Fatigue and jet lag

In search of sound sleep

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In 1996, I served as second officer on a container vessel that traded between the USA and the Far East, crossing the North Pacific Ocean at about 21-22 knots. I personally experienced the danger of crossing the time zones fairly quickly without allowing enough time for the body to adjust to the new time zone cues. One night while I was on watch (midnight to 0400), I found I was experiencing mounting difficulty rising to near inability to keep my eyes open. Although I forced myself to stay awake, I was totally useless in terms of decision-making.

This state of fatigue came after crossing the Pacific a couple of times and it is something that can be experienced by anybody who regularly crosses the oceans on fast ships.

I found some free time, after completing a degree on shipping operations, so I worked on this issue and wrote this article. I hope it will help towards understanding fatigue and jet lag suffered by seafarers.

Recently, emphasis has been placed on the examination of fatigue as a contributory factor to accidents and incidents at sea. Although a link between fatigue and accidents has been established in other areas of the transport industry, ?it is still under research in the maritime industry? Apparently, accident investigators are hesitant to report the contribution of fatigue to an accident without clear evidence. However, fatigue is very difficult to prove, as there is no accepted objective test for it.

The IMO Marine Safety Committee (MSC) circular 1014 identifies four general factors which contribute to seafarers' fatigue: crew-specific; management (ashore and aboard ship); ship-specific; and environment.

This article briefly discusses some of the crew-specific factors including circadian rhythms, jet lag, quality and quantity of sleep, shiftwork and work schedules.

Jet lag

Jet lag is a well-known phenomenon among air travellers: it is a physical response to an abrupt change in time zones. Everybody has peaks and low points during the 24-hour biological body clock known as the circadian rhythm. There are two periods of low alertness (low points) in each 24-hour time frame and they commonly occur between 3-5am and 3-5pm. These lowest alertness periods are followed by maximum alertness periods (peaks).

The body clock is a tiny cluster of nerve cells in the centre of the brain which relies on sunlight to keep it synchronised with planetary time. It releases appropriate hormones at the correct time of the day to keep you 'alert' in the daytime and 'sleepy' at night. Body rhythms can become out of kilter because of travel across multiple time zones and shift work schedules. It usually takes one day for every time zone crossed for the body to adjust to the new cues. The body is in a state of disrupted rhythm, until it catches up.

During this period, you may suffer some of these symptoms:

- Inability to sleep at night (insomnia)
- Urge to sleep at inappropriate times
- General lethargy and fatigue, lasting days after the trip
- Lack of concentration
- Decreased judgement, decision making and memory
- Slowed reflexes
- Fixation
- Gastrointestinal problems
- Irritability

In the early days of sail, seafarers suffered no such ill effects as they took months to cross the oceans. Their bodies had enough time to adjust to the cues of new time zones. However, a modern container vessel can travel from San Francisco to Yokohama in about nine days and from the UK to New York within about five-and-a-half days. In the first case, the time difference between San Francisco and Yokohama is seven hours. The time difference between the UK and New York is five hours. This means that the seafarers who travel on the first vessel have to retard their ship's clocks by seven hours in nine days. Some masters do not like to change clocks on the day of departure or arrival: in that case, they have to adjust their clocks by seven hours in seven days. In the same way, ship's clocks have to be adjusted by five hours in about four-and-a-half days when crossing the Atlantic.

In both the above voyages, the ship's clocks have to be adjusted by one hour each day while at sea. This suggests that they have just enough time for the body to adjust to the new cues in the new time zone, as generally it takes one day for every time zone crossed. Although it was not a significant threat to seafarers on slow-speed vessels, it is time to be concerned about the effect of disrupted rhythm on personal fatigue, especially on fast, ocean-crossing, ships.

Quality and quantity

The only cure for fatigue is to get effective sleep when the body needs it. However, all sleep does not have the same quality and does not provide the same effectiveness. According to the IMO's MSC circulation 1014, effective sleep has three main characteristics: duration; continuity; and quality.

It is of vital importance to consider the duration of sleep that each person gets before their watch, as alertness and performance are directly related to sleep. The MSC circular suggests that a person should have seven to eight hours sleep per 24 hour day on average in order to maintain or restore performance levels.

(Of course, seven one-hour naps do not have the same effectiveness as one seven-hour period of sleep).

It is impossible to force someone to sleep if his or her body is not ready for it. An individual has to obey the biological clock and synchronise with circadian rhythms to obtain a quality sleep. Sleeping at a time when the body is out of synchronisation is a time-consuming and tiring effort.

Shiftwork

Much research has been done in the area of sleep patterns/quality of sleep of shift workers in sectors like aviation, long-haul trucking, hospital workers, police and nuclear submariners. However only a few establishments such as the Seafarers International Research Centre (SIRC) in Cardiff, the Australian Maritime Safety Authority (AMSA) in Australia and the US Naval Health Research Centre, have researched into watch patterns on board ships and their contribution to crew fatigue.

The traditional pattern of watchkeeping (four on and eight off) makes no apparent contribution to fatigue. However, the reduction of manning levels and shorter ocean crossing time due to increased speed have caused onboard watch schedules to be re-assessed. The effects of disruption to the body's rhythms become more apparent in the deep-sea shipping sector. The alertness and efficiency of watch-keeping officers can be degraded when the watch pattern rotates and jet lag takes effect. Can the watch officers get effective sleep, when the sleeping times change daily to synchronise with on board time adjustments due to time zone crossing?

The hypothetical example in Table 1, below, illustrates the changing sleep pattern of a watch officer when crossing the Pacific Ocean within nine days.

It is apparent that the watch officer is having six hours continuous sleep. However, he delays the starting time of sleep on his body clock while advancing the ship's clock (assuming the body clock is not adjusting at a rate of one hour per day). This suggests that the watch officer never has the recommended seven to eight hours continuous sleep. Sanquist et al in the *Journal of Sleep Research* (1997), state that watchkeepers on the four on/eight off watch schedule in fact obtained less than four hours sleep in a 24 hour period for just over 22 per cent of their time at sea.

Combating fatigue

It is worth examining how jet lag and other forms of fatigue are combated in other modes of transport. The most vulnerable employees are flight crewmembers. The regulations that cover flight times and rest periods of pilots and crewmembers have been in place since the 1940s. The Federal Aviation Regulations (FARs) limit domestic flying operations to 30 hours in any seven consecutive days. Furthermore, regulations impose an eight hour limit for pilot's flight time during a 24 hour period, providing at least eight continuous hours of rest during the 24 hour period. According to FARs, each crewmember is required to be given a minimum of 24 consecutive hours of rest in each week. The FAA recommends seven to eight hours of sleep in the rest period for pilots.

The NASA Ames Research Centre has a pilot fatigue countermeasures programmes of preventative and operational strategies to combat fatigue. According to the NASA safety board; 'Preventative strategies focus on the underlying physiology by attempting to manage and maximise sleep and promote circadian adaptation. Operational strategies are in-flight measures that help to maintain alertness and performance.'

Long-haul cross-country truck drivers may be the next group of victims who have to combat fatigue due to disruptions to the body clock and which directly cause fatal accidents. They have to cope with time zone changes, which affect sleep patterns. The US National Transport Safety Board (NTSB) reported 3,783 heavy-truck related fatalities in 1993 and the significant role of fatigue in such accidents. The NTSB conducted a safety study in January 1995 to identify the factors that affect driver fatigue in heavy-truck accidents.

Fatigue countermeasures

The IMO and International Labour Organisation have adapted conventions in relation to minimum rest periods for watchkeepers and hours of work in shipping. The IMO convention provides a daily rest period of 10 hours per 24 hours, which can be divided into no more than two periods, including one period of at least six continuous hours. The ILO convention provides maximum working hours of 14 hours per day or a minimum rest period of 10 hours per day. These two conventions could be regarded as the first line of defence against crew fatigue. However, it is no secret that some unscrupulous owners/operators instruct masters to forge the entries in work/rest logbooks, where most port state control inspectors give will look.

These conventions have undoubtedly made life on board much more comfortable than before. However, neither concerns the sleep duration before the watch periods. The regulations are complied with once the watch officers have been given six hours' continuous rest in a 24 hour period, although that may not provide adequate and quality sleep. The most sleep somebody can get within a six hour period would be four to five hours, which is not sufficient to recover alertness. Therefore it

Days	Working hours	OT/ Paperwork etc.	Rest hours	Sleep hours	Time change
1st day	0000-0400 1200-1600	1600-1800	1800-2100	0500-1100 2100-2345	No change
2nd day	2400-0300 1100-1500	1500-1700	1700-2000	0400-1000 2000-2245	1hr adv
3rd day	2300-0200 1000-1400	1400-1600	1600-1900	0300-0900 1900-2145	1hr adv
4th day	2200-0100 0900-1300	1300-1500	1500-1800	0200-0800 1800-2045	1hr adv
5th day	2100-2400 0800-1200	1200-1400	1400-1700	0100-0700 1700-1945	1hr adv
6th day	2000-2300 0700-1100	1100-1300	1300-1600	2400-0600 1600-1845	1hr adv
7th day	1900-2200 0600-1000	1000-1200	1200-1500	2300-0500 1500-1745	1hr adv
8th day	1800-2100 0500-0900	0900-1100	1100-1400	2200-0400 1400-1645	1hr adv
9th day	1800-2100 0500-0900	0900-1100	1100-1400	2200-0400 1400-1645	No change

▲ Table 1: Changing sleep patterns when crossing the Pacific: hypothetical example

is of vital importance to consider amending the conventions and include the minimum continuous sleeping hours per day with which all watch officers must be provided.

Developing good habits

Circular 1014 recommends various good sleep habits to be developed by seafarers but some of these general guidelines may not be practicable on some types of vessels. They include developing and following a pre-sleep routine to promote sleep at bedtime such as a warm shower, reading calming material; making the environment conducive to sleep; ensuring that you will have no interruptions during your extended period of sleep; and avoiding alcohol and caffeine prior to settling down to sleep.

However, the inexorable influence of environmental stressors including motion, noise, adverse weather conditions, confined living and working spaces and poor ventilation and lighting which can lead to poor health and sleep habits are unique factors to seafarers. Furthermore, research in relation to unmanned machinery space watch schedules have revealed that watch duty with automatic alarm systems can reduce sleep length, sleep quality and recuperation.

'Prophylactic napping' is one technique identified as a mitigation method of the effects of fatigue until the seafarer can get proper sleep. It is a nap of about 20 minutes which can help to maintain performance levels during a long period of wakefulness but cannot replace the necessity of continuous sleep period. It should be noted, though, that naps longer than 30 minutes will cause sleep inertia, where situational awareness is impaired for up to 20 minutes.

SIRC research results indicates that a single shift in every 24 hours is better than a split shift in respect of less sleep disturbances and longer sleep length. Furthermore, Beare et al reported to *Ergonomics* journal (1981) that a six on/12 off watch schedule on nuclear submarines resulted in less sleep fragmentation than the traditional four on/eight off one. The study done by Brown (1989) for the Shipping Policy Division of the UK Department of Transport into hours of work, fatigue and safety at sea, recommended eight hours' continuous shift, as practised by other industries. Furthermore, he suggested a minimum period of 10 consecutive hours for rest and sleep in every 24 hours. All these studies and researches suggest longer sleeping hours and a single shift watch pattern to provide quality sleep in order to combat fatigue and adjust to the new time zone cues.

My proposal

I would like to suggest an eight hours on and 16 hours off watch schedule for the deep-sea sector, assuming that three watch officers are serving on board. The 16 hour rest period will provide a maximum seven to eight hours' continuous sleep, which will be adequate to adjust the body into the new time zone cues. The long and continuous rest period will diminish the adverse effects of sleep disturbance and all other fatigue related problems.

I should be very interested to learn, through *Seaways*, about the experiences of deep-sea masters who are currently practising this watch schedule on their vessels. And I would welcome comments from masters practising different kinds of watch patterns on board their ships.

letters

Pilot fatigue

I am the captain of a 300,000 dwt VLCC. Earlier this year we were loading a parcel of approximately 2 million barrels of Nemba crude in West Africa.

When navigating within the oilfield, and approaching the berth (spm), I noticed that the pilot was dozing in his chair. I asked if everything was OK and if he would like to have a cup of coffee or something refreshing. Later the embarrassed pilot explained he had only had a few hours' rest in last three days, as the pilot office had been sending him from one ship to another. Pilots are also utilised for some maintenance work in the oilfield.

This makes me wonder if the law is the same for all of us, as we seafarers are under continuous surveillance by various authorities and they are watching our working hours like hawks. There is nothing wrong with that and I feel it would only be reasonable that pilotage authorities should follow the same guidelines, as fatigue is apparently the greatest human factor contributing to marine casualties.

As captain of my ship, I understand and accept the fact that the ultimate responsibility always lies with me, no matter if there is a pilot aboard or not, but when navigating in highly specialised areas, like oil fields with several underwater obstructions that only the pilot with special local knowledge is aware of, I would certainly appreciate if we would be guided by an adequately rested pilot.

Captain Jan Olsen, Oslo, Norway

Human resources

I am currently pursuing a postgraduate diploma in human resources management and the subject I have chosen for my project is: 'Marine crew fatigue, including stress management and problems arising due to long separation from families: role of HRD to find practical solutions'.

My aim is to analyse the present HR system and make proposals for future action in a more professional and pro-active manner. The objective is to assist in the development of safety culture by addressing issues such as fatigue, stress and family separation; to reduce marine casualties by working on the stress and fatigue factors; and to innovate a more logical and good HR policy designed specially for the maritime industry.

I should very much appreciate readers' views on the difference between HR policy for shore industry and marine industry. I am also trying to answer the following questions:

Why are stress level so high in the marine industry and what can be done to reduce them?