The Need to Incorporate Training in Fatigue Management Into the Provisions of STCW Convention

By
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الخلاصة

أصبح الإرهاق مشكلة تؤرق صناعة النقل البحري' حيث أثبت في الكثير من التحقيقات البحرية في الفترة الأخيرة إن الإرهاق كان السبب وراء الكثير من هذه الحوادث.

يحتاج القضاء علي ظاهرة الإرهاق استحداث نظام لإدارة الإرهاق علي متن السفن' وأيضا وضع معايير وبرامج تدريب للعاملين بقطاع النقل البحري من أطقم سفن ومشغلي الشركات الملاحية لطرق القضاء علي الإرهاق، ومن الأرجح إدماج هذه البرامج التدريبية مع المعايير والمتطلبات المعمول بها حاليا في قطاع التعليم والتدريب البحري.

تستعرض هذه الورقة المخاطر والعواقب التي قد تنجم عن الإرهاق علي متن السفن كما تستعرض بعض المقترحات للقضاء علي هذه الظاهرة.

1. Abstract

Fatigue became a serious concern for the shipping industry in the recent years. Accidents investigations reveal that fatigue was the reason of many of the maritime casualties.

Eliminating the risk of fatigue requires the setting of fatigue management system onboard ships, and establishing and incorporating fatigue management training into the current maritime education and training (MET) systems.

The present paper discuses the risk of fatigue and its consequences on the shipping industry, the paper also points out the fatigue risk factors and recommends measures on how to overcome the consequences of fatigue.

2. Introduction

Advances in shipboard technology, reduced manning level onboard ships, excessive workload, insufficient rest between work periods, lack and poor quality of sleep and short sea passages. In addition to the adverse weather conditions, noise and vibration, motion and traffic conditions, among many other reasons are behind the exposure of seafarers to the risk of fatigue.

International Maritime Organization (IMO) 'guidance in fatigue mitigation and management' defines fatigue as a state of feeling tired, weary, or sleepy that results from prolonged mental or physical work, extended periods of anxiety, exposure to harsh

environments, or loss of sleep. The result of fatigue is impaired performance and diminished alertness.

In 2006, The Marine Accident Investigation Branch **(**MAIB) illustrates that 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 (ITF, 2007). The author believes that, one of the most significant causes of fatigue is the reduced manning level, accordingly seafarers, particularly watch keepers, have to spend long hours on watches, in addition to the excessive work load outside the watchkeeping duties.

Adding an extra watch keeper or a crew member designated with administrative tasks may reduce the workload on the other seafarers and reduce their exposure to fatigue. Bowring (2004) points out that extra cost due to increased manning can be acceptable to the industry as long as all players in the open market are forced to face the same expense, thus leveling the field competitively.

In 2006, at least 8 out of 88 groundings in Norwegian waters were influenced by watch keepers falling asleep. According to data from the Norwegian Maritime Directorate, the rate of fatigue-related incidents does not appear to be declining (Kristian & Vilhelm, 2008).

3. Existence of fatigue in the shipping industry

In 1997 The International Transport Workers Federation (ITF) have published a report based on responses from 2,500 seafarers of 60 nationalities, serving under 63 flags. Almost two thirds of the respondents stated that their average working hours were more than 60 hours per week and 25% reporting working more than 80 hours a week (42% of masters) (Smith et al, 2006).

However, 36% of the sample was unable to regularly obtain 10 hours rest in every 24, and 18% regularly unable to obtain a minimum of 6 hours uninterrupted rest, as required by the International Convention on Standards of Training, Certification and Watchkeeping for seafarers (STCW). Long periods of continuous watch-keeping were also reported, with 17% stating that their watch regularly exceeded 12 hours. 55% of the sample considered that their working hours presented a danger to their personal health and safety.

Furthermore, Raby and McCallum (1997) study into working conditions that contributes to fatigue related incidents, they found that hours on duty prior to the casualty and hours worked in the 24, 48 and 72 hours preceding the casualty contributed to such incidents.

Collisions between ships at sea were more likely to occur during early morning hours with a peak between 0600 and 0700 as shown in figure (1). In fatigue related personal injury cases mariners had worked an average of 7.7 hours prior to the incident in comparison to 3.2 hours in non-fatigue related incidents. In the 24 hours preceding the fatigue related incident seafarers reported working an average of 14.3 hours, compared to 8.4 hours (Smith, 2007).

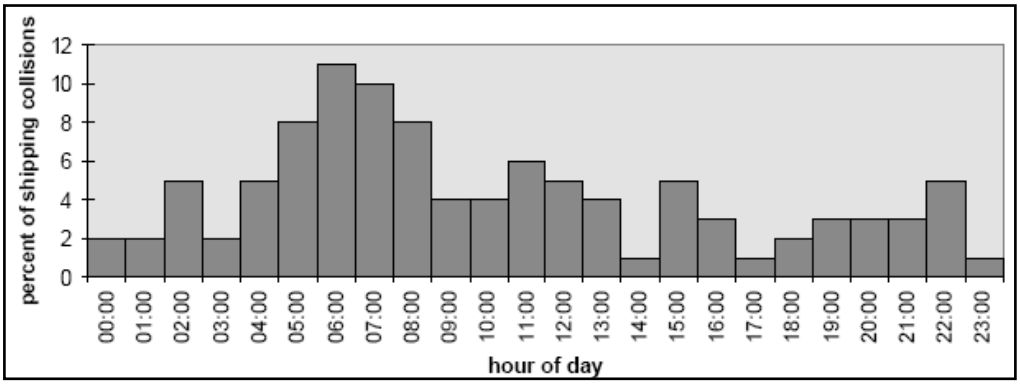

Figure (1): Incidence of Shipping Collisions at Each Hour of the Day
Source: Fatigue in ferry crews: A pilot study

Nevertheless, Roberts (2002) says, when compared with other British workers seafarers were found to be 26.2 times more likely to be involved in a fatal accident at work in the period between 1976 and 1995.

In the 10 years, 1994 to 2003 inclusive, 22 people have lost their life in 652 collisions and groundings were reported to the MAIB. There were also 995 near collisions reported during this time. MAIB bridge watchkeeping safety study (2004) reveals how a large number of the accidents were the result of watch systems with a 6-on/6-off schedule. The study concludes that the current provisions of STCW 95 convention in respect of safe manning, hours of work and lookout are not effective.

Additionally, in 2005, New Zealand Maritime Authority published a report. The report cited several studies that indicated (WMU, 2006):

- 25% of seafarers experienced fatigue on at least half their trips.
- 24% of seafarers saw others working fatigued on at least half their trips.

Fatigue among masters and mates working on the inter-island ferries were found to be at the following levels:

- 61% of officers often or always experienced fatigue when on duty.

- 50% of officers considered that fatigue often or always affected the performance of others on duty.
- 42% of officers could recall fatigue-related incidents or accidents on board, and 26% could recall such events in the last 6 months.

Furthermore, Cardiff university conducted a survey over 6 years of 1856 seafarers confirms that fatigue is a very real problem at sea, the study also exposed a tendency of many seafarers to under-record their working hours (Smith et al, 2006). The major findings of the research programme include:

- 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 the 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.

In addition, Smith (2007) wrote, given the evident presence of risk factors for fatigue in the maritime environment, and the absence of mitigating factors, it seems likely that the occurrence 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%.

Furthermore, a study on fatigue in the shipping industry was commissioned by the Dutch ministry of transport, public works and water management concludes that fatigue may be a causal factor in 11 to 23 percent of collisions and groundings (Houtman et al, 2005).

4. Risk factors for fatigue.

In order to set up a fatigue management system, plan or policy, it's very important to understand the specific risk factors for fatigue including:

4.1. Disruption of Energy Restoration:

Energy is a molecule, called adenosine tri-phosphate (ATP), found in all cells of the body. The level of energy produced is dependent on good nutrition, adequate hydration, oxygen, and sufficient sleep. Studies of brain function have shown that 7 to 8 hours of continuous sleep are necessary to restore energy supplies and for the human brain and the body to function well.

If the human body does not produce enough ATP, people think less clearly, become irritable, have problems communicating with others, experience fatigue throughout work and free time hours, become negative and less willing to resolve issues and problems and have less ability to fight disease.

4.2. Stress:

Chronic stress creates a constant drain on people's energy levels. Chronic stress is the type of stress induced in work environments, the three factors influence this type of stress are interpersonal relationships (lack of support from coworkers and supervisors), task design (heavy workload, infrequent rest periods, long work-hours, shift-work and hectic routine tasks), and management style (Lack of participation by workers in decision making, Poor communication between management and employees and Lack of family friendly policies).

When persons are under stress the adrenaline hormone will be released to provide the necessary energy to manage the stress, accordingly the amount of energy available to the individual will increase temporarily. This is a short-lived event; once energy is released it cannot be restored unless stress levels are reduced.

In a stressful work environment, crew members can be expected to have difficulty in enduring physical and mental challenges. They may experience frequent periods of reduced mental concentration and situational awareness (USCG, 2001).

4.3. Shift-workers and Disruption of Sleep:

The human brain requires 7 to 8 hours of continuous sleep every day to replenish mental and physiological resources. During sleep, the brain fluctuates among periods of light, deep, and dream sleep. These fluctuations are periodic, organized, and require approximately 90-120 minutes to complete each cycle.

The cycles are repeated during the night, any interruption of this process due to noise, bright lights, or movement, interrupts this sequence, causing the brain to spend more time in light sleep.

Sleep disruption reduces the effectiveness of energy restorative processes, as a result low mental and physical capability for the individual upon awakening. Nevertheless, reduced opportunity for sleep and reduced sleep quality are frequently related to accidents involving shift-workers (ITF, 2007).

4.4. Biological Clock and Disruption of Circadian Rhythms:

The biological clock is a physiological mechanism composed of neural networks and hormonal outputs that regulates the timing of sleep beginning and wake-up, as well as the availability of energy resources. Sleep must take place during a period of time established by the human internal biological clock.

The body's clock system maintains a sleep/wake schedule in synchronization with local sunrise and sunset, along with the duration of daylight hours. The biological clock regulates energy cycles so that alertness increases after wake-up time, peaks in the mid-morning hours, dips in the afternoon hours, peaks again in the early evening hours, and begins to decrease in the early night, reaching all time lows in the middle of the night, as shown in Figure (2).

Persons exposed to regular work schedules enjoy the benefits of a well adapted biological clock; this allows daily energy restorative cycles to take place on a regular basis. Whereas adaptation to night or day work requires the synchronization of physiological and cognitive resources with the biological clock, otherwise persons will suffer of shift-work maladaptation, resulting from the inability to adjust the clock to the watch schedule.

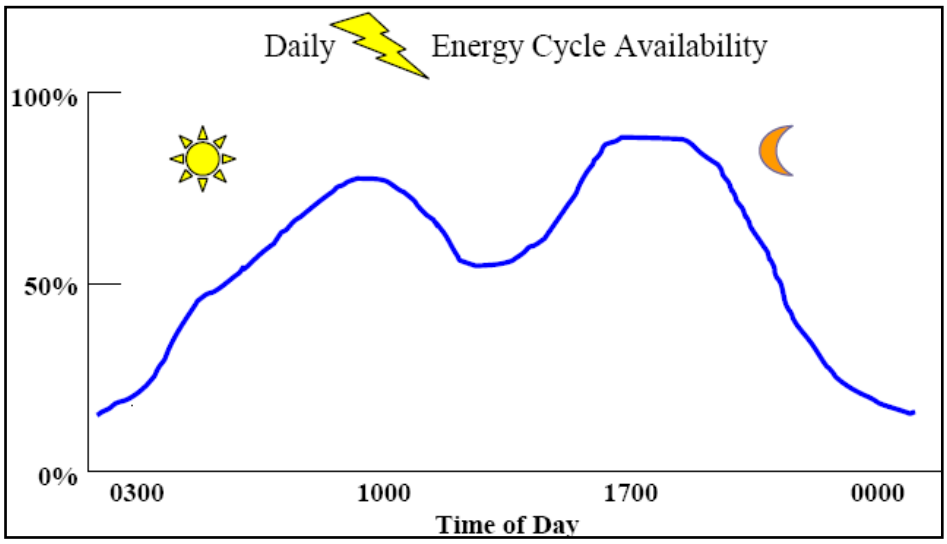

Figure (2): Daily Energy Cycle Availability
Source: Management of endurance risk factors: A guide for deep draft vessels

The circadian rhythms refer to the daily oriented body clock which controls the specific patterns of hormones, alertness and core body temperature. The word circadian is used to describe biological and behavioral rhythms regulated by the body clock. With a large proportion of seafarers on shift work the potential for disruption to circadian rhythms is

great and may be compounded by more and more pronounced ‘jet lag’ type effects as ships get increasingly faster (Malawwethanthri, 2003).

4.5. Noise

Exposure to ship engine noise from 65 decibel (dB) can have an adverse effect on sleep. A survey by Omdal (2003) of 11 Norwegian vessels aimed to identify factors potentially harmful to health and found noise to be the single most common problem, with 44% of respondents reporting noise as a problem.

Omdal (2003) suggests higher standards of noise reduction should be incorporated into ship design. Only 8% of crew onboard a noise-reduced vessel report stress from this environmental factor. Such evidence suggests that through technology and improved design some traditional hardships associated with the maritime life can be challenged and indeed overcome.

4.6. Motion Sickness:

Standing on a moving platform creates confusion, since the information stimulating the sensory systems does not match with the existing memory template. This mismatch creates a series of changes in physiology as the brain tries to create a new memory template. These changes are often experienced in terms of cold sweats, fatigue, dizziness, headaches, yawning, nausea, and vomiting.

4.7. Caffeine, Alcohol and Drugs:

Caffeine is a stimulant drug. For caffeine to serve as an alertness boost, it must be consumed at low levels and only when needed. High doses of caffeine can result in increased nervousness, lack of concentration, and digestive disorders. Unfortunately, frequent consumption of caffeine will result in addiction and in the further draining of energy resources.

Studies show that there are similar effects between fatigue and alcohol intake on a person’s 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.

The Convention recommends flag states to establish drug and alcohol prevention programmes taking into account the guidance contained in the ILO publication ‘Drug on Alcohol Prevention Programmes in the Maritime Industry (A Manual for Planners)’.

4.8. Cold Related Illness:

Winter months threaten crew members' health and endurance, working in unprotected deck areas exposed to the cold can result in hypothermia, trench foot and severe frostbite of hands and feet.

In these environments, crew members must be aware of a number of risk factors such as, wet clothing, insufficient insulation of body, head, hands, and feet from wind, ocean spray, and cold temperature, Use of medication that disrupts the body's ability to regulate core body temperature, Physical exhaustion and Prolonged work-related exposure to cold, windy, and wet environments allowing numbness of fingers and toes.

4.9. Heat Illness:

Heat illness is mostly caused by prolonged exposure to heat and insufficient water intake. The most apparent signs of someone overexposed to heat are pale and clammy skin, fast and shallow breathing and rapid pulse.

The physiological symptoms of heatstroke can be the experience of several symptoms such as, intense thirst, hot and dry skin, dizziness, headache, fatigue, no sweating, high body temperature (above 37° C), confusion and loss of consciousness.

5. Fatigue Management System

Having identified the fatigue risk factors, perhaps the next step is the setting of a fatigue management system. Fatigue management should be in the priority list of ship designers, ship managers and seafarers.

For the ship designers, it means being aware of, and as far as possible, eliminating the effects of fatigue risk factors in the ship designs. For the ship owners and managers, it means developing a fatigue management plan to ensure that the correct resources, training and procedures are in place to ensure the safety of the ship, as well as, safety, health and wellbeing of the seafarer. Additionally, seafarers should be able to identify the causes of fatigue and to work towards taking appropriate and early measures to prevent it.

The fatigue management system shall allow for the identification of the various environmental, operational, physiological, and psychological factors that can cause fatigue and find solutions to control it and mitigate it onboard ships. In addition, the system shall include responsibilities, procedures, feedback as well as fatigue reporting procedures and control measures. Fatigue management system can be an integrated part of the International Safety Management (ISM) Code.

Fatigue management system shall provide guidance on how to implement a scheme that includes fatigue management and a variety of education and training resources and materials to the crew in combating fatigue. Resources shall cover topics such as, 'the prevention of shift work maladaptation', 'night watch, day watch, sleep and work management', 'transition from day to night watch or otherwise', 'napping and circadian desynchronizes', 'pre-adaptation prior to travel across time zones', 'everyday sleep management' and many others will assist the crew to manage fatigue and mitigate its consequences.

Credibly, developing onboard fatigue management plan is an urgent need and requires bringing together expertise on fatigue and sleep with operational knowledge about the shipping industry.

United States Coast Guards (USCG) has developed a program to help industry manage fatigue and endurance risk factors. The Crew Endurance Management System (CEMS) uses a systematic, continuous improvement approach based on years of science and field testing.

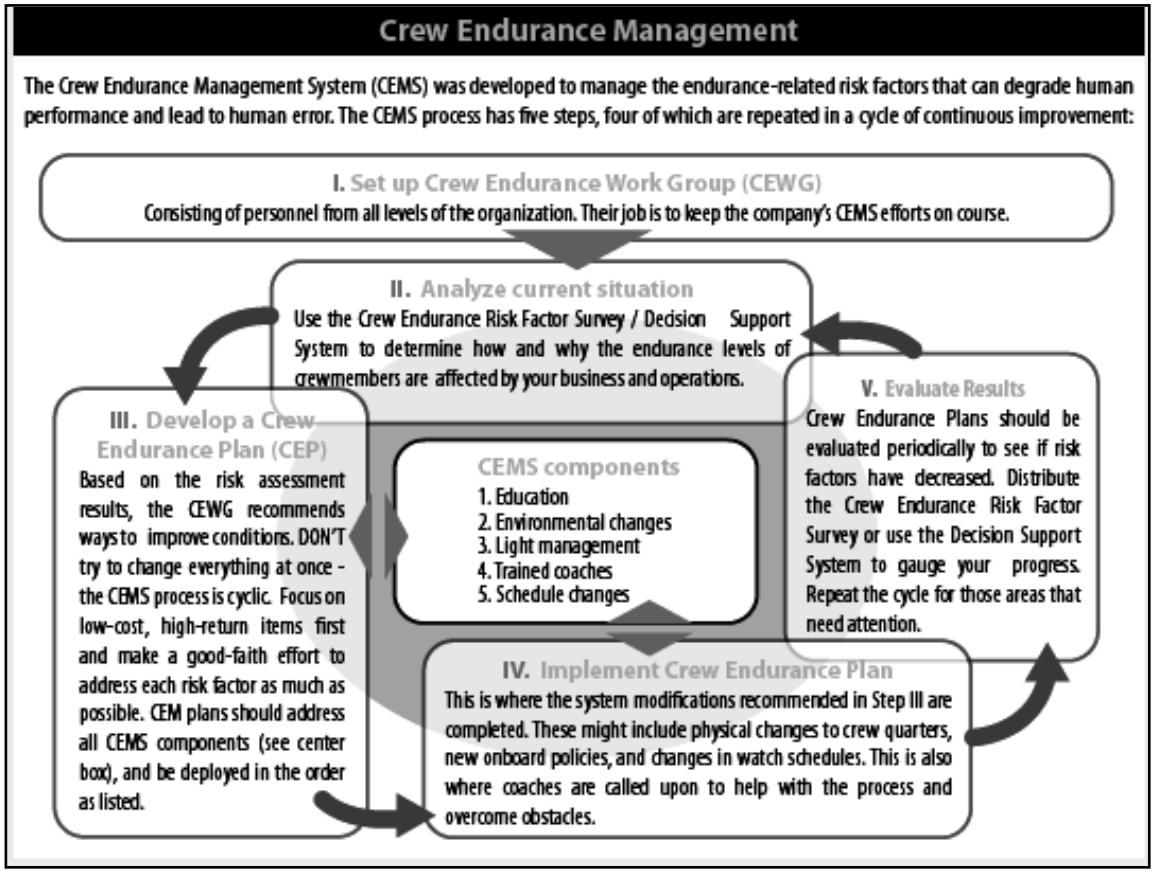

Figure (3) USCG Crew Endurance Management
Source: The International Maritime Human Element Bulletin Issue No.13

As shown in figure (3), there are five basic steps in CEMS process starting with identifying each vessel's unique specific endurance risks, a working group composed of shore-side and vessel personnel identify how often crewmembers experience 15 primary endurance risk factors while living and working onboard.

Recommendations may involve a wide range of options. After the plan is first implemented, the group then conducts periodic evaluations to validate whether or not the recommendations were effective. The process should be continued until risk factors are reduced as much as realistically possible.

According to USCG, over 100 companies from the US and abroad who have been practicing CEMS, have documented improvement in employee performance, morale, and general health and well-being.

6. Evaluating the current legislative measures to manage fatigue.

IMO "guidance in fatigue mitigation and management" assists stakeholders of the shipping industry in the development of marine safety culture by addressing the issue of fatigue, and assist them in better understanding and managing of fatigue.

IMO Resolution A.772 (18) recommends that, in establishing the minimum safe manning for each ship, Flag States should bear in mind that there should be a sufficient number of qualified personnel to meet peak workload situations and conditions with due regard to the number of hours of shipboard duties and rest periods that may be assigned to a seafarer.

Likewise, the International Labour Organization (ILO) 180 Convention requires that Flag States set the maximum limits for hours of work or minimum rest periods on ships flying their flags. In addition, every ship shall maintain schedules of service at sea and in port including maximum hours of work or minimum periods of rest per day and per week are to be posted on board.

However, STCW convention requires a specific minimum rest periods for the watch keeper to maintain, and for the administrations to ensure watch schedules are posted where they are easily accessible. Surprisingly, it is acceptable for a seafarer to work for 98 hours per week in STCW, 72 hours per week in ILO 180 and 48 hours per week in the European working time directive.

According to Kristian & Vilhelm (2008), six hours of continuous sleep, as required by STCW convention, is considered to be the physiological minimum per day, and most adults require seven and a half hours.

IMO resolution A.890 (21) defines the principles of safe manning of ships to ensure the safe operations and pollution prevention from ships. The resolution specifies the factors which shall be taken into account in determine the minimum safe manning level of ships.

However, the criteria in obtaining the minimum safe manning of ships differs from one State to another, considering many factors include national, social, economical, commercial factors and competition, in addition to the IMO principles of safe manning requirement.

Obviously, IMO and ILO measures in mitigating fatigue is out of service, Jones et al (2005) examined the extent to which STCW 95 and ILO 180 address the criteria of sleep duration, sleep quality, sleep debt, working at night, circadian rhythms, predictability of shifts, length of shift and rest breaks. STCW 95 does not have a requirement that rest should take place at the same time each day. Similarly, there is no requirement for timing schedule release. ILO 180 was found to be inadequate in terms of maximum working hours and sleep debt recovery.

Smith (2007) adds, one problem with these approaches is that there has been little attempt to evaluate their effectiveness. 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.

Nevertheless, the author believes that IMO guideline is lengthy but it does not provide specific or practical recommendations. In addition, the focus of responsibility for fatigue was always put on the personal side rather than the management and administration. In order to combat and mange fatigue a cultural change is needed.

For instance, subsequent to the implementation of the International Ship and Port Facility Security Code (ISPS Code) in 2004, a number of security measures could be carried out to protect the access to the ship, when security level two is declared such as, ‘Assigning additional personnel to patrol deck areas during silent hours to deter unauthorized access’, ‘Increasing the frequency and detail of searches of persons, personal effects, and vehicles being embarked or loaded onto the ship’.

The questions which raise themselves now, are those additional security duties could be achieved by using the same number of crew onboard? Are most of the flag States willing to increase their minimum manning level taking into account those additional security duties?

Apparently, the author accepts as true that fatigue in the shipping industry is an occupational health and safety issue that is common and extensive. It is not being adequately dealt with by current legislation, management or working practices and there is an urgent need to correct the situation.

7. Training in Fatigue Management.

Unquestionably, Education and Training is the cornerstone of appropriate implementation of fatigue management system. Effective fatigue and endurance related curriculum should be available for the MET institutions in order to provide training in fatigue management and mitigation.

Significantly, educating all the stakeholders of the shipping industry in fatigue management will assist in organizing the work places, systems, and seafarers' personal lives to alleviate causes and effects of fatigue. This includes the people who make policy decisions and allocate resources.

According to Squire (2007), while the IMO does not currently advocate mandatory training in fatigue management, common sense and good practice would suggest that such training is essential. It is time to wake up to the consequences of fatigue, such consequences can be costly.

Recognizing that, IMO had adopted STCW convention in order to enhance the maritime safety and environmental protection by improving the performance of human element, as well as, establishing global minimum standards for seafarer's competency.

An amendment to the current provisions of STCW convention shall add minimum mandatory training and certification in fatigue control issues. A proposed course in the 'Familiarization of shipboard personnel in the control and management of fatigue onboard ships' to be mandatory for all persons onboard, further advanced fatigue management course shall be provided for Masters, persons in charge of the fatigue management system onboard and ashore.

Truthfully, the cost of fatigue consequences can be massive for the shipping industry, perhaps the time have come for the members of IMO to enact new requirement mandates the training in fatigue management and mitigation, using all the available materials and resources.

8. Conclusion

Apparently, the present international legislation in the management and mitigation of fatigue is not effective. IMO's member States have to consider enacting more effective and obligatory measures to overcome the risk of fatigue onboard ships.

In addition to that, IMO's member States are required to review the current maritime MET systems to incorporate the fatigue management into it, as well as their manning legislation to ensure that there is enough number of person's onboard ships to carry out the required shipboard operations in safe and professional manners.

As well, ship designers shall be aware of shipboard fatigue and attempt to eliminate its effect while designing the ships. Perhaps, integrating fatigue management system into the safety management system will ensure practical and effective implementation of fatigue management plans and measures.

References

Bowring, A. (2004). Problems of minimum manning. *Seaways*, June, 23-24.

Foo, S.C., How, J., Siew, M.G., Wong, T.M., Vijayan, A., Kanapathy, R. (1994). Effects of sleep deprivation on naval seamen: *Annals of the Academy of Medicine, Singapore, 23(5), 676-679.*

Gould, K.S. & Koefoed, V.F. (2008). *Facing the facts on fatigue at sea:* Norwegian Maritime Directorate.

Houtman, I. Miedema, M. Jettinghof, K. Starren, A. Heinrich, J. Gort, J. (2005). *Fatigue in the shipping industry*: Dutch Ministry of Transport, Public Works and Water Management.

International Convention on Standards of Training, Certification and Watchkeeping for seafarers, 1978, as amended in 1995 and 1997 (STCW Convention), IMO, (2001).

International Labour Organization Convention (No. 180) concerning Seafarers' Hours of Work and the Manning of Ships, ILO, (1996).

International Maritime Organization. (1993, November 4). *Resolution A 772 (18): Fatigue factors in manning and safety:* IMO.

International Maritime Organization. (1999, November 25). *Resolution A 890 (21): Principles of safe manning:* IMO.

International Maritime Organization. (2001, June 8). *Circular/MSC/Circ.1014: Guidance on fatigue mitigation and management:* IMO.

International Transport Workers Federation. (2007). *Seafarer fatigue, where next:* ITF.

Jones, .C.B., Dorrian, J., Rajaratnam, S.M., Dawson, D., Shantha, M.W. (2005). Working hours regulations and fatigue in transportation: A comparative analysis. *Safety Science, 43(4), 225-252.*

Malawwethanthri, K. (2003). Fatigue and jet lag. *Seaways,* November, 26-28.

Marine Accident Investigation Branch (2004). *Bridge watchkeeping Safety Study*: MAIB.

Omdal, K.A. (2003). A survey of health and work environment onboard Norwegian ships. *Proceedings of the 7th International Symposium on Maritime Health.*

Raby, M. & McCallum, M. (1997). Procedures for Investigating and Reporting Fatigue Contributions to Marine Casualties. *Proceedings of the Human Factors and Ergonomics Society* 41st Annual Meeting.

Reyner, L. & Baulk, S. (1997) *Fatigue in ferry crews: A pilot study:* Loughborough University and Seafarers International Research Centre.

Roberts, S.E. (2002). Hazardous occupations in Great Britain. *The Lancet*, 360(9332), 543-544.

Smith, A. (2007). *Adequate crewing and seafarers' fatigue: the international perspective:* Centre for Occupational and Health Psychology, Cardiff University

Smith, A., Allen, P., Wadsworth, E. (2006). *Seafarer fatigue: the Cardiff research programme* : Centre for Occupational and Health Psychology, Cardiff University

Squire, D. (2007). Time to wake up to the consequences of fatigue. *The International Maritime Human Element Bulletin (ALERT),* 13, 1.

United States Coast Guard. (2001). *Management of endurance risk factors, a guide for deep draft vessels:* USCG.

United States Coast Guard. (2005). *Crew endurance management practices, a guide for Maritime operations:* USCG.

World Maritime University. (2006). *Fatigue at Sea, a review of research and related literature.* A report Prepared for the Swedish national road and transport research institute: WMU.