seafarer FATIGUE where next?

a summary document based on recent research from the Centre for Occupational and Health Psychology, Cardiff University

Seafarer fatigue where next?

The content of this brochure is drawn primarily from **Adequate Manning and Seafarers' Fatigue: The International Perspective** by Professor Andy Smith, Centre for Occupational and Health Psychology, Cardiff University, 63 Park Place, Cardiff, CF10 3AS, commissioned by the International Transport Workers' Federation, ITF House, 49-60 Borough Road, London, SE1 1DR.

Photographs: Patrice Terraz and ITF

Fatigue in the frame again over bulker grounding

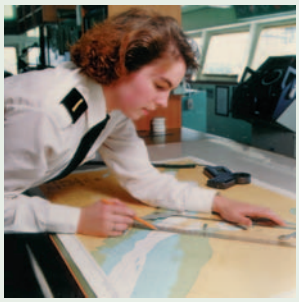
A fatigued master, alone and asleep on the bridge of his ship, caused the grounding of a British registered bulker in the Baltic Sea last October, a Marine Accident Investigation Branch report has concluded...

On a voyage from Hamburg to Klaipeda, the 2,777 dwt Lerrix was being monitored by Warnemunde VTS when it failed to alter course and despite efforts to contact the ship was seen to run aground. The master, who had permitted the look-out to leave the bridge, had fallen asleep in the pilot chair.The casualty is the latest in a consider-able list of incidents in which fatigue has played a major part...

Recommendations to the owners and UK Chamber of Shipping by MAIB included the need to impress upon owners, operators and managers the importance of fatigue related issues, safe lookout, the inappropriate use of personal electronic equipment and closer scrutiny of hours of rest worksheets.

Lloyd's List, Tuesday 18 April 2006

Introduction



Against a background of widespread concern amongst maritime regulators, responsible shipowners, P&I clubs, seafarers' welfare organisations and trade unions, two recent pieces of research from the same stable (Cardiff University, Centre for Occupational and Health Psychology) provide insights into different aspects of the problem of maritime fatigue.

A combination of minimal manning, sequences of rapid turn-arounds and short sea passages, adverse weather and traffic conditions, finds seafarers working long hours with insufficient opportunities for recuperative rest.

In these circumstances fatigue and reduced performance can lead to environmental damage, ill health and reduced lifespan among highly skilled seafarers who are in short supply. It is vital to take a holistic view of the effects of stress and health factors associated with long periods away from home, limited communication and consistently high workloads on seafarers. The issues of adequate crewing and the effect of fatigue upon health and safety are clearly closely related. It is also notable from the research that the cumulative effect of fatigue-inducing factors has an exponentially negative impact on the seafarers concerned.

A long history of research into working hours and conditions and their performance effects in process industries, road transport and civil aviation, where safety is a primary concern, can be usefully compared to the situation in commercial shipping. Because prevention and management of fatigue are more advanced in these other sectors, it should be possible to "fast-track" the approach to maritime fatigue. The extensive research and evidence base from other industries can be extrapolated to apply to seafarers' fatigue.

Given the evident presence of risk factors for fatigue in the maritime environment, and the absence of mitigating factors, it seems likely that the prevalence of fatigue would be significantly higher than in the general working population. (Fatigue in the general working population has been estimated to be as high as 22%)

Adequate Manning and Seafarers' Fatigue: The International Perspective

Whilst it is acknowledged that manning is not the only significant factor underlying the causes of and possible solutions to maritime fatigue, a good start to the process would be a review of the procedures to determine minimum levels of safe manning. Greater transparency is needed over the ways in which a minimum safe manning figure is arrived at. The methodology should, amongst other considerations, identify the level of redundancy and recovery time for crew. It should further allow for necessary maintenance activities on board, and should acknowledge any additional tasks required by the ISPS Code.

According to the current provisions in STCW, it is acceptable for a seafarer to work for 98 hours a week. This can be compared with 72 hours per week in ILO 180 and 48 hours per week in the European Working Time Directive.

Case Study from the Chemical Trade

V/1 loaded from Malaysian and Indonesian ports arrived Europe with heated cargo of different grades of palm oil in winters. En-route passage nothing much except Suez transit and heating of cargo. Total passage to N. Europe is about 25 days. After coming along side v/l will be discharging 4 parcels along side and 4 parcels to coasters. Head office kept well informed about berths and coaster arrival schedules. Coasters are arranged by owners and as per instructions received should not have any delay when coming alongside for loading. Boarding supervisor on board to monitor cargo operations and tank cleaning. Any slackness on part of crew is added as remarks in report. Total crew on board includes Chief Officer, 2 duty officers, 3 ABs, 1 OS, Pump man, Boson and two cadets. Due to hectic schedule and freezing nature of cargo chief officer is all the time in CCR to monitor cargo operations. Duty officers are continuously on six on six off. Crew are distributed as follows: 06:00 - 12:00, 18:00 - 24:00 - Pumpman, AB1, AB2, Cadet; 12:00 - 18:00, 00:00 - 06:00 - Boson, AB3, OS, Cadet

Except for fatty acids all cargoes require squeezing while stripping. This requires crew to go inside hot tanks and do manual squeezing. Coils are hot and tanks are slippery. Any delay in squeezing can freeze cargo at bottom and this can lead to ROB or delay by several hours in discharge of cargoes.

From each watch pump man and 1 cadet stay on top for operations and crew go inside for squeezing. But with only 2 crewmembers it is not possible to complete squeezing. View this all crew members (including off watch are called for squeezing tanks). It is important to give gap in stripping of tanks however at times gap can't be more then 15mins and immediately on completion crew has to enter into another tanks. Work load increases in case cargo stops going due to freezing when level of cargoes goes below heating coils.

On completion of discharge v/l to proceed to North Sea for tank cleaning. Next cargo is chemicals including some fine chemicals like Paraxylene, MEK, Acetone, Iso-Butane etc. Loading to take place in 3 consecutive ports.

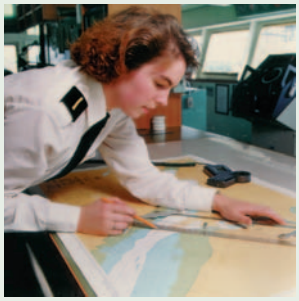
Time allocated for cleaning of 28 tanks is 4 days. To wash tanks with hot water followed by detergent and finally rinsing. Duty officer can't participate in tank cleaning view they are doing navigational watches. Chief Officer after completion of discharge is busy with tank cleaning schedule. Almost 3 days go in washing tanks and one day to prepare tanks for loading. Once about to complete you plan to return back for loading to avoid any delays. Tank cleaning involves manual cleaning after initial pre wash to remove traces of last cargo. Sometimes acid tanks need re-cleaning if not properly cleaned.

Once again prior to arrival you will receive schedule of berth rotation and coasters in first loading port. Immediately on arrival Surveyors come on first berth to take wall wash tanks to avoid delays at other berths. This shifting on berth and loading takes about 3 days in port. After loading v/l to proceed to two other nearby loading ports. After first port, pressure reduces as number of tanks to be loaded reduces. Total Discharge-Tank Cleaning and back loading takes about 12 days.

So in all, those 12 days of tank cleaning and back loading is full of work with no proper rest! Rest hours violation becomes common. With so much work in hand one has to worry about tank passing by surveyors and reports given by the boarding supervisor!! On chemical tanker additional duty officer should be a must, who can assist chief officer in tank cleaning operations.

Nautical Institute Fatigue Forum Report, 06/001

The research



The results of a 6 year research programme into seafarer fatigue, **Seafarer Fatigue: The Cardiff Research Programme** were published in November 2006.

Adequate Crewing and Seafarer Fatigue: The International Perspective has just been released.

The first of these reports, supported by the UK Maritime and Coastguard Agency, the Health and Safety Executive, Nautilus UK and the Seafarers' Research Centre, Cardiff seeks to predict worst-case scenarios for fatigue, health and injury; to develop best practice recommendations appropriate to ship type and trade and to produce advice packages for seafarers, regulators and policy makers.

The research took the form of a literature review, a survey of 1,856 seafarers, diary studies and objective testing on board.

In addition to the clear confirmation that fatigue is a very real problem at sea, the studies also exposed a tendency of many seafarers to under-record their working hours.

The 1989 grounding of the Exxon Valdez caused the release of 11.2 million gallons of crude oil. It was a true environmental disaster, the world's worst ever oil spill. The US National Transportation Safety Board later determined that the probable causes included "the failure of the third mate to properly manoeuvre the vessel because of fatigue and excessive workload" and "the failure of the Exxon shipping company to provide a fit master and a rested and sufficient crew for the Exxon Valdez".

Major findings:

- One in four seafarers said they had fallen asleep while on watch
- Almost 50% of seafarers taking part in the study reported working weeks of 85 hours or more
- Around half said their working hours had increased over the past 10 years, despite new regulations intended to combat fatigue
- Almost 50% of seafarers taking part in the study consider their working hours present a danger to their personal safety
- Some 37% said their working hours sometimes posed a danger to the safe operations of their ship

Many reported that they had worked to the point of collapse and fallen asleep at the wheel and over half of the sample believed that their personal safety was at risk because of fatigue.

Seafarer Fatigue: The Cardiff Research Programme

High potential for fatigue in seafarers

Complementing the aims of the earlier research, the newly published study, Adequate Crewing and Seafarers' Fatigue: The International Perspective broadens the perspective by considering international findings and looking at comparable industries and their approach to the problem. Amongst other things, the study concludes that there is overwhelming evidence of the existence of maritime fatigue even though the industry has been reluctant to invest resources into monitoring or preventing it.

The potential for fatigue amongst seafarers is high. The causes are well established in onshore jobs and many of the known risk factors are present offshore. In addition to the fatigue-inducing conditions present in other jobs, seafarers are exposed to specific problems that add to the risk of fatigue. Also, the workload of seafarers has greatly increased because of reduced manning levels, increased paperwork, faster port turnarounds and other pressures which reflect current economic demands. It is this combination of circumstances that leads to the high potential for fatigue in seafarers.

A typical example of watchkeeper fatigue occurred at 05:15 on a June morning when a 1,990gt general cargo vessel ran aground on the west coast of Scotland. The chief officer had been on watch since midnight and was suffering the cumulative effects of fatigue generated by the 6 on 6 off watchkeeping routine punctuated by regular port visits where he was expected to oversee all cargo operations. The chief officer fell asleep standing at the controls between 04:05 and 04:15 and missed a planned alteration of course. He woke an hour later, still standing, as the vessel grounded.

MAIB Bridge Watchkeeping and Safety Study, 2004

Fatigue vs. Alcohol

Studies show that there are comparable effects between fatigue and alcohol intake on a persons ability to function. Guidance in the STCW Convention (Section B-VIII/2 part 5 – annex 5) prescribes a maximum of 0.08% blood alcohol level during watchkeeping and prohibits the consumption of alcohol 4 hours before a watch. A number of States are planning initiatives to further limit alcohol intake on board and many shipowners already operate vessels with total bans. Curiously, although studies have established that fatigue is prevalent at sea and that its effects are in fact worse than those caused by alcohol, there would appear to be much less enthusiasm within the industry for addressing the problem of fatigue.

Fatigue, Alcohol and Performance Impairment

Reduced opportunity for sleep and reduced sleep quality are frequently related to accidents involving shift-workers. Poor-quality sleep and inadequate recovery leads to increased fatigue, decreased alertness and impaired performance in a variety of cognitive psychomotor tests. However, the risks associated with fatigue are not well quantified. Here we equate the performance impairment caused by fatigue with that due to alcohol intoxication, and show that moderate levels of fatigue produce higher levels of impairment than the proscribed level of alcohol intoxication.

Forty subjects participated in two counterbalanced experiments. In one they were kept awake for 28 hours (from 8:00 until 12:00 the following day), and in the other they were asked to consume 10-15g alcohol at 30-min intervals from 8:00 until their mean blood alcohol concentration reached 0.10%. We measured cognitive psychomotor performance at half-hourly intervals using a computer-administered test of hand-eye coordination (an unpredictable tracking task). Results are expressed as a percentage of performance at the start of the session.

Performance decreased significantly in both conditions. Between the tenth and twenty-sixth hours of wakefulness, mean relative performance on the tracking task decreased by 0.74% per hour. Regression analysis in the sustained wakefulness condition revealed a linear correlation between mean relative performance and hours of wakefulness that accounted for roughly 90% of the variance.

Regression analysis in the alcohol condition indicated a significant linear correlation between subject's mean blood alcohol concentration and mean relative performance that accounted for roughly 70% of the variance. For each 0.01% increase in blood alcohol, performance decreased by 1.16%. Thus, at a mean blood alcohol concentration of 0.10%, mean relative performance on the tracking task decreased, on average by 11.6%.

Equating the two rates at which performance declined (percentage decline per hour of wakefulness and percentage decline with change in blood alcohol concentration), we calculated that the performance decrement for each hour of wakefulness between 10 and 26 hours was equivalent to the performance decrement observed with a 0.004% rise in blood alcohol concentration. Therefore, after 17 hours of sustained wakefulness (3:00) cognitive psychomotor performance decreased to a level equivalent to the performance impairment observed at a blood alcohol concentration of 0.05%. This is the proscribed level of alcohol intoxication in many western industrialized countries. After 24 hours of sustained wakefulness (8:00) cognitive psychomotor performance decreased to a level equivalent to the performance deficit observed at a blood alcohol concentration of roughly 0.10%.

Plotting mean relative performance and blood alcohol concentration 'equivalent' against hours of wakefulness, it is clear that the effects of moderate sleep loss on performance are similar to moderate alcohol intoxication. As about 50% of shift-workers do not sleep on the day before the first night-shift, and levels of fatigue on subsequent night-shifts can be even higher, our data indicate that the performance impairment associated with shift-work could be even greater than reported here.

Nature, Volume 388, July-August 1997

Strong association between fatigue and accidents

Accident statistics show a strong association with factors that increase the risk of fatigue, such as under manning and long working hours. Objective measures of performance efficiency are also influenced by fatigue and this suggests that it is not just watch-keepers who are likely to be affected but other members of the crew as well. Fatigue increases human error which not only increases the risk of collisions or groundings but also increases the risk of personal injury and injury to others. A recent MAIB report of an accident in which an A/B tragically died determined that the seafarer was crushed due to unsafe equipment design, lack of appropriate training and insufficient maintenance. However, the comments regarding manning levels and hours of rest make for interesting reading:

Complement
Neermoor had a total crew of six, comprising master, mate, chief engineer, two AB deckhands and an OS/cook. At sea, the master and mate worked 6 on/6 off navigational watches, with the master keeping the 6 - 12 watches and the mate the 12 - 6 watches. The two ABs were employed on deck and as lookouts as required, assisted by the OS/cook when he was not busy with his catering duties. The chief engineer was solely responsible for the engine room and other technical issues.

The crew were all serving on short term renewable contracts, arranged through a third-party manning agency. This complement was in accordance with the minimum manning level specified in the vessel's MSMC. However, the ship had previously operated with a crew of 7…

Hours of rest records
Although hours of rest records were kept on board Neermoor, the records for the week preceding the accident were not available at the time of the accident, and they have not since been produced. While full details of crew hours just before the accident are not available, conclusions have been drawn from logbook entries, voyage reports and other sources.

The master and mate, as the only two navigating officers on board, worked a 6-on/6-off watchkeeping routine while on passage. In addition, they were required to work standby periods for arrival and departure from port, as well as administrative/ship's business and cargo related duties while in port.

The crew had a similar workload, as shown by the narrative of this accident. After the short passage from Dordrecht to Southampton, they were required for arrival and then berthing duties. The logbook shows that a security watch, in accordance with the requirements of the ISPSC, was maintained during the time spent discharging in Southampton. Once they had completed their unberthing duties, the ABs were set to work cleaning the hold; this took most of the night and they were barely finished on arrival at Teignmouth.

from the MAIB investigation of the fatal accident due to collapse of a portable bulkhead onboard mv Neermoor at Teignmouth, UK on 27 April 2006

Fatigue was clearly established as the principal causal factor in the case of an 80m long bulk carrier, which ran aground on rocks in the Western Islands of Scotland at 01:50 on an October morning. The vessel only had two watchkeeping officers including the master. Towards the end of his 18:00 to 24:00 watch, the master left the bridge and called the chief officer to relieve him. He returned to the bridge, plotted a position on the chart and sat in the wheelhouse chair to await the arrival of his relief. He fell asleep, and the chief officer remained asleep in his cabin. They both woke up as the vessel grounded. There had been no watch alarm fitted to the vessel and there had been no seaman on lookout duty.

In the previous 4 days, the master and the chief officer's workload had been arduous (Table 1) and they had not achieved more than 6 hours off duty at any one time. The quality of sleep during some of their rest periods had also been poor because of the uncomfortable movement of the ship in a sea-way. In port, their off-duty periods had been disrupted by the need to shift berths because of cargo loading requirements, and at sea the pressures of paperwork and meal times affected their ability to rest.

MAIB Bridge Watchkeeping and Safety Study, 2004

Increased health risk to seafarers

Fatigue increases the risk of mental health problems (depression, anxiety, sleep disorders) and these not only reduce quality of life but also increase the risk of chronic disease and possibly death. Suicide can be the result of psychopathology and there have been suggestions that the current working conditions of seafarers, especially under-manning, have increased the risk of self-harm.

Cabin fever: a growing cause for concern

In recent years the Association has noted an increase in incidents involving crew members who appear to be suffering from some form of psychological difficulty. This can range from mild anxiety attacks to aggressive behaviour to fellow crewmembers, including extreme physical violence. More tragically it can lead to suicide.

It is not clear what the main causes are, but a possible factor is the length of time spent away from home and sometimes an inability to get relieved from a ship. At the same time, there may be family pressure to remain at sea longer in order to earn more money and continue sending funds home.

In the modern world of shipping, turnaround times in port are also much quicker, creating more work for both officers and crew and less opportunity to relax, resulting in fatigue and stress…

North of England P&I Club, Signals Issue: 64 July 2006

Inadequate regulation

Given the scale of seafarers' fatigue it is perhaps surprising that little improvement in the situation has occurred in recent years. There have been some attempts to prevent or manage fatigue by legislation and guidance. One problem with these approaches is that there has been little attempt to evaluate their efficacy. Reports from different sectors and different members of the industry all show that these approaches have largely failed. Indeed, it could be argued that they may actually have made the situation worse and prevented easier detection of the levels of fatigue current in the industry.

A major problem is that although the guidance exists, there is extensive evidence to show that it is frequently ignored. Much greater emphasis needs to be placed on enforcement of the provisions within IMO Resolution A890. As stated in a UK report from 1994 (Safer Ships, Cleaner Seas report of Lord Donaldson's inquiry into the prevention of pollution from merchant shipping), too much is open to interpretation by the Flag State and is subject to competitive pressure. The need for a level playing field is paramount as is a more tangible link to a mandatory instrument such as the ISM Code.

Safer ships, cleaner seas

A more fundamental problem is that the international standards of manning may be too low in some cases: in particular some aspects of the manning standards are open to national interpretation leading to variations o actual levels. Consistency is extremely important. There are strong commercial pressures on manning levels: too small a crew is not only dangerous, but also represents unfair competition. If consistency is not achieved, the concept of safe manning will inevitably be weakened…

Report of Lord Donaldson's inquiry into the prevention of pollution from merchant shipping, London: HMSO, 1994

Conclusions

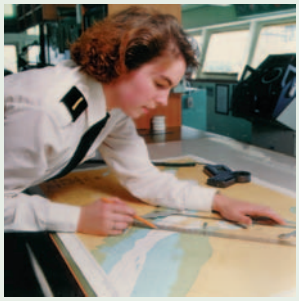
Industry and its regulators must acknowledge the serious risks and consequences inherent in allowing vessels to be manned by fatigued seafarers. These include:

- Potential for more environmental disasters
- Economic losses due to fines for accidents and/or increased insurance premiums
- Serious health implications for seafarers

The samples studied in the reports often reflect the better end of the industry and it is quite possible that the situation is far worse than described. What are well established are the methods for assessing risk factors for fatigue, perceived fatigue and the consequences of fatigue. It is also important to take a holistic view of fatigue and address issues that have received no attention as yet. For example, it is probably the case that fatigue-inducing working conditions lead to many young seafarers leaving the industry at an early stage. Similarly, the relatively short careers of many seafarers may reflect a reduced ability to cope with fatigue later in their career. Longitudinal studies are necessary to confirm these speculations. Such studies could also inform about links between fatigue, chronic disease and mortality.

Seafarers' fatigue is an occupational health and safety issue that is common and widespread. It is not being adequately dealt with by current legislation, management or working practices and there is an urgent need to rectify the situation.

The way forward



Treat fatigue as a serious health and safety issue

A large proportion of work-related death, injury and ill-health amongst seafarers arises from failure to manage health and safety effectively. This failure is exacerbated by changes that have taken place in the structure and organisation of the industry internationally over the last quarter of a century that both increase risks to health and safety and make prevention of harm to workers more difficult to regulate or manage. Industry wide, cultural change is needed to address fatigue. There are serious risks and consequences associated with fatigued seafarers such as the potential for more environmental disasters and loss of life, the economic losses due to accidents, and the impact on the health and well being of the seafarers. The first stage of dealing with fatigue is to get the relevant people to acknowledge that there is a problem to address.

A more robust approach to regulation and manning

A starting point for improving the situation must be a more robust approach to regulation. It is important to ensure that potential fatigue is taken into account when setting appropriate manning levels. Manning levels need to be addressed in a realistic way that prevents economic advantage accruing to those who operate with bare minimums. Such an approach must consider more than the minimum levels necessary to operate a vessel; rather it must address the need for maintenance, recovery time, redundancy, and the additional burden of the paperwork and drills associated with security and environmental issues. More transparent regulatory models need to be developed to allow such an approach.

Enforcement of existing legislation, elimination of false record-keeping, and better training and guidance

It is essential that existing guidelines are enforced with mandatory provisions and that effective measures are taken to overcome the problem of false record-keeping. One possibility could be to link the guidance in IMO A890 to the ISM Code. This must be supplemented with a serious attempt to promote a culture of safety on board ships. As long as seafarers feel compelled to falsify records of their hours of work, the problem will be hard to address.

Appropriate training and guidance regarding avoidance of fatigue and optimum working conditions is needed. Lessons can be learned from other transport industries and it is important to seek examples of best practice and apply these in an effective way to the maritime sector. One of these is to seek the involvement of all stakeholders in developing solutions to the problem.

Methods of addressing issues specific to seafaring are now quite advanced and a holistic approach to the issue of fatigue can lead to a culture that benefits the industry as a whole. If nothing is done now, the maritime industry may find itself compelled to respond to external drivers such as the environmental lobby or those pushing the security agenda.

Learn from best practice in the maritime sector and in other comparable industries

It is important to learn by example and adopt those strategies that will lead to a culture of "best practice" and an elimination of "worst case scenarios". This approach will require the collaborative efforts of all stakeholders and good models of such teams (the work force, owners, regulators, and academics) have been developed in other areas of transport.

For more detailed information on the outcomes of the recent research quoted in this document see:

Smith, A., Adequate Manning and Seafarers' Fatigue: The International Perspective January 2007

Smith, A., Allen, P., Wadsworth, E., Seafarer Fatigue: The Cardiff Research Programme November 2006

For more details of fatigue related accident reports see:

MAIB Bridge Watchkeeping Safety Study July 2004
and www.maib.gov.uk

international transport
workers' federation

Tel: +44 20 7403 2733
Fax: +44 20 7357 7871
Email: mail@itf.org.uk

ISBN: 1-904676-22-7

www.itfglobal.org