

GUIDELINES ON FATIGUE

ELECTRONIC EDITION

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Foreword

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 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.

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

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Guidelines on fatigue

Introduction

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 follows:

- Module 1: Fatigue
- Module 2: Fatigue and the rating
- Module 3: Fatigue and the ship's officer
- Module 4: Fatigue and the master
- Module 5: Fatigue and the training institution and management personnel in charge of training
- Module 6: Shipboard fatigue and the owner/operator/manager
- Module 7: Shipboard fatigue and the naval architect
- Module 8: Fatigue and the maritime pilot
- Module 9: Fatigue and tugboat personnel
- Appendices 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:

- Module 1: Fatigue
- Module 2: Fatigue and the rating
- Module 3: Fatigue and the ship's officer
- Module 4: Fatigue and the master
- Module 5: Fatigue and the training institution and management personnel in charge of training
- Module 6: Shipboard fatigue and the owner/operator/manager
- Module 7: Shipboard fatigue and the naval architect
- Module 8: Fatigue and the maritime pilot
- Module 9: Fatigue and tugboat personnel
- Appendices 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.

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 four 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 behaviour, 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
- Routeing
- Weather and sea conditions *en route*
- Traffic density *en 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 conditions 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., 1, insomnia-prolonged inability to obtain adequate sleep or e.g., 2, sleep apnoea – 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 co-ordination, 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.

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Guidelines on fatigue

Module 2

FATIGUE AND THE RATING

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.

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

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- Module 7: Shipboard fatigue and the naval architect
- Module 8: Fatigue and the maritime pilot
- Module 9: Fatigue and tugboat personnel
- Appendices 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.

1 How can you recognize fatigue in yourself and others?

You may exhibit one or more changes in behaviour 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 co-ordination 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 heartbeat;
- 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 crew members 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 co-ordination.
- *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 workload*

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 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, 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 fruit 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 min).

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 min. 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 min will cause sleep inertia, where situational awareness is impaired (grogginess and/or disorientation for up to 20 min after waking. A second is that the nap may disrupt later sleeping periods (you may not be tired when the time comes for an extended period of sleep).

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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:

- Module 1: Fatigue
- Module 2: Fatigue and the rating
- Module 3: Fatigue and the ship's officer
- Module 4: Fatigue and the master
- Module 5: Fatigue and the training institution and management personnel in charge of training
- Module 6: Shipboard fatigue and the owner/operator/manager
- Module 7: Shipboard fatigue and the naval architect
- Module 8: Fatigue and the maritime pilot
- Module 9: Fatigue and tugboat personnel
- Appendices 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).

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 • Pre-occupied 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

Table 1 – Effects of fatigue (cont.)

Performance impairment	Signs/symptoms
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 behaviour ● 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 behavioural 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 heartbeat;
- 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 co-ordination.

- *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 workload*

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?

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 co-ordination, 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.

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.

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 min).
- 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 min. 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 min will cause sleep inertia, where situational awareness is impaired (grogginess and/or disorientation for up to 20 min after waking. A second is that the nap may disrupt later sleeping periods (you may not be tired when the 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 travelling 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 travelled 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 behaviour (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 watch-keeping practices.

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

- International Labour Organization: Convention Concerning Seafarers' Hours of Work and the Manning of Ships – ILO Convention No. 180.*
- International Maritime Organization: International Convention on Standards of Training Certification and Watchkeeping for Seafarers, 1978 as amended in 1995 (STCW Convention);[†] Seafarer's Training, Certification and Watchkeeping Code (STCW Code), Parts A[†] and B;[‡] International Safety Management Code (ISM Code);[†] 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

International Maritime Organization (IMO) & International Labour Organization (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 – London, United Kingdom.

Kroemer, K.H.E., & Grandjean, E. (Reprinted 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.

* Not yet in force, but is considered to represent the international framework.

[†] Mandatory instrument.

[‡] Recommendatory guidance.