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GUIDANCE ON FATIGUE MITIGATION AND MANAGEMENT

1 The Maritime Safety Committee (MSC), at its seventy-first session (19 to 28 May 1999), considered the issue of human fatigue and the direction where IMO efforts should be focused. In this regard, it was agreed that practical guidance should be developed to provide appropriate information on fatigue to all parties concerned. This guidance should inform each party that has a direct impact on vessel safety (naval architects, owners/operators, masters, officers, ratings, training institutions, etc.) of the nature of fatigue, its causes, preventive measures and countermeasures.

2 Accordingly, the MSC, at its seventy-fourth session (30 May to 8 June 2001), approved the annexed guidelines, composed of self-contained Modules, each addressing a different party. The Modules have been assembled using existing information, in a useful format, for transmission to the different parties who have a direct impact on vessel safety.

3 Member Governments are invited to:

.1 bring the attached guidelines to the attention of their maritime Administrations and relevant industry organizations and to all other parties who have direct impact on ship safety;

.2 use this guidance as a basis for developing various types of tools for dissemination of the information given in the guidelines (such as: pamphlets, video training modules, seminars and workshops, etc.); and

.3 take the guidelines into consideration when determining minimum safe manning.

4 Shipowners, ship operators and shipping companies are strongly urged to take the issue of fatigue into account when developing, implementing and improving safety management systems under the ISM Code.

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ANNEX

GUIDELINES ON FATIGUE

INTRODUCTION

Foreword

Fatigue can be defined in many ways. However, it is generally described 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.

The effects of fatigue are particularly dangerous in the shipping industry. The technical and specialized nature of this industry requires constant alertness and intense concentration from its workers. Fatigue is also dangerous because it affects everyone regardless of skill, knowledge and training.

Effectively dealing with fatigue in the marine environment requires a holistic approach. There is no one-system approach to addressing fatigue, but there are certain principles (e.g. lifestyle habits, rest, medication, workload.) that must be addressed in order to gain the knowledge and the understanding to manage this human element issue.

OBJECTIVE

The human element, in particular fatigue, is widely perceived as a contributing factor in marine casualties. The Exxon Valdez, one of the worst maritime environmental disasters in the last century, is one of the many mishaps where fatigue was identified as a contributing factor.

To assist in the development of a marine safety culture by addressing the issue of fatigue, the International Maritime Organization (IMO) has developed practical guidance to assist interested parties to better understand and manage the issue of "fatigue."

The philosophy behind the development of the guidance was not to develop new information but rather assemble what already exists, in a useful format, for transmission to those parties who have a direct impact on ship safety.

The outline of the information is related to the potential dangers associated with fatigue and ultimately the effect on the health and safety of the personnel working on ships. The guidelines contain information on the symptoms and causes of fatigue, and address solutions to combat fatigue to improve the associated health problems and help prevent a fatigue related accident from occurring.

ORGANIZATION
The guidelines are composed of Modules each devoted to an interested party. The modules are as follow:

1.	Module 1	Fatigue
2.	Module 2	Fatigue and the Rating
3.	Module 3	Fatigue and the Ship's Officer
4.	Module 4	Fatigue and the Master
5.	Module 5	Fatigue and the Training Institution and Management Personnel in charge of Training
6.	Module 6	Shipboard Fatigue and the Owner/Operator/Manager
7.	Module 7	Shipboard Fatigue and the Naval Architect
8.	Module 8	Fatigue and the Maritime Pilot
9.	Module 9	Fatigue and Tugboat Personnel
6.	Appendix	Fatigue related documentation

HOW TO USE THESE MODULES
Although all Modules are self-contained, it is recommended that all parties become familiar with Module 1, which contains general information on fatigue. In other instances it will be beneficial if the reader (interested party) becomes familiar with Modules other than the immediately applicable one.

It is strongly suggested that maximum benefit will be derived from the integration of this material into:

- *Safety management systems under the ISM Code;*
- *Training courses, particularly management oriented courses;*
- *Accident investigation processes and methodologies and;*
- *Manning determinations.*

FUTURE WORK
These Guidelines are a living document; they should be updated periodically as research reveals new information and new methods are uncovered to deal with the issue of fatigue. Further, the present structure – self-contained Modules – allows for the creation of new Modules directed to other interested parties.

Guidelines on Fatigue
Module 1

FATIGUE
Foreword

The Guidelines on Fatigue contain practical information that can assist interested parties (Naval Architects/Ship designers, owners/operators, Masters, Officers, other crew members and training institutions) to better understand and manage fatigue.

The guidelines provide information on the potential dangers of fatigue and ultimately the effect on the health and safety of the personnel working on ships. The guidelines contain information on the symptoms and causes of fatigue, and address solutions to combat fatigue in order to reduce associated health problems and prevent fatigue-related accidents from occurring.

The guidelines have been divided into nine modules, as follows:

1. Module 1 Fatigue
2. Module 2 Fatigue and the Rating
3. Module 3 Fatigue and the Ship's Officer
4. Module 4 Fatigue and the Master
5. Module 5 Fatigue and the Training Institution and Management Personnel in charge of Training
6. Module 6 Shipboard Fatigue and the Owner/Operator/Manager
7. Module 7 Shipboard Fatigue and the Naval Architect/Ship Designer
8. Module 8 Fatigue and the Maritime Pilot
9. Module 9 Fatigue and Tugboat Personnel
10. Appendix Fatigue related documentation

It is recommended that all parties become familiar with Module 1 prior to using Modules 2 – 9. **Module 1 (Fatigue)** contains general information on the subject of fatigue – definitions, causes, effects, etc.

Guidelines on Fatigue
Module 1

FATIGUE

1. INTRODUCTION

For many years, fatigue was discounted as a potential cause of or contributor to human error. One reason for this misunderstanding was the old myth that fatigue could be prevented by various characteristics: personality, intelligence, education, training, skills, compensation, motivation, physical size, strength, attractiveness, or professionalism. However, recent accident data and research point to fatigue as a cause of and/or contributor to human error precisely because of its impact on performance. Human error resulting from fatigue is now widely perceived as the cause of numerous marine casualties, including one of the the worst maritime environmental disasters in the last century, the Exxon Valdez.

The negative effects of fatigue present a disastrous risk to the safety of human life, damage to the environment, and property. Because shipping is a very technical and specialized industry, these negative effects are exponentially increased, thereby requiring seafarers' constant alertness and intense concentration.

This module provides a general overview of fatigue, its causes, and its potential effects on maritime personnel. The key issue addressed within this module is that fatigue is a fundamental problem for the maritime industry as it detrimentally affects performance at work.

2. DEFINING FATIGUE

There is no universally accepted technical definition for fatigue. However, common to all the definitions is degradation of human performance. The following definition is found in IMO's MSC/Circ.813/MEPC/Circ.330, List of Human Element Common terms:

"*A reduction in physical and/or mental capability as the result of physical, mental or emotional exertion which may impair nearly all physical abilities including: strength; speed; reaction time; coordination; decision making; or balance.*"

3. FATIGUE AND LIFE ON A SEAGOING SHIP

Fatigue is a problem for all 24-hour a day transportation modes and industries, the marine industry included. However, there are unique aspects of seafaring that separate the marine industry from the others.

It must be recognized that the seafarer is a captive of the work environment. Firstly, the average seafarer spends between three to six months working and living away from home, on a moving vessel that is subject to unpredictable environmental factors (i.e. weather conditions). Secondly, while serving on board the vessel, there is no clear separation between work and recreation. Thirdly, today's crew is composed of seafarers from various nationalities and backgrounds who are expected to work and live together for long periods of time. The operational aspects associated with shipping become more complex compared with standard industries, for reasons such as: variety of ship-types, pattern and length of sea passage, port-rotation, and length of time a ship remains in port. All these aspects present a unique combination of potential causes of fatigue.

4. CAUSES OF FATIGUE

The most common causes of fatigue known to seafarers are lack of sleep, poor quality of rest, stress and excessive workload. There are many other contributors as well, and each will vary depending on the circumstance (i.e. operational, environmental).

There are many ways to categorize the causes of fatigue. To ensure thoroughness and to provide good coverage of most causes, they have been categorized into 4 general factors.

- Crew-specific Factors
- Management Factors (ashore and aboard ship)
- Ship-specific Factors
- Environmental Factors

A. Crew-specific Factors

The crew-specific factors are related to lifestyle behavior, personal habits and individual attributes. However, fatigue varies from one person to another and its effects are often dependent on the particular activity being performed.

The Crew-specific Factors include the following:

- Sleep and Rest
  - Quality, Quantity and Duration of Sleep
  - Sleep Disorders/Disturbances
  - Rest Breaks
- Biological Clock/Circadian Rhythms
- Psychological and Emotional Factors, including stress
  - Fear
  - Monotony and Boredom
- Health
  - Diet
  - Illness
- Stress
  - Skill, knowledge and training as it relates to the job
  - Personal problems
  - Interpersonal relationships

- Ingested Chemicals
  - Alcohol
  - Drugs (prescription and non-prescription)
  - Caffeine
- Age
- Shiftwork and Work Schedules
- Workload (mental/physical)
- Jet Lag

B. Management Factors (ashore and aboard ship)

The Management Factors relate to how ships are managed and operated. These factors can potentially cause stress and an increased workload, ultimately resulting in fatigue. These factors include:

1. Organizational Factors

- Staffing policies and Retention
- Role of riders and shore personnel
- Paperwork requirements
- Economics
- Schedules-shift, Overtime, Breaks
- Company culture and Management style
- Rules and Regulations
- Resources
- Upkeep of vessel
- Training and Selection of crew

2. Voyage and Scheduling Factors

- Frequency of port calls
- Time between ports
- Routing
- Weather and Sea condition on route
- Traffic density on route
- Nature of duties/workload while in port

C. Ship-specific Factors

These factors include ship design features that can affect/cause fatigue. Some ship design features affect workload (i.e. automation, equipment reliability), some affect the crew's ability to sleep, and others affect the level of physical stress on the crew (i.e. noise, vibration, accommodation spaces, etc.). The following list details ship-specific factors:

- Ship design
- Level of Automation
- Level of Redundancy
- Equipment reliability
- Inspection and Maintenance
- Age of vessel
- Physical comfort in work spaces

- Location of quarters
- Ship motion
- Physical comfort of accommodation spaces

D. Environmental Factors

Exposure to excess levels of environmental factors, e.g. temperature, humidity,excessive noise levels, can cause or affect fatigue. Long-term exposure may even cause harm to a person's health. Furthermore, considering that environmental factors may produce physical discomfort, they can also cause or contribute to the disruption of sleep.

Ship motion is also considered an environmental factor. Motion affects a person's ability to maintain physical balance. This is due to the extra energy expended to maintain balance while moving, especially during harsh sea conditions. There is a direct relation between a ship's motion and a person's ability to work. Excessive ship movement can also cause nausea and motion sickness.

Environmental factors can also be divided into factors external to the ship and those internal to the ship. Within the ship, the crew is faced with elements such as noise, vibration and temperature (heat, cold, and humidity). External factors include port and weather condition and vessel traffic.

There are a number of things that can be done to address these causes. Some contributors are more manageable than others. Opportunities for implementing countermeasures vary from one factor to another (noise can be better addressed during the vessel design stage, breaks can be addressed by the individual crew member, training and selection of the crew can be addressed during the hiring process, etc.). The remaining Modules will further highlight the prevention of fatigue.

Modules 2 - 9 provide a closer examination of the specific causes of fatigue and how each relates to specific industry groups.

5. BASIC CONCEPTS IN UNDERSTANDING FATIGUE

This section highlights some of the basic concepts that provide an overall understanding about fatigue.

A. Sleep

Sleep is an active process; when people sleep they are actually in an altered state of consciousness. All sleep does not have the same quality and does not provide the same recuperative benefits. In order to satisfy the needs of the human body, sleep must have three characteristics to be most effective:

- Duration: Everyone's sleep needs are unique; however, it is generally recommended that a person obtain, on average, 7 to 8 hours of sleep per 24-hour day. A person needs the amount of sleep that produces the feeling of being refreshed and alert. Alertness and performance are directly related to sleep. Insufficient sleep over several consecutive days will impair alertness. Only sleep can maintain or restore performance levels.
- Continuity: The sleep should be uninterrupted. Six one-hour naps do not have the same benefit as one six-hour period of sleep.
- Quality: People need deep sleep. Just being tired is not enough to ensure a good sleep. An individual must begin sleep in synch with the biological clock to ensure quality sleep. If the time of sleep is out of synchronization with his/her biological clock, it is difficult to sleep properly.

Many factors contribute to sleep disruption, some are within our control while others are not:

- environmental factors (e.g. ship's violent movement, weather, heavy vibration, noise or poor accommodation)
- food and consumption of chemicals (e.g. alcohol intake, coffee, medication, etc.)
- psychological factors (e.g. stress, family worries, on-duty responsibilities)
- sleep disorders (e.g. one, insomnia–prolonged inability to obtain adequate sleep or e.g. two, sleep apnea–a condition where breathing stops when sleep occurs due to a collapse of the upper airway or the diaphragm not moving causing the person to wake up)
- operational factors (e.g. disruptions caused by drills, loading and unloading)

B. Biological Clock and Circadian Rhythm

Each individual has a biological clock, and this clock regulates the body's circadian rhythm. To best understand both of these features, it is first necessary to understand how the circadian rhythm functions. Our bodies move through various physical processes and states within a 24-hour period, such as sleeping/waking, and cyclical changes in body temperature, hormone levels, sensitivity to drugs, etc. This cycle represents the circadian rhythm. The biological clock regulates the circadian rhythm. The biological clock is perfectly synchronised to the traditional pattern of daytime wakefulness and night-time sleep.

The biological clock makes a person sleepy or alert on a regular schedule whether they are working or not. In normal conditions, the sleep/wake cycle follows a 24-hour rhythm, however, the cycle isn't the same for everyone. Although individual rhythms vary, each person's cycle has two distinctive peaks and dips. Independent of other sleep-related factors that cause sleepiness, there are two times of low alertness (low-points or dips) in each 24-hour period . These commonly occur between 3-5am and 3-5pm. Preceding these lowest alertness periods, are maximum alertness periods (peaks).

The states of sleep/wakefulness and circadian rhythms interact in several ways:

- The two can work against one another and thereby weaken or negate each other's effect. For example, a well-rested person is still affected by a circadian low-point; conversely, a person who is sleep deprived may feel a momentary increase in alertness due to a peak in circadian rhythm.

- The two can also work in the same direction, thereby intensifying the effect they each have on a person's level of alertness. For example, when someone is sleep deprived, a circadian low point will further exacerbate the feeling of sleepiness.

For many seafarers, working patterns conflict with their biological clock. Irregular schedules caused by shifting rotations, crossing time zones, etc. cause the circadian rhythms to be out of synchronization.

Further, the internal clock can only adjust by an hour or two each day. Sometimes, depending on the new schedule, it takes several days to adjust. In the meantime, the internal clock wakes a person up when they need to sleep and puts them to sleep when they need to be awake.

C. Stress

Stress occurs when a person is confronted with an environment that poses a threat or demand, and the individual becomes aware of his/her inability or difficulty in coping with the environment (a feeling of being overwhelmed). This can result in reduced work performance and health problems.

Stress can be caused by a number of things, including:

- Environmental hardships (noise, vibration, exposure to high and low temperatures, etc)
- Weather (i.e. ice conditions)
- Personal problems (family problems, home sickness, etc.)
- Broken rest
- Long working hours
- On-board interpersonal relationships

6. EFFECTS OF FATIGUE

Alertness is the optimum state of the brain that enables us to make conscious decisions. Fatigue has a proven detrimental effect on alertness– this can be readily seen when a person is required to maintain a period of concentrated and sustained attention, such as looking out for the unexpected (e.g. night watch).

When a person's alertness is affected by fatigue, his or her performance on the job can be significantly impaired. Impairment will occur in every aspect of human performance (physically, emotionally, and mentally) such as in decision-making, response time, judgement, hand-eye coordination, and countless other skills.

Fatigue is dangerous in that people are poor judges of their level of fatigue. The following is a sample of fatigue's known effect on performance. Modules 2 - 9 contain a more extensive list for use by each individual industry group.

- Fatigued individuals become more susceptible to errors of attention and memory (for example, it is not uncommon for fatigued individuals to omit steps in a sequence).
- Chronically fatigued individuals will often select strategies that have a high degree of risk on the basis that they require less effort to execute.

- Fatigue can affect an individual's ability to respond to stimuli, perceive stimuli, interpret or understand stimuli, and it can take longer to react to them once they have been identified.
- Fatigue also affects problem solving which is an integral part of handling new or novel tasks.

Fatigue is known to detrimentally affect a person's performance and may reduce individual and crew effectiveness and efficiency; decrease productivity; lower standards of work and may lead to errors being made. Unless steps are taken to alleviate the fatigue, it will remain long after the period of sustained attention, posing a hazard to ship safety.

References

Calhoun S.R. (1999) – *Human Factors and Ship Design: Preventing and Reducing Shipboard Operator Fatigue.* University of Michigan/U.S. Coast Guard Research Project – Michigan, United States.

Kroemer K.H.E., Grandjean E. (1999) – *Fitting the task to the Human (Fifth Edition).* Taylor and Francis, Ltd. – United Kingdom.

Sandquist T., Raby M., Maloney A.L., Carvalhais T. (1996) - *Fatigue and Alertness in Merchant Marine Personnel: A field study of work and sleep patterns.* Report No. CG-D-06-97. Batelle Seattle Research Center and U.S. Coast Guard Research and Development Center – Connecticut, United States.

Transportation Safety Board of Canada (1997) - *A Guide for Investigating for Fatigue* - Canada.

Guidelines on Fatigue
Module 2

FATIGUE AND THE RATING

Foreword

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The guidelines have been divided into nine modules, as follows:

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6. Module 6 Shipboard Fatigue and the Owner/Operator/Manager
7. Module 7 Shipboard Fatigue and the Naval Architect/Ship Designer
8. Module 8 Fatigue and the Maritime Pilot
9. Module 9 Fatigue and Tugboat Personnel
10. Appendix Fatigue related documentation

It is recommended that all parties become familiar with Module 1 prior to using Modules 2 - 9. Module 1 contains pertinent background information on the subject of fatigue.

Module 2 contains practical information intended for the ***Rating*** working on board ships.

Guidelines on Fatigue
Module 2

FATIGUE AND THE RATING

1. HOW CAN YOU RECOGNIZE FATIGUE IN YOURSELF AND OTHERS?

You may exhibit one or more changes in behavior when experiencing fatigue. However, one very important fact to remember is that people who are experiencing fatigue have a very difficult time recognizing the signs of fatigue themselves. It is difficult for a number of reasons, but largely because fatigue can affect your ability to make judgements or solve complex problems. The following list describes how fatigue affects your mind, emotions and body; you may recognize some of these changes in others (with time, you may learn to identify some within yourself):

A. Physically:

- Inability to stay awake (an example is head nodding or falling asleep against your will)
- Difficulty with hand-eye coordination skills (such as, switch selection)
- Speech difficulties (it may be slurred, slowed or garbled)
- Heaviness in the arms and legs or sluggish feeling
- Decreased ability to exert force while lifting, pushing or pulling
- Increased frequency of dropping objects like tools or parts
- Non-specific physical discomfort
- Headaches
- Giddiness
- Heart palpitations / irregular heart beats
- Rapid breathing
- Loss of appetite
- Insomnia
- Sudden sweating fits
- Leg pains or cramps
- Digestion problems

B. Emotionally:

- Increased willingness to take risks
- Increased intolerance and anti-social behaviour
- Needless worry
- Reduced motivation to work well
- Increased mood changes (examples are irritability, tiredness and depression)

C. Mentally:

- Poor judgement of distance, speed, time, etc.
- Inaccurate interpretation of a situation (examples are focusing on a simple problem or failing to anticipate the gravity of the situation or failing to anticipate danger)
- Slow or no response to normal, abnormal or emergency situations
- Reduced attention span
- Difficulty concentrating and thinking clearly
- Decreased ability to pay attention

Whenever alertness is affected by fatigue, your performance will be handicapped.
It is important that you notify your supervisor when you recognize that you or other crewmembers are fatigued. It is important to have an open communication between you and your supervisor regarding fatigue prevention and detection.

2. WHAT CAN CAUSE FATIGUE?

Fatigue may be caused and/or made worse by one or a combination of things:

- Lack of sleep
  Only sleep can maintain or restore your performance level. When you do not get enough sleep, fatigue will set in and your alertness will be impaired. (Refer to Section 3)

- Poor quality of sleep
  Fatigue may be caused by poor quality of sleep. This occurs when you are unable to sleep without interruptions and/or you are unable to fall asleep when your body tells you to. (Refer to Section 3)

- Insufficient rest time between work periods
  Apart from sleep, rest (taking a break) between work periods can contribute to restoring your performance levels. Insufficient rest periods or postponing assigned rest times (to finish the job early) can cause fatigue. (Refer to Section 3)

- Poor quality of rest
  Disturbances while resting such as being woken up unexpectedly, on call (during port operations), or unpredictable work hours (when arriving in port) can cause fatigue.

- Stress
  Stress can be caused by personal problems (family), problems with other shipmates, long work hours, work in general, etc. A build up of stress will cause or increase fatigue.

- Boring and repetitive work
  Boredom can cause fatigue. You may become bored to the point of fatigue when your work is too easy, repetitive and monotonous and/or bodily movement is restricted.

- Noise or vibration
  Noise or vibration can affect your ability to sleep/rest, and it can affect your level of physical stress, thus causing fatigue.

- Ship movement
  The ship's movement affects your ability to maintain physical balance. Maintaining balance requires extra energy, which can then cause fatigue. A ship's pitching and rolling motions mean you might have to use 15-20% extra effort to maintain your balance.

- Food (timing, frequency, content and quality)
  Refined sugars (sweets, doughnuts, chocolates, etc.) can cause your blood sugar to rise rapidly to a high level. The downside of such short-term energy is that a rapid drop in blood sugar can follow it. Low blood sugar levels can cause weakness, instability and difficulty in

concentrating and in the extreme case unconsciousness. Eating large meals prior to a sleep period may disrupt your sleep.

- Medical conditions and illnesses
  Medical conditions (i.e. heart problems) and illnesses, such as the common cold, can cause or aggravate fatigue. The effect depends on the nature of the illness or medical condition, but also the type of work being carried out. For example, common colds slow response time and affect hand-eye coordination .
- Ingesting chemicals
  Alcohol, caffeine and some over-the-counter medications disrupt sleep. Caffeine consumption can also cause other side effects such as hypertension, headaches, mood swings or anxiety.

- Jet-lag
  Jet-lag occurs following long flights through several time zones. It is a condition that causes fatigue in addition to sleep-deprivation and irritability. It is easier to adjust to time zones while crossing from east to west as opposed to west to east. The greatest difficulty in adjustment results from crossing 12 time zones, the least from crossing one time zone. Our bodies adjust at the rate of approximately one-hour per day.

- Excessive work load
  Working consistently "heavy" workloads can cause fatigue. Workload is considered heavy when one works excessive hours or performs physically demanding or mentally stressful tasks. Excessive work hours and fatigue can result in negative effects such as the following:
  - Increased accident and fatality rates
  - Increased dependence upon drugs, tobacco or alcohol
  - Poor quality and disrupted sleep patterns
  - Higher frequency of cardiovascular, respiratory or digestive disorders
  - Increased risk of infection
  - Loss of appetite

3. HOW CAN YOU PROTECT YOURSELF FROM THE ONSET OF FATIGUE?

A. <u>Sleep Issues</u>

Sleep is the most effective strategy to fight fatigue. Sleep loss and sleepiness can degrade every aspect of a person's performance: physical, emotional and mental. To satisfy the needs of your body, you must acquire the following:

- Deep sleep
- Between 7 to 8 hours of sleep per 24-hour day
- Uninterrupted sleep

Here is some general guidance on developing good sleep habits:

- Develop and follow a pre-sleep routine to promote sleep at bedtime (examples are a warm shower or reading calming material).
- Make the sleep environment conducive to sleep (a dark, quiet and cool environment and a comfortable bed encourages sleep).
- Ensure that you will have no interruptions during your extended period of sleep.

- Satisfy any other physiological needs before trying to sleep (examples are, if hungry or thirsty before bed, eat or drink lightly to avoid being kept awake by digestive activity and always visit the toilet before trying to sleep).
- Avoid alcohol and caffeine prior to sleep (keep in mind that coffee, tea, colas, chocolate, and some medications, including cold remedies and aspirin, may contain alcohol and/or caffeine). Avoid caffeine at least six hours before bedtime.
- Consider relaxation techniques such as meditation and yoga, which can also be of great help if learnt properly.

B. Rest Issues

Another important factor that can affect fatigue and performance is rest. Rest, apart from sleep, can be provided in the form of breaks or changes in activities. Rest pauses or breaks are indispensable as a physical requirement if performance is to be maintained. Factors influencing the need for rest are the length and intensity of the activities prior to a break or a change in activity, the length of the break, or the nature or change of the new activity.

C. Guidelines for maintaining performance

Here are some general guidelines that can help you maintain performance:

- Get sufficient sleep, especially before any period when you anticipate that you will not get adequate sleep.
- When you sleep, make it a long period of sleep.
- Take strategic naps.
- Take breaks when scheduled breaks are assigned.
- Develop and maintain good sleep habits, such as a pre-sleep routine (something that you always do to get you ready to sleep).
- Monitor your hours of work and rest when opportunity arises.
- Eat regular, well-balanced meals (including fruits and vegetables, as well as meat and starches).
- Exercise regularly.

4. WHAT CAN MITIGATE THE EFFECTS OF FATIGUE?

The most powerful means of relieving fatigue is to get proper sleep and to rest when appropriate. However, a number of things have been identified as potentially providing some short-term relief. Note, however, that these countermeasures may simply mask the symptoms temporarily —the fatigue has not been eliminated.

- An interesting challenge, an exciting idea, a change in work routine or anything else that is new and different
- Bright lights, cool dry air, music and other irregular sounds
- Caffeine (encountered in coffee and tea, and to a lesser extent in colas and chocolate) may combat sleepiness in some people for short periods. However, regular usage over time reduces its value as a stimulant and may make you more tired and less able to sleep.

- Any type of muscular activity: running, walking, stretching or even chewing gum
- Conversation
- Controlled, strategic naps can also improve alertness and performance (the most effective length of time for a nap is about 20 minutes).

Strategic Napping

Research has identified "strategic napping" as a short-term relief technique to help maintain performance levels during long periods of wakefulness. The most effective length for a nap is about 20 minutes. This means that if you have the opportunity to nap you should take it. However, there are some drawbacks associated with napping. One potential drawback is that naps longer than 30 minutes will cause sleep inertia, where situational awareness is impaired (grogginess and/or disorientation for up to 20 minutes after waking. A second is that the nap may disrupt later sleeping periods (you may not be tired when time comes for an extended period of sleep).

REFERENCES

International Transport Workers' Federation (1997) - *Seafarer Fatigue: Wake up to the dangers.* IMO, MSC 69/INF.10 - United Kingdom.

Kroemer, K.H.E., & Grandjean, E. (Re-printed 1999) – *Fitting the Task to the Human.* Taylor & Francis Ltd. – London, United Kingdom.

McCallum, M.C., & Raby, M., Rothblum A. (1996) - *Procedures for Investigating and Reporting Human Factors and Fatigue Contributions to Marine Casualties*. Report No. CG-D-09-97. Batelle Seattle Research Center and U.S. Coast Guard Research and Development Center – Connecticut, United States.

Moore-Ede M., Mitchell R. E., Heitmann A., Trutsche U., Aguirre A., & Hajarnavis H. (1996) - *Canalert 1995: Alertness Assurance in the Canadian Railways* - Circadian Technologies, Inc. - Massachusetts, United States.

Parker, A.W., Hubinger, L.M., Green, S., Sargent, L., & Boyd, R. (1997) - *A survey of the health, stress and fatigue of Australian Seafarers* - Australian Maritime Safety Authority - Australia.

Pollard J.K., Sussman E.D., & Stearns M. (1990) - *Shipboard Crew fatigue, Safety and Reduced Manning.* Report No. DOT-MA-RD-840-90014. John A. Volpe National Transportation Systems Center – Massachusetts, United States.

Sandquist T., Raby M., Maloney A.L., Carvalhais T. (1996) - *Fatigue and Alertness in Merchant Marine Personnel: A field study of work and sleep patterns.* Report No. CG-D-06-97. Batelle Seattle Research Center and U.S. Coast Guard Research and Development Center – Connecticut, United States.

Transportation Safety Board of Canada (1997) - *A Guide for Investigating for Fatigue* - Canada.

United Kingdom National Union of Marine Aviation and Shipping Transport Officers (1997) - *Give us a Break: NUMAST Report on Fatigue*. IMO, MSC 68/INF. 9 - United Kingdom.

Videotel (1998). *Fatigue and Stress at Sea* [video] - London, United Kingdom.

Guidelines on Fatigue
Module 3

FATIGUE AND THE SHIP'S OFFICER

Foreword

The Guidelines on Fatigue contain practical information that can assist interested parties (naval architects/Ship designers, owners/operators, Masters, Officers, other crew members and training institutions) to better understand and manage fatigue.

The guidelines provide information on the potential dangers of fatigue and ultimately the effect on the health and safety of the personnel working on ships. The guidelines contain information on the symptoms and causes of fatigue, and address solutions to combat fatigue in order to reduce associated health problems and prevent fatigue-related accidents from occurring.

The guidelines have been divided into nine modules, as follows:

1. Module 1	Fatigue
2. Module 2	Fatigue and the Rating
3. Module 3	Fatigue and the Ship's Officer
4. Module 4	Fatigue and the Master
5. Module 5	Fatigue and the Training Institution and Management Personnel in charge of Training
6. Module 6	Shipboard Fatigue and the Owner/Operator/Manager
7. Module 7	Shipboard Fatigue and the Naval Architect/Ship Designer
8. Module 8	Fatigue and the Maritime Pilot
9. Module 9	Fatigue and Tugboat Personnel
10. Appendix	Fatigue related documentation

It is recommended that all parties become familiar with Module 1 prior to using Modules 2 - 9. Module 1 contains pertinent background information on the subject of fatigue.

Module 3 contains practical information intended for the ***Ship's Officer*** working on board ships. It is recommended that the Ship's Officer also becomes familiar with Module 2 (Fatigue and the Rating).

Guidelines on Fatigue
Module 3

FATIGUE AND THE SHIPS'S OFFICER

1. HOW CAN YOU RECOGNIZE FATIGUE IN YOURSELF AND OTHERS (SIGNS/SYMPTOMS)?

Fatigue can affect your mind, emotions and body (e.g. your capacity for tasks involving physical exertion and strength, as well as your ability to solve complex problems or make decisions, etc). Your level of alertness is dependent on fatigue, and therefore, human performance can be impaired.

Table 1 describes some of the possible effects of fatigue by listing the performance impairments and the symptoms associated with them. These signs and symptoms of fatigue may be used to identify an individual's level of alertness. It must be noted, however, that it is difficult for an individual to recognize the symptoms of fatigue within him/herself, because fatigue impairs judgement.

TABLE 1
EFFECTS OF FATIGUE

PERFORMANCE IMPAIRMENT		SIGNS/SYMPTOMS
1	Inability to concentrate	• *Unable to organize a series of activities* • *Preoccupied with a single task* • *Focuses on a trivial problem, neglecting more important ones* • *Reverts to old but ineffective habits* • *Less vigilant than usual*
2	Diminished decision-making ability	• Misjudges distance, speed, time, etc. • Fails to appreciate the gravity of the situation • Overlooks items that should be included • Chooses risky options • Difficulty with simple arithmetic, geometry, etc.
3	Poor memory	• Fails to remember the sequence of task or task elements • Difficulty remembering events or procedures • Forgets to complete a task or part of a task
4	Slow response	• Responds slowly (if at all) to normal, abnormal or emergency situations
5	Loss of control of bodily movements	• May appear to be drunk • Inability to stay awake • Affected speech e.g. it may be slurred, slowed or garbled • Feeling heaviness in the arms and legs • Decreased ability to exert force while lifting, pushing or pulling • Increased frequency of dropping objects like tools or parts

6	Mood change	• Quieter, less talkative than usual • Unusually irritable • Increased intolerance and anti-social behavior • Depression
7	Attitude change	• Fails to anticipate danger • Fails to observe and obey warning signs • Seems unaware of own poor performance • Too willing to take risks • Ignores normal checks and procedures • Displays a "don't care" attitude • Weakness in drive or dislike for work

In addition to the behavioral changes listed in the table (symptoms), there are also a number of other changes associated with fatigue that will manifest in physical discomfort, such as:

- Headaches
- Giddiness
- Heart palpitations / irregular heart beats
- Rapid breathing
- Loss of appetite
- Insomnia
- Sudden sweating fits
- Leg pains or cramps
- Digestion problems

2. WHAT CAN CAUSE FATIGUE?

Fatigue may be caused and/or made worse by one or a combination of things:

- Lack of sleep
  Only sleep can maintain or restore your performance level. When you do not get enough sleep, fatigue will set in and your alertness will be impaired. (Refer to Section 3 of this Module)

- Poor quality of sleep
  Fatigue may be caused by poor quality of sleep. This occurs when you are unable to sleep without interruptions and/or you are unable to fall asleep when your body tells you to. (Refer to Section 3)

- Insufficient rest time between work periods
  Apart from sleep, rest (taking a break) between work periods can contribute to restoring your performance levels. Insufficient rest periods or postponing assigned rest times (to finish the job early) can cause fatigue. (Refer to Section 3)

- Poor quality of rest
  Disturbances while resting such as being woken up unexpectedly while on call (during port operations or to answer machinery alarms) or unpredictable work hours (when arriving in port) can cause fatigue.

- Stress
  Stress can be caused by personal problems (family), problems with other shipmates, long work hours, work in general, etc. A build up of stress will cause or increase fatigue.

- Boring and repetitive work
  Boredom can cause fatigue. You may become bored to the point of fatigue when your work is too easy, repetitive and monotonous and/or bodily movement is restricted.

- Noise or vibration
  Noise or vibration can affect your ability to sleep/rest, and it can affect your level of physical stress, thus causing fatigue.

- Ship movement
  The ship's movement affects your ability to maintain physical balance. Maintaining balance requires extra energy, which can then cause fatigue. A ship's pitching and rolling motions mean you might have to use 15-20% extra effort to maintain your balance.
  .
- Food (timing, frequency, content and quality)
  Refined sugars (sweets, doughnuts, chocolates, etc.) can cause your blood sugar to rise rapidly to a high level. The downside of such short-term energy is that a rapid drop in blood sugar can follow it. Low blood sugar levels can cause weakness, instability, and difficulty in concentrating and in the extreme case, unconsciousness. Eating large meals prior to a sleep period may disrupt your sleep.

- Medical conditions and illnesses
  Medical conditions (i.e. heart problems) and illnesses such as the common cold can cause fatigue. The effect not only depends on the nature of the illness or medical condition, but also the type of work being carried out. For example, common colds slow response time and affect hand-eye coordination.

- Ingesting chemicals
  Alcohol, caffeine and some over the counter medications disrupt sleep. Caffeine consumption can also causes other side effects such as hypertension, headaches, mood swings and anxiety.

- Jet-lag
  Jet-lag occurs following long flights through several time zones. It is a condition that causes fatigue in addition to sleep-deprivation and irritability. It is easier to adjust to time zones while crossing from east to west as opposed to west to east. The greatest difficulty in adjustment results from crossing 12 time zones, the least from crossing one time zone. Our bodies adjust at the rate of approximately one hour per day.

- Excessive work load
  Working consistently "heavy" workloads can cause fatigue. Workload is considered heavy when a person works excessive hours or performs physically demanding or mentally stressful tasks. Excessive work hours and fatigue can result in negative effects such as the following:
  - Increased accident and fatality rates
  - Increased dependence upon drugs, tobacco or alcohol
  - Poor quality and disrupted sleep patterns

- Higher frequency of cardiovascular, respiratory or digestive disorders
- Increased risk of infection
- Loss of appetite

3. HOW CAN PEOPLE PREVENT THE ONSET OF FATIGUE?

Sleep Issues

The most effective strategy to fight fatigue is to ensure that you get the very best quality and quantity of sleep. Sleep loss and sleepiness can degrade every aspect of human performance such as decision-making, response time, judgement, hand-eye coordination, and countless other skills.

In order to be effective in satisfying your body's need, sleep must meet three criteria:

- Duration
  Everyone's sleep needs are unique; however, it is generally recommended that a person obtains on average 7 to 8 hours of sleep per 24-hour day. A person needs the amount of sleep that produces the feeling of being refreshed and alert. Insufficient sleep over several consecutive days will impair alertness; only sleep can maintain or restore performance levels.

- Continuity
  Sleep should be uninterrupted. Six one-hour naps do not have the same benefit as one six-hour period of sleep.

- Quality
  People need deep sleep. All sleep is not of the same quality and does not provide the same fully recuperative benefits.

Here are some general guidelines on developing good sleep habits:

- Develop and follow a pre-sleep routine to promote sleep at bedtime (e.g. a warm shower, reading calming material, or just making a ritual of pre-bed preparation can provide a good routine).
- Make the sleep environment conducive to sleep (a dark, quiet and cool environment and a comfortable bed encourages sleep).
- Ensure that you will have no interruptions during your extended period of sleep.
- Satisfy any other physiological needs before trying to sleep (e.g. if hungry or thirsty before bed, eat or drink lightly to avoid being kept awake by digestive activity and always visit the toilet before trying to sleep).
- Avoid alcohol and caffeine prior to sleep (keep in mind that coffee, tea, colas, chocolate, and some medications, including cold remedies and aspirin contain alcohol and/or caffeine). Avoid caffeine at least six hours before bedtime.
- Consider relaxation techniques such as meditation and yoga, which can also be of great help if learnt properly.

Rest Issues

Another important factor that can affect fatigue and recovery is rest. Rest, apart from sleep, can be provided in the form of breaks or changes in activities. Rest pauses or breaks are indispensable as a physical requirement if performance is to be maintained. Factors influencing the need for rest are the length and intensity of the activities prior to a break or a change in activity, the length of the break, or the nature or change of the new activity.

C. Guidelines for maintaining performance

Here are some general guidelines that can help you maintain performance:

- Get sufficient sleep, especially before a period when you expect that time for adequate sleep will not be available.
- Ensure continuous periods of sleep.
- Take strategic naps (the most effective length of time for a nap is about 20 minutes).
- Take breaks when scheduled breaks are assigned.
- Develop and maintain good sleep habits, e.g. develop a pre-sleep routine.
- Monitor and effectively manage hours of work and rest by maintaining individual records of hours rested or worked.
- Maintain fitness for duty including medical fitness.
- Eat regular, well-balanced meals.
- Exercise regularly.

4. WHAT CAN MITIGATE THE EFFECTS OF FATIGUE?

The most powerful means of relieving fatigue is to get proper sleep and to rest when appropriate. However, a number of countermeasures have been identified as potentially providing some short-term relief. It must be emphasized that these countermeasures will not restore an individual's state of alertness; they only provide short-term relief, and may in fact, simply mask the symptoms temporarily. The following list captures some of the short-term countermeasures:

- Interest or opportunity
  An interesting challenge, an exciting idea, a change in work routine or anything else that is new and different may help to keep you awake. If the job is boring or monotonous, alertness fades.

- Environment (light, temperature, humidity, sound, and aroma)
  Bright lights, cool dry air, obtrusive or loud music or other annoying irregular sounds, and some invigorating aromas (such as peppermint) may temporarily increase alertness.

- Food and consumption of chemicals
- Caffeine (encountered in coffee and tea and to a lesser extent in colas and chocolate) may combat sleepiness in some people for short periods. However, regular usage over time reduces its value as a stimulant and may make you more tired and less able to sleep.
  Muscular activity
  Any type of muscular activity helps to keep you alert; running, walking, stretching or even chewing gum can stimulate your level of alertness.

- Social Interaction
  Social interaction (conversation) can help you stay awake. However, the interaction must be active to be effective.

- Job Rotation
  Changing the order of activities, where personnel are assigned tasks that include variety in the nature of tasks, can be beneficial in breaking up job monotony. Mixing tasks requiring high physical or mental work with low-demand tasks can be beneficial.

- Strategic Napping
  Research has identified "strategic napping" as a short-term relief technique to help maintain performance levels during long periods of wakefulness. The most effective length of time for a nap is about 20 minutes. This means that if you have the opportunity to nap you should take it. However, there are some drawbacks associated with napping. One potential drawback is that naps longer than 30 minutes will cause sleep inertia, where situational awareness is impaired (grogginess and/or disorientation for up to 20 minutes after waking. A second is that the nap may disrupt later sleeping periods (you may not be tired when time comes for an extended period of sleep).

5. WHAT CAN BE DONE TO REDUCE CREW FATIGUE ON BOARD SHIP?

There are a number of steps that can be taken to prevent fatigue. Many of the measures that reduce fatigue are unfortunately beyond a single person's ability to influence, such as voyage scheduling, ship design, and work scheduling. Steps such as the following are important in the prevention of fatigue on board ship, and are within the Ship Officer's ability to influence and implement:

- Ensuring compliance with maritime regulations (minimum hours of rest and/or maximum hours of work)

- Using rested personnel to cover for those traveling long hours to join the ship and whom are expected to go on watch as soon as they arrive on board (i.e. allowing proper time to overcome fatigue and become familiarized with the ship)

- Creating an open communication environment (e.g. by making it clear to the crew members that it is important to inform supervisors when fatigue is impairing their performance and that there will be no recriminations for such reports)

- Scheduling drills in a manner that minimizes the disturbance of rest/sleep periods

- Establishing on-board management techniques when scheduling shipboard work and rest periods, and using watchkeeping practices and assignment of duties in a more efficient manner (using, where appropriate, IMO and ILO recommended formats – "Model format for table of shipboard working arrangements" and "Model format for records of hours of work or hours of rest of seafarers")

- Assigning work by mixing up tasks to break up monotony and combining work that requires high physical or mental demand with low-demand tasks (job rotation)

- Scheduling potentially hazardous tasks for daytime hours

- Emphasizing the relationship between work and rest periods to ensure that adequate rest is received; this can be accomplished by promoting individual record keeping of hours rested or worked. Using (where appropriate) IMO and ILO recommended formats in "IMO/ILO Guidelines for the Development of Tables of Seafarers' Shipboard Working Arrangements and Formats of Records of Seafarers' Hours of Work or Hours of Rest"

- Re-appraising traditional work patterns and areas of responsibility on board to establish the most efficient utilization of resources (such as sharing the long cargo operations between all the deck officers instead of the traditional pattern and utilizing rested personnel to cover for those who have traveled long hours to join the ship and who may be expected to go on watch as soon as they arrive)

- Ensuring that shipboard conditions, within the crew's ability to influence, are maintained in a good state (e.g., maintaining the heating, ventilation and air-conditioning (HVAC) on schedule, replacing light bulbs, and contending with the sources of unusual noise at the first opportunity)

- Establishing shipboard practices for dealing with fatigue incidents and learning from the past (as part of safety meetings)

- Increasing awareness of the long-term health care of appropriate lifestyle behavior (e.g. exercise, relaxation, nutrition, smoking and alcohol consumption)

6. WHAT RULES AND REGULATIONS ARE IN PLACE TO PREVENT AND DEAL WITH FATIGUE?

Each individual Flag Administration is responsible for the development, acceptance, implementation and enforcement of national and international legislation (conventions, codes, guidelines, etc.) that deals with the various fatigue aspects: work hours, rest periods, crew competency and watchkeeping practices.

The following international organisations have issued various conventions and other instruments that deal with the fatigue aspects:

- *International Labor Organisation: Convention Concerning Seafarers' Hours of Work and the Manning of Ships – ILO Convention No. 180*[1]

- International Maritime Organisation: International Convention on Standards of Training Certification and Watchkeeping for Seafarers, 1978 as amended in 1995 (STCW Convention)[2]; Seafarer's Training, Certification and Watchkeeping Code (STCW Code) Parts

[1] Not yet in force, but is considered to represent the international framework.
[2] Mandatory instrument.

A[3] and B[4]; International Safety Management Code (ISM Code)[5]; and various guidelines/recommendations

In addition to the international standards, company and flag administration policies, which may be more stringent in some cases, should be followed on board all ships.

REFERENCES

[1] **International Maritime Organization (IMO) & International Labour Office (ILO) (1999)-** *IMO/ILO Guidelines for the Development of Tables of Seafarers' Shipboard Working Arrangements and Formats of Records of Seafarers' Hours of Work or Hours of Rest.* IMO – London, United Kingdom

International Transport Workers' Federation (1997) - *Seafarer Fatigue: Wake up to the dangers.* IMO, MSC 69/INF.10 - United Kingdom.

Kroemer, K.H.E., & Grandjean, E. (Re-printed 1999) – *Fitting the Task to the Human.* Taylor & Francis Ltd. - London, United States.

McCallum, M.C., & Raby, M., Rothblum A. (1996) - *Procedures for Investigating and Reporting Human Factors and Fatigue Contributions to Marine Casualties*. Report No. CG-D-09-97. Batelle Seattle Research Center and U.S. Coast Guard Research and Development Center - Connecticut, United States.

Moore-Ede M., Mitchell R. E., Heitmann A., Trutsche U., Aguirre A., & Hajarnavis H. (1996) - *Canalert 1995: Alertness Assurance in the Canadian Railways* - Circadian Technologies, Inc. - Massachusetts, United States.

Parker, A.W., Hubinger, L.M., Green, S., Sargent, L., & Boyd, R. (1997) - *A survey of the health, stress and fatigue of Australian Seafarers* - Australian Maritime Safety Authority - Australia.

Pollard J.K., Sussman E.D., & Stearns M. (1990) - *Shipboard Crew fatigue, Safety and Reduced Manning.* Report No. DOT-MA-RD-840-90014. John A. Volpe National Transportation Systems Center - Massachusetts, United States.

Sandquist T., Raby M., Maloney A.L., Carvalhais T. (1996) - *Fatigue and Alertness in Merchant Marine Personnel: A field study of work and sleep patterns.* Report No. CG-D-06-97. Batelle Seattle Research Center and U.S. Coast Guard Research and Development Center - Connecticut, United States.

Transportation Safety Board of Canada (1997) - *A Guide for Investigating for Fatigue* - Canada.

[3] Mandatory instrument.
[4] Recommendatory guidance.
[5] Mandatory instrument.

United Kingdom National Union of Marine Aviation and Shipping Transport Officers (1997) - *Give us a Break: NUMAST Report on Fatigue*. IMO, MSC 68/INF. 9 - United Kingdom.

Videotel (1998). *Fatigue and Stress at Sea* [video] - London, United Kingdom.

Guidelines on Fatigue
Module 4

FATIGUE AND THE MASTER

Foreword

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9. Module 9	Fatigue and Tugboat Personnel
10. Appendix	Fatigue related documentation

It is recommended that all parties become familiar with Module 1 prior to using Modules 2 - 9. Module 1 contains pertinent background information on the subject of fatigue.

Module 4 contains practical information intended for the ***Master*** working on board ships. It is recommended that the Master also becomes familiar with Modules 2 and 3 (Fatigue and the Rating and Fatigue and the Ship's Officer respectively).

Guidelines on Fatigue
Module 4

FATIGUE AND THE MASTER

1. HOW CAN YOU RECOGNIZE FATIGUE IN YOURSELF AND OTHERS (SIGNS/SYMPTOMS)?

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Table 1 describes some of the possible effects of fatigue by listing performance impairments and the symptoms associated with them. These signs and symptoms of fatigue may be used to identify an individual's level of alertness. It must be noted, however, that it is difficult for an individual to recognize the symptoms of fatigue within him/herself, because fatigue impairs judgement.

TABLE 1
EFFECTS OF FATIGUE

PERFORMANCE IMPAIRMENT		SIGNS/SYMPTOMS
1	Inability to concentrate	• *Unable to organize a series of activities* • *Preoccupied with a single task* • *Focuses on a trivial problem, neglecting more important ones* • *Reverts to old but ineffective habits* • *Less vigilant than usual*
2	Diminished decision-making ability	• Misjudges distance, speed, time, etc. • Fails to appreciate the gravity of the situation • Overlooks items that should be included • Chooses risky options • Difficulty with simple arithmetic, geometry, etc.
3	Poor memory	• Fails to remember the sequence of task or task elements • Difficulty remembering events or procedures • Forgets to complete a task or part of a task
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6	Mood change	• Quieter, less talkative than usual • Unusually irritable • Increased intolerance and anti-social behavior • Depression
7	Attitude change	• Fails to anticipate danger • Fails to observe and obey warning signs • Seems unaware of own poor performance • Too willing to take risks • Ignores normal checks and procedures • Displays a "don't care" attitude • Weakness in drive or dislike for work

In addition to the behavioral changes listed in the table (symptoms), there are also a number of other changes associated with fatigue that will manifest as physical discomfort, such as:

- Headaches
- Giddiness
- Heart palpitations / irregular heart beats
- Rapid breathing
- Loss of appetite
- Insomnia
- Sudden sweating fits
- Leg pains or cramps
- Digestion problems

2. WHAT CAN CAUSE FATIGUE?

Fatigue may be caused and/or made worse by one or a combination of things:

- Lack of sleep
  Only sleep can maintain or restore your performance level. When you do not get enough sleep, fatigue will set in and your alertness will be impaired. (Refer to Section 3)

- Poor quality of sleep
  Fatigue may be caused by poor quality of sleep. This occurs when you are unable to sleep without interruptions or you are unable to fall asleep when your body tells you to. (Refer to Section 3)

- Insufficient rest time between work periods
  Apart from sleep, rest (taking a break) between work periods can contribute to restoring your performance levels. Insufficient rest periods or postponing assigned rest times (to finish the job early) can cause fatigue. (Refer to Section 3)

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  Boredom can cause fatigue. You may become bored to the point of fatigue when your work is too easy, repetitive and monotonous and/or bodily movement is restricted.

- Noise or vibration
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  The ship's movement affects your ability to maintain physical balance. Maintaining balance requires extra energy, which can then cause fatigue. A ship's pitching and rolling motions mean you might have to use 15-20% extra effort to maintain your balance.

- Food (timing, frequency, content and quality)
  Refined sugars (sweets, doughnuts, chocolates, etc.) can cause your blood sugar to rise rapidly to a high level. The downside of such short-term energy is that a rapid drop in blood sugar can follow it. Low blood sugar levels can cause weakness, instability and difficulty in concentrating and in the extreme case, unconsciousness. Eating large meals prior to a sleep period may disrupt your sleep.

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  Jet-lag occurs following long flights through several time zones. It is a condition that causes fatigue in addition to sleep-deprivation and irritability. It is easier to adjust to time zones while crossing from east to west as opposed to west to east. The greatest difficulty in adjustment results from crossing 12 time zones, the least from crossing one time zone. Our bodies adjust at the rate of approximately one-hour per day.

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- Loss of appetite

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A. Sleep Issues

The most effective strategy to fight fatigue is to ensure that you get the very best quality and quantity of sleep. Sleep loss and sleepiness can degrade every aspect of human performance such as decision-making, response time, judgement, hand-eye coordination, and countless other skills.

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- Consider relaxation techniques such as meditation and yoga, which can also be of great help if learnt properly.

B. Rest Issues

Another important factor that can affect fatigue and recovery is rest. Rest, apart from sleep, can be provided in the form of breaks or changes in activities. Rest pauses or breaks are indispensable as a physical requirement if performance is to be maintained. Factors

influencing the need for rest are the length and intensity of the activities prior to a break or a change in activity, the length of the break, or the nature or change of the new activity.

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- Maintain fitness for duty including medical fitness.
- Eat regular, well-balanced meals.
  Exercise regularly.

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The most powerful means of relieving fatigue is to get proper sleep and to rest when appropriate. However, a number of countermeasures have been identified as potentially providing some short-term relief. It must be emphasized that these countermeasures will not restore an individual's state of alertness; they only provide short-term relief, and may in fact, simply mask the symptoms temporarily. The following list captures some of the short-term countermeasures:

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  Research has identified "strategic napping" as a short-term relief technique to help maintain performance levels during long periods of wakefulness. The most effective length of time for a nap is about 20 minutes. This means that if you have the opportunity to nap you should take it. However, there are some drawbacks associated with napping. One potential drawback is that naps longer than 30 minutes will cause sleep inertia, where situational awareness is impaired (grogginess and/or disorientation for up to 20 minutes after waking. A second is that the nap may disrupt later sleeping periods (you may not be tired when time comes for an extended period of sleep).

5. WHAT CAN BE DONE TO REDUCE CREW FATIGUE ON BOARD SHIP?

There are a number of steps that can be taken to prevent fatigue. Many of the measures that reduce fatigue are unfortunately beyond a single person's ability to influence, such as voyage scheduling, ship design, and work scheduling. Steps such as the following are important in the prevention of fatigue on board ship, and are within the Master's ability to influence and/or implement:

- Ensuring compliance with maritime regulations (minimum hours of rest and/or maximum hours of work)

- Using rested personnel to cover for those traveling long hours to join the ship and whom are expected to go on watch as soon as they arrive on board (e.g. allowing proper time to overcome fatigue and become familiarized with the ship)

- Impressing upon shore management the importance and benefits of addressing fatigue management and countermeasures in the context of the company's Safety Management System (as required by the International Safety Management Code)

- Impressing upon shore management the importance of the constant interaction between them and the ship management with respect to fatigue awareness and preventive measures on board the ships

- Creating an open communication environment, by making it clear to the crew members that it is important to inform supervisors when fatigue is impairing their performance and ensuring that there will be no recriminations for such reports

- Emphasizing to shore management the importance of selecting seafarers with the right training and experience for the job

- Improving shipboard conditions to ensure that when there is an opportunity to sleep, crew members can take advantage of it without interruptions, e.g. by scheduling drills and routine maintenance functions in a manner that minimizes the disturbance of rest/sleep periods

- Establishing on-board management techniques when scheduling shipboard work and rest periods and when scheduling watchkeeping practices and assignment of duties in a more efficient manner (using, where appropriate, IMO and ILO recommended formats – "Model Format for Table of Shipboard Working Arrangements" and "Model Format for Records of Hours of Work or Hours of Rest of Seafarers")

- Assigning work by mixing up tasks to break monotony and to combine work requiring high physical or mental demand with low-demand tasks (job rotation)

- Scheduling potentially hazardous tasks for daytime hours

- Advocating to shore management that shipboard personnel should be provided with training and support so they may recognize and deal with the effects of fatigue

- Emphasizing the relationship between work and rest periods to ensure that adequate rest is received; this can be accomplished by promoting individual record keeping of hours at rest or worked. Using (where appropriate) IMO and ILO recommended formats in "IMO/ILO Guidelines for the Development of Tables of Seafarers' Shipboard Working Arrangements and Formats of Records of Seafarers' Hours of Work or Hours of Rest"

- Taking time to personally verify that watchkeeping personnel are getting adequate rest

- Ensuring that shipboard conditions, within the crew's ability to influence, are maintained in a good state (e.g. maintaining the heating, ventilation and air-conditioning on schedule, light bulbs are replaced, sources of unusual noise are taken care of at the first opportunity)

- Re-appraising traditional work patterns and areas of responsibility on board to establish the most efficient utilization of resources (such as sharing the long cargo operations between all the deck officers instead of the traditional pattern and utilizing rested personnel to cover for those who have travelled long hours to join the ship and who may be expected to go on watch as soon as they arrive)

- Promoting supportive relationships on board (good morale) and dealing with interpersonal conflict between seafarers

- Establishing shipboard practices for dealing with fatigue incidents and learning from them (e.g. as part of the safety meetings)

- Increasing awareness of the long term health care of appropriate lifestyle behavior (e.g. exercise, relaxation, nutrition, smoking and alcohol consumption)

6. WHAT RULES AND REGULATIONS ARE IN PLACE TO PREVENT AND DEAL WITH FATIGUE?

Each individual Flag Administration is responsible for the development, acceptance, implementation and enforcement of national and international legislation (conventions, codes, guidelines, etc.) that deal with the various fatigue aspects: work hours, rest periods, crew competency and watchkeeping practices.

The following international organizations have issued various conventions and other instruments that address fatigue:

- *International Labor Organisation (ILO)*
  Convention Concerning Seafarers' Hours of Work and the Manning of Ships – ILO Convention No.180[6]*;*
- International Maritime Organisation (IMO)
  International Convention on Standards of Training Certification and Watchkeeping for Seafarers, 1978, as amended in 1995 (STCW Convention)[7]; Seafarer's Training, Certification and Watchkeeping Code (STCW Code) Parts A[8] and B[9]; International Safety Management Code (ISM Code)[10]; and various guidelines/recommendations.

In addition to the international standards, company and flag administration policies, which may be more stringent in some cases, should be followed on board all ships.

7. HOW DOES FATIGUE RELATE TO THE ILO AND IMO INSTRUMENTS?

The following ILO instruments contain guidance on fatigue related aspects:

- Convention No. 180
  This convention introduces provisions to establish limits on seafarers' maximum working hours or minimum rest periods so as to maintain safe ship operations and minimize fatigue. The text from the Convention is provided in the Appendix.

- Other Conventions
  Other ILO Conventions related to fatigue include the following convention numbers: 92, 133, 140, 141 and 147. Each introduces minimum habitability requirements (e.g. noise control and air conditioning) on board ships.

[6] Not yet in force.
[7] Mandatory instrument.
[8] Mandatory instrument.
[9] Recommendatory guidance.
[10] Mandatory instrument.

The following IMO instruments contain guidance on fatigue related aspects:

- ISM Code
  This Code introduces safety management requirements on shipowners to ensure that conditions, activities, and tasks (both ashore and afloat) that affect safety and environmental protection are planned, organized, executed and verified in accordance with company requirements. The fatigue related requirements include:
  1. manning of ships with qualified and medically fit personnel;
  2. familiarization and training for shipboard personnel; and
  3. issuance of necessary support to ensure that the shipmaster's duties can be adequately performed.

- STCW Convention and STCW Code
  The STCW Convention requires that Administrations, for the purpose of preventing fatigue, establish and enforce rest period requirements for watchkeeping personnel. In addition, the Convention sets minimum periods and frequencies of rest. Part A of the Code requires posting of the watch schedules. Part B of the Code recommends that record keeping is useful as a means of promoting compliance with the rest requirements.

- Resolution A.772(18) [11] – Fatigue Factors in Manning and Safety
  This Resolution provides a general description of fatigue and identifies the factors of ship operations which may contribute to fatigue.

- Other Instruments
  The Appendix contains a list of IMO instruments identified as having some applicability to crew fatigue.

[11] Resolutions are not binding on governments, however their content is in some cases implemented by government through incorporation in domestic legislation.

REFERENCES

[1] **International Maritime Organization (IMO) & International Labour Office (ILO) (1999)-** *IMO/ILO Guidelines for the Development of Tables of Seafarers' Shipboard Working Arrangements and Formats of Records of Seafarers' Hours of Work or Hours of Rest.* IMO – London, United Kingdom

International Transport Workers' Federation (1997) - *Seafarer Fatigue: Wake up to the dangers.* IMO, MSC 69/INF.10 - United Kingdom.

Kroemer, K.H.E., & Grandjean, E. (Re-printed 1999) – *Fitting the Task to the Human.* Taylor & Francis Ltd. – London, United Kingdom.

McCallum, M.C., & Raby, M., Rothblum A. (1996) - *Procedures for Investigating and Reporting Human Factors and Fatigue Contributions to Marine Casualties*. Report No. CG-D-09-97. Batelle Seattle Research Center and U.S. Coast Guard Research and Development Center – Connecticut, United States.

Moore-Ede M., Mitchell R. E., Heitmann A., Trutsche U., Aguirre A., & Hajarnavis H. (1996) - *Canalert 1995: Alertness Assurance in the Canadian Railways* - Circadian Technologies, Inc. – Massachusetts, United States.

Parker, A.W., Hubinger, L.M., Green, S., Sargent, L., & Boyd, R. (1997) - *A survey of the health, stress and fatigue of Australian Seafarers* - Australian Maritime Safety Authority - Australia.

Pollard J.K., Sussman E.D., & Stearns M. (1990) - *Shipboard Crew fatigue, Safety and Reduced Manning.* Report No. DOT-MA-RD-840-90014. John A. Volpe National Transportation Systems Center – Massachusetts, United States.

Sandquist T., Raby M., Maloney A.L., Carvalhais T. (1996) - *Fatigue and Alertness in Merchant Marine Personnel: A field study of work and sleep patterns.* Report No. CG-D-06-97. Batelle Seattle Research Center and U.S. Coast Guard Research and Development Center – Connecticut, United States.

Transportation Safety Board of Canada (1997) - *A Guide for Investigating for Fatigue* – Canada.

United Kingdom National Union of Marine Aviation and Shipping Transport Officers (1997) - *Give us a Break: NUMAST Report on Fatigue*. IMO, MSC 68/INF. 9 - United Kingdom.

Videotel (1998). *Fatigue and Stress at Sea* [video] - London, United States.

Guidelines on Fatigue
Module 5

FATIGUE AND THE TRAINING INSTITUTION AND MANAGEMENT PERSONNEL IN CHARGE OF TRAINING

Foreword

The Guidelines on Fatigue contain practical information that can assist interested parties (Naval architects/Ship designers, owners/operators, Masters, Officers, other crew members and training institutions) to better understand and manage fatigue.

The guidelines provide information on the potential dangers of fatigue and ultimately the effect on the health and safety of the personnel working on ships. The guidelines contain information on the symptoms and causes of fatigue, and address solutions to combat fatigue in order to improve associated health problems and prevent fatigue related accidents from occurring.

The guidelines have been divided into nine modules, as follows:

1. Module 1	Fatigue
2. Module 2	Fatigue and the Rating
3. Module 3	Fatigue and the Ship's Officer
4. Module 4	Fatigue and the Master
5. Module 5	Fatigue and the Training Institution and Management Personnel in charge of Training
6. Module 6	Shipboard Fatigue and the Owner/Operator/Manager
7. Module 7	Shipboard Fatigue and the Naval Architect/Ship Designers
8. Module 8	Fatigue and the Maritime Pilot
9. Module 9	Fatigue and Tugboat Personnel
10. Appendix	Fatigue related documentation

It is recommended that all parties become familiar with Module 1 prior to using Modules 2 - 9. Module 1 contains pertinent background information on the subject of fatigue.

Module 5 contains practical information intended for the **Training Institution and Management Personnel in charge of Training**. It is recommended that they become familiar with all the other Modules or at least with Modules 2, 3 and 4 respectively (Fatigue and the Rating, Fatigue and the Ship's Officer, Fatigue and the Master).

Guidelines on Fatigue
Module 5

FATIGUE AND THE TRAINING INSTITUTIONS AND MANAGEMENT PERSONNEL IN CHARGE OF TRAINING

1. WHAT ARE THE OBJECTIVES OF EDUCATING STUDENTS ABOUT FATIGUE?

Fatigue can be defined and described. The goal of fatigue training is to help students understand the general concept of fatigue and be able to relate to it personally. Achieving this goal will create a foundation upon which the more specific topics of seafarer fatigue can be addressed.

The initial objective is to develop both an awareness of the principle dimensions of fatigue and instill an acceptance that all people experience fatigue – fatigue is not a personal shortcoming or weakness, but rather a part of the human condition. It is inevitable that some students will resist or deny the possibility of personally experiencing fatigue, but it is essential that students become aware of their own vulnerability to fatigue in order for training to reach a full and desired effect.

The secondary objective is for students to comprehend short and long-term fatigue symptoms, including effects and possible preventive and mitigating measures, specifically regarding seafaring. Possible preventive and mitigative techniques should be introduced only after a reasonable level of personalization and an acceptance of fatigue has been achieved.

Many known fatigue preventive-measures/mitigating-techniques within the shipboard environment lie outside the power of a single individual or appear impossible to counteract (such as the rearrangement of four-on/eight-off watches, changing ship design, or modifying voyage schedules). This realisation can discourage and overwhelm students for whom fatigue is a new concept. For this reason, it is recommended that instructors avoid using these very solutions as examples for the initial introduction of fatigue. However, these particular solutions might be very well suited for shipowners or ship management training sessions.

The tertiary objective is for students to develop strategies for preventing or minimizing fatigue within their places of work. All points and issues raised during earlier discussions should be integrated.

2. WHAT APPROACHES AND TECHNIQUES ARE SUCCESSFUL FOR TEACHING FATIGUE?

A wide variety of teaching techniques may be employed in order to accomplish the objectives referenced above. While the concepts of fatigue and prevention must be equally stressed, it remains most important that students personalize or "own" these concepts. Otherwise, the desired results will be nearly impossible to achieve.

It is imperative that instructors personalize the concept of fatigue by engaging students early on (the initial objective). Group discussion should be begun by inviting students to share their own

words for defining fatigue. Once various descriptions are shared, a consensus about the existence of, and the definition for, fatigue should be reached. Students should then be invited to share their own experiences. At this point, no real effort should be made to direct the conversation to a specific workplace or to seafaring. The instructor should point out that many people deny their personal experiences with fatigue or may not wish to recall them in public. Reminding the class of the fact that all people experience fatigue may help encourage students who previously denied any experience to acknowledge their own. In the end, it is very important that each individual accepts the concept of fatigue and is able to relate to it personally.

After determining that students have accepted the concept, the instructor should direct the training toward the concept of seafarer fatigue and preventive measures/mitigating techniques (the secondary objective). At this point, modules 2, 3, and 4 can be utilized to specifically tailor the training to the audience (such as ratings, officers, or masters). Specific items to be addressed and referenced include the causes, effects, mitigative and preventive factors, rules, and regulations concerning seafarer fatigue, and so forth.

The success of the training is directly related to whether or not the students personalize the concept. The instructor's professional opinion is the best way to measure the progress of the students. Likewise, it is the instructor who can best provide emphasis as needed to reach each student. Computer Based Training (CBT) could prove a valid method of delivery, but it would require careful design to ensure that each student "personalizes" the concept before s/he progresses to the secondary and tertiary objectives. It is true that any increased level of awareness is better than no awareness, but a truly effective training session must involve student feedback and should gauge their progression. No matter what pedagogical approach is chosen, the subject matter of this training can be greatly enhanced by video presentations and similar audio-visual aids.

3. WHAT CAN BE LEARNT FROM EXPERIENCE?

The final summary stage of training integrates the initial and secondary objectives and focuses on what the student will do after leaving the training session (the tertiary objective). Ideally, this new knowledge will be taken back to the workplace and put into practice. Prevention measures and mitigation techniques can become a way of life for the student who appreciates the concept of fatigue and its effects on seafaring.

Lessons learnt will provide a means to develop useful strategies to prevent or minimize fatigue. The instructor should review the previously shared personal experiences and direct the conversation toward the "lessons learnt" or strategies, as students see them. The focus should then shift toward specific experiences (case studies) within the seafarer's workplace. At this time, select case studies will also be instrumental in showing what each student should try to do upon returning to the workplace.

Three general learning objectives with desired training outcomes form the basis for a class outline or syllabus:

Objective One: Those successfully meeting the first objective of the course should be able to define fatigue, relate to fatigue on a personal level, and recognize the signs of fatigue.

Objective Two: Those successfully meeting the second objective of the course should be able to understand and recognize the characteristics of short term and long term fatigue including the effects and consequences of these effects on the seafarer. They should be able to understand what techniques are presently known which would prevent fatigue, and should understand the techniques and measures that might be used to mitigate fatigue.

Objective Three: Those successfully meeting the third objective of the course should be able to integrate their knowledge of fatigue and preventive-measures/mitigative-techniques into the workplace. These strategies will result in the reduction of personal fatigue and its consequences.

4. HOW CAN WE DISSEMINATE THE LESSONS LEARNT?

Lessons learnt play a key role in helping students develop strategies for the workplace. They are also useful in reinforcing awareness of fatigue among seafarers, shipowners, managers, and naval architects. A periodic summary of lessons learnt could be circulated on a ship-by-ship or company-by-company basis or even by governmental agencies to relevant populations. Various non-profit organizations (such as the Seamen's Church Institute) can also be instrumental in passing on "lessons learnt."

The subject of fatigue also fits well within companies, port authorities, and government agencies that print and distribute publications with a safety focus. CD-ROMs, videos, and Internet web-sites are another useful tool for dissemination. Furthermore, examples showing how fatigue affects other transportation industries could enhance the seafarer's understanding of how pervasive and far-reaching the problem is. Distributing these lessons will allow the government, shipowner/manager, or shipmaster to demonstrate their commitment to the awareness and prevention of seafarer fatigue.

5. WHY INCLUDE CASE STUDIES/EXAMPLES?

As seen in the tertiary objective, the development of strategies for "life after the training session" is critically important. In this regard, it is necessary to incorporate case studies/examples into the training. These cases serve to support the "lessons learnt" portion of the training. Case studies from all transportation industries are useful, but the majority should focus on the maritime sector and preferably that sector with which the student is involved (ships, barges, ratings, officers, etc.). The cases can be used to provide a picture of what happened, probable causes, and what can be done differently to prevent a reoccurrence.

Case studies are available from a number of sources. Insurance companies (particularly the P and I Clubs) should be encouraged to share their data on fatigue related claims, including the costs of such claims. The International Maritime Organization's (IMO) efforts on casualty statistics and investigations should be heightened and their results should be widely distributed. Newly created reporting schemes on accidents and near misses might generate a volume of information in this area. Finally, the IMO Harmonized reporting procedures (MSC/Circ.827) should be discussed in training sessions. It is hoped that the results of some of the reports can be shared in a "case study" manner.

REFERENCES

IMO – *Training Course for Instructors.*

McCallum, M.C., & Raby, M., Rothblum A. (1996) - *Procedures for Investigating and Reporting Human Factors and Fatigue Contributions to Marine Casualties*. Report No. CG-D-09-97. Batelle Seattle Research Center and U.S. Coast Guard Research and Development Center - Groton, Connecticut.

Parker, A.W., Hubinger, L.M., Green, S., Sargent, L., & Boyd, R. (1997) - *A survey of the health, stress and fatigue of Australian Seafarers* - Australian Maritime Safety Authority - Australia.

Transportation Safety Board of Canada (1997) - *A Guide for Investigating for Fatigue* - Canada.

Videotel (1998). *Fatigue and Stress at Sea* [video]. London.

Guidelines on Fatigue
Module 6

SHIPBOARD FATIGUE AND THE OWNER/ OPERATOR/MANAGER

Foreword

The Fatigue guidelines contain practical information that can assist interested parties (Naval architects/Ship designers, owners/operators, Masters, Officers, other crew members and training institutions) to better understand and manage fatigue.

The guidelines provide information on the potential dangers of fatigue and ultimately the effect on the health and safety of the personnel working on ships. The guidelines contain information on the symptoms and causes of fatigue, and address solutions to combat fatigue in order to improve associated health problems and prevent fatigue related accidents from occurring.

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8. Module 8	Fatigue and the Maritime Pilot
9. Module 9	Fatigue and Tugboat Personnel
10. Appendix	Fatigue related documentation

It is recommended that all parties become familiar with Module 1 prior to using Modules 2 - 9.; Module 1 contains pertinent background information on the subject of fatigue.

Module 6 contains practical information intended for the **Owner/Operator/Manager**. It is recommended that they become familiar with Modules 2, 3 and 4 respectively (Fatigue and the Rating, Fatigue and the Ship's Officer, Fatigue and the Master).

Guidelines on Fatigue
Module 6

SHIPBOARD FATIGUE AND THE OWNER/ OPERATOR/MANAGER

1. IS FATIGUE AN IMPORTANT ISSUE IN SHIPBOARD OPERATIONS?

Fatigue has been recognized as an important Occupational Health and Safety (OH&S) issue for seafarers. Fatigue has the potential to greatly increase the risk of accidents and injuries in the work place. It disrupts body rhythms and results in poor sleep quality, digestive problems, delusions, confusion, lethargy, respiratory problems, depression, irritability, neurosis and temporary psychosis. Fatigue adversely affects crew performance. It diminishes attentiveness and concentration, slows physical and mental reflexes and impairs rational decision making capability.

An assessment of accidents occurring in the last six months of 1995 indicated that 16% of critical ship casualties, and 33% of injuries, were partly due to human fatigue[1]. Clearly, addressing the issue of fatigue should have a positive effect on personnel safety and has the potential to cut cost for the shipowner, operator or manager by reducing injury and physical damage to high value assets and the environment.

Fatigue occurs primarily because an individual cannot get sufficient rest to recover from the effects of having been awake or heavily stressed for a prolonged period. The level of fatigue experienced will be influenced by additional factors apart from the wake period. The type of work undertaken, the environment in which the individual works and lives, and the time of day in which the work is done could all contribute to the level of fatigue experienced. One of the best ways to mitigate the effects of fatigue is through the accumulation of adequate recovery sleep. However, obtaining adequate recovery sleep can be difficult depending on factors like work schedule, circadian rhythm and the physical environment.

The normal sleep-wake cycle of human beings is controlled by a temperature rhythm, referred to as the circadian rhythm. This rhythm actively promotes sleep at night and wakefulness during the day. As a result, work at night is likely to be more fatiguing and an individual is less likely to be able to accumulate restful sleep during the daytime period when they are off watch. These persons will generally get less sleep during the day, than if they were sleeping for an equivalent period at night[2]. Furthermore, day sleepers sleep lightly and are thus easily disturbed by noise, temperature, etc. It is clear the management process must take this factor into account to effectively cope with crew fatigue.

2. HOW DOES FATIGUE AFFECT CREW PERFORMANCE?

In order to understand the physiological effects of fatigue, it is useful to describe these effects in relation to a known detriment to performance. In recent studies, the effect of fatigue was found to be comparable to those of alcohol, in terms of negatively impacting performance. One study found that a period of sustained wakefulness of 18 hours was comparable to a Blood Alcohol Concentration (BAC) of 0.05%[3]. As sleep deprivation continued for 24 hours, the effects of

fatigue equated to a BAC of 0.10%. What is even more alarming is that the subjects of this study were well-rested students (they had not accumulated a sleep debt prior to the study) who were not required to undertake any hard physical activity during the period. Similar effects can be expected from other populations, and in fact, it might be possible that the effects of sleep deprivation for older individuals would be greater. Both quality of sleep and recovery from fatigue are known to worsen with age.

Factors, such as the following, will have an effect on the level of fatigue experienced in a given period: (a) the time of day when work was started and completed, (b) the amount and timing of rest over the previous seven days, (c) the activities undertaken during the period of work, and (d) the environment in which work was carried out. If this level of performance degradation was due to alcohol intoxication at sea, this would be considered unacceptable. In view of the similarity between the effects of alcohol and fatigue, it is perhaps appropriate that both be considered in a similar fashion.

Other research has shown that periods of sustained operations for 24 hours result in a drop in performance of about 25%[4]. Specifically, fatigue will have a detrimental effect on higher level mental functions prior to the more obvious effects such as falling asleep on watch or mood change becoming apparent. Loss of higher mental functions will degrade the ability to solve complex problems or rapidly analyze information. A further danger is the likelihood that higher mental skills will be affected before any noticeable reduction in routine or simple activities.

One way to explain how the loss of sleep or rest can affect seafarers is to consider bridge watchkeeping. While on watch, sleep loss has been reported to have the following effects:

- Slowed reaction
- Delayed or false response
- Failure to respond at the correct time
- Slowed thinking and diminished memory

These outcomes each pose a risk to any position aboard, but especially those that have critical safety responsibilities. Should an individual fail to carry out an allotted task due to fatigue, the crew runs the risk of injury or accident. Any risk management strategy must focus on mitigating the potential for such hazards to arise by addressing the causes of fatigue. Systems and work procedures should be critically examined to engineer out design deficiencies that could contribute to fatigue.

3. WHAT ELEMENTS OF FATIGUE CAN THE SHIPOWNER, /OPERATOR, OR /MANAGER INFLUENCE?

While it is not possible for Shipowners, Operators and/or Managers to regulate and oversee the sleeping habits of every crewmember on every ship, it is within their capability to establish a fatigue management system. Hours of work are presently controlled by a prescriptive formula set out in Chapter VIII of the Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW) 1978/1995. Managers should be aware (when applying these hours of work limitations) that considering the effects of circadian rhythm and sleep debt are important for

ensuring that rest periods are of high quality. It also cannot be too highly stressed that rest means rest, not substituting a different form of work. Some necessary elements to an effective fatigue management system are as follows[5]:

- objective measurement of the causes and effects of fatigue
- comprehensive programmes comprise several elements
  - training and education on fatigue and shiftwork for all stakeholders (watchkeeping);
  - planning tools such as fatigue modelling or rosters (watchkeeping systems) and work arrangements
  - impairment testing programs, auditing the results of previous initiatives

The bullet describing comprehensive programmes details those activities that shipowners, operators and/or managers can implement in order to manage some of the risks involved with fatigue. The primary implication for management is to monitor and assess the effectiveness of fatigue management routines within their control.

Some organisations already maintain records of hours worked. However, these hours are normally assessed against the criteria set out by the STCW convention or similar instruments. Taking the effects of circadian rhythm into account can strengthen this approach. Planning tools such as fatigue modelling or rosters (watchkeeping systems) and work arrangements, which take these effects into account, enable management to do the following:

- Analyse planned work routines by management to ascertain the risk of fatigue
- Monitor work hours on board the ship to determine whether or not the risk of fatigue is increasing as a result of the work arrangements or from any variations that may have occurred
- Analyse and comparing information related to hours of work that will determine the effectiveness of employed routines, compared to other alternatives

Such modelling systems are becoming more readily available and systems that are applicable to the maritime environment are on the market. It is important to choose a system that has been validated by a number of studies and has been utilised in transport application[6]. Overall, it is important that management adopt a fatigue management system that is tailored to the individual enterprise.

4. HOW CAN OWNERS/OPERATORS/MANAGERS ENSURE THAT FATIGUE PREVENTION IS PRACTISED ONBOARD?

Management should consider the following in developing fatigue management policies and systems:

- ISM Code requirements for clear, concise guidance on operational procedures on board
- The need for joining crews to be adequately rested before assuming duties
- Scheduling time for proper hand over on crew change
- Voyage length, time in port, length of service and leave ratios
- Multicultural issues; language barriers, social, cultural and religious isolation
- Interpersonal relationships, stress, loneliness, boredom, social deprivation and increased workload as a result of small crew numbers
- Provision for shore leave and onboard recreation, family communication

- Watchkeeping arrangements
- Job rotation
- Improved sleeping berths and accommodation
- Adequate quality and quantity of food for proper nutrition
- Read Modules 2-4 for additional potential managerial mitigation tools
- Modification of present ship design or future designs

As noted in the previous section, an effective fatigue management system requires training. Ensuring the crew understands the necessity of getting regular rest and the implications of being fatigued (both to themselves and to the safety of the ship and/or those working with them) should be part of the education process. This process, as with any other training, needs to be ongoing in nature and may be assessed as part of management's supervision of the ship and its crew.

This training occurs in a system where the results of implementing mitigating strategies can be assessed. This implies that an information system should be established between management and the crewmembers of the ship. Such a system would provide feedback regarding hours- of-work by each crewmember. Such information would allow management to assess the status and effectiveness of work arrangements and confirm that work arrangements are being adhered to.

It may be impractical and unpopular to require crews to report exactly what they did during their time off work. Even though this will affect the precision and accuracy of tallied sleep accumulation results, the feedback on work/sleep still provides the basis by which management can monitor the effectiveness of their risk mitigation strategy.

5. WHAT RULES AND REGULATIONS ARE IN PLACE TO PREVENT AND DEAL WITH FATIGUE (INTERNATIONAL, NATIONAL AND MANAGEMENT)?

As discussed in the previous sections, Chapter VIII (Fitness for duty) of the STCW convention sets limits on the hours of work and minimum rest requirements for watchkeepers. However, it does not stipulate minimum requirements for those not keeping watches. The limits described in Table VIII/1 of the convention have been incorporated into national regulation in some countries. This action was taken in order to comply with the requirement of the STCW convention so that *"each administration shall, for the purpose of preventing fatigue… establish and enforce rest periods for watchkeepers."*

In addition to the STCW convention, the International Labour Organisation has developed ILO Convention No 180 (Seafarers Hours of Work and the Manning of Ships 1996). This convention requires governments to establish a work hour regime for crew members based on either minimum rest hours or maximum working hours, which can be undertaken in a single day or over a seven-day period. ILO 180 has not yet entered into force; however, this convention has been included in the new Protocol to ILO 147 (Merchant shipping convention). Nations that have ratified ILO 147 will be entitled to inspect foreign flagged ships to determine whether work standards, as required by ILO 147, are being complied with once the Protocol has been ratified by a sufficient number of countries and enters into force.

STCW 78/95 and ILO 180 (once ratified) are relevant to the implementation of the ISM code in so much as the code requires operators to "maintain their ship in conformity with the provisions of the relevant rules and regulations." Ensuring that those on board are fit to undertake their duty

is relevant to the maintenance of the ship in this context as it has an effect upon the seaworthiness of the ship.

Experience with the limits — set by STCW and ILO 180 — is needed to verify which conditions require supplemental information or modifications. However, these requirements must be examined with respect to other factors such as sleep propensity at given times of the day. A rest break taken between the hours of 0000 and 1200 may result in a sleep of 7 to 8 hours compared to a duration of only 5 to 6 hours for a rest break taken in the latter half of the day.

For countries that have independent OH&S legislation for their maritime industry, this factor will become more significant with wider acceptance of fatigue modelling and fatigue risk management. Under such circumstances, compliance with the requirements and the use of risk management tools, where available, will become necessary.

References

[1] **McCallum M.C, Raby M and Rothblum A.M (1996)** – *Procedures for Investigating and Reporting Human Factors and Fatigue Contributions to Marine Casualties*. Report No CG-D-09-97. National Technical Information Service – Virginia, United States.

[2] **Folkard S and Barton J (1993)** – *Does the 'Forbidden Zone' for sleep onset influence morning shift sleep duration?* – Ergonomics. 36(1-3): 85-91 - Australia.

[3] **Dawson D, Lamond N, Donkin K and Reid K (1997)** – *Quantitative Similarity between the Cognitive Psychomotor Performance Decrement Associated with Sustained Wakefulness and Alcohol Intoxication* – From the minutes of the AAPMA 36th Biennial Conference 1998 - Australia.

[4] **Belenky G, Balkin T.J, Redmond D.P, Sing H.P, Thomas M.L, Thorne D.R and Wesensten N.J (1998)** – *Sustaining Performance during Continuous Operations: The US army's Sleep Management System* - taken from The 3rd International Conference on fatigue and Transportation 1998 - Australia.

[5] **Dawson D, Fletcher A and Hussey F (1999)** – *Fatigue and Transport, Report to the Neville Committee* – The Centre for sleep Research, University of South Australia - Australia.

[6] **Reid T, Roberts T. and Dawson D. (1997)** – Improving Shiftwork management II: Shiftwork and Health – Occupation Health and Safety 1997, 13(5): 439-450 – Australia/New Zealand.

Guidelines on Fatigue
Module 7

SHIPBOARD FATIGUE AND THE NAVAL ARCHITECT/SHIP DESIGNER

Foreword

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4. Module 4 Fatigue and the Master
5. Module 5 Fatigue and the Training Institution and Management Personnel in charge of Training
6. Module 6 Shipboard Fatigue and the Owner/Operator/Manager
7. Module 7 Shipboard Fatigue and the Naval Architect/Ship Designer
8. Module 8 Fatigue and the Maritime Pilot
9. Module 9 Fatigue and Tugboat Personnel
10. Appendix Fatigue related documentation

It is recommended that all parties become familiar with Module 1 prior to using Modules 2 - 9. Module 1 contains pertinent background information on the subject of fatigue,
Module 7 contains practical information intended for the **Naval Architect/Ship Designer**, such as information on design guidance and applicable regulations.

Guidelines on Fatigue
Module 7

SHIPBOARD FATIGUE AND THE NAVAL ARCHITECT/SHIP DESIGNER

1. WHY DO THEY NEED TO KNOW ABOUT SHIPBOARD FATIGUE?

The International Maritime Organisation (IMO) has taken steps to publicise the role that human fatigue is increasingly recognised to play in Maritime Accidents, e.g. MSC/Circ.565. Crew fatigue jeopardises ship safety when it leads to human error. Human error is believed to be the major cause of accidents across many industries (Donaldson, 1994). Evidence for the role that it plays in maritime accidents has been provided by recent submissions to IMO, e.g. those made by Japan (MSC 71/INF.8; MSC 69/INF.16); Finland (MSC 68/INF.15); and Australia (MSC 69/INF.15). In addition to accidents, human fatigue also affects the potential for operational problems, system breakdowns and near miss-accidents. Fatigue can detrimentally affect factors such as decision-making, which ultimately leads to undesirable situations.

In addition to the threat of ship safety, shipboard fatigue can jeopardise seafarers' physical and psychological health, at a high cost to the individual and the industry. Seafarers work in a physically demanding environment that requires a high degree of alertness and concentration. Exhausted seafarers are more vulnerable to the many hazards onboard ships, resulting in slips and falls, strikes by falling objects, burns, body strains and other injuries. Injury claims from P&I Club statistics illustrate how much these hazards cost the industry, in addition to lost time and vessel delays.

Sleep-deprivation is among the main causes of seafarers' fatigue, but it is not the sole cause. Crew also become fatigued as a result of living and working onboard. This module will concentrate on guidance for improving the ambient environmental conditions onboard ship, as this is the main area where class rules and guidance can be used to alleviate fatigue. However, there is a limit on what can be achieved through design intervention with regards to the ambient environment. In light of this, the working environment and the working practices should be designed to reduce or compensate for crew fatigue. This module deals with design impacts and should therefore be read in conjunction with the other modules.

Reducing shipboard fatigue will require orchestrated action by many groups, including flag states, shipowners and operators. Naval architects and ship designers make their unique contribution by improving the design of shipboard conditions.

2. HOW DOES FATIGUE AFFECT CREW PERFORMANCE?

Fatigue can arise from sleep-deprivation, from physical or mental exhaustion; even from the boredom of watchkeeping in the still of the night. Whatever the cause, the effect of fatigue on crew performance can be crippling, bedevilling safe operations which rely on alertness and concentration. Fatigue affects crew performance in a number of detrimental ways:

- Causes drowsiness
- Impairs perception (e.g. causing failure to detect visual or auditory stimuli)
- Clouds judgement
- Slows reactions (physical and mental)
- Reduces motivation, encouraging apathy

The effect fatigue has on seafarers' performance is now well-understood thanks to comprehensive studies which were undertaken on the subject:

1. Parker A.W., Hubiner L.M., Green S., Sargent L. and R. Boyd (1997). A survey of the health, stress, and fatigue of Australian seafarers. Conducted on behalf of the Australian Maritime Safety Authority.

2. Sanquist T.F., Ravy M., Maloney A.L. and A.B. Carvalhais (1996). Fatigue and alertness in merchant marine personnel: a field study of work and sleep patterns.

3. Seafarer fatigue: Wake up to the dangers. Submitted to IMO by the International Transports Workers' Federation. (IMO MSC 69/INF.10.).

4. Pollard, J.K., Sussman, E.D and Stearn, S.M.(1990). Shipboard Crew Fatigue, Safety and Reduced Manning. (US DOT MA-RD-840-90014). US Department of Transportation, Maritime Administration.

The first two studies were conducted on behalf of the Australian and United States administrations respectively, whilst the third study, undertaken by the International Transport Workers' Federation, analysed the views of seafarers all over the world:

"Based on responses from 2,500 seafarers of 60 different nationalities, serving under 63 different flags, the report demonstrates the disturbing extent of excessive hours and fatigue within the industry." (IMO MSC 69/INF.10.).

These reports provide clear evidence to the extent of the problem and the ways in which fatigue is detrimental to performance. The third report contains a number of recommendations for improvements, the most pertinent for naval architects and ship designers being (a) the consideration of shipboard ergonomics and the ability to gain an adequate quality of sleep onboard, and (b) the improvement of shipboard conditions.

Before examining the relationship of ergonomics to fatigue, some discussion will be given to those aspects of fatigue that can be influenced by the application of ergonomics.

3. WHAT ELEMENTS OF FATIGUE CAN BE INFLUENCED BY THE DESIGN PROCESS?

There are various aspects of seafarers' fatigue that can potentially be influenced in the design process. These elements can be grouped in the following way:

- Sleep-interruption or deprivation due to accommodation design
  All aspects of crew cabins can be looked at to improve this situation, e.g. accommodation location, soundproofing measures, cabin/bunk designs and configuration.

- Workplace design
  Workplace design, particularly those that require unnecessary sustained exertion (physical or mental), can be offset by better design of the workplace or by better upkeep of the original condition of the ship.

- Harsh ambient environmental conditions
  For example, too much noise, excessive vibration, inadequate ventilation, poor lighting, excessive heat or cold, too much or too little humidity, poor air exchange in enclosed spaces where people live and work can cause fatigue.

- Boredom
  This particular boredom is due to little change in the environment during work tasks or loads. These states include monotony, reduced vigilance and mental satiation. While most of the solutions for these conditions might be related to modifying work practices, others might involve the innovative use of the following (all can be used to stave off fatigue through lack of stimuli):
  - lighting
  - temperature
  - sound
  - smell

- Onboard facilities
  Recovery from fatigue can be assisted or hampered by favourable or unfavourable crew onboard facilities including the design of features within:
  - accommodations
  - recreational facilities
  - galleys, mess rooms, food preparation and storage areas
  - hygiene facilities
  - medical facilities

- Ship motions

  Fatigue results from ship motions or seakeeping provisions relating to weather and sea states.

  Fatigue that results from the design of the working environment can be alleviated by improvements to the design of the working environment. General 'ergonomic' principles have been developed to aid designers. These are examined in the next section.

4. WHAT DOES ERGONOMICS HAVE TO DO WITH SHIPBOARD FATIGUE?

The discipline of ergonomics is founded on the belief that good design supports human performance and is not limited to aesthetic qualities. A well-designed work system or piece of equipment, from an ergonomics viewpoint, takes advantage of human capabilities and minimizes the impact of human limitation while ensuring that the equipment or system is fully functional, i.e. designed for human use and meets operational requirements. Ergonomics has been defined as:[12]

> "Ergonomics produces and integrates knowledge from the human sciences to match jobs, systems, products and environments to the physical and mental abilities and limitations of people. In doing so, it seeks to improve health, safety, well-being and performance."

[12] Defined by ISO/TC 159/SC 1/WG 1 'Principles of the design of work systems' Vienna, 6/10/97.

Ergonomically designed work systems enhance safety, effectiveness, and efficiency. They should also support the tasks done by officers and crewmembers under all conditions, including situations where people may be fatigued. Below is a set of general ergonomic principles[13] designed to reduce fatigue by adapting working conditions to the anatomical, physiological and psychological characteristics of people in relation to their work environment:

1. The design of the workspace and work equipment shall take into account constraints imposed by body dimensions, with due regard to the work process.

2. The design of the work shall be such as to avoid unnecessary or excessive strain in muscles, joints, ligaments, and in the respiratory and circulatory systems. Strength requirements shall be within physiologically desirable limits. Body movements should follow natural rhythms. Body posture, strength exertion, and body movements should be in harmony with each other.

3. The work environment shall be designed and maintained so that physical, chemical and biological conditions have no noxious effect on people but serve to ensure their health, as well as their capacity and readiness to work. Account shall be taken of objectively measurable phenomena and of subjective assessment.

4. The design of the work process shall safeguard workers' health and safety, promote their well-being, and facilitate task performance, in particular by avoiding overloading and underloading. Overloading and underloading will result in transgressing, respectively the upper or lower limits of the operational range of physiological and/or psychological functions, such as physical or sensory overloading produces fatigue. Conversely, under-loading or monotonous work will diminish vigilance.

   These general principles can be refined into a collection of more specific criteria, which are context-dependent. For example, the first principle (consideration of body dimensions) could be refined in terms of criteria for work-surface height, seating arrangements, space, range for controls, handles etc. The vast majority of ergonomic standards give specific guidance at a low-level of detail. Many of these are tailored for specific industries, some for marine.

Appropriate standards are referenced throughout the following sections. A few standards give guidance on how to incorporate ergonomics into the design process, e.g. ergonomic principles in the design of work systems. The remaining sections also look at specific help that is available to the ship designer wanting to reduce seafarer's fatigue. This "help" takes the form of tools, guides, standards, regulations and rules.

5. WHAT TOOLS ARE AVAILABLE FOR DESIGNING/BUILDING A FATIGUE-RESISTANT SHIP?

Unfavourable environmental conditions can be instrumental in causing fatigue. Environmental conditions include noise levels, vibration, ship motion, seakeeping qualities of the ship, lighting, temperature and ventilation. These environmental conditions affect crewmembers within their workplace (bridge, engine room, etc.) and accommodation quarters, (including dining, food preparation and storage areas, hygiene and medical support areas.)

[13] Taken from: Ergonomic principles in the design of work systems. ISO 6385-1981(E)

These environmental conditions extend across structural design, propulsion, hull forms and several other aspects of design. Often, constructive solutions may be employed to improve environmental conditions. For example, the transmission of noise can be dampened by the insertion of acoustic insulation; similarly, resilience techniques can be used to alleviate vibration problems.

There are a variety of tools such as Finite Element Analysis (FEA) which can assist the ship designer in ensuring that the limits specified by shipowners are not exceeded. These tools can be used for:

- Calculating noise limits
- Calculating vibration limits
- Calculating seakeeping qualities/quality of ride
- Analysing ventilation flows
- Performing model tests

The use of ergonomic standards is also considered to be a major tool for improving the working environment, particularly those that deal with environmental conditions (such as temperature, vibration, ventilation, etc.).

Another tool used during design is the electronic model. These models are increasingly being used to assess both the impact of environmental conditions as well as ergonomics of workplace. With increasing frequency, electronic models — including virtual reality and three-dimensional computer aided design — are allowing early evaluation of various aspects of design.

6. WHAT RULES ARE AVAILABLE FOR DESIGNING/BUILDING A FATIGUE-RESISTANT SHIP?

There are a number of rules, regulations, standards and guidelines designed to enhance environmental conditions, which can be used by the ship designer who wants to reduce seafarer fatigue. As this is a developing area, many of the measures referenced here are provisional.

Accommodation

Crew accommodation is usually located in a far from ideal location. It is built around the operation of the ship, being placed directly over the engine room. This area does not give the best quality of ride. In addition, it can be noisy. Acoustic insulation could be used to reduce noise in this area, but it must also be considered in conjunction with measures to increase sleep disturbances that must be heard, i.e. fire alarms.

Consideration could be given to ensure that the accommodation area is restful and that it aides in recovery from fatigue, e.g. in terms of decor, easy to clean. Some aspects of crew accommodation, for instance minimum size and acoustic insulation, are subject to regulation such as the International Labour Organisation (ILO) Conventions. The ILO Conventions that address crew accommodation are as follows:

- Convention No. 92 concerning crew accommodation on board ship (Revised 1949)
- Convention No. 133 concerning crew accommodation on board ship (supplementary provisions)
- Convention No. 147 concerning minimum standards in merchant ships
- Protocol of 1996 to Convention No. 147
- Recommendation 155 of 1976, recommendation concerning the improvement of standards in merchant ships
- Recommendation No. 140 concerning Crew Accommodation (Air Conditioning)
- Recommendation No. 141 concerning Crew Accommodation (Noise Control)

Crew accommodation is also subject to National Standards such as *The Ministry of Maritime Affairs and Fisheries of Korea, Ship Safety Act: Crew accommodation*.

Environmental conditions in crew-only spaces

Some Classification Societies have rules, most of them being optional rules, for aspects of environmental conditions (i.e. noise and vibration)for certain ship types:

- Passenger (e.g. cruise, Ro-Ro ferries)
- High speed craft (e.g. Surface Effect Ships, wave piercing catamarans, hydrofoil)
- Yachts

However, these rules could form the basis for an assessment of any ship type. The variance that lies between the different schemes operated by different classification societies. A number of these Rules include crew-only spaces as well as passenger spaces. Crew-only spaces are defined as the following:

- accommodation spaces (e.g. cabins, corridors, offices, mess rooms, recreation rooms)
- work spaces
- navigation spaces

These Rules are contained in:

Comfort Class: Tentative Rules for Classification of Ships. Part 5, Chapter 12. Det Norske Veritas. July 1995
Provisional Rules for Passenger and Crew Accommodation Comfort. February 1999. Lloyd's Register of Shipping
Rules for the Evaluation of Noise and Vibration Comfort on Board Passenger Ships. January 1999. Registro Italiano Navale

Noise

Several IMO requirements and Resolutions aim to protect the seafarer from unacceptable levels of noise:

- IMO, Res. A.468(XII) (1981), Code on noise levels onboard ship fixes permissible maximum limits of noise depending on the type of space.[14]

- SOLAS Regulation II-1/36 Protection against noise.[15]

[14] Recommendatory Guidance.
[15] Mandatory Instrument.

Relevant Standards on Noise:

ISO 2923	Acoustics - Measurement of noise onboard vessels
ISO 1999	Acoustics - Determination of occupational noise exposure and estimation of noise-induced hearing impairment
ISO 717/1	Acoustics - Rating of sound insulation in buildings and of building elements: - Part 1: Airborne sound insulation in buildings and interior elements. - Part 2: Impact sound insulation.
ISO 140	Acoustics - Measurement of sound insulation in buildings and of building elements: - Part 4: Field measurements of airborne sound insulation between rooms - Part 5: Filed measurements of airborne impact insulation of floors
IEC Publication 60651	Sound level meters
IEC Publication 60225	Octave, half-octave and third octave band filters intended for the analysis of sound and vibrations
IEC Publication 60804, and amendment No.1, 1989	Integrating-average in sound level meters
IEC Publication 60942	Sound calibrators

Other Standards on Vibration:

ISO 2041	Vibration and shock - vocabulary
ISO 2631	Guide for the evaluation of human exposure to whole-body vibration
ISO 4867	Code for the measurements and reporting of shipboard vibration data
ISO 4868	Code for the measurement and reporting of local vibration data of ship structures and equipment
ISO 6954	Mechanical vibration and shock - Guidelines for the overall evaluation of vibration in merchant ships

ISO 6954 is currently the subject of revision. The new version will be more appropriate for measuring the effect on vibration on humans.

Relevant National Standards on Vibration

VDI 2056	Criteria for assessing mechanical vibrations of machines, Verein Deutschen Ingenieure, Oct., 1964

Classification Societies' Guidelines for Noise and Vibration

In addition to the Comfort Notation described above, Classification Societies have guidelines for noise and vibration limits onboard ship, as listed below:

NK	Guide to ship noise control, 1982
KR	Guide to control of ship vibration and noise, 2nd edition, 1997
IACS	Unified Interpretation SC82 Protection against noise, 1993
BV	Recommendation designed to limit the effects of vibrations onboard, Guidance note, NI38 A-RD3, 1979
VERITEC	Vibration control in ships, 1985
LR	Guidance notes on acceptable vibration levels and their measurement, 1990

Working spaces

Regulations and standards exist for dealing with improvements to working spaces which may help in reducing fatigue. Some of the standards are still under development. These measures include bridge layout and navigation equipment, engine rooms, and general ergonomics, as follows.

Bridge Layout and Navigation Equipment

IMO	MSC/Circular.982, Guidelines on Ergonomic criteria for bridge equipment and layout[16]
ISO 8468	Ship's bridge layout and associated equipment - Requirements and Guidelines
ISO 14612	Ship's bridge layout and associated equipment - Requirements and Guidelines. *NB. This will be renamed to: Ship's Bridge Layout and Associated Equipment - Additional Requirements and Guidelines for Centralised Functions and Periodic One-Person Operation*
IEC 60945	Navigation equipment - general requirements'. This is backed by Assembly Resolution A.694
ASTM	Standard Practice for Human Engineering Design for Marine Systems, Equipment and Facilities'. 1995. American Society for Testing and Materials. Standard F1166-95a. West Chonshocken, PA
IACS	Unified N1 requirements for One Man Bridge Operated (OMBO) Ships. International Association of Classification Societies. 1992

[16] Recommendatory Guidance.

Engine Rooms

IMO MSC/Circular.834, Guidelines for engine room layout, design and arrangement.[17]

ISO Shipbuilding—Engine-room ventilation in diesel-engined ships—Design requirements and basis of calculations. ISO 8861

General Ergonomics[18]

ABS Guidance Notes on the Application of Ergonomics to Marine Systems. American Bureau of Shipping. January 1998

CEN Safety of machinery—Ergonomic design principles Part 1: Terminology and general principles. EN 614-1, (1994)

CEN Safety of machinery—Temperatures of touchable surfaces—Ergonomics data to establish temperature limit values for hot surfaces. EN 563. (1994)

ILO International data on anthropometry. Eds. Jurgens, H., Aune, I. and Pieper, U. Federal Institute for Occupational Safety and Health, Dartmund. Federal Republic of Germany. 92-2-106449-2. Occupational Safety and Health Series: No. 65, (1990)

ISO Ergonomics principles in the design of work systems. ISO 6385. (Draft)

ISO Ergonomics of the thermal environment—Assessment of the influence of the thermal environment using subjective judgement scales. ISO 10551

ISO Ergonomics of the thermal environment—Principles and application of relevant International Standards. ISO 11399

[17] Recommendatory Guidance.
[18] Standards for equipment design have been included for completion purposes. Really, they are outside of the remit of the ship designer, being items bought-in by the shipyard. However, ship designers are concerned with the integration of the equipment.

References

Donaldson, Lord (1994) *Safer ships, cleaner seas.* (Report of Lord Donaldson's inquiry into the prevention of pollution from merchant shipping). HMSO – London, United Kingdom.

IMO, *MSC 68/INF.15* Human Errors on the Bridge - A study of Finnish Shipping.

IMO, MSC 69/INF.10.Seafarer fatigue: Wake up to the dangers.

IMO, *MSC 69/INF.15* Fatigue - Groundings and collisions.

IMO, *MSC 69/INF.16*. Report on the investigation into near misses.

IMO, *MSC 71/INF.8*. Report on the investigation into near misses.

IMO, MSC/Circ.565. Fatigue as a Contributory Factor in Maritime Accidents.

IMO, *MSC/Circ.621*. Guidelines for the investigation of accidents where fatigue may have been a contributory factor.

Guidelines On Fatigue
Module 8

FATIGUE AND THE MARITIME PILOT

Foreword

The Fatigue guidelines contain practical information to assist interested parties (naval architects/Ship designers, owners/operators, Masters, Officers, other crew members and training institutions) to better understand and manage fatigue.

The guidelines provide information on the potential dangers of fatigue and ultimately the effect on the health and safety of the personnel working on ships. The guidelines contain information on the symptoms and causes of fatigue, and address solutions to combat fatigue to improve the associated health problems and help prevent a fatigue related accident occurring.

The guidelines have been divided into nine modules, as follow:

1. Module 1 Fatigue
2. Module 2 Fatigue and the Rating
3. Module 3 Fatigue and the Ship's Officer
4. Module 4 Fatigue and the Master
5. Module 5 Fatigue and the Training Institution and Management Personnel in charge of Training
6. Module 6 Shipboard Fatigue and the Owner/Operator/Manager
7. Module 7 Shipboard Fatigue and the Naval Architect/Ship Designer
8. Module 8 Fatigue and the Maritime Pilot
9. Module 9 Fatigue and Tugboat Personnel
10. Appendix Fatigue related documentation

It is recommended that all parties become familiar with Module 1 prior to using Modules 2-9. Module 1 contains pertinent background information on the subject of fatigue.

Module 8 contains practical information intended for the ***Maritime Pilot***. It is also recommended that the Maritime Pilot becomes familiar with Module 4 - Fatigue and the Master.

Guidelines on Fatigue
Module 8

FATIGUE AND THE MARITIME PILOT

1. WHY AND WHAT SHOULD A MARITIME PILOT KNOW ABOUT FATIGUE?

To begin, fatigue is a biological state to which all individuals are susceptible, regardless of skill, knowledge or training. A pilot's work environment (irregular and lengthy work hours, working at night, unpredictable duty rosters, and traveling to and from their jobs) can significantly contribute to fatigue. Moving a large vessel in confined waters is a high-risk task and the pilot assigned to that task has a responsibility to the State, the Port Authority and the ship's master.

Despite the differences among worldwide pilotage services (deep-sea, harbor, river pilots, etc.) and various pilotage systems (call systems, shift systems, etc.), fatigue is a common issue for all Maritime Pilots. There is no one-fits-all approach for addressing fatigue, but there are certain universal principles (lifestyle, rest, medication, workload, etc.) that must be addressed irrespective of the pilotage service or the pilotage system implemented.

With that understood, this particular module outlines the symptoms and causes of fatigue for the maritime pilot. It further addresses ways to mitigate fatigue, and as a result, can improve the associated health problems and help prevent a fatigue-related accident from occurring. More specifically, this module focuses on the potential risks of irregular and extended work hours (compared to a regular nine to five day), and ultimately, their effect on the health and safety common to Pilots and their areas of operation.

2. WHAT CAN CAUSE FATIGUE?

The primary cause of both acute and cumulative fatigue in Maritime Pilotage is the disruption to the circadian rhythm due to the 24-hour operation and the accumulation of sleep debt. Fatigue can be either work related or non-work related:

Work Related
Unpredictable work and shipping schedules, intense concentration, temperature extremes, adverse weather, and exposure to high-risk situations can all cause fatigue. An Australian[1] study revealed that pilots excreted high levels of adrenaline while providing pilotage services (sometimes taking up to two days to return to normal levels) and that pulse rates increased to over 160. This level of physiological stress is one factor of cumulative fatigue.

Other factors include the workload; the time of day at which the pilotage act is performed; the duration of work periods; the length of breaks within and between work periods; and the time of day and the frequency of duty rosters. Boarding ships with unfamiliar layout, crew etc. (an intrinsic part of maritime pilots' work) is stressful.

Non-work Related

Non-work related fatigue can be linked to a disruption within one's family or social life, financial difficulties or domestic responsibilities. Other contributory causes of fatigue are age and medical fitness. Age related changes such as the need for less sleep, hypertension, loss or deterioration of visual perception, poorer physical condition and the increased need for medication may lead to a decline in human performance. Obviously, certain medical conditions will affect work performance, but some not so obvious conditions are sleep apnea, narcolepsy, and insomnia.

3. HOW DOES FATIGUE AFFECT PILOTAGE PERFORMANCE?

Pilots are managers of high-risk situations that require intense concentration and skill levels, therefore, any decrease in performance can potentially lead to a catastrophe. A pilot error caused by fatigue can endanger the ship, crew, port and the environment.

Some of the more recognizable symptoms of fatigue found in Pilots are stress, mood swings, headaches and gastro-intestinal problems. Fatigue can affect pilot performance by impacting their ability to think clearly, to concentrate, to focus attention appropriately, to assess risky situations, or to act as quickly as necessary.

Table 1 describes some of the possible effects by listing performance impairments and the symptoms associated with them.

TABLE 1
Effects of Fatigue

PERFORMANCE IMPAIRMENT		SIGNS/SYMPTOMS
1	Inability to concentrate	• Unable to organise a series of activities • Preoccupation with a single task • Focuses on a trivial problem, neglecting more important ones • Less vigilant than usual
2	Diminished decision-making ability	• Misjudges distance, speed, time, etc. • Fails to appreciate the gravity of the situation • Fails to anticipate danger • Fails to observe and obey warning signs • Overlooks items that should be included • Chooses risky options • Has difficulty with simple arithmetic, geometry, etc
3	Poor memory	• Fails to remember the sequence of task or task elements • Has difficulty remembering events or procedures • Forgets to complete a task or part of a task
4	Slow Response	• Responds slowly (if at all) to normal, abnormal or emergency situations
5	Loss of bodily control	• May appear to be drunk • Inability to stay awake • Speech is affected, e.g. it may be slurred, slowed or garbled

6	Mood change	• Quieter, less talkative than usual • Unusually irritable
7	Attitude change	• Unaware of own poor performance • Too willing to take risks • Ignores normal checks and procedures • Displays a "don't care" attitude

Long-term effects of fatigue may lead to cardiovascular diseases, gastro-intestinal diseases, psychiatric problems and stress. Other external sources of stress, such as third party intervention and the threat of competition, can impact heavily on the health of pilots.

One of the most alarming consequences of fatigue is uncontrollable *micro sleep* that may last for only a few seconds to a couple of minutes. The problem with micro sleep is that the person is unaware of it having occurred. Micro sleep lapses have been well documented as causing a number of maritime, and other transportation, incidents.

4. WHAT CAN BE DONE TO MANAGE FATIGUE IN PILOTAGE?

The responsibility for controlling the hazards that may contribute to pilot fatigue, through elimination or minimization, should be shared amongst all parties. These parties are: the relevant authority, those who employ the Pilots' services and those who have responsibility for scheduling and the safe transit of Pilots to and from ships, and the individual Pilot. The Pilot side of the responsibility is to observe all safe work practices imposed by international/national/local legislation and to contrive to be fit for work.

Clear and open lines of communication must be established between the Maritime Pilot, those whom employ the Pilot's services, and those responsible for scheduling. Good communication between all parties will promote effective controls for workload management, such as vessel scheduling. Workload management by pilots and the competent authorities is a key component in managing fatigue. This will ensure that Pilots do not work excessive hours and that they have sufficient recovery time.

The relevant authority and pilots should recognize that high-risk operations within the pilotage area are particularly hazardous when undertaken during a circadian dip, especially the one that naturally occurs between 0300 and 0600. For example, the berthing of large tankers at night is prohibited in some ports because of the risk of a spill.

Fatigue Management Systems, such as those instituted in Australia, can help to manage some of the risks associated with fatigue. The Australian system uses a quantitative model to assess the working roster (including rest/work hours, work hours, rest frequency, etc.) in order to balance the hazards that produce fatigue and the forces that lead to recovery. However, it must be noted that not all quantitative models address the fatigue associated with high-risk industries such as pilotage. The use of a fatigue index score modelling[2] to formulate and modify rosters can enable organizations to quantify, compare and predict work-related fatigue. These models have shown improvements in fatigue management affecting the lives of pilots, their families and community.

Educating pilots, their co-workers and families on the underlying physiology of human performance and the lifestyle necessary for a piloting career may assist in reducing the incidence

and consequences of fatigue. Pilots and their families should be aware of the issue of fatigue, the potential consequences, and the practical techniques that can be used to help mitigate fatigue. In summary, pilots should learn to manage their off duty time and lifestyle.

5. WHAT PERSONAL MEASURES CAN A PILOT TAKE TO AVOID FATIGUE?

A pilot should not begin a work period with a sleep debt or an accumulative sleep debt (the normal requirement less the amount of sleep), as this can be potentially dangerous in terms of human performance. In most cases, two consecutive nights of recovery sleep will recuperate a pilot from a sleep debt. (Note, most adults working a 9-5 job accumulate a sleep debt of five to seven hours Monday to Friday and sleep in on the weekend to recover that debt.)

A strategic nap of no more than 30 minutes will aid rejuvenation. Naps longer than 30 minutes will cause sleep inertia where situational awareness is impaired for up to 20 minutes after waking. Management should provide suitable facilities for pilots to take rest breaks between piloting assignments.

When at home, the Pilot should develop a regular pre-sleep routine and sleep in a comfortable environment without noise, light or temperature extremes. A Pilot should not exercise or eat a large meal before sleep. Caffeine should be used sparingly as it has many side effects including hypertension, headaches, mood swings and anxiety.

Pilots should be encouraged to exercise regularly and to maintain a well balanced diet, avoiding "junk foods" which are often too convenient when working at night. Caffeine consumption should be limited to times of operational necessity and avoided for several hours prior to a sleep period.

Avoid alcohol and some over-the-counter medication as these disrupt sleep by disturbing normal sleep patterning. Alcohol in particular suppresses REM sleep (dreaming) and may lead to overall sleep loss. Cold medication containing psuedoephedrine, a stimulant, should be avoided as it can disrupt sleep.

Finally, it is important for Pilots to educate their families about the dangers to health and risk to the community of being a fatigued pilot to gain their support.

6. CASE STUDIES

Reporting incidents and/or accidents that involve near misses, personal injury or damage to equipment can assist the understanding of fatigue within the pilotage workforce and contribute to finding ways to deal with the issues associated with fatigue.

The following casualty investigation reports are provided as illustrative examples:

- The grounding of Panamanian flag vessel "New Reach" occurred on Heath Reef, Great Barrier Reef on May 17, 1999. The Pilot was in an advanced state of drowsiness. The passage was 464 miles and the pilot was on board for 34 hours.

- The grounding of the vessel "Venus" in St Lawrence River occurred on April 17, 1997. Although not the main cause for the grounding, fatigue was a contributing factor. The Pilot was not in the routine of night work on his first duty turn after a vacation. Further, the Pilot was on duty for approximately 24 hours. (Transportation Safety Board of Canada – Report Number M97L0030)

- The collision between the bulk carrier "NIRJA" and the "Hamilton Energy" on December 11, 1993 occurred in Hamilton Harbour, Ontario. The Pilot was not adequately rested having had three consecutive assignments in 24 hours. The Pilot may have misjudged the developing situation and did not take effective action in ample time, as a result of being fatigued. Performance degradation manifested in impaired judgement, probably contributed to the occurrence. (Transportation Safety Board of Canada – Report Number M93C0003)

- The grounding of the "Raven Arrow" in the Johnstone Strait, British Columbia on September 24, 1997. After electing to conduct the navigation of the vessel without assistance from the ship's complement (increasing his workload), the Pilot lost situational awareness and prematurely altered course. Contributing to the occurrence were the following factors: the pilot was probably fatigued (at the time of the occurrence the pilot had been awake for over 19.5 hours); sound navigational principles were not implemented by the bridge team (pilot elected to conduct the navigation of the vessel without assistance from the ship's complement); and the exchange of information between the pilot and officer of the watch was minimal (officer of the watch had some doubts with respect to course alteration but did not challenge the pilot's decision). This report goes beyond the individual pilot and fatigue, and addresses fatigue from the perspective of management by examining pilot scheduling and fatigue management. (Transportation Safety Board of Canada – Report Number M97W0197)

References

1. **Berger, Y (1984) -** *Port Phillip Sea Pilots: an Occupation at Risk.* PhD Thesis; Latrobe University - Australia.

2. **Fletcher A. and Dawson D. (1997) -** *A predictive model of work-related fatigue based on hours-of-work.* Australian Journal of Occupational Health and Safety 13(5) 471-486 – Australia.

Akerstedt T. (2000) – *Safety and Fatigue* – Australia.

AMPA (2000) - *Fatigue Management Standard.* Australian Marine Pilot's Association – Australia.

AMSA (1999) - *On Tour Analyses of the Work and Rest Patterns of Great Barrier Reef Pilots: Implications for Fatigue Management.* Queensland University of Technology for Australian Maritime Safety Authority – Australia.

Cantwell V. (1998) – *Human Factors in Marine Operations: Managing Fatigue, Alertness and Endurance in the Marine Pilot Operations* – Maryland, United States.

European Maritime Pilot Association (EMPA) - *Recommendation 26, Fatigue Prevention.*

Transportation Safety Board of Canada (1997) – *A Guide for Investigating for Fatigue* – Canada.

Guidelines on Fatigue
Module 9

FATIGUE AND TUGBOAT PERSONNEL

Foreword

The Guidelines on Fatigue contain practical information that can assist interested parties (Naval architects/Ship designers, owners/operators, Masters, Officers, other crew members and training institutions) to better understand and manage fatigue.

The guidelines provide information on the potential dangers of fatigue and ultimately the effect on the health and safety of the personnel working on ships. The guidelines contain information on the symptoms and causes of fatigue, and address solutions to combat fatigue in order to improve the associated health problems and help prevent fatigue related accidents from occurring.

The guidelines have been divided into nine modules, as follow:

1. Module 1 Fatigue
2. Module 2 Fatigue and the Rating
3. Module 3 Fatigue and the Ship's Officer
4. Module 4 Fatigue and the Master
5. Module 5 Fatigue and the Training Institution and Management Personnel in charge of Training
6. Module 6 Shipboard Fatigue and the Owner/Operator/Manager
7. Module 7 Shipboard Fatigue and the Naval Architect/Ship Designer
8. Module 8 Fatigue and the Maritime Pilot
9. Module 9 Fatigue and Tugboat Personnel
10. Appendix Fatigue related documentation

It is recommended that all parties become familiar with Module 1 prior to using Modules 2-9. Module 1 contains pertinent background information on the subject of fatigue.

Module 9 contains practical information intended for ***Tugboat Personnel***. It is recommended that they become familiar with Modules 2, 3 and 4 (Fatigue and the Rating, Fatigue and the Ship's Officer and Fatigue and the Master respectively).

Module 9

FATIGUE AND TUGBOAT PERSONNEL

1. HOW CAN YOU RECOGNIZE FATIGUE IN YOURSELF AND OTHERS?

You may exhibit one or more changes in behavior when experiencing fatigue. However, one very important fact to remember is that people who are fatigued have a very difficult time recognizing the signs of fatigue within themselves. It is difficult for a number of reasons, but largely because fatigue can affect your ability to make judgements or solve complex problems. The following list describes how fatigue affects your mind and body; you may recognize some of these changes in others (with time, you may learn to identify some within yourself):

A. Physically

- Inability to stay awake (an example is head nodding or falling asleep against your will)
- Difficulty with hand-eye coordination skills (e.g., switch selection)
- Speech difficulties (it may be slurred, slowed or garbled)
- Heaviness in the arms and legs or sluggish feeling
- Decreased ability to exert force while lifting, pushing or pulling
- Increased frequency of dropping objects like tools or parts
- Non-specific physical discomfort
- Headaches
- Giddiness
- Heart palpitations / irregular heard beats
- Rapid breathing
- Loss of appetite
- Insomnia
- Sudden sweating fits
- Leg pains or cramps
- Digestion problems

B. Emotionally

- Increased willingness to take risks
- Increased intolerance and anti-social behavior
- Needless worry
- Reduced motivation to work well
- Increased mood changes (e.g., irritability, tiredness and depression)

C. <u>Mentally</u>

- Poor judgement of distance, speed, time, etc.
- Inaccurate interpretation of a situation (e.g., focusing on a simple problem or failing to anticipate the gravity of the situation or failing to anticipate danger)
- Slow or no response to normal, abnormal or emergency situations
- Reduced attention span
- Difficulty concentrating and thinking clearly
- Decrease in ability to pay attention

Whenever alertness is affected by fatigue, your performance will be handicapped.
It is important that you notify your supervisor when you recognize that you or other crewmembers are fatigued. It is important to have an open communication between you and your supervisor regarding fatigue prevention and detection.

2. WHAT CAN CAUSE FATIGUE?

Fatigue may be caused and/or made worse by one or a combination of things such as:

- Lack of sleep
  Only sleep can maintain or restore your performance level. When you do not get enough sleep, fatigue will set in and your alertness will be impaired. (Refer to Section 3)

- Poor quality of sleep
  Fatigue may be caused by poor quality of sleep. This can occur when you are unable to sleep without interruptions or you are unable to fall asleep even though your body tells you to. (Refer to Section 3)

- Insufficient rest time between work periods
  Apart from sleep, rest (taking a break) between work periods can contribute to restoring your performance levels. Insufficient rest periods or postponing assigned rest times (to finish the job early) can cause fatigue. (Refer to Section 3)

- Poor quality of rest
  Disturbances while resting such as being woken up unexpectedly, on call (during port operations), or unpredictable working hours (when arriving in port) can cause fatigue.

- Stress
  Stress can be caused by personal problems (family), problems with other shipmates, long work hours, work in general, etc. A build up of stress will cause or increase fatigue.

- Boring and repetitive work
  Boredom can cause fatigue. You may become bored to the point of fatigue when your work is too easy, repetitive and monotonous and/or bodily movement is restricted.

- Noise or vibration
  Noise or vibration can affect your ability to sleep/rest, and it can affect your level of physical stress, thus causing fatigue.

- Ship's movement
  The ship's movement affects your ability to maintain physical balance. Maintaining balance requires extra energy, which can then cause fatigue. A ship's pitching and rolling motions mean you might have to use 15-20% extra effort to maintain your balance.

- Food (timing, frequency, content and quality)
  Refined sugars (sweets, doughnuts, chocolates, etc.) can cause your blood sugar to rise rapidly to a high level. The downside of such short-term energy is that a rapid drop in blood sugar can follow it. Low blood sugar levels can cause weakness, instability, difficulty in concentrating and in extreme cases unconsciousness. Eating large meals prior to a sleep period may disrupt your sleep.

- Medical conditions and illnesses
  Medical conditions (i.e. heart problems) and illnesses such as the common cold can cause fatigue. The effect depends on the nature of the illness or medical condition but also the type of work being carried out. For example, common colds slow response time and hand-eye coordination in performance.

- Ingesting chemicals
  Alcohol, caffeine and some over-the-counter medications disrupt sleep. Caffeine consumption can also causes other side effects such as hypertension, headaches, mood swings or anxiety.

- Jet-lag
  Jet-lag occurs following long flights through several time zones. It is a condition that causes fatigue in addition to sleep-deprivation and irritability. It is easier to adjust to time zones while crossing from east to west as opposed to west to east. The greatest difficulty in adjustment results from crossing 12 time zones, the least from crossing one time zone. Our bodies adjust at the rate of approximately 1-hour per day

- Excessive work load
  Working consistently "heavy" workloads can cause fatigue. Workload is considered heavy when one works excessive hours or performs physically demanding or mentally stressful tasks. Excessive work hours and fatigue can result in negative effects such as the following:
  - Increased accident and fatality rates;
  - Increased dependence upon drugs, tobacco or alcohol;
  - Poor quality and disrupted sleep patterns;
  - Higher frequency of cardiovascular, respiratory or digestive disorders;
  - Increased risk of infection; and
  - Loss of appetite.

3. HOW CAN YOU PROTECT YOURSELF FROM THE ONSET OF FATIGUE?

A. Sleep Issues

Sleep is the most effective strategy to fight fatigue. Sleep loss and sleepiness can degrade every aspect of a person's performance: physical, emotional and mental. To satisfy the needs of your body, experts agree that you should acquire the following:

- Deep sleep;
- Between 7 to 8 hours of sleep per 24-hour day;
- Uninterrupted sleep.

Here is some general guidance on developing good sleep habits:

- Develop and follow a pre-sleep routine to promote sleep at bedtime (examples are a warm shower or reading calming material).
- Make the sleep environment conducive to sleep (a comfortable bed, a dark, quiet and cool environment encourages sleep).
- Ensure that you will have no interruptions during your extended period of sleep.
- Satisfy any other physiological needs before trying to sleep (examples are if hungry or thirsty before bed, eat or drink lightly to avoid being kept awake by digestive activity and always visit the toilet before trying to sleep).
- Avoid alcohol and caffeine prior to sleep (keep in mind that coffee, tea, colas, chocolate, and some medications, including cold remedies and aspirin, may contain alcohol and/or caffeine). Avoid caffeine at least six hours before bedtime.
- Consider relaxation techniques such as meditation and yoga, which can also be of great help if learnt properly.

B. Rest Issues

Another important factor that can affect fatigue and performance is rest. Rest, apart from sleep, can be provided in the form of breaks or changes in activities. Rest pauses or breaks are indispensable as a physical requirement if performance is to be maintained. Factors influencing the need for rest are the length and intensity of the activities prior to a break or a change in activity, the length of the break, or the nature or change of the new activity.

C. Guidelines on maintaining performance

Here are some general guidelines that can help you maintain performance:

- Get sufficient sleep, especially before any period when you anticipate that you will not get adequate sleep.
- When you sleep, make it a long period of sleep.
- Take strategic naps.
- Take breaks when scheduled breaks are assigned.
- Develop and maintain good sleep habits, such as a pre-sleep routine (something that you always do to get you ready to sleep).
- Monitor your hours of work and rest when opportunity arises.
- Eat regular, well-balanced meals (including fruits and vegetables, as well as meat and starches).
- Exercise regularly.

4. WHAT CAN MITIGATE THE EFFECTS OF FATIGUE?

The most powerful means of relieving fatigue is to get proper sleep and to rest when appropriate. However, a number of things have been identified as potentially providing some short-term relief. Note, however, that these countermeasures may simply just mask the symptoms temporarily –the fatigue has not been eliminated.

- An interesting challenge, an exciting idea, a change in work routine or anything else that is new and different will keep you awake.
- Changing the order of activities, where personnel are assigned tasks that include variety in the nature of tasks, can be beneficial in breaking up job monotony. Mixing tasks requiring high physical or mental work with low-demand tasks can be beneficial.
- Bright lights, cool dry air, music and other irregular sounds can increase alertness.
- Caffeine (encountered in coffee and tea, and to a lesser extent in colas and chocolate) may combat sleepiness in some people for short periods. However, regular usage over time reduces its value as a stimulant and may make you more tired and less able to sleep
- Any type of muscular activity helps to keep you alert; running, walking, stretching or even chewing gum can stimulate our level of alertness.
- Conversation can help you stay awake.
- Controlled, strategic naps can improve alertness and performance (the most effective length of time for a nap is about 20 minutes).

Strategic Napping

Research has identified "strategic napping" as a short-term relief technique to help maintain performance levels during long periods of wakefulness. The most effective length of time for a nap is about 20 minutes. This means that if you have the opportunity to nap you should take it. However, there are some drawbacks associated with napping. One potential drawback is that naps longer than 30 minutes will cause sleep inertia, where situational awareness is impaired (grogginess and/or disorientation for up to 20 minutes after waking. A second is that the nap may disrupt later sleeping periods (you may not be tired when time comes for an extended period of sleep).

5. WHAT CAN BE DONE TO REDUCE CREW FATIGUE ON BOARD TUGBOATS?

There are a number of steps that can be taken to prevent fatigue. Many of the measures that reduce fatigue are unfortunately beyond a single person's ability to influence, such as voyage scheduling, ship design, work scheduling. Steps such as the following (where applicable) are important for the prevention of fatigue on board ship, and are within the tugboat personnel's ability to influence and implement:

- Ensuring the compliance with maritime regulations concerning minimum hours of rest and/or maximum hours of work
- Creating an open communication environment (e.g. by making it clear to the crew members that it is important to inform supervisors when fatigue is impairing their performance and that there will be no recriminations for such reports)
- Scheduling drills in a manner that minimizes the disturbance of rest/sleep periods
- Establishing on-board management techniques when scheduling shipboard work and rest periods, watchkeeping practices and assignment of duties in a more efficient manner

- Assigning work by mixing up tasks to break up monotony and combining work that requires high physical or mental demand with low-demand tasks (job rotation)
- Scheduling tasks with potential hazards for daytime hours, when appropriate
- Emphasizing the relationship between work and rest periods to ensure that adequate rest is received by promoting individual record keeping of hours rested or worked
- Ensuring that shipboard conditions, within the crew's ability to influence, are maintained in a good state (such as maintaining the heating, ventilation and air-conditioning (HVAC) on schedule, replacing light bulbs, and contending with the sources of unusual noise at the first opportunity)
- Establishing shipboard practices for dealing with fatigue incidents and learning from them (as part of safety meetings)
- Increasing awareness of the long-term health benefits of appropriate lifestyle behavior (e.g. exercise, relaxation, nutrition, smoking and alcohol consumption)

REFERENCES

International Transport Workers' Federation (1997) - *Seafarer Fatigue: Wake up to the dangers.* IMO, MSC 69/INF.10 - United Kingdom.

McCallum, M.C., & Raby, M., Rothblum A. (1996) - *Procedures for Investigating and Reporting Human Factors and Fatigue Contributions to Marine Casualties*. Report No. CG-D-09-97. Batelle Seattle Research Center and U.S. Coast Guard Research and Development Center – Connecticut, United States.

Moore-Ede M., Mitchell R. E., Heitmann A., Trutsche U., Aguirre A., & Hajarnavis H. (1996) - *Canalert 1995: Alertness Assurance in the Canadian Railways* - Circadian Technologies, Inc. – Massachusetts, United States.

Parker, A.W., Hubinger, L.M., Green, S., Sargent, L., & Boyd, R. (1997) - *A survey of the health, stress and fatigue of Australian Seafarers* - Australian Maritime Safety Authority - Australia.

Pollard J.K., Sussman E.D., & Stearns M. (1990) - *Shipboard Crew fatigue, Safety and Reduced Manning.* Report No. DOT-MA-RD-840-90014. John A. Volpe National Transportation Systems Center - Cambridge, Massachusetts.

Sandquist T., Raby M., Maloney A.L., Carvalhais T. (1996) - *Fatigue and Alertness in Merchant Marine Personnel: A field study of work and sleep patterns.* Report No. CG-D-06-97. Batelle Seattle Research Center and U.S. Coast Guard Research and Development Center – Connecticut, United States.

Transportation Safety Board of Canada (1997) - *A Guide for Investigating for Fatigue* - Canada.

United Kingdom National Union of Marine Aviation and Shipping Transport Officers (1997) - *Give us a Break: NUMAST Report on Fatigue*. IMO, MSC 68/INF. 9 - United Kingdom.

Videotel (1998). *Fatigue and Stress at Sea* [video] - London, United Kingdom.

APPENDICES

Foreword

The Fatigue guidelines contain practical information to assist interested parties (naval architects/Ship designers, owners/operators, Masters, Officers, other crew members and training institutions) to better understand and manage the fatigue issue.

The outline of the information is related to the potential dangers associated with fatigue and ultimately the effect on the health and safety of the personnel working on ships. The guidelines contain information on the symptoms and causes of fatigue, and addresses solutions to combat fatigue to improve the associated health problems and help prevent a fatigue related accident occurring.

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10. Appendix Fatigue related documentation

It is recommended that all parties become familiar with Module 1, which contains general information on the subject of fatigue, prior to using the rest of the Modules.

The **Appendices** contain reference material on the subject of fatigue, such as extracts from IMO and ILO instruments and lists of references.

APPENDICES

APPENDIX 1

REFERENCES

Module 1

Calhoun S.R. (1999) – *Human Factors and Ship Design: Preventing and Reducing Shipboard Operator Fatigue.* University of Michigan/U.S. Coast Guard Research Project – Michigan, United States.

Kroemer K.H.E., Grandjean E. (1999) – *Fitting the task to the Human (Fifth Edition).* Taylor and Francis, Ltd. – United Kingdom.

Sandquist T., Raby M., Maloney A.L., Carvalhais T. (1996) - *Fatigue and Alertness in Merchant Marine Personnel: A field study of work and sleep patterns.* Report No. CG-D-06-97. Batelle Seattle Research Center and U.S. Coast Guard Research and Development Center – Connecticut, United States.

Transportation Safety Board of Canada (1997) - *A Guide for Investigating for Fatigue* - Canada.

Modules 2, 3 & 4

International Transport Workers' Federation (1997) - *Seafarer Fatigue: Wake up to the dangers.* IMO, MSC 69/INF.10 - United Kingdom.

Kroemer, K.H.E., & Grandjean, E. (Re-printed 1999) – *Fitting the Task to the Human.* Taylor & Francis Ltd. – London, United Kingdom.

McCallum, M.C., & Raby, M., Rothblum A. (1996) - *Procedures for Investigating and Reporting Human Factors and Fatigue Contributions to Marine Casualties*. Report No. CG-D-09-97. Batelle Seattle Research Center and U.S. Coast Guard Research and Development Center – Connecticut, United States.

Moore-Ede M., Mitchell R. E., Heitmann A., Trutsche U., Aguirre A., & Hajarnavis H. (1996) - *Canalert 1995: Alertness Assurance in the Canadian Railways* - Circadian Technologies, Inc. - Massachusetts, United States.

Parker, A.W., Hubinger, L.M., Green, S., Sargent, L., & Boyd, R. (1997) - *A survey of the health, stress and fatigue of Australian Seafarers* - Australian Maritime Safety Authority - Australia.

Pollard J.K., Sussman E.D., & Stearns M. (1990) - *Shipboard Crew fatigue, Safety and Reduced Manning.* Report No. DOT-MA-RD-840-90014. John A. Volpe National Transportation Systems Center – Massachusetts, United States.

Sandquist T., Raby M., Maloney A.L., Carvalhais T. (1996) - *Fatigue and Alertness in Merchant Marine Personnel: A field study of work and sleep patterns.* Report No. CG-D-06-97. Batelle Seattle Research Center and U.S. Coast Guard Research and Development Center – Connecticut, United States.

Transportation Safety Board of Canada (1997) - *A Guide for Investigating for Fatigue* - Canada.

United Kingdom National Union of Marine Aviation and Shipping Transport Officers (1997) - *Give us a Break: NUMAST Report on Fatigue*. IMO, MSC 68/INF. 9 - United Kingdom.

Videotel (1998). *Fatigue and Stress at Sea* [video] - London, United Kingdom.

Module 5

IMO – *Training Course for Instructors.*

McCallum, M.C., & Raby, M., Rothblum A. (1996) - *Procedures for Investigating and Reporting Human Factors and Fatigue Contributions to Marine Casualties*. Report No. CG-D-09-97. Batelle Seattle Research Center and U.S. Coast Guard Research and Development Center - Groton, Connecticut.

Parker, A.W., Hubinger, L.M., Green, S., Sargent, L., & Boyd, R. (1997) - *A survey of the health, stress and fatigue of Australian Seafarers* - Australian Maritime Safety Authority - Australia.

Transportation Safety Board of Canada (1997) - *A Guide for Investigating for Fatigue* - Canada.

Videotel (1998). *Fatigue and Stress at Sea* [video]. London.

Module 6

Belenky G, Balkin T.J, Redmond D.P, Sing H.P, Thomas M.L, Thorne D.R and Wesensten N.J (1998) – *Sustaining Performance during Continuous Operations: The US army's Sleep Management System* - taken from The 3rd International Conference on fatigue and Transportation 1998, Fremantle, WA.

Dawson D, Lamond N, Donkin K and Reid K (1997) – *Quantitative Similarity between the Cognitive Psychomotor Performance Decrement Associated with Sustained Wakefulness and Alcohol Intoxication* – From the minutes of the AAPMA 36th Biennial Conference 1998.

Dawson D, Fletcher A and Hussey F (1999) – *Fatigue and Transport, Report to the Neville Committee* – The Centre for Sleep Research, University of South Australia.

Folkard S and Barton J (1993) – *Does the 'Forbidden Zone' for sleep onset influence morning shift sleep duration?* – Ergonomics. 36(1-3): 85-91

McCallum M.C, Raby M and Rothblum A.M (1996) – *Procedures for Investigating and Reporting Human Factors and Fatigue Contributions to Marine Casualties*. Report No CG-D-09-97. National Technical Information Service, Springfield, Virginia.

Reid T, Roberts T and Dawson D (1997) – *Improving Shiftwork management II: Shiftwork and Health* – Occupation Health and Safety (Aust/NZ), 13(5): 439-450

Module 7

Donaldson, Lord (1994) - *Safer ships, cleaner seas.* Report of Lord Donaldson's inquiry into the prevention of pollution from merchant shipping - HMSO, London.

IMO, MSC 68/INF.15 - *Human Errors on the Bridge - A study of Finnish Shipping*.

IMO, MSC 69/INF.10 - *Seafarer fatigue: Wake up to the dangers.*

IMO, MSC 69/INF.15 - *Fatigue - Groundings and collisions.*

IMO, MSC 69/INF.16 - *Report on the investigation into near misses*.

IMO, MSC 71/INF.8 - *Report on the investigation into near misses.*

IMO, MSC/Circ.565 - *Fatigue as a Contributory Factor in Maritime Accidents*.

IMO, MSC/Circ.621 - *Guidelines for the investigation of accidents where fatigue may have been a contributory factor***.**

Parker A.W., Hubiner L.M., Green S., Sargent L. and R. Boyd (1997) - *A survey of the health, stress and fatigue of Australian seafarers* - Conducted on behalf of the Australian Maritime Safety Authority.

Sanquist T.F., Ravy M., Maloney A.L. and A.B. Carvalhais (1996) - *Fatigue and Alertness in Merchant Marine Personnel: A Field Study of Work and Sleep Patterns*. Report No. CG-D-06-97. Batelle Seattle Research Center and U.S. Coast Guard Research and Development Center, Groton, Connecticut.

Module 8

Akerstedt T. (2000) – *Safety and Fatigue* – Australia. - taken from The 3rd International Conference on fatigue and Transportation 1998, Fremantle, WA.

AMPA (2000) - *Fatigue Management Standard.* Australian Marine Pilot's Association

AMSA (1999) - *On Tour Analyses of the Work and Rest Patterns of Great Barrier Reef Pilots: Implications for Fatigue Management.* Queensland University of Technology for Australian Maritime Safety Authority

Berger, Y (1984) - *Port Phillip Sea Pilots: an Occupation at Risk.* PhD Thesis; Latrobe University.

Cantwell V. (1998) – *Human Factors in Marine Operations: Managing Fatigue, Alertness and Endurance in the Marine Pilot Operations* - Maryland.

European Maritime Pilot Association (EMPA) - *Recommendation 26, Fatigue Prevention.*

Fletcher A. and Dawson D. (1997) - *A predictive model of work-related fatigue based on hours-of-work.* Australian Journal of Occupational Health and Safety 13(5) 471-486

Transportation Safety Board of Canada (1997) – *A Guide for Investigating for Fatigue* – Canada.

Module 9

International Transport Workers' Federation (1997) - *Seafarer Fatigue: Wake up to the dangers.* IMO, MSC 69/INF.10 - United Kingdom.

McCallum, M.C., & Raby, M., Rothblum A. (1996) - *Procedures for Investigating and Reporting Human Factors and Fatigue Contributions to Marine Casualties*. Report No. CG-D-09-97. Batelle Seattle Research Center and U.S. Coast Guard Research and Development Center – Connecticut, United States.

Moore-Ede M., Mitchell R. E., Heitmann A., Trutsche U., Aguirre A., & Hajarnavis H. (1996) - *Canalert 1995: Alertness Assurance in the Canadian Railways* - Circadian Technologies, Inc. – Massachusetts, United States.

Parker, A.W., Hubinger, L.M., Green, S., Sargent, L., & Boyd, R. (1997) - *A survey of the health, stress and fatigue of Australian Seafarers* - Australian Maritime Safety Authority - Australia.

Pollard J.K., Sussman E.D., & Stearns M. (1990) - *Shipboard Crew fatigue, Safety and Reduced Manning.* Report No. DOT-MA-RD-840-90014. John A. Volpe National Transportation Systems Center - Cambridge, Massachusetts.

Sandquist T., Raby M., Maloney A.L., Carvalhais T. (1996) - *Fatigue and Alertness in Merchant Marine Personnel: A field study of work and sleep patterns.* Report No. CG-D-06-97. Batelle

Seattle Research Center and U.S. Coast Guard Research and Development Center – Connecticut, United States.

Transportation Safety Board of Canada (1997) - *A Guide for Investigating for Fatigue* - Canada.

United Kingdom National Union of Marine Aviation and Shipping Transport Officers (1997) - *Give us a Break: NUMAST Report on Fatigue*. IMO, MSC 68/INF. 9 - United Kingdom.

Videotel (1998). *Fatigue and Stress at Sea* [video] - London, United Kingdom.