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 vesselship safety (naval architects, owners/operators/companies, masters, officers, ratings, seafarers, training institutions/providers, Ship designers, Administrations, and Port State Authorities, 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, inter-related 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 vesselship 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

There is no universally accepted technical definition for fatigue. However, common to all the definitions is degradation of human performance. For the purpose of the guidelines, the following definition is used:

“A reduction in state of physical and/or mental capability resulting from factors such as inadequate sleep, extended wakefulness, work/rest requirements out of synch with circadian rhythms and physical, mental or emotional exertion which may that can impair nearly all physical abilities including strength, speed, reaction time, coordination, decision making or balance, alertness and the ability to safely operate a ship or perform safety-related duties.”

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. An effective fatigue management strategy begins with determining operational workload requirements and matching on board manning levels and onshore support resources, combined with efficient management of workload and hours of work and rest onboard the ship. There is no one-system approach to addressing fatigue, but and there are other certain principles (e.g. lifestyle habits, rest, medication, workload, etc.) that should 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 identify, mitigate, and control fatigue to improve the associated health problems and help prevent a fatigue related accident incident 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

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 may 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 incident 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 inter-related 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 Companies, Masters, Officers, other crew members, Seafarers, and training institutions/providers, Ship designers, Administrations, and Port State Authorities) 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, identify, mitigate, and control 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 – 96.

Module 1 (Fatigue) contains general information on the subject of fatigue – definitions, causes, effects, etc.
INTRODUCTION

1. 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. This module provides a general overview of fatigue, its causes, and its potential effects on maritime personnel - seafarers. This knowledge is important for developing mitigation and control strategies to reduce the risk of fatigue and related incidents.

2. 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 worst maritime environmental disasters in the last century, the Exxon Valdez.

3. The negative effects of fatigue present a considerable risk to the safety and health of human life, security, 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.

4. It is recommended that all parties become familiar with Module 1 prior to using Modules 2-6.

1. 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.”

Online Notes

Guidelines on Fatigue

Module 1 - Module 1

Fatigue

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Post MeetingMinutes

Meeting 48 NOLA

Task 89, IMO Fatigue Guidance MSC 1014 Rev7.doc

Guidance on Fatigue Mitigation and Management.doc

Guidance on Fatigue GAQ Markup.doc

Guidelines on Fatigue Mitigation and Management.doc

Commented [CG/MERPAC2]: Note: These two sentences were taken from para 3 (and switched) of the Introduction of the original guidelines.
3. FATIGUE AND LIFE ON A SEAGOING SHIP

Fatigue and life on a seagoing ship

5. Fatigue is a challenge 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.

6. Maritime casualties have clearly demonstrated the consequences of sailing with crews suffering from fatigue. The demanding nature of shipping means that seafarers may be required to work long and irregular hours in less than ideal conditions. There are also unique aspects of seafaring that separate the marine industry from the others.

7. It is important to must be recognized that the seafarer is a captive of their work environment. This environment is unique and has a variety of work activities that are more complex than those associated with other industries. Firstly, the average seafarer spends between an average of three to six months working and living away from home, on a moving vessel that is subject to unpredictable environmental factors (i.e. changing weather conditions). Secondly, while serving on board the vessel, there is no clear separation between work and recreation off duty time. Thirdly, today’s crews are comprised of seafarers from various nationalities and backgrounds who are expected to work and live together for long periods of time. Finally, The operational aspects associated with shipping become more complex compared with standard industries, for reasons such as the variety of ship-types, the pattern and length of sea passages, the number of port visits and port-rotations, and the length of time a ship remains in port. All these aspects present a unique combination of further complexities that have the potential to causes of fatigue.

8. Increasingly complex technologies have also had an influence on ship operations and subsequently fatigue at sea. Technology is sometimes seen as a way to improve efficiency of work systems or to reduce levels. However, technology generally does not reduce work but merely changes it. Therefore, it is important to evaluate the impact of technological changes on crew workload.

9. There are also certain obstacles that need to be addressed. The widely held belief that fatigue “comes with the job,” whilst not particular to the maritime industry is certainly pervasive within it, making it difficult for seafarers to recognize and acknowledge fatigue as a problem and to take appropriate action.

10. Hence, an understanding of both the causes and consequences of fatigue as highlighted in this module should enable the relevant stakeholders to design and implement more effective strategies to manage fatigue-related risks.

4. CAUSES OF FATIGUE

Causes of Fatigue

11. Fatigue is caused by a range of factors, but is primarily affected by:
The most common causes of fatigue known to seafarers are
1. lack of sleep (i.e., inadequate restorative sleep);
2. poor quality of sleep and rest;
3. work/sleep at inappropriate times of the body clock (circadian rhythm);
4. staying awake for long periods;
5. stress; and
6. excessive workload (prolonged mental and/or physical exertion).

There are many other contributors as well, and each will vary depending on the circumstance (i.e., operational, environmental).

12 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/Seafarer-specific factors
- Management factors (ashore and aboard ship)
- Ship-specific factors
- Environmental factors

A. Crew/Seafarer-specific factors

13 The crew/seafarer-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.

14 The Crew/Seafarer-specific factors include the following:

1. Sleep and Rest
   a. Quality, Quantity and Duration of Quality of Sleep
   b. Sleep Disorders/Disturbances
   c. Rest Recovery, Rest/Breaks
2. Biological Body Clock/Circadian Rhythms
3. Psychological and Emotional factors, including stress
   a. Fear
   b. Monotony and Boredom
4. Health and well-being
   a. Diet/Nutrition/Hydration
   b. Exercise and fitness
   c. Illness and onset of illness
5. Ingested Chemicals
   a. Alcohol
   b. Drugs (prescription and non-prescription)
   c. Supplements

d. Caffeine and other stimulants

Stress

a. Skill, knowledge and training as it relates to the job
b. Personal problems - issues of concern in personal life
c. Interpersonal relationships at work or at home

Age

Shiftwork and work schedules

Workload (mental/physical)

Jet lag

B. Management Factors (ashore and aboard ship)

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, Manning policies, levels, and retention
   - Role of riders and shore personnel
   - Paperwork /reporting/inspection requirements
   - Economics
   - Duty schedules - shift, overtime, breaks
   - Company culture and management style
   - Shore based support
   - Rules and regulations
   - Other resources
   - Upkeep of the vessel
   - Training and selection of crew

2. Voyage and Scheduling Factors
   - Frequency and duration of port calls
   - Time between ports
   - Routing
   - Weather and sea condition on route
   - Traffic density on route
   - Nature of duties/workload while in port and at sea

Module 2 provides recommended strategies for identifying, mitigating, and controlling fatigue risks due to management factors.

C. Ship-specific Factors

These factors include some ship design features that can affect and contribute to cause fatigue. Some ship design features affect workload (i.e. automation, equipment design and
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 some influential ship-specific factors:

.1 Ship design
.2 Level and complexity of automation
.3 Level of redundancy
.4 Equipment design and reliability
.5 Inspection and maintenance
.6 Age of the vessel
.7 Physical comfort in work spaces
.8 Location of quarters
.9 Ship motion
.10 Physical comfort of accommodation spaces

18 Module 5 provides recommended strategies for identifying, mitigating, and controlling fatigue risks due to ship-specific factors.

D. Environmental Factors

19 Exposure to excess levels of environmental factors, e.g. temperature, humidity, excessive noise levels, can cause or affect fatigue. Environmental factors within areas in which seafarers live and work (both inside and outside the ship) may contribute to the onset of fatigue, and impact both sleep quantity and quality. Long term exposure may even cause harm to a person’s health. Environmental factors to consider include noise and vibration, light, ship motions, temperature and humidity, and ventilation/air exchange. Furthermore, considering that environmental factors may produce physical discomfort, they can also cause or contribute to the disruption of sleep. Long-term exposure to the following may impact a person’s health:

.1 Noise: (such as main engines, switchboards, TV, conversations, etc) affect the ability to fall asleep, causing sleep loss, or it can alter one’s sleep stage or depth of sleep.

.2 Vibration: may affect sleep and fatigue. For example, alterations in vibration pattern may keep people awake, keep them from advancing into deeper sleep, or wake them up.

.3 Light: (such as colour, intensity, exposure timing, etc) is a complicated environmental factor. In addition, the use of electronic displays that emit blue light (such as computer screens, flat screen telecommunications, and smart phones) can also influence the body clock and can delay the onset of sleep, especially when used prior to bedtime.

.4 Ship motion: Depending on the weather and sea conditions, ship motions may interfere with sleep, cause motion induced fatigue (fatigue caused by the extra energy expended to maintain balance while moving, especially during harsh sea conditions and seasickness).


Commented [CBS]: Suggest including what, specifically, could impact a person’s health: extreme environments with high or low temps, winds, humidity, noise levels, etc. It looks like we have deleted the examples before this sentence and put a few after, but the sentence doesn’t make sense in its current placement.
Temperature and humidity: All excessively hot and cold conditions will make an individual feel less alert and generally more fatigued. It is important that the shipboard temperature and humidity is controllable as this affects sleep and alertness. For example, the body sleeps best when the environment temperature is between 18 and 24°C.

Ventilation/Air Exchange: In addition to controlling temperature and humidity, air quality (e.g. noxious odours, stale air, etc.), and design/placement of the ventilation system may interfere with 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 to mitigate the effects of these factors vary and will be discussed further in subsequent modules. 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.

BASIC CONCEPTS IN UNDERSTANDING FATIGUE

Important basic concepts in understanding fatigue

This section highlights some of the basic important concepts that provide an overall understanding about fatigue. The most significant aspects of fatigue are:

1. sleep;
2. body clock and the circadian rhythm;
3. time awake;
4. jet lag;
5. workload;
6. stress;
7. health; and
8. individual differences.
A. Sleep

22 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:

- Quantity:
- Quality:
- Continuity

Duration Quantity: Everyone’s sleep needs are unique; however, it is generally recommended that a person obtain, on average, 7 to 8 hours of good quality sleep per 24-hour period. To perform adequately and effectively, 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.

Quality: Sleep is a highly organized sequence of events that follows a regular pattern of cycles between light and deep sleep. People need deep sleep. Just being tired is not enough to ensure good sleep. Deep sleep is a very restorative phase of sleep. An individual must begin sleep in synchrony 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.

Continuity: Sleep quality is dependent upon unbroken cycles of sleep, meaning sleep needs to be uninterrupted in order to retain its restorative value. The sleep should be uninterrupted. Six one hour naps do not have the same benefit as one six hour period of sleep. The more fragmented the sleep cycle, the less restorative sleep becomes. This results in continued feelings of tiredness and often impacts performance and decision-making. If the time of sleep is out of synchronization with his/her body clock, it is difficult to sleep properly. To note is that the proportion of time spent in deep sleep decreases as we get older, particularly amongst men. Sleep also becomes more fragmented as we get older.

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

1. environmental factors: (e.g. ship’s violent movement, weather, heavy vibration, noise or poor accommodation)
2. food;
3. and consumption of chemicals (e.g. alcohol intake, coffee, medication, etc.);
4. psychological factors (e.g. stress, family worries, on-duty responsibilities);
5. Sleep disorders (e.g., 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); and

6. Operational factors (e.g., disruptions caused by drills, cargo loading and unloading).

24. Sleep debt is “insufficient accumulated sleep over multiple consecutive 24-hour periods”. For
example, if an individual needs eight hours of sleep per 24-hour period and only obtains six hours,
they have accumulated a sleep debt. Sleep debt will affect the individual’s level of alertness and
performance. Long term sleep debt may also lead to health problems. Over time, sleep-deprived
individuals may become less aware of just how fatigued they are and are unable to judge their own
level or performance.

25. When someone is woken up suddenly, the brain can have difficulty transitioning out of deep
sleep. This is known as sleep inertia, feelings of grogginess and disorientation, with impaired short
term memory and decision-making which can last longer than 30 minutes. Sleep inertia can also
occur following lighter sleep, but it tends to be longer and more disorienting when someone is woken
abruptly out of deeper sleep.

B. Biological Body Clock and the Circadian Rhythm

26. The time of day in which work takes place is a key risk factor in determining fatigue. This is
because independent of prior sleep and wake, humans are biologically programmed to be active
during the day and to sleep at night.

27. Each individual has a biological body 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 body clock
regulates the circadian rhythm. The biological body clock is perfectly synchronised to the traditional
pattern of daytime wakefulness and night-time sleep.

28. The biological body 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).

29. Independent of other factors, fatigue is most likely, and when present, most severe, in the
early hours of the morning, coinciding with the strongest drive for sleep. This period typically occurs
between the hours of 0300 and 0500 hours and is commonly referred to as the window of circadian
low (WOCL).
30 In general, seafarers working through the night may be at a higher risk of fatigue and have to make additional effort to maintain alertness and performance. This is supported by maritime studies and investigations in which fatigue was found to be a contributing cause in incidents that mainly occurred between 0000 and 0600 hours. This indicates that from a maritime perspective high risk times may fall between these hours.

31 Apart from the WOCL, another distinct dip occurs between 1500 and 1700 (best known as the post lunch dip).

32 The states of sleep/wakefulness and circadian rhythms interact in several ways.
   1. 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.
   2. 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.

33 For many seafarers, working patterns conflict with their biological body clock. Irregular schedules caused by shifting rotations, crossing time zones, etc. cause the circadian rhythms to be out of synchronization. As circadian adjustment to a particular pattern of work and rest is a relatively slow process (only adjust by an hour or two each day), constant changes impair sleep. Work that requires seafarers to be awake and work at night or early morning or to work for extended periods can cause disruptions to the body clock resulting in increased fatigue.

34 Even though the body clock can be reset over time, such as when changing times zones for an extended period, research shows that it cannot be permanently adjusted to a reversed cycle of work and sleep. Because the body clock may not adapt fully to altered sleep/wake patterns:
   1. Seafarers should always take proper precautions/actions to ensure adequate sleep is obtained. However, additional effort may be required to maintain alertness and peak performance levels during the night shifts may experience more difficulty maintaining alertness, all watchstanders are responsible for doing their best to obtain the necessary rest to maintain vigilance during their watches.
   2. Seafarers should also be aware that shifting sleep routines to adjust to a night work schedule requires a period of adaptation; therefore, ensuring adequate rest during this adjustment period is critical.

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. Time Awake

1. hqs-nas-t-001\CG-5\CG-52\CG-MMC\FACA\MERPAC\Meetings\Meeting - 48 NOLA\Post Meeting\Minutes\5 Task 89. IMO Fatigue Guidance MSC 1014 Rev7.docx; https://docs.live.net/67885feb7afcf044/Documents/IMO/HTW/HTW Fatigue CG - USCG 2017-18/MSC 1014 - Guidance on Fatigue Mitigation and Management.doc
35 How long an individual is awake affects sleepiness and consequently fatigue levels. The longer an individual has been awake, the poorer their performance. In general, the longer a seafarer remains awake, the stronger the drive for sleep, and the higher the levels of fatigue. During the first hours awake, the urge to sleep may go unnoticed, but as the amount of continuous wakefulness approaches 16 hours, awareness of the pressure to sleep is highly likely. This occurs sooner if the seafarer is already suffering from sleep debt.

36 Alertness and performance levels begin to decrease after a number of hours awake, with long duty periods associated with higher levels of fatigue than shorter duty periods due to extended wakefulness and demands on attention. In addition, the longer an individual has continuously been on a task without a break the more likely they will be fatigued. Accident rates rise exponentially after 12 hours of consecutive work, particularly when working at night.

37 Long work hours are associated with poor performance, higher injury rates, poorer safety, and/or health outcomes (both mental and physical). Another important aspect to consider are work commutes. Many seafarers may be required to travel or drive long distances to the ship and then have to work.

D. Jet Lag

38 Jet lag occurs following long flights through several time zones. Seafarers crossing time zones to join their ship are exposed to a sudden change in the day/night cycle causing circadian disruption. It is a condition that causes fatigue in addition to sleep-deprivation and irritability. The body clock will eventually adapt to a new time zone, however depending on the new schedule, it takes several days to adjust. During the period of adaptation to the new time zone, common symptoms include wanting to eat and sleep at times that are out of step with the local routine, problems with digestion, degraded performance on mental and physical tasks, and mood changes. It is easier to adjust while crossing from east to west as opposed to west to east.

E. Workload

39 Workload refers to the type and intensity of tasks performed. Fatigue can occur when workload is either very high or very low. High workload and monotonous tasks may be present in a shipboard work environment, and are likely to induce fatigue. Fatigue resulting from workload becomes an increasing concern when combined with long periods of wakefulness and long duty hours.

1. High Workload: Both high physical and mental (such as tasks with excessive demands on attention) workload may lead to fatigue. Examples of high workload routinely experienced on board ships include (but are not limited to): navigating in congested and dangerous waters; frequent port calls, navigating in conditions of poor visibility, and/or bad weather; entering and exiting a port/harbour; having to complete multiple tasks; tank cleaning, cargo operations, etc.

2. Low Workload: Monotonous tasks, such as monitoring (e.g. engine-room displays) can result in loss of interest and boredom, which also increases the effects of fatigue. This can be a particular problem when conducting bridge or engine monitoring and
vigilance tasks across long periods of time. This can be readily seen when a person is required to maintain a period of concentrated and sustained attention especially during the night (e.g. night duty). People are generally not good at long duration vigilance tasks. Performance and alertness is further impacted if vigilance and monitoring tasks need to be carried out during the night time hours, specifically between 0000 and 0500 hours.

C. Stress

F. Stress

40 Stress occurs when a person is confronted with an environment or situation 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 is influenced by many characteristics of the work environment or issues or changes to personal/family/home environment. Stress can be caused by a number of things including:

1. Environmental hardships factors (constant/irregular noise, vibration, exposure to high and low temperatures, weather such as ice conditions, fog, etc)

Weather (i.e. ice conditions)

2. Personal circumstances problems (family problems, home sickness, isolation, etc.)

3. Broken rest Inadequate restorative sleep

4. Broken/interrupted sleep/rest periods

5. Long Excessive working hours

6. Intense mental and/or physical workload

7. On-board interpersonal relationships

41 These stressors, and others, can impact the extent to which a seafarer is able to acquire sufficient sleep and consequently lead to fatigue. For example, family aspects that require attention but are beyond the seafarer's control may lead to short sleep duration and extended wakefulness. Seafarers may be away from home for extended periods of time. Loneliness, isolation, family conflict, and concern about family members may provide enough stress to be considered risk factors.

G. Health

42 Healthy lifestyle choices such as good physical fitness and a healthy diet have been reported to reduce fatigue and improve alertness and performance. Conversely, unhealthy lifestyle choices can negatively impact sleep and therefore contribute to fatigue.

1.https://www.oecd.org/ctp/...
1 Nutrition: A poor diet that does not include fresh fruits and vegetables can contribute to fatigue by adversely affecting a seafarer’s health. In addition, irregular meal times can adversely affect digestion which also follows the circadian rhythm. Digestion is programmed to be most efficient during the day and much less so at night. Food eaten at night is digested at a slower rate. This can often lead to feeling bloated or constipated and can cause heartburn and indigestion. Gastrointestinal upsets are very common in people who eat outside of traditional meal times. These upsets can be made worse by drinking tea, coffee, or alcohol. Additionally, when lying down right after eating a large meal acid reflux may occur. Night workers are five times more likely to get peptic ulcers than day workers.

2 Hydration: Dehydration is also a factor that adversely affects fatigue. When the body is low on water, it tries to conserve what it has left. It does this by reducing activity and making the body relax and slow down. When relaxed, people have a higher chance of falling asleep. Being dehydrated can also make people feel light-headed and cause headaches. In addition to maintaining cognitive function and alertness, drinking adequate water helps keep the digestive and circulatory systems operating properly. Water brings healthy nutrients to cells and carries away toxins.

3 Exercise and Fitness: Poor physical fitness adversely affects overall health and causes people to tire easily. Exercise speeds up metabolism and increases blood flow, which helps to keep a person awake. Exercise also helps the body cope with stress and can help individuals suffering from depression, a condition that can be characterized by fatigue. Physical exercise can also help reduce a person’s susceptibility to certain diseases and infections. The inability to exercise is considered a risk factor because it is a circumstance that takes away a crew member’s ability to increase physical fitness, enhance sleep, think clearly and manage stress.

4 Caffeine and other stimulants: Caffeine can be found in beverages such as coffee, tea and some soft drinks. Caffeine can improve alertness and concentration in moderate doses, but it is not a substitute for adequate sleep and rest. Too much caffeine can have harmful effects such as increased heart rate, blood pressure, and can cause fatigue in some people. It takes caffeine about 15 – 30 minutes to enter the body’s system, and its physiological effects peak after about an hour after the drug reaches the bloodstream. The effects of caffeine can be highly variable from individual to individual and depends on physical condition, age, level of sleep debt, frequency of use, and time of day. Generally, caffeine levels drop by half every 5-6 hours. Its effects can last long after consumption and may interfere with needed sleep. Caffeine shortens total sleep time by preventing sleep. Caffeine consumption can also cause dehydration.

5 Alcohol: Although alcohol is a central nervous system depressant, it can impair the quality of sleep. Alcohol can lead to increased sleepiness and reduced alertness, even after the alcohol is no longer detectable. There are also serious health consequences related to the long-term abuse of alcohol. Many shipping companies have “zero alcohol tolerance.”
6. **Nicotine**: Nicotine is highly addictive and the dangers to health are well documented. Nicotine users generally have more disturbed sleep, typically taking longer to fall asleep and experiencing more wake time during a sleep period.

7. **Drugs and Supplements**: It is important for seafarers to be aware of how drugs and supplements may affect their health and their sleep-wake cycles. Drug effects vary not only from person to person, they can also vary for the same person depending on time of day, mood, tiredness, and the amount of food eaten. In addition, there are other drugs prescribed for specific ailments that can have sedating side effects. Some prescription drugs can affect people’s ability to operate machinery (induce sleepiness). They may also interact with existing fatigue levels and other drugs (including alcohol) and supplements, further affecting performance. Some over-the-counter drugs used for pain relief or colds and flu may increase drowsiness and fatigue-related symptoms. Additionally, there are now a number of nutritional supplements, natural products, and energy drinks that are available on the market that directly influence sleep/wake states. Just because they are sold over-the-counter does not mean they are safe or appropriate for everyone. These products may interact with prescription or over-the-counter drugs to further affect performance. Individuals should proactively seek advice and guidance from their healthcare providers before using these products to learn about their appropriate use.

8. **Sleep Disorders**: Other health-related aspects are the wide variety of sleep disorders known to disrupt the quality of sleep and make it impossible to obtain restorative sleep, even when individuals spend enough time trying to sleep. The most common sleep disorders are obstructive sleep apnea, insomnia, narcolepsy, shiftwork related and restless legs syndrome. Undiagnosed or untreated sleep disorders can cause sleepiness problems. Sleep disorders pose a particular risk for seafarers, especially as maritime operations already expose seafarers to restricted sleep. Large numbers of individuals suffering from sleep disorders are unaware of and have not been diagnosed or treated for their disorder.

- **Obstructive sleep apnea (OSA)** results in breathing being interrupted during sleep. Repetitive episodes of non-effective breathing, very shallow breaths, or inadequate breaths lead to frequent partial arousals from sleep, resulting in ineffective sleep and sleep debt. OSA is a potentially serious sleep disorder resulting in excessive daytime sleepiness and can lead to cardiovascular problems. Sleep apnea often goes undiagnosed and untreated and has been known to be a contributing factor to incidents in all modes of transportation. Some risk factors include excessive weight, high BMI, high blood pressure, smoking, diabetes, and loud snoring with pauses of silence.

- **Insomnia** is the most prevalent sleep disorder and is characterised by an inability to fall asleep and/or by waking up during the night and having difficulty going back to sleep. Long term insomnia is more common in women than men and tends to increase with age. Short-term insomnia may be caused by emotional or physical discomfort, stress, environmental noise, extreme temperatures, or jet lag, or may be the side effect of medication.
Secondary insomnia may result from a combination of physical or mental disorders, undiagnosed or uncontrolled sleep disorders and effects of prescription or non-prescription medications.

- Restless legs syndrome (RLS) is a movement disorder that is often associated with a sleep complaint. People with RLS have unpleasant leg sensations and an almost irresistible urge to move the legs. Symptoms are worse during inactivity and often interfere with sleep. Sitting still for long periods becomes difficult; symptoms are usually worse in the evening and night and less severe in the morning.

- Shift work sleep disorder is characterized by insomnia and excessive sleepiness affecting people whose work hours overlap with the typical sleep period. There are numerous shift work schedules (permanent, intermittent or rotating); consequently, the manifestations of this disorder are quite variable. Those with shift work disorder complain more of mood problems such as impatience and depression, as well as more self-reported health complaints such as ulcers and substance use.

- Narcolepsy is a chronic sleep disorder that usually becomes evident during adolescence or young adulthood. The main characteristic of narcolepsy is excessive and overwhelming daytime sleepiness (even after adequate nighttime sleep). A person with narcolepsy is likely to become drowsy or to fall asleep at inappropriate times and places, and in extreme cases during periods of activity. Daytime sleep attacks may occur without warning and may be irresistible. In addition, nighttime sleep may also be fragmented.

**H. Individual differences**

Individuals respond to fatigue differently and may become fatigued at different times, and to different degrees of severity, under the same circumstances. There are also individual characteristics related to circadian rhythms. People can be characterized as morning or evening types depending on the period of the day when they perform at their best.

**6. EFFECTS OF FATIGUE**

**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. When impairment due to fatigue, such as impaired memory...
or poor communication, coincides with other risks in the environment, incidents can result. This is evidenced in a number of maritime casualties in which fatigue was a contributory factor. Maritime studies have also confirmed the association between fatigue and poor performance.

45 **Fatigue is dangerous in that people are poor judges of their own level of fatigue, performance, and decision-making.** The following is a sample of fatigue’s known effects on performance. Modules 2–9 contain a more extensive list for use by each individual industry group:

1. 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).

2. **Chronically fatigued individuals** will often select strategies that have a high degree of risk on the basis that they require less effort to execute.

3. Fatigue can **negatively** affect an individual's ability to **identify and respond to stimuli**, perceive stimuli, interpret or understand stimuli, and it can take longer to react to them once they have been identified.

4. Fatigue can also **negatively affect problem solving** which is an integral part of handling new or **challenging novel tasks**.

46 Particularly dangerous situations at sea emanating from sleep debt are brief uncontrolled and spontaneous sleep episodes whilst working, termed micro-sleeps. During a micro-sleep, the brain disengages from the environment (it stops processing visual information and sounds). Sleep deprivation, which is caused by cumulative sleep debt, can make people more susceptible to micro-sleeps. The likelihood of micro-sleeps is even more likely if the individual is on duty during a circadian low.

47 The range of effects and signs of fatigue can typically be grouped into three categories: mental (e.g. loss of vigilance), physical (e.g. yawning, micro-sleeps), and behavioural (e.g. irritability, mood). The table below outlines some of the major symptoms under each category; however, it is not inclusive. Additionally, many of these symptoms may be subtle.

### TABLE 1
**EFFECTS OF FATIGUE**

<table>
<thead>
<tr>
<th>PERFORMANCE IMPAIRMENT</th>
<th>MENTAL</th>
</tr>
</thead>
</table>
| 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  
• Decline in ability to solve complex problems  
• Lapses of attention  
• Difficulty in multitasking |
### Dimensioned 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.
- Greater indecisiveness

### 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
- Memory lapses

### Slowing of mental response
- Responds slowly (if at all) to normal, abnormal or emergency situations

### PHYSICAL

<table>
<thead>
<tr>
<th>PERFORMANCE IMPAIRMENT</th>
<th>SIGNS/SYMPTOMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Involuntary need to sleep</td>
<td></td>
</tr>
<tr>
<td>Slow eyelid closures</td>
<td></td>
</tr>
<tr>
<td>Droopy eyelids</td>
<td></td>
</tr>
<tr>
<td>Itchy eye</td>
<td></td>
</tr>
<tr>
<td>Nodding off</td>
<td></td>
</tr>
<tr>
<td>Inability to stay awake</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Loss of control of bodily movements</th>
</tr>
</thead>
<tbody>
<tr>
<td>May appear to be drunk</td>
</tr>
<tr>
<td>Inability to stay awake</td>
</tr>
<tr>
<td>Affected speech e.g. it may be slurred, slowed or garbled or hard to find the right words</td>
</tr>
<tr>
<td>Feeling heaviness in the arms and legs</td>
</tr>
<tr>
<td>Decreased ability to exert force while lifting, pushing or pulling</td>
</tr>
<tr>
<td>Increased frequency of dropping objects like tools or parts</td>
</tr>
<tr>
<td>Difficulty with hand-eye coordination skills (such as, switch selection)</td>
</tr>
<tr>
<td>Tremor</td>
</tr>
<tr>
<td>Clumsiness</td>
</tr>
</tbody>
</table>

### Health Issues
- Headaches
- Giddiness
- Rapid breathing
- Digestion problems
- Leg pains or cramps
- Insomnia
- Sudden sweating fits
- Heart palpitations / irregular heart beats
- Loss of appetite (and sometimes an increase in unhealthy eating habits)
PERFORMANCE IMPAIRMENT | SIGNS/SYMPTOMS
--- | ---
Mood change | Quiet, less talkative than usual
 | Unusually irritable
 | Decreased/Increased intolerance and anti-social behavior
 | Depression
Attitude change | Fails to anticipate danger
 | Fails to observe and obey warning signs
 | Seems unaware of own poor performance
 | Too-More willing to take risks
 | Ignores normal checks and procedures
 | Displays a “don’t care” attitude
 | Weakness in drive or dislike for work
 | Less desire to socialize
 | Increasing omissions and carelessness
 | Low motivation

48 Sleep debt, over long periods of time (more than two weeks) has long-term effects on health and clinical illnesses, increasing the risks of pain, stress, obesity, coronary heart disease, gastrointestinal disorders and diabetes. Long-term affects also point to mental health problems such as negative mood states and depression.

49 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. The instances of injuries and incidents reportedly related to fatigue within maritime operations have resulted in great economic, environmental and human cost. Thus, addressing the risks of fatigue and its causes are essential. Unless steps are taken to alleviate the fatigue, it will remain long after the period of sustained attention, posing a hazard to ship safety.

ILO and IMO instruments related to fatigue

1 The following IMO instruments contain guidance on fatigue-related aspects:

1.1 International Convention on Standards of Training Certification and Watchkeeping for Seafarers, 1978 as amended (STCW Convention)

   1 Regulation VIII/1 (Fitness for duty) states that "each Administration shall, for the purpose of preventing fatigue:

   a. establish and enforce rest periods for watchkeeping personnel and those whose duties involve designated safety, security and prevention of pollution duties in accordance with the provisions of section A-VIII/1 of the STCW Code; and
b. require that watch systems are so arranged that the efficiency of all watchkeeping personnel is not impaired by fatigue and that duties are so organized that the first watch at the commencement of a voyage and subsequent relieving watches are sufficiently rested and otherwise fit for duty”.

2 In addition, Part A of the Code sets minimum periods and frequencies of rest and requires that watch schedules be posted where they are easily accessible.

1.2 International Safety Management Code (ISM Code)

1 This Code introduces safety management requirements on ship companies to assess all identified risks (both ashore and afloat) that affect safety (to ship and personnel) and environment and establish appropriate safeguards. The fatigue related requirements include the requirement for the company to:

a. Develop, implement and maintain a safety management system (ISM Code, 1.4);

b. Ensure that each ship is manned with qualified, certificated and medically fit seafarers in accordance with national and international requirements and are appropriately manned in order to encompass all aspects of maintaining safe operations on board (ISM Code, 6.2);

c. Ensure necessary shipboard support is provided so that the master's duties can be safely performed (ISM Code 6.1.3); and

d. Provide familiarization and training for shipboard personnel (ISM Code 6.3, 6.4 and 6.5).

1.3 Resolution A.1047(27) – Principles of Minimum Safe Manning

1 This resolution provides guidelines for determining minimum safe manning. In particular in ensuring 'fitness for duty'. Section 1.4.2 of the guideline states that "in determining the minimum safe manning of a ship, consideration should also be given to the capability of the master and the ship's complement to coordinate the activities necessary for the safe operation and for the security of the ship and for the protection of the marine environment”.

1.4 Resolution A.772(18)1 – Fatigue Factors in Manning and Safety

1 This Resolution provides a general description of fatigue and identifies the factors of ship operations which may contribute to fatigue.
2 Other Instruments

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

2 The following ILO instruments contain guidance on fatigue related aspects:

2.1 Maritime Labor Convention (MLC, 2006). Relevant aspect of the MLC includes, but are not limited to:

- Regulation 2.3 (hours of work and hours of rest) introduces provisions to establish limits on seafarers' maximum working hours or minimum rest periods so as to maintain safe ship operations and minimize fatigue.

- Regulation 2.7 (manning levels) ensure that seafarers work on board ships with sufficient personnel for the safe, efficient and secure operation of the ship.

- Regulation 3.1 (accommodation and recreational facilities) ensures that seafarers have decent accommodation and recreational facilities on board.

- Regulation 3.2 (food and catering) ensure that seafarers have access to good quality food and drinking water provided under regulated hygienic conditions.

- Regulation 4.3 (health and safety protection and accident prevention) ensure that seafarers' work environment on board ships promotes occupational safety and health.
References


Guidelines on Fatigue
Module 62

SHIPBOARD FATIGUE AND THE OWNER/OPERATOR/COMPANY

Foreword

The Fatigue guidelines contain practical information that can assist interested parties (Naval architects/Ship designers, owners/operators, Masters, Officers, other crew members, Seafarers, and training providers/institutions, Ship Designers, Administrations, and Port State Authorities) 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, identify, mitigate, and control fatigue in order to improve associated health problems and prevent fatigue related incidents from occurring.

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

1. Module 1 Fatigue
2. Module 2 Shipboard Fatigue and the Company
3. Module 3 Fatigue and the Seafarer
4. Module 4 Fatigue and Training
5. Module 5 Fatigue and the Ship Designer
6. Module 6 Fatigue, the Administration, and Port State Authorities
7. Appendix Fatigue related documentation

It is recommended that all parties become familiar with Module 1 prior to using Modules 2 - 69. Module 1 contains pertinent background information on the subject of fatigue.
Module 62 contains practical information intended for the Owner/Operator/Manager. 
It is recommended that they also become familiar with Modules 2, 3 and 4 respectively (Fatigue and the Rating, Fatigue and the Ship’s Officer, Fatigue and the Master Seafarer).
**Guidelines on Fatigue**

**Module 2**

**SHIPBOARD FATIGUE AND THE OWNER/OPERATOR/MANAGER COMPANY**

**Is fatigue an important issue in shipboard operations?**

1. 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 workplace. 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.

2. 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. 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 company by reducing injury and physical damage to high value assets and the environment.

3. 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.

4. 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. 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 seafarer fatigue.

**How does Fatigue affect seafarer performance?**

How does fatigue affect seafarer performance?

5 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%. 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.

6 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.

7 Other research has shown that periods of sustained operations for 24 hours result in a drop in performance of about 25%. 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.

8 One way to explain how the loss of sleep or rest can affect seafarers is to consider bridge watchkeeping, operational safety, or security. While on watch, sleep loss deprivation has been reported to have the following effects including, but not limited to, the following:

- Slowed reaction
- Delayed or false response
- Failure to respond at the correct time
- Slow thinking and diminished memory
- Poor decision making
- Increased risk of personal injury (slips, trips, falls, etc)

9 These and other outcomes each pose a risk to any position aboard, but especially those that have critical safety and security responsibilities. Should an individual fail to carry out an allotted task due to fatigue, the crew runs the risk of a safety or security incident, 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. The company should provide an adequate level of support for managing the risks of fatigue at both the organisational and operational levels.
What elements of Fatigue can the Company influence?

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

10 While it is not possible for Shipowners, Operators and/or Managers the company to regulate and oversee the sleeping habits of every crewmember seafarer on every ship, it is within their capability to establish a fatigue management system mitigate the risks of fatigue through ship design, operational, and manning policies. Resolution A. 1047, Principles of Minimum Safe Manning, provides for an assessment of the tasks, duties and responsibilities of the ship's complement to ensure that manning levels are adequate at all times to meet all conditions and requirements including meeting peak workload situations and emergency conditions. Hours of rest 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, as amended. Managers should be aware (when applying these hours of work limitations rest) 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. This should be supported by appropriate manning, resources, processes, and policies, so that fatigue risks can be managed in a way that supports safe, compliant, and productive operations. Importantly, fatigue risk control measures forming part of company support should:

1. Identify and assess fatigue risks
2. Assess operational workload requirements in accordance with Resolution A. 1047
3. Ensure that manning and resources are adequate and available for assessed workload requirements and to conduct all ship operations safely;
4. Ensure “Company” wide awareness of the risk of fatigue;
5. Ensure a healthy shipboard environment

11 Figure 3.1 below provides an instrument to assess the hazards associated with fatigue and different strategies to mitigate the risk of fatigue.
Some necessary elements to an effective fatigue management system are as follows:\footnote{https://docs.live.net/67885feb6feb6f044/Documents/IMO/HTW/HTW Fatigue CG-USCG-2017-18/MSC 1014 - Guidance on Fatigue Mitigation and Management.doc}

- 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.

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{Figure3.1.png}
\caption{Instrument to mitigate risk of fatigue}
\end{figure}
12 Some organisations already maintain records of hours worked. However, these hours are normally assessed against the criteria set out by the STCW MLC 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
- Analysing and comparing information related to hours of work that will determine the effectiveness of employed routines, compared to other alternatives

13 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. Overall, it is important that management adopt a fatigue management mitigation and control system strategy that is tailored to the individual enterprise.

How can the Company ensure that Fatigue prevention is practiced onboard?

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

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

- ISM Code requirements for clear, concise guidance on operational procedures on board;
- 2 Assure adequate resources including manning levels;
- Promoting a safety reporting culture with open communication and no fear of reprisal
- The need for joining seafarer 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 if practicable;
- Improved Adequate sleeping berths and accommodation;
- Adequate quality and quantity of food for proper nutrition;
- Read other Modules 2-4 for additional potential managerial mitigation tools; and
- Modification of present ship design or future designs if necessary.
Fatigue training and awareness are essential components. The company should ensure all personnel have appropriate training. This includes shore-based personnel whose decisions may impact on the management of fatigue (such as those involved in resource planning, including shipping manning levels, and duty scheduling decisions) and fatigue-related processes. This is important, as their decisions potentially affect fatigue levels of seafarers and consequently shipboard safety.

Initial fatigue-related training should establish a common level of understanding among seafarers and shore-based personnel about the dynamics of sleep loss and recovery, the effects of the body clock on circadian rhythms, the influence of workload, and the ways in which these factors interact with operational demands to produce fatigue (covered in Module 1). In addition, it is useful for all seafarers to have information on how to manage their personal fatigue and sleep issues (covered in Module 4 of these guidelines).

This process, as with any other training, should be ongoing in nature. Hence, training should be conducted on an initial and recurrent basis. The interval between training should be determined by the company, given their operational characteristics and training needs analysis.

Placeholder - Include text for reporting.

A. Adequate Resources (including shipping manning levels)

Adequate resources, including manning, is one of the primary determinants of seafarers' duty hours, workload, duty scheduling, average time off-duty, and other key factors that can have an influence or elevate fatigue. The company should ensure that adequate resources are available with a need to proportionally balance varying work and task demands and deal with unexpected surge to reduce the risk of fatigue across shipboard operations.

Although the master is responsible for managing the ship and its crew, the company should ensure that the master is adequately supported and resourced to conduct shipboard duties and operations safely and effectively.

Effective operational planning is critical to ensuring adequate resources including manning are available at all times so that operational and other demands placed on the ship and its crew can be managed safely and effectively. Planning should account for:

1. Varying work and task demands within and across days (e.g. amount of time the ship is travelling through confined and congested waters and less confined open waters);
2. Trading patterns (i.e. number of port calls – the more port calls the higher the workload);
3. Planning for disturbances, such as weather, ship movement in port, port entry and exit delays and port surveys and inspections;
4. Ensuring adequate manning is available to cover planned and unplanned aspects such as training, illnesses, injuries and sickness;
5. Ensuring company commercial obligations or interests do not impinge or effect safety in any way.

Placeholder - Include text for reporting.
22 The company should consider strategies to deal with periods of high workload and to manage this accordingly. Appropriate strategies may include:

   1. The allocation of crew numbers to peak times and demands is a fundamental factor in minimising the exposure to risks associated with extended duty hours. Numbers and types of seafarers should be scheduled on the basis of predictable operational demands to account for daily, weekly, and monthly operational trends;

   2. Ensure the master is well resourced and supported to carry out all shipboard tasks safely and to allow for unexpected surge and over-riding operational conditions;

   3. Ensure there are adequate resources, including manning, to complete shipboard tasks safely without placing excessive demands on seafarers;

   4. Augment with shore based support or additional rest when ship is in port such as during loading and unloading, port inspections, etc. to ensure shipboard crew obtain adequate time off for rest and sleep and are fit for duty when the ship leaves port;

   5. Provide shipboard administrative support or a means for relieving the burden associated with paperwork and related administrative tasks;

   6. Where practicable, provide remote support to shipboard crew, in areas such as paperwork, loading/unloading calculations etc;

   7. Utilise other crewing concepts, such as the use of port captains and/or shore based crew; and

   8. Plan arrival and departures (tides in ports, delays due to weather, pilotage boarding, etc.) to take into account adequate sleep and rest.

23 An important aspect that needs to be mentioned is that of Overriding Operational Conditions. In accordance with STCW Section B-VIII/1. ‘Overriding Operational Conditions’ should be construed to mean only essential shipboard work which cannot be delayed for safety, security or environmental reasons or which could not reasonably have been anticipated at the commencement of the voyage. This means that they should not be occurring on a regular basis. Planning, using risk assessment tools and operational experience can foresee these potential disruptions or delays (e.g. weather, port inspections, traffic congestion during departure/arrivals, and illness of seafarers).

B. Healthy Shipboard Environment

24 Unique to shipping is the fact that seafarers are required to not only work but live on board a ship. Hence, ensuring a healthy shipboard environment is crucial to minimising the risks of fatigue. The most important aspects should include:

   1. Healthy Eating: Healthy nutritious food is available and served on board;

   2. Healthy Sleep: The shipboard sleeping environment is commensurate with providing comfortable and good quality sleep (bedding, pillows, mattresses, adequate light management, etc.)

   3. Exercise: Adequate exercise facilities are provided (such as well-designed and equipped training facilities and outside spaces), to ensure seafarers can maintain a healthy lifestyle on-board.

   4. Stress: Adequate shipboard measures are in place to recognise and ensure adequate support to seafarers suffering from stress.
Furthermore, initial ship design plays a part in ensuring a healthy operational environment (dealt with in Module 6).

C. Adequate Sleep Opportunity

26 Effective fatigue management is predominantly about ensuring that seafarers are provided with adequate sleep opportunity.

27 It is not correct to assume that a given rest period from duty will provide a given level of sleep and hence recovery. The length of the rest period is only one key factor. The relationship between the recovery value of off duty periods and the actual amount of sleep obtained in a shipboard environment is increasingly complex. As highlighted in Module 1, sleep quantity and quality (and its restorative value) depends on going through uninterrupted sleep. The more sleep is fragmented by waking-up, the less restorative value sleep has in terms of how seafarers feel and function when they are on duty.

28 Shipboard related factors that affect sleep include the design of duty schedules (i.e. length and timing of duty periods, length and timing of breaks within and between a duty period), and the environment (e.g., heat, humidity, noise, vibration, lighting levels, ship routines, diet, etc.). These can all have negative effects on the amount of time seafarers are allocated for sleep in a twenty-four-hour period.

D. Duty Scheduling and Planning

29 Duty scheduling and planning is a key factor in managing fatigue. Hence, the company should be responsible for ensuring duty schedules provide adequate opportunity for sleep.

30 Companies at the very least MUST be in compliance with Regulation VIII/1 of the STCW Convention.

31 From a practical perspective, it is important to determine whether a given duty schedule, on average, enables adequate sleep opportunity. There are eight primary duty schedule considerations that should be considered when scheduling. They are:

1. **Maximum work hours**: As indicated in Module 1, as the length of a given period of work increases, the subsequent sleep opportunity decreases. Research has demonstrated that apart from a reduction in performance, extended hours of work are also associated with reduced individual wellbeing, reduced organisational commitment and poor health outcomes. Administrative work, shipboard drills, training, ship loading and unloading tasks are all considered to be work hours. These factors in turn have been linked to declining levels of productivity and safety.

2. **Rest hours (rest periods) between work periods**: This is the length of time off between work periods and should reflect the fact that seafarers do not simply fall asleep as soon as they are off-duty and wake just before they go back on-duty. Seafarers, like shore-based workers, have many activities and responsibilities to...
manage between work periods such as eating, showering, socializing with other crew, relaxing, studying, and writing to and communicating with family members and friends back home. Fatigue increases as the number of rest hours decrease therefore rest hours should provide for adequate sleep opportunity, time to complete those other tasks noted above be adaptable to the individual circadian rhythm, and account for the effects of sleep inertia after waking. Hence, the interval between two successive work periods should allow sufficient time to obtain adequate sleep before the start of the next work period.

3. **Night watches or work**: As indicated in Module 1, seafarers working during night-time, specifically during the circadian low can experience severe performance degradation initially. If the seafarer maintains a regular schedule they will adapt over time. However, it is important to provide those seafarers working during night-time a good sleeping opportunity and environment during the day.

4. **Short rest breaks within work periods**: Short rest breaks benefit performance and help maintain alertness. As indicated in Module 1, one of the most important determinants of fatigue is ‘time on task’. Frequent short breaks are associated with performance benefits and results in better fatigue management when the timing of rest is at the discretion of the individual. While it is recognised that this may not always be feasible in a shipboard environment, it should be noted that the ‘time on task’ effect can also be reduced during the work period by task rotations/substitutions.

5. **Naps**: are an effective countermeasure to fatigue, exhaustion from long work hours, and restricted sleep. Whether before an anticipated short night’s sleep or after, brief naps improve performance and alertness, and delay fatigue-induced performance degradation. Overall research has shown that the benefits of controlled napping out-weigh the potential risks associated with sleep inertia.

6. **Recovery Sleep**: The provision for sufficient recovery time following periods of sleep debt is important. It should be noted that provision of minimum rest periods may not sufficiently acknowledge the critical role that the circadian rhythm plays in the rate at which fatigue accumulates and the rate at which people recover. To work safely across a given duty and to then return to the next work period sufficiently recovered requires that the seafarer obtains sufficient quantity and quality of sleep between work periods. While one or two recovery sleeps of eight hours or more are generally enough following a period of acute sleep loss (one night), recovery following a period of sleep debt (two or more nights of sleep loss) may take in excess of three nights. Sleep opportunities during the circadian low are preferable because sleep that occurs during the circadian low provides the most recuperative value. It is recognised that in a shipboard environment this may not always be feasible.

7. **Reset Breaks**: The risk of fatigue increases over successive work days of sleep debt, it seems logical that some “recovery” must take place over spans of rest days.
This is typically an issue at sea as seafarers are exposed to potentially arduous duty schedules over a long period of time (in excess of seven days, sometimes months on end) without the possibility of a reset break [INSERT DEFINITION]. It is recognised that in a shipboard environment this is likely not practical, however this may be a factor to consider when determining crew rotation.

32 Ship operators should consider napping and short break policies to manage fatigue if practicable.

33 Companies should also acknowledge impairment through sleep inertia when planning tasks and activities, giving adequate time for seafarers to be alert before performing critical tasks when possible.

E. Tools to Assess Fatigue in Scheduling

34 The planning of duty schedules based on fatigue science as well as operational requirements permits predictive identification of fatigue hazards. This assists in allocating adequate rest periods that provide sufficient sleep opportunity.

35 There are useful additional tools for the mitigation and control of fatigue such as:

1. Fatigue Risk Assessment Tool: The risk level of a specific duty schedule may be accessed via a fatigue risk score.

2. Fatigue Predictive Software Tools: Models and related software to predict fatigue levels for specific operations can be useful additional tools for the management of fatigue risks.

36 However, it should be noted that they should not be used in isolation nor be the main driver for duty scheduling decisions as they are not sufficient to determine the full extent of fatigue-related risk. They should always be supported by other operational data. Their main purpose should be limited to identifying potentially fatigue inducing duty schedules or scheduling hot spots and allow for better decisions in the selection of duty schedules. This is because numerous unforeseen circumstances can cause changes to planned schedules, for example, weather conditions, unexpected technical problems, or seafarer’s illnesses. Seafarer fatigue is the result of what is actually worked, not what is planned. Thus another proactive approach for identifying fatigue hazards is to analyse actual duty schedules in operation.

F. Workload Management

37 As discussed in Module 1, mental and physical demands of work can contribute to a seafarer becoming impaired by fatigue in a number of ways. Concentrating for extended periods of time, performing repetitious or monotonous work and performing work that requires continued physical effort can increase the risk of fatigue. Mental fatigue and physical fatigue are different and a seafarer can experience them at the same time. It is important to be aware of a seafarers’ optimal level of workload and stress and to have realistic attitudes towards these. Understanding that different people react differently to stressful situations (such as emergencies, family problems at home, job related) is critical for effective interventions. Hence, the use of effective
communication with seafarers and monitoring and observing any behaviours that may indicate a change to a seafarer’s fatigue as a result of workload is important (see fatigue signs and symptoms in Module 1).

38 Typical techniques for managing workload while on duty include: prioritisation of tasks, task delegation, task rotation crew rotation, and task shedding. A list of risk mitigation strategies that should be used in managing workload may include:

1. Carefully consider task design according to the workload and the resources, including manning, available;
2. Reducing the amount of time seafarers need to spend performing sustained physically and mentally demanding work (tank cleaning, navigation through congested waters, etc.);
3. Where possible, planning for a minimum of two crewmembers together on navigational watch;
4. Managing workload and work-pace change caused by machinery breakdowns and planned and unplanned sicknesses and illnesses;
5. Where practicable, minimising routine and administrative tasks or redesigning them to ensure seafarers can focus on core duties in their working time;
6. Minimize repetitive or monotonous tasks by using task rotation, where practicable.
7. Where practicable, defer non-urgent work to if necessary allow appropriate rest and recovery.

G. Work and Living Environment

39 The work and living environment is important for ensuring adequate opportunity for sleep and should be considered. Because good quality sleep is critical, companies should develop procedures to minimize interruptions to seafarers’ sleep. Opportunities for implementing countermeasures in this area vary from shipboard environmental, procedural to operational changes. For example, most environmental aspects such as noise can be better addressed during ship design (Module 6). However, there are control measures that the company can implement to assist in reducing noise levels in the sleeping environment.

40 Environmental, procedural and operational measures may also range from low cost solutions, such as porthole blinds and door baffles, to high cost solutions, such as re-fitting the ship exhaust or air conditioning systems.

41 Operational and procedural changes may include developing napping policies or defining blocks of time (sleep opportunities) during which seafarers are not contacted except in emergencies. These protected sleep opportunities need to be known to all relevant personnel. Depending on the situation, changes should be made to those areas that will have the most impact, and following evaluation, consideration to other changes can then be made.

42 Environmental control measures may include, but are not limited to:
1. Adequate facilities for rest, sleep and meal breaks and other essential requirements, such as bathroom facilities and personal storage;
2. Making sleeping areas darker, quieter, and more comfortable and increasing lighting in certain areas of the ship, such as:
   a. Providing a dark sleeping atmosphere using black out blinds for portholes or berths in sleeping spaces;
   b. Installing-insulation baffles over cabin door louvers;
   c. Improving air conditioning (ambient temperature) and air flow;
   d. Supplying good quality and comfortable bedding such as mattresses and pillows;

3. Making sleeping spaces, including their location, a priority in retrofitting and new ship construction;

4. Ensuring adequate personal storage space is available for seafarer’s personal effects.

Procedural and operational control measures may include, but are not limited to:

1. Increasing access to healthier food choices by ensuring nutritious food is served on-board;
2. Providing information and advice on healthy eating and physical fitness;
3. Making exercise equipment and facilities available to seafarers;
4. Providing and maintaining a quiet atmosphere for sleep. Develop a ‘do not disturb’ policy for sleeping seafarers;
5. Where practicable, calls for drills should be conducted in a manner that minimizes the disturbance of rest periods as they can be extremely disruptive;
6. Putting in place short breaks within duty periods, including napping policies;
7. Ensuring ship routines such as meal times are commensurate with seafarer working schedules. This includes providing personnel working at night with appropriate meal choices;
8. Providing access to counselling services to assist in any issues arising from the disruption to individual, family or social patterns and shipboard related aspects. Implement a consistent stress management program;
9. Have a policy in place to support seafarers experiencing elevated levels of workload;
10. If possible, avoid assigning seasick and ill seafarers shipboard work;
11. If possible, provide shipboard phone, internet, and e-mail access to all seafarers; and
12. If possible, ensure that maintenance work does not disrupt personnel sleeping.

H. Adequate Sleep Obtained

44. Given that sleep loss is a primary contributor to fatigue, the company should determine whether adequate sleep is obtained.

45. Situations may arise where a seafarer is provided with an adequate sleep opportunity, but they may not get adequate sleep. Hence, while an adequate sleep opportunity provides an indication of the quantity of sleep likely to be obtained, it is important to know whether adequate sleep has actually been obtained. Seafarers, should be provided the opportunity to report back situations when they have been unable to obtain adequate sleep or feel at risk of making fatigue-related errors without repercussions.
46 In general, seafarers are responsible to use adequate sleep opportunity appropriately, so they are alert and capable of performing assigned shipboard work safely. However, there are a number of reasons why seafarers may not obtain adequate sleep. Aspects mentioned below can all affect the amount and quality of sleep obtained:

1. a seafarer working during the night may have difficulty getting quality sleep;
2. seafarer upon joining the ship may experience difficulty adjusting to the sleep schedule;
3. seafarer travelling for an extended time to the ship should not be required to report to work until adequate rest is obtained;
4. undiagnosed and untreated sleep disorders as highlighted in Module 1;
5. emotional stress;
6. the sleeping environment (comfort, noise, darkness, ship motion, privacy, room location) may not allow for adequate sleep;
7. the type of food consumed;
8. medication or use of prescribed/over the counter/natural remedies;
9. consumption of stimulants such as caffeine and amphetamines;
10. use of personal electronic devices before sleep, which may delay the onset of sleep and not allow adequate sleep to be obtained.

47 Regardless of the circumstances causing insufficient or poor quality sleep, these should preferably be identified through proactive measures and treated as a potential shipboard hazard.

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.

What Rules and Regulations are in place to prevent and deal with Fatigue (International, National, and Company)?

Commented [CG/MERPAC13]: Global comment: request committee to ensure updated Rules and Regulations.
48 Addressing fatigue is a twin pronged problem beginning with determining manning levels that match the operational workload, followed by efficient management of the workload onboard the ship. Operational workload is determined through an assessment by the company of operational factors that need to be taken into account in Resolution A. 1047, Principles of Minimum Safe Manning. In addition, SOLAS V/14, Ship’s Manning, provides that governments shall ensure that ships are sufficiently and efficiently manned by taking into account the relevant guidance in A. 1047 in issuing a minimum safe manning document. The ISM Code, paragraph 6.2, refers to the Principles of Minimum Safe Manning in A.1047 for the company to ensure the ship is appropriately manned in order to encompass all aspects of maintaining safe operations on board.

49 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 watchkeeping personnel and those whose duties involve designated safety, security and prevention of pollution duties. However, it does not stipulate minimum requirements for those not keeping watches. Other persons. The limits described in Table regulation 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 watchkeeping personnel and those whose duties involve designated safety, security and prevention pollution duties watchkeepers."

50 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)MLC 2006. This convention requires governments to establish a work hour regime for crew members and seafarers 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.

51 STCW 78/95MLC 1978, as amended, and ILO 180 (once ratified)MLC 2006 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.

52 Experience with the limits — set by STCW and ILO 180MLC 2006 — 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.

53 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

<Commented [TM14]: Alternate text: Ensure vessels are Appropriately manned in order to encompass all aspects of maintaining safe operations on board (in accordance with the Principles of minimum safe manning, adopted by the Organization by resolution A.1047(27)).

<Commented [GQ15]: These are fundamental regulations on establishing safe manning levels and should be included in any guidelines on fatigue.

<Commented [AMG16]: Accurate?"
management, mitigation and control Under such circumstances, compliance with the requirements and the use of risk management tools, where available, will become necessary.
References


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.

[Old Module 2 – Fatigue and the Rating, deleted]
[Old Module 3 – Fatigue and the Ship’s Officer, deleted]
Guidelines on Fatigue
Module 34

FATIGUE AND THE MASTERSEAFARER

Foreword

The Guidelines on Fatigue contain practical information that can assist interested parties (Naval architects, ship designers, owners/operators, Seafarers, Companies, Masters, Officers, other crew members and training institution providers, Ship designers, Administrations, and Port State Authorities) 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, identify, mitigate, and control fatigue in order to improve associated health problems and prevent fatigue related accidents from occurring.

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

1. Module 1  Fatigue
2. Module 2  Shipboard Fatigue and the Company
3. Module 3  Fatigue and the Seafarer
4. Module 4  Fatigue and Training
5. Module 5  Fatigue and the Ship Designer
6. Module 6  Fatigue, the Administration, and Port State Authorities
7. Appendix  Fatigue related documentation
8. Module 1  Fatigue
9. Module 2  Fatigue and the Rating
10. Module 3  Fatigue and the Ship’s Officer
11. Module 4  Fatigue and the Master
12. Module 5  Fatigue and the Training Institution and Management Personnel in charge of Training
13. Module 6  Shipboard Fatigue and the Owner/Operator/Manager
14. Module 7  Shipboard Fatigue and the Naval Architect/Ship Designer
15. Module 8  Fatigue and the Maritime Pilot
16. Module 9  Fatigue and Tugboat Personnel
17. Appendix  Fatigue related documentation

It is recommended that all parties become familiar with Module 1 prior to using Modules 2 - 64. Module 1 contains pertinent background information on the subject of fatigue.
Module 34 contains practical information intended for the Master Seafarer 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).
Module 34

FATIGUE AND THE MASTERSEAFARER

1. Module 3 contains practical information intended for the seafarer (master, officers, ratings and all other shipboard personnel) working on ships. Prior to reviewing this module, it is strongly recommended that all seafarers become familiar with Module 1 (Fatigue - Causes and Consequences) first. Management level seafarers (master and officers) should also become familiar with Module 2 (Fatigue and the Company).

2. As highlighted in Module 2, the responsibility for managing fatigue risks and minimizing the risk to safety is a shared responsibility between the company (as your employer) and yourself (as the employee). The company is primarily responsible for creating a work and living environment that minimizes fatigue-related risks. You are responsible for ensuring that time available for rest and sleep is used appropriately and your behavior does not create or increase risk.

What causes fatigue and why is it important?

3. The maritime industry operates a variety of work schedules in a wide range of operational environments which means that at some point you are likely to experience fatigue. Fatigue affects all individuals, regardless of skill, rank, knowledge or training.

4. As highlighted in Module 1, fatigue is caused by a range of factors but is primarily affected by:

   1. lack of sleep (i.e. inadequate restorative sleep);
   2. poor quality of sleep and rest;
   3. work/sleep at inappropriate times of the body clock (circadian rhythm);
   4. staying awake for long periods of time;
   5. stress;
   6. workload (prolonged mental and/or physical exertion);
   7. illness or onset of illness.

5. Fatigue can impact your ability to perform tasks involving physical exertion and strength, as well as your ability to solve complex problems or make decisions etc., which means that in some cases you cannot continue to perform shipboard tasks safely and efficiently.

6. Fatigue is caused and may be made worse by one or a combination of factors. These include, ship operational factors (work schedules, workload), adverse environmental conditions (noise, ship motion, etc.), stress and health (medical condition, sleep disorders, use of supplements, diet, etc.); see Module 1 for more detail. These factors alone, or in combination may also contribute to inadequate restorative sleep.

7. The quantity and quality of sleep are important for preventing and recovering from fatigue and for maintaining alertness and optimal performance. Sleep loss and sleepiness may...
degrade a person's performance, mental, physical and behavioral. Studies found the effect of sleep debt to be comparable to alcohol impairment, in terms of negatively impacting performance.

8. Working on a ship may limit seafarers' opportunity for sleep and recovery in each 24-hour period. There are particular times when the risks associated with fatigue are increased, regardless of the relationship between fatigue and recovery sleep. Times when fatigue risk levels are particularly high are:

1. When working during the circadian low as defined in Module 1, Section B.29;
2. When regular short breaks have not been taken;
3. Excessive time on duty;
4. When adjusting to a new schedule;
5. When suffering from jet lag

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

How can you recognize fatigue in yourself and in others (signs/symptoms)?

9. Fatigued individuals are poor judges of their own level of fatigue and performance because fatigue can affect their ability to make judgements or solve complex problems.

10. Fatigue related signs and symptoms are often divided into three categories: mental, physical and behavioural; see Table 1.1 in Module 1. These signs and symptoms of fatigue may be used to identify an individual’s level of alertness. You may recognize some of these in others and with time, you may learn to identify some within yourself.

11. Some of the more apparent signs and symptoms include:

1. Cognitive (Mental)
   - Focuses on a trivial problem, neglecting more important ones
   - Slow or no response to normal, abnormal, or emergency situations;
   - Lapses of attention
   - Poor judgement of distance, speed, time, etc;
   - Forgets to complete a task or part of a task
   - Difficulty concentrating and thinking clearly;

2. Physical
   - Inability to stay awake (an example is head nodding or falling asleep involuntarily)
   - Difficulty with hand-eye coordination skills (such as switch selection)
   - Speech difficulties (it may be slurred, slowed or garbled)
   - Increased frequency of dropping objects like tools or parts
   - Digestion problems
3. Behavioural
   - Decreased tolerance and/or anti-social behavior
   - Irregular/atypical mood changes (examples are irritability, tiredness and/or depression)
   - Ignores normal checks and/or procedures
   - Increasing omissions, mistakes, and/or carelessness

12. Long-term effects of sleep loss may lead to cardiovascular diseases, gastro-intestinal diseases, mental health problems and stress.

13. The more signs and symptoms you observe in others and/or experience yourself, the more likely it is that alertness is significantly reduced. Fatigue is not the only cause of such symptoms, but when several occur together, it is likely to indicate fatigue-related impairment. It is important that you notify your crewmate and supervisors when you recognize that you or other crewmembers are fatigued. It is important to have open communication between you, your crewmates and your supervisor regarding fatigue prevention and detection. Your company's fatigue risk mitigation strategy should allow for open communication and reporting between you, your supervisor, and management level seafarers regarding fatigue prevention and detection and should prohibit any action directed against a seafarer for such communications or reports.

<table>
<thead>
<tr>
<th>TABLE 1</th>
<th>EFFECTS OF FATIGUE</th>
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<tbody>
<tr>
<td>PERFORMANCE IMPAIRMENT</td>
<td>SIGNS/SYMPOTMS</td>
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</table>
| 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.  
● 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  
● Slow response |  
● Responds slowly (if at all) to normal, abnormal or emergency situations |

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1. https://nas.t-001CG-5/CG-52CG-MMC/FACA/MERPAC/Meetings/Meeting - 49 NOLA/Post Meeting/Minutes/5

### Loss of bodily control
- 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

### Mood change
- Quieter, less talkative than usual
- Unusually irritable
- Increased intolerance and anti-social behavior
- Depression

### 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)

- Poor quality of rest
  Disturbances while resting such as being woken up unexpectedly while 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 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 cause other side-effects such as hypertension, headaches, mood swings and anxiety.

1\hs-nas-t-001\CG-5\CG-52\CG-MMC\FACA\MERPAC\Meetings\Meeting - 48 NOLA\Post Meeting\Minutes\5 Task 89 IMO\Fatigue Guidance MSC 1014 Rev7.doc https://docs.live.net/67885feb3a8f0434/Documented-M O\HTW\HTW\Fatigue CG - USCG - 2015-18\MSC-1014 - Guidance on Fatigue GAO\Markus.doc\Circs\Res\MSC MSC 1014 - Guidance on Fatigue Mitigation and Management.doc
- **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:
  - 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

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**HOW CAN PEOPLE PREVENT THE ONSET OF FATIGUE?**

What can seafarers do to help reduce and manage the risk of fatigue on ships?

1. **Obtain adequate sleep**
   - The most effective strategy to fight fatigue is to ensure that you get the very best quality and quantity of sleep. As indicated in Module 2, the company should provide you with an adequate sleep opportunity for recovery. Insufficient sleep over several consecutive days will impair alertness; only sleep can maintain or restore performance levels. In order to effectively satisfy your body’s needs, sleep must meet three criteria, and include:
   - **Quantity**
   - **Quality; and**
   - **Continuity.**

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

1. **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. Insufficient sleep over several consecutive days will impair alertness; only sleep can maintain or restore performance levels.

15. **Sleep is most valuable if obtained in a single block.** Whilst a short sleep or nap can provide a powerful boost in alertness it does not eliminate the need for longer period of sleep.
16 There may be instances when you may not obtain adequate sleep, even though you are provided with adequate sleep opportunity. Items mentioned below can all affect the quantity and quality of sleep obtained:

1. you are working during the night and may simply be unable to sleep during the day;
2. your sleep may have been interrupted by colleagues, unexpected events or operational demands;
3. you may suffer from a sleep disorder, or other medical or physical problem that keeps you awake;
4. emotional stress due to family problems at home;
5. inability to get to sleep due to concerns about work or other worries;
6. the sleeping environment (comfort, noise, darkness, ship motion, privacy) may not allow for adequate sleep;
7. the type of food consumed;
8. medication or use of prescribed/over the counter/natural remedies;
9. consumption of stimulants (i.e. caffeine, amphetamines, energy drinks);
10. consumption of alcohol
11. use of electronic devices which emit blue light (smart phones, tablets, computer screens, etc) have been shown to adversely affect the onset of sleep);
12. adjusting to a new watch schedule and recovering from jet lag
13. social activities or high arousal just before your sleep period

17 Regardless of the circumstances causing insufficient or poor quality sleep, these should preferably be identified through proactive measures and treated as a potential shipboard hazard.

18 The company should have processes in place to provide you the opportunity to report back situations when you have been unable to obtain adequate sleep or feel at risk of making fatigue-related errors, specifically if conducting safety critical tasks, without fear of reprisal. This can be as simple as verbally reporting to your supervisor, management level seafarers and/or the ship's safety committee.

19 Here are Below is some general guidance on developing good sleep habits:

1. If possible, develop consistent sleep times (i.e. try to go to bed at the same time every day);
2. Develop and follow 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.
3. Get sufficient sleep, especially before a period when you expect that time for adequate sleep will not be available.
4. Avoid stimulating activities prior to sleep such as exercise, television and movies, etc.
5. Make the sleep environment conducive to sleep (a dark, quiet and cool environment, and a comfortable bed encourages sleep). (A white noise generator or ear plugs can be of use if you find them helpful.) Block out as much light as possible. This might involve the use of blackout curtains, roller shutters, heavy blinds, or an inexpensive option such as black plastic. A sleep mask can also be used.
6. As much as possible, ensure that you will have no you will not be interrupted 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).

7 Avoid alcohol, and caffeine, and other stimulants 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.

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

9 Do not nap if you have difficulty sleeping during your normal sleep period.

10 Avoid eating right before sleeping.

11 Limit the use of electronic devices that emit blue light prior to bedtime.

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 on maintaining performance

Maintain fitness for duty

20 Ensuring you are fit for duty and able to maintain safe levels of alertness and performance is important. Taking responsibility for your duty schedules and rest periods and providing feedback to your supervisor, management level seafarers and the company is important to ensure that you are provided with the best possible opportunity to maintain fitness for duty.

21 In some cases, monitoring and assessing your level of fatigue prior to your duty schedule can be helpful in ensuring you are able to perform tasks safely. There are a number of tools that can be used to assess how you feel prior to and during your duty period such as self-monitoring or fatigue assessment tools. It is important to report (to your supervisor and/or management level seafarers) any instances in which you feel that safety could have been or will be compromised due to fatigue impairment in either yourself or your peers.

22 Here below are some general guidelines that can help you maintain fitness for duty:

- 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 advantage of scheduled breaks; when scheduled breaks are assigned;
- Develop and maintain good sleep habits, e.g. develop a pre-sleep routine.
- Whenever possible, monitor and effectively manage your sleep;
- Whenever possible, maintain and monitor fitness for duty including medical fitness;
5. Report any fatigue impairment in yourself and others that may have the potential of affecting ship safety;
6. Record and report actual hours of work and rest as required by MLC and STCW by maintaining individual records of hours rested or worked.

Maintain fitness for duty including medical fitness.

7. Eat regular, well-balanced meals;
8. Exercise regularly; and
9. Limit the use of medications that may affect your level of alertness and performance including seasickness medications (if you are using such medications inform your shipboard supervisor).

3. 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 in managing fatigue. 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. At some stage, sleep must be obtained for physical and mental recovery to occur. The following list captures some of these short-term countermeasures:

1. **Short rest breaks within duty periods**
   Rest, apart from sleep, can be provided in the form of short breaks or changes in activities during the duty period. Rest breaks may be helpful if performance is to be maintained over long periods of time. 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. It is recognized that in a shipboard environment this may not always be feasible, however as much as possible short breaks should be planned into the duty period.

2. **Strategic Napping**
   A short sleep or nap can provide a powerful boost to alertness. Research has identified “strategic napping” as a short-term relief technique to help maintain performance levels during long periods of wakefulness. Naps as short as 10 to 15 minutes are known to deliver measurable benefits. Naps are helpful in maintaining performance if sufficient longer sleep is occasionally missed. The most effective length of time for a nap is about 20 minutes. It is recommended that you take naps in the way that you believe best suits you. Napping should be encouraged to be a planned activity of fatigue management and prevention. 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).

3. **Food and consumption of chemicals - Caffeine**
   Another popular fatigue countermeasure is the strategic use of caffeine (encountered in coffee and tea, and to a lesser extent in colas and chocolate) as a

Commented [AM18]: Note from v1 – “Recommend that definitions list be attached to each module”
stimulant, may combat sleepiness in some people for short periods. Caffeine can improve alertness temporarily but it is not a substitute for adequate sleep and rest. It takes caffeine 15-30 minutes to take effect and caffeine levels drop by half every 5-6 hours. Its effects can last long after consumption and may interfere with needed sleep. It is important to consider however, that there are individual differences in terms of how the effects of caffeine, tolerance and withdrawal develop. Caffeine should be avoided before bedtime. However, in addition, regular usage over time reduces its value as a stimulant and may make you more tired and less able to sleep. Caffeine consumption can also cause other side effects such as hypertension, headaches, mood swings, and anxiety.

- **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.

- **Nutrition and Hydration**
  Adequate nutrition and hydration is important for managing and preventing fatigue. Ideally, one should have a balanced diet, eat regularly, have healthy snacks, plan meals, drink water regularly and avoid meals just before bedtime (which result in slower digestion). The recommended daily intake of water is two litres or eight glasses. To be as alert and awake as possible, you need to monitor your fluid intake.

- **Environment** (light, temperature, humidity, and 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.

- **Muscular-Physical activity**
  Physical well-being has a number of key components: notably exercise, diet, hydration, and sleep. Any type of muscular physical activity helps to keep you alert; running, walking, stretching or even chewing gum can stimulate your level of alertness. Exercise can also improve sleep. Proper physical self-care results in a range of positive outcomes including reserves of energy during the duty period, consistent and restful sleep patterns, proper concentration spans and a satisfying sense of feeling healthy. The benefits of regular exercise include improved mood, better stress coping, and enhanced self-esteem and well-being.

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

- **Job Rotation when practicable**
  Changing the order of activities, where personnel are assigned tasks that include variety of 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.
24. When feeling fatigued, seafarers may engage in individual fatigue countermeasures (such as walking around, using caffeine or stimulants, etc.) to reduce the likelihood of fatigue-related errors. However, there may be instances where high levels of fatigue cannot be mitigated by individual countermeasures. Hence, prompt, consistent, and appropriate action is required (by the management level seafarers through company support) whenever a seafarer is potentially not fit for duty. This may include the need for additional actions (such as task rotation, additional supporting resources, etc.) for managing fatigue related risks. The aim should be to maintain and promote safety.

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

1. What are the seafarer responsibilities in fatigue risk management on ships?

25. The particular nature of fatigue as a safety hazard makes managing shipboard fatigue and associated risks the shared responsibility of the company and the seafarer. As highlighted in other sections, there are a number of steps that can be taken to prevent fatigue. Many of these measures that reduce fatigue are unfortunately beyond a single person’s ability to influence, such as voyage scheduling, ship design, and work scheduling.

26. Seafarer responsibilities include:

1. Doing your best to commence your duty schedule in a fit state to work the expected duty length and perform assigned shipboard work safely;
2. Monitoring and effectively managing hours of sleep;
3. Reporting fatigue related hazards that effect safety;
4. Maintaining appropriate communication about safety;
5. Being aware of fatigue and how to counter its effects; and
6. Using available rest periods appropriately, in addition to using personal fatigue mitigation strategies.

27. Seafarers are responsible to monitor and seek appropriate treatments for any health concerns that may impact their fitness for duty. Your well-being can be affected by a variety of factors including health conditions, genetic predispositions, nutrition, hydration, sleep difficulties. A wide range of sleep difficulties can affect fatigue, circadian rhythm, sleep duration and sleep quality. This includes a diversity of sleep disorders as indicated in Module 1.

28. Module 2 provides recommended strategies for the company, to manage the risks of fatigue at sea. Some important aspects related to company responsibility include:

1. Developing policies and practices within the ship’s safety management system to manage fatigue related risks;
2. Developing work schedules that prevent high levels of fatigue during duty periods;
3. Developing work schedules that allow for adequate rest and recovery periods between duty schedules (if possible allow for an anchor sleep period of 7 to 8 hours);
4. Implementing appropriate and safe duty/watch periods taking into account circadian rhythms;
5. Providing an adequate sleep environment on the ship;

1. https://maritimetsertis.org/Documents/MSC/Circs/MSC-MERPAAC/Meetings/Meeting - 48 NOLA/Post Meeting/Minutes/5
2. IMO Fatigue Guidance MSC 1014 Rev7.doc
3. HTW/HTW Fatigue CG - USCG.pdf
4. Guidance on Fatigue Mitigation and Management.doc
Ensuring all seafarers are trained and aware of the causes and consequences of fatigue;

Promoting a safety reporting culture with open communication and no fear of reprisal; and

Continuously assessing, controlling, monitoring and evaluating fatigue-related hazards.

What can management level seafarers do to reduce and manage the risk of seafarer fatigue on ships?

The following provides a recommended list of important fatigue management strategies: Steps such as the following are important in controlling and reducing the prevention risk of fatigue on board ships, and are within the management level seafarers' Master's ability to influence and/or implement:

1. Ensuring, at a minimum, compliance with maritime regulations (minimum hours of rest and/or maximum hours of work);

2. 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);

3. Managing the amount of time seafarers need to spend performing physically and mentally demanding work for a sustained period of time (tank cleaning, navigation through congested waters, etc);

4. Ensuring nutritious food options are served on-board and seafarers have continuous access to drinking water;

5. Providing nighttime personnel with appropriate meal choices;

6. Impress 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;

7. 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 or that of others and ensuring that there will be no recriminations for such reports;

8. Ensure that selected seafarers can do the job for which they are assigned to prevent the potential for fatigue in other crew members;

9. Improving shipboard conditions to ensure that when there is an opportunity to sleep, crewmembers 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. All relevant seafarers should be aware of these protected sleep opportunities;

10. Establishing on-board management techniques when scheduling shipboard work and rest periods and when scheduling watchkeeping work 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
11 If practicable, 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);

12 Avoid scheduling potentially hazardous tasks for daytime hours during the circadian lows of the seafarers involved, when practicable;

13 Advocating to shore management that shipboard personnel should be provided support for seafarers to with training and support so they may recognize and deal with the effects of fatigue including onboard training if provided;

14 Emphasizing the relationship of seafarer’s responsibility to sleep during between work and rest periods to ensure that adequate rest sleep is received obtained; 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”;

15 Taking time to personally monitor that watchkeeping all personnel are getting adequate rest sleep;

16 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);

17 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);

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

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

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

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

What rules and regulations are in place to help manage fatigue?

30 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 (Module 6): work hours, work scheduling, rest periods, crew competency and watchkeeping practices.
31 The following international organizations have issued various conventions and other mandatory instruments that address fatigue:

- **International Labor Organisation (ILO)**
  - Convention Concerning Seafarers' Hours of Work and the Manning of Ships — ILO Convention No.180;

- **International Maritime Organisation (IMO)**
  - International Safety Management Code (ISM Code); and various guidelines/recommendations
  - IMO Resolution A.1047(27) Principles of Minimum Safe Manning

32 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.

6 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.

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:

- Manning of ships with qualified and medically fit personnel;
- Familiarization and training for shipboard personnel; and
- 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) – 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.

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


Guidelines on Fatigue

Module 45

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, training institutions, Companies, Masters, Officers, other crew members, Seafarers, and training institutions, Ship designers, Administrations, and Port State Authorities) 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 Shipboard Fatigue and the Company
3. Module 3 Fatigue and the Seafarer
4. Module 4 Fatigue and Training
5. Module 5 Fatigue and the Ship Designer
6. Module 6 Fatigue, the Administration, and Port State Authorities
7. Appendix Fatigue related documentation
8. Module 1 Fatigue
9. Module 2 Fatigue and the Rating
10. Module 3 Fatigue and the Ship’s Officer
11. Module 4 Fatigue and the Master
12. Module 5 Fatigue and the Training Institution and Management Personnel in charge of Training
13. Module 6 Shipboard Fatigue and the Owner/Operator/Manager
14. Module 7 Shipboard Fatigue and the Naval Architect/Ship Designers
15. Module 8 Fatigue and the Maritime Pilot
16. Module 9 Fatigue and Tugboat Personnel
17. Appendix Fatigue related documentation

It is recommended that all parties become familiar with Module 1 prior to using Modules 2 - 17. Module 1 contains pertinent background information on the subject of fatigue.
Module 45 contains practical information intended for the Training Institution and Management Personnel in charge of Training providers. 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 Seafarer 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. This module builds upon the previous modules and contains practical information intended to assist in teaching fatigue awareness.

2. What are the objectives of educating raising awareness and training students about on fatigue?

3. Fatigue training and awareness are essential components for effective fatigue risk management. Fatigue management can be defined and described taught. The goal of fatigue training is a way that can assist students to trainees seafarers understand the general concept of fatigue and be able to relate to it personally. Seafarers will at some point be required to make operational decisions based on their knowledge of fatigue. Hence, all personnel who work on ships, and shore-based personnel who contribute to fatigue risk management in the company need to have appropriate training. Achieving this goal will create a foundation upon which the more specific topics of seafarer fatigue can be addressed.

4. As many known on board fatigue mitigation strategies on board lie outside the power of most individuals to implement (such as ship manning levels, the rearrangement of watches, changing ship design, or modifying voyage schedules), fatigue training should not just be limited to seafarers but should also include shore-based personnel involved in overall operational risk assessment and resource allocation, including manning levels, on ships.

5. The initial objectives are to develop provide:

   1. Both an awareness of the principle dimensions of fatigue and an acceptance that everyone experiences fatigue – it is not a personal shortcoming or weakness;

   2. Know-how about short and long-term fatigue signs and symptoms, including its effects, and possible preventive and mitigating measures; and

   3. The ability to develop and implement fatigue management strategies for preventing or minimizing fatigue within places of work on board.
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.

What approaches and techniques are successful for teaching fatigue management?

Training in the causes and management of fatigue causes and its management extends from the underlying science (Module 1) to mitigation, control and monitoring (Modules 2, 3 and 5). It can be taught as part of general existing maritime training courses such as Basic Training, Engine Room Resource Management, or Bridge Resource Management, or as specialized short courses. It can be taught ashore or afloat on board. It can be included in refresher or revalidation training.

Part of the education process should be to ensure that seafarers and shore-based personnel who contribute to fatigue management in the company understand the necessity of getting regular rest and sleep, and the implications of being fatigued (both to themselves and to the safety of the ship and/or those working with them).

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.

8. Training should include recognizing the symptoms of fatigue and developing preventive measures/mitigating techniques. Earlier modules should be utilized to specifically tailor the training to the audience. Areas covered can include the causes, symptoms, effects, prevention and mitigation factors, including rules and regulations concerning fatigue.

9. Initial fatigue-related training efforts should establish a common base level of understanding among seafarers and shore based company employees about fatigue and the impairment it causes. This training should be provided to all seafarers and shore based personnel involved in resource allocation, including manning and duty scheduling decisions.

10. As a minimum, seafarer training should comprise of:
   
   1. Fatigue, its causes and potential consequences (contributors, consequences, high risk situations);
   2. Sleep (circadian rhythms, body clock, sleep process, circadian low; sleep disorders, working at night and watchkeeping);
   3. Fatigue countermeasures (mitigation strategies; managing sleep habits, caffeine, nicotine, alcohol, nutrition, exercise, napping, rest breaks, etc.);
   4. Basic information on sleep disorders and their treatment, where to seek help if needed, and any requirements relating to fitness for duty;
   5. An understanding of the rules and regulations dealing with fatigue (MLC and STCW), and a recognition that these represent one line of defence in managing the risk of fatigue (i.e. limitations of mere compliance as a fatigue mitigation strategy as opposed to a full fatigue risk management system);
   6. How to identify fatigue in themselves and others;
   7. Personal strategies that they can use to improve their sleep and to minimize their own fatigue risk, and that of others, while they are on duty;
   8. Fatigue risk management, and how it works;
   9. The responsibility of the company to provide and seafarers to take advantage of adequate rest periods;
   10. The responsibility of the seafarer to report situations when unable to obtain adequate sleep or feeling at risk of making fatigue-related errors; and
   11. The responsibility of the company to have policies in place to appropriately manage fatigue risks including policies against retaliation for reporting.

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 training.

Commented [CB21]: Somewhere in this section, it is important to include the seafarer's responsibility for ensuring they obtain adequate rest and speaking up if their duty schedule prohibits them from doing so. It is mentioned in other sections, but should be included in training.

Commented [AMG22]: Also add company responsibilities
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.

11 Decisions on watch schedules can affect operational fatigue management, hence training and awareness about factors that contribute to fatigue and how duty and watch schedule design is crucial to fatigue risk management should be part of more comprehensive training. This training should be directed to shipboard management level officers, seafarers and shore based personnel involved in resource allocation including manning and duty scheduling decisions. This can be integrated as part of leadership and team working skills as required under Section A-II/1 and Section A-III/1 of the STCW Code.

12 As a minimum, training for these personnel should comprise of:

.1 Seafarer training on fatigue as indicated above;
.2 Their role in relation to fatigue hazard identification, risk assessment, evaluation and reporting;
.3 How scheduling affects sleep opportunities and can disrupt the body clock, the fatigue risk that this creates, and how it can be mitigated through proper work scheduling (in particular, the timing of duty schedules, work duration, recovery time between duty periods, recovery time between watch schedules and the potential impact that unscheduled or planned changes can have on fatigue);
.4 The use and limitations of any duty and watch scheduling tools and models for fatigue management, used to predict the levels of crew fatigue/alertness;
.5 Processes and procedures for assessing the potential fatigue impact of planned scheduling changes; and
.6 The development of policies and procedures for assessing the potential fatigue impact of planned scheduling changes; and
.7 Providing resources as outlined in other modules (lighting, food/diet, environmental, etc.) to manage fatigue.

13 As in all training, the subject matter can be greatly enhanced by use of computers, video presentations and similar audio-visual aids. In addition training providers and trainers should be appropriately qualified.

Why include case studies/examples?

14 It is important to incorporate case studies/examples into the training. These cases serve to support the "lessons learnt". 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 (coastal or ocean going ships, barges, seafarers, 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 recurrence.

What can be learned from experience?

15 Crew Seafarers will all come with their personal experience of duty and watch scheduling and perception of fatigue and how to mitigate it. It is very important to share a common understanding on fatigue issues and on its management. 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 measures can become a way of life for those the student who appreciates grasp the concept of fatigue and its effects on seafaring.

156 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 appropriate case studies and specific experiences (case studies as indicated above) within the seafarer’s workplace. At this time, select case studies will also be instrumental in that to showing what each student fatigue risk and management strategies practices should may be adopted try to do upon returning to the workplace.

16 Seafarers will all come with their personal experience and perception of fatigue and how to mitigate it. It is important to share a common understanding on fatigue issues and on its management. Ideally, this new knowledge will be taken back to the workplace and put into practice.

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.

I. 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.

2. 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 recurrence.

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.

IMO Model Course 1.21 Personal Safety and Social Responsibilities [2015 Edition]

Cardiff University, Seafarers Fatigue Film: https://www.youtube.com/watch?v=ua-ppReV684


Guidelines on Fatigue

Module 57

SHIPBOARD FATIGUE AND THE NAVAL ARCHITECT/SHIP DESIGNER

Foreword

The Fatigue guidelines contain practical information that can assist interested parties (Ship designers, naval architects/Ship designers, owners/operators, Companies, Masters, Officers, other crew members and Seafarers, training institutions/providers, Ship designers, Administrations, and Port State Authorities) 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, identify, mitigate, and control fatigue in order to improve associated health problems and prevent fatigue related accidents and incidents from occurring.

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

1. Module 1 Fatigue
2. Module 2 Shipboard Fatigue and the Company
3. Module 3 Fatigue and the Seafarer
4. Module 4 Fatigue and Training
5. Module 5 Fatigue and the Ship Designer
6. Module 6 Fatigue, the Administration, and Port State Authorities
7. Appendix Fatigue related documentation
8. Module 1 Fatigue
9. Module 2 Fatigue and the Training
10. Module 3 Fatigue and the Ship’s Officer
11. Module 4 Fatigue and the Master
12. Module 5 Fatigue and the Training Institution and Management
13. Module 6 Fatigue and the Owner/Operator/Manager
14. Module 7 Fatigue and the Naval Architect/Ship Designer
15. Module 8 Fatigue and the Maritime Pilot
16. Module 9 Fatigue and Tugboat Personnel
17. Appendix Fatigue related documentation

It is recommended that all parties become familiar with Module 1 prior to using Modules 2 - 69. Module 1 contains pertinent background information on the subject of fatigue.

Module 55 contains practical information intended for the Naval Architect/Ship Designer, such as information on design guidance and applicable regulations.
Module 5 contains practical information intended for the Ship Designer for improving the design conditions on ships. This module highlights the principles a ship designer should consider and includes methods that can be applied in the design process for reducing the risk of fatigue on seafarers. Module 1 (Fatigue – Causes and Consequences) should be read prior to going through this module.

Companies should specify that the design principles for fatigue management should be considered early in the design process. Administrations should ensure SOLAS requirements for noise and vibration are enforced in the design and construction approval.

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. Fatigue is a hazard that affects safety, health, and well-being. This presents a considerable risk to safety of life, property, security and protection of the marine environment. Seafarers often live and work aboard ships for extended periods of time. Habitability deficiencies can have significant negative health ramifications when affects to seafarers, especially when seafarers are exposed to them over these for long (or cumulative) periods of time.

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.

As highlighted in Module 1, Sleep deprivation inadequately restores sleep (quantity and quality) is among the main causes of seafarers’ fatigue, but it is not the sole cause. Crew also becomes fatigued as a result of factors onboard. Hence, ship design plays an important role in ensuring restorative sleep is achieved. This module will concentrate on guidance for improving the ambient environmental conditions onboard ships,
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.

4. Companies should specify that the design principles for fatigue management should be considered early in the design process.

1. 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:


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


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.

4 Shipboard ergonomics and the environmental conditions on board are important considerations into ensuring seafarers are provided with the best opportunity to:

- gain adequate sleep quality;
- maintain safe levels of alertness and performance during duty periods; and
- gain adequate sleep quality; and
- maintain good health and resilience to fatigue through the provision of adequate sleeping, recreational and exercise facilities.

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.

What elements of ship design can influence fatigue?

can be influenced by the design process?

5 There are various aspects of seafarers’ fatigue that can potentially be influenced by the design of the living, sleeping, and working environment. Excessive noise, vibration, heat, cold, temperature, light, humidity and air quality, etc., where people live and work can cause fatigue and may play a role in fatigue and impede the ability to achieve restorative sleep. These elements can be grouped in the following way:

6 Ships as a whole should be designed for good seakeeping. Sleeping, living, and working areas should be located within the ship to minimize motions, vibrations, and noise due to both seakeeping and machinery.

7 Appropriate noise levels (SOLAS regulation II-1/3-12) support effective communication and reduce mental workload while on duty, and improve the quality of sleep and rest when off duty. Noise and vibration prediction modelling efforts should be done early in the vessel design process to ensure the most cost effective design and layout for noise and vibration control and mitigation.

A. Accommodation spaces and layout design (Design to promote rest and well-being)

8 Crew accommodation is often built around the operation of the ship, with little consideration for crew comfort. This may result in crew accommodations usually being placed directly over theCommented [CB24]: Paragraphs 8 and 10. These are both related to being conducive to rest. Can we combine them?
engine room which may lead to vibration and noise exposure. These aspects should be considered:

1. Cabins are cool, quiet, dark, and well ventilated;
2. Bunk design, layout, and orientation;
3. Mattress, bedding, padding for ship movement, headroom clearance especially upper bunk/deckhead;
4. Insulate and/or isolate sleeping areas;
5. Insulation or isolation from cargo, engine, or other disturbances (noise and vibration);
6. Design and lighting to support day and night sleep (Lighting/dimmers and block-out);
7. Ventilation/air quality;
8. Temperature locally adjustable and humidity (design for sleep); and
9. Use of color and artwork in the cabins could be considered;

Acoustic insulation can be used to reduce noise in this area, but consideration should be given to sounds that must be heard, i.e. fire alarms. However, it should be noted that insulation is one of the least preferred and most expensive methods of noise mitigation, especially to apply after construction.

10. Consideration should be given to providing an accommodation area that is conducive of rest and that it aids in recovery. The following should be considered:

1. Design for minimal flows in sleeping quarters;
2. Consider laundry, changing, hygiene, privacy;
3. Insulation or isolation from cargo, engine, or other disturbances (noise and vibration);
4. Design and lighting to support day and night sleep (Lighting/dimmers and block-out);
5. Ventilation/air quality;
6. Temperature locally adjustable and humidity (design for sleep); and
7. Location and layout of galley & mess room(s);

Recreation and recovery include:

- Range of needs (personality and culture);
- Privacy and social life;
- Minimal "housekeeping";
- Gym/training facilities; and
- Library, media rooms, ease of study.

B. Workplace design (Design for alertness and performance)

Workplace design, particularly for tasks that require sustained physical or mental exertion should consider the following aspects:

1. Workplace – optimum layout (placement, storage, adjustable, visibility, ease of communication, noise, vibration, temperature, humidity)
Design of workflow – minimizing the distance needed to move between work areas, eliminating obstructions, facilitating access to information.

3. Working position (seated/standing, height, flooring material (shock and balance)).

4. Ease of access to all control and reading of displays (incorporate human machine interface principles).

5. Protection from hazards (e.g. provide suitable hand holds, stairs and surfaces to allow easy movement in bad weather).

6. Design lighting for work spaces to support alertness (colour, natural light access, bright light).

7. Maintenance – Design for maintainability (access envelopes accounting for required tools and motions, etc).

13. Additionally, design of control centers such as machinery control room layout, cargo control room layout, etc., should consider the integration of people with equipment systems to reduce mental overload and boredom.

- 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

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:

"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."

Ergonomics is defined as the scientific discipline concerned with the application of validated scientific research about people, their abilities, characteristics and limitations to the design of systems they use, environments in which they function and interact, and jobs they perform to improve health, safety, well-being and overall system performance.

Ergonomically designed work systems enhance safety, effectiveness, and efficiency. They should also support the shipboard tasks done by officers and crewmembers under all conditions, including situations where people may be fatigued.

The ergonomic approach to design is human-centered. This means that all designable components (ship, ship's systems, equipment, service, etc.) are fitted to the characteristics of the intended users, operators or workers (e.g. seafarers, maintainers, etc.) rather than selecting and/or adapting humans to fit the system and/or product. This should be done by consideration of:

1. the intended target population

*Defined by ISO/TC 159/SC 1/WG 1 ‘Principles of the design of work systems’ Vienna, 6/10/97.*
An ergonomically designed work process. Below is a set of general ergonomic principles designed to reduce fatigue by adapting working conditions to the anatomical, physiological and psychological characteristics of people in relation to their work environment, which can be employed:

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 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.

Both the needs and limitations of the end-users (e.g. seafarers, maintenance or repair teams etc.) should be considered during the design of ship systems and equipment. Those with experience and knowledge of the requirements of ship systems and equipment should be consulted, as far as possible, during the design and construction phases of new ships. Early and continued participation and involvement is regarded as an efficient design strategy within ergonomics since, in addition to improving the design, it reduces late-stage re-work and increases user acceptance. Task-oriented design also takes into account differences that can be observed between the designed task and the way the task is actually performed.
20 Both the needs and limitations of the end-users (e.g. seafarers, maintenance or repair teams, etc.) should be considered during the design of ship systems and equipment. Those with experience and knowledge of the requirements of ship systems and equipment, operation and maintenance should be consulted, as far as possible, during the design and construction phases of new ships.

21 Task-oriented design also takes into account differences that can be observed between the designed task and the way the task is actually performed. Activities in performing a task are affected by variations and changes in, for example, context, procedures, equipment, products or materials.

22 The relations between the conditions and demands placed on the seafarer and their response to being exposed to such conditions and their effects need to be considered in the design of ship systems, services, products and tasks in order to avoid impairing effects on the individual. The response to conditions and demands are dependent on individual characteristics (e.g. body size, age, capacities, abilities, skills, etc.).

23 Appropriate standards are included in the references 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.

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.)

24 Application of the use of ergonomic standards are effective 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.).

25 Computer simulation can be used to support ergonomic design. These are increasingly being used to assess both the impact of environmental conditions as well as work and living design ergonomics. Examples include virtual reality and three-dimensional computer aided design. Use of simulation tools is encouraged as they allow early and more cost effective evaluation of various aspects of design. There are a variety of design tools that can be applied early in the design process to assist the ship designer in ensuring that specified limits are not exceeded.

26 Environmental conditions also 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, structural resilience techniques can be used to alleviate vibration problems.
There are a variety of tools such as Finite Element Analysis (FEA) and noise prediction tools, 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; and
- Performing model tests

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.

What rules and guidance are available for designing/building a fatigue-resistant ship?

There is a number of rules, regulations, standards and guidelines designed to enhance environmental shipboard 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 field and the designer should check for new material.

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 aids 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), Maritime Labour Convention (MLC) 2006. The MLC, 2006 Conventions. The ILO Conventions that addresses crew accommodation are as follows in Title 3 (Accommodation, Recreational Facilities, Food and Catering).

The MLC, 2006 as it related to habitability, institutes minimum standards of living through the provision of crew accommodation areas that are:

1. free from hazardous levels of noise and vibration;
2. provide appropriate levels of lighting and indoor climatic qualities; and
3. offer improved crew accommodation design.

Commented [CG/MERPAC25]: General comment: references to be updated. IMO Secretariat Legal staff to complete?
31 The MLC 2006, Guideline B3.1 (Accommodation and recreational facilities) provides more specific guidelines for ship design, covering the following aspects:

1. Ventilation;
2. Heating;
3. Lighting;
4. Sleeping rooms;
5. Mess rooms;
6. Sanitary accommodation;
7. Hospital accommodation; and
8. Prevention of noise and vibration

- 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)

32 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

33 Some Classification Societies have guidance and rules, most of them being optional rules, for aspects of environmental conditions (i.e. noise and vibration) for certain ship types (see references). Designers are encouraged to refer to the relevant guidelines -

- 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:

Lloyd’s Register of Shipping

Noise and Vibration

Several IMO has implemented requirements and resolutions aimed to protect the seafarer from unacceptable levels of noise:

- SOLAS Regulation II-1/3-12 Protection against noise.
- Res. MSC. 337(91) Code on noise levels onboard ships (This code is mandatory under regulation II-1/3-12 with entry into force on 1 July 2014).
- IMO. Resolution. A.468(XII) (1981), Code on noise levels onboard ship fixes permissible maximum limits of noise depending on the type of space.\(^9\)
- SOLAS Regulation II 1/36 Protection against noise.\(^{10}\)

In addition, relevant ISO/IEC Standards on noise and vibration should be considered throughout the design process (see references).

**Relevant Standards on Noise:**

- ISO 2923  
  Acoustics - Measurement of noise on board 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 1: Field measurements of airborne sound insulation between rooms
    - Part 5: Field 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

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\(^9\) Recommender Guidance.
\(^{10}\) Mandatory Instrument.
amendment No. 1, 1989
IEC-Publication 60942

Other Standards on Vibration:

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
IACS Unified Interpretation SC82 Protection against noise, 1993
BV Recommendation designed to limit the effects of vibrations onboard, Guidance note, NI38 A RD3, 1979
VERIT Vibration control in ships, 1985
EC
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. These are developed by organizations such as IMO, ISO/IEC and Classification Societies. References to these standards in ship design is encouraged (see reference section). 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**

<table>
<thead>
<tr>
<th>Organization</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>IMO</td>
<td>MSC/Circular.982, Guidelines on Ergonomic criteria for bridge equipment and layout</td>
</tr>
<tr>
<td>ISO</td>
<td>ISO 8468, Ship’s bridge layout and associated equipment - Requirements and Guidelines</td>
</tr>
<tr>
<td>ISO</td>
<td>ISO 14612, Ship’s bridge layout and associated equipment - Requirements and Guidelines</td>
</tr>
<tr>
<td>IEC</td>
<td>IEC 60945, Navigation equipment - general requirements</td>
</tr>
<tr>
<td>IACS</td>
<td>Unified N1 requirements for One Man Bridge Operated (OMBO) Ships, International Association of Classification Societies, 1992</td>
</tr>
</tbody>
</table>

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11 Recommendatory Guidance.
Engine Rooms

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

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

General Ergonomics


ISO  Ergonomics principles in the design of work systems. ISO 6285. (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
References


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.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.


Crew Habitability on Ships. American Bureau of Shipping (ABS) (February, 2016).

IMO MSC/Circular.982, Guidelines on Ergonomic criteria for bridge equipment and layout.

IMO Resolution A.708(17), Navigation bridge visibility and functions, (6 November 1991)

IMO MSC/Circular.834, Guidelines for engine-room layout, design and arrangement.

LR The human-centred approach - a best practice guide for ship designers, April 2014

Noise and Vibration References

1 ISO 2923:1996 Acoustics - Measurement of noise onboard vessels
4 IEC Publication 60651 Sound level meters
5 IEC Publication 60225 Octave, half-octave and third octave band filters intended for the analysis of sound and vibrations

2https://docs.live.net/67885feb3a6c0f45/Documented-M OHTW/H1C5-Fatigue CG-USCG-2017-18MSC-1014 - Guidance on Fatigue GAO Markups.doc
3https://docs.live.net/67885feb3a6c0f45/Documented-M OHTW/H1C5-Fatigue CG-USCG-2017-18MSC-1014 - Guidance on Fatigue Mitigation and Management.doc
ISO 2041:2009 Mechanical vibration, shock and condition monitoring - Vibration and shock vocabulary

ISO 2631 (Series) Mechanical vibration and shock – Evaluation of human exposure to whole-body vibration


ISO 6954:2000 Mechanical vibration and shock – Guidelines for the overall measurement, reporting and evaluation of vibration with regard to habitability on passenger and in merchant ships

LR. Ship Vibration and Noise, Guidance Notes, Rev 2.1, 2006

NK Noise and Vibration Guideline, July 2011

ABS Noise and Vibration control for inhabited spaces, July 2014

HSE noise and vibration ot001068.pdf [need to update]

General Ergonomics References


ISO 6385:2004 Ergonomics principles in the design of work systems ISO 6385


ISO 9241 Ergonomic requirements for office work with visual display terminals (VDTs):
- Part 5 (1998): Workstation layout and postural requirements
- Part 6 (1999): Guidance on the work environment

ISO 11064 Ergonomic design of control centres. Part 1 (2000): Principles for the design of control centers

ISO 15535:2012 General requirements for establishing anthropometric databases

ISO 8468:2007 Ships and marine technology - Ship's bridge layout and associated equipment - Requirements and Guidelines
Guidelines on Fatigue

Module 65

FATIGUE, THE ADMINISTRATION, AND PORT STATE AUTHORITIES

Foreword

The Fatigue guidelines contain practical information that can assist interested parties (Administrations, Port State Authorities, Companies, Seafarers, training institutions, providers, and Ship designers, Administrations, and Port State Authorities) 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 identify, mitigate, and control fatigue in order to improve associated health problems and prevent fatigue related incidents from occurring.

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

1. Module 1                  Fatigue
2. Module 2                  Shipboard Fatigue and the Company
3. Module 3                  Fatigue and the Seafarer
4. Module 4                  Fatigue and Training
5. Module 5                  Fatigue and the Ship Designer
6. Module 6                  Fatigue, the Administration, and Port State Authorities
7. Appendix                  Fatigue related documentation

It is recommended that all parties become familiar with Module 1 prior to using Modules 2 - 6. Module 1 contains pertinent background information on the subject of fatigue.

Module 6 contains practical information intended for the Administration and Port State Authorities, such as information on applicable regulations.
GUIDELINES OF FATIGUE

MODULE 6

FATIGUE, THE ADMINISTRATION AND PORT STATE AUTHORITIES

1. Module 6 contains practical information intended for administrations (which means the Government of the Party whose flag the ship is entitled to fly) and Port State authorities (which means the Government of the State in which the port of call is located). This module provides guidance for considering fatigue in port and flag state requirements. It also recommended that Administrations and Port State authorities become familiar with Modules 1 to 5.

Fatigue and the Administration

2. Administrations have an important role to play in mitigating and managing the risks of fatigue at sea. Administrations have an important role to play in mitigating and managing the risks of fatigue at sea.

   .1. Implementation and enforcement of international regulations that have direct impact on mitigating and managing fatigue. These include:

       • as required under the STCW Convention, take into account the danger posed by fatigue on seafarers, especially those whose duties involve the safe and secure operation of a ship;

       • take A.1047 (Principles of Safe Manning) into account when making a determination on safe manning levels for ships flying its flag;

       • ensure that its ships are appropriately manned in order to encompass all aspects of maintaining safe operations on board and its ships are in compliance with the ISM Code, Section 6.2.1;

       • ensure that all identified risks (including the risk of fatigue) to its ships, personnel and the environment are assessed and appropriate safeguards established as required under the ISM Code;

       [ensure that its ships are appropriately manned in order to encompass all aspects of maintaining safe operations on board and its ships are in compliance with the ISM Code, Section 6.2.1];

       [ensure that applicable regulations and requirements affecting fatigue mitigation and management, such as habitability, design, and environmental controls, are met, every seafarer’s right to decent working and living conditions on board ships meet the regulatory requirements of the MLC, 2006];

       •
[ensure that every seafarers’ right to a safe and secure workplace that complies with safety standards meet the requirements of the MLC, 2006;]

- ensure SOLAS requirements that affect fatigue mitigation and management, such as for noise and vibration, are enforced in the design and construction approval.

2. Promote Ensure that these guidelines (MSC Circ. 1014) are available to all stakeholders including, seafarers, companies, naval architects/ship designers, training institutions/providers, administration officials and any other affected stakeholders.

3. Promote awareness, education and training on the causes and consequences of fatigue and its management to address the risk (seafarers and companies, lessons learnt, etc.).

4. Incorporate assessment of fatigue in accident/incident investigations. Based on information received as a result of investigating maritime casualties, Administrations should iteratively evaluate the effectiveness of their fatigue prevention program(s), (if any) and modify as appropriate based on lessons learnt.

5. Encourage companies with ships registered under their flag to incorporate fatigue risk mitigation and management practices principles into existing safety management systems.

6. [Monitor the performance of Recognised Organisations (ROs) with delegated responsibilities to ensure they take into account international guidelines and regulations addressing the mitigation and management of fatigue, as appropriate.]

Fatigue and Port State Authorities Other Considerations by Administrations

3. Port State Authorities also have an important role to play in mitigating and managing the role of fatigue at sea. Port state authorities are encouraged to consider the potential effects that inspections may have on the wider aspect of seafarer fatigue. In particular, the following should be considered:

1. The need to reduce as much as possible administrative and reporting requirements related to port calls. For example, consider establishing mechanisms for ships or their agents (or company personnel ashore) to electronically provide information to port state authorities in advance of the ship’s arrival.

2. Whenever possible, allow for single points of contact for delivery of information by ships to minimize the number of times seafarers are required to prepare and provide information to authorities or other parties.

3. As well as port state authorities providing information on scheduling of any inspections in advance of the ship’s arrival to permit planning of the ship’s work schedule.

1) [https://doc.live.net/67885feb7afcf044/Documents/IMO-HTW/HTW Fatigue CG -USCG 2017-18/MSC 1014 - Guidance on Fatigue GAO Mark up.doc]
2. Whenever possible, allow for single points of contact for delivery of information by ships to minimize the number of times seafarers are required to prepare and provide information to authorities or other parties.

4. During inspections, the PSC examiner, working with the master, should consider scheduling drills and other crew-related activities to minimize their impact on fatigue, keeping in mind other activities taking on board the ship whilst in port such as cargo operations and bunkering.

3. Port state authorities should consider scheduling drills in a manner that minimizes the disturbance of rest periods and does not induce fatigue.

3 bis. Crew-related considerations should be taken into account during PSC inspections and have due regard for the prior engagement of specific personnel with other activities taking place onboard the ship whilst in port such as cargo operations and bunkering.

Whenever possible, liaise with ships master and other port authorities to take account of seafarers' [hours of rest][fatigue] and available resources on board when scheduling on board inspections.

54. Due consideration for arrangements is given to the timing and duration of inspections. Arrangements for the timing of PSC inspections should, as far as possible, balance the time required to conduct the necessary inspection with the impact a longer inspection may have on safety.

65. Limitation and consolidation of inspections, customs and immigration, PSC, class, etc., should be considered whenever possible. If possible, Port State authorities should monitor and mitigate the impact of inspection and reporting requirements on seafarer fatigue.

65. If possible develop fatigue guidance for shore-based third parties that impact ship schedules to minimize the impact to fatigue management of ship personnel.

65. If possible, Port State authorities should monitor and mitigate the impact of inspection and reporting requirements on seafarer fatigue.

65. Undertake the monitoring of international guidelines, as appropriate, and the enforcement of international regulations that have an impact on mitigating and managing fatigue. These include:

- Monitoring ships calling at their ports to verify they are actually operating in accordance with the operating factors or parameters taken into account in the transparent procedure that established their safe manning level and the issuance of a Safe Manning Document in accordance with SOLAS V, Regulation 14.
2. monitoring ships calling at their ports to verify compliance with mandatory provisions and documentation of work and rest hours in the STCW Code and MLC, 2006;

3. monitoring ships calling at their ports to verify the ship is appropriately manned in order to encompass all aspects of maintaining safe operations on board in accordance with the ISM Code, paragraph 6.2.1;

4. ensure that the conditions on ships calling at their ports meet at least the minimum regulatory requirements of the MLC, 2006.