



MGN 505 (M) Amendment 1

HUMAN ELEMENT GUIDANCE- PART 1 Fatigue and Fitness for Duty: Statutory Duties, Causes of Fatigue and Guidance on Good Practice

Notice to all Ship Owners, Ship Operators and Managers, Masters, Officers and Crew of Merchant Vessels, Skippers and Crew of Domestic Passenger Ships and Inland Waterway Vessels

This notice replaces MGN 211

Summary

This Marine Guidance Note:

1. Reminds owners, operators, managers and all personnel working on board seagoing, domestic and inland waterway vessels about their duties under UK and international shipping legislation in relation to fatigue, and
2. Provides some practical information and guidance for consideration about;
 - i. Factors leading to fatigue and impaired fitness for duty,
 - ii. Policies and practices which can reduce the cause and impact of fatigue and other performance impairing factors
 - iii. Development and use of fatigue management plans to improve the identification, management and reduction of fatigue and other performance impairing factors,
 - iv. Useful checklists to help identify fatigue and stress and take preventative actions, and
 - v. Useful sources of additional information about fatigue and fatigue management.

This Marine Guidance Note draws upon a wide range of legislation, knowledge and research findings to provide practical guidance about dealing with fatigue and other factors leading to impaired fitness for duty.

1. Introduction/Background

- 1.1 **Fatigue** – “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; co-ordination; decision making; or balance” (IMO, MSC/Circ.813)“**Fatigue**



kills: careers, clients, crew”¹. Fatigue amongst seafarers is recognised to be a serious issue affecting maritime safety. Objective evidence consistently shows fatigue to be a contributory cause of accidents, injuries, death, long term ill health, major damage, loss of vessels and enormous environmental harm. (1 “The Human Element: a guide to human behaviour in the shipping industry” MCA).

- 1.2 A good basic understanding of the causes and effects of fatigue on human performance, together with practical actions that can be taken to prevent fatigue can make a significant contribution to improving maritime safety in all sectors of the industry.
- 1.3 This Marine Guidance Note is not intended to be a definitive guide to the prevention of fatigue, rather it draws upon a wide range of knowledge and research findings to provide all personnel working in the various maritime sectors with knowledge and practical information about fatigue and guidance about strategies for dealing with it.

2. Fatigue Management Plans

- 2.1 Fatigue can be prevented, or at least considerably reduced by putting a plan in place as part of the daily operation of the vessel measures which recognise and address the risk of fatigue. This is known as a Fatigue Management Plan (FMP).
- 2.2 Fatigue Management Plans are proven to work. Evidence from a range of industries underpins this statement. Organisations which manage fatigue effectively are shown to experience significantly reduced levels of accidents, injuries, and staff turnover. However, for a fatigue management plan to be effective it must involve all levels in the organisation and other parts of the shipping industry i.e., masters, crews, ship owners, ship managers, regulators and inspectors.
- 2.3 Fatigue Management Plans should meet the specific circumstances of the company and/or vessel. However, the following 4-point approach provides a good basic framework;
 - a) Understand fatigue and other factors affecting fitness for duty, their causes, and effects
 - b) Understand practices and principles that help mitigate the effects of fatigue and other factors leading to impairment of fitness for duty
 - c) Know your duties and responsibilities under the law
 - d) Implement fatigue preventing management policies and working practices

3. Understanding and Preventing Fatigue

- 3.1 Information contained in the Annexes will help companies and crews understand fatigue and the actions that can be taken to address it.
- 3.2 **Annex A** – provides a précis of the various regulations governing the duties and responsibilities of companies, masters, and crew in relation to health and safety on board, and also a summary of the rules governing hours of work and rest for seagoing vessels, inland waterway vessels and self-employed Boatmasters
- 3.3 **Annex B** - provides a basic knowledge and awareness about factors leading to fatigue and impaired fitness for duty, their causes, and effects, including biological, working and organisational factors. It also provides practical information for companies and seafarers about how to reduce their effects. This is a highly complex and detailed subject, but a basic understanding of the fundamental principles can help manage work more effectively and safely.
- 3.4 **Annex C** – describes in more detail the basic fatigue management plan outlined above.



It provides desired outcomes and actions that companies can take to prevent fatigue.
3.5 **Annex D** – provides information on further reading and resources to assist companies to develop their fatigue management plans

More Information

Seafarer Safety and Health
Maritime and Coastguard Agency
Bay 2/17
Spring Place
105 Commercial Road
Southampton
SO15 1EG

Tel: +44 (0) 203 8172501
e-mail: humanelement@mcga.gov.uk

Website Address: www.gov.uk/government/organisations/maritime-and-coastguard-agency

General Enquiries: infoline@mcga.gov.uk

Published: April 2021
Please note that all addresses and telephone numbers are correct at time of publishing

© Crown Copyright 2021

Safer Lives, Safer Ships, Cleaner Seas



Annex A

Duties Under Legislation:

1. Part 1 - Statutory Duties and Regulations in Relation to Health and Safety

1.1 Seagoing and Non-Seagoing Ships: Health and Safety

- 1.1.1 Under the Merchant Shipping and Fishing Vessels (Health and Safety at Work) Regulations 1997 (SI 1997/2962 as amended by SI 2001/54), all employers have a duty to

“ensure the health and safety of workers and other persons, so far as is reasonably practicable” (reg 5)

These regulations apply to both sea-going and non-sea going ships.

- 1.1.2 The regulations set out the principles of risk identification and assessment, risk avoidance, and reduction. One of these principles is

“the adoption of work patterns and procedures which take account of the capacity of the individual, especially in respect of the design of the workplace and the choice of work equipment, with a view in particular to alleviating monotonous work and to reducing any consequent adverse effect on workers’ health and safety;” (reg 5(1)(c))

- 1.1.3 In particular, that duty encompasses

“the provision and maintenance of...systems of work that are, so far as is reasonably practicable, safe and without risk to health;” (reg 5(2)(a)).

- 1.1.4 The same regulations require the employer to carry out –

“a suitable and sufficient assessment of the risks of the health and safety of workers arising in the normal course of their activities or duties” (reg 7(1)).

That risk assessment must be reviewed if there is a significant change to the matters to which it relates. In particular, a risk assessment for fatigue should be carried out when workers are affected by any significant change in their working hours, for example as a result of a change in the trading pattern of the ship.

- 1.1.5 The same regulations also detail General Duties of Workers. In particular, the duty of every worker aboard a ship to which the Regulations apply

“to take reasonable care for the health and safety of himself and of any other person aboard ship who may be affected by his acts or omissions” (reg 21(1)(a))

“Every worker shall immediately inform the master or the safety officer or another competent person appointed under Regulation 14(1) of any matter which may reasonably be considered to represent a deficiency in the Company’s protection arrangements for the health and safety of persons on board the ship” (reg 21(3)), and

“Every worker shall immediately inform his employer, the safety officer or other competent person –

- a) of any work situation which he reasonably considers to represent a serious and immediate danger to health and safety; and*



- b) of any matter which he reasonably considers to represent a deficiency in the employers protection arrangements for health and safety” (reg 21(4))*

1.2 Duties Under the International Safety Management Code (ISM) and Domestic Safety Management Code (DSM)

- 1.2.1 Attention is drawn to duties under the International Safety Management Code (ISM) and Domestic Safety Management Code (DSM).
- 1.2.2 The objectives of both Codes are to ensure safety at sea, prevent injury or loss of life and prevent damage to the environment, and in doing so impose certain obligations and duties on ship owners and operators. In relation to health and safety, particular attention is drawn to the obligations regarding;
- a) Requirements to comply with applicable rules and regulations
 - b) Ensuring safety on board
 - c) Preventing injury and loss of life
 - d) Ensuring that all vessels are adequately manned by qualified, certificated and medically fit seafarers in accordance with appropriate regulations
 - e) Ensuring all seafarers receive proper familiarization with their duties and are conversant with all relevant international, national and company rules, procedures, regulations, guidelines and codes.
- 1.2.3 The full requirements of obligations and duties under ISM are contained in;
- a) The Merchant Shipping (International Safety Management (ISM) Code) Regulations
 - b) International Safety Management Code published by the International Maritime Organization
- 1.2.4 The full requirements of obligations and duties under DSM are contained in;
- a) The Merchant Shipping (Domestic Passenger Ships) (Safety Management Code) Regulations and apply to domestic passenger ships of Classes III to VI(A)
 - b) MSN 1754 (M)
 - c) MGN 158 (M)
- 1.2.5 To fulfil its obligations under the Regulations the United Kingdom implements a number of policies in relation to health and safety, hours of work and rest, and management of fatigue, in particular;
- a) Rigorous assessment of Safe Manning levels to ensure the vessel can be operated safely in accordance with the Regulations
 - b) Monitoring hours of work and rest records to ensure compliance with national and international Regulations

1.3 Personnel Working For More Than One Employer / Company

1.3.1 Companies are responsible for the health and safety of workers regardless of employment status of the worker. For instance, in the case of workers who work for more than one company, records should include consideration of hours worked elsewhere.

2. Part 2 - Hours of Work and Rest Regulations

2.1 eagoing vessels (except Fishing Vessels)



2.1.1 **EC Directive 1999/63/EC** mandates ILO Convention 180, of which Article 5 requires rules to be made either for maximum hours of work OR minimum hours of rest.

2.1.2 Hours of work and rest are regulated in the UK by the UK Merchant Shipping (Hours of Work) Regulations 2002, and also embedded in the International Convention of Standards of Training, Certification & Watchkeeping 1995 as amended and the Maritime Labour Convention 2006.

2.1.3 The UK Merchant Shipping (Hours of Work) Regulations 2002 Regulation 5 states:

- 1) *minimum hours of rest shall not be less than;*
 - i. *10 hours in any 24-hour period; and*
 - ii. *77 hours in any seven-day period.*
- 2) *Hours of rest may be divided into no more than two periods, one of which shall be at least six hours in length, and the interval between consecutive periods of rest shall not exceed 14hours.*

2.2 Inland Waterways Vessels

2.2.1 The Merchant Shipping (Working Time: Inland Waterways) Regulations 2003, MSN 1778(M), regulate hours of work for vessels on Inland Waterways.

Application:- Regulation 3 states:

1. These Regulations apply to any United Kingdom ship, wherever it may be, which –
 - a) operates, or ordinarily operates, under a certificate which does not allow the ship to go beyond the limits of waters of category A, B, C, and D (as categorised in Merchant Shipping Notice No. MSN 1778(M)), or
 - b) is not required to be certificated.
2. These Regulations apply to any ship, other than a United Kingdom ship, which operates in the United Kingdom and does not go beyond the limits of waters of categories A, B, C, and D, as categorised in Merchant Shipping Notice No. MSN 1778(M).

2.2.1 Maximum weekly working time:- Regulation 6 states:

- (1) A worker's working time, including overtime, in any reference period which is applicable in his case shall not exceed an average of 48 hours for each seven days.
- (2) An employer shall take reasonable steps, in keeping with the need to protect the health and safety of workers, to ensure that the limit specified in paragraph (1) is complied with in the case of each worker employed by him in relation to whom it applies.
- (3) Subject to paragraphs (4) and (5) and any agreement under regulation 15, the reference periods which apply in the case of a worker are –
 - a) where the relevant agreement provides for the application of this regulation in relation to successive periods of 17 weeks, each such period, or
 - b) in any other case, any period of 17 weeks in the course of his employment.



- (4) Where a worker has worked for his employer for less than 17 weeks, the reference period applicable in his case is the period that has elapsed since he started work for his employer.
- (5) Paragraphs (3) and (4) shall apply to a worker to whom regulation 14 applies as if for each reference to 17 weeks there shall be substituted a reference to 26 weeks.
- (6) For the purposes of this regulation, a worker's average working time for each seven days during a reference period shall be determined according to the formula -

$$\frac{A + B}{C}$$

Where,

A is the aggregate number of hours comprised in the worker's working time during the course of the reference period

B is the aggregate number of hours comprised in his working time during the course of the period beginning immediately after the end of the reference period and ending when the number of days in that subsequent period on which he has worked equals the number of excluded days during the reference period;

C is the number of weeks in the reference period.

"Excluded days" means days comprised in –

- a) any period of annual leave taken by the worker in exercise of his entitlement under regulation 11
- b) any period of sick leave taken by the worker, and
- c) any period of maternity, paternity, adoption or parental leave taken by the worker

2.2.2 Further, The Merchant Shipping (Working Time: Inland Waterways) Regulations 2003, MSN 1778(M) require employers to take all reasonable steps to ensure that a worker's working time does not exceed 48 hours per week averaged over the relevant reference period.

2.2.3 The employer is required to keep records adequate to demonstrate that the workers are not exceeding the maximum working hours, and that the requirements on health assessments for night workers have been complied with. It is also recommended that the records are adequate to demonstrate that workers have received their entitlements (eg adequate rest, annual leave).

2.2.4 These records do not have to be specially created or dedicated to this purpose – they may be included in personnel records, or records kept for the purposes of determining pay. Nor is there any mandatory format for the records. They must however provide sufficient information to allow the MCA, or an employment tribunal, to investigate any claim of a breach of the regulations.

2.3 Self Employed Boatmasters



2.3.1 **The Merchant Shipping (Inland Waterway and Limited Coastal Operations) (Boatmasters' Qualifications and Hours of Work) Regulations 2006** regulate hours of work for self-employed Boatmasters.

2.3.2 **Application** - Regulation 28 states these regulations apply to a person who –

- a) is serving as master of a craft which is either—
 - i. a United Kingdom ship which is a passenger ship of Class IV, V, VI or VI(A), or
 - ii. a hovercraft carrying more than 12 passengers, and
- b) is not a person to whom—
 - i. the Working Time Regulations 1998,
 - ii. Merchant Shipping (Hours of Work) Regulations 2002, or
 - iii. the Merchant Shipping (Working Time: Inland Waterways) Regulations 2003, apply.

2.3.3 Regulation 29, The self-employed masters' working hours code, states:

- 1) A master must, so far as is reasonably practicable, ensure that he is properly rested when first going on duty on any working day.
- 2) Subject to paragraphs (5) to (7), a master's working day must not exceed 16 hours.
- 3) Subject to paragraphs (5) to (7), a master must not on any working day have command or charge of a vessel for periods amounting in aggregate to more than 10 hours.
- 4) Subject to paragraphs (5) to (7), if on any working day a master has been on duty—
 - a) for a period of 6 hours, the end of which does not correspond to the end of the working day, or
 - b) for periods amounting in aggregate to 6 hours without having enjoyed a rest period of at least 30 minutes and the end of the last of those periods does not correspond to the end of the working day, he must take a rest period of not less than 30 minutes at the end of that 6-hour period or (as the case may be) at the end of the last of those periods.
- 5) If the Secretary of State considers that it would be appropriate to do so, he may grant an exemption from all or any of the foregoing provisions of this regulation, on such terms (if any) as he may specify.
- 6) An exemption—
 - a) may be granted in respect of one or more craft or a class of craft, and
 - b) may be restricted to specified voyages or operations.
- 7) Subject to giving reasonable notice to the person affected thereby, the Secretary of State may alter or cancel an exemption.

Annex B

1. Fatigue Knowledge and Awareness



1.1 This Annex provides a basic overview of fatigue, its causes, recognition of its effects on health and fitness for duty, and preventative actions.

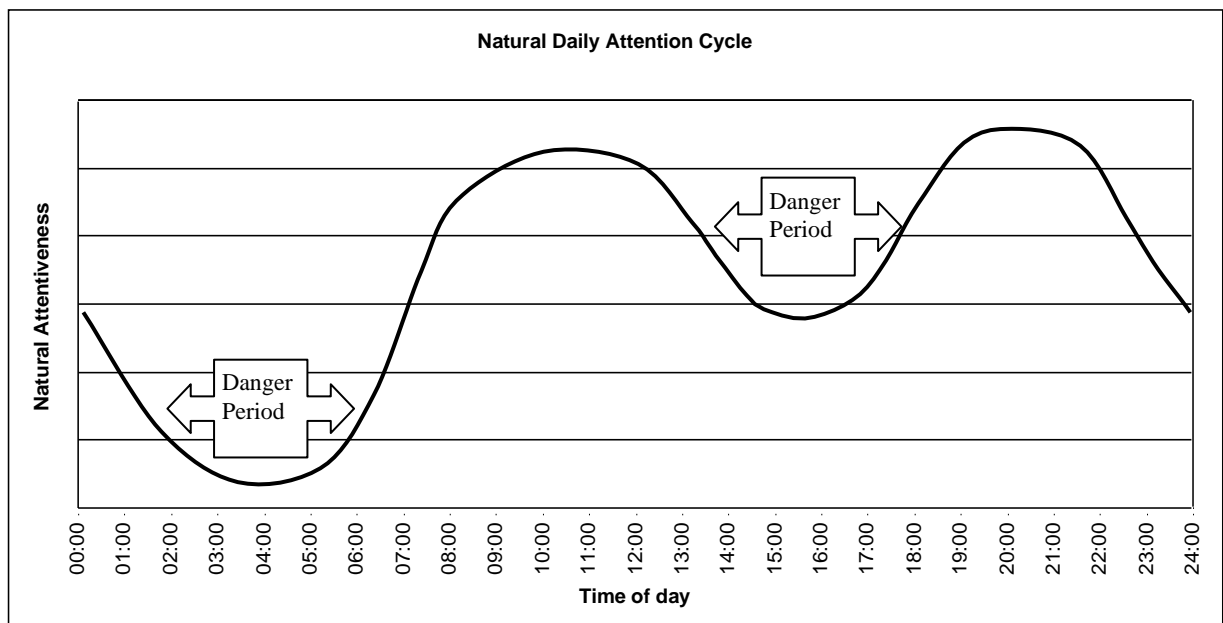
1.2 Fatigue is an extremely complex scientific subject that has been studied in considerable depth. This MGN does not attempt to address the full complexity or detail of fatigue - there are many publications available that do this. However, a knowledge and understanding of the overall principles can help maritime operational and management staff deal with the organisational and personal issues resulting from fatigue more effectively.

2. What causes Fatigue?

2.1 In simple terms fatigue has two main causes, natural human biological factors, and external or work and environmental factors. Both are significant and their effects need to be understood if we are to manage fatigue effectively.

3. Human Biological Factors

3.1 Humans have evolved over millions of years to be awake during the day and asleep at night, with most of our activity taking place in the morning and late afternoon/evening. Our many natural biological rhythms have adapted over this time to align with our wake/sleep pattern. Put simply, regardless of our activities, our bodies naturally want to sleep at night and to a lesser extent early afternoon.

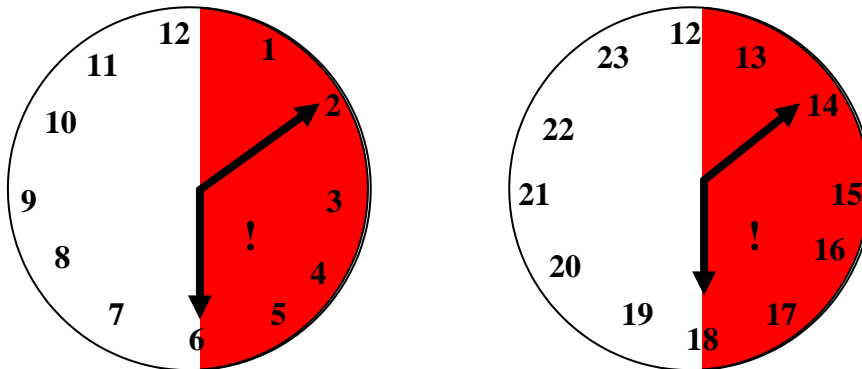


3.2 The diagram above illustrates the fundamental natural ability to pay attention throughout the day. This is the basic foundation upon which all our other activities act. During the periods of low attentiveness – the danger periods - we are naturally more prone to;

- a) Falling asleep
- b) Making errors
- c) Making misjudgements
- d) Having accidents



The Danger Times – Low levels of Alertness



4. Workload

- 4.1 Generally the harder people work the more tired they become and the sooner they need rest and sleep. However, workload and its effect are not easy to measure. They are influenced by a number of factors including;
- Physical and mental effort to undertake the work
 - Length of time the work is carried out
 - Suitability of the tools, equipment and procedures used for the job (are they user-centred?)
 - Skills, competence and experience of the people doing the work
 - Is the workload constant or does it fluctuate?
 - Physical and mental stamina of the individual

5. Environment

- 5.1 The working environment has a considerable impact on fatigue and people's ability to deal with it. Fatigue is more likely, or will develop sooner in adverse environments;
- Poor levels of light
 - Noise, 40-50 dBA interferes with sleep. 70dBA significantly disrupts sleep
 - Motion and vibration
 - Temperature extremes

6. Health

- 6.1 General health can affect both our ability to work and to recover from it. Poor physical health can make individuals more prone to fatigue.

7. Nutrition

- 7.1 Correct nutrition is important. Inadequate nutrition may accelerate the onset of fatigue. Whilst a balanced diet is essential for good health we need to consider the best times for certain types of food;
- Heavy meals with lots of carbohydrates tend to generate sleepiness
 - Lighter, protein based meals encourage alertness



8. Stress

8.1 Stress results when the demands on people (real or perceived) consistently exceed their ability to deal with them. Stress is always bad, and can have lasting long term effects on people. One of the first signs of stress is difficulty in sleeping which adds to sleep debt. There are many causes of stress, and not all related to work. Whatever the cause, stress will have an impact on our ability to work safely. Common causes include;

- a) Long hours
- b) High workload
- c) Difficult work
- d) Unpleasant working environment
- e) Employment worries
- f) Social and personal issues, loneliness, separation from families
- g) Health worries
- h) Relations with colleagues

9. The Effect of Shift Work and Watch Patterns

9.1 One of the key components of the shipping industry is the requirement to operate ships on a 24/7 basis, i.e., seafarers are required to work, and perform safely, at times when the body naturally wants to sleep. The effect of watch patterns and shift work on fatigue and performance is therefore critical to maintaining a safe operation.

9.2 Adults need between 6 to 9 hours of sleep per night, preferably during one single, uninterrupted period. Shift work can cause:

- a. difficulties getting to sleep
- b. shorter time spent asleep
- c. sleep debt that leads to sleepiness during working days and days off.

9.3 The effects of shift work are exacerbated when it includes night work. This is because night work conflicts with our natural biological rhythms. Working during the night has shown to increase the likelihood of accidents and errors.

9.4 Research³ has shown that:

- a) watch patterns have a strong influence on seafarers' performance and their ability to acquire effective sleep
- b) Seafarers working the 4-on/8-off watch pattern are much more able to acquire sufficient levels of sleep
- c) Those working 4-on/8-off averaged around 7½ hours sleep per day which is generally sufficient for effective recovery
- d) Those working 6-on/6-off averaged a little over 6 hours per day which is likely to lead to sleep debt in a short period of time
- e) 6-on/6-off watchkeeping shows a greater incidence of watchkeepers falling asleep on duty than the 4-on/8-off pattern. However, both watch patterns show significant levels of falling asleep during the early hours of the morning
- f) Increased rates of sleeping on duty are likely where there has been a disturbance to the previous off-duty period
- g) Sleep is not normally initiated immediately after the watch, taking on average 50 minutes but often much longer, especially if sleeping during daylight hours
- h) Watchkeepers were most tired at night and in the afternoon
- i) Sleepiness levels peaked towards the end of night watches
- j) Slowest reaction times were at the end of night watches
- k) Sleeping on watch occurred mostly during night and early morning watches



- l) 6-on/6-off was more tiring than 4-on/8-off
- m) The onset of tiredness on 6-on/6-off occurred more quickly than predicted
- n) Disturbed off-duty periods produce significantly high levels of tiredness
- o) Seafarers working 6-on/6-off typically get markedly less sleep than those working 4-on/8-off

(³ Jepsen, Zhao and van Leeuwen (2015) Seafarer fatigue: a review of risk factors, consequences for seafarers' health and safety and options for mitigation)



Checklist! Fatigue and Stress

Recognising the Danger Signs in Individuals*	
Fatigue	Stress
<p>Physical signs:</p> <ul style="list-style-type: none"> • Shortness of breath • Muscle weakness/pain • Easily tired • Poor coordination • Headaches • Nausea • Palpitations • Loss of appetite • Falling asleep suddenly and without meaning to <p>Behavioural signs:</p> <ul style="list-style-type: none"> • Lack of motivation • Difficulty concentrating • Poor memory • Low mood • Not feeling refreshed by sleep • Irritability/ mood swings 	<p>Physical signs:</p> <ul style="list-style-type: none"> • Weight gain • Tiredness • Low energy • Nausea • Breathlessness • Frequent need to urinate • Noticeably stronger heartbeat • Tingling sensations • Less care in appearance/hygiene <p>Behavioural signs:</p> <ul style="list-style-type: none"> • Negative thoughts • Forgetfulness • Irritability/ mood swings • Difficulty focusing • Avoiding people
<p>*Information also taken from 'Wellbeing at Sea: A Pocket Guide for Seafarers' by the Maritime and Coastguard Agency. Published by TSO. Crown copyright 2020.</p>	



Checklist! Fatigue and Stress

Recognising the Operational Danger Signs	
Operational Signs Of Fatigue	Effects of Fatigue On Performance
<p>Degraded mental performance eg confusion, poor concentration, narrowed perception and forgetfulness. Leads to degraded vigilance and poor response to changing situations.</p> <p>Diminished personal safety Reduced self and situation awareness leading to apathy, less attention to personal hygiene, neglect of normal safety precautions, and more risk taking.</p> <p>Impaired leadership Some people take longer to make decisions while others make poorer ones. The decision maker is often unaware of the decline. Fatigue can make people accept irrational, erroneous or illegal orders – or ignore good ones.</p> <p>Worsening team performance eg decreased interaction with crew members and degraded communication due to lower sensitivity to other people's needs and aims. People may lose their sense of humour and become moody, irritable, argumentative or socially withdrawn, all of which can badly affect crew relations.</p> <p>Decreased morale Fatigue decreases satisfaction, motivation and interest in team tasks and goals. Pessimism increases; people tend to think the worst, reject the group and take offence easily.</p> <p>Odd behaviour People may talk 'gibberish', neglect routine tasks, have stupid accidents and suffer hallucinations.</p> <p><i>Adapted from: Murphy (2002) with permission of Dir. of Psychology, Aus DoD</i></p>	<p>Decreased attention and vigilance People become less alert and slower to notice things. They may fail to detect signals or their significance, especially during monotonous tasks or in tedious environments. Tasks requiring sustained attention or surveillance are especially affected by fatigue.</p> <p>Communication difficulties It becomes increasingly difficult to decide what needs to be said, how to say it, or what another said.</p> <p>Inability to concentrate Maintaining focus on the task at hand, even for a few seconds, is difficult. People cannot follow complex directions or numerical calculations, and are easily confused.</p> <p>Omissions & carelessness People increasingly skip steps, miss checks and make mistakes.</p> <p>Slower comprehension & learning It takes increasingly longer to understand any written or spoken information, or display patterns, eg a map or charts.</p> <p>Slower information processing It takes increasingly longer to transform data or process information, eg map coordinates are decoded slowly and mistakes are made doing it.</p> <p>Mood changes Irritability, depression and apathy increases.</p> <p>Hallucinations Extreme fatigue and low stimulation make people see, hear and act on things that appear very realistic, but illusory.</p> <p>Muddled thinking Reasoning becomes slow and confused and deteriorates to irrational thoughts, poor logic and delusions.</p> <p>Faulty memory Recall of recent events or orders becomes faulty. For example, the content of a radio message may be immediately forgotten or recalled incorrectly.</p> <p>Task complexity Tasks that are complicated</p>



	and boring are more seriously affected, compared with simpler, more interesting ones.
--	---

Adapted from: Murphy (2002), with permission of Dir. of Psychology, Aus DoD

** Table extracted from "The Human Element – a guide to human behaviour in the shipping industry" sponsored by the Maritime and Coastguard Agency, supported by BP Shipping, Teekay Marine Services and the Standard P&I Club. Crown Copyright 2010.*



10. Sleep and Recovery

- 10.1 Sleep requirements vary between people but the longer we stay awake, the more tired we naturally become. The more energy we use, whether physical, mental or emotional, the more tired we become. The two essential ways we recover from this tiredness are through eating and sleep. Approaching both issues with greater awareness can make a significant contribution to fatigue avoidance.
- 10.2 Think of sleep like a fuel tank. Once the tank is full we cannot add any more fuel. The same is true for sleep. We need sleep to replenish our energy after wakeful activity, by sleeping. We cannot store extra sleep.
- 10.3 We have evolved to be awake for about 16 hours a day and asleep for 8 hours, i.e., broadly speaking for every 2 hours we are awake we need 1 hour sleep.
- 10.4 If our sleep falls below this requirement we build up a sleep debt. People with a sleep debt;
- Fail to stay alert
 - Misread situations
 - Overlook key information
 - Fall asleep
 - Put themselves and colleagues at extreme risk
- 10.5 The only remedy is sufficient good quality sleep. The greater the sleep debt, the longer we need to sleep to pay off the debt.
- 10.6 A basic understanding of sleep helps us understand why we need the right amount of the right quality sleep.
- 10.7 Sleep occurs in cycles consisting of five stages. Each cycle lasts between 90 and 110 minutes where we move through all 5 stages of sleep. A full night's sleep normally involves 4 or 5 of these cycles.
- 10.8 The 5 stages are;

Stages 1 & 2 Dropping off and light sleep

- This is the transition from being awake to deep sleep and accounts of about half our sleep

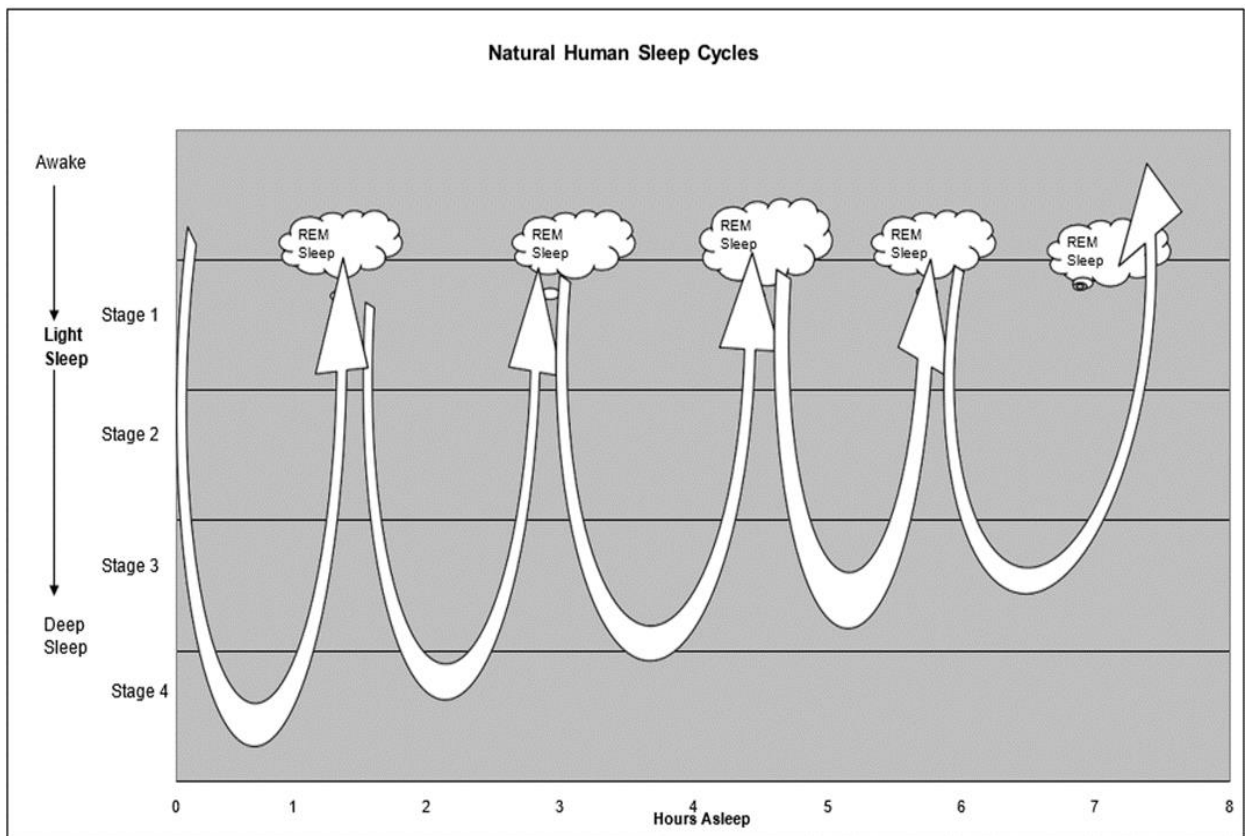
Stages 3 & 4 Deep sleep

- Essential for physical and mental recovery.
- The more we are fatigued, the more deep sleep we need.
- It is harder to be woken from deep sleep and it takes longer to become fully alert.

Stage 5 Rapid Eye Movement (REM) sleep

- Occurs at the end of each cycle and is the time when we dream.
- It is important for mental stability, memory and learning.
- Lack of REM sleep leads to irritability and poor judgement.





10.9 The diagram above shows how we cycle through the stages during a “normal” night’s sleep. It can be seen how;

- a) 6-on/6-off reduces the amount of sleep to a level below that required
- b) Being disturbed part way through a cycle can leave a seafarer having to recover from deep sleep, rather than light sleep. Deep sleep is much harder to recover from and takes longer to become fully alert. NB:- sleep debt is only repaid when we reach stages 3, 4.

11. The power of the nap

11.1 Operational seafaring demands – e.g., the six on/six off watch system – often mean it is not possible to take the ideal 7-8 hour sleep period each 24 hours. In these circumstances, napping becomes a powerful friend. Here is how to get the most out of it;

- a) The longer the nap, the greater the increase in mood, performance and alertness – but the longer it takes to recover. Always allow a few minutes for the grogginess to clear – up to 30 minutes if the nap has been 2 hours or so
- b) Naps taken between 04.00 and 06.00 and 14.00 to 16.00 are accompanied by most grogginess on waking.
- c) Afternoon naps have the best chance of repaying some sleep debt since they contain the most Stage 4 sleep
- d) Naps are best taken before fatigue builds up, rather than after
- e) Naps should be taken in a comfortable, darkened area free of noise. Noise prevents deeper napping, and reduces its benefit, so ear plugs and eye shades should be considered. Chairs that recline and provide leg support are of most benefit
- f) Naps of 20-30 minutes provide significant benefit and the least grogginess afterwards. Even naps of 10 minutes are worthwhile
- g) Caffeine taken just before a 30-minute nap will kick in at wakeup time, assisting recovery to alertness



Adapted from Murphy (2002), with permission of Dir. of Psychology, Aus DoD

** Extracted from "The Human Element – a guide to human behaviour in the shipping industry" sponsored by the Maritime and Coastguard Agency, supported by BP Shipping, Teekay Marine Services and the Standard P&I Club. Crown Copyright 2010.*

12. Nutrition

12.1 It is important to understand the impacts of nutrition on levels of fatigue. You can help mitigate the effects of fatigue by both what you eat and when.

- a) Here are the key tips; Meals made up largely of carbohydrates facilitate better sleep
- b) Meals made up largely of protein assist wakefulness and activity
- c) Regular meal timings help to regulate the human 24-hour cycle
- d) On night watch, main meals should be eaten before 01.00 hrs
- e) After a night watch, a light snack of carbohydrates should be taken no later than two hours before expected sleep time
- f) Drinking alcohol before sleep is a bad idea – it may help you to 'drop off', but shortens the deep sleep you really need
- g) Taking caffeine within 4 hours of sleep is likely to disrupt it. But it can assist nap recovery

**Information also taken from 'Wellbeing at Sea: A Pocket Guide for Seafarers' by the Maritime and Coastguard Agency. Published by TSO. Crown copyright 2020.*



Checklist! Self Help

What the Ship Owner/ Manager, Master and Seafarer can do to prevent Fatigue

The Shipowner/Manager should ensure	The Master should ensure	Th Seafarer should ensure
<p>Clear communication of ISM Code requirements</p> <p>Adequate rest for joining crews before assuming duties</p> <p>Adequate time for proper hand over on crew change</p> <p>Voyage length, time in port, length of service & leave ratios are okay</p> <p>Good use of time in port for administrative tasks</p> <p>Proper manning of the ship, giving consideration to the safe performance of the various tasks onboard and the nature of the trade</p> <p>Awareness of schedules when contacting the ship from the office. Do not wake Seafarers for insignificant reasons. Be aware of time differences and the workload onboard.</p> <p>Ensure Masters, Officers and other crew are familiar with he causes, effects and mitigations of fatigue</p>	<p>All elements of the Shipowner/ Manager policy are met</p> <p>Small crew issues met e.g., loneliness, boredom, higher, workload</p> <p>Adequate shore leave, onboard recreation, and family contact</p> <p>Effective work/rest arrangements and napping opportunities particularly considering safe manning principles, watch schedules and port visits.</p> <p>Potentially hazardous tasks are scheduled for daytime hours</p> <p>Crew education and training to recognise and mitigate fatigue</p> <p>Drills and training exercises are planned to minimise disruption to rest periods</p> <p>Creation of open, just culture for reporting & dealing with fatigue</p> <p>Rotation of high-demand and low-demand tasks</p> <p>Accuracy of individual record keeping of hours rested/worked</p> <p>Adequate heating, ventilation, air-conditioning and lighting</p> <p>Minimisation of noise and vibration in rest areas</p> <p>Healthy lifestyle and diet</p>	<p>Adequate personal sleep arrangements</p> <ul style="list-style-type: none"> • Aim for deep, uninterrupted sleep 7-8 hours per 24- hour day • Take strategic naps • Develop pre-sleep routine, e.g., warm shower, light reading • Ensure dark, quiet, cool sleep area and comfortable bed • Avoid interruptions during extended period of sleep <p>Adequate diet and fitness</p> <ul style="list-style-type: none"> • Avoid alcohol and caffeine before sleep • Eat regular, well-balanced meals, but eat lightly before bed • Exercise regularly – it increases alertness both on and off duty <p>Adequate self-monitoring</p> <ul style="list-style-type: none"> • Accurately record hours of work and rest • Minimise disturbance of rest/sleep patterns • Take a break between work periods • Get sufficient sleep before high activity periods

Adapted from ALERT! (2007), with permission



** Table extracted from “The Human Element – a guide to human behaviour in the shipping industry” sponsored by the Maritime and Coastguard Agency, supported by BP Shipping, Teekay Marine Services and the Standard P&I Club. Crown Copyright 2010.*

**Information also taken from ‘Wellbeing at Sea: A Guide for Organisations by the Maritime and Coastguard Agency. Published by TSO. Crown copyright 2020.*



Annex C

Fatigue Management Plan – General Principles

Fatigue Management Plans (FMP) are a proven method to identify, manage and reduce fatigue. They are mandatory in some industries. FMPs vary in nature from simple to complex, depending on the organisation, nature and criticality of its work, size of workforce, diversity of operation and geographical locations etc. This Annex is not a detailed instruction or reference manual about the construction of an FMP, rather it focuses on some basic principles for organisations to consider when developing an FMP.

1. Understand Fatigue

Objective

All personnel, on board and ashore, involved in operation and management of ships have appropriate knowledge and understanding of fatigue and fatigue management.

Principles

1. The company has procedures in place to ensure that all personnel, on board and ashore, involved in operation and management of ships;
 - i. Understand the causes of fatigue and fitness impairing factors, including,
 - a) Normal human biological factors
 - b) The effect of wakeful activity, work, working patterns, workload, environmental conditions, social & cultural conditions etc
 - c) The effect of stress
 - ii. Understand the company's fatigue management policy and practices.

2. Fatigue Preventative Practices

Objective

All personnel, on board and ashore, involved in operation and management of ships have appropriate knowledge and understanding of the various management and operational practices that can contribute to preventing fatigue.

Principles

1. The company has procedures in place to ensure that all personnel, on board and ashore, involved in operation and management of ships understand policies and practices to mitigate the effects of fatigue and factors leading to impaired performance;
 - i. How to recognise fatigue, stress and impaired fitness in themselves and in colleagues,
 - ii. Effective roster management that;
 - a) Complies with the hours of work and rest regulations
 - b) Enables adequate rest and sleep
 - c) Minimises disruptions to periods of rest and sleep
 - d) Maintains a reasonable balance between working hours and circadian rhythms
 - e) Limits tours to a manageable length
 - f) Provides adequate flexibility in roster arrangements to enable effective management of unavoidable disruptions



- iii. Seafarers maintain a healthy personal lifestyle, including;
 - a) Adequate sleep, rest and recreation
 - b) Healthy, well balanced diet
 - c) Exercise

- iv. Foster an effective on board culture;
 - a) Listening, reporting, learning “just culture”
 - b) Workforce involvement in safety improvement
 - c) Full consideration for personal requirements

- v. Habitability, on board environmental conditions;
 - a) Quality of crew accommodation
 - b) Noise, vibration, heat, cold
 - c) Pitching, rolling and other ship movement
 - d) Recreational facilities
 - e) Access to internet, sat-phone etc

3. Duties and Responsibilities

Objective

All personnel, on board and ashore, involved in operation and management of ships have appropriate knowledge and understanding of their duties in respect of fatigue and their responsibilities under current merchant shipping regulations.

Principles

3.1 The company has procedures in place to ensure that all personnel, on board and ashore, involved in operation and management of ships;

- i. Have appropriate knowledge and understanding of their duties and responsibilities under current merchant shipping regulations, including;
 - a) Hours of work and rest,
 - b) Health and safety of workers and other persons
 - c) ISM and DSM Codes
 - d) Risks to health and safety
 - e) International guidance on ship safety

4. Management Policies and Practices

Objective

Fatigue is prevented, monitored and controlled through effective management policies and practices.

Principles

1. The company has established appropriate policies and practices that are designed to ensure that all personnel, on board and ashore, involved in operation and management of ships;

- i. Have received appropriate training and are sufficiently aware of
 - a) Fatigue, performance and fitness impairing factors
 - b) The various management and operational practices that can contribute to preventing fatigue
 - c) The company’s fatigue management policy and practices
 - d) Appropriate knowledge and understanding of their duties in respect of fatigue and their responsibilities under current merchant shipping regulations



- ii. Accurate records are kept of hours of work and rest and are reported to the company. Research from the World Maritime University* (2020) has shown that work/rest records are often adjusted by sea-going personnel to facilitate compliance. Management has a responsibility to ensure that personnel understand the importance of accurate record keeping. Company policies and procedures regarding safe manning and hours of work and rest should be carefully considered to ensure that they do not implicitly encourage non-compliance. For example, where incentives for overtime such as bonuses are offered. Sea-going personnel should be encouraged to highlight potential issues with safe manning, where it impacts hours of work/rest and the ability to complete work safely, without fear of punishment.
*World Maritime University, 2020. *Culture Of Adjustment. Evaluating The Implementation Of The Current Maritime Regulatory Framework On Rest And Work Hours.*
- iii. Procedures are in place to;
 - a) Verify hours of work and fitness for duty records
 - b) Monitor and assess the levels of fatigue experienced by sea-going personnel and evaluate the causes for that fatigue and any mitigating action that could be taken
 - c) Review the fatigue management plan for effectiveness, non-conformities, breaches of legislation etc
 - d) Ensuring that all changes to legislation, guidance, safety management system (SMS), fatigue management plan (FMP) etc are notified to all appropriate personnel in a timely way so as to enable continual compliance with appropriate requirements.
 - e) New or amended information regarding fitness for duty is notified to all appropriate staff in a timely manner
 - f) Monitoring the fitness for duty of sea-going personnel

5. Development of a Fatigue Management Plan

Objective

An effective fatigue management plan is developed and implemented that is appropriate to the company's operations.

Principles

1. Everyone in the company, at sea and ashore, recognises the benefits of an effective fatigue management plan.
2. All risks of fatigue are taken into account;
 - a) Human biological factors
 - b) Hours of work and rest, sleep debt and sleep hygiene
 - c) Shift patterns and nature of work
 - d) Disruptions to sleep and rest
 - e) Effect of crossing time zones and travel to and from place of duty
 - f) Length of tours of duty (in combination with Watchkeeping patterns)
 - g) Leadership and management capabilities
 - h) Stress
 - i) General health of seafarers
 - j) Personal and social conditions on board
 - k) Environmental issues eg geographical location of vessels
 - l) Trading patterns, including port calls and cargo working
 - m) Company policies, practices, administrative procedures, ship-shore communication
 - n) Ship specific factors - technical including familiarisation with a new ship
 - o) Ship specific factors - social
 - p) Effective monitoring of fatigue, health, fitness for duty etc
3. Involve a full range of affected personnel;



- a) Masters
 - b) Crew at all levels
 - c) Shore-side staff
4. Work for an effective safety culture, which embodies;
- a) The principles of a “Just Culture”
 - b) All personnel taking ownership of safety
 - c) Recognition that fatigue, and the “can-do” culture that enables it, is dangerous to seafarers, ships, cargoes and company viability, and that it should not be tolerated at any level in the industry



Annex D

Further Reading

ABS (2001) Crew Habitability on Ships, American Bureau of Shipping, Dec 2001

ALERT! (2007) Time to wake up to the consequences of fatigue, The International Maritime Human Element Bulletin, The Nautical Institute, Issue No. 13 January 2007

Australian Government (2000) Beyond the Midnight Oil: An Inquiry into Managing Fatigue in Transport, House of Representatives Transport Committee, Australian Government

Calhoun S.R (LT) & Lamb T. (1999) Human Factors in Ship Design: Preventing and Reducing Shipboard Operator Fatigue, University of Michigan Department of Naval Architecture and Marine Engineering U.S. Coast Guard Research Project

HSE (2004) Work-related stress: a short guide, Health & Safety Executive

HSE (2006) Fatigue and Risk Index: In Nov 2009, the report is at <http://www.hse.gov.uk/research/rrpdf/rr446.pdf> (in Mar '10)

Jepsen, J., Zhao, Z., & Van Leeuwen, W. (2015). Seafarer fatigue: a review of risk factors, consequences for seafarers' health and safety and options for mitigation. International Maritime Health, 66(2), 106-117. doi: 10.5603/imh.2015.0024

LUL (2007) Integration of Human Factors into Systems Development, London Underground Ltd, Standard 1-217 v. A1, Oct 2007, LUL/WN/00834

MAIB (2009b) Report on the investigation of the grounding of Antari Near Larne, Northern Ireland 29 June 2008, Marine Accident Investigation Branch, Carlton House, Carlton Place, Southampton, UK, Report No 7/2009, February 2009

MCA (2010) "The Human Element – a guide to human behaviour in the shipping industry" Sponsored by the Maritime and Coastguard Agency, BP Shipping, Teekay Marine Services and the Standard P&I Club.

Authored by Dik Gregory and Paul Shanahan Crown Copyright 2010.

MCA (2020) "Wellbeing at Sea: A Guide for Organisations" Authored by Connie S.Gehrt and Georgina Robinson. Crown Copyright 2020.

MCA (2020) "Wellbeing at Sea: A Pocket Guide for Seafarers" Authored by Connie S.Gehrt and Georgina Robinson. Crown Copyright 2020.

MOD (2008) DefStan 00-250 Human Factors for Designers of Systems, Pts 0 - 4, UK Ministry of Defence <http://www.dstan.mod.uk> (in Mar '10)

Moore-Ede M., Heitmann A., Dawson T. & Guttkuhn R.(2005) Truckload Driver Accident, Injury and Turnover Rates Reduced by Fatigue Risk-Informed



Performance-Based Safety Program. Transport Canada: Proceedings of the 2005 International Conference on Fatigue Management in Transportation Operations, September 2005, Seattle. <http://www.tc.gc.ca/innovation/tdc/publication/tp14620/h04.htm> (in Mar '10)

Murphy P.J. (2002) Fatigue management during Operations: A Commander's Guide, Defence Science and Technology Organisation, Australian Department of Defence (Army)

Parker A.W., Hubinger L.M., Green S., Sargaent L. & Boyd R. (1997) A Survey of the Health, Stress and Fatigue of Australian Seafarers. Canberra: Australian Maritime Safety Authority

Project HORIZON Consortium – Project HORIZON-A Wake-up Call. EU 7th Framework Programme 2012. www.project-horizon.eu

RSSB (2006) Coping with Shift Work & Fatigue: a good practice guide for drivers, Rail Safety and Standards Board, London

Smith A., Allen P. & Wadsworth E. (2006) Seafarer Fatigue: The Cardiff Research Programme, Centre for Occupational & Health Psychology, Cardiff University

Sutherland, V.J. and Flin, R.H. (1989) Stress at Sea: A Review of Working Conditions in the Offshore Oil and Fishing Industries, *Work and Stress* 3(3): 269– 85

Thomas M. (2005) Lost at Sea and Lost at Home: the Predicament of Seafaring Families, Seafarers International Research Centre, Cardiff University

Thomas M. & Bailey N. (2006) Square pegs in round holes? Leave periods and role displacement in UK-based seafaring families, *Work, Employment & Society*, Volume 20, No. 1, Sage publications

US DoD (1999) MIL-STD-1472F Human Engineering Military Specifications and Standards, US Department of Defense

Maritime New Zealand, Fatigue Advisor Resource PO Box 27006, Wellington 6141, New Zealand www.maritimenz.govt.nz

NTC Australia
Basic Fatigue management (BFM) Standards
ISBN 1 291168 79 X

US Coast Guard Research and Development Center
US Coast Guard Guide for the Management of Crew Endurance Risk factors

International Maritime Organization
MSC/Circ.1014 Guidance on Fatigue Mitigation and Management

