaction times both pre- and post- shift (table 10).

Table 9: Focused attention

		< 59 dB(A)	≥ 59 dB(A)
Pre-shift reaction time (msecs)	F (1, 61) = 9.18, p<.01; ß =.364, t =3.029, p<.01	mean=455.1 s.d=54.2 n=28	mean=498.5 s.d=65.6 34
Post-shift reaction time (msecs)	F(1, 61)= 10.29, p<.01; ß =.383, t =3.207, p<.01	mean=440.2 s.d=47.2 n=28	mean=477.2 s.d=68.9 n=34
Pre-test eriksen effect (msecs)	F (1, 61) = 7.84, p<.01; ß =-.340, t =-2.800, p<.01	mean=3.7 s.d=37.0 n=28	mean=-21.0 s.d=45.5 n=34
Post- shift eriksen effect (msecs)	F (1, 61) = 6.96, p<.05; ß =-.322, t =2.638, p<.05	mean=14.7 s.d=39.1 n=28	mean=-8.7 s.d=35.6 n=34
Pre-shift: number of long responses	F (1, 61) = 5.56, p<.05; ß =.291, t =2.357, p<.05	mean=1.9 s.d=2.2 n=28	mean=4.5 s.d=5.8 n=34
Post-shift: number of long responses	F (1, 61) = 7.97, p<.01; ß =.342, t =2.823, p<.01	mean=1.3 s.d=2.1 n=28	mean=3.0 s.d=5.8 n=34

Table 10: Categoric search

		< 59 dB(A)	≥ 59 dB(A)
Pre-shift reaction time (msecs)	F (1, 61) = 7.71, p<.01; ß =.337, t =2.777, p<.01	mean=540.1 s.d.=65.7 n=28	mean=601.8 s.d.=77.9 n=34
Post-shift mean reaction time	F(1, 61)= 8.27, p<.01; ß =.348, t =2.876, p<.01	mean=522.3 s.d.=55.2 n=28	mean=574.5 s.d.=70.1 n=34

[2] Noise exposure did not vary a great deal from day to day (as infered from the high correlation between day 1 and day 2 exposure levels).

Day/Night shift

Mood

There were far fewer effects of day versus night shift. There was, unsuprisingly, a significant decrease in reported alertness between pre- and post-shift measurement, with alertness declining substantially for those working nights but increasing for those working days (Table 11).

Table 11: Mood

		Day	Night
Change – Alertness (the lower the score the greater drop in alertness)	$F (1, 59) = 7.18$, $p \leq .01$; ß =-.332, t =-2.679, $p \leq .01$	mean=7.4 s.d.=57.0 n=51	mean=-48.9 s.d.=64.2 n=9

Choice reaction time tasks

On the categoric search task there were two significant change scores; mean reaction time was increased in those working night shifts (especially on more difficult [incompatible] conditions) and there was a significant increase in the number/percentage of long responses made in the night group.

Noise x time of day

There were no significant interactions in the analyses of mood or simple reaction time data. All significant interactions were on the attention tasks, specifically the categoric search task. The profile of results suggested that the combined noise and night condition was associated with slower but more accurate responses (Table 12).

Table 12: Categoric search

		Day / quiet	Day / noise	Night/ quiet	Night/ noise
Change – RT (target alone)- more positive scores show a greater slowing	$F (1, 61) = 9.67$, $p<.01$; ß =.373, t =3.110, $p<.01$	mean= -23.8 s.d.= 28.6 n=22	mean= -26.4 s.d.=34 .2 n=31	mean= -2.4 s.d.= 28.3 n=6	mean= 24.0 s.d.= 3.8 n=3
Post-shift long responses (>1,000 milliseconds)	$F (1, 61) = 6.86$, $p<.05$; ß =.320, t =2.619, $p<.05$	mean= 1.8 s.d.= 1.9 n=22	mean= 3.5 s.d.= 4.8 n=31	mean= 2.8 s.d.= 4.0 n=6	mean= 13.0 s.d.= 14.2 n=3
Post-shift number of errors – low scores = greater accuracy	$F (1, 61) = 5.52$, $p<.05$; ß =-.290, t =-2.349, $p<.05$	mean= 5.8 s.d.= 3.4 n=22	mean= 4.7 s.d.= 4.4 n=31	mean= 3.2 s.d.= 3.2 n=6	mean= 1.4 s.d.= 1.5 n=3
Change – number of errors	$F (1, 61) = 11.55$, $p \leq .001$; ß =-.402, t =-3.398, $p \leq .001$	mean= 1.6 s.d.= 2.4 n=22	mean= 1.6 s.d.= 2.8 n=31	mean=- 1.7 s.d.= 2.9 n=6	mean= -1.0 s.d.= 0.0 n=3

Summary of results

There were a large number of main effects of objectively measured noise exposure on mood and performance. Noise was associated with a more alert and positive mood but slower reaction times. Those working night shifts showed a large drop in alertness over the course of work and became slower at tasks requiring more organisation of the response (i.e. trials involving incompatible responses). There were also a limited number of interactions between noise exposure and day/night shift, such as (a) slower reaction times and more lapses in attention – as signified by long response times on the attention tasks – and (b) fewer incorrect responses in the noise/night condition.

Discussion

The results from the present study suggest that either noise or day/night generally has an effect and there are few effects that present themselves as interactions between the two factors. However, there is some suggestion of specific areas of cognitive performance where the stressors in combination have a greater influence. Specifically, the combination of noise and nightwork was associated with slower responses and more lapses of attention in the categoric search task but also more accurate responding. In other words, the combined condition showed a change in the speed-error tradeoff function, an effect often associated with increased fatigue.

The general profile of individual of noise and nightwork supports those reported in the literature. For example, noise increased alertness as in the Smith and Miles (1986) study. Similarly, it increased the frequency of occasional long reaction times which is in agreement with studies cited by Broadbent (1979). As in laboratory studies (Smith and Miles, 1986; 1987(a), 1987(b)) noise and night work were found to have largely selective and independent effects.

The effects of nightwork were less obvious, although alertness was found to decline more rapidly over the night shift than the day shift. The absence of other effects of working at night may reflect the small sample size. Indeed, analyses of a larger sample of seafarers working at night (Smith, Lane and Bloor, 2001) showed that their reaction times also slowed over the course of the shift. However, there was also some sign of adaptation to nightwork, with those who had been working nights for more than 5 days showing fewer impairments than those who were less than 5 days into their tour of duty.

It is worth considering the number of analyses that we would expect to be significant by chance (i.e. approximately 5%). 34.8% of the 66 analyses were significant. 21.2% showed main effects of noise, 6.1% showed main effects of day/night shift and 7.6% were interaction between noise and day/night shift. The noise effects seem robust and a number of the other effects both intuitive and highly significant. Others however could be chance effects and replication is desirable.

The research methodology described here provides a potential technique for examining combinations of stressors within a specific occupational environment. However, the present results must be treated with caution for a number of reasons. First, the number of nightworkers was small. Secondly, the issue of other potentially confounding influences requires more detailed consideration. As was highlighted earlier volunteers were from three different vessels, and night workers were exclusively recruited from just one of these vessels, a dive support vessel. Therefore there were obviously some unmeasured, and uncontrolled for, variables that may explain at least some of the present findings.

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A CROSS-VESSEL SURVEY OF SEAFARERS EXAMINING FACTORS ASSOCIATED WITH FATIGUE

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As part of the second phase of the seafarers fatigue project a questionnaire based survey was administered through onboard field research and a mail shot, replicating phase one. The short sea and coastal shipping industry was investigated in contrast with the offshore oil industry examined in the first phase. Higher fatigue and lower health were found in the phase two sample, suggesting the importance of vessel type in determining levels of fatigue. Ship based fatigue differences were detected in the stage two sample, prompting further investigation of factors which define ships at a practical level. Tour length and watch / duty schedules may be particularly useful in terms of characterising vessels and therefore by extension these factors may be of use in terms of ultimately accounting for seafarers fatigue.

Introduction

In phase one of the seafarers fatigue project the offshore oil industry was examined (Smith, Lane and Bloor, 2001). This initial study represented the first comprehensive investigation of fatigue at sea, adopting a series of subjective and objective measures and involving onboard field research. A questionnaire based survey was also administered to both onboard participants and to a larger sample via a mail shot. In the second phase of the project the short sea and coastal shipping industry was examined in order to widen the scope and generalised relevance of results from phase one. Whilst slight adjustments were made to the onboard measures between phases one and two (Ellis *et al,* 2003), the survey format was identical to that previously adopted. Results from the phase two survey will form the basis of this paper.

Survey content

The questionnaire used in the survey was identical to that used in phase one of the project and consists of three sections:

1. *Offshore:* Questions in this section refer specifically to time spent offshore, encompassing measures of work and rest patterns, and subjective measures of attitudes towards work.

2. *On leave:* Questions in this section relate to time spent on leave/at home and include subjective measures of health and well-being, fatigue, sleeping patterns, and health-related behaviours such as eating, drinking, smoking and exercise.

3. *Life in general:* Questions in this section are designed to measure incidence of accidents and injuries, and general health and well-being, using a number of standardised scales such as the General Health Questionnaire (GHQ), the Profile of Fatigue Related Symptoms (PFRS), the Cognitive Failures Questionnaire (CFQ), and the MOS Short Form Health Questionnaire (SF-36).

Sample

In parallel with phase one of the project, two techniques were used to administer the survey to seafarers. Firstly, the questionnaire was sent out in a mail shot to the officers union NUMAST and four individual seafaring companies. Secondly, the questionnaire was completed by participants recruited as part of the onboard study. The ships involved with onboard testing represented the same four companies targeted with the mail shot. Characteristics of the onboard sample are described in the accompanying paper by Burke *et al* (2003). The mail shot sample is described below.

Mail shot sample

The survey was sent to two ferry/freight companies and two tanker companies. The number of questionnaires sent out and response rates are shown in Table 1 below. As can be seen from Table 1, response rates were relatively low, however these rates were approximately comparable across the different sub-samples which reduces the possibility of any selective group biases. The mail shot sample had a mean age of 45.0 years (range 17- 66, SD=9.72). This was high due to the large proportion of NUMAST respondents in this sample. NUMAST respondents represent officers and those in senior positions. In terms of education, 54.7% of respondents reported completing GCSE's / 'O' levels, which again may have been skewed by the large number of officers in the sample.

Table 1. Mail shot response rates

Company	**Number of Questionnaires Sent**	**Number of Questionnaires Received**	**Response Rate** (%)
Numast	2740	539	19.7
Ferry Co.1	650	137	21.1
Ferry Co.2	110	35	31.8
Tanker Co.1	110 Polish / 90 English	30	15.0
Tanker Co.2	250	48	19.2

Phase 1 vs. Phase 2 comparison

A key concern within the second phase of the project was to determine the extent to which the findings from the offshore oil industry could be generalised to short sea and coastal shipping. Table 2 below shows the type of vessel respondents reported working on in both stages (mail shot and onboard sample combined). As the table shows, phase one focused upon industrial type vessels, whilst in phase two passenger carrying vessels were most highly represented.

Table 2. Phase 1 and Phase 2 vessel types

	Vessel type	**% Respondents**
Phase 1 (seafarers only)	Offshore support	26.3 (n=147)
	Supply vessel	29.0 (n=162)
	Standby vessel	13.4 (n=75)
	Tanker	4.2 (n=23)
	Other	27.2 (152)
Phase 2	Passenger ferry	40.3 (n=372)
	High speed passenger ferry	9.0 (n=83)
	Freight	21.1 (n=195)
	Tanker	16.2 (n=150)
	Dredger	6.6 (n=61)
	Other	6.8 (n=63)

The next stage was to assess relative levels of fatigue within the two phases.

Levels of fatigue

In order to assess relative levels of phase one and phase two fatigue, four measures were adopted from the survey. In addition to the Profile of Fatigue Related Symptoms (PFRS) fatigue subscale, three separate factors were derived as detailed below. Constituent factor items were kept consistent across the two phases.

General Fatigue Symptoms. Factor analysis was conducted on seven items addressing symptoms of fatigue. On each item respondents had to rate the extent to which they had experienced the specific symptom whilst at sea, from 1 (very) to 5 (not at all). The symptoms were; 1. Confusion, 2. Lethargy, 3. Poor quality sleep, 4. Depression, 5. Tension, 6. Loss of concentration and 7. Increased use of caffeine. In phase one these items clustered on two factors, with only items 3 and 7 loading most highly on the second factor. Whilst only one factor was extracted in the phase 2 analysis, the two least loading items were again 3 and 7. A combined factor was therefore calculated as the average of scores across items 1, 2, 4, 5 and 6.

Fatigue at work. Factor analysis was conducted on all six items within the 'feelings at work' section of the questionnaire. The first three items were found to load on a single factor relating to fatigue at work. These items assessed the respondents' typical state during work, their level of tiredness at work and how often they felt sleepy at work. This finding was consistent across both phases, and therefore a combined factor was calculated as the average of items 1 to 3.

Fatigue after work. The last three items in the 'feelings at work' section were found to load on a separate factor addressing fatigue after work. These items assessed levels of physical and mental tiredness at the end of the working day, and how tense the respondent felt after the working day. Again this finding was consistent across both phases, and therefore a combined factor was calculated as the average of items 4 to 6.

In Table 3 below phase one and phase two fatigue scores are shown across the four fatigue scales detailed above. On all scales a higher score indicates higher levels of fatigue (score ranges: General fatigue = 1 to 5; Fatigue at work = 1 to 6: Fatigue after work = 1 to 4: PFRS fatigue scale = 12 to 84).

Table 3. Mean levels of fatigue in phases one and two

	General Fatigue symptoms	Fatigue at work*	Fatigue after work*	PFRS Fatigue scale**
Phase 1	1.39 (n=494, S.E = 0.04)	3.63 (n=550, S.E = 0.04)	2.35 (n=559, S.E = 0.03)	25.4 (n=553, S.E = 0.53)
Phase 2	1.43 (n=793, S.E = 0.03)	3.74 (n=905, S.E = 0.03)	2.46 (n=911, S.E = 0.02)	29.3 (n=907, S.E = 0.47)

*= differ significantly at the $p<0.05$ level. ** = differ significantly at the $p<0.01$ level

As Table 3 above shows, phase two consistently reported higher levels of fatigue. The next question to address was whether these fatigue based differences had any direct relation to reported health status.

Health status

Table 4 compares the two phases using the Short Form Health Survey (SF-36) section of the questionnaire which assesses eight health dimensions. A low score on all subscales indicates poorer functioning, except the 'bodily pain' scale where a low score indicates an absence of significant pain. As Table 4 shows, phase two respondents consistently reported poorer health except on the bodily pain subscale, thus supporting an intuitive link between fatigue and health scores. The next question to address concerned what actually causes the between stage differences that have been identified.

Table 4. Comparison of health status in phases one and two

	phase 1 (mean)	phase 2 (mean)
Physical functioning	**90.0** (n=556 , S.E = 0.67)	**89.6** (n=901 , S.E = 0.49)
Role-physical **	**87.9** (n=536 , S.E = 1.14)	**83.1** (n=909, S.E = 0.95)
Bodily pain *	**77.9** (n=559 , S.E = 0.87)	**75.1** (n=930 , S.E = 0.74)
General health **	**70.4** (n=557 , S.E = 0.73)	**67.0** (n=907 , S.E = 0.63)
Vitality **	**64.0** (n=558 , S.E = 0.76)	**59.7** (n=904 , S.E = 0.64)
Social functioning **	**84.9** (n=554 , S.E = 0.87)	**81.2** (n=917 , S.E = 0.76)
Role-emotional **	**88.3** (n=527 , S.E = 1.17)	**81.5** (n=914 , S.E = 1.06)
Mental health *	**74.8** (n=555 , S.E = 0.70)	**72.5** (n=904 , S.E = 0.58)

*= differ significantly at the $p<0.05$ level. ** = differ significantly at the $p<0.01$ level

Accounting for the between phase differences in fatigue and health status

Whilst the between phase differences that have been found are interesting in isolation, these differences prove most useful in terms of highlighting factors directly associated with seafarers fatigue. Ship type in particular was identified as potentially useful in accounting for between phase differences, therefore this factor was examined independently within the phase two sample. Clearly any ship based fatigue differences would have considerable applied relevance.

Ship type differences

Five ship groupings were made within the phase two survey sample into which most respondents naturally fell (Passenger, High speed passenger, Freight, Tanker and Dredger). Any unclear cases were put into a sixth 'other' category.

Levels of fatigue
In Table 5 fatigue after work scores are shown for the six ship categories.

Table 5. Ship comparison of fatigue after work

Vessel	**After work fatigue** (Mean)
Passenger	**2.57** (n=363 , S.E = 0.03)
High speed Passenger	**2.57** (n=79 , S.E = 0.07)
Freight	**2.37** (n=189 , S.E = 0.05)
Tanker	**2.32** (n=147 , S.E = 0.05)
Dredger	**2.39** (n=61 , S.E = 0.06)
Other	**2.36** (n=62 , S.E = 0.07)

As shown in Table 5, there were found to be differences between the vessels in terms of self-reported levels of fatigue. A series of analyses of co-variance (ANCOVA) co-varying for age, education and socio-economic status (SES) found significant between-vessel differences on three of the four fatigue scales (fatigue at work ($p<0.01$), fatigue after work ($p<0.01$) and PFRS fatigue scale ($p<0.01$)). Differences on the general fatigue symptoms scale were also approaching significance ($p=0.063$). The most marked difference across the four fatigue scales was that the passenger and high speed passenger respondents in particular reported noticeably higher levels of fatigue than the tanker respondents. Evidence was also shown for a broader industrial / passenger split with the passenger vessels (passenger ferry, High speed passenger ferry, freight) generally reporting higher levels of fatigue than the more industrial type vessels (tanker, dredger, other). Therefore it appears that to a large extent phase one versus phase two fatigue differences can be accounted for by the effect of ship type. The next area to consider is whether the concept of ship type can account for health status differences that were found between the two phases.

Health status
In Table 6 the different vessel types are compared in terms of health status. As the table illustrates, significant differences were found between the ships in terms of specific health scores (e.g. vitality). On other scales, however, differences were less pronounced (e.g. mental health) or negligible (e.g. general health). Conclusions are therefore more difficult to draw concerning the relative health status of different ship types. The only justifiable conclusion is that there is marginal evidence on a number of the health scores to support a broad industrial / passenger division as previously identified. The fact that a ship based comparison did not reveal clear health differences raises questions in terms of the use of

this variable in accounting for the unequivocal phase based differences which were found. In terms of understanding this result two possibilities therefore emerge; 1. Ship type is not the most crucial variable distinguishing phase one from phase two, or more plausibly, 2. Vessel differences within phase two do not reflect the magnitude of vessel differences between the phases. Assuming the second possibility to be true, the next stage is to identify which factors are crucial within the concept of ship type in terms of understanding fatigue. Therefore whilst phase differences arguably pointed towards ship type, ship type must also point towards a number of factors, such as tour length or shift type, which actually characterise ships on a practical level.

Table 6. Ship comparison of SF-36 Health scores

Vessel	Vitality** (Mean)	Mental Health (Mean)	General Health (Mean)
Passenger	56.7 (n=362, S.E = 0.95)	72.0 (n=359, S.E = 0.85)	66.7 (n=362, S.E = 0.90)
H.speed passenger	56.4 (n=78, S.E = 2.24)	72.1 (n=78, S.E = 2.14)	68.5 (n=81, S.E = 2.46)
Freight	60.6 (n=187, S.E = 1.52)	70.0 (n=186, S.E = 1.39)	67.2 (n=188, S.E = 1.49)
Tanker	64.7 (n=143, S.E = 1.75)	74.5 (n=148, S.E = 1.50)	66.6 (n=145, S.E = 1.62)
Dredger	60.7 (n=61 , S.E = 2.12)	76.3 (n=61, S.E = 1.78)	63.8 (n=59 , S.E = 2.36)
Other	65.3 (n=62 , S.E = 1.90)	74.8 (n=61 , S.E = 2.07)	69.5 (n=60 , S.E = 2.20)

**= differ significantly at the $p<0.05$ level.

Conclusion

Through examination of phases one and two of the Seafarers Fatigue Project differences were found in terms of levels of fatigue and also health status. These differences were identified as primarily reflective of the different vessel types studied within the two phases. Whilst vessel differences are interesting, however, in terms of identifying the causes of fatigue the concept of vessel type itself needs to be disassembled into key defining factors.

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THE IMPACT OF WORK PATTERNS ON STRESS AND FATIGUE AMONG OFFSHORE WORKER POPULATIONS

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This study examined the effects of tour length on stress and fatigue in seafarers in the coastal and short sea shipping industry, in terms of both self report and objective measures. Firstly, a brief outline of the sample and measures used will be given. Then, some background on the issue of tour length is provided. This will be followed by analysis of length of tour for this study in terms of its impact on various measures used in testing. These included self-reports of sleep quality, fatigue, stress levels and mood and performance on reaction time and attention tasks and objectively measured sleep quality. These findings are then outlined and discussed, and the role of tour length in seafarers stress and fatigue is evaluated.

Assessment of Fatigue Onboard Ship

The unique combination of stressors present in the offshore environment - e.g. extreme weather conditions, noise, motion and demanding work schedules - mean that research findings from other transport industries and onshore populations cannot automatically be applied to seafarers. As well as collecting survey data, it was felt important to actually go onboard ships to gather more detailed information. In this part of the research, a variety of objective indicators and subjective reports were used in assessing seafarers' fatigue.

Sample

177 participants were recruited in total by researchers who visited seven ships, operating in the UK sector. These consisted of 3 small oil tankers, 2 passenger ferries, a freight ferry, and a fast ferry. This sample was compared with the survey sample and the two were found to be generally similar, although the onboard sample were younger on average, which may be attributable to the higher proportion of officers in the survey sample, or to the comparatively young crew of the fast ferry. This is compared with the phase one onboard sample of 144 workers from the offshore oil industry in order to assess generalisability of findings between phases.

Age

Participants were generally older in the phase one sample. This may again be partially accounted for by the relative youth of the fast ferry crew, and also the relative youth of those working on ferries compared to those working on the offshore oil support ships studied in phase one (see Table 1)

Table 1: Mean ages of subjects by vessel type

Group	N	Mean	SD
Phase 1	144	41.31	9.82
Pipe Layer	18	40.78	10.14
Dive support vessel	81	42.04	8.63
Shuttle tanker	19	38.84	12.85
Supply Vessel	12	44.00	8.16
Standby/supply Vessel	14	38.86	12.51
Phase 2	177	36.07	11.40
Freight	27	39.11	10.45
Tankers	24	41.83	12.67
Passenger Ferries	71	37.28	9.90
Fast ferries	55	30.49	11.07

There were more mixed nationality crews in phase 2, with only 63.8% (n=113) of crews being from the British Isles, in comparison to 91.2% (n=134) in phase 1. Other nationalities in phase 2 included Spanish (20.3%, n=36), Polish (13.0%, n=23), and Canadian (2.8%, n=5).

Length of tour

The typical tour length was shown to differ between the two phases, with the majority of participants in phase 1 (68.3%, n=99) working 4 weeks on/4 weeks off tours, in comparison to phase 2 in which the majority worked 1 week tours (34.4%, n=61) (see Table 2). However, again this was skewed by tour length on the fast ferry, which never exceeded seven days.

Table 2: Tour length

Tour length	Phase 1	Phase 2
1 week	----	34.4% (n=61)
2 weeks	2.8% (n=4)	15.3 (n=27)
3 weeks	4.1% (n=6)	6.2% (n=11)
4 weeks	68.3% (n=99)	3.4% (n=6)
5 weeks	6.9% (n=10)	0.6% (n=1)
6 weeks	2.1% (n=3)	1.1% (n=2)
7 weeks	9.0 (n=13)	----
8 weeks	6.9 (n=10)	10.2% (n=18)
8+ weeks	----	29.0% (n=51)

Phase 1 and phase 2 participants were tested at a similar stage into the tour, with the highest proportion of subjects being tested in week 1 (43.7% in phase 1, and 48.0% in phase 2) (see Table 3).

Table 3 . Weeks into tour at testing

Weeks in tour	Phase 1	Phase 2
week 1	43.7% (n=62)	48.0% (n=85)
week 2	26.1% (n=37)	13.0% (n=23)
week 3	16.2% (n=23)	6.8% (n=12)
week 4	4.2% (n=6)	5.6% (n=10)
week 5	2.1% (n=3)	4.0% (n=7)
week 6	1.4% (n=2)	4.5% (n=8)
week 7	5.6% (n=8)	3.4% (n=6)
week 8	0.7% (n=1)	5.1% (n=9)
week 8+	----	9.6% (n=17)

Procedure

Volunteers participated in four sessions overall, which were scheduled before and after work on the first and final day of their testing, typically an interval of 5-7 days. During these sessions, before and after work questionnaires (henceforth 'logbooks') recording food intake, medication, breaks, caffeine consumption, smoking, sleep, symptoms of fatigue and perception of work related issues were completed. Performance tasks measuring reaction times, errors and lapses of attention as well as subjective reports of alertness, hedonic tone (happiness, sociability) and anxiety were also administered during these sessions.

Further objective measures involved sleep recording to assess sleep quality, noise measurements from different areas of the ship, and measurements of the pitch, roll, and heave dimensions of motion. The survey was completed by participants onboard ship in their own time during this testing interval.

Tour Length - Background

Seafaring may be regarded as a very important occupational area for study, having high accident rates and more deaths per capita than any other industry in Britain. It is therefore necessary to examine the issues that make this so. However, studies of seafarers have, until now, paid little attention to potentially important factors such as days-into-tour. Intuitively the expectation is that longer tours of continuous duty would be more detrimental in terms of cumulative effects leading to more fatigue and poorer health. It is indeed the case that some research on installation workers (Collinson, 1998; NUMAST, 1992) has indicated that tours exceeding 2 weeks show increased injury rates, and that adverse physiological changes may be related to tour lengths exceeding one week.

However Forbes' (1997) study found that accident frequency among installation workers was greatest at the beginning of a tour, specifically during the first tour week, and then declined steadily over the course of a tour. Thus clearly, these mixed findings indicate that this intuitive sense that longer tours are more detrimental in health and fatigue terms requires re-examination.

Generally indications from phase one (Smith *et al*, 2001) also affirmed that shorter tours are not necessarily better in terms of seafarers' well-being. Although the accident data is limited, most accidents were found to occur in the first week of tour regardless of actual tour length. The logbook data confirmed that the impact of their work and work environment on seafarers may change over the course of the tour. For example, sleep duration was reduced for the first night offshore but improved with days into tour. Also, seafarers showed improvements in alertness across the week, and analyses of effects of days into tour on those working night shifts showed that those more than 5 days into tour (average 18 days) made fewer errors on performance tasks than those less than 5 days into tour (average 3 days).

It was found that many phase one respondents reported feeling 'below par' on returning to their vessel/installation after a period of leave. Approximately half of all respondents felt that adjusting to life offshore took at least 2-3 days and felt their performance to be affected during this period of adjustment. This may partially account for these findings, since the period of adjustment takes up a smaller proportion of longer tours than of shorter tours.

Tour Length – Phase Two

This analysis was conducted to yield information about changes in seafarers' stress, fatigue and performance levels over a discrete period of time, in order to assess the impact of offshore work on seafarers as a function of time into tour. This was done using a mixture of data from both the logbooks and the objective measures. Survey data were not relevant to this analysis since the measures within the survey were only completed once, not at the specific onboard testing intervals.

The period of analysis matched the period of the performance testing onboard, i.e. typically 5-7 days, and the analysis itself had two layers. Firstly, the aim was to reveal any fatigue and performance related differences there may be as a result of a specific period – that is to uncover what, if any, effect working over approximately a week long period has on self-reports of fatigue, work-related variables, and objectively measured performance and sleep. Secondly, these effects were analysed as a function of time into tour, to assess whether longer tours mitigated or exacerbated these effects. This analysis was restricted to the logbooks only.

Approximately forty participants (the fast ferry sample) were excluded from this analysis since their entire tour was only 6-7 days long, and it was felt that including them would bias the data set, by confounding ship type with tour length.

Key findings:

- Levels of job stress, job effort, alertness and outcomes on some of the performance measures were more negative further into tour
- Habituation to noise levels aboard ship seems to occur fairly consistently as a function of time into tour.
- Sleep appears to improve further into tour, which may help account for the relatively low levels of fatigue in this sample.

Both the logbook and the objective measures provide evidence that the cumulative effect of work, both across the day and across the working week, may influence both levels of fatigue and performance. Across the working week, job stress was found to increase and this was mirrored by slower task reaction times and lower levels of alertness. This may indicate that over longer periods, seafaring work has a detrimental effect on individual fatigue and performance.

There is also some evidence from the logbooks that seafarers' sleep improves as a function of time into tour. Although an actual improvement in sleep was not recorded by the objective measures, no impairment in sleep was identified either so at the very least these do not contradict the logbook findings. Also, generally habituation to noise levels onboard was observed as a function of days into tour.

Key differences on the first fortnight vs. after two weeks analysis:

First fortnight of tour:

- Physical effort significantly lower after seven days
- General health significantly worse after seven days

After first two weeks of tour:

- Almost no change in sleep across the testing interval
- Physical effort significantly higher after seven days
- Weather becomes more of an issue across the testing interval, despite no change in actual weather conditions
- Support from fellow workers, self-regulation of own work, and work satisfaction are all affirmed more highly after seven days for this sub-sample

This further analysis of the logbook data indicates that any cumulative effects over the testing interval vary as a function of weeks into tour. There is some evidence of habituation, and some evidence of cumulative negative effects of time at sea, e.g. fewer effects of noise are observed further into tour, whereas the subjective impact of motion increases. This first fortnight/after second week of tour split is supported by the manifest differences between the two sub-samples. For example, from day one to day seven of the first fortnight of tour, there is a significant increase in self reported work stress and lack of sleep, and even though physical effort decreases over the seven day period, general health is reported as worse. After the first fortnight of the tour there are fewer negative day one day seven differences. Again, general health was found to be worse on day 7. Stress is mostly the same, sleep appears stable over a week long period after the first fortnight of the tour. There are some indications that longer tours may be better in that there is higher affirmation of receiving support from fellow workers, self-regulation of work and work satisfaction further into tour.

Conclusion

Thus tour length seems to be an important factor in stress and fatigue at sea, and also to affect sleep and other exposure variables. Furthermore, the effects of work and work related issues on seafarers over the work period vary as a function of time into tour. These time into tour differences may even indicate that in some ways, longer tours are actually less detrimental in terms of fatigue and work related exposure variables than shorter ones. This finding is supported by analyses of the survey data, indicating that the longer the tour, the lower the fatigue as measured by the PRFS scale and the fatigue at/after work factors.

Thus it seems that tour length may in fact prove quite an important factor in addressing issues of fatigue and health, and indeed accident and injury in seafaring. Further analysis is currently being undertaken to extend our understanding of the importance of this issue.

Acknowledgements

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THE INFLUENCE OF NOISE AND MOTION ON SLEEP, MOOD, AND PERFORMANCE OF SEAFARERS

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The effects of noise and motion have been widely studied in transport industries. However little research has examined these combined factors, especially in the short sea shipping industry. This paper describes the second phase of a project looking at seafarers fatigue, in which objective measures of noise and motion onboard short sea shipping vessels were examined in order to assess their influence on performance, mood and sleep. Data were collected from 177 participants on 7 vessels. As in previous offshore research, noise and motion levels were shown to affect both performance and mood. However no effect of noise or motion was seen on measures of sleep. Multiple regression analyses further indicated that noise predicted a number of the performance variables. However it also indicated that other factors, such as tour length, influenced performance and mood.

Introduction

Although a number of studies have looked at the effect of noise and motion in the work environment (Smith and Ellis, 2000; Hygge *et al*, 1998; Powel and Crossland, 1998; Lewis and Griffiths, 1997), few have examined both variables together, especially in the offshore shipping industry. Such factors may be especially relevant offshore, as seafarers are continuously exposed to these conditions, which may affect not only performance at work, but also health and well being (Collins *et al*, 2000). A recent study has investigated effects of motion and noise on seafarer fatigue in the offshore oil industry (Smith *et al*, 2001). The results showed that high levels of exposure to noise were associated with increased alertness, and greater focusing of attention, but also more lapses of attention, sleep disturbance, and poorer sleep efficiency. Fewer associations were found between motion and performance measures, although motion was found to be positively related to the number of errors on a categoric search task. However this study had a number of methodological shortcomings. Motion was measured in degrees, ignoring acceleration within these dimensions, and the sampling time frame was relatively slow (every 3 seconds). There were also a number of problems with the measurement of noise, as this was measured in 24-hour blocks making analysis of the influence of noise at specific times, such as during the work period, impossible. These methodological shortcomings were addressed in the second stage of the project, which examined fatigue in the coastal and short sea shipping industry.

The specific aims of this paper are to examine the influence of noise and motion on performance, mood, and sleep, and to draw comparisons with the findings from the study of the support ships in the offshore oil industry.

Methods

This study was a direct continuation of that conducted by Smith *et al*, (2001), and the methods used were generally the same. Objective measures and subjective reports were used to assess levels of fatigue, performance, sleep efficiency, and mood. A brief overview of the measures used is outlined below, with any changes from the earlier project described.

Sleep measures

Sleep efficiency was measured using the Actiwatch system (For more details see Smith *et al*, 2001). Participants wore the sleep watch on two occasions, during the sleep period before the testing session on day 1, and during the sleep period prior to testing on the seventh day. Subjects from the fast ferry (n=55) were not included in the analysis of sleep measures as they did not sleep on the vessel.

Performance measures

Mood, subjective alertness, and performance were assessed using a battery of computerised tasks (see Smith *et al*, 2001, for details). Participants completed these tasks both before and after their shift, on day 1 and 7 days later. Mood was assessed using 18 bi-polar visual analogue scales (after Herbert *et al*, 1976). Three main factors were derived from the scale: alertness, hedonic tone, and anxiety. The first performance task was a variable fore-period simple reaction time task. In this task a box appeared in the centre of the computer screen, and at varying intervals (from 1-8 seconds) a target square appeared in the centre of the box, which the participant responded to by pressing a key on an external response box as quickly as possibly. Mean reaction times were recorded to the nearest millisecond for each minute of the task. The second task was a choice reaction time task involving focused attention (Broadbent *et al*, 1986). In this task three warning crosses appeared on the screen followed by target letters (either A or B) in the centre of the screen. Participants were required to respond by pressing the left key of the response box if the target was an A and the right key if it was a B. On certain trials distracters were presented either side of the letter, for example A's, B's, or asterisks. Within the test a number of factors were measured including reaction times to the target alone and with distracters, the percentage correct, occasional long reaction times, speed of encoding of targets which were the same or different from the previous trial, and a measure of focusing of attention (the Eriksen effect). The third task, a categoric search task, was similar to the focused attention task but the volunteer did not know in which of two locations the target would appear. Again participants were required to respond to target letters (either A or B), as quickly and accurately as possible. These letters were presented either in the centre, or the far left, or the far right of the screen. Distracters (in this case digits) were also presented on some trials. This task measured a number of factors including reaction times and percentage correct for targets presented alone and with distracters, targets in near and far locations, targets that were the same or different from the previous trial, and targets presented in the same or a different location to the previous trial.

Vessel Motion
Motion of the vessel was measured continuously throughout the testing period using the Seatex MRU H.2 as in phase 1 (see Smith *et al*, 2001, for details). However a number of adjustments were made. As in phase 1 pitch, roll and heave, were recorded (in degrees), however accelerations within these dimensions (metres/second) were also additionally recorded. The sampling rate was also increased, and data were logged for these dimensions every third of a second. From this data root mean squared (RMS) displacement scores (the standard deviation of the raw values) were calculated for acute time periods, and for motion of the vessel overall. The acute time periods included an hour period around the time of testing, the time during the work shift on day 1 and day 7, and the sleep period on day 1 and 7. The overall motion of the vessel during the visit was summarised using the time period between the end of shift on day 1 and the start of shift on day 7. Motion data were only recorded onboard the tankers (n=24), as the motion on the other vessel types was negligible.

Noise levels
Noise was measured using CEL-460 Dosimeters as in phase 1 (see Smith *et al*, 2001, for details). However in this second phase, the dosimeters were set to record consecutive 1-hour blocks data continuously throughout the visit, not single 24-hour blocks as in phase 1. Two dosimeters were used; one was located on the vessel's bridge, and the other was located in a cabin. From this data average equivalent sound levels (Leq) were calculated again for the testing and sleep periods, and for noise levels over the 7 day period. No noise data were available for two of the ships studied (n=34) due to problems with the dosimeters.

Procedure
Participants initially completed a familiarisation session in which they ran through a shortened version of the performance tasks. On completion of the tasks they were given an actiwatch and asked to wear this during the sleep period prior to the shift they were to be tested on. They were then tested immediately before, or as close to the beginning of their shift as possible. At the end of their shift they returned and repeated the tasks. Seven days later (or as close to the seventh day as possible) participants were again given a sleep watch for the sleep period prior to testing, and asked to wear it during their sleep. Participants then completed performance tasks before and after their shifts, using the same procedure as day 1.

Participants
Data were collected from 177 participants from seven vessels within the short sea shipping industry. These ships included 3 small oil tankers, 2 passenger ferries, a freight ferry, and a fast ferry. The mean age of participants was 36.07 years (s.d.=11.40), with crew generally consisting of mixed nationality crews. 63.8% of the volunteers were from the British Isles, 20.3% (n=36) were Spanish, 13.0%, (n=23) were Polish, and 2.8%, (n=5) were Canadian. 72.3% (n=128) were marine crew, with the highest proportion of participants (34.4%, n=61) being on a 1 week on/ 1 week off shift pattern. Nearly half

(43.78%, n=85) of participants were test in the first week of their tour. However, this bias towards 1 week tours, and being tested in the first week of tour was due to the large number of participants from the fast ferry (see Table 1), who worked predominantly one week on/ one week off tours.

Table 1. The percentage of subjects from each vessel type

Vessel Type	Frequency
Freight ferries	15.3% (n=27)
Tankers	13.6% (n=24)
Passenger Ferries	40.1% (n=71)
Fast ferries	31.1% (n=55)

Results

Of those recruited into the study, 80.2% (n=142) completed testing on both day 1 and 7, the remainder being tested only once (due to practical considerations).

Noise - Performance tasks

A significant correlation was found between noise levels at the time of testing and the speed of encoding of new information on the focused attention task both for day 1 before and after shift (r=-.182, n=137, p=.033, and r=-.197, n=134, p=.022 respectively), suggesting that as noise levels increase the ability to encode new information in a known location improves. No significant differences were found for the other performance measures, and given the number of analyses conducted the above result may be a chance effect.

Noise - Subjective mood

No correlations were found between alertness and noise measures at acute periods. However significant difference were found between low and high noise vessels (as defined by a median split) for levels of anxiety, for the before shift test on day 1, and for the before and after shift test on day 7, with those on noisier vessels reporting lower levels of anxiety.

Noise - Sleep

Sleep quality was not found to be influenced by noise, either during the sleep period, or as a function of motion in general.

Motion - Performance measures

Performance measures were not found to relate to any of the measures of motion, either at test periods, or over the course of the visit.

Motion - Subjective mood

There was a significant difference between alertness for the high and low motion vessels (see table 2), with those on low motion vessels generally appearing more alert.

Table 2. Mean alertness scores (SD in parentheses) for high and low motion ships

	High Motion	Low Motion
Alertness		
Day 1, before work	239.28 (24.94)	287.35 (78.83)
Day 1, after work	225.00 (28.36)	286.12 (73.78)
Day 7, before work	227.57 (28.08)	277.36 (76.41)
Day 7, after work	217.86 (29.01)	285.67 (65.64)

Motion - Sleep

Measures of sleep efficiency were not found to be influenced by motion during the sleep period, or by the motion of the vessel over the seven day period.

Multivariate analysis

Although the univariate analysis seems to indicate that noise and motion may influence performance and mood (although not sleep measures), such analysis ignores the impact of other factors. This may have two possible effects. Firstly, variations in performance and mood that were attributed to noise and motion may actually be due to other related factors (i.e. ship type). Secondly, variations in these measures due to noise and motion may be masked by the influence of other factors. Therefore in order to disentangle this effect multiple regression analyses were conducted, allowing assessment of effects of noise when the influence of other factors are taken in to account. Due to the limited amount of motion data available (i.e. tankers only, n=24) multiple regression analyses were not carried out on the motion data.

As in the univariate, analysis the multiple regressions indicated that speed of encoding on the focused attention task was predicted by noise on the bridge at the time of testing (r^2 =.068). However multiple regressions also identified a number of the outcome variables which were influenced by measures of noise not shown in the initial unvariate analysis. Speed of encoding on the categoric search task was found to be predicted by noise on the bridge (r^2 =.151), and mean reaction time on the simple reaction time task was also found to be predicted my overall noise levels on the bridge (r^2 =.058). In addition, average overall levels of cabin noise were found to be predictive of changes in both alertness and hedonic tone between the day 1 and 7 tests (r^2 =.043, and r^2 =.091 respectively), with high noise exposure leading to reduced alertness and hedonic tone. Although anxiety was found to be related to noise levels in the initial analysis, the multiple regression suggested that variation in levels of anxiety are actually predicted by tour length (r^2 =.032), and not overall levels of noise. Again, there no effects of noise on sleep were found.

Discussion

This study offers some support for the view that performance and mood are influenced by noise levels on offshore vessels. As in our earlier research, the effect of motion on performance and mood was less pronounced. However, the specific measures that were affected in phase 2 were different from those in phase 1. This may reflect a number of factors. Firstly these differences may relate to the variation in the ship types studied in the two phases, and the characteristics of these vessel types. For example, in phase 1 intermittent noise such as alarms and doors closing was common. However, in the present study noise was more continuous, and produced by the engine or discharging pumps. The lack of effect of motion on performance and mood may also reflect the vessels studied, as the ships in the present study worked in coastal areas, and were generally exposed to less severe weather condition, and lower levels of motion than ships studied earlier. The differences between the findings of the two phases may also reflect the increased sensitivity of the measurement used both for noise and motion, which allowed a more accurate assessment of the effect of these environmental factors at the time of test. In contrast to phase 1, motion and noise did not affect sleep measures. Again, this may relate to the less severe environment in phase 2.

Although motion and noise influenced both performance and mood, the study also indicated that there are a number of other factors such as age and tour length that affect performance and mood offshore. It may be more appropriate to consider noise and motion as part of a multitude of factors which influence performance and mood offshore, in order to obtain a clearer and more accurate picture.

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The research described in this article is supported by the Maritime and Coastguard Agency, the Health and Safety Executive, NUMAST and the Seafarers International Research Centre. We would also like to acknowledge the contribution made by the ship owners and seafarers who have participated in the research.

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APPENDIX 2: DESCRIPTIVE STATISTICS OF THE WHOLE SURVEY SAMPLE, SHOWN IN THE QUESTIONNAIRE FORMAT

The Research

This questionnaire marks the start of a series of independent studies supported by NUMAST, MCA, HSE and the Seafarers International Research Centre, aimed at investigating the effects of seafarers' fatigue.

There has been little research into the effects of work and rest schedules of seafarers, although maritime regulators, ship owners and trade unions alike are becoming increasingly aware that the working conditions offshore almost certainly generate fatigue in crewmembers. This has potentially disastrous consequences both for the individual in terms of reduced performance and poor health, and for the environment, if accidents occur as a result of lowered alertness.

This study will look at fatigue and health in terms of the voyage cycle, crew composition, watch-keeping patterns and the working environment.

It is hoped that as a result of the study, worst-case scenarios for fatigue, health and injury can be predicted. Furthermore, best practice recommendations can be developed, which will serve to reduce the incidence and effects of fatigue, and the risk of injuries and accidents which could occur as a result of fatigue.

With the introduction of better working practices, you and your colleagues will benefit the most, as you will feel more willing and able to perform tasks to the best of your ability. By providing strategies to increase safety and efficiency of marine operations in general, the environment will also be protected from potentially harmful incidents occurring indirectly as a result of fatigue.

The Questionnaire

The questionnaire is voluntary and strictly confidential. We are only interested in groups of workers and therefore no individual will be identified in connection with any of the research findings. Your identity and responses to the questionnaire will be completely protected.

The questionnaire is split into three sections, the first refers to your work and time at sea in general, the second refers to your time spent on leave/at home, and the third refers to your general feelings and well-being.

Please read each question carefully and mark the response that BEST reflects your knowledge or feelings. Do not spend a lot of time on each one; your FIRST answer is usually the best. It is important that you answer each question even if you are unsure. Please make sure you mark all answers in the space provided.

Your responses are valuable to provide a safer and more productive work environment for yourself and fellow crewmembers. Your participation is greatly appreciated!

If you have any questions or queries about the study or the questionnaire, please do not hesitate to contact us either by e-mail or on the number below.

Contact details: ***The Seafarers Fatigue Group (*****Psych-Fatigue-L@cardiff.ac.uk*****)***

Research assistants: *Tel: 02920 876598*
Neil Ellis
Ailbhe Burke
Paul Allen

Consent Form

Please complete the following details:

I (full name) ____

Of (address) ____

____

____

(Telephone number) ____________________

(E-mail address) ____________________

hereby fully and freely consent to participate in a questionnaire survey entitled:

FATIGUE, HEALTH AND INJURY AMONG OFFSHORE WORKERS

I understand and acknowledge that the survey is designed to assess the extent of fatigue, health, accidents and injury in the offshore industry.

I understand that I may withdraw my consent at any stage. I acknowledge the purpose of this survey. The nature of the procedures to be used in the survey has been detailed to me in an information sheet and/or has been explained to me. I have the opportunity to contact an investigator to discuss these matters.

Signature of Crewmember…………………….. Date………………………

NB. The consent form will be detached from the questionnaire and so ensuring complete confidentiality.

Demographics

Date of Birth: .... ☐☐ ☐☐ **19** ☐☐

Age:- Mean= 44.97[1] (n=718, S.E.=0.37)

Age band:-

10-19.9 years	0.3% (n=2)
20-29.9 years	9.3% (n=67)
30-39.9 years	18% (n=129)
40-49.9 years	35.7% (n=256)
50-59.9 years	33.1% (n=238)
60-69.9 years	3.6% (n=26)

Sex: .... **Male** 97.4% (n=707)
Female 2.6% (n=19)

Current Status : *(Tick one box)*

Single	11.6% (n=84)	*1*	Separated	3.4% (n=25)	*4*
Living with partner	9.7% (n=70)	*2*	Divorced	5.5% (n=40)	*5*
Married	69% (n=500)	*3*	Widowed	0.8% (n=6)	*6*

Education Completed:

	(Tick one box)	
No schooling	1.0% (n=7)	*0*
Primary education only	0.7% (n=5)	*1*
Some secondary education but left school before 16	12.5% (n=88)	*2*
Secondary education: Completed CSE's / 'O' levels / GCSE's	53.6% (n=378)	*3*
Secondary education: Completed 'A' levels	19.7% (n=139)	*4*
At least one year of university but no degree	5.2% (n=37)	*5*
University graduate, BA or BSc	6.7% (n=47)	*6*
Masters degree, MA or MSc	0.4% (n=3)	*7*
Higher degree Ph.D., MD or other	0.1% (n=1)	*8*

Other education received but not listed above	Master/Captain:	51.7% (n=57)
	City & Guilds:	7.8% (n=17)
	Officer certification	2.5% (n=18)
	Higher Ed HNC HND ONC	18.1% (n=133)
	Other	15.8% (n=116)
	Multiple	1.8% (n=13)

[1] All times reported are in decimals, not years and month, or hours and minutes.

The first section of the questionnaire follows, and refers to your working life. These questions should be answered by considering your working and rest patterns and practices whilst at Sea.

Fatigue, Health and Injury among Seafarers – Section 1

Voyage cycles, work and rest patterns

1. **What nationality/citizenship are you?**

British	77.2% (n = 563)
English	4.3% (n = 31)
Irish	2.3% (n = 17)
Welsh	0.1% (n = 1)
UK	2.3% (n = 17)
New Zealand	0.3% (n = 2)
Duel	0.1% (n = 1)
Polish	8.1% (n = 59)
Other	5.2% (n = 38)

2. **No. of nationalities in crew (count British and Irish as one):** ……….

Mean= 2.70 (n=691, S.E.=0.23)

Frequency	1 nationality	37.2% (n=257)
	2 nationalities	37.9% (n=262)
	3 nationalities	13.5% (n=93)
	4 nationalities	4.8% (n=33)
	5+ nationalities	6.7% (n=46)

3. **In what rank or position do you serve?** ……………………………….

4 **For how long have you worked at sea?** …………………………Years.

Mean= 24.46 years (n=725, SE=0.40)

Year groups	0 yrs	0.3% (n=2)
	1-5 years	6.2% (n=45)
	6-10 years	6.5% (n=47)
	11-15 years	10.6% (n=77)
	16-20 years	9.4% (n=68)
	21-25 years	17.5% (n=127)
	26-30 years	19% (n=138)
	31-35 years	13.9% (n=101)
	36-40 years	13.1% (n=95)
	>40+ years	3.4% (n=25)

5 **Flag of current ship** ……………………………………………..

6 **How long will you have been on this ship when your current contract ends? Please give your answer in months, weeks and days:**

…………… months …………… weeks ………….. days

7. **How long were you on your last ship?** …………… months …………. Days

8. **Since you began going to sea, have you at anytime worked for periods ashore?**

YES 40.1% (n=294) NO 59.1% (n=433)

If yes, why did you return to sea? ……………………………………………….

Financial conditions	14.1% (n=103)
Wanted to return to sea	6.8% (n=50)
Redundancy/ failure of business	3.0% (n=22)
Seconded	0.5% (n=4)
Personal	2.5% (n=18)
New contract	1.4% (n=10)
Other	6.4% (n=47)

9. **On what type of vessel do you presently serve?** *(Please tick)*

Passenger ferry	42.5% (n=310)	*1*	Cruise ship	0.3% (n=2)	*10*
High speed ferry	6.7% (n=49)	*2*	Bulker	1.2% (n=9)	*11*
Freight ro-ro	17.8% (n=130)	*3*	General cargo	1.8% (n=13)	*12*
Products tanker	13.0% (n=95)	*4*	Reefer	0.1% (n=1)	*13*
Shuttle tanker	0.4% (n=3)	*5*	Offshore support	0.5% (n=4)	*14*
Crude tanker	0.3% (n=2)	*6*	Supply vessel	0.4% (n=3)	*15*
Chemical tanker	0.1% (n=1)	*7*	Standby vessel		*16*
Gas tanker		*8*	Other *(please state)*	14.3% (n=104)	*17*
Car carrier	0.4% (n=3)	*9*	- - - - - - - - - - - - - -		

Other type of vessel:

Dredgers	57.3% (n=59)
Passenger and Freight Ro-Ro	9.7% (n=10)
Tug/ emergency tow vessel	9.7% (n=10)
High speed passenger ferry	3.9% (n=4)
Ro Pax	3.9% (n=4)
Tanker – other (i.e. Butemin, Bumber etc)	3.9% (n=4)
Surveying	2.9% (n=3)
Other	2.9% (n=3)
Containers	1.9% (n=2)
Ferry - type unknown	1.9% (n=2)
Pilot	1.0% (n=1)
Bunker Barrage	1.0% (n=1)

10. **Please give approx. size of vessel in either gross tones (grt) or deadweight tones (dwt):**

11. **What is the year of build of the vessel?** ……………

12. **Who is the beneficial owner of the ship?** ………………………………………

Stena	13.9%, n = 102
Crescent	4.8%, n = 35
Other	49.9%, n = 366
P&O	21.8%, n = 160
BP Oil	1.4%, n = 10

13. **To your knowledge, how often has the ship changed ownership?** ……. times

None	58.3% (n=395)
1 time	10.8% (n=73)
2 times	12.7% (n=86)
3 times	13.1% (n=89)
4 times	3.5% (n=24)
5+ times	1.4% (n=10)
Unknown	7.6% (n=56)

14. **What is your ship's trading area?** *(Please tick)*

Offshore oilfield	1.8% (n=13)	*1*
N Europe	81.3% (n=596)	*2*
Elsewhere *(please specify)*	14.9% (n=109)	*3*

Other trading area:

Not specified	94.3% (n=691)
Multiple trading locations (i.e. worldwide)	1.5% (n=11)
English Channel	4.2% (n=31)

15. **Who is your employer?** …………………………………………………………

16. **What is your present area of operation?** *(Please tick)*

Deep sea	2.9% (n=21)	*1*
Short sea & Coastal	89.1% (n=645)	*2*
Middle sea (Baltic & med)	1.9% (n=14)	*3*
Offshore	2.1% (n=15)	*4*
Other *(please specify)* ……………………	4.0% (n=29)	*5*

Other area of operation:

North Sea	66.7% (n=12)
UK Continental	33.3% (n=6)

17. **What is the work/leave system onboard?**

4 weeks on, 4 weeks off	3.6% (n=26)	1
2 weeks on 2 weeks off	30.2% (n=219)	2
1 week on, 1 week off	20% (n=145)	3
Other (Please state)	46.1% (n=334)	4

- -

Other work leave system:-

3on/ 3off	8.5% (n=62)
4on/varying off duties	0.8% (n=6)
5 on/5 off	1.4% (n=10)
6on/ 6off	1.4% (n=10)
7on/ 7off	1.0% (n=7)
on completion of project	0.4% (n=3)
varying/ flexible	1.4% (n=10)
8 on/ 4 off	10.0% (n=33)
Other	25.4% (n=186)

18. **On a typical day, what is your watch/duty schedule?**

12 hours on, 12 hours off	27.6% (n=200)	1
6 hours on, 6 hours off	18.2% (n=132)	2
4 hours on, 8 hours off	5.5% (n=40)	3
4 hours on, 4 hours off	0.4% (n=3)	4
Other (Please describe)	48.2% (n=349)	5

- -

Other watch/ duty schedule:

1 as required	8.3% (n=61)
2 day work	3.1% (n=23)
3 16 hours on/ 8off	0.7% (n=5)
4 11 hour shifts	0.5% (n=4)
5 8 on/ 8 off	3.1% (n=23)
6 other	29.6% (n=217)

19. **What hours do you stand watch (if applicable)?**

00-04	7.0% (n=48)	00-06	11.9% (n=83)
04-08	7.1% (n=49)	06-12	12.0% (n=83)
08-12	10.5% (n=73)	12-18	9.6% (n=66)
12-16	8.0% (n=55)	18-24	7.1% (n=49)
16-20	6.4% (n=44)	Watch-free	32% (n=216)
20-24	7.5% (n=52)		

20. **Is the shift/duty schedule:** **Fixed** 68% (n=458)

Rotating? 32% (n=216)

21. **Do your shifts begin at different times of the day/night?**

YES 55.3% (n=397) NO 44.7% (n=321)

22. **How long have you been on your present watch/duty schedule?**

0.1 - 5 years	63.7% (n=454)
5.1 – 10 years	21% (n=117)
10.1 – 15 years	8.6% (n=48)
15.1 – 20 years	2.1% (n=12)
> 20 years	4.6% (n=24)

23. **What hour would you consider to be the beginning of your working day?**

00.00-01.59	10.7% (n=59)
02.00-03.59	4.9% (n=27)
04.00-05.59	19.2% (n=106)
06.00-07.59	32.5% (n=180)
08.00-09.59	20.8% (n=115)
10.00-11.59	2.4% (n=13)
12.00-13.59	3.1% (n=17)
14.00-15.59	0.5% (n=3)
16.00-17.59	0.9% (n=5)
18.00-19.59	2.4% (n=13)
20.00-21.59	0.9% (n=5)
22.00-23.59	1.8% (n=10)

24. **Please tick as many of the following you need to properly describe your work**:

None	0.6 (n=4)
Equipment maintenance	66.9 (n=480)
Cargo monitoring	41.7% (n=295)
Crew accounts	20.7% (n=145)
Stores issue and inventory	47.8% (n=338)
Paperwork for officials	66.8% (n=474)
Supervising maintenance	61.2% (n=435)
Supervising other crew members	73.7% (n=526)
Other (Please state)	42.5% (n=301)

Other work duties

Catering	0.7% (n=5)
DP	0.1% (n=1)
Watch keeping/ monitoring	7.9% (n=58)
Project management/ supervising	2.3% (n=17)
Navigation/ driving	11.6% (n=85)
Cargo work	0.7% (n=5)
Vessel management	2.5% (n=18)
Other (rigging, crane driving)	7.1% (n=52)
Multiple other work	5.9% (n=43)

25. **How many hours a day do you work on additional duties?**

None	37.5% (n=248)
1-2 hours	32.3% (n=214)
3-5 hours	21% (n=139)
5+ hours	9.2% (n=61)

26. **What hours of work are required by your contract?**

Per day:	<5hrs	25.6% (n=3)
	5-10hrs	13.5% (n=91)
	11-15hrs	58.8 (n=397)
	16-20	1.3% (n=9)
	>20	0.7% (n=5)

Per week:	<30	43.6% (n=263)
	30-39	1.3% (n=8)
	40-49 hours	6% (n=36)
	50-59 hours	3.2% (n=19)
	60-69 hours	0.7% (n=4)
	70-79 hours	8.5% (n=51)
	80-89 hours	30.5% (n=184)
	90-99 hours	6.0% (n=36)
	100-109	0.3% (n=2)

27. **In a typical tour of duty, how many port calls do you make?**

Mean= 19.28 (n=685, SE=0.89)

Frequency:	None	6.1% (n=42)
	1-5 port calls	33% (n=226)
	6-10 port calls	9.6% (n=66)
	11-15 port calls	9.3% (n=64)
	16-20 port calls	6.4% (n=44)
	>20 port calls	35.5% (n=243)

28. **When you are in port do you:** *(Please circle)*

	YES	NO
Work the same hours as at sea	71.8% (n=456)	28.2% (n=179)
Work more hours than at sea	34.9% (n=170)	65.1 (n=317)
Obtain time to go ashore	36.5% (n=182)	63.5 (n=316)
Go ashore in off-duty hours	51.3% (n=286)	48.7 (n=272)

29. **Please use the space below to list the duties that you are required to perform whilst the vessel is in port, if different from duties at sea.**

N/A ☐

……………………………………………………………………………………………………

……………………………………………………

30. **Whilst the vessel is in port, is the work**: *(Please tick one)*

More demanding than onboard	26.6% (n=192)	*1*
Less demanding than onboard	6.7% (n=48)	*2*
About the same	52.7% (n=386)	*3*
Not applicable	13.2% (n=95)	*4*

31. **Do you find the switch from working at sea to working in port particularly fatiguing**?

YES 21% (n=148) NO 79% (n=558)

32. **How do you spend your off-duty hours at sea**:
(Please tick and enter the average amount of time per day in hours)

i	Socialising with other crew members			0.75hrs (n=685, SE=0.035)
ii	Sleeping			5.6hrs (n=696, SE=0.11
iii	Laundry			0.31hrs (n=671, SE=0.020)
iv	Alone in cabin or elsewhere on ship	A	Reading	0.84 hrs (n=687, SE=0.031)
		B	Writing letters	0.15 hrs (n=654, SE=0.021)
		C	Listening to music	0.40 hrs (n=672, SE=0.027)
		D	Watching TV	0.93 hrs (n=677, SE=0.039)
		E	Exercising	0.19 hrs (n=664, SE=0.019)
v	Other (Please state)		…………………..	0.23 hrs (n = 654, SE=0.027)

33. **Do you have any knowledge of international regulations to control seafarers working hours?**

YES 79.5% (n=577) **NO** 20.5 (n=149)

34. **Do you have any knowledge of national regulations to control your working hours?**

YES 74.3% (n=538) **NO** 25.7% (n=186)

35. **Does your employer have any policies or guidelines to control your working hours?**

YES 86.9% (n=621) **NO** 13.1% (n=94)

36. **Have you received any training in recognizing fatigue or in dealing with the problem?**

YES 8.3% (n=60) **NO** 91.7% (n=667)

37. **Are details of duty rosters posted onboard your ship?**

YES 78.8% (n=570) **NO** 21.2% (n=153)

38. **What are your present average daily working hours?** *(Please tick one box)*

Less than 8	0.8% (n=6)	*1*
8 – 12	39.3% (n=285)	*2*
12 – 15	55.5% (n=403)	*3*
15 - 18	4.1% (n=30)	*4*
More than 18	0.3% (n=2)	*5*

39. **How many hours, on average do you work each week?** *(Please tick one box)*

Less than 50	5.5% (n=40)	*1*
50 - 59	5.9% (n=43)	*2*
60 – 84	42.6% (n=308)	*3*
85 – 93	32.6% (n=236)	*4*
94 - 100	10.1% (n=74)	*5*
More than 100	3.0% (n=22)	*6*

40. **Do you regularly have the opportunity to gain 10 hours rest in every 24-hour period?**

62.3% (n=451)   37.7% (n=273)

41. **Do you regularly have the opportunity to gain at least 6 hours uninterrupted sleep?**

74.6% (n=540)   25.4% (n=184)

42. **Typically, what is your longest period of continuous duty?**

<13 hrs	65.5% (n=445)
13 – 20 hrs	30.7% (n=212)
21 – 30 hrs	3.2% (n=22)
31 – 40 hrs	0.3% (n=2)
>40 hrs	0.3% (n=2)

43. **Do you consider your working hours to ever present a danger to your personal health and safety?**

YES 52.6% (n=382)   **NO** 47.4% (n=344)

44. **Do you consider your working hours to ever present a danger to the safe operations onboard your ship?**

YES 41.8% (n=302)   NO 58.2% (n=420)

45. **In the past five to ten years, have your working hours**:

Increased	59% (n=428)	1
Decreased	9.8% (n=71)	2
Remained the same	31.2% (n=226)	3

46. **How long is your usual stay onboard between leave?**

Mean= 26.87 (S.E.=1.22), n=671

Frequency:	Do not stay on board	6.3% (n=42)
	<7 days	2.1% (n=14)
	7-14 days	52.6% (n=353)
	15-21 days	12.1% (n=81)
	22-28 days	3.7% (n=25)
	29-35 days	1.8% (n=12)
	36-42 days	3.3% (n=22)
	43-49 days	0.1% (n=1)
	50-56 days	4.8% (n=32)
	57-63 days	1.5% (n=10)
	64-70 days	2.5% (n=17)
	71-77 days	0.6% (n=4)
	78-84 days	3.3% (n=22)
	85-91 days	1.2% (n=8)
	>92 days	4.2% (n=28)

47. **Please mark on a scale of 1 – 5 (1 = very: 5 = not at all), to what extent you experience the following symptoms of fatigue whilst at sea.**

1	**Confusion**	1	2.3% (n=15)
		2	7.5% (n=48)
		3	12.8% (n=82)
		4	30.7% (n=196)
		5	46.6% (n=29)
2	**Lethargy**	1	6.3% (n=41)
		2	21.4% (n=139)
		3	33% (n=214)
		4	26.8% (n=174)
		5	12.5% (n=8)
3	**Poor quality sleep**	1	23.4% (n=152)
		2	29.4% (n=191)
		3	23.9% (n=155)
		4	13.4% (n=87)
		5	9.9% (n=64)
4	**Depression**	1	3.6% (n=23)
		2	10.0% (n=64)
		3	14.9% (n=96)
		4	29.7% (n=189)
		5	41.8% (n=267)
5	**Tension**	1	7.5 (n=49)
		2	23.5% (n=154)
		3	32.9% (n=216)
		4	25.6% (n=168)
		5	10.5% (n=69)
6	**Loss of concentration**	1	5.4% (n=35)
		2	15.2% (n=99)
		3	30.1% (n=196)
		4	35.4% (n=231)
		5	14.0% (n=91)
7	**Increased use of caffeine**	1	20.8% (n=135)
		2	20.2% (n=132)
		3	14.7% (n=95)
		4	15.1% (n=98)
		5	29% (n=188)

48. **What period of time do you find the most difficult in terms of feeling the effects of fatigue whilst at sea?** *(Please tick one)*

00.00 – 04.00	38.4% (n=258)	*1*	12.00 – 16.00	9.2% (n=62)	*4*
04.00 – 08.00	29.2% (n=196)	*2*	16.00 – 20.00	7.4% (n=50)	*5*
08.00 – 12.00	4.3% (n=29)	*3*	20.00 – 24.00	11.5% (n=77)	*6*

49. **Do you believe the effects of fatigue increase the longer you are at sea?**

84.2% (n=607)	15.8% (n=114)

50. **After a period on leave, do you still feel below par when you return to sea?**

34.6% (n=239)	65.4% (n=433)

51. **After a period on leave, how long does it take you to adjust to life onboard ship once more?**

N/A	15.7% (n=115)
< 1 Day	45.2% (n=331)
2-3 Days	30.2% (n=221)
4-7 Days	5.9% (n=43)
>1 week	2.1% (n=15)

52. **If applicable, do you believe your performance is affected in this period?**

44.8% (n=313)	55.2 (n=385)

53. **Have you ever been involved in a fatigue related incident or accident? If so please indicate how many incidents/accident and give brief details below.**

None:	84.1% (n = 602)
1-2:	12% (n = 86)
3-4:	1.8% (n = 13)
5+:	2.1% (n = 15)

54. **On the assumption that any of the listed changes were realistic, how useful would the following measures be in reducing fatigue? Rate on the scale of 1 – 5 (where 1 = very and 5 = not at all).**

1 Tougher laws

1	36.90% (n=227)
2	13.6% (n=84)
3	19.8% (n=122)
4	12.8% (n=79)
5	16.9% (n=103)4

2 Extra manning

1	58.9% (n=382)
2	18% (n=117)
3	11.2% (n=73)
4	5.7% (n=37)
5	6.2% (n=40)

3 More leave

1	37.6% (n=234)
2	19.9% (n=124)
3	17.4% (n=108)
4	13% (n=81)
5	12.1% (n=75)

4 Over time

1	7.5% (n=43)
2	4.9% (n=28)
3	12% (n=69)
4	13.8% (n=79)
5	61.8% (n=355)

5 Better conditions

1	25.9% (n=159)
2	23.7% (n=146)
3	26.3% (n=162)
4	15.8% (n=97)
5	8.3% (n=51)

6 Less paperwork

1	31.4% (n=193)
2	25.2% (n=155)
3	20.8% (n=128)
4	11.7% (n=72)
5	10.9% (n=67)

7 Other *(please state)*

1	69.8% (n=67)
2	15.6% (n=15)
3	1.0% (n=1)
4	2.1% (n=2)
5	11.5% (n=11)

Other changes:

More Leave	2.2% (n=2)
Better nutrition/ ship hygiene/ cabin facility	12.1% (n=11)
More education	3.3% (n=3)
Reduce long shifts	20.9% (n=19)
More entertainment	61.5% (n=56)

Feelings at Work

1. Which of the following responses best describes your **typical state** during work? *(tick one)*

Sleepy	Somewhat sleepy	Somewhat alert	Alert	Very alert
8.2% (n=59)	55.8% (n=401)	28.% (n=205)	6.7% (n=48)	0.8% (n=6)

2. About how often do you feel **tired** at work? *(tick one)*

Never	Less than once a month	Once or twice a month	Once a week	Two or three times a week	About everyday
2.2% (n=16)	3.1% (n=22)	6.9% (n=50)	17.9% (n=129)	43.8% (n=316)	26.1% (n=188)

3. About how often do you feel **sleepy** at work? *(tick one)*

Never	Less than once a month	Once or twice a month	Once a week	Two or three times a week	About everyday
6.3% (n=46)	8.6% (n=63)	10.1% (n=74)	24.3% (n=178)	34.9% (n=256)	14.3% (n=105)

4. On a normal workday, how **physically tired** do you usually feel at the end of the working day? *(tick one)*

Not at all	A little	Quite a bit	Extremely
4.7% (n=34)	40.8% (n=295)	45.8% (n=336)	8.1% (n=59)

5. On a normal workday, how **mentally tired** do you usually feel at the end of the working day? *(tick one)*

Not at all	A little	Quite a bit	Extremely
5.5% (n=40)	33.8% (n=244)	49.8% (n=359)	10.8% (n=78)

6. On a normal workday, how **tense** do you usually feel at the end of the workday? *(tick one)*

Not at all	A little	Quite a bit	Extremely
14.4% (n=104)	52% (n=376)	29.5% (213)	4.1% (n=30)

Do you take tablets or medicine whilst at sea?

YES	18.3% (n=131)	NO	68.2% (n=489)	SOMETIMES	13.5% (n=97)

Name of tablets/medicine if known

Pain relief / anti-inflammatories	37.5% (n=78)
Digestive	6.7% (n=14)
Cardiovascular	19.7% (n=41)
Nausea/Sea-sickness	1.9% (n=4)
Sleeping tablets	3.4% (n=7)
Anti-depressants / tranquillisers	6.7% (n=14)
Vitamins / natural supplements	9.1% (n=19)
Asthma/Hay fever/Allergies	4.8% (n=10)
Other (No listed)	10.1% (n=21)

Approximately how many days sick leave have you had in the last 12 months?
Sick leave in this instance refers to time taken off work whilst at sea either by staying on the vessel or evacuating the vessel. *(Please tick one)*

None	77.9% (n=565)
1-5 days	21.1% (n=153)
6-10 days	0% (n=0)
11-15 days	0% (n=0)
>15 days	1% (n=7)

About Your Work

The following questions ask about where you work and about the sort of things you have to do. For each question, please circle ONE answer that best describes your work.

		Often	Sometimes	Seldom	Never/almost never
1	Do you work at night?	74.9% (n=543)	17.1% (n=124)	4.7% (n=34)	3.3% (n=24)
2	Do you do shift work?	70.6% (n=508)	7.6% (n=55)	5.1% (n=37)	16.7% (n=120)
3	Do you have to work long and or unsociable hours?	71.8% (n=518)	20.5% (n=148)	5.7% (n=41)	1.9% (n=14)
4	Do you have unpredictable working hours?	32.6% (n=237)	30.0% (n=218)	23.1% (n=168)	14.2% (n=103)
5	Does your job ever expose you to breathing fumes, dusts or other potentially harmful substances?	36.1% (n=262)	32.1% (n=233)	17.8% (n=129)	13.9% (n=101)
6	Does your job ever require you to handle or touch potentially harmful substances or materials?	18.3% (n=133)	27.1% (n=199)	28.2% (n=207)	25.4% (n=186)
7	Do you ever have to work tasks that leave you with a ringing in your ears or a temporary feeling of deafness?	10.9% (n=79)	17.1% (n=124)	29% (n=210)	43% (n=311)
8	Does the level of back ground noise in your work disturb your concentration?	17.1% (n=124)	32.5% (n=235)	29.38% (n=216)	20.6% (n=149)
9*	Does the level of vibration in your workplace affect your performance?	10.8% (n=78)	29.1% (n=211)	30.2% (n=219)	29.8% (n=216)
10*	Do you experience feelings of nausea brought on by motion effects?	5.1% (n=37)	18.0% (n=130)	27.4% (n=198)	49.5% (n=358)

In these next questions we would like to know whether or not you agree with some statements about your work. If you DON'T agree with the statement, tick the box marker No then move on to the next statement. If you DO agree with a statement, tick the box marked Yes AND tick one box to show how much it distresses you.

	No	Yes	Not at all	Some-what	Rather	Very distressed
a) I have constant time pressure due to a heavy workload	39.5% (n=288)		7.5% (n=55)	41.0% (n=299)	10.7% (n=78)	1.2% (n=9)
b) I have many interruptions and disturbances in my job	25.5% (n=186)		10.9% (n=79)	45.6% (n=332)	16.3% (n=119)	1.6% (n=12)
c) I have a lot of responsibility in my job	8.0% (n=58)		35.0% (n=255)	35.4% (n=258)	19.0% (n=138)	2.6% (n=19)
d) I am often under pressure to work overtime	56.6% (n=411)		7.7% (n=56)	23.3% (n=169)	9.6% (n=70)	2.8% (n=20)
e) I have experienced or expect to experience an undesirable change in my work	52.5% (n=382)		3.7% (n=27)	21.4% (n=156)	15.8% (n=115)	6.6% (n=48)
f) My job promotion prospects are poor	57.9% (n=416)		14.6% (n=105)	10.7% (n=77)	11.8% (n=85)	5.0% (n=36)
g) My job security is poor	55.1% (n=399)		4.4% (n=32)	17.5% (n=127)	14.9% (n=108)	8.0% (n=58)
h) I am treated unfairly at work	80.0% (n=584)		2.9% (n=21)	9.6% (n=70)	4.1% (n=30)	3.4% (n=25)

For the next set of questions, the orders of 'Yes' and 'No' is changed. So, if you DO agree with a statement, tick the box marked Yes then move on to the next statement. If you DON'T agree with the statement, tick the box marked No AND tick one box to show how much it distresses you.

	Yes	No		Not at all	Some-what	Rather	Very distressed
a) Considering all my efforts and achievements, my work prospects are adequate	68.9% (n=500)		➡	4.0% (n=29)	16.8% (n=122)	7.2% (n=52)	3.2% (n=23)
	Yes	**No**					
b) I receive the respect I deserve from my superiors and colleagues	65.8% (n=480)		➡	5.8% (n=42)	17.4% (n=127)	8.5% (n=62)	2.6% (n=19)
	Yes	**No**					
c) I experience adequate support in difficult situations	66.1% (n=482)		➡	4.1% (n=30)	17.8% (n=130)	9.7% (n=71)	2.2% (n=16)
	Yes	**No**					
d) Considering all my efforts and achievements, I receive the respect and prestige I deserve at work	57.0% (n=414)		➡	8.0% (n=58)	22.5% (n=163)	9.2% (n=67)	3.3% (n=24)

Sleep Behaviour on the Ship

1. **In a typical 24-hour period, how many sleep periods (sleeps longer than 1.5 hours) do you take?** *(Please tick)*

a. 1 sleep period	43.6% (n=299)
b. 2 sleep periods	52.5% (n=358)
c. 3 or more sleep periods	3.9% (n=27)

2. **At what time do you take your sleep?**

	Go to sleep-Period 1	Get up-period 1	Go to sleep-Period 2	Get up-Period 2	Go to sleep Period 3	Get up – Period 3
00:00 – 03:59	22.2% (n=121)	7.1% (n=40)	11.9% (n=35)	9% (n=27)	5.6% (n=1)	22.2% (n=4)
04:00 – 07:59	15.4% (n=84)	53.8% (n=302)	8.3% (n=25)	19% (n=57)	16.7% (n=3)	0% (n=0)
08:00 – 11:59	10.3% (n=56)	16.2% (n=91)	6.9% (n=21)	9% (n=27)	16.7% (n=3)	27.8% (n=5)
12:00 – 15:59	9.6% (n=52)	10.5% (n=59)	36% (n=109)	14.7% (n=44)	16.7% (n=3)	5.6% (n=1)
16:00 – 19:59	4.8% (n=26)	7.8% (n=44)	16.2% (n=49)	30% (n=90)	5.6% (n=1)	27.8% (n=5)
20:00 – 23:59	37.7% (n=205)	4.5% (n=25)	20.8% (n=63)	18.3% (n=55)	38.9 (n=7)	16.7% (n=3)

3. **How much sleep do you feel you get?** *(Please circle a number)*

Too little (1)	(2)	Enough (3)	(4)	Too much (5)
13.4% (n=92)	31% (n=213)	54.2% (n=373)	1.5% (n=4)	0% (n=0)

4. **What is your ideal sleep length?**

Mean= 7.36 hours (S.E. = 0.038)

4 hours or less	1.5% (n=10)
5-5.99 hours	3.5% (n=24)
6-6.99 hours	13.3% (n=91)
7-7.99 hours	32.6% (n=223)
8-8.99 hours	42.9% (n=294)
9-9.99 hours	4.8% (n=33)
10 hours +	1.5% (n=10)

5. **Do you take naps?** **YES** 44.1% (n=307) **NO** 55.9% (n=389)

6. If yes, in a typical 24-hour period, how many naps do you take?

None	58.3% (n=399)
1 nap	31.6% (n=216)
2 naps	8.9% (n=61)
3 naps	0.6% (n=4)
4+	0.6% (n=4)

And how long do you nap for?

Not at all	56.5% (n=385)
1 – 5 mins	2.3% (n=16)
6 - 10 mins	1.6% (n=11)
11 - 20 mins	7.5% (n=51)
21 - 30 mins	10% (n=68)
31 – 40 mins	1.3% (n=9)
41 - 50 mins	1.5% (n=10)
51 - 60 mins	11% (n=75)
> 60 mins	8.4% (n=57)

7. **On average, how long does it take you to fall asleep?**

1 – 5 mins	11.5% (n=78)
6 - 10 mins	14.3% (n=97)
11 - 20 mins	24.4% (n=165)
21 - 30 mins	27% (n=183)
31 – 40 mins	1.2% (n=8)
41 - 50 mins	2.2% (n=115)
51 - 60 mins	13% (n=88)
> 60 mins	6.4% (n=43)

8. **On average, how many times do you wake up during a typical sleep period?**

None	13.5% (n=93)
1 time	29.1% (n=200)
2 times	31.3% (n=215)
3 times	17.3% (n=119)
4+	8.8% (n=61)

9. **How often do you?** *(Please circle a number on the scale)*

	Not at all	A little	Quite a bit	Almost always
a) Have difficulty in falling asleep	24.4% (n=170)	47.5% (n=331)	22.5% (n=157)	5.6% (n=39)
b) Have difficulty in staying asleep	22.3% (n=155)	43.7% (n=303)	27.8% (n=193)	6.2% (n=43)
c) Wake up during sleep	7.9% (n=55)	43.4% (n=301)	31.7% (n=220)	16.9% (n=117)
d) Have difficulty getting up	48.0% (n=334)	36.8% (n=256)	12.8% (n=89)	2.4% (n=17)
e) Have restless or disturbed sleep	13.9% (n=96)	40.3% (n=279)	32.9% (n=228)	12.9% (n=89)
f) Disturb the sleep of other people	82.5% (n=569)	12.9% (n=89)	3.5% (n=24)	1.2% (n=8)
g) Wake up confused, disorientated, irritable	51.5% (n=357)	37.1% (n=257)	9.7% (n=67)	1.7% (n=12)

10. **How much do any of the conditions mentioned below disturb your sleep?**

	Not at all	A little	Quite a bit	Very much
a) Noise	12.1% (n=84)	42.6% (n=295)	30.3% (n=210)	14.9% (n=103)
b) Bad weather	10.9% (n=75)	32.4% (n=222)	35.1% (n=241)	21.6% (n=148)
c) Heat or cold	29.9% (n=205)	46.1% (n=316)	19.5% (n=134)	4.5% (n=31)
d) Quality of bed	35.5% (n=242)	39.5% (n=269)	15.9% (n=108)	9.1% (n=62)
e) Light	45.5% (n=311)	33.4% (n=228)	13.3% (n=91)	7.8% (n=53)
f) Ship motion	21.8% (n=147)	41.6% (n=280)	23.3% (n=157)	13.2% (n=89)
g) Some other environment	58.1% (n=358)	33.0% (n=203)	7.1% (n=44)	1.8% (n=11)
h) Other people	41.9% (n=284)	41.4% (n=280)	13.3% (n=90)	3.4% (n=23)
i) Emergencies	30.3% (n=203)	49.9% (n=334)	10.2% (n=68)	9.6% (n=64)
j) Exhaustion	46.6% (n=312)	38.1% (n=255)	12.9% (n=86)	2.4% (n=16)
k) Being 'on call'	33.6% (n=225)	36.7% (n=246)	20.3% (n=136)	9.4% (n=63)

11. Do you share a cabin? 1% (n=7) YES 99.0% (n=693 NO *(Please tick)*

12. Is it possible for you to screen out daylight in your cabin? 87.8% (n=611) YES 12.2% (n=85) NO

1 ***How often do you eat breakfast whilst at sea?*** (Please tick ONE box).

Never	Less than once a week	Once or twice a week	Most days (3-6)	Every day
10.8% (n=78)	9.1% (n=66)	13.7% (n=99)	27.6% (n=199)	38.8% (n=280)

2 ***How often do you eat breakfast CEREAL?*** (Please tick ONE box).

Never	Less than once a week	Once or twice a week	Most days (3-6)	Every day
27.1% (n=196)	12.8% (n=93)	18.2% (n=132)	19.3% (n=140)	22.5% (n=163)

3 **Do you consume alcohol whilst at sea?**
(Please tick ONE box). If no, go to the next page YES 16.6% (n=120) NO 83.4% (n=604)

Every Week	5.9% (n=43)	*4*
Most weeks	3.0% (n=22)	*3*
Some weeks	2.9% (n=21)	*2*
Hardly ever	4.7% (n=34)	*1*

4 **If you drink alcohol regularly** (Every Week or Most Weeks)

♦ One unit = half a pint of beer or one pub measure of wine or spirits

Units per week	Please indicate **when** you drink your alcohol: Units during the week	Units during weekend
0 91.4% (n=657)	0 92.5% (n=667)	0 92.5%, n=667
1-10 3.6% (n=26)	1-10 5.7% (n=41)	1-10 6.8% n=49
11-20 3.1% (n=22)	11-20 1.4% (n=10)	11-20 0.6% n=4
21-30 1.7% (n=12)	21-30 0.1% (n=1)	21-30 0.1% n=1
31-40 0.1% (n=1)	31-41 0% (n=0)	31-42
>40 0.1% (n=1)	>40 0.3% (n=2)	>40

5 **Or if you only drink alcohol occasionally** (Some Weeks or Hardly Ever)

Units per month	Please indicate **when** you drink your alcohol: Units during the week	Units during weekends
0 93.2%, n=668	0 96.6% (n=691)	0 96.8 n = 696
1-10 5% (n=36)	1-10 3.2% n =23	1-10 3.1% n = 22
11-20 1.3% (n=9)	11-20 ---	11-20 0.1% n = 1
21-30 0.6% (n=4)	21-30 0.1% n = 1	21-30 ----
31-43 ----	31-44 ----	31-45 ----
>40 7.1% (n=1)	>40 ----	>40 ----

6 **What drinks do you drink?**

(Try to indicate the breakdown of a typical weeks drinking)

			Units
♦ Only complete this section if you drink every week or most weeks.	1	Beer / Lager	None 88.4% n=634 1-10 7.4% (n=53) 11-20 3.1% (n=22) 21-30 0.7% (n=5) 31-40 0.1% (n=1) >40 0.3% (n=2)
♦ REMEMBER - One unit = half a pint of beer or one pub measure of wine or spirits	2	Wine	None 97.3% n = 694 1-10 2.4% (n=17) 11-20 0.3% n=2 21-30 ---- 31-40 ---- >40 ----
	3	Spirits	None 96.1% n=688 1-10 3.1% n=22 11-20 0.7% (n=5) 21-30 0.1% (n=1) 31-40 ---- >40 ----
♦ Please **specify** which other drinks	4	Other	None 99.7% n=713 1-10 0.3% n=2 11-20 21-30 31-40 >40
♦ Does this Total tally with the value in **UNITS PER WEEK?** (above)		**Total**	

The second section of the questionnaire follows, and refers to your time spent on leave/at home. These questions should be answered by considering your feelings, and your health, exercise, eating, drinking, smoking and sleeping habits whilst you are on leave.

Fatigue, Health and Injury among Seafarers – Section 2

Health

1. **Whilst on leave, how often do you visit your GP?**

(Please tick one box)

Hardly ever	67% (n=491)	1
Occasionally	27.5% (n=199)	2
Quite often	4.1% (n=31)	3
Very often	0.3% (n=2)	4

2. **What would you say is your most common health complaint?**

Viral infections / colds/sore throats	30.6% (n=157)
Joint/Muscular pains	29% (n=149)
Digestive disorders	7.4% (n=38)
Cardiovascular disorders	7% (n=36)
Psychological problems	8% (n=41)
Chronic illness (e.g., asthma, diabetes)	2.7% (n=14)
Headaches	2.5% (n=13)
Skin complaints	4.1% (n=21)
Other (non-categorisable)	8.6% (n=44)

3. **Approximately how many days sick have you had in the last 12 months whilst on leave?** ***(Please tick one)***

None	70.5% (n=525)
1-5	14.5% (n=108)
6-10	5.5% (n=41)
11-15	3.1% (n=23)
>15	5.8% (n=43)
N/A	0.7% (n=5)

4. **Thinking about your job whilst on leave, do you find your job:**

(Please tick one box)

Not at all stressful	17.6% (n=133)	1
Mildly stressful	31.9% (n=241)	2
Moderately stressful	35.1% (n=265)	3
Very stressful	13.4% (n=101)	4
Extremely stressful	2.1 % (n=16)	5

5. **How do you find life outside work in general?**

(Please tick one box)

Not at all stressful	45.6% (n=345)	*1*
Mildly stressful	43.2% (n=327)	*2*
Moderately stressful	10.0% (n=76)	*3*
Very stressful	0.9% (n=7)	*4*
Extremely stressful	0.3% (n=2)	*5*

Home/Work Interface

We would like to know how your work affects your family life. *(Please tick)*

Would you say:	Not at all	To Some extent	A great deal	N/A
a) Your job reduces the amount of time you would like to spend with the family	12.0% (n=91)	40.8% (n=309)	44.1% (n=334)	3.0% (n=23)
b) Problems at work make you irritable at home	36.6% (n=277)	50.4% (n=381)	11.2% (n=85)	1.7% (n=13)
c) Your job causes problems and/or arguments with loved ones	47.7% (n=360)	40.8% (n=308)	9.4% (n=71)	2.0% (n=15)
d) Your job takes up so much energy you don't feel up to doing things that need attention at home	35.2% (n=266)	46.1% (n=348)	17.1% (n=129)	1.6% (n=12)

Fatigue

1. **Please mark on a scale of 1 – 5 (1 = very: 5 = not at all), to what extent you experience the following symptoms of fatigue whilst on leave.**

1 Confusion

1	2.7% (n=19)
2	2.3% (n=16)
3	5.5% (n=39)
4	15.6% (n=110)
5	74.0% (n=523)

2 Lethargy

1	6.1% (n=44)
2	12.0% (n=86)
3	23.0% (n=165)
4	28.5% (n=204)
5	30.3% (n=217)

3 Poor quality sleep

1	6.5% (n=47)
2	10.6% (n=76)
3	21.0% (n=151)
4	24.2% (n=174)
5	37.6% (n=270)

4 Depression

1	2.8% (n=20)
2	5.5% (n=39)
3	10.5% (n=74)
4	21.9% (n=155)
5	59.3% (n=420)

5 Tension

1	4.1% (n=29)
2	9.0% (n=64)
3	16.7% (n=119)
4	33.9% (n=242)
5	36.3% (n=259)

6 Loss of concentration

1	2.5% (n=18)
2	6.9% (n=49)
3	12.6% (n=90)
4	30.6% (n=218)
5	47.4% (n=338)

7 Increased use of caffeine

1	4.8% (n=34)
2	6.1% (n=43)
3	8.8% (n=62)
4	15.1% (n=106)
5	65.2% (n=459)

2. **Whilst on leave, would you say you experience the after-effects of fatigue from working at sea?** *(Please tick)*

76.7% (n=579)	23.3% (n=176)

3. For how long into your leave period do you still experience the effects of fatigue?

<1 day	19.6% (n=117)
2-3 days	60.4% (n=361)
4-7 days	12.5% (n=75)
>1 week	5.7% (n=34)
N/A	1.8% (n=11)

4. If applicable, do you believe your performance is affected in this period?

YES	77.0% (n=455)	NO	23.0% (n=136)

Your Lifestyle

1. ***Whilst on leave, how often do you take part in sports OR activities that are:***
(Please tick one box per category)

	3 times a week or more	Once or twice a week	About once to 3 times a month	Never/ hardly ever
A) **Mildly Energetic** (e.g. walking, woodwork, weeding, hoeing, bicycle repair, playing darts, general housework)	74.5% (n=544)	19.5% (n=142)	4.0% (n=29)	2.1% (n=15)
B) **Moderately energetic** (e.g. scrubbing, polishing the car, chopping, dancing, golf, cycling, decorating, lawn mowing, leisurely swimming)	37.9% (n=278)	44.7% (n=328)	12.5% (n=92)	4.9% (n=36)
C) **Vigorous** (e.g. running, hard swimming, tennis, squash, digging, cycle racing, aerobics)	11.8% (n=85)	18.6% (n=134)	23.4% (n=168)	46.2% (n=332)

2. **Please give the average number of hours per week you spend in such sports or activities whilst on leave.**

a) Mildly energetic	1-10 hours	60.2% (n=374)
	11-20 hours	22.4% (n=164)
	21-30 hours	9.8% (n=61)
	31-40 hours	1.9% (n=12)
b) Moderately energetic	1-10 hours	82.9% (n=517)
	11-20 hours	12.9% (n=80)
	21-30 hours	3.1% (n=19)
	31-40 hours	0.6% (n=4)
c) Vigorous	1-10 hours	97.0% (n=295)
	11-20 hours	2.6% (n=8)
	21-30 hours	0.3% (n=1)
	31-40 hours	-----

3. **Whilst on leave, how many hours of sleep do you have on an average weeknight?** *(Please tick one box)*

5 hours or less	6 hours	7 hours	8 hours	9 hours or more
2.0% (n=15)	10.6% (n=80)	31.3% (n=237)	41.9% (n=317)	14.2% (n=107)

4. **Are you a vegetarian or a vegan?** (Please tick ONE box).

Vegetarian	Vegan	Neither
1.3% (n=10)	*1.3% (n=10)*	*97.3% (n=733)*

5. **How often do you eat breakfast whilst on leave?** (Please tick ONE box).

Never	Less than once a week	Once or twice a week	Most days (3-6)	Every day
9.4% (n=71)	5.4% (n=41)	11.7% (n=89)	25.3% (n=192)	48.2% (n=365)

6. **How often do you eat breakfast CEREAL?** (Please tick ONE box).

Never	Less than once a week	Once or twice a week	Most days (3-6)	Every day
22.2% (n=168)	12.7% (n=96)	16.8% (n=127)	22.6% (n=171)	25.8% (n=195)

7. **Do you smoke cigarettes now** (i.e. NOT cigars/pipe)?

YES 26.3% (n=199)   NO 73.7% (n=559)   *If no, go to question 10*

8. **How many cigarettes do you smoke per day?**

Manufactured	1-10	29.8% (n=42)
	11-20	51.8% (n=73)
	21-30	14.2% (n=20)
	31-40	0.7% (n=1)
	>40	3.5% (n=5)
Handrolled	1-10	27.7% (n=18)
	11-20	43.1% (n=28)
	21-30	15.4% (n=10)
	31-40	6.2% (n=4)
	>40	7.7% (n=5)

9. **Do you smoke:** *(Please tick one)*

More cigarettes at sea	60.0% (n=115)
More cigarettes on leave	7.3% (n=14)
About the same amount for both periods	32.5% (n=62)

Now go to question 13

10. **If you are not a present smoker, did you smoke in the past?**

YES 46.6% (n=257)   NO 53.4% (n=294)   *If no, go to question 13*

11. **How many cigarettes did you smoke per day?**

Manufactured	1-10	11.9% (n=21)
	11-20	44.6% (n=79)
	21-30	16.9% (n=30)
	31-40	16.4% (n=29)
	41-50	4.0% (n=7)
	> 50	6.2% (n=11)
Handrolled	1-10	27.3% (n=9)
	11-20	33.3% (n=11)
	21-30	24.2% (n=8)
	31-40	12.1% (n=4)
	> 50	3.0% (n=1)

12. **How old were you when you stopped smoking?**

Mean= 32.57 Years (n=205, SE=0.62)

Age groups:-	21-30	45.8% (n=108)
	31-40	31.4% (n=74)
	41-50	18.2% (n=4329)
	> 50	4.7% (n=11)

13. **Do you consume alcohol whilst on leave?** YES 95.8% (n=727) NO 4.2% (n=32)

(Please tick ONE box). If no, go to the next page

Every Week	72.1% (n=524)	*4*
Most weeks	10.9% (n=79)	*3*
Some weeks	11.3% (n=82)	*2*
Hardly ever	5.8% (n=42)	*1*

14a. **If you drink alcohol regularly** (Every Week or Most Weeks)

♦ One unit = half a pint of beer or one pub measure of wine or spirits

Units per week		Please indicate **when** you drink your alcohol			
		Units during the week		Units during weekend	
1-10	20.2 (n=89)	1-10	52.3% (n=194)	1-10	62.2% (n=245)
11-20	31.4% (n=138)	11-20	27.8% (n=103)	11-20	27.4% (n=108)
21-30	23.6% (n=104)	21-30	12.7% (n=47)	21-30	6.3% (n=25)
31-46	13.2% (n=58)	31-47	3.8% (n=14)	31-48	2.8% (n=11)
>40	21.6% (n=51)	>40	3.5% (n=13)	>40	1.3% (n=5)

14b. **or if you only drink alcohol occasionally** (Some Weeks or Hardly Ever)

- One unit = half a pint of beer or one pub measure of wine or spirits

Units per week	Please indicate **when** you drink your alcohol	
	Units during the week	Units during weekend
1-10 69.5 (n=73)	1-10 58.4% (n=286)	1-10 89.5% (n=77)
11-20 22.9% (n=24)	11-20 28.4% (n=139)	11-20 8.1% (n=7)
21-30 3.8% (n=4)	21-30 ----	21-30 1.2% (n=18)
31-49 2.9% (n=3)	31-40 ----	31-40 1.2% (n=8)
>40 1% (n=1)	>40 ----	>40 ----

15. What drinks do you drink?

(Try to indicate the breakdown of a typical weeks drinking)

			Units
♦ Only complete this section if you drink every week or most weeks.	1	Beer / Lager	1-10 54.6 (n=289) 11-20 27.4% (n=145) 21-30 8.7% (n=46) 31-50 4.3 % (n=17) >40 4.9% (n=25)
♦ REMEMBER - One unit = half a pint of beer or one pub measure of wine or spirits	2	Wine	1-10 77.2% (n=298) 11-20 18.1% (n=70) 21-30 3.9% (n=15) 31-40 0.8% (n=1) >40 0.4% (n=2)
	3	Spirits	1-10 83.1 (n=207) 11-20 13.7% (n=34) 21-30 2.4% (n=6) 31-40 0.8% (n=2) >40 ----
♦ Please **specify** which other drinks	4	Other	1-10 100% (n=16) 11-20 ---- 21-30 ---- 31-40 ---- >40 ----
♦ Does this Total tally with the value in **UNITS PER WEEK?** (above)		**Total**	

Your Sleep Profile on Leave

USUALLY

I go to bed at …………		I fall asleep at ……………..		I get up at ……………….	
20.00 – 20.59	----	20.00 – 20.59	----	04.00 – 04.59	0.3% (n=2)
21.00 – 21.59	1.6% (n=10)	21.00 – 21.59	1% (n=6)	05.00 – 05.59	2.4% (n=17)
22.00 – 22.59	24.7% (n=154)	22.00 – 22.59	11.6% (n=71)	06.00 – 06.59	13.3% (n=94)
23.00 – 23.59	58.4% (n=364)	23.00 – 23.59	51.8 (n=318)	07.00 – 07.59	41% (n=291)
00.00 – 00.59	7.9% (n=49)	00.00 – 00.59	22% (n=135)	08.00 – 08.59	26.7% (n=189)
01.00 – 01.59	5.9% (n=37)	01.00 – 01.59	11.4% (n=70)	09.00 – 09.59	11.8% (n=84)
02.00 – 02.59	1% (n=6)	02.00 – 02.59	1.3% (n=8)	10.00 – 10.59	2.5% (n=18)
03.00 - 03.59	0.5% (n=3)	03.00-03.59	1% (n=6)	11.00 – 11.59	0.8% (n=6)
---------	---------	---------	---------	12.00 – 12.59	1.0% (n=7)
---------	---------	---------	---------	13.00 – 13.59	0.1% (n=1)

(Please circle)

	Not Applicable	Never	Sometimes	Often	Always
4. I am satisfied with my sleep		3.3% (n=25)	20.1% (n=153)	56.8% (n=432)	19.8% (n=151)
5. My partner complains that I twitch or move a lot during my sleep.	11.0% (n=83)	17.7% (n=134)	39.7% (n=300)	19.4% (n=147)	12.2% (n=92)
6. I dream a lot		9.6% (n=73)	54.6% (n=416)	26.9% (n=205)	8.9% (n=68)
7. I wake a lot during the night		14.8% (n=112)	55.5% (n=421)	23.8% (n=181)	5.9% (n=45)
8. My partner complains that I snore loudly	10.2% (n=77)	20.3% (n=153)	33.8% (n=254)	18.9% (n=142)	16.8% (n=126)
9. I am restless during the night		17.2% (n=131)	57.1% (n=434)	18.6% (n=141)	7.1% (n=54)
10. I have very unpleasant or frightening dreams		56.6% (n=431)	39.3% (n=299)	3.7% (n=28)	0.4% (n=3)

	Not Applicable	Never	Sometimes	Often	Always
11. I take a long time to go off to sleep at night		34.2% (n=261)	56.7% (n=433)	7.1% (n=54)	2.0% (n=15)
12. I wake up terrified, without knowing why		88.2% (n=672)	10.8% (n=82)	0.7% (n=5)	0.4% (n=3)
13. I feel very tired in the morning		21.7% (n=166)	61.6% (n=471)	13.2% (n=101)	3.4% (n=26)
14. When I wake up in the night I can't get off to sleep again		31.7% (n=240)	52.0% (n=394)	13.6% (n=103)	2.6% (n=20)
15. I wake up very easily in the morning		7.6% (n=58)	27.0% (n=206)	39.1% (n=298)	26.3% (n=201)
16. When I get up I feel groggy and muzzy-headed		33.5% (n=255)	51.4% (n=392)	12.9% (n=98)	2.2% (n=17)
17. My sleep is refreshing		4.1% (n=31)	32.9% (n=250)	46.8% (n=356)	16.3% (n=124)
18. I feel very tired during the day		17.1% (n=130)	65.8% (n=500)	14.9% (n=113)	2.2% (n=17)
19. I walk in my sleep		95.5% (n=728)	3.4% (n=26)	0.8% (n=6)	0.3% (n=2)
20. I keep dropping off to sleep during the day		52.3% (n=399)	40.8% (n=311)	5.5% (n=42)	1.4% (n=11)
21. I take tablets to help me sleep		94.1% (n=716)	4.9% (n=37)	0.8% (n=6)	0.3% (n=2)
22. I have a nap during the day		35.5% (n=268)	54.6% (n=412)	9.0% (n=68)	0.8% (n=6)
23. I wake up very early in the morning and can't get off to sleep again		36.3% (n=272)	48.9% (n=367)	12.3% (n=92)	2.5% (n=19)
24. I take tablets or medicine during the day.		78.3% (n=582)	9.4% (n=70)	1.7% (n=13)	10.5% (n=78)

Name of tablets/medicine if known
…………………………………………………………

Pain relief/Anti-inflammatories	30% (n=45)
Digestion	12% (n=18)
Cardiovascular	26% (n=39)
Nausea/Sea-sickness	2.7% (n=4)
Sleeping tablets	1.3% (n=2)
Anti-depressants/Tranquilisers	7.3% (n=11)
Vitamins / natural supplements	4.7% (n=7)
Asthma/Hay Fever/Allergies	4.7% (n=7)
Other (not listed)	11.3% (n=17)

Do you have any children under 5? **YES** 12.3% (n=89) **NO** 87.7% (n=636)

The questions on the following pages refer to your health in general and how you feel about various aspects of your life. Some questions may seem irrelevant to the effects of your working patterns. However, the answers to these questions will serve as an indication to the impact of working schedules and conditions on quality of life in general.

Accidents and Injuries

1. **When did you last go to a Casualty Department (or Accident and Emergency Unit) to be treated?**

(Please tick one box)

In the past 3 months	2.6% (n=19)	1
In the past 4-12 months	7.3% (n=52)	2
Over 12 months ago	59.3% (n=425)	3
Never	30.8% (n=221)	4

2. **Have you had any accident, injury or poisoning, needing hospital treatment or a visit to Casualty in the past 3 months?** *(Please tick)*

3.

YES 5.4% (n=55) **NO** 94.6% (n=960) *(If no, please go on to the next page)*

3a. **The injury was a**:
(If you have had more than one injury, please think of the most recent one.)

(Please tick one box)

Break or fracture	22.7% (n=10)	1
Poisoning	4.5% (n=2)	2
Head injury	4.5% (n=2)	3
Cut or puncture	13.6% (n=6)	4
Burn	2.3 (n=1)	5
Another kind of injury *(Please state below)*	52.3% (n=23)	6

Other kind of injury:

No data available

3b. **The accident was**:
(If you have had more than one accident, please think of the most recent one.)

(Please tick one box)

In the home	43.6% (n=17)	*1*
In traffic	5.1% (n=2)	*2*
At work (in port)	33.3% (n=13)	*3*
At work (at sea)	7.7% (n=3)	*4*
Somewhere else	10.3% (n=4)	*5*

CFQ

The following questions are about minor mistakes, which everyone makes from time to time, but some of which happen more often than others. We want to know how often these things have happened to you in the last **six months**. Most questions are directed at your time spent on leave. *(Please circle the appropriate number).*

		Very often	Quite often	Occas-ionally	Very rarely	Never
1.	Do you read something and find you haven't been thinking about it and must read it again?	4	3	2	1	0
2.	Do you forget why you went from one part of the house to the other?	4	3	2	1	0
3.	Do you fail to notice signposts on the road?	4	3	2	1	0
4.	Do you find you confuse right and left when giving directions?	4	3	2	1	0
5.	Do you bump into people?	4	3	2	1	0
6.	Do you find that you forget whether you've turned off a light or a fire or locked the door?	4	3	2	1	0
7.	Do you fail to listen to people's names when you are meeting them?	4	3	2	1	0
8.	Do you say something and realise afterwards that it might be taken as insulting?	4	3	2	1	0
9.	Do you fail to hear people speaking to you when you are doing something else?	4	3	2	1	0
10.	Do you lose your temper and regret it?	4	3	2	1	0
11.	Do you leave important letters unanswered for days?	4	3	2	1	0
12.	Do you find you forget which way to turn on a road you know well but rarely use?	4	3	2	1	0

		Very often	Quite often	Occas-ionally	Very rarely	Never
13.	Do you fail to see what you want in a supermarket (although it's there)?	4	3	2	1	0
14.	Do you find yourself suddenly wondering whether you've used a word correctly?	4	3	2	1	0
15.	Do you have trouble making up your mind?	4	3	2	1	0
16.	Do you forget appointments?	4	3	2	1	0
17.	Do you forget where you put something like a newspaper or a book?	4	3	2	1	0
18.	Do you find you accidentally throw away the thing you want and keep what you meant to throw away – as in the example of throwing away the matchbox and putting the used match in your pocket?	4	3	2	1	0
19.	Do you daydream when you ought to be listening to something?	4	3	2	1	0
20.	Do you find you forget people's names?	4	3	2	1	0
21.	Do you start doing one thing at home and get distracted into doing something else (unintentionally)?	4	3	2	1	0
22.	Do you find you can't quite remember something although it's 'on the tip of your tongue'?	4	3	2	1	0
23.	Do you find that you forget what you came to the shops to buy?	4	3	2	1	0
24.	Do you drop things?	4	3	2	1	0
25.	Do you find you can't think of anything to say?	4	3	2	1	0

CFQ Score = 39.2 (n=703, SE=0.53)

Fatigue (PFRS)

Below is a list of problems, which may or may not apply to you. For each problem, please say to what extent you have experienced this during the **PAST WEEK (including today)**. Do not think for too long before answering but give your immediate reaction. Please be careful not to miss out any of the items. Remember, we are talking about the past week and not your illness in general. Give your answer by circling any number from 1 to 7 to the right of the item, where:

1 = not at all
4 = moderately
7 = extremely

1.	Feeling physically tired even when taking things easy	1	2	3	4	5	6	7
2.	Your limbs feeling heavy	1	2	3	4	5	6	7
3.	Getting easily upset by things	1	2	3	4	5	6	7
4.	Difficulty concentrating	1	2	3	4	5	6	7
5.	Stomach pain	1	2	3	4	5	6	7
6.	Not having the physical energy to do anything	1	2	3	4	5	6	7
7.	Difficulty standing for long	1	2	3	4	5	6	7
8.	Losing your temper easily	1	2	3	4	5	6	7
9.	Difficulty remembering things	1	2	3	4	5	6	7
10.	Muscles feel weak even after resting	1	2	3	4	5	6	7
11.	Feeling depressed	1	2	3	4	5	6	7
12.	Muscles tender to the touch	1	2	3	4	5	6	7
13.	Slowness of thought	1	2	3	4	5	6	7
14.	Tremor or twitching	1	2	3	4	5	6	7
15.	The slightest exercise making you physically tired	1	2	3	4	5	6	7
16.	Being irritable	1	2	3	4	5	6	7
17.	Difficulty reasoning things out	1	2	3	4	5	6	7
18.	Burning, tingling or crawling sensations	1	2	3	4	5	6	7
19.	Numbness in some part of your body	1	2	3	4	5	6	7

1 = Not at all
4 = Moderately
7 = Extremely

20.	Back pain	1	2	3	4	5	6	7
21.	Feeling anxious	1	2	3	4	5	6	7
22.	A feeling of confusion (‘mental fog’)	1	2	3	4	5	6	7
23.	Bouts of sweating (day or night)	1	2	3	4	5	6	7
24.	Feeling physically drained	1	2	3	4	5	6	7
25.	Dizziness or giddiness	1	2	3	4	5	6	7
26.	Absent-mindedness	1	2	3	4	5	6	7
27.	Worrying about things that do not matter	1	2	3	4	5	6	7
28.	Feeling physically tired even after a good night’s sleep	1	2	3	4	5	6	7
29.	Difficulty understanding; e.g. what someone was saying to you	1	2	3	4	5	6	7
30.	Feeling pessimistic about the future	1	2	3	4	5	6	7
31.	Cold hands or feet	1	2	3	4	5	6	7
32.	Having to stop doing something, that was easy in itself, because it made you tired	1	2	3	4	5	6	7
33.	Muscles feeling weak after slight exercise	1	2	3	4	5	6	7
34.	Difficulty following things; e.g. a simple plot on TV	1	2	3	4	5	6	7
35.	Hot or cold spells	1	2	3	4	5	6	7
36.	Feeling tense	1	2	3	4	5	6	7
37.	Feeling faint	1	2	3	4	5	6	7
38.	Difficulty finding the right word	1	2	3	4	5	6	7
39.	Feeling chilled or shivery	1	2	3	4	5	6	7
40.	Tearfulness	1	2	3	4	5	6	7
41.	Irregular or rapid heartbeats	1	2	3	4	5	6	7
42.	Feeling worthless	1	2	3	4	5	6	7

1 = Not at all
4 = Moderately
7 = Extremely

43.	Forgetting what you were trying to say	1	2	3	4	5	6	7
44.	Being easily angered when things went wrong	1	2	3	4	5	6	7
45.	Feeling mentally tired even after a good night's sleep	1	2	3	4	5	6	7
46.	Diarrhoea or constipation	1	2	3	4	5	6	7
47.	Feeling nervous	1	2	3	4	5	6	7
48.	Feeling sad	1	2	3	4	5	6	7
49.	The slightest effort making you mentally tired	1	2	3	4	5	6	7
50.	Feeling like you had a temperature	1	2	3	4	5	6	7
51.	Other people annoying you	1	2	3	4	5	6	7
52.	A sore throat	1	2	3	4	5	6	7
53.	Feelings of resentment	1	2	3	4	5	6	7
54.	Being slow to react	1	2	3	4	5	6	7

Emotional Distress Score: Mean = 35.8 (n=713, SE = 0.63)

Fatigue score: Mean = 28.88 (n=721, SE = 0.52)

Cognitive difficulties score: Mean = 25.31 (n=719, SE = 0.43)

Somatic symptoms score: Mean = 27.15 (n=720, SE = 0.44)

Your General Well-Being

GHQ

These questions are about how you have been feeling in the last few months in general. Please try to answer ALL the questions by circling one answer for each line.

Have you recently:		**1**	**2**	**3**	**4**
a)	Been able to concentrate on whatever you're doing?	Better than usual	Same as usual	Less than usual	Much less than usual
b)	Lost much sleep over worry?	Not at all	Same as usual	Rather more than usual	Much more than usual
c)	Felt that you are playing a useful part in things?	More so than usual	Same as usual	Less useful than usual	Much less useful
d)	Felt capable of making decisions about things?	More so than usual	Same as usual	Less so than usual	Much less capable
e)	Felt constantly under strain?	Not at all	No more than usual	Rather more than usual	Much more than usual
f)	Felt you couldn't overcome your difficulties?	Not at all	No more than usual	Rather more than usual	Much more than usual
g)	Been able to enjoy your normal day-to-day activities?	More so than usual	Same as usual	Less so than usual	Much less than usual
h)	Been able to face up to your problems?	More so than usual	Same as usual	Less able than usual	Much less able
i)	Been feeling unhappy and depressed?	Not at all	No more than usual	Rather more than usual	Much more than usual
j)	Been losing confidence in yourself?	Not at all	No more than usual	Rather more than usual	Much more than usual
k)	Been thinking of yourself as a worthless person?	Not at all	No more than usual	Rather more than usual	Much more than usual
l)	Been feeling reasonably happy, all things considered?	More so than usual	Same as usual	Less so than usual	Much less than usual

GHQ Score = 1.76 (n=732, SE = 0.10)
GHQ total score = 23.4 (n=719, SE = 0.18)

Health Survey (SF-36)

1. IN GENERAL, WOULD YOU SAY YOUR HEALTH IS:

(tick one)

Excellent ☐ *1*

Very good ☐ *2*

Good ☐ *3*

Fair ☐ *4*

Poor ☐ *5*

2. **Compared to one year ago,** how would you rate your health in general **now**?

(tick one)

Much better now than one year ago ☐ *1*

Somewhat better now than one year ago ☐ *2*

About the same as one year ago ☐ *3*

Somewhat worse now than one year ago ☐ *4*

Much worse now than one year ago ☐ *5*

3. The following questions are about activities you might do during a typical day. Does **your health now limit you** in these activities? If so, how much?

(Circle one number on each line)

Activities	**Yes, limited a lot**	**Yes, limited a little**	**No, not limited at all**
a. **Vigorous activities**, such as running, lifting heavy objects, participating in strenuous sports.	1	2	3
b. **Moderate activities**, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf.	1	2	3
c. Lifting or carrying groceries.	1	2	3
d. Climbing **several** flights of stairs.	1	2	3
e. Climbing **one** flight of stairs	1	2	3
f. Bending, kneeling, or stooping.	1	2	3
g. Walking **more than a mile.**	1	2	3
h. Walking **half a mile.**	1	2	3
i. Walking **one hundred yards.**	1	2	3
j. Bathing or dressing yourself.	1	2	3

4. During the **past 4 weeks** have you had any of the following problems with your work or other regular daily activities **as a result of your physical health?**

(Circle one number on each line)

	Yes	No
a. Cut down on the **amount of time** you spent on work or other activities.	1	2
b. **Accomplished less** than you would like.	1	2
c. Were limited in the **kind** of work or other activities.	1	2
d. Had **difficulty** performing the work or other activities (for example, it took extra effort)	1	2

5. During the **past 4 weeks**, have you had any of the following problems with your work or other regular daily activities **as a result of any emotional problems** (such as feeling depressed or anxious)?

(Circle one number on each line)

	Yes	No
a. Cut down on the **amount of time** you spent on work or other activities.	1	2
b. **Accomplished less** than you would like.	1	2
c. Didn't do work or other activities as **carefully** as usual.	1	2

6. During the **past 4 weeks**, to what extent has your physical health or emotional problems interfered with your normal social activities with family, friends, neighbours, or groups?

(tick one)

Not at all ☐ *1*

Slightly ☐ *2*

Moderately ☐ *3*

Quite a bit ☐ *4*

Extremely ☐ *5*

7. How much **bodily** pain have you had during the **past 4 weeks**?

(tick one)

None ☐ *1*

Very mild ☐ *2*

Mild ☐ *3*

Moderate ☐ *4*

Severe ☐ *5*

Very severe ☐ *6*

8. During the **past 4 weeks**, how much did **pain** interfere with your normal work (including both work outside the home and housework)?

(tick one)

Not at all	☐	*1*
A little bit	☐	*2*
Moderately	☐	*3*
Quite a bit	☐	*4*
Extremely	☐	*5*

9. These questions are about how you feel and how things have been with you **during the past 4 weeks**. For each question, please give the one answer that comes closest to the way you have been feeling. How much of the time during the **past 4 weeks**:

(Circle one number on each line)

	All of the time	**Most of the time**	**A good bit of the time**	**Some of the time**	**A little of the time**	**None of the time**
a. Did you feel full of life?	1	2	3	4	5	6
b. Have you been a very nervous person?	1	2	3	4	5	6
c. Have you felt so down in the dumps that nothing could cheer you up?	1	2	3	4	5	6
d. Have you felt calm and peaceful?	1	2	3	4	5	6
e. Did you have a lot of energy?	1	2	3	4	5	6
f. Have you felt downhearted and low?	1	2	3	4	5	6
g. Did you feel worn out?	1	2	3	4	5	6
h. Have you been a happy person?	1	2	3	4	5	6
i. Did you feel tired?	1	2	3	4	5	6

10. During the **past 4 weeks**, how much of the time has your **physical health or emotional problems** interfered with your social activities (like visiting with friends, relatives, etc.)?

(tick one)

All of the time	☐	*1*
Most of the time	☐	*2*
Some of the time	☐	*3*
A little of the time	☐	*4*
None of the time	☐	*5*

11. How **TRUE** or **FALSE** is **<u>each</u>** of the following statements for you?

(CIRCLE ONE NUMBER ON EACH LINE)

	Definitely true	**Mostly true**	**Don't know**	**Mostly false**	**Definitely false**
a. I seem to get ill more easily than other people	1	2	3	4	5
b. I am as healthy as anybody I know	1	2	3	4	5
c. I expect my health to get worse	1	2	3	4	5
d. My health is excellent	1	2	3	4	5

Physical functioning: **Mean = 90.01 (n=710, SE=0.46)**
Role-physical: **Mean = 83.29 (n=718, SE=1.07)**
Bodily pain: **Mean = 75.48 (n=733, SE=0.80)**
General Health: **Mean = 67.01 (n=716, SE=0.67)**
Vitality: **Mean = 63.98 (n=558, SE=0.76)**
Social functioning: **Mean = 81.95 (n=724, SE=0.83)**
Role-emotional: **Mean = 82.27 (n=716, SE=1.18)**
Mental Health: **Mean = 72.860 (n=716, SE=0.61)**

Thank you for completing this questionnaire!

To return the questionnaire to us at Cardiff University, simply seal it into the FREEPOST envelope provided, and either hand it to the ships' medic for later collection, *or* send it through the post. (NB. NO STAMP REQUIRED!)

Future Studies

If you are prepared to take part in any additional surveys or tasks assessing sleeping patterns, fatigue, health and injury (or a similar area) in crewmembers, both whilst offshore and during a small proportion of your leave-time, please enter your name and address in the space provided below. We will contact you to inform you of any further assessments occurring in the near future, and you may decide whether or not you are still willing or able to take part. Your details will be detached from this questionnaire and therefore held in total confidentiality.

Title: ………………….

Full Name:

……………………………………………………………………………

Address:

……………………………………………………………………………

……………………………………………………………………………

……………………………………………………………………………

……………………………………………………………………………

……………………………………………………………………………

………

Daytime Telephone Number: ..………………………………………

Evening Telephone Number: ………………………………………….

E-mail Address: ……………………………………………………….

APPENDIX 3: VESSELS AND PARTICIPANTS RECRUITED

Details of the vessels, and the participants recruited from each of these in phase 2

Vessel 1 (Freight Ferry)

Type	Freight ferry
Project	The ferry operates between Killingholm (UK), and Hook of Holland, with a 48-hour turn around.
Data collection	Data was collected on most days during the period of the 27^{th} November to the 9^{th} December.
Ship activity	*The ship sailed everyday, and had the following appropriate schedule. Times varied due to which dock the ferry was in, and weather/ sea conditions* 08.00 - 09.00 Arrive in docks 09.00 - 10.00 Drive on freight (lorries) unloaded 10.00 - 14.00 Other freight unloaded by AB's (or Stevedores in Holland) 15.00 – 18.00 Unaccompanied freight is loaded onto the ferry 18.00 – 20.00 Lorries are loaded onto the ferry 20.00 – 21.00 Ship sails
The Crew	28 of the ships 31 crew were recruited for the study, 17 of which were Polish and 11, British. Thirteen of the crew worked day shifts, ten 6 on/ 6 off, two 4 on/ 8 off, and three worked variable shifts. The majority of the Polish crew (n=16) worked 8 weeks on/ 4 off. Other tour leave patterns included 1 week on / 1 week off (n=4), 1 month on / 1 month off (n=4), and other work-leave patterns (n=4). Seven of the crew were in the 1^{st} week of their tour, 5 in the 2^{nd}, 5 in the 3^{rd}, 1 in the 4^{th}, 1 in the 5^{th}, 5 in the 6^{th}, 2 in the 7^{th}, and 2 in the 8^{th}. The following ranks were recruited: 1 Captain; 1 4^{th} engineer; 2 Chef 1 Chief officer; 2 Motorman; 2 OBS manager 2 2^{nd} officer; 1 ETO; 3 Stewards 1 3^{rd} officer; 1 Electrician; 1 Cadet 1 Chief engineer; 1 Boson 1 3^{rd} engineer; 7 AB's
The weather/ sea conditions	During the 13-day period the weather was good, with only one day of high winds. The vessel was fairly stable, with on average less than 2 degrees roll, although this went up to 6 degrees on the crossing in high winds.
Notes	The researchers could not test on one day due to an inspection. The computerized tests assessing mood were a problem for many of the Polish subjects due to language difficulties and therefore translation cards were used.

Data collection summary

Performance tasks/ saliva samples	1 day only (start and end of shift) 3 individuals All marine staff 1 and 7th day (start and end of shift) 24 individuals All marine staff
Sleep data	1 day only (start and end of shift) 3 individuals (All 1 day subjects) 1 and 7th day (start and end of shift) 18 individuals on day 1 (75.0% of day 1&7 subjects) 20 individuals on day 7 (83.3% of day 1&7 subjects)
Noise data	No noise data was recorded due to problems with the equipment
Motion data	The motion of the ship was recorded continuously from 27th November to 9th December 2001.
Saliva samples	Saliva samples were taken from all subjects at the beginning and end of each shift. Subjects who smoked were excluded from analysis. Cortisol levels were available for 51.9% (n=14) of subjects.

Vessel 2 (Small Oil Tankers)

Type	Small Oil Tanker
Project	The vessel operated in a number of ports in Southern Ireland, and in Milford Haven, loading and discharging diesel, petrol, and oil products.
Data collection	Data was collected on most days during the period of the 23rd January to the 2nd February 2002.
Ship activity	*An outline of the ships activity during the testing period* 23/01/2002 (10.00) – 25/01/2002 (2.22) Sailing from Milford Haven (Texaco) to Limerick 25/01/2002 (2.22) – 25/01/2002 (15.00) Loading and discharging in Limerick 25/01/2002 (15.00) – 26/01/2002 (19.45) Sailing from Limerick to Whitegate 26/01/2002 (19.45) – 27/01/2002 (4.10) Loading and discharging in Whitegate 27/01/2002 (4.10) – 27/01/2002 (11.50) Sailing from Whitegate to New Ross 27/01/2002 (11.50) – 27/01/2002 (17.10) New Ross (at anchor) 27/01/2002 (17.10) – 28/01/2002 (4.00) Loading and discharging in New Ross 28/01/2002 (4.00) – 28/01/2002 (14.55) Sailing from New Ross to Milford Haven 28/01/2002 (14.55) – 28/01/2002 (23.05) Milford Haven (at anchor) 28/01/2002 (23.05) – 29/01/2002 (8.10) Loading and discharging in Milford Haven (Texaco) 29/01/2002 (8.10) – 29/01/2002 (8.50) Sailing from Milford Haven (Texaco) to Milford Haven (Petroplus) 29/01/2002 (8.50) – 29/01/2002 (17.15) Loading and discharging in Milford Haven (Petroplus) 29/01/2002 (17.15) – 30/01/2002 (3.25) Sailing from Milford Haven (Petroplus) to New Ross 30/01/2002 (3.25) – 31/01/2002 (8.45) New Ross (at anchor) 31/01/2002 (8.45) – 02/02/2002 (7.35) Loading and discharging in New Ross 02/02/2002 (7.35) – 02/02/2002 (18.00ish) Sailing from New Ross to Milford Haven (Elf)
The Crew	All of the ships 7 crew were recruited for the study, 4 of whom were Polish and 3, British. The following ranks were recruited: Captain, Mate, Chief engineer, 2nd Mate, 2nd Engineer, and 2 AB's. Shifts were varied and depended on the location of the vessel and the work situation. All of the British crew (n=3) worked 3 weeks on/ 3 off, compared to the Polish crew who worked between 2 and 7 months on/ and 2 off. One of the crew was in the 1st week of their tour, 1 in the 2nd, 1 in the 4th, 1 in the 7th, and 3 were in the 10th or more week of their tour.
The weather/ sea conditions	During the 11-day period the weather was poor, with high levels of motion being recorded during the majority of time at sea. Over 17 degrees of roll, and 7 degrees of pitch were recorded during the worst motion days, with up to 8 meters of heave also being found. During the offshore wind periods winds got up to 9 (strong gale), with sea states of 8 (very high, 20-40 feet)
Notes	Although the weather was poor and the ship had frequent and often short notice turnarounds this is not unusual for the vessel. The load at New Ross was found not to be up to specifications and had to be taken back to Milford Haven, although this was nothing to do with the crew of the vessel.

Data collection summary

Performance tasks/ saliva samples	1 and 7th day (start and end of shift) 7 Subjects All marine staff
Sleep data	1 and 7th day (start and end of shift) 7 individuals on day 1 (All day 1&7 subjects) 5 individuals on day 7 (71.4% of day 1&7 subjects)
Noise data	No noise data was recorded due to problems with the equipment
Motion data	The motion of the ship was recorded continuously from 23rd January to the 2nd February 2002.
Saliva samples	Saliva samples were taken from all subjects at the beginning and end of each shift. Subjects who smoked were excluded from analysis. Cortisol levels were available for 42.9% (n=3) of subjects.

Vessel 3 (Small Oil Tanker)

Type	Small Oil Tanker
Project	The vessel operated in a number of ports including Belfast, New Ross, Cambletown, and Milford Haven, loading and discharging diesel, petrol, and oil products.
Data collection	Data was collected on most days during the period of the 20th March to the 2nd April 2002.
Ship activity	*An outline of the ships activity during the testing period* 21/03/2002 (00.15) – 21/03/2002 (7.10) Sailing from Eastham to Haysham 21/03/2002 (7.10) – 21/03/2002 (11.05) Haysham (at anchor) 21/03/2002 (11.05) – 21/03/2002 (18.05) Loading and discharging in Haysham 21/03/2002 (18.05) – 22/03/2002 (9.30) Sailing from Haysham to Cambletown 22/03/2002 (9.30) – 22/03/2002 (18.40) Loading and discharging in Cambletown 22/03/2002 (18.40) – 23/03/2002 (00.15) Sailing from Cambletown to Belfast 23/03/2002 (00.15) – 23/03/2002 (13.40) Belfast (at anchor) 23/03/2002 (13.40) – 23/03/2002 (22.15) Loading and discharging in Belfast 23/03/2002 (22.15) – 24/03/2002 (4.25) Sailing from Belfast to Cambletown 24/03/2002 (4.25) – 24/03/2002 (10.35) Loading and discharging in Cambletown 24/03/2002 (10.35) – 24/03/2002 (17.45) Sailing from Cambletown to Belfast 24/03/2002 (17.45) – 25/03/2002 (2.05) Loading and discharging in Belfast 25/03/2002 (2.05) – 26/03/2002 (1.25) Sailing from Belfast to Milford Haven 26/03/2002 (1.25) – 26/03/2002 (12.10) Milford Haven (at anchor) 26/03/2002 (12.10) – 27/03/2002 (8.55) Loading and discharging in Milford Haven 27/03/2002 (8.55) – 27/03/2002 (9.30) Sailing from Milford Haven to New Ross 27/03/2002 (9.30) – 28/03/2002 (7.00) New Ross (at anchor) 28/03/2002 (7.00) – 28/03/2002 (16.00) Loading and discharging in New Ross 28/03/2002 (16.00) – 29/03/2002 (18.00) Sailing from New Ross to Cambletown 29/03/2002 (18.00) – 29/03/2002 (23.50) Loading and discharging in Cambletown 29/03/2002 (23.50) – 30/03/2002 (8.00) Sailing from Cambletown to Belfast 30/03/2002 (8.00) – 30/03/2002 (15.35) Loading and discharging in Belfast 30/03/2002 (15.35) – 30/03/2002 (21.10) Sailing from Belfast to Cambletown 30/03/2002 (21.10) – 31/03/2002 (3.05) Loading and discharging in Cambletown 31/03/2002 (3.05) – 31/03/2002 (10.10) Sailing from Cambletown to Belfast
The Crew	All of the ship's 7 crew was recruited for the study, 4 of which were Polish, and 3 British. The following ranks were recruited: Captain, Mate, Chief engineer, 2nd Mate, 2nd Engineer, and 2 AB's. Most of the crew's shifts were varied and depended on the location of the vessel and the work situation. However the chief engineer and the second engineer worked alternate 6 hours on/ 6 hours off shift, covering from 7.00-13.00, 19.00-1.00 hours, and 1.00-7.00, 13.00-19.00 hours respectively. Two of the British crew worked 3 weeks on/ 3 off, with the other British crewmember working 1 week only, as he was filling in from another company. Three of the Polish crew were working 4 months on/ and 2 off, and 1 was working 7 months on / and 2 off. Two of the crew were in the 1st week of their tour, 1 in the 2nd, 1 in the 6th, and 3 were in the 10th of more week of their tour.
The weather/ sea conditions	During the two week period the weather was good, with only moderate wind and sea conditions being encountered. The vessel was fairly stable, although up to 8 degrees roll was recorded during some periods, and 1.5m of heave. However the vessel did not pitch considerably, with the highest recorded being less than 3 degrees.
Notes	3 subjects had to be finished early (4 or 5 day) as they were going off leave, or where only on board ship for a week period. This vessel has a much shorter turn around time in comparison to the companies other tankers.

Data collection summary

Performance tasks/ saliva samples	1 and 7th day (start and end of shift) 7 Subjects All marine staff
Sleep data	1 and 7th day (start and end of shift) 7 individuals on day 1 (All subjects) 7 individuals on day 7 (All subjects)
Noise data	Noise data was recorded continuously from 20th March to the 2nd April 2002, with the data being split into consecutive hour blocks.
Motion data	The motion of the ship was recorded continuously from 20th March to the 2nd April 2002.
Saliva samples	Saliva samples were taken from all subjects at the beginning and end of each shift. Subjects who smoked were excluded from analysis. Cortisol levels were available for 28.6% (n=2) of subjects.

Vessel 4 (Passenger ferry)

Type	Passenger (400 max) ferry
Project	The ferry operates between Mostyn, (North Wales, UK), and Dublin (Ireland), with a 24-hour turn around.
Data collection	Data was collected on most days during the period of the 9th April 2002 to the 20th April 2002.
Ship activity	*All times are approximate and vary due to weather/ sea conditions* 05:00 - arrive in Dublin docks 05.00 - 5.30 Drive on freight (lorries) unloaded 05:30 – 07:30 Other freight unloaded by AB's 09:00 – 10:30 Unaccompanied freight is loaded onto the ferry 10.30 – 11:00 Lorries are loaded onto the ferry 13:00 - Ship sails 19:00 – Ship arrives in Mostyn 19:00 – 19:30 Drive on freight (lorries) unloaded 19:30 – 21:30 Other freight unloaded by AB's 21:30 – 22:30 Unaccompanied freight is loaded onto the ferry 22:30 – 23:00 Lorries are loaded onto the ferry 23:30 – Ship sails
The Crew	34 of the 45 crew were recruited for the study, 20 of which were Spanish and 14, British. 15 of the crew worked day shifts, 2 night shifts, 16 6on/6off, and 1 worked 4:00 – 16:00. All the Spanish crew (n=20) worked 12 weeks on/ 4 off. Other tour leave patterns included 2 weeks on / 2 weeks off (n=11), 3 weeks on / 2 weeks off (n=2), and the cadet worked 3 weeks on/1 week off. 7 of the crew were in the 1st week of their tour, 9 in the 2nd, 5 in the 3rd, 4 in the 4th, 1 in the 6th, 2 in the 7th, 3 in the 8th, and 3 had done more than 8 weeks of their tour. The following ranks were recruited: 1 Captain; 1 Relief Master; 1 Chief officer; 2 2nd officer; 1 Chief engineer; 1 3rd engineer 1 Motorman; 1 Electrician; 1 Boson; 1 Fitter; 9 AB's; 2 head chef / catering manager 3 Chef; 6 Stewards; 1 Cadet; 2 Receptionists
The weather/ sea conditions	During the 11-day period, the weather was good and there was very little motion on the ferry (maximum pitch = 0.75 degrees, maximum roll = 3.95 degrees, maximum heave = 0.56m)
Notes	---

Data collection summary

Performance tasks/ saliva samples	1 day only (start and end of shift) 2 individuals All non-marine staff 1 and 7th day (start and end of shift) 34 individuals 23 marine staff 9 non-marine staff
Sleep data	1 day only (start and end of shift) 2 individuals (All 1 day subjects) 1 and 7th day (start and end of shift) 26 individuals on day 1 (81.3% of day 1&7 subjects) 26 individuals on day 7 (81.3% of day 1&7 subjects)
Noise data	Noise data was recorded continuously from 9th April 2002 to the 20th April 2002, with the data being split into consecutive hour blocks.
Motion data	The motion of the ship was recorded continuously from 9th April 2002 to the 20th April 2002.
Saliva samples	Saliva samples were taken from all subjects at the beginning and end of each shift. Subjects who smoked were excluded from analysis. Cortisol levels were available for 38.2% (n=13) of subjects.

Vessel 5 (Small Oil Tanker)

Type	Small Oil Tanker
Project	The vessel operated in a number of ports on the east coast of the UK, including Forley, Peterhead, Hull, Immingham, and Aberdeen, loading and discharging diesel, petrol, and oil products.
Data collection	Data was collected on most days during the period of the 13th May 2002 to the 23rd May 2002.
Ship activity	*An outline of the ships activity during the testing period* 12/05/2002 (23.48) – 13/05/2002 (6.30) Loading and discharging in Fawley 13/05/2002 (6.30) – 15/05/2002 (11.05) Sailing from Fawley to Peterhead 15/05/2002 (11.05) – 15/05/2002 (18.36) Peterhead (at anchor) 15/05/2002 (18.36) – 15/05/2002 (19.06) Sailing from anchor to Peterhead 15/05/2002 (19.06) – 16/05/2002 (17.12) Loading and discharging in Peterhead 16/05/2002 (17.12) – 17/05/2002 (20.42) Sailing from Peterhead to Hull 17/05/2002 (20.42) – 20/05/2002 (11.22) Loading and discharging in Hull, a cargo pump also fixed 20/05/2002 (11.22) – 20/05/2002 (13.00) Sailing from Hull to Anchor 20/05/2002 (13.00) – 21/05/2002 (6.06) Hull (at anchor) 21/05/2002 (6.06) – 21/05/2002 (9.48) Sailing from Hull (at anchor) to Immingham. 21/05/2002 (9.48) – 21/05/2002 (21.54) Loading and discharging in Immingham 21/05/2002 (21.54) – 22/05/2002 (21.42) Sailing from Immingham to Aberdeen 22/05/2002 (21.42) – 23/05/2002 (5.00) Loading and discharging in Aberdeen 23/05/2002 (5.00) – Sailing from Aberdeen to Immingham.
The Crew	All of the ships 8 crew were recruited for the study, including an extra 2 crew who were on changeover. Half of the crew were British, and half were Canadian. The following ranks were recruited:- The Captain, 2 Chief engineer's, the 1 st officer, the 2nd officer, 2 2nd Engineer's, 2 AB's, and a cadet. Half of the crew worked varied shifts, the engineers worked 8-6 days (although they were on call 24 hours a day), and the AB's worked 6 hours, on 6 off back to back of each other. Half of the crew (n=5) worked 10 weeks on/ 5 off. Other shift patterns included 3months on/ 1off, 10 weeks on/ 10 off, 13 weeks on/ 4 off, and 5 weeks on/ 5 off. Two of the crew were on the first week of the tour, 2 in the 4th week, 1 in the 5th week, 2 in the 6th week, 1 in the 8th week, and 2 were over 2 months into their tour.
The weather/ sea conditions	During the 11-day period, the weather was generally good and there was very little motion (maximum pitch = 1.01 degrees, maximum roll = 1.43 degrees, maximum heave = 0.18m)
Notes	---

<u>Data collection summary</u>

Performance tasks/ saliva samples	<u>1 day only (start and end of shift)</u> 2 individuals All marine staff <u>1 and 7th day (start and end of shift)</u> 8 individuals All marine staff
Sleep data	<u>1 day only (start and end of shift)</u> 2 individuals <u>1 and 7th day (start and end of shift)</u> 8 individuals on day 1 (80.0% of day 1&7 subjects) 7 individuals on day 7 (70.0% of day 1&7 subjects)
Noise data	Noise data was recorded continuously from 13th May 2002 to the 23rd May 2002, with the data being split into consecutive hour blocks.
Motion data	The motion of the ship was recorded continuously from 13th May 2002 to the 23rd May 2002.
Saliva samples	Saliva samples were taken from all subjects at the beginning and end of each shift. Subjects who smoked were excluded from analysis. Cortisol levels were available for 70.0% (n=7) of subjects.

Vessel 6 (Passenger ferry)

<table>
<tr><td>Vessel Type</td><td>Passenger (420 max) ferry</td></tr>
<tr><td>Project</td><td>The ferry operates between Cairnryan, (Scotland), and Larne (Northern Ireland) with 3 round trips a day, voyage time = 2hr, turnaround time = 2hr.</td></tr>
<tr><td>Data collection</td><td>Data was collected on most days during the period of the 5th June 2002 to the 15th June 2002.</td></tr>
<tr><td>Ship activity</td><td>All times are approximate and vary due to weather/ sea conditions
4:15 – Departs Cairnryan
6:00 – Arrives Larne
8:00 – Departs Larne
9:55 – Arrives Cairnryan
11:45 – Departs Cairnryan
13:45 – Arrives Larne
15:45 – Departs Larne
17:45 – Arrives Cairnryan
19:45 – Departs Cairnryan
21:45 – Arrives Larne
23:59 – Departs Larne
2:00 – Arrives Cairnryan</td></tr>
<tr><td>The Crew</td><td>37 of the crew were recruited for the study, 16 of which were Spanish and 21, British. There was a large crew change during our visit, which meant that we were not able to recruit all subjects, and some of those we did recruit could only be tested for 1 day. 16 of the crew worked day shifts, 3 worked night shifts, and 18 worked split shifts that covered both day and night work. All the Spanish crew (n=16) worked 12 weeks on / 4 weeks off. Other tour leave patterns included 2 weeks on / 2 weeks off (n=14), 3 weeks on / 2 weeks off (n=3), 2 weeks on / 1 week off (n=2). 1 person was doing a weeks relief work and 1 person normally works 6 months / 6 months off but was doing some extra work on this vessel. 11 of the crew were in the 1st week of their tour, 8 in the 2nd, 2 in the 3rd, 2 in the 4th, 5 in the 5th, 4 in the 8th, and 5 had done more than 8 weeks of their tour. The following ranks were recruited:

1 * Captain (British) / 4 * 2nd engineer (British) / 1 * head chef (British)
1 * Relief Master (British) / 2 * Motorman (Spanish) / 2 * Cooks (British)
1 * Chief officer (British) / 1 * Electrician (British) / 6 * Stewards (Spanish)
4 * 2nd officer (British) / 1 * Boson (Spanish) / 1 * Hotel Service Manager (British)
1 * Chief engineer (British) / 1 * Ass. Boson (Spanish) / 1 * shop assistant (British)
3 * 3rd engineer (British) / 6 * AB's (Spanish)</td></tr>
<tr><td>The weather/ sea conditions</td><td>During the 11-day period, the weather was good and there was very little motion on the ferry (maximum pitch = * degrees, maximum roll = * degrees, maximum heave = *m)</td></tr>
<tr><td>Notes</td><td>---</td></tr>
</table>

Data collection summary

Performance tasks/ saliva samples	1 day only (start and end of shift) 16 individuals 15 marine staff 1 non-marine staff 1 and 7th day (start and end of shift) 21 individuals 11 marine staff 10 non-marine staff
Sleep data	1 day only (start and end of shift) 14 individuals (87.5% of 1 day only subjects) 1 and 7th day (start and end of shift) 14 individuals on day 1 (66.6% of day 1&7 subjects) 18 individuals on day 7 (85.7% of day 1&7 subjects)
Noise data	Noise data was recorded continuously from 5th June 2002 to the 15th June 2002, with the data being split into consecutive hour blocks.
Motion data	The motion of the ship was recorded continuously from 5th June 2002 to the 15th June 2002.
Saliva samples	----

Vessel 7 (Fast ferry)

Vessel Type	Fast Ferry (passenger)
Project	The ferry operates between Cairnryan, (Scotland), and Larne (Northern Ireland) with 5 round trips a day, voyage time = 1hr, turnaround time = 45mins.
Data collection	Data was collected during the period of July 27th to August 4th 2002.
Ship activity	*All times are approximate and vary due to weather/ sea conditions* 06:00 – Departs Larne 07:00 – Arrives Cairnryan 07:30 – Departs Cairnryan 08:30 – Arrives Larne 09:15 – Departs Larne 10:15 – Arrives Cairnryan 11:00 – Departs Cairnryan 12:00 – Arrives Larne 12:45 – Departs Larne 13:45 – Arrives Cairnryan 14:30 – Departs Cairnryan 15:30 – Arrives Larne 16:15 – Departs Larne 17:15 – Arrives Cairnryan 18:00 – Departs Cairnryan 19:00 – Arrives Larne 19:45 – Departs Larne 20:45 – Arrives Cairnryan 21:30 – Departs Cairnryan 22:30 – Arrives Larne
The Crew	55 of the crew were recruited for the study, all British. Due to the shift patterns high number and regularity of crew changes during our visit testing intervals varied, not exceeding five days and a few of those recruited could only be tested for 1 day. There were three separate crew types: Officers, General Purpose Ratings (G.P.'s) and Customer Services, and four of each crew, such that on any given day two of each crew were working and two were off. As such there were many crew changes during the testing period. There were four officers per shift, working 6 on/6 off, first three days 08.30-19.00, last three days 19.00-08.30. There were approx six G.P.'s per shift, working the same hours as the officers, but 7 on/7 off, 7 nights one week then 7 days the next. There were between 8-15 customer service staff per shift depending on passenger numbers. They worked 6 on/3 off, first three days on 05.00-12.00, last three days on 12.00-23.00. The following ranks were recruited: 3 * Captain 4 * Chief officer 2 * Cust Serv manager 3 * 1st engineer 3 * Boson 2 * Cust Serv Supervisor 1 * 2nd engineer 10 * GP's 27 * Customer Services
The weather/ sea conditions	During the 11-day period, the weather was good and there was very little motion on the ferry (maximum pitch = * degrees, maximum roll = * degrees, maximum heave = *m)
Notes	---

Data collection summary

Performance tasks/ saliva samples	1 day only (start and end of shift) 12 individuals 8 marine staff 4 non-marine staff 1 and 7th day (start and end of shift) 43 individuals 20 marine staff 23 non-marine staff
Sleep data	1 day only (start and end of shift) 14 individuals (87.5% of 1 day only subjects) 1 and 7th day (start and end of shift) 13 individuals on day 1 (30.2% of day 1&7 subjects) 10 individuals on day 7 (23.3% of day 1&7 subjects)
Noise data	Noise data was recorded continuously from July 27th to August 4th 2002, with the data being split into consecutive hour blocks.
Motion data	The motion of the ship was recorded continuously from July 27th to August 4th 2002.
Saliva samples	---

APPENDIX 4: LOGBOOK LAYOUT, CONTENTS AND DESCRIPTIVES

Appendix 4 presents the layout and structure of the logbooks questionnaires, along with the descriptive statistics for each item for the whole onboard sample.

Day 1 – Before Shift

Sleeping and Eating Questionnaire

Please provide the information asked for below by circling one of the choices and / or providing details as appropriate.

A. Alcohol

1. Did you consume any alcohol yesterday? Yes [15.0% (n=26)] No [85.0% (n=147)]

If yes, then how many units of alcohol =
(½ pint / 1 glass wine / 1 spirit measure = 1unit)

Mean = 5.75 (n=28, S.E.=1.59)

1-5 units	75.0% (n=21)
6-10 units	14.3% (n=4)
11-20 units	3.6% (n=1)
21+ units	7.1% (n=2)

B. Sleep

1. Please complete with respect to the **main** sleep period you have had today and **use a 24-hour clock.**

	Main Sleep period	
Time you went to bed:	00.00-02.59	26.8% (n=45)
	03.00-05.59	8.9% (n=15)
	06.00-08.59	4.8% (n=8)
	09.00-11.59	5.4% (n=9)
	12.00-14.59	2.4% (n=4)
	15.00-17.59	--- (n=0)
	18.00-20.59	7.1% (n=12)
	21.00-23.59	44.6% (n=75)
Time you went to sleep:	00.00-02.59	38.5% (n=65)
	03.00-05.59	8.3% (n=14)
	06.00-08.59	6.5% (n=11)
	09.00-11.59	5.9% (n=10)
	12.00-14.59	1.8% (n=3)
	15.00-17.59	--- (n=0)
	18.00-20.59	5.3% (n=9)
	21.00-23.59	33.7% (n=57)

	Main Sleep period	
Time you woke up:	00.00-02.59	4.0% (n=7)
	03.00-05.59	31.2% (n=54)
	06.00-08.59	38.2% (n=66)
	09.00-11.59	12.1% (n=21)
	12.00-14.59	4.0% (n=7)
	15.00-17.59	5.2% (n=9)
	18.00-20.59	--- (n=0)
	21.00-23.59	5.2% (n=9)
Time you got up:	00.00-02.59	4.1% (n=7)
	03.00-05.59	22.2% (n=38)
	06.00-08.59	47.4% (n=81)
	09.00-11.59	12.9% (n=22)
	12.00-14.59	3.5% (n=6)
	15.00-17.59	5.3% (n=9)
	18.00-20.59	--- (n=0)
	21.00-23.59	4.7% (n=8)
Sleep duration:	Mean = 5.52 hours (n=170, S.E.=0.13)[2]	
Number of awakenings during the sleep period	No awakenings	30.9% (n=51)
	1 awakening	20.0% (n=33)
	2 awakenings	21.8% (n=36)
	3 awakenings	15.2% (n=25)
	4 awakenings	5.5% (n=9)
	5+ awakenings	12.1% (n=20)

2. Please tick **ONE** of the following boxes to indicate whether last nights sleep was:

about normal for you?	60.5% (n=104)
shorter than normal?	34.5% (n=59)
longer than normal?	5.8% (n=10)

[2] Hours are in decimal, not hours and minutes (i.e. 1.75 is 1 hour and 45 minutes)

3. Please rate your Sleep

	Least (1)				Most (5)
	1	2	3	4	5
Ease of falling asleep	8.1% (n=14)	18.0% (n=31)	27.9% (n=48)	29.1% (n=50)	16.9% (n=29)
Ease of arising	8.1% (n=14)	22.7% (n=39)	27.9% (n=48)	22.1% (n=38)	18.0% (n=31)
Was this sleep period sufficient?	12.2% (n=21)	25.0% (n=43)	37.8% (n=65)	19.8% (n=34)	5.2% (n=9)
How deep was your sleep?	2.9% (n=5)	18.6% (n=32)	37.2% (n=64)	30.2% (n=52)	11.% (n=19)
Interrupted sleep	26.0% (n=45)	26.6% (n=46)	31.8% (n=55)	11.0% (n=19)	4.6% (n=8)

C. Breakfast

1. Did you have breakfast this morning? Yes 45.7% (n=80) No 54.3% (n=95)

   If no, then go to section D.

2. What time did you have breakfast **(please use a 24-hour clock)**?

05.00-05.59	9.0% (n=7)
06.00-06.59	5.1% (n=4)
07.00-07.59	10.3% (n=8)
08.00-08.59	28.2% (n=22)
09.00-09.59	25.6% (n=20)
10.00-10.59	11.5% (n=9)
11.00-11.59	2.6% (n=2)
12.00-12.59	5.1% (n=4)
13.00-13.59	1.3% (n=1)
18.00-18.59	1.3% (n=1)

3. What did you have to **eat** and **drink**?[3]

Toast	8.6% (n=6)
Cereal	32.9% (n=23)
Porridge	1.4% (n=1)
Orange juice/ fruit	1.4% (n=1)
Cooked breakfast	21.4% (n=15)
Other	15.7% (n=11)
Combination	18.6% (n=13)

[3] Drinks are not listed in the below frequencies as they are covered in the next question.

D. Drinks

How many cups of the following drinks have you had today already?

Coffee	Caffeinated	Mean= 1.58 cups (n=80, S.E.=0.24)		
			None	32.5% (n=26)
			1 cup	37.5% (n=30)
			2 cups	12.5% (n=10)
			3 cups	2.5% (n=2)
			4 cups	7.5% (n=6)
			5+ cups	7.5% (n=6)
	Decaffeinated	Mean= 0.30 cups (n=40, S.E.=0.01)		
			None	80.0% (n=32)
			1 cup	10.0% (n=4)
			2 cups	10.0% (n=4)
			3 cups	--- (n=0)
			4 cups	--- (n=0)
			5+ cups	--- (n=0)
Tea	Caffeinated	Mean= 1.46 cups (n=69, S.E.=0.28)		
			None	37.7% (n=26)
			1 cup	39.1% (n=27)
			2 cups	10.1% (n=7)
			3 cups	1.4% (n=1)
			4 cups	1.4% (n=1)
			5+ cups	10.1% (n=7)
	Decaffeinated	Mean= 0.33 cups (n=36, S.E.=0.14)		
			None	80.6% (n=29)
			1 cup	11.1% (n=4)
			2 cups	5.6% (n=2)
			3 cups	--- (n=0)
			4 cups	2.8% (n=1)
			5+ cups	--- (n=0)

E. Medication

1. Have you taken any medication in the last 12 hours?

Yes	14.7% (n=20)
No	85.3% (n=116)

If no, then go to section F.

2. What did you take?

Pain relief/ anti-inflammatory	30.0% (n=3)
Cardiovascular	10.0% (n=1)
Anti-depressants/ tranquilliser	10.0% (n=1)
Vitamins/ Natural supplements	30.0% (n=3)
Other	20.0% (n=2)

3. What time did you take it **(please use a 24-hour clock)?**

00.00-02.59	--- (n=0)
03.00-05.59	11.8% (n=2)
06.00-08.59	41.2% (n=7)
09.00-11.59	--- (n=0)
12.00-14.59	17.6% (n=3)
15.00-17.59	5.9% (n=1)
18.00-20.59	11.8% (n=2)
21.00-23.59	11.8% (n=2)

F. Smoking

1. How many of the following have you smoked today?

Cigarettes (manufactured) Mean= 2.88 (n=86, S.E.=0.51)

None	33.7% (n=29)
1-5	53.5% (n=46)
6-10	8.1% (n=7)
11-15	1.2% (n=1)
16-20	2.3% (n=2)
More than 20	1.2% (n=1)

Cigarettes (handrolled) Mean= 1.63 (n=46, S.E.=0.68)

None	78.3% (n=36)
1-5	10.8% (n=5)
6-10	6.5% (n=3)
11-15	--- (n=0)
16-20	4.3% (n=2)
More than 20	--- (n=0)

Pipes	Mean= 0.15 (n=402, S.E.=0.13)		
		None	95.0% (n=38)
		1-5	5.0% (n=2)
		6-10	--- (n=0)
		11-15	--- (n=0)
		16-20	--- (n=0)
		More than 20	--- (n=0)
Cigars	Mean= 0.10 (n=39, S.E.=0.10)		
		None	97.4% (n=38)
		1-5	2.6% (n=1)
		6-10	--- (n=0)
		11-15	--- (n=0)
		16-20	--- (n=0)
		More than 20	--- (n=0)

Day 1 – After shift

About today's work

The following questions ask you about today's work
Please state what you did and when.

Daytime Health-Related Behaviours Questionnaire

A. Lunch

1. Did you have lunch today? Yes 73.7% (n=123) No 26.3% (n=44)

If no, then go to section B.

2. When did you have lunch **(please use a 24-hour clock)** ....……….

00.00-02.59	1.7% (n=2)
03.00-05.59	1.7% (n=2)
06.00-08.59	3.3% (n=4)
09.00-11.59	14.2% (n=17)
12.00-14.59	65.0% (n=78)
15.00-17.59	10.0% (n=12)
18.00-20.59	2.5% (n=3)
21.00-23.59	1.7% (n=2)

B. Other breaks

1. Have you had any other breaks during the working day? Yes 78.8% (n=126) No 21.3% (n=34)

When did you take your first break?

00.00-02.59	6.6% (n=8)
03.00-05.59	3.3% (n=4)
06.00-08.59	14.9% (n=18)
09.00-11.59	31.4% (n=38)
12.00-14.59	18.2% (n=22)
15.00-17.59	19.0% (n=23)
18.00-20.59	4.1% (n=5)
21.00-23.59	2.5% (n=3)

How long was your first break?

0-15 mins	17.2% (n=22)
16-30 mins	55.5% (n=71)
31-60 mins	10.2% (n=13)
61-120 mins	4.7% (n=6)
>120 mins	12.5% (n=16)

What type was your first break?

Tea/Coffee Break	52.3% (n=56)
Food Break	23.4% (n=25)
Sleep/Rest Break	15.0% (n=16)
Cigarette Break	1.9% (n=2)
Other Break	7.5% (n=8)

When did you take your second break?

00.00-02.59	5.4% (n=4)
03.00-05.59	2.7% (n=2)
06.00-08.59	2.7% (n=2)
09.00-11.59	17.6% (n=13)
12.00-14.59	27.0% (n=20)
15.00-17.59	27.0% (n=20)
18.00-20.59	14.9% (n=11)
21.00-23.59	2.7% (n=2)

How long was your second break?

0-15 mins	31.6% (n=25)
16-30 mins	45.6% (n=36)
31-60 mins	12.7% (n=10)
61-120 mins	2.5% (n=2)
>120 mins	12.2% (n=6)

What type was your second break?

Tea/Coffee Break	60.6% (n=40)
Food Break	21.2% (n=14)
Sleep/Rest Break	9.1% (n=6)
Cigarette Break	4.5% (n=3)
Other Break	4.5% (n=3)

When did you take your third break?

00.00-02.59	--- (n=0)
03.00-05.59	8.3% (n=2)
06.00-08.59	--- (n=0)
09.00-11.59	--- (n=0)
12.00-14.59	12.5% (n=3)
15.00-17.59	41.7% (n=10)
18.00-20.59	29.2% (n=7)
21.00-23.59	8.3% (N=2)

How long was your third break?

0-15 mins	29.6% (n=8)
16-30 mins	44.4% (n=12)
31-60 mins	14.8% (n=4)
61-120 mins	3.7% (n=1)
>120 mins	7.4% (n=2)

What type was your third break?

Tea/Coffee Break	54.5% (n=12)
Food Break	36.4% (n=8)
Rest break	9.1% (n=2)

2. Were you able to decide when you took these breaks? Yes 61.0% (n=75) No 39.0% (n=48)

C. Drinks

How many cups of the following drinks have you had during today's work period?

Coffee

Caffeinated ……………….. mean = 3.13, n=100, S.E. = 0.31

None	17.0% (n=17)
1 cup	12.0% (n=12)
2 cups	19.0% (n=19)
3 cups	15.0% (n=15)
4 cups	21.0% (n=21)
5+ cups	16.0% (n=16)

Decaffeinated ……………….. mean = 1.43, n=42, S.E. = 0.51

None	64.3% (n=27)
1 cup	2.4% (n=1)
2 cups	16.7% (n=7)
3 cups	4.8% (n=2)
4 cups	4.8% (n=2)
5+ cups	7.1% (n=3)

Tea	Caffeinated	……………….. mean = 2.56, n=81, S.E. = 0.30	
		None	22.2% (n=18)
		1 cup	22.2% (n=18)
		2 cups	16.0% (n=13)
		3 cups	8.6% (n=7)
		4 cups	14.8% (n=12)
		5+ cups	16.0% (n=13)
	Decaffeinated	……………….. mean = 0.86, n=35, S.E. = 0.25	
		None	68.6% (n=24)
		1 cup	8.6% (n=3)
		2 cups	5.7% (n=2)
		3 cups	5.7% (n=2)
		4 cups	8.6% (n=3)
		5+ cups	2.9% (n=1)

E. Smoking

1. How many of the following have you smoked today?

Cigarettes (manufactured) ......……….. mean = 9.03, n=96, S.E. = 0.90

None	31.3% (n=30)
1-5	11.5% (n=11)
6-10	20.8% (n=20)
11-15	16.7% (n=16)
16-20	13.5% (n=13)
>20	6.3% (n=6)

Cigarettes (handrolled) ......……….. mean = 4.21, n=52, S.E. = 1.11

None	63.5% (n=33)
1-5	13.5% (n=7)
6-10	7.7% (n=4)
11-15	5.8% (n=3)
16-20	7.7% (n=4)
>20	1.9% (n=1)

Pipes ......……….. mean = 0.15, n=40, S.E. = 0.09

None	--- (n=0)
1-5	--- (n=0)
6-10	--- (n=0)
11-15	--- (n=0)
16-20	--- (n=0)
>20	--- (n=0)

Cigars ......……….. mean = 0.00, n=37, S.E. = 0.00

None	100.0% (n=37)
1-5	--- (n=0)
6-10	--- (n=0)
11-15	--- (n=0)
16-20	--- (n=0)
>20	--- (n=0)

Workload

Physical Effort

Could you please indicate on the scale below the amount of effort you have put into doing your job today.
(1=little or no effort, 7 = maximum effort)

1	2	3	4	5	6	7
Little or no physical effort						Maximum physical effort

Mean = 4.17, n=166, S.E. = 0.12

1:	7.8% (n=13)
2:	14.5% (n=24)
3:	18.7% (n=31)
4:	24.7% (n=41)
5:	25.9% (n=43)
6:	5.4% (n=9)
7:	3.0% (n=5)

Physical Demand

Could you please indicate on the scale below how demanding you felt your working day to be?
(1= not at all demanding, 7=extremely demanding)

1	2	3	4	5	6	7
Not at all physically demanding						Extremely physically demanding

Mean = 3.75, n=166, S.E. = 0.11

1:	7.8% (n=13)
2:	14.5% (n=24)
3:	18.7% (n=31)
4:	24.7% (n=41)
5:	25.9% (n=43)
6:	5.4% (n=9)
7:	3.0% (n=5)

Mental Effort

Could you please indicate on the scale below the amount of effort you have put into doing your job today.
(1=little or no effort, 7 = maximum effort)

1	2	3	4	5	6	7
Little or no Mental effort						Maximum mental effort

Mean = 4.46, n=168, S.E. = 0.13

1:	6.5% (n=11)
2:	7.1% (n=12)
3:	11.9% (n=20)
4:	21.4% (n=36)
5:	23.8% (n=40)
6:	19.6% (n=33)
7:	9.5% (n=16)

Mental Demand

Could you please indicate on the scale below how demanding you felt your working day to be?

(1= not at all demanding, 7=extremely demanding)

1	2	3	4	5	6	7
Not at all mentally demanding						Extremely mentally demanding

Mean = 4.23, n=168, S.E. = 0.12

1:	6.5% (n=11)
2:	8.9% (n=15)
3:	16.1% (n=27)
4:	19.6% (n=33)
5:	29.2% (n=49)
6:	11.3% (n=19)
7:	8.3% (n=14)

The following questions address potential health hazards that you feel you may have been exposed to at work. <u>The following questions ask you about your work TODAY only.</u> For each question please tick ONE box that best describes today's work.

		Not at all	Mildly	Moderately	Very	Extremely
a)	**The work environment was very noisy today.**	16.7% (n=28)	28.0% (n=47)	31.5% (n=53)	19.6% (n=33)	4.2% (n=7)
b)	**I was exposed to breathing fumes, dusts or other potentially harmful substances.**	39.5% (n=66)	25.7% (n=43)	20.4% (n=34)	9.6% (n=16)	4.8% (n=8)
c)	**I handled or touched potentially harmful substances or materials.**	57.1% (n=96)	20.8% (n=35)	11.3% (n=19)	9.5% (n=16)	1.2% (n=2)
d)	**I was left with a ringing in my ears or a temporary feeling of deafness.**	85.1% (n=143)	6.5% (n=11)	4.8% (n=8)	2.4% (n=4)	1.2 (n=2)
e)	**My concentration was disturbed by the level of background noise in the workplace.**	51.8% (n=87)	29.8% (n=50)	15.5% (n=26)	1.8% (n=3)	1.2% (n=2)
f)	**I felt that the air temperature was too hot/cold to work effectively.**	44.6% (n=75)	22.4% (n=41)	19.0% (n=32)	8.9% (n=15)	3.0% (n=5)
g)	**I felt I had too much work to do today.**	46.4% (n=78)	28.0% (n=47)	18.5% (n=31)	5.4% (n=9)	1.8% (n=3)
h)	**I felt that I had good support from my fellow workers if I needed it today.**	16.8% (n=28)	13.2% (n=22)	18.6% (n=31)	41.9% (n=70)	9.6% (n=16)

		Not at all	**Mildly**	**Moderately**	**Very**	**Extremely**
I)	**I felt that management were supportive and would listen to me if I needed their help today.**	14.1% (n=23)	15.3% (n=25)	28.2% (n=46)	34.2% (n=58)	6.7% (n=11)
		Not at all	**Mildly**	**Moderately**	**Very**	**Extremely**
j)	**Did you find your job required a lot of effort today?**	16.7% (n=28)	28.6% (n=48)	38.7% (n=65)	14.9% (n=25)	1.2% (n=2)
		Not at all	**Mildly**	**Moderately**	**Very**	**Extremely**
k)	**How stressful did you find your job today?**	25.1% (n=42)	32.3% (n=54)	32.3% (n=54)	8.4% (n=14)	1.8% (n=3)
		Not at all	**Mildly**	**Moderately**	**Very**	**Extremely**
l)	**Did you have a choice in deciding what you did at work or how you did your work?**	29.2% (n=49)	20.2% (n=34)	22.6% (n=38)	20.8% (n=35)	7.1% (n=12)
		Not at all	**Mildly**	**Moderately**	**Very**	**Extremely**
m)	**Was your job boring today?**	39.9% (n=67)	31.5% (n=53)	14.3% (n=24)	7.7% (n=13)	6.5% (n=11)
		Not at all	**Mildly**	**Moderately**	**Very**	**Extremely**
n)	**Did you feel satisfied with what you did at work today?**	10.8% (n=18)	11.4% (n=19)	35.9% (n=60)	32.3% (n=54)	9.6% (n=16)
		Not at all	**Mildly**	**Moderately**	**Very**	**Extremely**
o)	**Did you find your job demanding today?**	26.3% (n=44)	24.6% (n=41)	34.7% (n=58)	11.4% (n=19)	3.0% (n=5)
		Very good	**Good**	**Fair**	**Bad**	**Very bad**
p)	**Describe your general health today**	10.7% (n=16)	34.7% (n=52)	32.0% (n=48)	18.0 (n=27)	4.7% (n=7)

Your environment

Weather	mean=1.85, n=167, S.E. = 0.07
Motion of ship/ferry/Installation	mean = 1.58, n=165, S.E. = 0.06
Noise	mean = 2.69, n=167, S.E. = 0.08

Weather mean=1.85, n=167, S.E. = 0.07	Fine	1 47.9% (n=80)	2 25.1% (n=42)	3 21.6% (n=36)	4 4.8% (n=8)	5 0.6% (n=1)	Stormy
Motion of ship/ferry/ Installation mean = 1.58, n=165, S.E. = 0.06	Minimal	1 56.4% (n=93)	2 32.7% (n=54)	3 8.5% (n=14)	4 1.2% (n=2)	5 1.2% (n=2)	Extreme
Noise mean = 2.69, n=167, S.E. = 0.08	Very quiet	1 13.8% (n=23)	2 29.3% (n=49)	3 36.5% (n=61)	4 15.0% (n=25)	5 5.4% (n=9)	Intense

Day 7 – Before Shift

Sleeping and Eating Questionnaire

Please provide the information asked for below by circling one of the choices and / or providing details as appropriate.

A. Alcohol

1. Did you consume any alcohol yesterday? Yes 13.1% (n=18) No 86.9% (n=119)

If yes, then how many units of alcohol =
(½ pint / 1 glass wine / 1 spirit measure = 1unit)

Mean = 4.52 (n=27, S.E.=1.19)

1-5 units	58.8% (n=10)
6-10 units	11.8% (n=2)
11-20 units	29.4% (n=3)
21+ units	--- (n=0)

B. Sleep

1. Please complete with respect to the **main** sleep period you have had today and **use a 24-hour clock.**

	Main Sleep period	
Time you went to bed:	00.00-02.59	38.1% (n=51)
	03.00-05.59	3.0% (n=4)
	06.00-08.59	5.2% (n=7)
	09.00-11.59	11.2% (n=15)
	12.00-14.59	3.7% (n=5)
	15.00-17.59	--- (n=0)
	18.00-20.59	3.7% (n=5)
	21.00-23.59	35.1% (n=47)
Time you went to sleep:	00.00-02.59	51.2% (n=66)
	03.00-05.59	5.4% (n=7)
	06.00-08.59	3.1% (n=4)
	09.00-11.59	11.6% (n=15)
	12.00-14.59	5.4% (n=7)
	15.00-17.59	--- (n=0)
	18.00-20.59	2.3% (n=3)
	21.00-23.59	20.9% (n=27)

	Main Sleep period	
Time you woke up:	00.00-02.59	2.2% (n=3)
	03.00-05.59	21.3% (n=29)
	06.00-08.59	42.6% (n=58)
	09.00-11.59	17.6% (n=24)
	12.00-14.59	3.7% (n=5)
	15.00-17.59	8.1% (n=11)
	18.00-20.59	2.2% (n=3)
	21.00-23.59	2.2% (n=3)
Time you got up:	00.00-02.59	0.8% (n=1)
	03.00-05.59	16.5% (n=22)
	06.00-08.59	45.9% (n=61)
	09.00-11.59	19.5% (n=26)
	12.00-14.59	4.5% (n=6)
	15.00-17.59	8.3% (n=11)
	18.00-20.59	2.3% (n=3)
	21.00-23.59	2.3% (n=3)
Sleep duration:	Mean = 5.98 hours (n=130, S.E.=0.17)[4]	
Number of awakenings during the sleep period	No awakenings	27.0% (n=31)
	1 awakening	27.0% (n=31)
	2 awakenings	18.3% (n=21)
	3 awakenings	13.9% (n=16)
	4 awakenings	13.9% (n=16)
	5+ awakenings	--- (n=0)

[4] Hours are in decimal, not hours and minutes (i.e. 1.75 is 1 hour and 45 minutes)

2. Please tick **ONE** of the following boxes to indicate whether last nights sleep was:

about normal for you?	71.3% (n=82)
shorter than normal?	37.4% (n=40)
longer than normal?	15.6% (n=15)

3. Please rate your Sleep

Least (1) Most (5)

	1	2	3	4	5
Ease of falling asleep	7.4% (n=10)	16.2% (n=22)	34.6% (n=47)	23.5% (n=32)	18.4% (n=25)
Ease of arising	8.1% (n=11)	24.4% (n=33)	31.9% (n=43)	26.7% (n=36)	8.9% (n=12)
Was this sleep period sufficient?	15.6% (n=21)	25.2% (n=34)	33.3% (n=45)	18.5% (n=25)	7.4% (n=10)
How deep was your sleep?	2.9% (n=4)	16.9% (n=23)	32.4% (n=44)	35.3% (n=48)	12.5% (n=17)
Interrupted sleep	24.4% (n=33)	20.0% (n=27)	35.6% (n=48)	13.3% (n=18)	6.7% (n=9)

D. Drinks

How many cups of the following drinks have you had today already?

Coffee Caffeinated Mean= 0.83 cups (n=90, S.E.=0.13)

None	52.2% (n=47)
1 cup	31.1% (n=28)
2 cups	7.8% (n=7)
3 cups	4.4% (n=4)
4 cups	1.1% (n=1)
5+ cups	1.1% (n=1)

Decaffeinated Mean= 0.18 cups (n=67, S.E.=0.07)

None	89.6% (n=60)
1 cup	6.0% (n=4)
2 cups	1.5% (n=1)
3 cups	3.0% (n=2)
4 cups	--- (n=0)
5+ cups	--- (n=0)

Tea	Caffeinated	Mean= 0.77 cups (n=70, S.E.=0.18)		
			None	58.6% (n=41)
			1 cup	28.6% (n=20)
			2 cups	5.7% (n=4)
			3 cups	2.9% (n=2)
			4 cups	1.4% (n=1)
			5+ cups	2.9% (n=2)
	Decaffeinated	Mean= 0.14 cups (n=63, S.E.=0.05)		
			None	88.9% (n=56)
			1 cup	7.9% (n=5)
			2 cups	3.2% (n=2)
			3 cups	--- (n=0)
			4 cups	--- (n=0)
			5+ cups	--- (n=0)

F. Smoking

3. How many of the following have you smoked today?

Cigarettes (manufactured)	Mean= 2.00 (n=81, S.E.=0.37)		
		None	43.2% (n=35)
		1-5	44.4% (n=36)
		6-10	11.1% (n=9)
		11-15	--- (n=0)
		16-20	1.2% (n=1)
		More than 20	--- (n=0)
Cigarettes (handrolled)	Mean= 1.54 (n=50, S.E.=1.54)		
		None	86.0% (n=43)
		1-5	6.0% (n=3)
		6-10	4.0% (n=2)
		11-15	2.0% (n=1)
		16-20	--- (n=0)
		More than 20	2.0% (n=1)
Pipes	Mean= 0.00 (n=47, S.E.=0.00)		
		None	--- (n=0)
		1-5	--- (n=0)
		6-10	--- (n=0)
		11-15	--- (n=0)
		16-20	--- (n=0)
		More than 20	--- (n=0)

Cigars	Mean= 0.10 (n=45, S.E.=0.00)	
	None	--- (n=0)
	1-5	--- (n=0)
	6-10	--- (n=0)
	11-15	--- (n=0)
	16-20	--- (n=0)
	More than 20	--- (n=0)

Day 7 – After shift

Daytime Health-Related Behaviours Questionnaire

A. Lunch

1. Did you have lunch today? Yes 79.7% (n=106) No 20.3% (n=27)

If no, then go to section B.

4. When did you have lunch **(please use a 24-hour clock)** ....………

00.00-02.59	--- (n=0)
03.00-05.59	1.0% (n=1)
06.00-08.59	13.7% (n=14)
09.00-11.59	12.7% (n=13)
12.00-14.59	58.8% (n=60)
15.00-17.59	9.8% (n=10)
18.00-20.59	2.9% (n=3)
21.00-23.59	1.0% (n=1)

B. Other breaks

1. Have you had any other breaks during the working day? Yes 76.6% (n=98) No 23.4% (n=30)

When did you take your first break?

00.00-02.59	5.3% (n=5)
03.00-05.59	8.5% (n=8)
06.00-08.59	7.4% (n=7)
09.00-11.59	27.7% (n=26)
12.00-14.59	22.3% (n=21)
15.00-17.59	17.0% (n=16)
18.00-20.59	7.4% (n=7)
21.00-23.60	4.3% (n=4)

How long was your first break?

0-15 mins	21.8% (n=22)
16-30 mins	47.5% (n=48)
31-60 mins	8.9% (n=9)
61-120 mins	7.9% (n=8)
>120 mins	13.9% (n=14)

What type was your first break?

Tea/Coffee Break	46.2% (n=36)
Food Break	25.6% (n=20)
Sleep/Rest Break	23.1% (n=18)
Cigarette Break	1.3% (n=1)
Other Break	3.8% (n=3)

When did you take your second break?

00.00-02.59	3.9% (n=2)
03.00-05.59	5.9% (n=3)
06.00-08.59	--- (n=0)
09.00-11.59	9.8% (n=5)
12.00-14.59	23.5% (n=12)
15.00-17.59	29.4% (n=15)
18.00-20.59	19.6% (n=10)
21.00-23.59	7.8% (n=4)

How long was your second break?

0-15 mins	24.5% (n=13)
16-30 mins	47.2% (n=25)
31-60 mins	7.5% (n=4)
61-120 mins	5.7% (n=3)
>120 mins	15.1% (n=8)

What type was your second break?

Tea/Coffee Break	------------
Food Break	------------
Sleep/Rest Break	------------
Cigarette Break	------------
Other Break	------------

When did you take your third break?

00.00-02.59	--- (n=0)
03.00-05.59	16.7% (n=3)
06.00-08.59	--- (n=0)
09.00-11.59	--- (n=0)
12.00-14.59	11.1% (n=2)
15.00-17.59	27.8% (n=5)
18.00-20.59	38.9% (n=7)
21.00-23.60	5.6% (n=1)

How long was your third break?

0-15 mins	16.7% (n=3)
16-30 mins	50.0% (n=9)
31-60 mins	16.7% (n=3)
61-120 mins	--- (n=0)
>120 mins	16.7% (n=3)

What type was your third break?

Tea/Coffee Break	-------------
Food Break	-------------
Rest break	-------------

2. Were you able to decide when you took these breaks? YES 51.5% (n=50) NO 48.5% (n=47)

C. Drinks

How many cups of the following drinks have you had during today's work period?

Coffee	Caffeinated		……………….. mean = 2.86, n=95, S.E. = 0.38
		None	25.3% (n=24)
		1 cup	15.8% (n=15)
		2 cups	20.0% (n=19)
		3 cups	11.6% (n=11)
		4 cups	9.5% (n=9)
		5+ cups	17.9% (n=17)
	Decaffeinated		……………….. mean = 1.04, n=57, S.E. = 0.29
		None	73.7% (n=42)
		1 cup	3.5% (n=2)
		2 cups	1.8% (n=1)
		3 cups	7.0% (n=4)
		4 cups	8.8% (n=5)
		5+ cups	5.3% (n=3)
Tea	Caffeinated		……………….. mean = 2.39, n=75, S.E. = 0.29
		None	29.3% (n=22)
		1 cup	14.7% (n=11)
		2 cups	17.3% (n=13)
		3 cups	10.7% (n=8)
		4 cups	13.3% (n=10)
		5+ cups	14.7% (n=11)
	Decaffeinated		……………….. mean = 0.38, n=45, S.E. = 0.15
		None	80.0% (n=36)
		1 cup	11.1% (n=5)
		2 cups	6.7% (n=3)
		3 cups	--- (n=0)
		4 cups	--- (n=0)
		5+ cups	2.9% (n=1)

E. Smoking

2. How many of the following have you smoked today?

Cigarettes (manufactured) ......……….. mean = 9.20, n=85, S.E. = 1.00

None	32.9% (n=28)
1-5	12.9% (n=11)
6-10	15.3% (n=13)
11-15	14.1% (n=12)
16-20	17.6% (n=15)
>20	7.1% (n=6)

Cigarettes (handrolled) ......……….. mean = 2.37, n=48, S.E. = 0.74

None	79.2% (n=38)
1-5	--- (n=0)
6-10	14.6% (n=4)
11-15	5.8% (n=3)
16-20	7.7% (n=4)
>20	--- (n=0)

Pipes ......……….. mean = 0.05, n=42, S.E. = 0.03

None	95.2% (n=40)
1-5	4.8% (n=2)
6-11	--- (n=0)
11-15	--- (n=0)
16-20	--- (n=0)
>20	--- (n=0)

Cigars ......……….. mean = 0.00, n=40, S.E. = 0.00

None	100.0% (n=40)
1-5	--- (n=0)
6-10	--- (n=0)
11-15	--- (n=0)
16-20	--- (n=0)
>20	--- (n=0)

Workload

Physical Effort

Could you please indicate on the scale below the amount of effort you have put into doing your job today.
(1=little or no effort, 7 = maximum effort)

1	2	3	4	5	6	7
Little or no physical effort						Maximum physical effort

Mean = 3.97, n=132, S.E. = 0.12

1:	4.5% (n=6)
2:	11.4% (n=15)
3:	21.2% (n=28)
4:	24.2% (n=32)
5:	25.0% (n=33)
6:	11.4% (n=15)
7:	2.3% (n=3)

Physical Demand

Could you please indicate on the scale below how demanding you felt your working day to be?
(1= not at all demanding, 7=extremely demanding)

1	2	3	4	5	6	7
Not at all physically demanding						Extremely physically demanding

Mean = 3.66, n=133, S.E. = 0.12

1:	4.5% (n=6)
2:	17.3% (n=23)
3:	24.1% (n=32)
4:	23.3% (n=31)
5:	24.1% (n=32)
6:	6.0% (n=8)
7:	0.8% (n=1)

Mental Effort

Could you please indicate on the scale below the amount of effort you have put into doing your job today.
(1=little or no effort, 7 = maximum effort)

1	2	3	4	5	6	7
Little or no Mental effort						Maximum mental effort

Mean = 3.97, n=133, S.E. = 0.13

1: 6.0% (n=8)
2: 6.0% (n=8)
3: 17.3% (n=23)
4: 22.6% (n=30)
5: 25.6% (n=34)
6: 15.8% (n=21)
7: 6.8% (n=9)

Mental Demand

Could you please indicate on the scale below how demanding you felt your working day to be?

(1= not at all demanding, 7=extremely demanding)

1	2	3	4	5	6	7
Not at all mentally demanding						Extremely mentally demanding

Mean = 3.97, n=132, S.E. = 0.13

1: 6.0% (n=8)
2: 7.5% (n=10)
3: 27.8% (n=37)
4: 23.3% (n=31)
5: 18.8% (n=25)
6: 12.8% (n=17)
7: 3.8% (n=5)

The following questions address potential health hazards that you feel you may have been exposed to at work. <u>The following questions ask you about your work TODAY only.</u> For each question please tick ONE box that best describes today's work.

		Not at all	Mildly	Moderately	Very	Extremely
a)	**The work environment was very noisy today.**	19.4% (n=26)	35.1% (n=47)	25.4% (n=34)	16.4% (n=22)	3.7% (n=5)
b)	**I was exposed to breathing fumes, dusts or other potentially harmful substances.**	45.5% (n=61)	22.4% (n=30)	18.7% (n=22)	9.7% (n=13)	3.7% (n=5)
c)	**I handled or touched potentially harmful substances or materials.**	59.7% (n=80)	20.9% (n=28)	9.7% (n=13)	9.0% (n=12)	3.7% (n=5)
d)	**I was left with a ringing in my ears or a temporary feeling of deafness.**	79.1% (n=106)	11.9% (n=16)	4.5% (n=6)	1.5% (n=2)	3.0 (n=4)
e)	**My concentration was disturbed by the level of background noise in the workplace.**	56.4% (n=75)	27.1% (n=36)	10.5% (n=14)	3.0% (n=4)	3.0% (n=4)
f)	**I felt that the air temperature was too hot/cold to work effectively.**	42.5% (n=57)	30.6% (n=41)	15.7% (n=21)	7.5% (n=10)	3.7% (n=5)
g)	**I felt I had too much work to do today.**	35.1% (n=47)	26.9% (n=36)	25.4% (n=34)	10.4% (n=14)	2.2% (n=3)
h)	**I felt that I had good support from my fellow workers if I needed it today.**	11.2% (n=15)	14.9% (n=20)	26.1% (n=35)	41.0% (n=55)	6.7% (n=9)

		Not at all	**Mildly**	**Moderately**	**Very**	**Extremely**
I)	**I felt that management were supportive and would listen to me if I needed their help today.**	9.2% (n=12)	19.8% (n=26)	32.1% (n=42)	32.8% (n=43)	6.1% (n=8)
		Not at all	**Mildly**	**Moderately**	**Very**	**Extremely**
j)	**Did you find your job required a lot of effort today?**	14.9% (n=20)	25.4% (n=34)	41.8% (n=56)	15.7% (n=21)	2.2% (n=3)
		Not at all	**Mildly**	**Moderately**	**Very**	**Extremely**
k)	**How stressful did you find your job today?**	18.9% (n=25)	30.3% (n=40)	36.4% (n=48)	12.1% (n=16)	2.3% (n=3)
		Not at all	**Mildly**	**Moderately**	**Very**	**Extremely**
l)	**Did you have a choice in deciding what you did at work or how you did your work?**	26.9% (n=36)	20.1% (n=27)	26.1% (n=35)	22.4% (n=30)	4.5% (n=6)
		Not at all	**Mildly**	**Moderately**	**Very**	**Extremely**
m)	**Was your job boring today?**	29.9% (n=40)	38.1% (n=51)	20.1% (n=27)	6.7% (n=9)	5.2% (n=7)
		Not at all	**Mildly**	**Moderately**	**Very**	**Extremely**
n)	**Did you feel satisfied with what you did at work today?**	8.2% (n=11)	11.9% (n=16)	38.1% (n=51)	37.3% (n=50)	4.5% (n=6)
		Not at all	**Mildly**	**Moderately**	**Very**	**Extremely**
o)	**Did you find your job demanding today?**	20.9% (n=28)	25.4% (n=34)	37.3% (n=50)	14.9% (n=20)	1.5% (n=2)
		Very good	**Good**	**Fair**	**Bad**	**Very bad**
p)	**Describe your general health today**	9.2% (n=12)	42.3% (n=55)	34.6% (n=45)	11.5 (n=15)	2.3% (n=3)

Your environment

Weather	mean=2.07, n=132, S.E. = 0.10
Motion of ship/ferry/Installation	mean = 1.58, n=130, S.E. = 0.06
Noise	mean = 2.42, n=131, S.E. = 0.09

Weather mean=2.07, n=132, S.E. = 0.10	Fine	1 44.7% (n=59)	2 20.5% (n=27)	3 22.7% (n=30)	4 7.6% (n=10)	5 4.5% (n=6)	Stormy
Motion of ship/ferry/ Installation mean = 1.58, n=130, S.E. = 0.06	Minimal	1 56.9% (n=74)	2 30.8% (n=40)	3 10.8% (n=14)	4 0.8% (n=1)	5 0.8% (n=1)	Extreme
Noise mean = 2.42, n=131, S.E. = 0.09	Very quiet	1 22.1% (n=29)	2 35.9% (n=47)	3 26.0% (n=34)	4 9.9% (n=13)	5 6.1% (n=8)	Intense

Work in General

Please complete the following questions in reference to your **work in GENERAL**, and **not the day** you completed the questionnaire.

1. **The following questions ask you about your work and the sorts of things you have to do. For each question, please tick the answer which best describes your job or the way you deal with problems at work.**

		Often	Sometimes	Seldom	Never/ almost never	Not applicable
A.	I have to work very fast.	30.1% (n=43)	39.9% (n=57)	4.9% (n=7)	17.5% (n=25)	7.7% (n=11)
B.	I have to work very intensively.	19.6% (n=28)	47.6% (n=68)	8.4% (n=12)	16.8% (n=24)	7.7% (n=11)
C.	I have enough time to do everything I need to do at work.	25.9% (n=37)	39.2% (n=56)	13.3% (n=19)	18.2% (n=26)	3.5% (n=5)
D.	My tasks are such that others can help me if I do not have time.	16.1% (n=23)	35.7% (n=51)	23.1% (n=33)	19.6% (n=28)	5.6% (n=8)
E.	I have the possibility of learning new things through work.	23.1% (n=33)	29.4% (n=42)	17.5% (n=25)	20.3% (n=29)	9.8% (n=14)
F.	My work demands a high level of skill / expertise	30.1% (n=43)	30.8% (n=44)	15.4% (n=22)	13.3% (n=19)	10.5% (n=15)
G.	My job requires me to take the initiative.	44.8% (n=64)	23.8% (n=34)	6.3% (n=9)	10.5% (n=15)	14.7% (n=21)
H.	I have to do the same thing over and over again.	43.4% (n=62)	24.5% (n=35)	9.8% (n=14)	7.7% (n=11)	14.7% (n=21)
I.	I have a choice in deciding HOW I do my work.	24.5% (n=35)	36.4% (n=52)	14.0% (n=20)	16.8% (n=24)	8.4% (n=12)
J.	I have a choice in deciding WHAT I do at work.	16.8% (n=24)	31.5% (n=45)	25.9% (n=37)	18.9% (n=27)	7.0% (n=10)

2. **This section is about your position at work. Please tick ONE box only to indicate how often the following statements apply.**

		Often	Sometimes	Seldom	Never / almost never	Not applicable
A.	Others take decisions concerning my work.	28.7% (n=41)	30.1% (n=43)	16.1% (n=23)	19.6% (n=28)	5.6% (n=8)
B.	I have a great deal of say in decisions about my work.	26.1% (n=37)	26.1% (n=37)	22.5% (n=32)	14.8% (n=21)	10.6% (n=15)
C.	I have say in my work speed.	22.4% (n=32)	36.4% (n=52)	21.0% (n=30)	10.5% (n=15)	9.8% (n=14)
D.	My working time can be flexible.	14.8% (n=21)	38.7% (n=55)	16.9% (n=24)	26.1% (n=37)	3.5% (n=5)
E.	I can decide when I take a break.	21.0% (n=30)	33.6% (n=48)	23.1% (n=33)	18.2% (n=26)	4.2% (n=6)
F.	I can take my holidays more or less when I wish.	10.6% (n=15)	25.4% (n=36)	21.8% (n=31)	28.2% (n=40)	14.1% (n=20)
G.	I have a say in choosing who I work with.	7.0% (n=10)	25.2% (n=36)	25.2% (n=36)	37.1% (n=53)	5.6% (n=8)
H.	I have a great deal of say in planning my work environment.	9.2% (n=13)	28.9% (n=41)	24.6% (n=35)	28.9% (n=41)	8.5% (n=12)

3. **The following questions ask about <u>consistency</u> and <u>clarity</u> at work during the day. How often do the following statements apply? Please tick ONE box only.**

		Often	Sometimes	Seldom	Never / almost never	Not applicable
A.	Do different groups demand things from you that you think are hard to combine?	7.7% (n=11)	44.8% (n=64)	28.0% (n=40)	14.0% (n=20)	5.6% (n=8)
B.	Do you get *sufficient* information from line management (your superiors)?	32.4% (n=46)	28.9% (n=41)	12.0% (n=17)	18.3% (n=26)	18.3% (n=26)
C.	Do you get *consistent* information from line management (your superiors?)	30.8% (n=44)	30.1% (n=43)	11.9% (n=17)	18.9% (n=27)	8.4% (n=12)

4. **These questions are about your job involvement. Please tick ONE box only.**

		Often	Sometimes	Seldom	Never / almost never	Not applicable
A.	Does your job provide you with a variety of interesting things to do?	24.5% (n=35)	30.8% (n=44)	18.2% (n=26)	19.6% (n=28)	7.0% (n=10)
B.	Is your job boring?	9.8% (n=14)	42.7% (n=61)	19.6% (n=28)	17.5% (n=25)	10.5% (n=15)

5. **Now we would like to ask you about when you are having difficulties at work. Please tick ONE box only.**

		Often	Sometimes	Seldom	Never / almost never	Not applicable
A.	How often do you get help and support from your colleagues?	35.0% (n=50)	28.0% (n=40)	13.3% (n=19)	13.3% (n=19)	10.5% (n=15)
B.	How often are your colleagues willing to listen to your work related problems?	37.1% (n=53)	23.8% (n=34)	15.4% (n=22)	11.2% (n=16)	12.6% (n=18)
C.	How often do you get help and support from your immediate superior?	27.3% (n=39)	28.0% (n=40)	17.5% (n=25)	15.4% (n=22)	11.9% (n=17)
D.	How often is your immediate superior willing to listen to your problems?	36.4% (n=52)	21.0% (n=30)	14.0% (n=20)	13.3% (n=19)	15.4% (n=22)

Appendix 5: Descriptive statistics for objective measures of motion and noise

1. MOTION

	N	Minimum	Maximum	Mean		Std. Deviation
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic
Acute period 1 pitch, mean position	24	-.21	1.75	.4762	.1469	.71955
Acute period 1 pitch, max negative displacement	24	-6.93	-.22	-2.1046	.5451	2.67062
Acute period 1 pitch, max positive displacement	24	.22	7.95	2.3413	.6103	2.98972
Acute period 1 pitch, RMS	24	.06	1.97	.6151	.1611	.78903
Acute period 1 roll, mean position	24	-.43	.65	.1563	.0760	.37217
Acute period 1 roll, max negative displacement	24	-9.28	-.42	-3.2009	.6767	3.31493
Acute period 1 roll, max positive displacement	24	.47	9.19	2.9825	.6466	3.16781
Acute period 1 roll, RMS	24	.14	2.75	.8827	.2033	.99591
Acute period 1 heave, mean position	24	.00	.00	.0003	.0002	.00089
Acute period 1 heave, max negative displacement	24	-6.16	.00	-1.7568	.4915	2.40805
Acute period 1 heave, max positive displacement	24	.00	5.76	1.6129	.4488	2.19849
Acute period 1 heave, RMS	24	.00	1.59	.4549	.1284	.62912
Acute period 1 pitch (acc), mean position	24	.00	.00	.0000	.0001	.00046
Acute period 1 pitch (acc), max negative displacement	24	-.92	-.03	-.2607	.0635	.31099
Acute period 1 pitch (acc), max positive displacement	24	.01	.84	.2646	.0650	.31830
Acute period 1 pitch (acc), RMS	24	.00	.21	.0658	.0160	.07820
Acute period 1 roll (acc), mean position	24	.00	.00	-.0001	.0000	.00020
Acute period 1 roll (acc), max negative displacement	24	-1.40	-.02	-.4862	.1008	.49378
Acute period 1 roll (acc), max positive displacement	24	.02	1.42	.4912	.1046	.51227
Acute period 1 roll (acc), RMS	24	.00	.36	.1233	.0268	.13131
Acute period 1 heave (acc), mean position	24	-.04	-.03	-.0347	.0003	.00151
Acute period 1 heave (acc), max negative displacement	24	-4.34	-.01	-1.2092	.3148	1.54214
Acute period 1 heave (acc), max positive displacement	24	.01	3.84	1.1986	.2982	1.46109
Acute period 1 heave (acc), RMS	24	.00	.98	.3130	.0812	.39803
Acute period 2 pitch, mean position	24	-.22	.49	.1085	.0421	.20634
Acute period 2 pitch, max negative displacement	24	-5.60	-.14	-1.4218	.3454	1.69227
Acute period 2 pitch, max positive displacement	24	.11	5.55	1.4957	.3648	1.78716
Acute period 2 pitch, RMS	24	.03	1.68	.3940	.1005	.49252
Acute period 2 roll, mean position	24	-.81	.93	.1532	.1089	.53333
Acute period 2 roll, max negative displacement	24	-10.09	-.25	-3.0904	.6467	3.16800
Acute period 2 roll, max positive displacement	24	.45	11.20	2.9974	.6508	3.18843
Acute period 2 roll, RMS	24	.11	2.99	.8417	.1850	.90607
Acute period 2 heave, mean position	24	.00	.00	.0002	.0001	.00045
Acute period 2 heave, max negative displacement	24	-4.91	-.06	-1.1572	.3230	1.58229

Acute period 2 heave, max positive displacement	24	.04	5.67	1.2182	.3450	1.69024
Acute period 2 heave, RMS	24	.01	1.48	.3250	.0947	.46386
Acute period 2 pitch (acc), mean position	24	.00	.00	.0002	.0002	.00085
Acute period 2 pitch (acc), max negative displacement	24	-.63	-.03	-.1889	.0399	.19551
Acute period 2 pitch (acc), max positive displacement	24	.03	.74	.1968	.0438	.21475
Acute period 2 pitch (acc), RMS	24	.01	.18	.0498	.0113	.05548
Acute period 2 roll (acc), mean position	24	.00	.00	.0006	.0003	.00142
Acute period 2 roll (acc), max negative displacement	24	-1.42	-.03	-.4969	.0874	.42823
Acute period 2 roll (acc), max positive displacement	24	.08	1.37	.4999	.0868	.42517
Acute period 2 roll (acc), RMS	24	.01	.37	.1291	.0250	.12266
Acute period 2 heave (acc), mean position	24	-.04	-.03	-.0353	.0004	.00175
Acute period 2 heave (acc), max negative displacement	24	-3.14	-.04	-.8593	.1931	.94620
Acute period 2 heave (acc), max positive displacement	24	.04	3.05	.8544	.1880	.92113
Acute period 2 heave (acc), RMS	24	.00	.90	.2281	.0545	.26710
Acute period 3 pitch, mean position	14	-.36	1.70	.5751	.2666	.99764
Acute period 3 pitch, max negative displacement	22	-5.59	-.09	-.6359	.2485	1.16543
Acute period 3 pitch, max positive displacement	22	.10	6.38	.6834	.2868	1.34508
Acute period 3 pitch, RMS	22	.03	1.34	.1671	.0603	.28306
Acute period 3 roll, mean position	22	-.62	.72	-.0423	.1124	.52698
Acute period 3 roll, max negative displacement	22	-5.10	-.11	-1.1780	.3056	1.43331
Acute period 3 roll, max positive displacement	22	.11	5.21	1.2285	.2878	1.34969
Acute period 3 roll, RMS	22	.03	1.15	.2724	.0682	.32008
Acute period 3 heave, mean position	22	.00	.00	.0001	.0001	.00061
Acute period 3 heave, max negative displacement	22	-3.91	-.03	-.3981	.1746	.81873
Acute period 3 heave, max positive displacement	22	.03	3.09	.3693	.1422	.66686
Acute period 3 heave, RMS	22	.01	.77	.0917	.0356	.16714
Acute period 3 pitch (acc), mean position	22	.00	.00	.0005	.0004	.00188
Acute period 3 pitch (acc), max negative displacement	22	-.64	-.02	-.0851	.0281	.13201
Acute period 3 pitch (acc), max positive displacement	22	.02	.73	.0875	.0315	.14763
Acute period 3 pitch (acc), RMS	22	.00	.13	.0200	.0059	.02775
Acute period 3 roll (acc), mean position	22	.00	.00	-.0002	.0002	.00074
Acute period 3 roll (acc), max negative displacement	22	-.72	-.02	-.1833	.0384	.18012
Acute period 3 roll (acc), max positive displacement	22	.02	.85	.2071	.0447	.20971
Acute period 3 roll (acc), RMS	22	.01	.15	.0403	.0092	.04324
Acute period 3 heave (acc), mean position	22	-.04	-.03	-.0350	.0002	.00108
Acute period 3 heave (acc), max negative displacement	22	-2.20	-.04	-.2884	.0992	.46549
Acute period 3 heave (acc), max	22	.04	2.44	.3004	.1078	.50540

positive displacement						
Acute period 3 heave (acc), RMS	22	.01	.52	.0659	.0230	.10784
Acute period 4 pitch, mean position	22	-1.32	3.32	.4583	.2770	1.29901
Acute period 4 pitch, max negative displacement	22	-5.53	-.08	-1.0197	.2666	1.25064
Acute period 4 pitch, max positive displacement	22	.06	7.61	1.5997	.4475	2.09915
Acute period 4 pitch, RMS	22	.02	1.56	.3020	.0740	.34696
Acute period 4 roll, mean position	22	-1.06	1.84	.0749	.2120	.99421
Acute period 4 roll, max negative displacement	22	-13.80	-.10	-2.2968	.6342	2.97481
Acute period 4 roll, max positive displacement	22	.18	15.72	2.7466	.7149	3.35314
Acute period 4 roll, RMS	22	.05	4.61	.6594	.2040	.95663
Acute period 4 heave, mean position	22	-.01	.00	-.0011	.0008	.00386
Acute period 4 heave, max negative displacement	22	-5.09	.00	-.7998	.2511	1.17781
Acute period 4 heave, max positive displacement	22	.00	4.45	.6020	.2126	.99701
Acute period 4 heave, RMS	22	.00	1.45	.1821	.0693	.32488
Acute period 4 pitch (acc), mean position	22	.00	.00	-.0005	.0002	.00094
Acute period 4 pitch (acc), max negative displacement	22	-1.29	-.01	-.2139	.0706	.33102
Acute period 4 pitch (acc), max positive displacement	22	.01	.70	.1265	.0367	.17207
Acute period 4 pitch (acc), RMS	22	.00	.17	.0318	.0087	.04101
Acute period 4 roll (acc), mean position	22	.00	.00	-.0003	.0002	.00095
Acute period 4 roll (acc), max negative displacement	22	-1.93	-.02	-.3441	.1011	.47426
Acute period 4 roll (acc), max positive displacement	22	.01	1.63	.4248	.0936	.43898
Acute period 4 roll (acc), RMS	22	.00	.52	.0910	.0279	.13099
Acute period 4 heave (acc), mean position	22	-.04	-.03	-.0355	.0004	.00166
Acute period 4 heave (acc), max negative displacement	22	-2.90	.00	-.4688	.1462	.68566
Acute period 4 heave (acc), max positive displacement	22	.00	3.24	.4918	.1583	.74228
Acute period 4 heave (acc), RMS	22	.00	.88	.1166	.0433	.20324
All day 1 pitch, mean position	24	-.20	1.37	.3239	.0980	.48003
All day 1 pitch, max negative displacement	24	-6.97	-.41	-2.7889	.4864	2.38289
All day 1 pitch, max positive displacement	24	.46	10.00	3.2596	.6263	3.06844
All day 1 pitch, RMS	24	.09	1.63	.6943	.1153	.56498
All day 1 roll, mean position	24	-.55	.78	.1010	.0928	.45473
All day 1 roll, max negative displacement	24	-11.60	-1.14	-4.6549	.8732	4.27792
All day 1 roll, max positive displacement	24	1.01	11.13	4.9316	.8241	4.03712
All day 1 roll, RMS	24	.24	2.51	.9879	.1829	.89606
All day 1 heave, mean position	24	.00	.00	.0003	.0001	.00044
All day 1 heave, max negative displacement	24	-8.01	-.27	-2.1551	.5207	2.55074
All day 1 heave, max positive displacement	24	.27	5.76	2.0307	.4581	2.24421
All day 1 heave, RMS	24	.02	1.29	.4006	.1046	.51248
All day 1 pitch (acc), mean position	24	.00	.00	.0004	.0001	.00038

All day 1 pitch (acc), max negative displacement	24	-.97	-.04	-.3388	.0579	.28343
All day 1 pitch (acc), max positive displacement	24	.05	.88	.3353	.0659	.32301
All day 1 pitch (acc), RMS	24	.01	.16	.0588	.0122	.05991
All day 1 roll (acc), mean position	24	.00	.00	.0001	.0001	.00033
All day 1 roll (acc), max negative displacement	24	-1.43	-.16	-.7543	.0956	.46836
All day 1 roll (acc), max positive displacement	24	.15	1.45	.7447	.1025	.50222
All day 1 roll (acc), RMS	24	.01	.34	.1405	.0248	.12132
All day 1 heave (acc), mean position	24	-.04	-.03	-.0350	.0003	.00151
All day 1 heave (acc), max negative displacement	24	-4.34	-.33	-1.5605	.2887	1.41446
All day 1 heave (acc), max positive displacement	24	.35	4.55	1.6203	.2972	1.45608
All day 1 heave (acc), RMS	24	.02	.87	.2898	.0653	.32005
All day 7 pitch, mean position	22	-1.10	2.18	.4359	.2268	1.06371
All day 7 pitch, max negative displacement	22	-6.26	-.38	-1.6499	.2670	1.25246
All day 7 pitch, max positive displacement	22	.47	9.56	3.4186	.6160	2.88926
All day 7 pitch, RMS	22	.08	1.79	.5528	.0918	.43049
All day 7 roll, mean position	22	-.95	.94	-.0857	.1218	.57128
All day 7 roll, max negative displacement	22	-16.65	-.50	-3.2053	.6904	3.23848
All day 7 roll, max positive displacement	22	.76	15.78	3.8592	.6818	3.19784
All day 7 roll, RMS	22	.15	4.26	.6541	.1823	.85496
All day 7 heave, mean position	22	.00	.00	-.0003	.0002	.00117
All day 7 heave, max negative displacement	22	-5.94	-.08	-1.2917	.2717	1.27430
All day 7 heave, max positive displacement	22	.05	5.32	.7695	.2411	1.13067
All day 7 heave, RMS	22	.00	1.41	.1558	.0642	.30096
All day 7 pitch (acc), mean position	22	.00	.00	.0002	.0001	.00034
All day 7 pitch (acc), max negative displacement	22	-1.29	-.05	-.4585	.1011	.47437
All day 7 pitch (acc), max positive displacement	22	.04	.84	.1512	.0390	.18275
All day 7 pitch (acc), RMS	22	.01	.19	.0270	.0084	.03953
All day 7 roll (acc), mean position	22	.00	.00	.0002	.0001	.00026
All day 7 roll (acc), max negative displacement	22	-2.01	-.08	-.3980	.1005	.47128
All day 7 roll (acc), max positive displacement	22	.12	2.21	.6632	.1110	.52058
All day 7 roll (acc), RMS	22	.01	.47	.0709	.0238	.11151
All day 7 heave (acc), mean position	22	-.04	-.03	-.0351	.0003	.00128
All day 7 heave (acc), max negative displacement	22	-3.59	-.04	-.5686	.1653	.77552
All day 7 heave (acc), max positive displacement	22	.05	4.00	.6107	.1837	.86150
All day 7 heave (acc), RMS	22	.00	.88	.0975	.0408	.19148
Sleep period 1 pitch, mean position	24	-.22	2.19	.5318	.1639	.80296
Sleep period 1 pitch, max negative displacement	24	-6.94	-.31	-2.4809	.5755	2.81932
Sleep period 1 pitch, max positive displacement	24	.32	10.03	3.2354	.8249	4.04137
Sleep period 1 pitch, RMS	24	.07	1.87	.6195	.1543	.75589

Sleep period 1 roll, mean position	24	-.43	.48	.1107	.0689	.33730
Sleep period 1 roll, max negative displacement	24	-11.63	-.82	-4.9149	.7672	3.75856
Sleep period 1 roll, max positive displacement	24	.80	9.32	4.6970	.6697	3.28093
Sleep period 1 roll, RMS	24	.22	2.71	1.0559	.2013	.98594
Sleep period 1 heave, mean position	24	.00	.00	.0004	.0001	.00046
Sleep period 1 heave, max negative displacement	24	-8.01	-.21	-2.5261	.6843	3.35258
Sleep period 1 heave, max positive displacement	24	.22	5.76	1.9436	.5036	2.46715
Sleep period 1 heave, RMS	24	.03	1.52	.4838	.1337	.65484
Sleep period 1 pitch (acc), mean position	24	.00	.00	-.0001	.0001	.00029
Sleep period 1 pitch (acc), max negative displacement	24	-.97	-.06	-.3549	.0816	.39999
Sleep period 1 pitch (acc), max positive displacement	24	.05	.88	.3254	.0713	.34923
Sleep period 1 pitch (acc), RMS	24	.01	.19	.0681	.0160	.07845
Sleep period 1 roll (acc), mean position	24	.00	.00	-.0002	.0001	.00054
Sleep period 1 roll (acc), max negative displacement	24	-1.52	-.15	-.7076	.1051	.51488
Sleep period 1 roll (acc), max positive displacement	24	.14	1.44	.6684	.1025	.50234
Sleep period 1 roll (acc), RMS	24	.02	.35	.1394	.0270	.13226
Sleep period 1 heave (acc), mean position	24	-.04	-.03	-.0342	.0003	.00167
Sleep period 1 heave (acc), max negative displacement	24	-4.34	-.15	-1.5427	.3534	1.73112
Sleep period 1 heave (acc), max positive displacement	24	.17	4.55	1.6208	.3688	1.80696
Sleep period 1 heave (acc), RMS	24	.02	.93	.3152	.0779	.38153
Sleep period 7 pitch, mean position	19	-.34	1.69	.5301	.1784	.77743
Sleep period 7 pitch, max negative displacement	19	-4.72	-.09	-.7778	.2394	1.04336
Sleep period 7 pitch, max positive displacement	19	.08	5.91	.8268	.2993	1.30464
Sleep period 7 pitch, RMS	19	.02	.86	.1311	.0439	.19125
Sleep period 7 roll, mean position	19	-.62	.66	-.1167	.1032	.44977
Sleep period 7 roll, max negative displacement	19	-7.28	-.15	-1.6547	.4240	1.84814
Sleep period 7 roll, max positive displacement	19	.18	7.32	1.7011	.4013	1.74927
Sleep period 7 roll, RMS	19	.03	1.54	.3020	.0858	.37396
Sleep period 7 heave, mean position	19	.00	.00	.0000	.0001	.00045
Sleep period 7 heave, max negative displacement	19	-3.79	-.01	-.5188	.1921	.83740
Sleep period 7 heave, max positive displacement	19	.01	4.23	.5512	.2147	.93598
Sleep period 7 heave, RMS	19	.00	.72	.0906	.0369	.16073
Sleep period 7 pitch (acc), mean position	19	.00	.00	-.0001	.0001	.00055
Sleep period 7 pitch (acc), max negative displacement	19	-.96	-.01	-.1227	.0483	.21068
Sleep period 7 pitch (acc), max positive displacement	19	.02	.48	.0940	.0239	.10432
Sleep period 7 pitch (acc), RMS	19	.00	.09	.0170	.0042	.01831
Sleep period 7 roll (acc), mean position	19	.00	.00	-.0002	.0001	.00046
Sleep period 7 roll (acc), max negative	19	-1.47	-.02	-.2888	.0740	.32250

displacement						
Sleep period 7 roll (acc), max positive displacement	19	.02	1.29	.2949	.0679	.29601
Sleep period 7 roll (acc), RMS	19	.00	.26	.0437	.0138	.06022
Sleep period 7 heave (acc), mean position	19	-.04	-.03	-.0347	.0002	.00080
Sleep period 7 heave (acc), max negative displacement	19	-3.16	-.02	-.5187	.1586	.69122
Sleep period 7 heave (acc), max positive displacement	19	.02	2.89	.5067	.1450	.63194
Sleep period 7 heave (acc), RMS	19	.00	.54	.0745	.0270	.11764
Mid pitch, mean position	22	-.78	1.45	.3396	.1735	.81359
Mid pitch, max negative displacement	22	-10.67	-1.48	-4.9062	.8668	4.06579
Mid pitch, max positive displacement	22	1.20	10.36	4.4845	.8707	4.08395
Mid pitch, RMS	22	.12	1.29	.7462	.1009	.47347
Mid roll, mean position	22	-.47	.63	-.0693	.0973	.45650
Mid roll, max negative displacement	22	-19.44	-1.87	-9.4359	1.5629	7.33067
Mid roll, max positive displacement	22	3.14	22.77	10.8035	1.8112	8.49524
Mid roll, RMS	22	.40	2.19	.9888	.1563	.73333
Mid heave, mean position	22	.00	.00	-.0003	.0001	.00062
Mid heave, max negative displacement	22	-9.86	-.78	-3.8022	.9029	4.23483
Mid heave, max positive displacement	22	.82	8.10	3.2363	.7247	3.39907
Mid heave, RMS	22	.05	.89	.3171	.0751	.35222
Mid pitch (acc), mean position	22	.00	.00	.0001	.0000	.00004
Mid pitch (acc), max negative displacement	22	-1.37	-.20	-.6419	.1084	.50837
Mid pitch (acc), max positive displacement	22	.15	1.37	.5792	.1183	.55493
Mid pitch (acc), RMS	22	.01	.13	.0493	.0100	.04681
Mid roll (acc), mean position	22	.00	.00	.0001	.0000	.00010
Mid roll (acc), max negative displacement	22	-2.61	-.51	-1.3696	.1872	.87812
Mid roll (acc), max positive displacement	22	.59	2.99	1.4578	.2304	1.08065
Mid roll (acc), RMS	22	.03	.26	.1116	.0193	.09063
Mid heave (acc), mean position	22	-.04	-.03	-.0349	.0002	.00113
Mid heave (acc), max negative displacement	22	-4.52	-.76	-2.2488	.3442	1.61439
Mid heave (acc), max positive displacement	22	.65	4.41	2.2952	.3224	1.51221
Mid heave (acc), RMS	22	.04	.46	.1939	.0343	.16071
Valid N (listwise)	12					

2. NOISE – Leq levels
a. Tankers

Descriptive Statistics[a]

	N	Minimum	Maximum	Mean		Std.
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic
Ac1LeqB	17	60.00	75.70	66.3706	1.2783	5.27076
Ac2LeqB	17	60.00	76.10	67.0471	1.1552	4.76289
Ac3LeqB	15	64.70	76.00	68.3000	.9688	3.75214
Ac4LeqB	15	60.50	76.30	67.6267	1.3189	5.10790
AllLeqB	17	63.30	70.52	66.2736	.8892	3.66625
D1t7LeqB	15	62.57	70.73	66.3061	.9979	3.86471
D1wLeqB	17	63.89	68.86	65.8615	.4269	1.76031
D2wLeqB	15	63.78	75.83	68.5018	1.2056	4.66942
S1wLeqB	17	61.80	73.47	66.6812	1.1451	4.72134
S2wLeqB	14	62.65	77.50	67.1430	1.3557	5.07238
Ac1LeqC	16	56.00	75.00	67.0375	1.4049	5.61959
Ac2LeqC	16	59.00	76.00	66.0125	1.2886	5.15440
Ac3LeqC	15	58.80	75.60	68.1267	1.3851	5.36436
Ac4LeqC	15	63.60	73.90	66.6133	.9357	3.62410
AllLeqC	17	63.87	68.32	65.7023	.5474	2.25710
D1t7LeqC	15	64.07	68.11	65.8200	.4886	1.89238
D1wLeqC	17	59.00	69.53	64.9918	.5628	2.32048
D2wLeqC	15	60.54	73.63	66.8295	.9483	3.67274
S1wLeqC	17	49.74	73.63	65.5936	1.7311	7.13751
S2wLeqC	14	58.88	74.22	67.4716	1.2194	4.56243
Valid N (listwise)	12					

a. Type of vessel = Tankers

b. Passenger ferries

Descriptive Statistics[a]

	N	Minimum	Maximum	Mean		Std.
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic
Ac1LeqB	71	57.80	74.00	65.6282	.4423	3.72697
Ac2LeqB	69	57.00	71.30	63.9826	.5387	4.47467
Ac3LeqB	51	60.40	76.60	65.8510	.4983	3.55822
Ac4LeqB	49	57.60	76.60	64.6000	.6344	4.44058
AllLeqB	71	62.81	68.10	65.5652	.3157	2.66039
D1t7LeqB	52	62.09	68.24	64.7804	.3342	2.40978
D1wLeqB	69	59.95	71.49	65.6232	.4377	3.63559
D2wLeqB	48	61.35	69.86	66.2512	.3344	2.31655
S1wLeqB	56	57.85	71.60	65.0255	.5049	3.77835
S2wLeqB	44	59.52	70.16	65.0892	.4195	2.78285
Ac1LeqC	30	55.00	70.50	62.4600	.8291	4.54127
Ac2LeqC	32	55.00	71.60	63.3625	.7969	4.50818
Ac3LeqC	29	34.30	77.30	57.7759	2.5350	13.65163
Ac4LeqC	37	55.50	78.70	63.3486	.8405	5.11260
AllLeqC	71	58.53	63.82	61.2880	.3162	2.66407
D1t7LeqC	51	58.08	64.34	60.2355	.3611	2.57905
D1wLeqC	69	56.90	37357.00	1142.6266	758.7595	6302.730
D2wLeqC	48	57.00	70.57	61.7967	.6136	4.25091
S1wLeqC	41	55.00	69.18	59.7527	.5026	3.21828
S2wLeqC	41	46.65	69.10	60.1505	.6176	3.95484
Valid N (listwise)	2					

a. Type of vessel = Passanger

c. Fast ferry

Descriptive Statistics[a]

	N	Minimum	Maximum	Mean		Std.
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic
Ac1LeqB	52	42.60	68.20	63.4962	.4638	3.34459
Ac2LeqB	50	59.80	68.10	63.6860	.2506	1.77224
Ac3LeqB	39	61.70	68.00	64.9308	.3508	2.19103
Ac4LeqB	37	61.50	68.10	64.6541	.3429	2.08588
AllLeqB	55	63.19	63.19	63.1913	.0000	.00000
D1t7LeqB	38	61.69	64.39	63.0579	.1213	.74765
D1wLeqB	50	57.85	69.57	62.8332	.3176	2.24608
D2wLeqB	39	69.29	93.70	77.6510	1.0187	6.36170
S1wLeqB	0					
S2wLeqB	0					
Ac1LeqC	51	66.40	75.20	70.9824	.2371	1.69301
Ac2LeqC	50	65.50	72.80	70.6200	.2140	1.51348
Ac3LeqC	38	65.10	74.30	70.3184	.3340	2.05871
Ac4LeqC	37	68.50	75.10	71.3730	.2459	1.49604
AllLeqC	55	69.95	69.95	69.9459	.0000	.00000
D1t7LeqC	38	69.29	71.06	70.0206	.0632	.38950
D1wLeqC	50	66.40	72.47	70.0175	.1971	1.39398
D2wLeqC	39	66.81	72.63	70.1831	.2429	1.51667
S1wLeqC	0					
S2wLeqC	0					
Valid N (listwise)	0					

a. Type of vessel = Fast ferry

3. NOISE – SEL (maximun noise exposure)
a. Tanlers

Descriptive Statistics[a]

	N	Minimum	Maximum	Mean		Std.
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic
Ac1SELB	17	95.60	111.20	101.8941	1.2750	5.25708
Ac2SELB	17	95.60	111.70	102.6294	1.1529	4.75365
Ac3SELB	15	66.60	111.50	101.4867	2.6705	10.34297
Ac4SELB	15	96.00	111.80	103.1800	1.3221	5.12044
AllSELB	17	98.73	106.09	101.7590	.9053	3.73281
D1t7SELB	15	97.88	106.29	101.8268	1.0107	3.91433
D1wSELB	17	99.45	104.44	101.4188	.4283	1.76585
D2wSELB	15	96.44	111.35	103.4092	1.4024	5.43143
S1wSELB	17	97.34	109.02	102.2363	1.1441	4.71718
S2wSELB	14	93.43	113.02	102.2686	1.4959	5.59710
Ac1SELC	16	91.50	110.60	102.6000	1.4126	5.65025
Ac2SELC	16	94.50	111.50	101.5438	1.2896	5.15855
Ac3SELC	15	94.40	111.20	103.7133	1.3839	5.35975
Ac4SELC	15	99.20	109.50	102.1867	.9345	3.61917
AllSELC	17	99.70	103.88	101.4243	.5142	2.12021
D1t7SELC	15	99.53	103.67	101.3212	.4998	1.93563
D1wSELC	17	94.50	105.07	100.5007	.5672	2.33858
D2wSELC	15	96.10	109.22	102.4054	.9505	3.68117
S1wSELC	17	99.13	109.20	103.2114	1.0331	4.25955
S2wSELC	14	94.44	109.82	103.0396	1.2204	4.56633
Valid N (listwise)	12					

a. Type of vessel = Tankers

b. Passenger ferries

Descriptive Statistics[a]

	N	Minimum	Maximum	Mean		Std.
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic
Ac1SELB	71	93.40	109.60	101.1986	.4424	3.72756
Ac2SELB	69	92.60	106.90	99.5449	.5399	4.48463
Ac3SELB	52	96.00	112.20	101.5635	.5084	3.66590
Ac4SELB	49	93.20	112.20	100.1612	.6351	4.44568
AllSELB	71	98.41	103.72	101.1784	.3167	2.66819
D1t7SELB	52	97.63	103.94	100.3889	.3394	2.44745
D1wSELB	69	95.52	107.07	101.1883	.4382	3.63978
D2wSELB	48	96.92	105.40	101.8696	.3357	2.32567
S1wSELB	56	93.45	107.15	100.5985	.5046	3.77603
S2wSELB	44	95.07	105.72	100.6658	.4217	2.79753
Ac1SELC	30	90.60	106.00	98.0200	.8262	4.52529
Ac2SELC	32	90.50	107.20	98.9406	.7993	4.52177
Ac3SELC	23	90.70	112.90	99.4565	1.4405	6.90822
Ac4SELC	37	91.00	114.20	98.9000	.8415	5.11838
AllSELC	71	94.08	99.57	96.9433	.3278	2.76219
D1t7SELC	51	93.63	99.91	95.8318	.3703	2.64421
D1wSELC	69	60.73	104.27	96.1160	.8297	6.89185
D2wSELC	48	92.55	106.13	97.8070	.6777	4.69502
S1wSELC	41	90.50	104.72	95.3038	.5029	3.22028
S2wSELC	41	90.70	104.67	96.0250	.5201	3.33003
Valid N (listwise)	1					

a. Type of vessel = Passanger

c. Fast ferry

Descriptive Statistics[a]

	N	Minimum	Maximum	Mean		Std.
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic
Ac1SELB	54	95.60	103.70	99.3611	.2166	1.59142
Ac2SELB	50	95.40	103.60	99.2580	.2507	1.77305
Ac3SELB	39	97.30	103.50	100.4769	.3487	2.17769
Ac4SELB	37	97.10	103.60	100.2000	.3398	2.06707
AllSELB	55	98.59	98.59	98.5908	.0000	.00000
D1t7SELB	38	97.49	99.93	98.7096	.1132	.69804
D1wSELB	50	95.08	103.30	99.0137	.2288	1.61764
D2wSELB	39	95.84	104.86	100.0361	.3697	2.30864
S1wSELB	0					
S2wSELB	0					
Ac1SELC	51	101.20	110.70	106.4431	.2549	1.82069
Ac2SELC	50	101.00	108.30	106.1780	.2141	1.51406
Ac3SELC	38	100.70	109.90	105.8868	.3328	2.05126
Ac4SELC	37	104.00	110.70	106.9568	.2483	1.51025
AllSELC	55	105.30	105.30	105.2969	.0000	.00000
D1t7SELC	38	104.83	106.61	105.2779	.0635	.39171
D1wSELC	50	101.20	108.03	105.4506	.2108	1.49081
D2wSELC	39	102.36	108.17	105.6662	.2493	1.55664
S1wSELC	0					
S2wSELC	0					
Valid N (listwise)	0					

a. Type of vessel = Fast ferry