INTERNATIONAL MARITIME ORGANIZATION

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Agenda item 8

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ROLE OF THE HUMAN ELEMENT

Report of the Correspondence Group on the Revision of the Guidelines on Fatigue

Submitted by Australia

SUMMARY

Executive summary:	This document provides the report of the Correspondence Group on the revision of the *Guidelines on Fatigue*. Attached in the annex are the draft guidelines for review and appropriate action by the HTW Sub-Committee
Strategic direction:	5.4
High-level action:	5.4.1
Output:	5.4.1.2
Action to be taken:	Paragraph 15
Related documents:	MSC 94/18/7, MSC 94/21; MSC 95/9/3, MSC 95/9, MSC 95/22; MSC/Circ.1014; HTW 2/8, HTW 2/8/2; HTW 2/19; HTW 3/8; HTW 3/8/1; and HTW 3/8/2

Introduction

1 HTW 3 established a correspondence group, coordinated by Australia, to review the proposed amendments to the *Guidelines on Fatigue* (MSC/Circ.1014). The correspondence group was instructed to use HTW 3/8 (Australia), as amended by the Working Group (HTW 3/WP.5, annex 1), as the base document, taking into account the proposed principles set out in paragraphs 11 to 14 of document HTW 3/8/2 (ICS), the approach for the revision presented in document MSC 95/9/3 (United Kingdom) and the additional requirements outlined in paragraph 12 of document HTW 3/WP.5.

2 The terms of reference for the correspondence group were to:

.1 review the proposed amendments to the *Guidelines on Fatigue* (MSC/Circ.1014), using as a basis document HTW 3/8, as amended by the Working Group (HTW 3/WP.5, annex 1) and taking into account the proposed principles set out in paragraphs 11 to 14 of document HTW 3/8/2, the approach for the revision presented in document MSC 95/9/3 and the additional requirements outlined in paragraph 12 of document HTW 3/WP.5;

.2 when reviewing Module 2 on Fatigue and the Company, take into account the proposed additional modifications contained in document HTW 3/8/1 and that the fatigue risk management system should not be the only method to address Module 2;

.3 consider whether port and coastal States and other stakeholders should be part of the guidelines and develop contents of the module(s), as appropriate;

.4 consider the scope, contents and title of module 6 on Fatigue and the Administration; and

.5 submit its report to HTW 4.

3 The following Member States participated in the correspondence group: Argentina, Australia, the Bahamas, Belgium, Brazil, Canada, Chile, China, Denmark, Finland, France, Germany, Greece, India, Ireland, Italy, Japan, Kenya, Latvia, Liberia, the Marshall Islands, New Zealand, Norway, Poland, Portugal, the Republic of Korea, the Russian Federation, Singapore, Sweden, the United Kingdom, Ukraine and the United States.

4 The following Associate Member participated in the group: Hong Kong, China.

5 The following intergovernmental organization, European Commission (EC), and non-governmental organizations, ICS, IACS, OCIMF, IFSMA, CLIA, INTERCARGO, IMarEST, ITF and the Nautical Institute (NI), also participated in the group.

Correspondence Group – method of work

6 Three rounds of postings were used for the Introduction, Modules 1 to 6 and the Appendices. A new version of the draft revised modules was provided in each posting along with feedback on previous inputs including consensus based decisions. Many diverse comments had to be considered and finding consensus was sometimes difficult.

7 The correspondence's group method of work was as follows:

.1 A feedback matrix was developed to assess feedback and provide comments back to the correspondence group in an open and transparent manner. This allowed a number of the correspondence group members to refer back to earlier comments or to compare comments with those from other members;

.2 Paragraphs in the introduction and Modules 1 to 6 were numbered for easy reference. The same paragraph numbers were retained throughout the process to ensure traceability;

.3 All comments and suggestions received from correspondence group members were considered. Any major changes that have affected the intent of the guidelines were sent back to the correspondence group members in order to gain consensus. Upon receiving feedback and consensus from the correspondence group members, these were included in the document;

.4 In some cases it was necessary to exercise judgement and blend several comments to arrive at compromise solutions. This has been completed as appropriately as possible, and always aiming for broad consensus;

.5 Where consensus was not possible, text was placed in square brackets for further consideration; and

.6 The correspondence group was given the opportunity to undertake a final review (4th posting) on each of the modules and an additional review of the final report to HTW 4.

What has the correspondence group completed?

8 In considering the principles set out in paragraphs 11 to 14 of document HTW 3/8/2, the review process involved a number of editorial changes to remove duplication and to ensure that the text was consistent, readable and logical. However, general consensus on some parts of the document could not be reached.

9 Agreement was reached on the use of the following terminology which is now consistent throughout the document:

.1 *maritime industry*, replacing *shipping industry* and *marine industry*;

.2 *mitigate and manage* (or *mitigation and management*) is now used throughout the document;

.3 *risk of fatigue*, replacing *fatigue-related risks*, *risks of fatigue* and *fatigue risks*;

.4 where possible and to ensure gender neutral language is used, the word *manning* was replaced with the word *crewing*; and

.5 where relevant *duty* has been changed to *work.*

10 As part of the review process, the correspondence group affected the following changes. Some items in the list that follows are relevant to all modules (including the introduction and the appendices):

.1 wherever possible, gender neutral language is utilized;

.2 text identified as requiring further clarification was included with a definition (some still pending a definition) in the introduction in square brackets;

.3 wherever possible, text has been streamlined within and between modules to ensure consistency;

.4 text was added to improve readability and clarity;

.5 some text and paragraphs were deleted to remove duplication and improve readability;

.6 some obsolete references were deleted; and

.7 modules 1 and 2 were restructured to improve readability.

11 The following summarizes key changes specific to each of the sections/modules:

.1 Introduction

.1 most responses from members indicated in-principle agreement to the introduction with some text in square brackets as per paragraph 13.1 below for consideration.

.2 Module 1: Fatigue - Causes and consequences

.1 paragraphs 3, 12, 35, 36, 37, 45, 46 and 54 were deleted;

.2 most responses from members indicated in-principle agreement to module 1 with some text in square brackets as per paragraph 13.2 below for consideration.

.3 Module 2: Fatigue and the Company

.1 any reference to Fatigue Risk Management System was removed from Module 2 and some paragraphs in relation to this were moved to the appendix;

.2 paragraphs 4, 5, 13, 18, 22, 23, 24, 25, 26, 28, 29, 30, 31, 32, 33, 35, 36, 37, 38, 46, 73, 76, 78, 79, 85, 86, 87, 88, 89 and 90 were deleted. Note that some content was moved to other paragraphs and some content was moved to the appendix;

.3 some members expressed concern with privacy issues in relation to the proposed options of sleep and alertness monitoring at sea resulting in further editing of some paragraphs;

.4 concerns from the members of the correspondence group have been included in square brackets in paragraph 13.3 below for further consideration.

.4 Module 3: Fatigue and the seafarer

.1 the style has been changed from the first person (you) to the third person (the seafarer). In doing so some minor changes to the text was made to retain clarity;

.2 the term *management level seafarers* has been added to refer to seafarers with supervisory/management responsibility, together with a definition in the introduction;

.3 most responses from members indicated in principle agreement to module 3 with some text in square brackets as per paragraph 13.4 below for further consideration.

.5 Module 4: Fatigue awareness and training

.1 title changed to "**Fatigue awareness and training**";

.2 opted to use the word *trainee* rather than *student*;

.3 fatigue training is already a requirement under the STCW Code, part A (section A-VI/1, table A-VI/1-4) and supported by the IMO Model Course 1.21 (2016 edition) on Personal Safety and Social Responsibility. This is now reflected in module 4 with additional paragraphs added (paragraphs 2b and 17) and others modified to reference this requirement for fatigue training;

.4 paragraphs 4, 5, 10, 24, 25, and 26 were deleted;

.5 there was some concern that this module may be too prescriptive, hence changes were made to soften the language regarding the flexibility of fatigue awareness and training;

.6 in noting the above changes, there was concern expressed by some members regarding this module that need to be resolved as identified in paragraph 13.5 below.

.6 Module 5: Fatigue and the ship designer

.1 to improve clarity, a definition of ship designer has been included in the introduction and placed in square brackets for further consideration;

.2 paragraphs 3, 4, 5, 44, 45, and 46 were deleted;

.3 wherever possible, referenced standards and guidance were updated;

.4 most responses from members indicated in principle agreement to this module with some text in square brackets as per paragraph 13.6 below.

.7 Module 6: Fatigue, the Administration and Port State Authorities

.1 in considering the scope of module 6 the correspondence group gathered feedback on steps to be included with the following considered: (1) **Step 1** – Guidance for Administrations (definition from the STCW Convention articles); (2) **Step 2** – Expand the scope of module 6 to include guidance for Port State Control authorities as provided in the STCW Convention under Regulation I/4. (3) **Step 3** - Expand the scope of module 6 to include guidance for coastal states.

Following feedback, most members indicated their preference for module 6 to cover Administration (step 1) and Port State Authorities (step 2). As a result, the title of module 6 was changed to *Fatigue, The Administration and Port State Authorities* to reflect a new scope, with the document split into these two parts;

.2 this review did not consider the aspect of 'other stakeholders' and some members indicated that this needs to be considered;

.3 to clarify scope, the introduction now includes a definition of Administration (as per the STCW), and Port State Authorities as follows [Port State Authorities**:** means government commissions and/or official organizations that controls and manages the activities in a port and includes PSC, customs, immigration, law enforcement agencies and port/harbour authorities.];

.4 considering the huge task and workload associated with the review of the guidelines and the demands associated with this meant that the draft text for module 6 has not benefited from the same time, inputs and consideration as the other modules hence further consideration is required as indicated in paragraph 13.7 below.

.8 Appendices: Fatigue Management Tools

.1 appendices renumbered following addition of Appendix 1 (Fatigue Risk Management System (FRMS));

.2 content related to FRMS contained in module 2 (including Figure 2.1) was moved to Appendix 1;

.3 the draft appendices have not benefitted from the same level of attention as the other modules hence further consideration as indicated in paragraph 13.8 is required.

For further discussion at HTW 4

12 Considering the task at hand, finding consensus was at times challenging. There have been clear differences in opinion throughout the process, however, in-principle agreement was reached for some of the modules. In some instances, the correspondence group was unable to obtain consensus on a consolidated draft document. Hence, it was agreed to leave some text in square brackets for further consideration by the HTW Sub-Committee.

13 The following paragraphs identify areas for further discussion and agreement:

.1 Introduction:

.1 the cover note for introducing the circular (first page of the introduction) requires further input and should be updated. Additional text to support this has been added in square brackets for further discussion;

.2 paragraph 12 (and the figure) have been placed in square brackets as a reminder that they need to be reviewed following completion of all modules;

.3 definitions added by the correspondence group to improve clarity have been included in square brackets for further discussion and agreement;

.4 it is suggested that the "definitions" section be reviewed again after completing a review of all modules;

.2 Module 1:

.1 the last sentence of paragraph 30.4 is in square brackets for further discussion. It has been proposed that this be moved to module 2;

.2 paragraph 61 is in square brackets for further discussion (there was a proposal to delete 'defined as more than 60 hours per week' from this paragraph, however another proposal indicated that this be retained);

.3 two observers expressed concern that module 1 is too long and consider it could benefit from further refinement.

.3 Module 2:

.1 second sentence of paragraph 1 is in square brackets for further discussion. Following many comments from members of the correspondence group this sentence was modified. However, two observers suggested that this text should be deleted. Noting consensus was not evident it remains in square brackets;

.2 paragraph 2 is in square brackets for further consideration. Two observers indicated this text should be redrafted believing it is redundant and not aligned with the principles of the guideline, however consensus was not evident and hence it remains in square brackets;

.3 the last two sentences of paragraph 14 are in square brackets for further consideration. Two observers indicated this text should be deleted believing it is not appropriate, however consensus was not evident and hence it remains in square brackets;

.4 paragraph 19 is in square brackets for further consideration. A member indicated that this requires further review as it is not aligned to the ISM Code (section 1.2.2) and Maritime Labour Convention (MLC, 2006) (regulation 4.3.1). As consensus was not evident this is in square brackets;

.5 paragraph 27 is in square brackets for further consideration. Three observers indicated that this could have implications on how they manage fatigue. As consensus was not evident it is in square brackets;

.6 paragraphs 44 is in square brackets for further consideration pending a decision on module 4 as per paragraph 13.5 below;

.7 paragraph 48.6 is in square brackets for further consideration. Two observers indicated that this should be deleted as it is considered not appropriate to include in the guideline. As consensus was not evident it remains in square brackets;

.8 text in the last sentence of paragraph 49.1 is in square brackets for further consideration. Two observers indicated that this is too prescriptive and should be deleted. As consensus was not evident it remains in square brackets;

.9 paragraph 52 is in square brackets for further consideration pending a decision on whether references to MLC, 2006 should be included in the guideline as highlighted in paragraph 13.9 below;

.10 text in the last sentence of paragraph 57 is in square brackets for further consideration. Some members indicated that this should be deleted as there is concern that this sentence appears confusing;

.11 paragraph 59.2 is in square brackets for consideration. A member indicated that this requires further review as it does not appropriately convey the issue of long working hours. As consensus was not evident it remains in square brackets;

.12 text in the middle of paragraph 59.5 is in square brackets for further consideration. Two observers indicated that this text should be deleted as reference to specific length of sleep periods is too prescriptive and conflicts with the requirements in relevant

instruments. The text was redrafted and aligned with HTW 3/8/1 following many comments. As consensus for deletion was not evident it remains in square brackets;

.13 paragraph 59.8 is in square brackets for consideration. Some members indicated that due to the practicalities of applying this within the maritime industry this paragraph should be given further consideration;

.14 paragraph 62 is in square brackets for further consideration. Two observers indicated that this should be deleted from the main text and/or moved to the appendix were the example tools are located. In reviewing this whole paragraph the consensus was to delete the sub points (62.1 – 62.3) which were subsequently deleted. However, as consensus for deletion of the main paragraph (62) was not evident it remains in square brackets;

.15 paragraph 66.3 is in square brackets for further consideration. Two observers indicated that the language in this text does not align with the relevant convention and should be deleted. There were considerable changes made to this paragraph during the review process, hence as consensus for deletion is not evident this remains in square brackets;

.16 paragraph 69 is in square brackets for further consideration pending a decision on whether references to MLC, 2006 should be included in the guideline as highlighted in paragraph 13.9 below;

.17 last sentence of paragraph 72 is in square brackets for further consideration. Some members expressed concern with this text indicating it should be deleted. However, considerable changes were made to this text during the review process, which were affected. Hence, consensus for deletion is not evident and is in square brackets;

.18 paragraph 77 (including sub-title) as below is in square brackets for further consideration. Following a review of this paragraph there was split feedback on whether this should be deleted or retained, hence is in square brackets;

.19 paragraph 82 as below is in square brackets for further consideration. Following a review of this paragraph there was split feedback on whether this should be deleted or retained, hence is in square brackets;

.4 Module 3:

.1 paragraphs 3, 4, 5, 9 and 6 are in square brackets for further discussion. This needs to be read in conjunction with module 1 section "Important basic concepts in understanding fatigue", to ensure the language is not repetitive and terminology is consistent;

.2 paragraph 8.2 is in square brackets for further discussion. Two observers contend that the risk of fatigue can be high or low with or without short breaks and propose deletion of this paragraph. Consensus for deletion is not evident and the text is in square brackets noting that research supports the beneficial effects of short breaks on fatigue;

.3 part of last sentence of paragraph 45 is in square brackets for further discussion. Two observers indicated that this text is aimed at the responsibilities of seafarers and proposed modification or deletion. Consensus for deletion is not evident and it is in square brackets for further consideration;

.4 last sentence of paragraph 56 is in square brackets for further discussion. Following many comments from members of the correspondence group this sentence was modified. However, two observers indicated that this text should be deleted. Noting consensus was not evident it is in square brackets;

.5 paragraphs 58.6 and 58.7 are in square brackets for further review and discussion as proposed by some members. Any changes must be viewed in context with the rest of paragraph 58;

.6 first sentence of paragraph 59.2 is in square brackets for further discussion. Some concerns by members were raised that this could be misinterpreted and is in square brackets for further consideration;

.7 paragraph 61 ibis added in square brackets for consideration as a replacement for 61 above it;

.8 paragraphs 65 and 66 are in square brackets for further review and consideration. Although most members indicated the content to be acceptable, it was considered that the paragraphs require further drafting to improve clarity and grammar;

.9 two observers indicated that paragraph 61 in module 2 on sleep inertia should also be added to module 3;

.10 the reference section is in square brackets for further consideration and agreement.

.5 Module 4:

.1 there were significant discussions and concern regarding some content in module 4. This is yet to be resolved. Some members indicated that the original text in MSC/Circ.1014, Module 5 – *"Fatigue and the training institution and management personnel in charge of training"* provides a better alternative as it directly relates to training institutions. However, other members indicated that module 4 aims to guide content on fatigue awareness and training and should be retained. Module 4 is in square brackets for further discussion, and possible development at HTW4. In deciding the most appropriate way forward for module 4, the Sub-Committee should consider the comments in paragraph 11.5 above.

.6 Module 5:

.1 paragraphs 16 and 17 are in square brackets for further consideration. It is noted that these require further editing to improve clarity;

.2 paragraph 18.6*bis* added and placed in square brackets for further consideration. Both should be considered and a decision made on which is best;

.3 paragraphs 25 and 26 are in square brackets for further consideration, pending confirmation that this information is from the most recent standards;

.4 paragraphs 38 and 39 are in square brackets for further consideration. Consensus was not reached on whether references to the MLC, 2006 should be deleted or retained in the guideline as per 13.9 below;

.5 the United States will propose an amended table for inclusion in this module. This will be presented at HTW4;

.6 further direction is required from the IMO Secretariat on practices of the Organization for the inclusion of lists of guidance documents and standards.

.7 Module 6:

.1 paragraph 1 (last part of 2nd sentence); paragraph 1.1 – 4th sentence; paragraphs 2.4*bis*; paragraph 2.6*bis* (last two paragraphs) are suggested additions to the base document and included in square brackets for further discussion and consideration;

.2 as per other modules, any reference to MLC, 2006 (paragraph 1.1 – 5th and 6th dot points) are in square brackets for further discussion as consensus was not reached as per 13.9 below;

.3 the correspondence group ran out of time and hence module 6 has not benefited from the same level of consideration as other modules. Further inputs and detailed consideration is required to finalize module 6.

.4 due to the limited time available the aspect of whether 'other stakeholders' should be included as part of the guidelines was not considered. Hence, interested member States and observer organisations are encouraged to submit further inputs related to "other stakeholders" for consideration.

.8 Appendices:

.1 as indicated in paragraph 11.8 some members felt the content of the Appendices needed more discussion than was possible in the time available. Hence all the appendices are in square brackets;

.2 interested member States and observer organizations are encouraged to submit further inputs related to the appendices for consideration;

.3 it is recommended that the appendices be reviewed following completion of all modules.

.9 General Considerations for all modules:

.1 consensus is required on whether references to the MLC, 2006 should be deleted or retained;

.2 references in each of the modules have been reviewed for relevance, however the need to have references at all has been questioned. Consensus on the inclusion of references was not reached and needs to be considered;

.3 the correspondence group proposes that the same paragraph numbering is retained until the review process is complete. The Secretariat can then review and update paragraph numbering accordingly.

14 The correspondence group has provided the Sub-Committee with information in this document relating to areas where the group was able to reach consensus in revising the guidelines, and highlighting in paragraph 13 above, further actions and decisions that need to be taken by the Sub-Committee when revising the aforementioned guidelines.

Action requested of the Sub-Committee

15 The HTW Sub-Committee is invited to consider the information above and decide, as appropriate.

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ANNEX

GUIDANCE ON FATIGUE MITIGATION AND MANAGEMENT
(MSC/Circ.1014)

(Note: only the text revised by the working group is reproduced)

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

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

3 Member Governments are invited to:

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

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

.3 take the guidelines into consideration when determining minimum safe manning levels for ships flying their country's flag.

[.3 bis take the guidelines into consideration when developing or implementing IMO instruments in national laws and regulations to mitigate their potential impact on seafarer fatigue].

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

GUIDELINES ON FATIGUE

Introduction

1 Fatigue is a ~~major human element~~ hazard because it may affect~~s most aspects of~~ a seafarer's ability to do their job effectively and safely. Importantly, fatigue affects everyone regardless of skill, knowledge and training. The effects of fatigue ~~are~~ can be particularly dangerous in the transportation sector, including the shipping industry. ~~The technical and specialized nature of this industry requires constant alertness and intense concentration from its workers~~. All stakeholders should be alert to the factors which may contribute to fatigue, and take them into account in efforts to mitigate and manage the risks posed by fatigue.

2 [~~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, and/or loss of sleep. The result of fatigue is impaired performance and diminished alertness.~~]

3 The special nature of working and living at sea can contribute to fatigue. The maritime industry operates a variety of work schedules, types of work, locations, and demographics and does so in a wide range of operational environments which vary from ship to ship ~~that may affect fatigue.~~ Any of these ~~Fatigue is caused by a~~ range of factors may cause fatigue but is primarily affected by lack of sleep ~~(i.e. inadequate restorative sleep)~~, poor quality of sleep and rest, work/sleep at inappropriate times of the body clock ~~(circadian cycle)~~, staying awake for very long periods, stress and workload (prolonged mental and/or physical exertion)~~inadequate sleep, staying awake for very long periods, prolonged mental or physical work, and work/sleep at inappropriate times of the body clock (circadian cycle)~~. In the maritime industry where operations continue 24 hours per day ~~24-hour continuous operations such as the maritime industry~~ these are common factors that may contribute to fatigue. ~~general~~ As a result, ~~awareness, identification and~~ the mitigation and management of fatigue, including the awareness and identification of fatigue related risks ~~is~~ are ~~a~~ significant priorities ~~priority~~ for the maritime industry.

~~4 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.~~

5 ~~[Several studies have shown that seafarers in general may [1-4]~~:

~~.1 obtain one to three hours less sleep per day when on the ship compared to when at home;~~
~~.2 are be exposed to broken sleep patterns;~~
~~.3 are not always be provided with sufficient rest times when in port; and~~
~~.4 endure less than ideal environmental conditions in sleeping spaces.]~~

~~6 The maritime industry operates a variety of work schedules in a wide range of operational environments. From coastal operations through to remote blue waters, the work schedules, work type, location, demographics and work/rest environment vary from ship to ship.~~

7 Effectively addressing fatigue requires a comprehensive approach that recognizes the roles and responsibilities of all stakeholders in the mitigation and management of fatigue. There are many approaches and considerations that should be taken into account to address fatigue. ~~dealing with fatigue in the marine environment requires a holistic approach. There is no one system single approach to addressing fatigue, but there are certain principles factors (e.g. duty schedules, lifestyle habits, rest, medication, workload) that must should be addressed in order to gain the knowledge and the understanding understood in order for it to be managed effectively. this human element issue~~.

The aim of these guidelines is to provide that information for all stakeholders in a readily accessible format. ~~The tools and systems contained in this document can be tailored to suit a range of operations. The objective is to minimize the incidence and consequences of fatigue.~~

Objective

~~8 *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.*~~

9 The International Maritime Organization (IMO) has developed these guidelines to assist all stakeholders better understand their roles and responsibilities in mitigating and managing the risk of fatigue. ~~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".~~

~~[10 The philosophy behind the development of the guidance was not to develop new information but rather assemble and update what already exists, in a useful format, for transmission to those parties who have a direct impact on ship safety.]~~

11 ~~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 and the protection of the environment.~~ The ~~guidelines~~ guidance provides ~~contain~~ information on the ~~symptoms and~~ causes and consequences of fatigue, and ~~address solutions to combat control and manage~~ the risks it poses to the safety and health of seafarers, operational safety, security and protection of the marine environment. ~~of fatigue to improve the associated health problems and help prevent a fatigue related accident incidents from occurring.~~ It has been prepared to assist stakeholders to mitigate and manage the risk of fatigue, by structuring existing information in an easily understandable and useful format for all those parties who have a direct impact on ship safety

Organization

[12 ~~The~~ As shown in figure 1, the guidelines, as set out in this annex, are composed of separate Modules each devoted to an interested party. The modules are as follow:

1.	Module 1	Fatigue – Causes and Consequences
2.	Module 2	Fatigue and the ~~Rating~~ Company
3.	Module 3	Fatigue and the ~~Ship's Officer~~ Seafarer
~~4.~~	~~Module 4~~	~~Fatigue and the Master~~
~~5~~4.	Module 4 ~~5~~	Fatigue Awareness and ~~the~~ Training ~~Institution and Personnel in charge of Training~~
~~6.~~	~~Module 6~~	~~Shipboard Fatigue and the Owner/Operator/Manager~~
5 ~~7~~.	Module 5 ~~7~~	~~Shipboard~~ Fatigue and ~~the Naval Architect~~ Ship Design
6 ~~8~~.	Module 6 ~~8~~	Fatigue, ~~and~~ the ~~Maritime Pilot~~ Administration and Port State Authorities
~~9.~~	~~Module 9~~	~~Fatigue and Tugboat Personnel~~
7 ~~6.~~	Appendix	Fatigue Management ~~related documentation~~ Tools

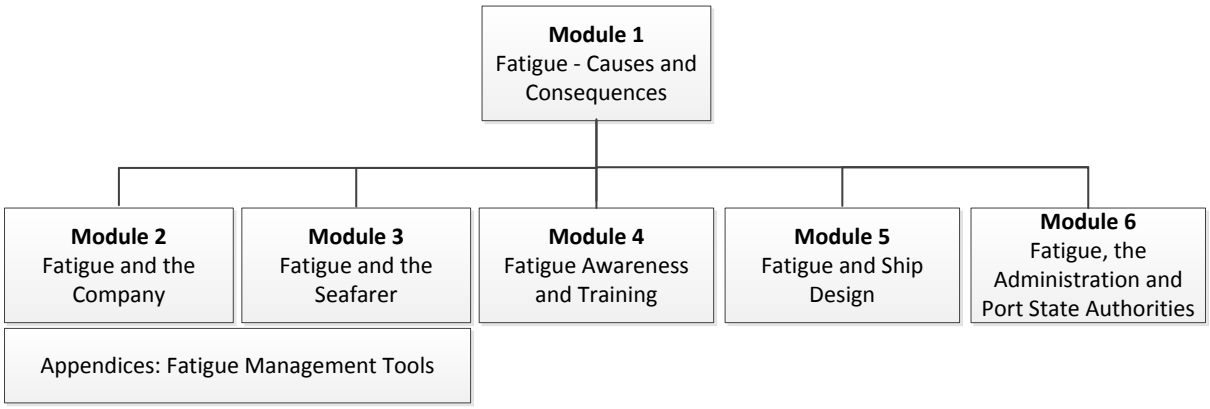

Figure 1: Organization of the Guidelines on Fatigue]

How to use these modules

13 Although all Modules are self-contained there are connections between some modules.– iIt is recommended that all parties become familiar with Module 1, which contains general information on fatigue. In other instances it will be beneficial if the reader (interested party) becomes familiar with modules other than the immediately applicable one.

14 This guidance should be taken into consideration when: ~~It is strongly suggested that maximum benefit will be derived from the integration of this material into:~~

.1 Developing, implementing and maintaining s~~S~~afety management systems under the ISM Code;

.2 Promoting fatigue mitigation and–management; ~~Corporate management systems, such as medical, human resources, etc.;~~

.3 Promoting awareness of the causes and consequences of fatigue and developing and delivering training programmes and courses; ~~Training courses, particularly management oriented and those required by the STCW Code courses;~~

.4 Conducting casualty or a~~A~~ccident/incident investigations ~~processes and methodologies~~; and

.5 Preparing applications for minimum safe manning documents or when determining minimum safe manning levels for ships. ~~Manning determinations, when considered in conjunction with the manning requirements (IMO resolution A.1047(27) *Principles of Minimum Safe Manning* and the ISM Code 6.2.2).~~

~~**Future work**~~

~~15 These guidelines are a living document;. Tthey 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 mModules – allows for the creation of new mModules directed to other interested parties.~~

Definitions

Acute fatigue: Insufficient sleep accrued within a single 24 hour period.

[Administration: The Government of the Party whose flag the ship is entitled to fly.]

Body clock: Also referred to as the biological clock. It regulates precise timing of body functions including daily cycles of alertness and sleepiness, body temperature, hormone levels and digestion. ~~The body clock sustains circadian rhythm.~~

Chronic fatigue: Sleepiness and performance impairment that accumulates when sleep is restricted day after day.

Circadian rhythm (*circa* = around; *dian* = day)**:** The body's natural rhythms that are repeated approximately every 24 hours, responding primarily to light and dark in a person's environment.

Company: The Owner of the ship or any other organization or person such as the Manager, or the bareboat Charterer, who has assumed the responsibility for operation of the ship from the Shipowner and who, on assuming such responsibility, has agreed to take over all duties and responsibilities imposed on the company by regulation. (Section I/1.25 of the STCW Convention; Section 1.1.2 of ISM Code)

~~**Duty** **Work:** Any tasks that shipboard personnel are required to perform, including but not limited to routine and emergency shipboard duties, watchkeeping, drills, maintenance, training, administrative work, bunkering, mooring, hold cleaning, tank washing, cargo work, loading and unloading.

~~**Duty h****Hours of work**: Time during which seafarers are required to do work on account of the ship. ~~The number of hours on duty which starts when personnel report for or commence a duty and ends when they are free from all duties.~~

Ergonomics/Human Factors: 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 optimize human well-being and overall system performance.

Fatigue: A state of physical and/or mental performance impairment, resulting from factors such as inadequate sleep, extended wakefulness, circadian phase and physical, mental or emotional exertion that can impair alertness and the ability to safely operate a ship or perform safety-related duties.

[Fatigue Risk Management: A risk based approach which enables ~~the management of~~ fatigue to be addressed in a manner appropriate to the level of risk exposure and the nature of operations in order to prevent and minimize the adverse effects of fatigue on individual health and safety of operations.]

[the process of identifying, analyzing, and communicating fatigue-related risk and then mitigating and managing it to an acceptable level in order to minimize the adverse effects of fatigue on individual health and safety of operations.]

Jetlag: A temporary sleep disorder~~. It~~ that occurs when the body's internal clock is out of sync with cues from a new time zone. ~~Cues can include light exposure and eating times. Fatigue and difficulty concentrating are symptoms.~~

[Management level seafarers: (STCW definition preferred)] [Seafarers with authority to assign, schedule or monitor work]

[Operational Safety:]

[Port State Authorities: means government commissions and/or official organizations that controls and manages the activities in a port and includes PSC, customs, immigration, law enforcement agencies and port/harbour authorities.]

[Recognised Organisation (RO):]

Recovery sleep: Sleep required for recovery from the effects of cumulative sleep debt (over multiple consecutive 24-hour periods). ~~Sleep debt is not recovered hour-for-hour. Two nights of unrestricted sleep is typically required for recovery of normal sleep function.~~

Hours of ~~R~~rest ~~period~~: Time outside of work; this term does not include short breaks. ~~A continuous and defined period of time, subsequent to and/or prior to duty, during which personnel are free of all duties.~~

[**Resources**: A stock or supply of money, materials, personnel, and other assets that can be drawn on by a person or organization in order to function effectively.]

Riders: Individuals or squads of workers - not seafarers- brought on board as additional labor.

[**Ship designer:** A group of people responsible for the design, layout, and construction of the vessel.]

Sleep debt: Insufficient (or disrupted) accumulated sleep over multiple consecutive 24-hour periods.

Sleep Inertia: A period of grogginess, disorientation, and/or slowed performance that may occur after awakening from sleep or naps. ~~A short-lived feeling of lethargy immediately following awakening from a sleep period. Sleep inertia can occur coming out of lighter sleep (nap), but it tends to be longer and more disorienting when someone is woken abruptly out of slow-wave sleep (deeper sleep).~~

[Sleep Monitoring:]

Sleep quality: Capacity of sleep to restore waking function.

Travel/travel time: Time that cannot be considered rest.]

Guidelines on Fatigue
Module 1

FATIGUE

Foreword

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

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

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

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

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

MODULE 1

FATIGUE – CAUSES AND CONSEQUENCES

Introduction

1 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, A recent aAccident data and research point to fatigue as a cause of and/or contributor to human error precisely because of its impact on performance. Human error resulting from fatigue is now widely perceived as the cause of numerous marine casualties, including one of the the worst maritime environmental disasters in the last century, the Exxon Valdez.

2 The negative effects of fFatigue presents is a hazard that affects safety, health and well-being. This presents a disastrousconsiderable risk to, the safety, and health of human life, security, damage to the environment, and property, health, security and protection of the marine environment. Because shipping is a very technical and specialized industry, these negative effects are exponentially increased, thereby requiring seafarers' constant alertness and intense concentration.

3 Due to the human, environmental and economic costs associated with fatigue-related incidents, it is the obligation of all stakeholders (seafarers, company, ship designers and administrations) to systematically and effectively manage fatigue-related risk.

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

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

Defining fatigue

6 There is no universally accepted technical definition for fatigue. However, common to all the definitions is degradation of in human performance. For the purposes of these guidelines, Tthe following definition can be is used: is found in IMO's MSC/Circ.813/MEPC/Circ.330, List of Human Element Common terms:

.1 "A Fatigue is a reduction in state of physical and/or mental capability performance impairment, as the resulting of from factors such as inadequate sleep, extended wakefulness, disturbances to the body clock, circadian phase and physical, mental or emotional exertion which may that can impair alertness and the ability to safely operate a ship or perform work safety-related duties." impair nearly all physical abilities including: strength; speed; reaction time; coordination; decision making; or balance."

Fatigue and life on a ~~seagoing~~ ship

7 Fatigue is a problem for all 24-hour a day transportation modes and industries, the marine maritime industry included. However, operational aspects associated with the maritime industry are also more complex than those associated with other industries. For example, variety of ship-types,

the pattern and length of sea passage, the number of port visits and port-rotations, and the length of time a ship remains in port, all present unique combinations of potential causes of fatigue.

8 ~~Maritime casualties have clearly demonstrated the consequences of sailing with crews suffering from fatigue [8].~~ The ~~increasingly intensive and~~ demanding nature of shipping means that seafarers may be required to work long and irregular hours ~~in less than ideal conditions~~. Seafaring is unique in that the ship is both seafarers' work and home for their time at sea. ~~It is important to recognize that Principle among these is that It must be recognized that the seafarer is a captive of the work environment. However, t~~There are ~~also~~ unique aspects of seafaring that separate the marine industry from the others. As a result:

9

- ~~Firstly,~~ ~~the average~~ a seafarer may spend~~s~~ an extended period of time ~~an average of between three to six months~~ working and living away from home, on a moving ~~vessel~~ ship that is subject to unpredictable environmental factors (i.e. changing weather conditions).
- the ship is both a seafarer's workplace and home whilst at sea.
- ~~Secondly,~~ while serving on board the vessel, there is no clear separation between on work and off duty/work and rest ~~work and recreation~~. ~~Thirdly, today's crews is composed are comprised of seafarers from various nationalities and backgrounds who are expected to work and live together for long periods of time. The operational aspects associated with shipping become are also more complex than those associated compared with standard other industries. Ffor reasons such as example, variety of ship-types, pattern the pattern and length of sea passage, the number of port visits and port-rotations, and the length of time a ship remains in port. All these aspects, all present a unique combinations of potential causes of fatigue.~~

10 ~~[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 crew numbers~~. ~~However, t~~Technology ~~generally does not reduce work but merely~~ changes the nature of work and alters workload, therefore it is important to evaluate the impact of technological changes on crew workload and consequently fatigue. ~~Unfortunately, implementation or changes often occur with very little evaluation or regard to the impact on the socio-technical system or the seafarers themselves. Technological developments, for example have resulted in quick turn-around times with most ships spending less than 24 hours in port and pressure to reduce this further. This means that "time in port" which used to last for a few days or more and was traditionally used by crew as recovery time is now no longer available. In many cases crew are expected to unload/load a vessel, prepare the vessel to sail and then sail within a very short time frame. The literature suggests that fatigue levels are usually worse on departure than on arrival with most shipboard crew having to sail the vessel irrespective of whether they have had adequate rest [5-7]. Maritime casualties have clearly demonstrated the consequences of sailing with crews suffering from fatigue [8].]~~

11 ~~There are also certain cultural obstacles that need to be addressed. Most commonly, seafarers are willing to work whilst highly fatigued because it is seen as 'professional' to do so.~~ The misconception ~~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 f~~Fatigue ~~a~~is a hazard ~~problem and to take appropriate action~~ and needs to be addressed ~~[5, 9].~~

~~12 Hence, an understanding of both the causes and consequences of fatigue as highlighted in this module should enable the relevant stakeholders company, seafarers, maritime training institutes, administrations and ship designers and naval architects to design and i more effective systems to manage fatigue-related risks.~~

Important basic concepts in understanding fatigue

27 The most significant aspects of fatigue are:

.1 adequate sleep (not just rest) for restoring and maintaining all aspects of waking functions (both quantity and quality);
.2 ~~circadian rhythms and the~~ body clock;
.3 increasing hours of wakefulness on the need and pressure for sleep;
.4 influence of stress on fatigue;
.5 workload (physical and mental task related factors) on the speed of onset of fatigue; and
.6 lifestyle aspects in increasing the risks of fatigue.

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

A. Sleep

29 Repair, restoration and maintenance of physical and mental functions are undertaken during sleep. Sleep is a critical need for our daily functioning that cannot be dismissed.

30 ~~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~~ tTo satisfy the needs of the human body, sleep must have three characteristics ~~to be most effective~~:

a. ~~Duration~~ Quantity;
b. Quality; and
c. Continuity.

.1 Quantity: ~~Everyone's sleep needs are unique; however,~~ iIt is generally recommended that a person obtain, on average, 7 to 8 hours of good quality sleep per 24-hour period ~~day night~~ to perform adequately and effectively [~~15~~]. However, individual sleep needs are unique and may vary over time~~. Any less than this and the effects on alertness, performance and vigilance can be detrimental, particularly if sustained for several days~~. 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~~ ~~leads to sleep debt and~~ will impair alertness ~~[16].~~ Insufficient sleep over several consecutive days leads to sleep debt. Only sleep can maintain or restore performance levels.

.2 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 ~~night~~ and only obtains six hours, they have accumulated a sleep debt. ~~are deprived of two hours of sleep. If this occurs over four consecutive nights, the sleep loss per night would accumulate into an eight hour sleep debt [17, 18]. Sleep debt is of significant concern within the maritime industry. Seafarers are exposed to long and irregular duty schedules, extended work durations, night work and are required to sleep away from home sometimes in an environment not conducive to sleep. Some may receive inadequate sleep night after night, possibly for weeks or even months [1, 4]. This~~ Sleep debt ~~will~~ may affect the individual's level of alertness and performance ~~[16, 19-21]~~. Long term, sleep debt can also lead to ~~chronic fatigue and~~ health problems. ~~A particularly dangerous aspect of fatigue is that as time goes on, chronically~~ Over time sleep-deprived individuals may become less aware of just how

fatigued they are and are unable to judge their own level of performance. Hence, obtaining sufficient recovery time following periods of sleep debt is important.

.3 ~~Research has clearly highlighted the issue of sleep debt through comparative analyses carried out between the 6on/6off two watch schedules and the 4on/8off three watch schedules. The findings showed that participants in the 6on/6off watch schedule had markedly less sleep and experienced higher levels of fatigue while on duty. In addition, participants showed a significant onset of fatigue in the 6 on/6 off watch patterns over a shorter timeframe~~ [~~22-25~~].

.4 **Quality:** Just being tired is not enough to ensure ~~a~~ good sleep. Sleep is a highly organized sequence of events that follows a regular pattern that cycles between light (referred to as Rapid Eye Movement) and deep (referred to as Non-Rapid Eye Movement) sleep. ~~cyclic program each night. It basically goes through two phases referred to as Non-Rapid Eye Movement (non-REM) and Rapid Eye Movement (REM) sleep.~~ Both are critical for ensuring restorative sleep and contribute to physical and mental restoration. ~~Non-REM sleep goes through stages of very light to deep sleep.~~ People need deep sleep. Deep sleep is a very restorative phase of sleep. ~~It is usually extremely hard to be awakened by external stimuli during deep sleep.~~ [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][Shift to Module 2] [~~26~~].

.5 ~~REM sleep is the phase of sleep where dreams happen. During REM sleep the eyes move under the closed eyelids which is often accompanied by muscle twitches and irregular heart rate and breathing. Most adults normally spend about a quarter of their sleep time in REM sleep.~~

.6 ~~Both non-REM and REM sleep are important not only for mental restoration but also contribute to physical restoration. Non-REM sleep is particularly important for the consolidation of some types of memory and learning. REM sleep is important for learning (because memory consolidation occurs) and mental health~~ [26].

.7 **Continuity:** Sleep quality (and its restorative value) depends on an individual going through unbroken cycles of ~~non-REM and REM~~ sleep. The sleep should be uninterrupted. ~~Six one-hour naps do not have the same benefit as one six-hour period of sleep.~~ Six one-hour naps do not have the same benefit as one six-hour period of sleep. The more ~~the non-REM/REM cycle~~ sleep is fragmented by waking or as a result of restricted sleep, the less restorative value sleep has in terms of how an individual feels and functions the next day. An individual must begin sleep in synch~~s~~ with the body clock to ensure quality sleep. If the time of sleep is out of synchronization with his/her body clock, it is difficult to sleep properly. ~~To note~~ It should be noted ~~is~~ that the proportion of time spent in deep sleep decreases as we get older~~, particularly amongst men~~. Sleep generally also becomes more fragmented as we get older ~~[27]~~.

31 Many factors contribute to sleep disruption and poor sleep quality, some are within ~~our~~ the control of the seafarer while others are not. The risk of being awakened is especially high during the early stages of sleep. This can potentially lead to a situation in which individuals~~:~~ may never reach the important deep sleep stage. Aspects that may disturb sleep include:

.1 environmental factors (constant/irregular noise and vibration, ventilation / air exchange, temperature, humidity, lighting and ship motion ~~e.g. ship's violent movement~~ motion, weather, ~~heavy vibration, noise or poor accommodation);~~
.2 food;
.3 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. ~~one~~ insomnia–prolonged inability to obtain adequate sleep, sleep apnea; and
.6~~5~~ operational factors (e.g. disruptions caused by drills, loading and unloading).

B. Body~~iological~~ Clock and the Circadian Rhythm

32 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.

33 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~~ synchronized to the traditional pattern of daytime wakefulness and night-time sleep.

34 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. Generally, each person's cycle has two distinct peaks and dips. These are independent of other sleep-related factors that cause sleepiness, with two times of low alertness (low-points or dips) in each 24-hour period. These commonly occur between 0200 and 0500 hours (Circadian Low) and 1500 to 1700 hours (post lunch dip) for people on a normal daytime work schedule. These low alertness periods alternate with periods of maximum alertness.

~~35 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).~~

~~36 Seafarers, particularly those who are working during the hours of midnight (0000) are more likely to have been up and working for longer than those who work later in the morning (i.e. at 0400 hours or later). This indicates that from a maritime perspective high risk times may fall between 0000 and 0500 hours. In general, seafarers working through the night can be expected to be sleepy and have to make additional effort to maintain alertness and performance. This is supported by maritime studies in which Evidence indicates that fatigue was an issue a factor in collisions and groundings that mainly occurred between 0000 and 0600 hours [28-31].~~

~~37 Apart from the WOCL, another distinct dip occurs between 1500 and 1700 (best known as the post lunch dip). 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. PrecedingProceeding these lowest alertness periods (WOCL and post lunch dip), are maximum alertness periods (peaks).~~

38 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 ~~[1, 2]~~. ~~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 ~~[32]~~. 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 ~~[33]~~.

39 The ~~states of~~ sleep/wake pattern ~~fulness~~ and circadian rhythms can interact in several ways.

- The two can work against one another and thereby weaken or negate each other's effect. For example, a well-rested person is still affected by a circadian low-point; conversely, a person who is sleep deprived may feel a momentary increase in alertness due to a peak in circadian rhythm.
- The two can also work in the same direction, thereby intensifying the effect they each have on a person's level of alertness. For example, when someone is sleep deprived, a ~~the drive for sleep during the~~ circadian low point will further exacerbate the feeling of sleepiness. ~~In addition, sleep during the daytime is difficult due to the drive for wake. 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.~~

40 Further, the ~~internal~~ body 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 body ~~internal~~ clock wakes a person up when they need to sleep and makes them sleepy ~~puts them to sleep~~ when they need to be awake.

41 Even though the body clock can be reset over time, ~~such as when changing time zones for an extended period,~~ research shows that it cannot be permanently adjusted to a reversed cycle of work and sleep. ~~even if external events remain the same, such as occurs on ships~~ [34-36]. ~~The fact that~~ Because the body clock does not adapt fully to altered sleep/wake patterns has ~~three main~~ the following consequences:

~~.1 duty times that overlap with seafarers' usual sleep times (particularly night operations) tend to cause sleep restriction and potentially a sleep debt;~~

.2 seafarers who work through the night can be expected to be sleepy and have to make additional effort to maintain alertness and performance; and

.3 some seafarers ~~crew~~ may be fatigued at the start of their ~~duty~~ work period, as they adapt to their sleep routine ~~and towards the end, as the effects of insufficient recovery from fatigue induced by working duty times accumulate~~.

The body clock is highly influenced by light exposure and its intensity. The effect of light on the body clock is dependent upon when, in the circadian cycle, light exposure occurs. The intensity of light also plays a major role. Bright light causes bigger shifts (delays and onset of sleep) in the body clock than dim light, and the clock is particularly sensitive to blue light (which promotes alertness). Exposure to bright light also has immediate and significant effects on improving alertness and mood. Conversely, limited exposure to bright light can negatively impact mood. This is similar to the effects on mood due to seasonal changes in the light-dark cycle. Although light is one of the most influencing factors in the body clock, in reality, staying in step with the day/night cycle is more complex than this. On ships, seafarers may have very haphazard exposure to light, depending on whether they are working during the day or during the night. This also depends on their exposure to natural light (whether working in the engine control room or on the bridge). As such the pattern of light/dark exposure should be balanced to optimize the effects on circadian timing and the immediate effects on alertness and mood.

C. Time Awake

42 How long an individual is awake affects sleepiness and consequently fatigue levels. The longer an individual has been awake, the poorer their performance [37-39]. In general, the longer an individual seafarer remains awake;

- the poorer their performance, the: ;
- stronger the drive for sleep, and the higher the levels of fatigue ;
- [16]. During the first hours awake, the urge to sleep may go unnoticed, but as the amount of continuous wakefulness approaches after being awake 16 hours, awareness of

- the pressure to for sleep increases is highly likely.

This occurs sooner if the seafarer person is already suffering from sleep debt.

43 Alertness and performance levels begin to decrease after a certain number of hours awake, with long duty periods (12 hours or more) associated with higher levels of fatigue than shorter duty periods (8 hours or less) due to extended wakefulness and demands on attention [40, 41]. The risk of an accident in the12th hour of work is more than double the risk of an accident in the 8th hour of work [41, 42]. In addition, the longer an individual has continuously been on a task without a break the more likely they will be fatigued. For every continuous hour worked beyond eight or nine (continuous) hours without a break, the risk of an accident increases exponentially [43].

44 Many seafarers work more than 12 continuous hours or more per day and a working week of over 70 hours is common practice at sea [1, 4, 7]. This makes them particularly susceptible to fatigue. 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.

45 While the amount of wakefulness at sea prior to a dayshift may be typically short (between 30 minutes to 1 hour) during night-time work seafarers may have been awake for many consecutive hours prior to the start of a night duty, increasing the risk of fatigue.

46 Seafarers who work long hours will have reduced cognitive ability, less energy, and less ability to plan and prioritize. Thus, fatigue risk management should consider the effect of cumulative wakefulness, both prior to and throughout the duty period.

D. Jet lag

47 Jet lag occurs following long flights through several time zones. Seafarers crossing time zones to join their ship are exposed expose their circadian rhythms 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. Further, adaptation generally takes longer when more time zones are crossed. 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 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.

E. Workload

48 ~~Workload is an important factor which leads to the onset of fatigue.~~ 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, which ~~are both~~ may be present in a shipboard work environment, are ~~most~~ likely to induce ~~be~~ fatigue ~~inducing~~. 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 ~~are a concern~~. ~~Tasks with a very high mental workload result in fatigue due to excessive demands on attention. Fatigue resulting from workload becomes an increasing concern when combined with long periods of wakefulness and long duty hours.~~ 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. ~~The number of port calls also leads to high workload and needs to be taken into account because more port calls involves more berthing/unberthing; loading/unloading, which are both task intensive and safety critical and can accelerate the onset of fatigue.~~

.2 Low Workload: ~~In addition,~~ Monotonous tasks, ~~that have a very low mental workload,~~ 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. ~~Research indicates that performance consistently declines beyond two hours of conducting monitoring and vigilance tasks [44]. Furthermore, it is difficult to maintain performance at a safe level after four to five hours of continuous vigilance. 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.~~

F. Stress

49 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 personal situation. Stress can be caused by a number of ~~things~~ factors, including:

.1 Environmental factors ~~hardships~~ (constant/irregular noise, vibration, ~~exposure to high and low~~ temperatures, weather such as ice conditions, etc.)
~~.2 Weather (i.e. ice conditions)~~
.3 Personal situation ~~problems~~ (family problems, home sickness, isolation, etc.)
.4 ~~Broken~~ Inadequate restorative sleep
.5 broken/interrupted sleep/rest periods ~~rest~~
~~.5 Broken rest~~
.6 ~~Long~~ Excessive working hours
.7 Intense mental and/or physical workload
.8 On-board interpersonal relationships
.9 Job control

50 ~~All t~~These stressors, and others can impact the extent to which a seafarer is able to acquire sufficient sleep and consequently lead to fatigue ~~[23, 37, 45~~]. ~~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. This lifestyle imposes serious strain on seafarers and their families.~~ Loneliness, isolation, family conflict, and concern about family members provide enough stress to be considered risk factors. Families provide a source of intimacy, support, continuity, satisfaction, and pride. ~~Seafarers who leave their homes for extended periods of time miss out on these benefits.~~

51 Unlike shore based workers, ~~Furthermore,~~ seafarers ~~are unable to leave their work environment.~~ do not get the relief of being detached from work, which is also linked to fatigue. ~~with poor psychological detachment linked to fatigue. This is particularly challenging on a ship where crew are constantly reminded about work while off-duty and are expected to recover from their work environment.~~

G. Health

52 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 on sleep and therefore contribute to fatigue.

.1 Nutrition: ~~An unbalanced~~ A poor diet ~~that does not include fresh fruits and vegetables can adversely affect a seafarer's health and~~ 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 ~~can lead to~~ fatigue ~~and lack of concentration~~. 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~~, carrying oxygen to the brain. The increase in metabolism and blood flow~~ 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: People who work during the night and even those who work long hours tend to drink a lot of caffeinated beverages to get through the work period. Caffeine ~~occurs naturally in many plants including coffee beans, tea~~

~~leaves, and cocoa nuts. It is also~~ can be found in ~~an array of food products and~~ beverages such as ~~chocolate and~~ coffee, tea and soft ~~cola~~ 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 it ~~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~~, which is particularly bad when an individual, for example is experiencing seasickness~~.

.5 Alcohol: Alcohol is a central nervous system depressant. Alcohol can lead to increased sleepiness and reduced alertness, even after the alcohol is no longer detectable. This effect is commonly known as a hangover. There are also serious health consequences related to the long-term abuse of alcohol. These problems include alcoholism, cardiovascular disease, abnormalities in the absorption of food nutrients, chronic pancreatitis, liver disease, brain damage and cancer. ~~Sustained alcohol abuse is also associated with interpersonal, financial and employment problems. Many shipping companies have "zero alcohol tolerance"~~.

.6 Nicotine: Nicotine is highly addictive and the dangers to health are well documented. Smokers generally have more disturbed sleep, typically taking longer to fall asleep and experiencing more wake time during a sleep period. ~~Smoking cigarettes also increases the chances of heart and lung disease, gum disease, numerous cancers, poor circulation and dozens of other health problems. Smoking complicates a range of medical conditions, including asthma, tuberculosis and pneumonia. Most smokers are less fit than non-smokers.~~

.7 Drugs and Supplements: Drug effects vary ~~not only~~ from person to person, ~~they~~ and can also vary for ~~the same~~ an individual person depending on time of day, mood, tiredness, and the amount of food eaten. In addition, ~~there are other~~ a number of 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 job 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 n~~N~~utritional supplements, natural products, and energy drinks that can also ~~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~~ can interact with prescription or over-the-counter drugs to further affect performance. ~~It is important for seafarers to be aware of how drugs and supplements may affect their health and their sleep-wake cycles.~~ Individuals should ~~proactively~~ seek advice ~~and guidance~~ from their healthcare providers or guidance from product manufacturers ~~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. ~~Undiagnosed or untreated sleep disorders can cause sleepiness problems [46]. Sleep disorders pose a particular risk for seafarers, especially as maritime operations~~

~~already expose seafarers to restricted sleep. The most common sleep disorders are obstructive sleep apnoea, insomnia, narcolepsy, shiftwork related and restless legs syndrome.~~ Large numbers of individuals suffering from sleep disorders are unaware of and have not been diagnosed or treated for their disorder. Undiagnosed sleep disorders can pose an operational risk. The most common of these are:

- Obstructive sleep apnoea (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. Excessive daytime sleepiness is a major symptom of this condition.

- 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. ~~Primary~~ Long term insomnia is more common in women than men and tends to increase with age. Short-term ~~or transient~~ 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. ~~a circadian rhythm related sleep-wake disorder that is thought to affect up to 10% of shift workers.~~ There are numerous shift work schedules (permanent, intermittent, or rotating); consequently, the manifestations of this disorder are quite variable. ~~Symptoms include insomnia and/or excessive sleepiness associated with the shift work schedule. The condition is closely linked with the duty schedule, and symptoms typically resolve when the main sleep period is taken at conventional times (2100-0700). In comparison to shift workers without shift work disorder t~~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 ~~[47~~].

- 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 night-time sleep). A person with narcolepsy is likely to become drowsy or to fall asleep at inappropriate times and places. Daytime sleep attacks may occur without warning and may be irresistible. In addition, night-time sleep may also be fragmented. ~~Narcolepsy results in difficulty staying awake, and in extreme conditions, sleeping episodes can occur during periods of activity.~~

H. Individual differences

53 Individuals respond to fatigue differently and may become fatigued at different times, and to different degrees of severity, under the same circumstances. For example, night-time sleep may prove to be more challenging as people get older. There are also individual characteristics related to circadian rhythms. ~~For example as people get older, they generally have more difficulty with sleep. Even night-time sleep may prove to be more challenging as people get older. An aging bladder can also contribute to sleep disturbances as it causes people to wake up more often. This means that coping with night-time work becomes increasingly more difficult with age.~~

~~54 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. Morning people adapt better to early morning hours but will have difficulty coping with night work. Evening types cope more easily with evening and night shifts, and catch up by sleeping late in the morning.~~

Causes of fatigue

13 Fatigue is caused by a range of factors, ~~but is~~ primarily ~~affected~~ by [~~10~~]:

.1 fragmented/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 cycle)~~;
.4 staying awake for very long periods;
.5 stress; and
.6 ~~excessive~~ workload (prolonged mental and/or physical exertion).

~~14 The most common causes of fatigue known to seafarers are lack of sleep, poor quality of rest, stress and excessive workload~~. ~~There are many other contributors as well, and each will vary depending on the circumstance (i.e. operational, environmental, individual differences).~~

15 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:

.1 ~~Crew~~Seafarer~~s~~-specific f~~F~~actors
.2 Management f~~F~~actors (ashore and aboard ship)
.3 Ship-specific f~~F~~actors
.4 Environmental f~~F~~actors

A. Seafarer~~s~~ ~~*Crew-specific factors*~~

16 ~~The s~~Seafarer~~screw~~-specific factors are related to aspects that affect individual fatigue including lifestyle behavior, body clock, personal habits and individual attributes. ~~However,~~ The effects of ~~F~~fatigue vary~~ies~~ from one person to another and its effects are often dependent on the particular activity being performed.

~~17 The crew-specific factors are related to lifestyle behavior, personal habits and individual attributes. Fatigue varies from one person to another and its effects are often dependent on the particular activity being performed.~~

The seafarer~~sCrew~~-specific f~~F~~actors include ~~the following~~:

.1 Sleep and Rest
  a. ~~Quality,~~ Quantity and ~~Duration of~~ quality of ~~S~~sleep
  b. Sleep ~~D~~disorders/~~D~~disturbances
  c. ~~Rest~~ Recovery rest ~~B~~breaks

d. Shiftwork and work schedules
e. Body Clock variations (e.g. jet lag)

~~.2 Biological Body Clock/Circadian Rhythms~~

.3 Psychological and ~~E~~emotional ~~F~~factors~~, including stress~~
a. Fear
b. Monotony and ~~B~~boredom

.4 Health and well-being
a. Diet/Nutrition/Hydration
b. Exercise and fitness
c. Illness

.5 ~~Ingested chemicals~~ Medication and substance use
a. Alcohol
b. Drugs (prescription and non-prescription)
c. Supplements
d. Caffeine and other stimulants.

6 Stress
a. Skill, knowledge and training as it relates to the job
b. Personal problems
c. Interpersonal relationships.

~~7 Ingested chemicals~~

.8 Age

~~.9 Shiftwork and work schedules~~

.10 Workload (mental/physical)

~~.11 Jet Lag~~

Module 3 provides seafarer guidance for mitigating and managing risks associated with fatigue.

B. Management factors (ashore and aboard ship)

18 Management factors relate to how ships are managed and operated. Some ~~These~~ factors ~~can~~ may potentially cause stress, limiting the time available for sleep and rest and ~~an~~ increase~~d~~ workload, ~~ultimately~~ resulting in fatigue. These factors include:

.1 **Organizational ~~F~~factors**
- ~~Staffing~~ Crewing policies and r~~R~~etention
- Role of ~~[riders]~~ riders and shore personnel
- Administrative work ~~Paperwork/~~(reporting/inspections) ~~requirements~~
- Economics
- ~~Duty~~ Work schedules-shift, overtime, breaks
- Company procedures ~~culture and management style~~
- Company enforcement of procedures
- Resources which includes crewing levels and shore side support
- ~~Upkeep~~ Maintenance and repair of vessel
- Drills schedules and onboard ~~T~~training ~~and selection~~ of crew
- Nature of duties/workload while in port and at sea

.2 **Voyage and scheduling factors**
- Frequency and duration of port calls
- Time between ports

- Routing
- Weather and sea/port condition ~~on route~~
- Traffic density on route
- ~~Nature of duties/workload while in port and at sea~~

19 Module 2 provides ~~recommended strategies~~ guidance for ~~controlling and~~ mitigating and managing ~~fatigue~~ risks associated with fatigue due to management factors.

C. Ship-specific Factors

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

Ship Design

~~.1 Ship design –~~ Location, layout and comfort of work areas
~~.2~~ Location, layout and comfort in accommodation spaces
.3 Availability and accessibility of recreational facilities
.4 Ship motion
.5 Age of vessel
.6 Ease of inspection and maintenance
.7 Type and level of lighting

Equipment Design

.8 Level and complexity of automation
.9 Level of redundancy
.10 Equipment reliability
.11 Equipment usability
~~.12 inspection and maintenance~~
~~.13 Age of vessel~~
~~.14 Physical comfort, in work spaces~~
~~.15 Physical comfort of accommodation spaces~~
.16 Presentation of information

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

D Environmental Factors

22 ~~[Exposure to e~~Environmental factors ~~disturbances~~ within areas in which seafarers live and work (both inside and outside the ship) ~~can impact~~ may contribute to the onset of fatigue, and impact both sleep quantity and quality. ~~Exposure to excess levels of environmental factors, e.g. temperature, humidity, excessive noise levels, can cause or affect fatigue~~. Long-term exposure may ~~even~~ cause harm to ~~a person's~~ health. Environmental factors to consider include ~~excessive~~ constant/irregular noise and vibration, ~~inadequate~~ ventilation / air exchange, ~~excessive heat or cold~~, temperature, ~~too much or too little~~ humidity, ~~poor air exchange, poor~~ lighting and ~~excessive~~ ship motion. ~~Furthermore, considering that environmental factors may produce physical discomfort, they can also cause of contribute to the disruption of sleep.]~~

.1 **Noise** ~~Noise~~, whether high/ loud (main engines, switchboards), ~~or~~ low/soft (radio in another cabin, TV in lounge, conversations, etc.), or constant/irregular can affect the quantity and quality of sleep. Noise ~~can~~ may also affect the ability to fall asleep, causing sleep loss, or it can alter one's sleep stage or depth of sleep .

.2 **Vibration** affects sleep and fatigue~~.~~ since ~~For example, vibration~~ it may keep people awake, keep them from advancing to deeper sleep, or wake them up. ~~The risk of being woken up is especially high when people are in the early stages of sleep, because they can be easily awakened. This can potentially lead to a situation in which an individual's sleep will never reach the important deep sleep stage. Moreover, when noise or vibration disrupts the early deep sleep stages, it has the same impact as loss of sleep, because people need to go through all stages of sleep before they can be fully restored~~ .

.3 **Light** (such as color, intensity, exposure timing, etc.) is a complex environmental factor that can ~~also~~ delay or advance the onset of sleep and hence impact fatigue. ~~levels~~. ~~The body clock is highly influenced by light exposure and its intensity~~. ~~The effect of light on the body clock is dependent upon when in the circadian cycle light exposure occurs. The intensity of light also plays a major role. Bright light causes bigger shifts (delays and onset of sleep) in the body clock than dim light, and the clock is particularly sensitive to blue light (which promotes alertness) [12].~~ ~~Exposure to bright light also has immediate and significant effects on improving alertness and mood. Conversely, limited exposure to bright light can negatively impact mood. This is similar to the effects on mood due to seasonal changes in the light-dark cycle. Although light is one of the most influencing factors in the body clock, in reality, staying in step with the day/night cycle is more complex than this. On ships, seafarers may have very haphazard exposure to light, depending on whether they are working during the day or during the night This also depends on their exposure to natural light (whether working in the engine control room or on the bridge. As such the pattern of light/dark exposure should be balanced to optimize the effects on circadian timing and the immediate effects on alertness and mood.~~

~~.4~~ In addition, the use of electronic displays ~~personal devices~~ ~~(such as laptops and smart phones)~~ ~~specifically ones~~ that emit blue light can also influence the body clock and can delay the onset of sleep, especially when used in the evening prior to bedtime ~~[13]~~.

.5 **Ship motions**: Depending upon the weather and sea conditions, ship motions~~, the vessel~~ may ~~be subject to ship motions which can~~ interfere with sleep~~.~~ ~~From a fatigue perspective, **ship motion** is associated with~~ and may cause motion-induced fatigue (extra energy expended to maintain balance while moving, especially during harsh sea conditions) and seasickness~~. Motion induced fatigue is related to the extra energy expended to maintain balance while moving, especially during harsh sea conditions [14].~~ ~~There is a direct relation between a ship's motion and a person's ability to work. This also means that the combined effect of workload in a moving environment accelerates the onset of fatigue. Seasickness, another negative consequence associated with ship motion is caused by a conflict between the eyes, perceiving that the person is stationary, and the body, feeling motion. Seasickness causes symptoms such as feelings of nausea, vomiting, dizziness, visual problems (including impaired night vision), and memory problems.~~

.6 **Temperature and humidity:** ~~Generally, one experiences high ambient temperatures as dry heat (temperature above 24° C, humidity less than 50%) or as humid heat (temperature above 24° C, humidity above 80%) can influence a seafarer's level of fatigue.~~ All excessively hot and even 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 eaffects sleep and alertness. For example, the body sleeps best when the environmental temperature is between 18 and 24°C.

.7 **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.

When noise or vibration prevents people from advancing to deeper sleep stages, it has the same impact as loss of sleep, because people need to go through all stages of sleep before they can be fully restored.

~~23 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.~~

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

~~25 There are a number of things that can be done to address these causes. Some contributors more manageable than others. Opportunities for implementing countermeasures vary and will be discussed further in subsequent modules. from one factor to another (noise can be better addressed during the vessel design stage (see Module 5), breaks can be addressed by the individual crew member (Module 3) or through company processes (Module 3), training and selection of the crew can be addressed during the hiring process, etc.).~~ Opportunities to mitigate and manage the risks associated with these factors vary and will be discussed further in subsequent modules.

~~26 Modules 2 – 96 provide a closer examination of the specific causes of fatigue and how each relates to specific industry groups.~~

~~Important basic concepts in understanding fatigue~~ [note para 27 to 55 moved after para 8 – same numbering preserved]

~~27 The most significant aspects of fatigue are:~~

~~.7 adequate sleep (not just rest) for restoring and maintaining all aspects of waking functions (both quantity and quality);~~
~~.8 circadian rhythms and the body clock;~~
~~.9 increasing hours of wakefulness on the need and pressure for sleep;~~
~~.10 influence of stress on fatigue;~~
~~.11 workload (physical and mental task related factors) on the speed of onset of fatigue; and~~

~~.12 lifestyle aspects in increasing the risks of fatigue.~~

~~28 This section highlights some of these the basic important concepts that provide an overall understanding about fatigue.~~

~~H. Sleep~~

~~29 Repair, restoration and maintenance of physical and mental functions are undertaken during sleep. Sleep is a critical need for our daily functioning that cannot be dismissed.~~

30 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:

d. Duration Quantity;
e. Quality; and
f. Continuity.

.1 **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 day night to perform adequately and effectively . However, individual sleep needs are unique and may vary over time. Any less than this and the effects on alertness, performance and vigilance can be detrimental, particularly if sustained for several days. 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 leads to sleep debt and will impair alertness . Only sleep can maintain or restore performance levels.

.2 Sleep debt is "insufficient accumulated sleep over multiple consecutive 24-hour periods". For example, if an individual needs eight hours of sleep per night and only obtains six hours, are deprived of two hours of sleep. If this occurs over four consecutive nights, the sleep loss per night would accumulate into an eight hour sleep debt . Sleep debt is of significant concern within the maritime industry. Seafarers are exposed to long and irregular duty schedules, extended work durations, night work and are required to sleep away from home sometimes in an environment not conducive to sleep. Some may receive inadequate sleep night after night, possibly for weeks or even months . This Sleep debt will affect the individual's level of alertness and performance . Long term, sleep debt can also lead to chronic fatigue and health problems. A particularly dangerous aspect of fatigue is that as time goes on, chronically sleep-deprived individuals become less aware of just how fatigued they are and are unable to judge their own level of performance.

.3 Research has clearly highlighted the issue of sleep debt through comparative analyses carried out between the 6on/6off two watch schedules and the 4on/8off three watch schedules. The findings showed that participants in the 6on/6off watch schedule had markedly less sleep and experienced higher levels of fatigue while on duty. In addition, participants showed a significant onset of fatigue in the 6 on/6 off watch patterns over a shorter timeframe .

.4 **Quality:** Just being tired is not enough to ensure a good sleep. Sleep is a highly organized sequence of events that follows a regular cyclic program each night. It basically goes through two phases referred to as Non-Rapid Eye Movement (non-REM) and Rapid Eye Movement (REM) sleep. Both are critical for ensuring restorative sleep and Non-REM sleep goes through stages of very light to deep sleep. People need deep sleep. Deep sleep is a very restorative phase of sleep. It is usually extremely hard to be awakened by external stimuli during deep sleep. [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.

.5 REM sleep is the phase of sleep where dreams happen. During REM sleep the eyes move under the closed eyelids which is often accompanied by muscle twitches and

irregular heart rate and breathing. Most adults normally spend about a quarter of their sleep time in REM sleep.

.6 Both non-REM and REM sleep are important not only for mental restoration but also contribute to physical restoration. Non-REM sleep is particularly important for the consolidation of some types of memory and learning. REM sleep is important for learning (because memory consolidation occurs) and mental health .

.7 **Continuity:** Sleep quality (and its restorative value) depends on an individual going through unbroken cycles of non-REM and REM sleep. The sleep should be uninterrupted. Six one-hour naps do not have the same benefit as one six-hour period of sleep. The more the non-REM/REM cycle is fragmented by waking or as a result of restricted sleep, the less restorative value sleep has in terms of how an individual feels and functions the next day. An individual must begin sleep in synch with the body clock to ensure quality sleep. 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 .

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

.1 environmental factors (noise and vibration, ventilation / air exchange, temperature, humidity, lighting and ship motion e.g. ship's violent movement motion, weather, heavy vibration, noise or poor accommodation);
.2 food;
.3 consumption of chemicals (e.g. alcohol intake, coffee, medication, etc.);
.4 psychological factors (e.g. stress, family worries, on-duty responsibilities); sleep disorders (e.g. one insomnia- prolonged inability to obtain adequate sleep, sleep apnea; and
.5 operational factors (e.g. disruptions caused by drills, loading and unloading).

I. Bodyiological Clock and the Circadian Rhythm

32 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.

33 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 synchronized to the traditional pattern of daytime wakefulness and night-time sleep.

34 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.

35 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).

36 Seafarers, particularly those who are working during the hours of midnight (0000) are more likely to have been up and working for longer than those who work later in the morning (i.e. at 0400 hours or later). This indicates that from a maritime perspective high risk times may fall between 0000 and 0500 hours. In general, seafarers working through the night can be expected to be sleepy and have to make additional effort to maintain alertness and performance. This is supported by maritime studies in which Evidence indicates that fatigue was an issue a factor in collisions and groundings that mainly occurred between 0000 and 0600 hours .

37 Apart from the WOCL, another distinct dip occurs between 1500 and 1700 (best known as the post lunch dip). 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. PrecedingProceeding these lowest alertness periods (WOCL and post lunch dip), are maximum alertness periods (peaks).

38 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 .

39 The states of sleep/wake pattern fulness and circadian rhythms can interact in several ways. 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 the drive for sleep during the circadian low point will further exacerbate the feeling of sleepiness. In addition, sleep during the daytime is difficult due to the drive for wake. 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.

40 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.

41 Even though the body clock can be reset over time, such as when changing time zones for an extended period, research shows that it cannot be permanently adjusted to a reversed cycle of work and sleep. even if external events remain the same, such as occurs on ships . The fact that body clock does not adapt fully to altered sleep/wake patterns has three main consequences:

.1 duty times that overlap with seafarers' usual sleep times (particularly night operations) tend to cause sleep restriction and potentially a sleep debt;
.2 seafarers who work through the night can be expected to be sleepy and have to make additional effort to maintain alertness and performance; and
.3 some crew may be fatigued at the start of their duty period, as they adapt to their sleep routine and towards the end, as the effects of insufficient recovery from fatigue induced by working duty times accumulate.

J. Time Awake

42 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 after being awake 16 hours, awareness of the pressure to sleep is highly likely. This occurs sooner if the seafarer is already suffering from sleep debt.

43 Alertness and performance levels begin to decrease after a certain number of hours awake, with long duty periods (12 hours or more) associated with higher levels of fatigue than shorter duty periods (8 hours or less) due to extended wakefulness and demands on attention . The risk of an accident in the12th hour of work is more than double the risk of an accident in the 8th hour of work . In addition, the longer an individual has continuously been on a task without a break the more likely they will be fatigued. For every continuous hour worked beyond eight or nine (continuous) hours, the risk of an accident increases exponentially .

44 Many seafarers work more than 12 continuous hours per day and a working week of over 70 hours is common practice at sea . This makes them particularly susceptible to fatigue. 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.

45 While the amount of wakefulness at sea prior to a dayshift may be typically short (between 30 minutes to 1 hour) during night-time work seafarers may have been awake for many consecutive hours prior to the start of a night duty, increasing the risk of fatigue.

46 Seafarers who work long hours will have reduced cognitive ability, less energy, and less ability to plan and prioritize. Thus, fatigue risk management should consider the effect of cumulative wakefulness, both prior to and throughout the duty period.

K. Jet lag

47 Jet lag occurs following long flights through several time zones. Seafarers crossing time zones to join their ship expose their circadian rhythms 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. Further, adaptation generally takes longer when more time zones are crossed. 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 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.

L. Workload

48 Workload is an important factor which leads to the onset of fatigue. 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, which are both present in a shipboard work environment, are most likely to be fatigue inducing.

.1 **High Workload**: Both high physical and mental workload are a concern. Tasks with a very high mental workload result in fatigue due to excessive demands on attention. Fatigue resulting from workload becomes an increasing concern when combined with long periods of wakefulness and long duty hours. Examples of high workload routinely experienced on board ships include (but are not limited to): navigating in congested and dangerous waters; 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. The number of port calls also leads to high workload and needs

to be taken into account because more port calls involves more berthing/unberthing; loading/unloading, which are both task intensive and safety critical and can accelerate the onset of fatigue.

.2 **Low Workload:** In addition, Monotonous tasks, that have a very low mental workload, 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 requied 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. Research indicates that performance consistently declines beyond two hours of conducting monitoring and vigilance tasks . Furthermore, it is difficult to maintain performance at a safe level after four to five hours of continuous vigilance. 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.

M. Stress

49 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 personal situation. Stress can be caused by a number of things factors, including:

.1 Environmental factors hardships (noise, vibration, exposure to high and low temperatures, etc.)
.2 Weather (i.e. ice conditions)
.3 Personal problems (family problems, home sickness, isolation, etc.)
.4 Broken Inadequate restorative sleep rest
.5 Broken rest
.6 Long working hours
.7 Intense mental and/or physical workload
.8 On-board interpersonal relationships
.9 Job control

50 All these stressors, 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. This lifestyle imposes serious strain on seafarers and their families. Loneliness, isolation, family conflict, and concern about family members provide enough stress to be considered risk factors. Families provide a source of intimacy, support, continuity, satisfaction, and pride. Seafarers who leave their homes for extended periods of time miss out on these benefits.

51 Unlike shore based workers, Furthermore, seafarers are unable to leave their work environment. do not get the relief of being detached from work, with poor psychological detachment linked to fatigue. This is particularly challenging on a ship where crew are constantly reminded about work while off-duty and are expected to recover from their work environment.

N. Health

52 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 on sleep and therefore contribute to fatigue.

.1 **Nutrition:** An unbalanced diet that does not include fresh fruits and vegetables can adversely affect a seafarer's health and contribute to fatigue 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 can lead to fatigue and lack of concentration. 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, carrying oxygen to the brain. The increase in metabolism and blood flow 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:** People who work during the night and even those who work long hours tend to drink a lot of caffeinated beverages to get through the work period. Caffeine occurs naturally in many plants including coffee beans, tea leaves, and cocoa nuts. It is also found in an array of food products and beverages such as chocolate and coffee, tea and soft cola 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, which is particularly bad when an individual, for example is experiencing seasickness.

.5 **Alcohol:** Alcohol is a central nervous system depressant. Alcohol can lead to increased sleepiness and reduced alertness, even after the alcohol is no longer detectable. This effect is commonly known as a hangover. There are also serious health consequences related to the long-term abuse of alcohol. These problems include alcoholism, cardiovascular disease, abnormalities in the absorption of food nutrients, chronic pancreatitis, liver disease, brain damage and cancer. Sustained

alcohol abuse is also associated with interpersonal, financial and employment problems. Many shipping companies have "zero alcohol tolerance".

.6 **Nicotine:** Nicotine is highly addictive and the dangers to health are well documented. Smokers generally have more disturbed sleep, typically taking longer to fall asleep and experiencing more wake time during a sleep period. Smoking cigarettes also increases the chances of heart and lung disease, gum disease, numerous cancers, poor circulation and dozens of other health problems. Smoking complicates a range of medical conditions, including asthma, tuberculosis and pneumonia. Most smokers are less fit than non-smokers.

.7 **Drugs and Supplements:** 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. It is important for seafarers to be aware of how drugs and supplements may affect their health and their sleep-wake cycles. Individuals should proactively seek advice and guidance from their healthcare providers or guidance 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. 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. The most common sleep disorders are obstructive sleep apnoea, insomnia, narcolepsy, shiftwork related and restless legs syndrome. Large numbers of individuals suffering from sleep disorders are unaware of and have not been diagnosed or treated for their disorder.

- Obstructive sleep apnoea (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. Excessive daytime sleepiness is a major symptom of this condition.

- 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. Primary insomnia is more common in women than men and tends to increase with age. Short-term or transient 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 a circadian rhythm related sleep-wake disorder that is thought to affect up to 10% of shift workers. Symptoms include insomnia and/or excessive sleepiness associated with the shift work schedule. The condition is closely linked with the duty schedule, and symptoms typically resolve when the main sleep period is taken at conventional times (2100-0700). In comparison to shift workers without shift work disorder 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 night-time sleep). A person with narcolepsy is likely to become drowsy or to fall asleep at inappropriate times and places. Daytime sleep attacks may occur without warning and may be irresistible. In addition, night-time sleep may also be fragmented. Narcolepsy results in difficulty staying awake, and in extreme conditions, sleeping episodes can occur during periods of activity.

H. Individual differences

53 Individuals respond to fatigue differently and may become fatigued at different times, and to different degrees of severity, under the same circumstancesFor example as people get older, they generally have more difficulty with sleep. Even night-time sleep may prove to be more challenging as people get older. An aging bladder can also contribute to sleep disturbances as it causes people to wake up more often. This means that coping with night-time work becomes increasingly more difficult with age.

54 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. Morning people adapt better to early morning hours but will have difficulty coping with night work. Evening types cope more easily with evening and night shifts, and catch up by sleeping late in the morning.

Effects of fatigue

55 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).

56 When a person's alertness is affected by fatigue, his or her performance on the job can may be significantly impaired. Impairment will may occur in every any aspect of human performance (physically, emotionally, and mentally), such as in decision-making, response time, judgment, and hand-eye coordination. and countless other skills [16, 20, 48, 49]. When impairment due to fatigue, such

~~as impaired memory or poor communication,~~ coincides with other operational risks ~~in the environment~~, incidents can result. This is evidenced in a number of maritime casualties in which fatigue was a contributory factor ~~[8, 50-53]~~. Maritime studies have also confirmed the association between fatigue and poor performance ~~[22, 24, 25, 54]~~.

57 ~~Fatigue is dangerous in that~~ ~~p~~People are poor judges of their level of fatigue, which can be potentially dangerous. The following is a sample of fatigue's known effect on performance. ~~Modules 2 - 9 contain a more extensive list for use by each individual industry group.~~

.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 f~~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 affect an individual's ability to respond to stimuli, perceive stimuli, interpret or understand stimuli, and it can take longer to react to them once they have been identified.

.4 Fatigue also affects problem-solving which is an integral part of handling new or novel tasks.

58 ~~Particularly dangerous situation at sea emanating from~~ ~~s~~Sleep debt may also cause ~~Micro-sleeps are~~ brief uncontrolled and spontaneous sleep episodes ~~whilst working~~, termed micro-sleeps, which can be a dangerous situation at sea. ~~As highlighted, t~~The pressure for sleep increases progressively across successive days of sleep debt ~~restriction~~. This is particularly more so if the individual is on duty during the circadian low. During a micro-sleep, the brain disengages from the environment (it stops processing visual information and sounds). ~~Research has clearly show that i~~Individuals working duty schedules that disrupt their body clock and are not getting adequate sleep are particularity at risk of micro-sleeps ~~[24, 25, 54]~~.

59 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 1.1: Fatigue signs and symptoms

Mental	
Symptom	**Signs**
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 simple and complex problems • Lapses of attention • Difficulty multitasking
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.~~ • 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 processes	• Responds slowly (if at all) to normal, abnormal or emergency situations
Physical	
Symptom	**Signs**
Involuntary need to sleep	• Slow eyelid closures • Droopy eyelids • Itchy eye • Involuntary sleep attacks • Nodding off • Inability to stay awake
Loss of control of bodily movements	• ~~Speech difficulties (it may be slurred, slowed or garbled)~~ • May appear to be drunk • Affected speech e.g. it may be slurred, slowed or garbled or hard to find the right words • Feeling of heaviness in the arms and legs • Clumsiness such as increased frequency of dropping objects like tools or parts • Difficulty with hand-eye coordination skills (such as, switch selection) • Tremor • ~~Clumsiness~~
Health Issues	• Headaches • Giddiness • Rapid breathing • Digestion problems • Leg pains or cramps • Insomnia • Sudden sweating fits • Heart palpitations / irregular heart beats
Behavioral	
Symptom	**Signs**
Mood change	• Quieter, less talkative than usual • Unusually irritable • Decreased tolerance and anti-social behaviour • Depression
Attitude change	• Less desire to socialize • ~~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 • Increasing omissions and carelessness. • Displays a "don't care" attitude

	• ~~Weakness in drive or dislike for work~~ • Loss of appetite (and sometimes an increase in unhealthy eating habits) • Low motivation ~~to perform optional activities~~

60 Sleep debt~~, specifically irregular work hours~~ over long periods of time (more than two weeks) ~~has~~ may have long-term effects on health and clinical illnesses, increasing the risks of pain, stress, obesity, coronary heart disease, gastrointestinal disorders and diabetes ~~[55-57]~~. Long-term affects ~~also point to~~ may also include mental health problems such as negative mood states and depression ~~[29, 37, 55]~~.

[61 ~~In addition, a~~ A substantial body of literature has linked long working hours (defined as more than 60 hours per week) over several years, with poorer health and wellbeing such as lower mental health status, self-reported hypertension, heart problems, high blood pressure; gastrointestinal disorders; job dissatisfaction, smoking, and frequent circadian disruption including effects on eating and sleeping] [~~37, 48, 58, 59~~].

62 Fatigue is known to detrimentally affect performance and may reduce individual and crew effectiveness and efficiency; decrease productivity; lower standards of work and may lead to errors ~~being made~~. ~~The high instances of injuries and accidents (e.g. *Fingal* (2007); *Antari* (2008); *Shen Neng 1* (2010); *Spring Bok* (2012)) reportedly related to fatigue within maritime operations results in great economic, environmental and human cost.~~ Therefore it is important that ~~Hence~~, ~~Uunless~~ steps are taken to mitigate and manage ~~alleviate~~ fatigue and its associated risks.~~, it will remain long after the period of sustained attention, posing a hazard to ship safety~~. ~~Thus, the management of fatigue management systems which address the risks of fatigue and its causes are essential~~.

[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 Watchkeping 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:

- 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

- 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).

SOLAS V - Regulation 14 Ships' manning.

1 Contracting Governments undertake, each for its national ships, to maintain, or, if it is necessary, to adopt, measures for the purpose of ensuring that, from the point of view of safety of life at sea, all ships shall be sufficiently and efficiently manned.*
* *Refer to Refer to the Principles of minimum safe manning (A.1047(27)).*

2 For every ship to which chapter I applies, the Administration shall:

.1 establish appropriate minimum safe manning following a transparent procedure, taking into account the relevant guidance adopted by the Organization*; and

* *Refer to the Principles of minimum safe manning (resolution A.1047(27)).*

.2 issue an appropriate minimum safe manning document or equivalent as evidence of the minimum safe manning considered necessary to comply with the provisions of paragraph 1.

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 include, but are not limited to:

- **Regulation 2.3** (hours of work and hours of rest) with the purpose to ensure that seafarers have regulated hours of work or 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) with the purpose to 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) with the purpose to ensure that seafarers have decent accommodation and recreational facilities on board.

- **Regulation 3.2** (food and catering) with the purpose to 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) with the purpose to ensure that seafarers' work environment on board ships promotes occupational safety and health.]

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

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~~Guidelines on Fatigue~~
~~Module 6~~

~~SHIPBOARD FATIGUE AND THE OWNER/ OPERATOR/MANAGER~~

~~Foreword~~

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

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

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

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

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

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

~~FATIGUE~~ MODULE ~~6~~ 2

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

1 The Company should provide adequate level of support for mitigating and managing the risk of fatigue. This aligns with the objective of the ISM Code in which it states that the company should assess all identified risks to its ships, personnel and the environment and establish appropriate safeguards. [Fatigue may lead to [crew] turnover, injuries and sickness, medical claims, and damage to property.] Module 2 contains guidance ~~practical information intended~~ for the C~~c~~ompany~~.~~ ~~It outlines~~ to asses, mitigate and manage the risk of fatigue ~~Fatigue Risk Management (FRM) based on available evidence in relation to managing fatigue~~ in operational environments, together with a set of practical support tools for consideration ~~companies to consider~~. It is recommended that the C~~c~~ompany become familiar with Modules 1, 3, 4 and 5 4 respectively (Fatigue – Causes and Consequences; Fatigue and the Seafarer; Fatigue Awareness and Training, Fatigue and Ship Design).

18 Managing ~~f~~atigue in an operational environment involves a risk based approach which enables fatigue to be addressed in a manner appropriate to the level of exposure to risk and the nature of operations, in order to minimize the effects of fatigue on shipboard personnel and the safety of operations.

Mitigating fatigue refers to actions or measures implemented to lessen or contribute to lessening the likelihood of fatigue-related hazards arising on board ships.

[2 This guidance recommends the incorporation of the principles of fatigue management into existing safety and risk management systems. It ~~This guidance~~ is not intended to imply the need to create a ~~separate/formal~~ stand-alone fatigue management system.] ~~, but to incorporate the principles of fatigue management into existing safety management systems.~~

A comprehensive fatigue risk management should take into account ILO and IMO instruments related to fatigue as listed in module 1 of this guidance.

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

~~3 FatigueFatigue has been recognized as an important Occupational Health and Safety (OH&S) issue hazard for seafarers. The 24-hour nature of ship operations that the risk of fatigue is high and Fatigue has the potential to to greatly increase the risk of, incidents and injuries in the work place. It disrupts body rhythms and results in poor sleep quality, digestive problems, delusions, confusion, lethargy, respiratory problems, depression, irritability, neurosis and temporary psychosis. Fatigue adversely affects crew performance. It diminishes attentiveness and concentration, slows physical and mental reflexes and impairs rational decision making capability~~.

~~4 Evidence for the role that fatigue plays in maritime safety has been provided by a number of accident reports ((e.g. Fingal (2007); Antari (2008); Shen Neng 1 (2010); Spring Bok (2012)). In addition to accidents, human fatigue also affects the potential for operational problems, system breakdowns and near miss incidents [1-6].~~

~~5 An assessment of accidents occurring in the last six months of 1995 indicated that 16% of critical ship casualties, and 33% of injuries, were partly due to human fatigue 1. Clearly, aAddressing the issue of fatigue through FRM 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 [7].~~

~~6 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.

7 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 night2. Furthermore, day sleepers sleep lightly and are thus easily disturbed by noise, temperature, etc. It is clear the management process must take this factor into account to effectively cope with crew fatigue.

2. HOW DOES FATIGUE AFFECT CREW PERFORMANCE?

8 In order to understand the physiological effects of fatigue, it is useful to describe these effects in relation to a known detriment to performance. In recent studies, the effect of fatigue was found to be comparable to those of alcohol, in terms of negatively impacting performance. One study found that a period of sustained wakefulness of 18 hours was comparable to a Blood Alcohol Concentration (BAC) of 0.05%3. As sleep deprivation continued for 24 hours, the effects of fatigue equated to a BAC of 0.10%. What is even more alarming is that the subjects of this study were well-rested students (they had not accumulated a sleep debt prior to the study) who were not required to undertake any hard physical activity during the period. Similar effects can be expected from other populations, and in fact, it might be possible that the effects of sleep deprivation for older individuals would be greater. Both quality of sleep and recovery from fatigue are known to worsen with age.

9 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.

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

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

.1 Slowed reaction
.2 Delayed or false response
.3 Failure to respond at the correct time
.4 Slowed thinking and diminished memory

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

How can the Company mitigate and manage the risk of fatigue? ~~What elements of fatigue can the company influence~~?

~~13 While it is not possible for Shipowners, Operators and/or Managers the company to regulate and oversee the sleeping habits of every crewmember on every ship, it is within their capability establish an a fatigue management FRM system.~~

14 Fatigue should be managed in the same way as any other shipboard hazard. The Company should develop and implement procedures, plans or instructions to ~~assess~~ mitigate and manage the risk of fatigue on board ships. ~~This can be achieved through the implementation of an FRM system, a holistic approach incorporating a system of defences to mitigate and prevent fatigue-related hazards. An understanding of the causes and consequences of fatigue as highlighted in Module 1 provides the essential background for. putting a maritime FRM in place.~~ [Figure 2.1 in Appendix 1 provides an example framework for a risk based approach composed of multiple layers of defences with associated fatigue hazards and risk mitigation measures. Further details on this approach are ~~is~~ provided in Appendix 1.]

15 ~~The provision of hours of work and rest requirements Hours of work are presently controlled by a prescriptive formula set out in the IMO~~ Chapter ~~VIII~~ VIII of the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW) and its Code ~~1978 as amended~~ and ~~the ILO Regulation 2.3 of the Maritime Labor Convention (MLC), 2006/1995~~ regulate the hours of rest requirements. ~~are important, and provide one line of defence in fatigue risk mitigation. Managers~~ However, the risk of fatigue exists even though the hours of rest are adhered to because many other factors (e.g. sleep quantity and quality, body clock) contribute to fatigue. ~~16 the company should be aware (when applying these hours of work limitations and rest) that the effects of considering the effects of circadian rhythm, sleep debt, are important. for ensuring that sleep and rest periods provide for adequate recovery. These provisions ensuring that rest periods are of high quality. on their own do not provide the means to identify and evaluate fatigue risks in work and rest arrangements, as well as control fatigue risks higher than an 'acceptable' (ALARP) level when this risk is present.~~ Hence, other measures should need to be in place to further mitigate and manage the risk of fatigue.

17 Mitigating and managing the risk of fatigue should be a goal-based, multi-level strategy that can be applied by a Company in a manner appropriate to the level of risk exposure and the nature of operations. The goal is to minimize the adverse effects of fatigue on individual health and safety of operations. ~~It is therefore important that the hours of rest provisions are supported by~~ Supporting these IMO provisions with an effective FRM is important as it is entirely possible for a seafarer to comply with the hours of work and rest requirements but still suffer from a state of fatigue ~~and be unable to conduct shipboard work safely. Therefore, FRM is important, as it employs a goal based, multi-layered defensive strategy to manage fatigue-related risks regardless of their source [8].~~

18 ~~FRM is defined as: *"A risk based approach which enables the management of fatigue in a manner appropriate to the level of risk exposure and the nature of operations in order to minimize the adverse effects of fatigue on individual health and safety of operations."*~~

28 Fatigue risk management is meant to be scalable and commensurate with the Company's operational requirements. Some elements, such as training, might be identical from ship to ship, or possibly even from Company to Company. However, other elements such as the appropriateness and effectiveness of risk control measures are likely to be specific to each operation. The degree to which this occurs will depend on the size and complexity of the operation. Implementation of fatigue risk management is likely to be progressive and the steps involved will form part of the existing safety and risk management system as it evolves. Hence, there is a strong case for starting small.

[19 The responsibility for mitigating and managing the risk of fatigue ~~risks~~ on board ships is a shared responsibility between the ~~c~~Company ~~(as the employer)~~ and the seafarer~~s (as the employee)~~ ~~(see Module 3)~~. ~~Both share responsibility for minimizing the risk to safety.~~ The C~~c~~ompany should be able to provide ~~is primarily responsible for creating~~ ~~a work and~~ living and working conditions ~~environment~~ on board ships that mitigate and manage ~~minimizes~~ the risk of fatigue~~-related risks~~. This includes safe work scheduling, fatigue awareness and training, adequate resources and crewing levels~~,~~ and providing a healthy living environment~~.~~ The seafarers are responsible for ensuring that time available for rest ~~and sleep~~ is used appropriately and their behavior does not create or increase risk.] ~~Crucial to this is early consultation between the company and seafarers to identify issues, establish fatigue reporting channels and provide appropriate level of fatigue management, education and training.~~

~~20 It also cannot be too highly stressed that rest means rest, not substituting a different form of work. Some necessary elements to an effective fatigue management system are as follows5:~~

~~.1 objective measurement of the causes and effects of fatigue~~
~~.2 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~~

~~21 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.~~

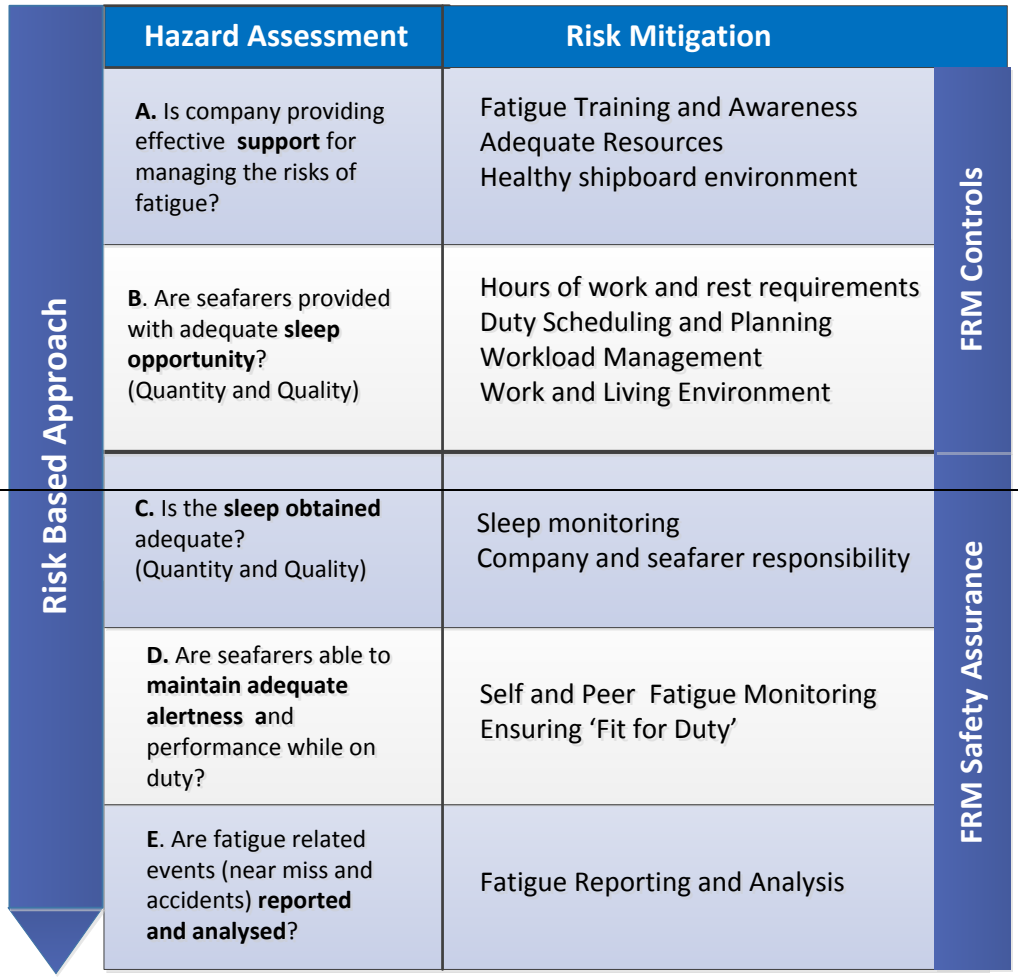
3~~What can the company do to manage the risk of fatigue onboard?~~

~~22 As with all risk management approaches, fatigue hazards should be identified, effectively managed and assessed, just like any other shipboard hazard.~~ ~~**Figure 2.1**~~ ~~provides a holistic framework recommending for a maritime FRM system that is composed of multiple layers of defences with associated fatigue hazards and risk mitigation measures. This is primarily based on implementing 'risk mitigation measures' which are scalable and complement each other~~ [9, 10]~~.~~

~~23 FRM is composed of two important processes, within which are included appropriate layers of defences critical for its success. These include~~

~~.1 FRM controls; and~~

~~.2 FRM safety assurance~~.



~~**Figure 2.1:** Fatigue Risk Management~~

~~24 FRM controls, effectively deal with the first two layers which are the principle mitigation strategies required to control and manage fatigue related risks:~~

~~.1 The first layer requires effective **company support** and commitment for managing and controlling the risks of fatigue;~~

~~.2 The second layer requires that seafarers are provided with **adequate opportunity for sleep**. This ensures that both quantity and quality of sleep are considered.~~

~~25 FRM safety assurance provides the data driven feedback (assessment and evaluation) through monitoring, to assure that the FRM controls are working effectively:~~

~~.1 The third layer ensures that any issues affecting seafarers' quantity and quality of sleep, even though adequate sleep has been provided, are being effectively captured. This entails **monitoring and assessing sleep obtained** and provides for the implementation of risk mitigation controls when issues are identified;~~

~~.2 The fourth layer ensures that seafarers obtain what is considered, on average, sufficient sleep and are able to **maintain adequate alertness and performance** while performing their duties (that is they are fit for duty). This entails monitoring and assessing levels of fatigue and fitness for duty; and~~

.3 The fifth layer ensures that formal processes are in place for identifying and assessing **fatigue related events** or accidents. This layer relies on having an effective safety reporting culture (i.e. just culture).

26 The combination of FRM controls and FRM safety assurance allows for continuous improvement with the following key steps (see Figure 2.1):

.1 **Hazard assessment**: assess fatigue risks associated with current condition and evaluate potential consequences of fatigue arising from the identification of hazards;

.2 **Risk mitigation**: eliminate or reduce the risks by putting control measures in place (i.e. better design of duty schedules, fatigue management training, etc.); and

.3 **Safety assurance**: monitor to evaluate the success of FRM controls and make further adjustments if necessary. As the company's understanding of its own fatigue risk grows, through experience, it needs to be able to adjust and use the feedback driven by the FRM safety assurance to improve the FRM controls.

[27 Companies should may consider supporting their FRM with the tools and resources included as guidance in the appendices of this document. It is important to understand that the tools mentioned in these guidelines are only a few examples the Company and seafarers may use. that can be used to monitor sleep, sleepiness and fitness for duty. The Ccompany and seafarers themselves may use other tools. However, the methods selected have established validity and are easy to use. Overall, they form a core set of tools that can be used for routine monitoring in an FRM system.]

4Is fatigue risk management (FRM) scalable?

28 FRM is meant to be scalable and commensurate with the company's operational requirements. Some elements, such as training packages, might be identical from ship to ship, or possibly even from company to company. However, other elements such as the appropriateness and effectiveness of risk control measures are likely to be specific to each operation. The degree to which this occurs will depend on the size of the operation and complexity. Overall, it is important that management the company adopts a fatigue management FRM system that is tailored to the individual individual enterprise operational requirements.

29 Implementation of a FRM system is likely to be progressive and the steps involved will form part of the system as it evolves. Hence, there is a strong case for starting small. The initial focus may be on:

.1 **fully** analysing planned and actual hours of work. This also includes a commitment to ensure actual hours of rest (and work) are being properly recorded;

.2 raising fatigue awareness via targeted training; and

.3 learning all possible organizational lessons from complete investigation of incidents where fatigue may have been a contributory factor.

5Can FRM be integrated within other shipboard processes?

30 FRM should not be stand alone. As it has a safety function it should be integrated within existing shipboard Safety Management Systems (SMS). Part A, section 1.2.2.1 and 1.2.2.2 of the

International Safety Management (ISM) Code states that the safety management objective should be to:

.1 "*Provide for safe practises in ship operation and a safe working environment*"; and

.2 "*Assess all identified risks to its ships, personnel and the environment and establish appropriate safeguards*".

31 As fatigue is an operational safety risk then appropriate control measures should be implemented, managed, and assessed in accordance with the ship's SMS objectives.

32 Companies' operating under the current ISM Code should be able to readily understand and adopt FRM. For example, rather than being an additional, separate process, fatigue should form one element of the hazard assessment and risk mitigation already being undertaken, as part of the SMS.

33 Hence, the most effective approach is to integrate FRM to the ship's SMS. This enables fatigue to be managed within company's existing safety structures, ensuring resources are appropriately distributed across the systems and, where possible, processes are not duplicated, maximising the effectiveness and efficiency of FRM.

6How can the Ccompany support ensure fatigue mitigation prevention is practiced onboard?

34 Management The cCompany should and consider the following in developing fatigue management policies and FRM systems (Figure 2.1):

.1 Is the company providing effective**support**for managing the risks of fatigue?
A1 Development and implementation of FRM documentation;
A2 Company-wide fatigue training and awareness;
A3 Availability of adequate resources to conduct all ship operations safely; and
A4 The provision of a healthy shipboard environment
.2 Are seafarersprovided with adequate **sleep opportunity** (Duration and Quality
A. 3. Is the sleep **obtain**ed adequate **sleep** (Duration and Quality)
B. 4. Are seafarers are able to **maintain adequate alertness and** performance while on duty
C. 5. re fatigue related events (near miss and accidents) **reported and analysed**?

A Company Support

35 The company should provide adequate level of support for managing the risks of fatigue. This establishes the core risk control measure of a FRM. This needs to be supported by appropriate systems and processes, 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 include the need to ensure:

.1 Development and implementation of FRM documentation;
.2 Company-wide fatigue training and awareness;
.3 Availability of adequate resources to conduct all ship operations safely; and
.4 The provision of a healthy shipboard environment.

Development and implementation of FRM documentation

36 .1 Is the company providing effectivesupportfor managing the risks of fatigue? The FRM documentation should set the basis for company support and commitment for managing the risks of fatigue. The company should develop FRM policy, integrating this to the ship's SMS. The FRM policy should:

.1 reflect company support and commitment;

.2 include fatigue training programmes and training requirements;

.3 must include records of planned and actual daily hours of work and rest, with reasons for significant deviations noted (Section A-VIII/1, paragraph 7 of the STCW Code and Standard A2.3-12 of the MLC);

.4 include FRM safety assurance outputs including findings from collected data, recommendations, and actions taken;

.5 include company commitment to effective safety reporting (which is already an integral part of the SMS).

37 Seafarers and shore based personnel should be consulted and involved in the FRM development process, including the opportunity to provide feedback.

38 A key requirement for successful implementation is the underlying culture into which FRM is introduced. A just culture is critical given the reliance on seafarers to report and provide feedback, not only on fatigue related incidents but also their sleep and fatigue levels within and across days.

A2 Company-wide fatigue training and awareness

39 As noted in the previous section, aAn effective fatigue management system FRM requires training. The Ccompany should ensure all personnel have appropriate training. This includes shore-based personnel whose decisions may impact the management of fatigue (such as those involved in resource planning, manning crewing of ships and duty work scheduling decisions) and fatigue-related processes. This is important, as their decisions potentially affect fatigue levels of seafarers and consequently shipboard safety.

40 Initial fatigue-related awareness and/or 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 (physical and mental), and the ways in which these factors interact with operational demands to produce fatigue (see Module 1). In addition, it is important useful for all seafarers to have information on how to manage their personal individual fatigue and sleep (see Module 3).

41 From an organizational perspective, it is important to share a common understanding of the risk of fatigue, fatigue risks and its mitigation and management. As the FRM matures, training material should be expanded to include such content as the use and limitations of any scheduling tools and fatigue predictive modelling tools that may be used to predict the levels of fatigue and performance across duty schedules.

42 Module 4 provides more detail on recommended content on fatigue training.

43 Ensuring both the crew and shore based personnel understands the necessity of getting regular sleep and rest and the implications of being fatigued (both to themselves the crew 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. Training should be conducted on an

initial (e.g. prior to commencing any operational duty) and recurrent basis. The interval between training should be determined by the company, given their operational characteristics and training needs analysis.

[44 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. Module 4 provides more detail guidance on fatigue awareness and training.]

A3 Adequate resources

45 Adequate resources is one of the primary determinants of seafarers duty work hours, workload, duty work schedules, average time off-work duty, and other key factors that can have an influence or elevate fatigue. The cCompany should ensure that there are adequate resources to maintain safe operations on board. 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.

46 Part A, Section 6.2.2 of the ISM Code states that "*the company should ensure that each ship is appropriately manned in order to encompass all aspects of maintaining safe operations on board. (Refer to the Principles of minimum safe manning, adopted by the Organization by resolution A.1047 (27)).*"

47 Although the master is responsible for managing the ship and its crew, Tthe Ccompany needs should to ensure that the master is adequately supported by shore management and provided withand sufficient resourcesd to conduct shipboard work duties and operations safely and effectively. This includes having available adequate resources to do so across all shipboard operations. Part A, Section 6.1.3 of the ISM code states that *'the company should ensure that the master is given the necessary support so that the master's duties can be safely performed'*.

48 Although there may be instances in which seafarers' where workload or working arrangements is are impacted in certain ports due to unforeseen events unplanned, such as regulatory inspections, it is ultimately the Ccompany's responsibility to should understand the framework within which they their ships operate and to provide sufficient adequate resources to maintain safe operations in port. ensure the ship's business (which includes inspections by governmentand other agencies) can be carried out without undue stress on the seafarers. This includes having available adequate resources to do so across all shipboard operations.
As the unforeseen events, such as inspections, may originate from the requirements of any number of external parties (such as government authorities, charterers, terminal operators, class societies and other agencies), the Company should expect to be able to make arrangements with those external parties so as to minimize the impact on rest hours and reduce the stress of seafarers in these situations. Effective operational planning is critical for ensuring adequate resources 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 vessel is travelling through confined and congested waters and less confined open waters);

.2 trading patterns and operations (i.e. number of port calls – the more port calls the higher the demands and hence workload);

.3 as far as possible, planning for disturbances to normal operations, such as weather, ship movement in port; port entry and exit delays, ~~and~~ port surveys, ~~and~~ inspections, training, illnesses, injuries and sickness (including motion sickness);

~~.4 ensuring adequate resources are available to cover planned and unplanned aspects such as training, illnesses, injuries and sickness (including motion sickness);~~

.5 ~~ensuring proper consideration is taken of manning determinations in conjunction with the manning requirements as set out in IMO Resolution A.1047(27) – Principles of Minimum Safe Manning and Regulation 2.7 –Manning Levels set out in the MLC~~;

[.6 ensuring the C~~c~~ompany's contractual obligations so that safety is not affected ~~that affect the commercial and financial revenue do not impinge or affect safety in any way~~.]

49 The C~~c~~ompany ~~needs to~~ should consider strategies to deal with periods of high workload and to manage these 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~~ work 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. [Crewing concepts such as the use of port captains and/or shore based support may assist shipboard crew to obtain adequate time off for rest and sleep and are fit for work when the vessel leaves port];

.2 ensure the master is given the necessary support and the ship is appropriately crewed ~~well~~ and adequately resourced ~~and supported~~ in order to encompass all aspects of maintaining safe operations on board ~~to carry out all shipboard tasks safety and to allow for unexpected surge~~;

.3 ensure there are adequate resources available to complete shipboard tasks safel~~t~~y without placing excessive demands on seafarers~~. Increase resources if necessary~~;

~~.4 useing other crewing concepts, such as the use of port captains and/or shore based support when ship is in port 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 vessel leaves port (examples include the use of shore based 'cargo officers' which assist in cargo operations while the ship is in port);~~

.5 where practicable, provide shipboard administrative support or a resource 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.; and

.7 where practicable, plan arrival and departures (tides in ports, delays due to weather, pilotage boarding, etc.) to take into account adequate sleep and rest.

50 An important aspect that needs to be mentioned is that of overriding operational conditions. ~~The guidelines~~ ~~i~~In accordance with Section B-VIII/1.1 ~~of the STCW Convention defines~~ ~~'~~"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". ~~'~~Overriding operational conditions~~'~~ refer to occurrences that are statistically unlikely. In general, for circumstances to be statistically unlikely, they should only occur in less than five per cent in any sample of shipboard ~~duty~~ work periods. 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, meeting regulatory requirements, traffic congestion during departure/arrivals, and sickness of crew members).~~ Nevertheless, if overriding operational conditions still occur, the Company should ensure that appropriate recovery rest periods are provided afterwards.

A4 Healthy shipboard environment

51 Seafarers are required to not only work but also live on board a ship. Hence, ensuring a healthy shipboard environment is crucial to minimizing the risk~~s~~ of fatigue and ensuring mental well-being is not affected. The most important aspects should include ~~are the need to ensure~~:

.1 Healthy eating: Healthy nutritious food is available and served on board and crew afforded unlimited access to drinking water;

.2 ~~Healthy s~~Sleep: The shipboard sleeping environment is commensurate with providing comfortable and good quality sleep, whenever possible (bedding, pillows, mattresses, etc.);

.3 Physical well-being: ~~Adequate~~ Appropriate recreational facilities are provided (such as ~~well-designed and equipped~~ physical exercise ~~training~~ facilities and outside spaces), to ~~ensure~~ assist crew ~~can~~ in maintaining their health and well-being ~~a healthy lifestyle~~ on-board.

[52 The MLC sets out minimum requirements in this area, in particular:

.1 Regulation 3.1 – Accommodation and recreational facilities, to ensure that seafarers have decent accommodation and recreational facilities on board; and

.2 Regulation 3.2 – Food and catering, to ensure that seafarers have access to good quality food and drinking water provided under regulated hygienic conditions.]

53 Furthermore, ship design plays a part in ensuring a healthy ~~operational~~ shipboard environment (see Module 5).

B Ensuring Adequate Sleep Opportunity

54 Effective fatigue management is predominantly about ensuring that seafarers are provided with adequate sleep opportunity. ~~The ship's management level officers (master and officers) should facilitate this through recommended mitigation and control strategies mentioned in Module 3 (Fatigue and the Seafarer).~~

55 It is not correct to assume that a given rest period from work ~~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~~ work periods and the actual amount of sleep obtained in a shipboard environment is complex. ~~As highlighted in~~ Module 1 states that sleep quantity and quality (and its restorative value) depends on going through unbroken ~~night time~~ 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.

56 Shipboard related factors that affect sleep include:

.B1 ~~duty~~ work scheduling and planning;

.B2 workload and its management; and

.B3 the work and living environment.

B1 ~~Duty~~ Work Scheduling and Planning

57 ~~Duty~~ Work scheduling and planning is a key factor in managing fatigue ~~[11~~]. [The C~~c~~ompany is responsible for ensuring ~~duty~~ work schedules provide adequate opportunity for sleep.] ~~At the very least, the company must be in compliance with Regulation VIII/1 of the STCW Convention and Regulation 2.3 of the MLC.~~

~~58 The optimal duty schedule for most individuals is daytime duties (0700-1800) with unrestricted sleep at night (2100 to 0700). Anything else is a compromise.~~

59 From a practical perspective, it is important to determine whether a given work ~~duty~~ schedule, on average, enables adequate sleep opportunity. Primary ~~duty~~ work schedule characteristics that have been found to have a significant impact on individual sleep, performance and safety include:

***.1 Maximum ~~W~~work hours per 7 days*:** As the total hours worked increases, sleep opportunity decreases. Research demonstrates that apart from a drop in performance, extended hours of work ~~(defined as more than (60 hours per 7 days)~~ are also associated with reduced individual wellbeing, reduced organizational commitment and poor health outcomes. These factors in turn have been linked to declining levels of productivity and safety. ~~Current regulations (MLC, 2006) allow for a maximum of 72 hours of work in a 7-day period. However it is important to note that when work exceeds 60 hours in any 7-day period the risk of fatigue is high [12-16].~~

[***.2 Hours of work (duty period) per 24 hour period*:** ~~As the length of a given duty period increases, the subsequent for sleep opportunity decreases.~~ Current regulations (MLC, 2006) allow a maximum of 14 hours of work (or minimum 10 hours of rest) in a 24-hour period. ~~However, the research is clear that after the 8th hour on duty the risk of fatigue increases substantially. Furthermore, rhas shown that tThe risk of an accident in the 12th hour of work. is more than double the risk of an accident in the 8th hour of work [17, 18].~~ Administrative work, shipboard drills, training, ship loading and unloading tasks are all considered to be work hours. ~~Hence, work across a 24-hour period should not exceed 12 hours. [11, 17]. Standard A2.3 (a) of the MLC defines hours of work as "*time during which seafarers are required to do work on account of the ship*".]~~

***.3 Rest hours (rest periods) between ~~duty~~ work periods*:** ~~This is the length of time off between duty periods.~~ This is the time outside of hours of work. As the hours of rest between subsequent duty periods decreases, so does the sleep opportunity. The timing of rest periods should as far as possible provide ~~maximize~~ adequate opportunity for night sleep. Depending on the time ~~of day that~~ a rest period is provided, the length of a rest period required to obtain adequate sleep could vary considerably ~~the amount of time off needed to get adequate sleep could vary substantially~~. ~~This reflects the fact that s~~Seafarers do not ~~simply fall a~~sleep the moment their rest hours begin or wake-up moments before work ~~as soon as they are off-duty and wake just before they go back on-duty~~. ~~Furthermore, s~~Seafarers, ~~like all other shore-based workers,~~ have other ~~many~~ activities ~~and responsibilities to~~ they manage or complete between ~~duty~~ work periods such as eating, showering, and communicating with friends and family at home ~~socializing with other crew, relaxing, studying and writing to family members and friends back home~~. Rest hours should provide for adequate sleep opportunity, ~~be adaptable to the individual circadian rhythm, provide time to complete those other tasks noted above~~ and account for other

activities, the body clock and the effects of sleep inertia after waking. ~~Hence, the interval between two successive duty periods should allow sufficient time to obtain adequate sleep before the start of the next duty period~~ [~~19-22~~]. [~~(As a rule of thumb, 10 hours rest during night time (2100-0700) is required to provide adequate sleep opportunity (approximately 8 hours), while 16 hours rest during the daytime (0700-2100) is required to obtain adequate sleep)~~].

.4 ***Night watch ~~shift work~~***: Seafarers working during night-time, specifically during the circadian low can experience performance degradation initially. ~~The situation becomes worse following consecutive night work. Working consecutive night shifts increase the risk of fatigue across days and can result in the onset of chronic fatigue [23-26]. In addition, late starts (2100-0000) and early finishes (0400-0600) will reduce night time sleep opportunity and result in a significant reduction in total sleep opportunity.~~ If the seafarer maintains a regular schedule they may adapt over time. However, ~~I~~it is important to provide those seafarers working during night-time with a good sleep opportunity and environment during the day.

.5 ***Recovery Sleep ~~Breaks~~***: Before beginning a work period, a seafarer should be sufficiently rested to enable them to sustain work activities safely and effectively throughout the work period. This requires effective quantity and quality of rest and sleep between work periods. Following periods of sleep debt it is beneficial to provide sufficient time for effective recovery. [One or two recovery sleeps of 8 hours or more may be adequate to recover from acute fatigue (one 24-hour period), but recovery from a period of sleep debt (two or more 24-hour periods of sleep loss) may require more than three recovery sleeps. In doing so, the critical effect of circadian timing on fatigue and recovery must be taken into account, and recovery time may need to be adjusted accordingly.] When practicable, sleep opportunities should be taken during the circadian low as this is when the most effective recuperative sleep takes place. ~~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 timing plays in the rate at which fatigue accumulates and the rate at which people recover. When a seafarer commences their work they need to be sufficiently rested so as to be able to sustain their work activities over the designated duration of the next duty period. 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 duty 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 [27, 28]. Sleep opportunities during the circadian low are preferable because sleep that occurs during the circadian low provides the most recuperative value. The provision for sufficient recovery time following periods of sleep debt is important. It is recognised that in a shipboard environment this may not always be feasible.~~

.6 ***Short breaks within ~~duty~~ work periods***: Short breaks can be associated with ~~benefit~~ performance benefits and assist ~~help~~ in maintaining alertness. ~~One of the most important determinants of fatigue is 'time on task'. Frequent short breaks (10 to 20 minutes in duration) are associated with performance benefits and when the timing of these short breaks is at the discretion of the individual it results in better fatigue management [27, 29-31]. It is recognized that in a shipboard environment~~ Although short breaks may not always be practicable ~~feasible~~ during a work period, ~~however as many as possible~~ appropriate short breaks should be provided and taken into account as far as possible during the planning of shipboard working arrangements. ~~when possible planned into the duty period. It should be noted that the 'time on task' effect can also be reduced during the duty period by task rotations/substitutions. Note~~

~~that short rest breaks count as part of the duty period and should not to be included as part of the hours of rest. This is clear in Standard A2.3 (b) of the MLC which states that "*hours of rest means time outside hours of work; this term do not include short breaks*".~~

.7 ***Naps*****:** are an effective countermeasure to fatigue, exhaustion from long work hours, and inadequate ~~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 t~~The benefits of strategic ~~controlled~~ napping out-weigh the potential risks associated with sleep inertia.

[***.8*** ***Reset Breaks***: ~~Given that~~ As the risk of fatigue increases over a span of successive work days of sleep debt, ~~it seems logical that~~ some "recovery" must take place over spans of rest days otherwise the risk of fatigue would continue to rise ~~[32]~~. This is typically an issue at sea as seafarers are exposed to potentially arduous ~~duty~~ work schedules over a long period of time (in excess of seven days, sometimes months on end) without the possibility of a reset break. ~~Adequate~~ A reset break~~s are critical for recovery and~~ is typically ~~should at least be~~ 24 (1 day) consecutive hours in duration per 7 days. ~~Standard A2.3.3 of the MLC acknowledges this need by stating that "the normal working hours standard for seafarers, like that for other workers shall be based on an eight-hour day with one day (24 hours) of rest per week".~~ It is recognized that in a shipboard environment this is likely not practical; however, this may be a factor to consider when determining crew rotation.]

~~60 The FRM should consider napping and short break policies.~~

61 In managing the risk of fatigue, ~~It should also acknowledge~~ impairment through sleep inertia should also be acknowledged, specifically for seafarers who are woken up suddenly in the middle of their sleep period (for emergency or other purposes) or need to wake up during the circadian low to take over a duty period.

Tools to Assess ~~of~~ Fatigue in Scheduling

[62 ~~The p~~Planning tools ~~of duty schedules~~ based on fatigue science as well as operational requirements ~~permits~~ can provide predictive identification of fatigue hazards. This assists in allocating ~~adequate~~ hours of work, rest, short breaks and reset breaks ~~that~~ to provide sufficient sleep opportunity and recovery. It should be noted that these tools should not be used in isolation nor be the main driver for work scheduling decisions as they are not sufficient to determine the full extent of the risk of fatigue. They should always be supported by other operational data. Their main purpose should be limited to identifying potentially fatigue inducing work schedules or scheduling hot spots and allow for better decisions in the selection of work schedules. This is because numerous unforeseen circumstances can cause changes to planned schedules, for example, weather conditions, unexpected technical problems, or crew illnesses. It is noted that many Companies already account for fatigue informally during planning activities. Seafarer fatigue relates to what is actually worked, not what is planned. Thus a proactive approach for identifying fatigue hazards is to analyse actual work schedules in operation to determine whether or not the risk of fatigue is increasing as a result of the work arrangements.] The following tools may be considered:

~~Some organisations already maintain records of hours worked. However, these hours are normally assessed against the criteria set out by the STCW convention or similar instruments. Taking the effects of circadian rhythm into account can strengthen this approach. Planning Such 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:~~

.1 Analyse planned work routines duty schedules by management to ascertain the risk of fatigue;

.2 Monitor work hours and sleep 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;

.3 Analyse and compare information related to hours of work that will determine the effectiveness of employed routines, compared to other alternatives.

63 These can be useful additional tools for the management of fatigue. It should be noted that these tools 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 crew illnesses. It is noted that many companies already account for fatigue informally during planning activities. Seafarer fatigue relates to what is actually worked, not what is planned. Thus a proactive approach for identifying fatigue hazards is to analyse actual duty schedules in operation.

.1 Fatigue Risk Assessment Tool: The risk level of a specific work schedule may be assessed via a fatigue risk score. An example is shown in Appendix 21 provides a simple tool that can be used to assess fatigue risk associated with a particular duty schedule [32] and is based on some of the duty schedule characteristics identified. A fatigue risk score rating and control measures table is included to support the risk assessment matrix. One of the key control measures may be is to re-design duty work schedules to minimise the risk of fatigue. A list of duty work schedule design principles is included in Appendix 3 2.

.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 the risk of fatigue risks. A range of fatigue predictive software tools are commercially available with several also available in the public domain. When using such tools, it is suggested that the company takes a cautionary approach and consider the model's limitations and relevance to the operational environment it may be used. Additionally, model predictions should not be used without reference to operational experience, when making decisions about duty schedule design [33].

B2 Workload and its management

64 As highlighted in Module 1 describes the mental and physical demands of work and the number of ways these can contribute to a seafarer becoming impaired by fatigue in a number of ways. For example, 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.

65 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).

66 Typical techniques for managing workload on ships include: prioritisation of tasks, task delegation, task ~~rotation~~ and crew rotation~~,~~ and task shedding. A list of risk control strategies ~~that should be used in~~ for managing workload may include:

.1 carefully consider task design according to the demands of the tasks and resources available;

.2 where possible, reducing the amount of time seafarers need to spend performing sustained physically and mentally demanding work ~~to not more than 2 hours~~ (tank cleaning, navigation through congested waters, etc.);

[.3 ~~where possible,~~ plan~~ning~~ for sufficient personnel ~~a minimum of two crewmembers together~~ on navigational watch, ~~specifically~~ particularly during night time ~~(two tired persons make better decisions than one person alone)~~;]

.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 (such as assigning paper work ashore, or adding a shipboard administrator);

.6 minimize repetitive or monotonous tasks by using task rotation, where practicable (monitoring (engine and bridge), look-out, helm duty);

.7 where practicable, ~~defer non-urgent~~ prioritise work to allow appropriate rest and recovery.

B3 Work and Living Environment

67 The work and living environment is important for ensuring adequate opportunity for sleep. ~~and should be considered~~. ~~Because~~ ~~g~~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 practises. For example~~ While most environmental aspects such as noise can be better addressed during ship design (Module 5)~~. However~~, there are ~~control~~ measures that the ~~c~~Company can implement to assist in ~~reducing noise levels in the~~ providing a good sleeping environment.

68 ~~***Environmental***, procedural and operational measures may range from low cost solutions, such as porthole blinds and door baffles, to high cost solutions, such as re-fitting the vessel exhaust or air conditioning systems.~~ Environmental control measures 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 vessel, such as:

- providing a dark sleeping atmosphere using black out blinds for portholes or berths in sleeping spaces;
- installing insulation baffles over cabin door louvres;
- improving air conditioning (ambient temperature) and air flow (i.e. sleeping berth temperatures should allow for settings between 17-21 degrees C during sleep time);

- supplying good quality ~~and comfortable~~ bedding such as mattresses, linen and pillows;

.3 considering ~~making~~ sleeping spaces, comfort and personal spaces ~~the first priority~~ in retro-fitting and new ship construction;

~~.4 ensuring adequate personal storage space is available for seafarer's personal effects.~~

[69 The MLC addresses some of these aspects through Standard A3.1 – Accommodation and recreational facilities. This sets out minimum standards to ensure that any accommodation for seafarers, working or living on board, or both, is safe, decent and in accordance with the relevant provisions. It considers the following aspects:

.1 the size of rooms and other accommodation spaces;
.2 heating and ventilation;
.3 noise and vibration and other ambient factors;
.4 sanitary facilities;
.5 lighting; and
.6 hospital accommodation.]

70 Operational and procedural changes may include developing napping and short break 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 and respected ~~to~~ by all relevant personnel, aboard ship and ashore. Depending on the situation, changes should be made to those areas that will have the most impact, and following assessment and evaluation, consideration to other changes can then be made. Procedural and operational control measures include, but are not limited to:

.1 increasing access to healthier food choices by ensuring ~~only~~ nutritious food is served on-board;~~. Reference should be made to the requirements in the MLC as set out in Standard A3.2 – Food and catering;~~

.2 providing information and advice on healthy eating, ~~and~~ physical and mental well-being;

.3 where possible making a variety of exercise equipment and facilities available to seafarers;

.4 providing and maintaining a quiet atmosphere for sleep. Develop a 'do not disturb' policy ~~within the FRM~~ for sleeping seafarers;

.5 where practicable, calls for drills should be conducted in a manner that minimizes the disturbance of rest periods. ~~not occur during a rest period as they can be extremely disruptive.~~ This is a requirements in the STCW Convention under Section A-VIII/1.4 which states that "Musters, fire-fighting and lifeboat drills, and drills prescribed by national laws and regulations and by international instruments, shall be conducted in a manner that minimizes the disturbance of rest periods and does not induce fatigue".;

.6 where practicable, ~~putting in place~~ short breaks should be provided ~~within~~ during ~~duty~~ work periods~~, including having in place 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~~ where possible, provide support to seafarers experiencing ~~elevated~~ high work demands that effect the ability to obtain adequate sleep opportunity ~~levels of workload~~;

.10 if possible, avoid assigning seasick and ill seafarers shipboard work;

.11 if practicable, put in place plans and procedures to manage the use of any communication devices and internet (as applicable) on board ships; ~~provide proceduralized phone, internet and e-mail use to all crew;~~ and

.12 where possible, ensure that maintenance work does not disrupt personnel sleeping.

C Supporting Adequate Sleep ~~Obtained~~

71 ~~Given that s~~Sleep loss is a primary contributor to fatigue.~~,~~ ~~t~~The C~~c~~ompany should therefore take an active role in supporting ~~determine whether~~ adequate sleep is obtained.

72 Situations may arise where a seafarer is provided with an adequate sleep opportunity, but 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 and encouraged to report back situations when they have been unable to obtain adequate sleep or feel at risk of making fatigue-related errors~~, specifically if conducting safety critical tasks (such as navigating in congested waters)~~. ~~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, t~~[The feedback ~~on work/sleep~~ ~~still~~ provides the basis by which management can monitor the effectiveness of their risk mitigation and management strategy ~~FRM~~.]

~~73 A valuable and commonly used measure for proactive fatigue hazard identification is sleep monitoring. This may involve a planned sleep data collection process that includes a few days or weeks, possibly repeated a few times annually. Sleep monitoring should be implemented through relevant procedures of the ship's SMS. Smaller companies can use verbal feedback through their ship's safety committee. Whatever the method, this layer of defence within the FRM safety assurance enables the company to determine whether adequate sleep is actually obtained. It further provides a retrospective safety assurance that the FRM controls (layers 1 and 2) are working effectively.~~

74 In general, seafarers are responsible for using adequate sleep opportunities appropriately, so they are fit for work ~~duty~~ and capable of performing assigned shipboard work safely. However, there are a number of reasons why seafarers may not obtain adequate sleep as explained in Module 3 (paragraph 50). ~~The quantity and quality of sleep obtained can be affected by many aspects, including:~~

~~.1 a seafarer working during the night may simply be unable to sleep during the day;~~

~~.2 upon joining the ship a seafarer may experience difficulty adjusting to the sleep schedule;~~

~~.3 sleep disorders as highlighted in Module 1;~~

~~.4 emotional stress (i.e. due to family problems at home);~~

.5 the sleeping environment (comfort, noise, darkness, ship motion, privacy) may not allow for adequate sleep;

.6 the type of food consumed;

.7 medication or use of prescribed/over the counter/natural remedies;

.8 consumption of stimulants such as caffeine and amphetamines;

.9 use of personal electronic devices before sleep, which may delay the onset of sleep and not allow adequate sleep to be obtained.

75 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. Recommended Some tools that can be used for this purpose are included in Appendix 3. to monitor sleep include: (1) subjective self-reports and (2) objective measures.

.1 Subjective self-reporting tools: are the simplest and cheapest methods used for monitoring sleep. In general, they provide reasonable information at the group level. They include a daily sleep dairy in which seafarers' record when they sleep and wake, and rate the quality of their sleep. Appendix 3 is an example of a subjective **sleep diary** that can be used to record and monitor sleep by individual seafarers. This example includes a Sleep Quality rating scale for each sleep period and the Karolinska Sleepiness Scale (KSS) to rate sleepiness after the sleep period [34].

.2 Objective tools: include the use of wrist worn activity monitors. There are a number of manufacturers of these devices, and each type comes with specific software that estimates when the wearer was asleep and awake (based on a validated algorithm). They also provide some indication of sleep quality (that is how disruptive the sleep period was). Wrist worn activity monitors are designed to record continuously for several weeks so they are valuable tools for monitoring sleep and wake patterns at sea. Wrist worn activity monitors are small and unobtrusive to wear.

76 The success of this layer of defence and others (see below), depends on the willingness of seafarers to participate in the data collection process. Participation reflects their level of understanding of their roles and responsibilities in the FRM system and their confidence that the purpose of the data collection is to improve safety. In this type of 'just culture', concerns about whether some seafarers might exaggerate in their responses, for personal or industrial reasons, should be minimal. In addition, extreme ratings become obvious when compared with group averages.

[Ensuring Adequate Alertness and Performance while on Duty]

[77 Ensuring seafarers are fit for duty and that they are able to maintain safe levels of alertness and performance is important. Even when adequate sleep opportunity has been provided and 'sleep monitoring' indicates sufficient sleep has been obtained, there may be instances in which some seafarers may still show signs of fatigue. An example of this is when seafarers are engaged in night work. In this case, the circadian drive dictates that it is during this time that seafarers will experience the highest levels of fatigue.]

78 This safety assurance layer of defence aims to:

.1 identify seafarers who continue to exhibit signs of fatigue despite being provided with and getting sufficient sleep; and

.2 monitor and assess the effectiveness of the other layers of defences.

79 Monitoring and evaluation of fatigue can be carried out in conjunction with sleep monitoring. It should also be implemented through relevant procedures of the SMS.

80 Several tools are available for monitoring and assessing levels of fatigue. This can be done through, self-monitoring, peer monitoring and using fit for duty checklists. A balance needs to be maintained between gathering enough data to be confident to allow for adequate decisions and actions be taken on control measures, and the additional demands that data collection can place on seafarers. Examples of simple fatigue assessment tools that Companies may find useful to consider are included in Appendix 5 and 6.

.1 ***Self-monitoring through subjective fatigue and sleepiness ratings*** Subjective sleepiness and fatigue ratings are particularly useful for gathering data fairly quickly to decide whether additional fatigue risk mitigation strategies are needed. Appendix 4 describes two standard fatigue and sleepiness rating scales that can be cheaply and easily used for monitoring purposes. Seafarers can be asked to complete these fatigue and sleepiness ratings at specific intervals within and across days. The tools in Appendix 4 include the Karolinska Sleepiness Scale (KSS) [34] and the Samn-Perelli Crew Status Check [35]. These scales have been scientifically validated and are designed to be completed at multiple points within and across days. The KSS has been most widely used in maritime studies [1, 36, 37]. Using these standard scales also enables comparison of fatigue and sleepiness levels to be made within and between ship operations within the same company. This can be helpful in making decisions about where controls and mitigations are most needed.

.2 ***Fatigue Self-Assessment Tool:*** Appendix 5 is an example of a cheap and easy to use fatigue self-assessment tool [38]. A one minute, easy to use personal fatigue assessment, this tool supports the seafarer with the identification of fatigue. The tool provides a risk assessment and risk control strategy that can be easily implemented.

.3 ***Peer monitoring:*** can be undertaken in a number of ways. The fatigue signs and symptoms table in Module 1 can be used as a peer monitoring tool by seafarers to assess if any fatigue signs and symptoms are observed in any of their peers. Alternatively, peer monitoring can be undertaken using the 'fatigue self-assessment' tool in Appendix 5. For example, during duty hand-over the outgoing officer-of-the-watch can ask the incoming officer-of-the-watch whether they have had adequate sleep and they are fit for duty, using the "self-assessment" tool as a checklist.]

E. Encouraging Reporting of Fatigue Related Events

81 Companies FRM should have systems in place to promote reporting of fatigue related events. This layer of defence reactively identifies instances where fatigue related events (such as accidents and incidents) have occurred and feeds this information back to strengthen higher level controls. Feedback on Reports about fatigue-related events can assist the Company in improving the management of fatigue on board its ships. are vital to keeping informed about fatigue hazards in day-to-day operations. In addition, a series of fatigue reports can become a trigger for further investigation.

[82 Safety management systems include procedures, ensuring that non-conformities, accidents and hazardous situations are reported to the Company, investigated and analysed. Fatigue related incidents or situations could be reported under these or similar procedures.] Important to note is that the need to report and analyse incidents is a mandatory requirement within the ISM Code. Part A, Section 9.1 includes reporting provisions within the ship's safety management system "*ensuring that non-conformities, accidents and hazardous situations are reported to the company, investigated and analyzed with the objective of improving safety and pollution prevention.*" In addition, Section 9.2 of

~~the ISM Code also includes the following provision, "*the company should establish procedures for the implementation of corrective action, including measures intended to prevent recurrence*". Hence, reporting of fatigue related non-conformities, accidents and hazardous situations should be implemented through relevant SMS procedures. Seafarers should be encouraged to report such events in the following instances:~~

~~***.1 through*** a voluntary reporting system when something in the operating environment is likely to impact on their, or other seafarer's, alertness to such an extent that safety margins could be reduced to unsatisfactory levels;~~

~~.2 through the ship's reporting system when an incident or event has occurred where fatigue may have been a contributory factor. To enable this, it is preferable for there to be a fatigue reporting facility or prompt on the company's incident reporting forms.~~]

83 The C~~c~~ompany should be aware that their responses to reporting of fatigue related events will, to a large extent, impact the motivation of crew to report fatigue and the subsequent effectiveness of the hazard identification processes. ~~An effective reporting system requires an effective reporting culture.~~ It is recommended ~~needs~~ to:

.1 use forms that are easy to access, quick to complete and submit;

.2 have clearly understood rules about confidentiality of reported information;

.3 have clearly understood voluntary reporting protection limits;

.4 include ~~regular~~ analysis of reports; and

.5 provide ~~regular~~ feedback about decisions or actions taken. ~~based on the reports and lessons learnt.~~

84 ~~***Reporting Forms***:~~ An example of a fatigue event report form is provided in Appendix ~~6~~ 7.

~~85 Lessons learnt play a key role in helping to develop fatigue risk management strategies for the workplace. They are useful in reinforcing awareness of fatigue among seafarers. Some of these reports and incidents together with lessons learnt could be circulated on a ship-by-ship basis. Distributing these lessons learnt will allow administrations, companies, and seafarers to demonstrate their commitment to the awareness and prevention of fatigue.~~

7~~How can continuous safety improvement be ensured?~~

~~86 FRM should have mechanisms in place to evaluate whether the defences and control strategies are working well and to identify any areas for improvement. The ISM code has provisions in place for verification, review and evaluation of the ship's SMS (Part A, Section 12). Hence, when reviewing the SMS, an evaluation of the FRM should be part of this.~~

~~4. ISM Code requirements for clear, concise guidance on operational procedures on board~~
~~5. The need for joining crews to be adequately rested before assuming duties~~
~~6. Scheduling time for proper hand over on crew change~~
~~7. Voyage length, time in port, length of service and leave ratios~~
~~8. Multicultural issues; language barriers, social, cultural and religious isolation~~
~~9. Interpersonal relationships, stress, loneliness, boredom, social deprivation and increased workload as a result of small crew numbers~~
~~10. Provision for shore leave and onboard recreation, family communication~~
~~11. Watchkeeping arrangements~~
~~12. Job rotation~~
~~13. Improved sleeping berths and accommodation~~

14. Adequate quality and quantity of food for proper nutrition
15. Read Modules 2-4 for additional potential managerial mitigation tools
16. Modification of present ship design or future designs
17.

4What rules and regulations are in place to prevent and deal with fatigue?]

87 As discussed in the previous sections, Chapter Chapter VIII, Section A-VIII/1 (Fitness for duty) of the STCW Code onvention 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. ers. However, ilt does not stipulate minimum requirements for for those not keeping watches other persons. The limits described in Table Section A-VIII/1 VIII/1 of the STCW Cconventionode have been incorporated into national regulation in some countries. This action was taken in order to comply with the international requirement as stated in Chapter VIII, Regulation VIII/1 of the STCW Convention of the STCW convention so that "*Eeach Aadministration shall, for the purpose of preventing fatigue e… 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". watchkeepers*."

88 In addition to the STCW Cconvention, the International Labour Organisation Organization has developed ILO Convention No 180 (Seafarers Hours of Work and the Manning of Ships 1996).Maritime Labour Convention (MLC) 2006 This convention requires governments members to *ensure that "the hours of work or hours of rest for seafarers are regulated" and "shall establish maximum hours of work or minimum hours of rest over given periods that are consistent with the provisions in the Code".*
establish a work hour regime for crew members based on either minimum rest hours or maximum working hours, which can be undertaken in a single day or over a seven-day period. ILO 180 has not yet entered into force; however, this convention has been included in the new Protocol to ILO 147 (Merchant shipping convention). Nations that have ratified ILO 147 will be entitled to inspect foreign flagged ships to determine whether work standards, as required by ILO 147, are being complied with once the Protocol has been ratified by a sufficient number of countries and enters into force.
Regulation 4.3 of MLC 2006 also requires the application of health and safety protection and accident prevention to *"ensure that seafarers' work environment on board ships promotes occupational safety and health*". In particular is the requirement for each Member to *"develop and promulgate national guidelines for the management of occupational safety and health on board ships that fly its flag".*

89 Both the STCW 78 as amended /95 and the 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.
Experience with the limits — set by STCW and ILO 180 — is needed to verify which conditions require supplemental information or modifications. However, tThese requirements set out in the STCW and MLC represent one line of defense in mitigation the risk of fatigue and must be examined with respect to other factors such as 'duty scheduling and planning'. 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.

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

combination with and the use of fatigue risk management tools, where available, will become is now necessary.

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MODULE 3 4
FATIGUE AND THE ~~MASTER~~ SEAFARER

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 ~~It is~~ recommended that all seafarers become familiar with Module 1 (Fatigue - Causes and Consequences) ~~first~~. ~~Management level officers (master and officers) should also become familiar with~~ and Module 2 (Fatigue and the Company).

2 As ~~highlighted~~ described in Module 2, ~~the responsibility for~~ mitigating and managing the risk of fatigue ~~risks and minimizing the risk to safety~~ is a shared responsibility between the ~~c~~Company ~~(as your employer)~~ and all seafarers ~~yourself~~ ~~(as the employee)~~. The ~~c~~Company is primarily responsible for creating a work and living environment that minimizes the risk of fatigue~~-related risks~~. This includes, but is not limited to, safe work scheduling, adequate resources, the provision of a healthy living environment and raising awareness on the risk of fatigue. It is important that the ship is sufficiently and efficiently manned to meet all situations and conditions, including emergencies. ~~You~~ All seafarers are responsible for ensuring that time available for rest and sleep is used appropriately and their ~~you're~~ behaviour ~~does not~~ creates an environment that minimises the ~~or increase~~ risk of fatigue.

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 and a variety of working arrangements which means that at some point ~~you~~ seafarers may ~~are likely to~~ experience fatigue. ~~[1-3]~~. Fatigue can affect~~s~~ all seafarers ~~individuals~~, regardless of skill, rank, knowledge or training.]

[4 ~~As highlighted in~~ Module 1~~,~~ explains that 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 cycle);~~

.4 staying awake for very long periods;

.5 stress; and

.6 workload (prolonged mental and/or physical exertion).]

[5 Fatigue may also be made worse by one or a combination of factors. These include, ship operational factors (work schedules, workload, etc.), adverse environmental conditions (constant/irregular noise, light, ship motion, etc.), stress and health (medical condition, sleep disorders, use of supplements, diet, etc.).~~-~~(sSee Module 1 for more detail). ~~These factors alone, or in combination may also contribute to inadequate restorative sleep.~~]

[9 ~~etc. Your level of alertness is dependent on~~ When fatigued, seafarers' ~~and therefore human~~ physical and mental performance is more likely to be impaired.~~–~~This means that in some cases seafarers may not be able to continue to conduct shipboard tasks safely and efficiently. Fatigued individuals are poor judges of their own level of fatigue and hence performance, largely because fatigue can affect their ability to make judgments or solve complex problems.]

[6 ~~When determining why fatigue has occurred, there is often a focus on sleep. This is because b~~Both the quantity and quality of sleep are important for preventing and recovering~~y~~ from fatigue

and for maintaining alertness and performance. Sleep loss and sleepiness may ~~can~~ degrade ~~every aspect of~~ a person's performance~~,~~ including mental, physical and behavioural. ~~Studies found~~ ~~t~~The effect of sleep debt on performance has been found to be comparable to alcohol impairment.~~, in terms of negatively impacting performance~~ [4, 5].]

~~7 Also, as we get older, it generally becomes more difficult to get to sleep when we want to sleep and to stay asleep. This is particularly true during daytime sleep, but even night-time sleep may prove to be more challenging as we get older. Frequent awakenings can lead to increased sleepiness when you are awake.~~

8 Working at sea may limit seafarers' opportunity for sleep and recovery in each 24-hour period. ~~Seafarers working during the night, especially during their circadian low, will in most cases be working while they are fatigued. These~~ ~~h~~Hours of work may also limit the amount of time available for sleep. There are also particular circumstances ~~times~~ when the risks associated with fatigue are increased, regardless of the ~~relationship between fatigue and recovery~~ quantity and quality of sleep. ~~Times when~~ ~~f~~Fatigue risk levels may be ~~are~~ particularly high when ~~include~~:

.1 ~~When~~ working during ~~the~~ circadian lows;

[.2 ~~When~~ regular short breaks have not been taken;]

.3 working for an excessive period of time; ~~When duty schedules are longer than 8 hours~~;

.4 working during scheduled rest periods due to planned operational requirements (i.e. berthing, bunkering etc.). It is difficult to sleep outside of normal rest periods in preparation; ~~Early duty starts. Early start times~~ ~~. often shorten sleep obtained. This is because most people often find it difficult to go to bed earlier in compensation and find it hard to get to sleep quickly if they do go to bed early;~~

adjusting to a new schedule;

.5 ~~new to the job or ship. When learning a new job and/or getting to know a new ship and crew is often challenging. Some individuals may find they do not sleep well during the first week on a new ship~~. ~~This is especially worse if they are suffering from jet lag.~~

suffering from jet lag.

~~1.~~How can ~~you~~ seafarers recognize fatigue in themselves ~~yourself~~ and in others (signs/symptoms)?

9 ~~Fatigue can affect your mind, body and emotions and body (e.g. your capacity ability to perform for tasks involving physical exertion and strength, as well as your ability to solve complex problems or make decisions) etc. Your level of alertness is dependent on When fatigued, your and therefore human performance can be is impaired, which means that in some cases you cannot continue to perform shipboard tasks safely and efficiently. A dangerous aspect is that fatigued individuals are poor judges of their own level of fatigue and hence performance, largely because fatigue can affect their ability to make judgments or solve complex problems.~~

10 ~~Fatigue-related signs and symptoms are often divided into three categories: mental, physical and behavioural.~~ Table 1.1 in Module 1 ~~describes some of the possible effects of fatigue by listing~~ lists ~~these~~ three categories (mental, physical, and behavioural) of fatigue signs and symptoms ~~into the three categories (mental, physical and behavioural)~~. These signs and symptoms of fatigue may be used to identify an individual's level of alertness. ~~performance impairments and the symptoms associated with them~~. ~~These signs and symptoms of fatigue may be used to identify an individual's level of alertness~~. ~~It must be noted, however, that it is difficult for an individual to recognize the symptoms of fatigue within him/herself, because fatigue impairs judgement~~. ~~You~~ A

seafarer may recognize some of these signs and symptoms in others (with time, ~~you~~ seafarers may learn to identify some within ~~yourself~~ themselves).

11 Some of the more visible signs and symptoms include:

.1 Mental

- Focuses on a trivial problem, neglecting more important ones
- ~~Less vigilant than usual~~ Slow or no response to normal, abnormal and emergency situations
- Lapses of attention
- ~~Misjudges~~ Poor judgment of distance, speed, time, etc.
- Forgets to complete a task or part of a task
- Difficulty concentrating and thinking clearly
- ~~Fails to remember the sequence of task or task elements~~

.2 Physical

- Inability to stay awake (an example is head nodding or falling asleep involuntarily)
- Difficulty with hand-eye coordination ~~skills~~ (such as operating controls ~~switch selection~~)
- Speech difficulties (it may be slurred, slowed or garbled)
- Increased frequency of dropping objects like tools or parts
- Insomnia

.3 Behavioural

Decreased tolerance and anti-social behaviour

- Increased mood changes (examples are irritability, tiredness and depression)
- Ignores normal checks and procedures
- Increasing omissions and carelessness

12 It is important to address fatigue not only for reasons of safety but also ~~L~~long-term health effects ~~as~~ because sleep debt ~~loss~~ may also lead to cardiovascular diseases, gastro-intestinal diseases, mental health problems and stress [~~6, 7~~].

13 The more of the signs and symptoms ~~you~~ seafarers experience or observe in others, the more likely it is that alertness is significantly reduced. It is important that the seafarer ~~you~~ notifies~~y~~ their ~~your~~ supervisor (or management level seafarers ~~officers~~) when ~~you~~ they observe fatigue symptoms in themselves ~~recognize that you~~ or other crewmembers ~~are fatigued~~. It is important to have open communication between ~~you~~ seafarers and ~~your~~ supervisors regarding the risk of fatigue, its mitigation and management ~~prevention and detection~~. ~~Your~~ TheeCompany~~'s fatigue risk management (FRM) processes~~ should support ~~allow for~~ open communication and reporting ~~between you and your supervisor (or management level seafarers officers)~~ regarding the risk of fatigue, its mitigation and management ~~prevention and detection~~. Reporting is important as it assists the Company to make an accurate assessment of the risk of fatigue and take appropriate measures, which may include adjustments to workload and/or manning levels.

TABLE 1
EFFECTS OF FATIGUE

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

14 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

WHAT CAN CAUSE FATIGUE?

15 Fatigue may be caused and/or made worse by one or a combination of things:
Lack of sleep
16 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)

17 Poor quality of sleep
18 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)

19 Insufficient rest time between work periods
20 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)

21 Poor quality of rest
22 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.

23 Stress
24 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.

25 Boring and repetitive work
26 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.

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

29 Ship movement
30 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.

31 Food (timing, frequency, content and quality)
32 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.~~

~~33 Medical conditions and illnesses~~
~~34 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.~~

~~35 Ingesting chemicals~~
~~36 Alcohol, caffeine and some over the counter medications disrupt sleep. Caffeine consumption can also causes other side effects such as hypertension, headaches, mood swings and anxiety.~~

~~37 Jet lag~~
~~8 Excessive work load~~
~~40 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:~~
~~41 Increased accident and fatality rates~~
~~42 Increased dependence upon drugs, tobacco or alcohol~~
~~Poor quality and disrupted sleep patterns~~

~~43 Higher frequency of cardiovascular, respiratory or digestive disorders~~
~~44 Increased risk of infection~~
~~Loss of appetite~~

~~2~~What can seafarers do ~~How can prevent~~ to mitigate ~~help reduce~~ and manage~~ing~~ the risk of ~~the onset of~~ fatigue on board ships?

~~45~~ Obtain adequate sleep ~~Issues~~

45 The most effective strategy to fight fatigue is to obtain ~~ensure that you get the~~ very good ~~best~~ quality and quantity of sleep. ~~The provision of adequate sleep opportunity is important to ensure adequate sleep~~. ~~Sleep loss and sleepiness can degrade every aspect of human performance such as decision-making, response time, judgement, hand-eye coordination, and countless other skills.~~ ~~As indicated in module 2, [~~Whilst it is the ~~c~~Company's responsibility to ~~should~~ provide ~~the seafarer you with an~~ adequate sleep opportunity], seafarers should ensure that the time provided for rest and/or sleep is used appropriately. ~~for recovery. In order to be effective in satisfying your body's need, sleep must meet three criteria, and include:~~

- ~~Quantity~~ Duration
- ~~Quality; and~~
- ~~Continuity.~~

~~46 Duration~~
~~.1 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.~~

47 Sleep is most valuable if obtained in a single block. Whilst a~~A~~ short sleep or nap can provide a powerful boost to alertness,~~.~~ ~~However, it is important to know that napping~~ it does not eliminate the need for sleep.

~~.1 Continuity~~

~~48 Sleep should be uninterrupted. Six one-hour naps do not have the same benefit as one six-hour period of sleep.~~

~~.1 Quality~~

~~49 People need deep sleep. All sleep is not of the same quality and does not provide the same fully recuperative benefits.~~

50 There could be instances in which a seafarer ~~you~~ may not obtain adequate sleep, even though ~~you~~ they are provided with adequate sleep opportunity. Aspects mentioned below can all affect the quantity and quality of sleep obtained:

.1 ~~you are~~ working during the night ~~and~~ may mean that a seafarer is ~~simply be~~ unable to sleep during the day;

adjusting to a new watch schedule and recovering from jet lag;

.2 ~~your~~ sleep may have been interrupted by shipmates ~~colleagues~~, unexpected events or operational demands ~~(role-dependent)~~;

.3 ~~you~~ may suffer from a sleep disorder (see Module 1), or other medical or physical problem that keeps ~~you~~ a seafarer awake;

.4 emotional stress, for example due to family problems at home and/or concerns about work;

~~.5 inability to get to sleep due to concerns about work or other worries;~~

.6 the sleeping environment (comfort, constant/irregular noise, darkness, ship motion, privacy, etc.) may not allow for adequate sleep;

.7 the type of food and the time that ~~food~~ it is consumed;

.8 medication or use of prescribed/over the counter/natural remedies;

.9 consumption of stimulants (i.e. caffeine, amphetamines, energy drinks ~~alcohol~~);

consumption of alcohol;

.10 use of personal electronic devices (and other sources of blue light) before sleep, which may delay the onset of sleep and not allow adequate sleep to be obtained; and

.11 social and physical activities or excitement ~~high arousal~~ just before ~~you're~~ a sleep period~~, and inability to sleep~~.

51 Regardless of the circumstances causing insufficient or poor quality sleep, these should ~~preferably~~ be identified ~~through~~ proactively ~~measures~~ and treated as a potential shipboard hazard. ~~This is an important aspect of any safety risk management program that includes the need to report sleep related issues.~~

52 Seafarers should make themselves aware of ~~the~~ Company procedures in place ~~The company should have processes in place (Module 2)~~ to provide feedback on risk to fatigue, and use them appropriately. ~~you the opportunity to report back situations when you have been unable to obtain adequate sleep or feel at risk of making errors., specifically if conducting safety critical tasks (such as navigating in congested waters or in proximity of navigational hazards, stand-by conditions, etc.)~~.This can be ~~as simple as~~ through verbally reporting to ~~you're~~ the supervisor,

management level seafarers ~~officers~~ and/or the ship's safety committee. ~~or by utilising a sleep diary to monitor your sleep~~. ~~Keeping a sleep diary is one way to keep track and monitor sleep. Appendix 3 provides an example of a simple subjective sleep diary that can be used. Objective measures such as activity monitor watches (see Module 2) can also be used to monitor sleep.~~

~~53 If you continue experiencing inadequate sleep and the opportunity for recovery from work is not provided, this will prolong fatigue putting your health, well-being and safety of the ship at risk.~~

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

.8 Whenever possible, allow for ~~ensure that you give yourself~~ enough time in bed for plenty of sleep;~~.~~

.9 As much as possible, ~~should~~ try and ensure ~~you~~ they ~~that you will have no~~ are not interrupted ~~ions~~ during ~~you're~~ their ~~extended~~ period of sleep;~~.~~

.5 Avoid stimulating activities prior to sleep such as exercise, television, ~~and~~ movies~~, etc.~~ and if possible limit the use of personal electronic devices;~~.~~

.11 Avoid ~~alcohol and caffeine~~ alcohol, caffeine and other stimulants prior to sleep (check labels and keep in mind that coffee, tea, colas, chocolate, and some medications, ~~including cold remedies and aspirin~~ contain alcohol and/or caffeine). If possible, ~~A~~avoid caffeine at least ~~six~~ four hours before bedtime;~~.~~

.4 Get sufficient sleep, especially before a period when ~~you~~ it is expected that time for adequate sleep will not be available;~~. A white noise generator or ear plugs can be of used if you can sleep with them in.~~

.1 If possible, develop consistent sleep times (i.e. try to go to bed at the same time every day);

.2 Develop and follow a pre-sleep routine to promote sleep at bedtime (e.g. ~~a warm shower,~~ reading calming material~~, or just making a ritual of pre-bed preparation~~). Try and avoid eating before sleeping;

~~3~~ Get sufficient sleep, especially before a period when you expect that time for adequate sleep will not be available.6 Make the sleep environment conducive to sleep (a dark, quiet and cool environment, sources of blue light eliminated and a comfortable bed encourages sleep);~~.~~

.7 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; and

~~10 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).~~

~~12 Consider r~~Relaxation techniques may help (such as meditation). ~~and yoga, which can also be of great help if learnt properly.~~

.13 ~~Avoid alcohol, 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 four hours before bedtime.~~

~~.14 Do not nap during the day if you have difficulty sleeping during your normal sleep period.~~

~~.15 Limit the use of personal electronic devices prior to bed time.~~

Maintaining fitness for ~~duty~~ work ~~Guidelines on maintaining performance~~

55 Ensuring ~~you~~ that seafarers are fit for ~~duty~~ work and able to maintain safe levels of alertness and performance is important. ~~Taking responsibility for your duty schedules and rest periods and p~~Providing feedback to ~~your~~ supervisors, management level seafarers ~~officers~~ and the ~~c~~Company is important to ensure that ~~you~~ seafarers are provided with the best possible opportunity to maintain fitness for ~~duty~~ work.

56 In some cases~~,~~ monitoring and assessing ~~your level of~~ individual fatigue on board ships, in particular prior to ~~your duty~~, work periods ~~schedule can~~ might be helpful to assess the results of efforts to mitigate and manage the risk of fatigue at sea. ~~in ensuring you are able to perform tasks safely.~~ There are a number of methods and tools that may ~~can~~ be used to assess fatigue levels ~~how you feel~~ prior to and during ~~your duty~~ work periods (~~see~~ Appendix 5 and 6). ~~This can be done through: self-monitoring (Appendix 4 - Subjective Fatigue and Sleepiness Ratings), and fatigue assessment (Appendix 5 - Fatigue Self-Assessment Tool).~~ [These tools can also be used as a discussion point prior to ~~duty~~ work hand-over.~~] It is important to report (to your supervisor and/or management level officers) 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. This is important as it provides a way of defending the vessel against threats to safety, and forms an integral part of fatigue risk management (FRM).~~

57 Some ships may have systems in place to monitor and assess seafarer sleep and fitness for work ~~duty~~. It is important that ~~you~~ seafarers contribute to this process. ~~This information provides an indicator to the management level officers and the company of fatigue levels~~.

58 ~~Here~~ Below ~~are~~ is some general guidance~~ines~~ that ~~can~~ may help ~~you~~ seafarers maintain ~~performance~~ fitness for ~~duty~~ work:

~~.1 Get sufficient sleep, especially before a period when you expect that time for adequate sleep will not be available.~~

~~.2 Ensure continuous periods of sleep.~~

9 The seafarer should review their ~~Maintain a~~ ~~Develop and maintain good sleep habits, e.g. develop a pre-sleep routine. R~~recordsRecord ~~and report actual~~ of ~~your~~ daily hours of work and rest for accuracy. ~~Apart from being~~ This is a regulatory requirement and ~~these~~ may assist with managing the risk of fatigue; ~~an indicator on whether your workload is manageable by maintaining individual records of hours rested or worked~~;

.8 Report any fatigue impairment in themselves and others that could have or may have the potential of effecting ship safety;

.3 Take strategic naps (the most effective length of time for a nap is about 20 minutes);

.4 Take short breaks when scheduled ~~short breaks are assigned~~;

~~.5 Develop and maintain good sleep habits, e.g. develop a pre-sleep routine.~~

[.6 Whenever possible, monitor and effectively manage ~~your~~ sleep (can use Appendix 3);]

.7 Whenever possible, maintain and monitor fitness for work ~~duty including medical fitness~~ (can use Appendix 4 and Appendix 5);]

~~.8 Report any fatigue impairment in and others that could have or may have the potential of effecting ship safety;~~

~~.9 The seafarer should review the Rrecord and report actual hours of work and rest. Apart from being a regulatory requirement and these an indicator on whether your workload is manageable by maintaining individual records of hours rested or worked;~~

.10 Eat regular, well-balanced meals and exercise regularly; and ~~Try and avoid eating right before sleeping. Try and exercise regularly~~

.11 Limit the use of seasickness medication (if ~~you are~~ using medication ~~inform your~~ shipboard supervisor or management level seafarer should be informed).

Strategies that provide short term relief

~~59 The most powerful means of relieving fatigue is to get proper sleep and to rest when appropriate. However,~~ A number of ~~countermeasures~~ strategies have been identified as potentially providing some ~~short-term~~ relief in mitigating and managing fatigue. It must be emphasized that these ~~countermeasures~~ strategies 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, adequate sleep must be obtained for physical and mental recovery to occur. The following list captures some of these ~~management~~ strategies ~~short-term countermeasures~~:

.1 Short rest breaks within ~~duty~~ work periods.

~~Rest, apart from sleep, can be provided in the form of~~ sShort breaks or changes in activities during ~~the~~ long ~~duty~~ work periods can benefit performance. ~~Rest pauses or~~ Short breaks ~~are indispensable~~ may be helpful ~~as a physical requirement~~ if performance is to be maintained over long periods of time. For example, whilst on watch or conducting demanding physical work activities, taking 5-10 minutes break when it is safe to do to reduce the risk of fatigue. ~~Factors influencing the need for rest a 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.~~ The practical issues in a shipboard environment are ~~It is~~ recognised, ~~that in a shipboard environment this may not always be feasible,~~ however as much as possible short breaks should be planned into the ~~duty~~ work period.

.2 Strategic napping

[Unauthorized napping while on watch or duty is not acceptable.] ~~A~~ However a short sleep or nap whilst off work can provide a powerful boost to alertness. ~~Research has identified s~~Strategic napping ~~a~~is a short-term relief technique to help maintain performance levels during long periods of wakefulness or if sufficient longer sleep is occasionally missed. Naps as short as 10 to 15 minutes are known to deliver measurable benefits. The most effective length of time for a nap is about 20 minutes. ~~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 are taken in the way that ~~you believe~~ best suits ~~you~~ each individual seafarer. Napping should be encouraged to be a planned activity of fatigue management ~~and prevention~~. This means that if ~~you~~ a seafarer has~~ve~~ the opportunity to nap ~~you~~ it should be taken ~~it~~.

However, seafarers need to be aware that naps ~~there are some drawbacks associated with napping. One potential drawback is~~ 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 Caffeine ~~Food and consumption of chemicals~~

Another popular fatigue countermeasure is the strategic use of caffeine (encountered in coffee and tea, some energy drinks, and to a lesser extent in colas and chocolate) as a stimulant. 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. If possible, Ccaffeine should be avoided before bedtime. In addition, However regular usage over time reduces its value as a stimulant and may make you a seafarer more tired and less able to sleep. Caffeine consumption can also cause other side effects such as hypertension, headaches, mood swings and anxiety.

3 What strategies can be used to help mitigate the effects of fatigue?

•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.

.4 Nutrition and Hydration

Adequate nutrition and hydration is also important for managing and preventing fatigue. To be as alert and awake as possible, a seafarer needs to monitor hydration level. Ideally, one should have a balanced diet, eat regularly, have healthy snacks, eat breakfast, plan meals, and drink water and appropriate fluids regularly and avoid late night meals (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. Refer to module 1 for more information.

.5 Environment (light, temperature, humidity, and sound, and aroma)

Bright lights, cool dry air, obtrusive or loud music or other annoying irregular sounds may temporarily increase alertness. Refer to module 2 for more information.

.6 Muscular Physical activity

Physical well-being has a number of key components: notably exercise, diet, hydration, and sleep. Any type of physical activity helps to keep you seafarers alert; running, walking and stretching or even chewing gum can stimulate your anyone's 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, improved ability to cope with better stress, coping, and enhanced self-esteem and well-being. All of these benefits assist in managing fatigue.

.7 Social Interaction

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

.8 Job Rotation

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

60 An important consideration is that wWhen feelings of fatigue levels are high, seafarers may try to reduce the likelihood of fatigue related errors by using some of the methods as mentioned in this Module control fatigue 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 circumstances when ~~instances that~~ high levels of fatigue cannot be mitigated and managed ~~control~~ by individual methods ~~countermeasures~~. Hence, prompt, consistent, and appropriate action is required (by the management level seafarers ~~officers~~ through ~~c~~Company support) whenever a crewmember is potentially not fit for ~~duty~~ work. This may include the need for additional actions (such as ~~task rotation,~~ additional supporting resources, etc.) for managing the risk of fatigue ~~related risks~~. The aim should be to maintain and promote safety.

~~4What are the seafarers' responsibilities in fatigue risk management on ships?~~

61 ~~As highlighted in~~ section 3~~, there are~~ This module provides information on a number of ~~steps~~ measures that can be taken to mitigate and manage ~~and reduce~~ the risk of fatigue on ships. ~~Many of the~~ Some factors contributing to fatigue ~~measures that reduce fatigue~~ are ~~unfortunately~~ beyond the individual seafarers' control ~~a single person's ability to influence~~, such as voyage scheduling, cargo operations, ship design, and work scheduling which can all affect the quality and quantity of sleep. Therefore, the particular nature of fatigue as a safety hazard makes managing shipboard fatigue and associated risks the shared responsibility of the ~~c~~Company ~~(as the employer)~~ and the seafarer ~~(as the employee)~~. ~~Both must be aware of the risks involved, especially the impact of various types of duty and work schedules~~.

61 ibis [This Module has provided information for seafarers on recognizing symptoms of fatigue and outlined a number of approaches they may take to mitigate or manage fatigue on board ships. Although some factors contributing to fatigue may be beyond an individual seafarer's control.]

62 The following is a list of some of the responsibilities seafarers have related to the mitigation and management of fatigue on board ships ~~Seafarer responsibilities include:~~

.5 Being aware of fatigue and how to counter its effects;

.2 Monitoring and effectively managing hours of sleep;

.6 Using available rest periods appropriately;

.3 Reporting fatigue related events that affect safety;

.4 Maintaining appropriate communication about safety; and

.1 Making best effort to commence ~~Commencing~~ their ~~duty~~ work schedule in a fit state to work the expected duty length and capable of performing assigned shipboard work safely;

~~.2 Monitoring and effectively managing hours of sleep.~~

~~.3 Reporting fatigue related hazards that effect safety in accordance with the ship's safety management system;~~

~~.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.~~

63 Seafarers should monitor and seek appropriate treatment for their health and general well-being, as physical health can impact on fatigue. Health and well-being is affected by ~~short-term (acute) and (chronic) long-term~~ many things including physical and mental condition, genetic predispositions, nutrition, hydration and sleep difficulties. A wide range of sleep difficulties can affect fatigue, circadian functions, sleep duration and sleep quality. ~~This includes a diversity of sleep disorders as indicated in Module 1. Hence, w~~When managing fatigue, seafarers ~~are~~

~~responsible to~~ should ~~monitor and manage~~ report any health concerns that may impact on their fitness for ~~duty~~ work.

~~64 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 effects;~~

~~.5 Providing an adequate sleep environment on the ship;~~

~~.6 Ensuring all crew are trained and aware of the causes and consequences of fatigue;~~

~~.7 Promoting a safety reporting culture and open communication; and~~

~~.8 Continuously assessing, controlling, monitoring and evaluating fatigue-related hazards.~~

[65 What can management level seafarers ~~officers~~ do ~~be done~~ to help ~~reduce and~~ mitigate and manage the risk of ~~seafarer~~ fatigue on ~~board~~ ships?]

[66 The following provides a recommended list of important fatigue management strategies ~~Steps such as the following are important~~ for mitigating and managing ~~in controlling and reducing~~ the ~~prevention~~ risk of fatigue on board ships, and may be ~~are~~ within the management level seafarers' ~~officers'~~ ability to influence and/or implement:

.1 ~~Ensuring c~~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~~ scheduled to ~~go on~~ ~~watch~~ ~~duty~~ work as soon as they arrive on board (e.g. allowing proper time to overcome fatigue~~ and become familiarized with the ship~~);

.3 Are aware of and promote the implementation of the Company's fatigue management policies; ~~Impressing upon shore management the importance and benefits of addressing fatigue management and countermeasures in the context of the company's Safety Management System (as required by the International Safety Management Code) and highlighted in Module 2~~;

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

.5 ~~Setting standards and policies to a~~Allowing time for communication at watch/~~duty~~ work handovers;

.6 ~~Ensuring~~ Providing nutritious food options are served on-board and crew have continuous access to drinking water;

.7 Providing nighttime personnel with ~~appropriate~~ healthy meal options ~~choices~~;

~~.8 Impressing upon shore management the importance of the~~ Maintaining constant interaction between shore management and the ship management with respect to fatigue awareness and ~~preventive~~ mitigation measures ~~on board the ships~~;

.9 Creating an open communication environment~~, by making it clear to the~~ where crew can report ~~that it is important to inform supervisors~~ when fatigue is impairing their performance ~~or that of others and ensuring that there will be no~~ without recrimination~~s for such reports~~;

.10 Ensur~~e~~ing that ~~selected~~ seafarers can do the job for which they are assigned to prevent the potential for fatigue in other crew members;

.11 Improving shipboard conditions to ensure that when there is an opportunity to sleep, crew members can take advantage of it without interruptions, e.g. by scheduling drills and routine maintenance functions in a manner that minimizes the disturbance of rest/sleep periods. All relevant crew should be aware of these protected sleep opportunities;

~~.12 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 Arrangements" and "Model Format for Records of Hours of Work or Hours of Rest of Seafarers");~~

.13 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);

.14 Avoid scheduling potentially hazardous tasks during the circadian lows of the seafarers involved, when practicable;

.15 ~~Provide~~ Facilitating training and support for seafarers to recognize and deal with the effects of fatigue ~~including onboard training if provided~~;

.16 Emphasizing the ~~relationship~~ seafarers' responsibility to sleep during ~~between work and~~ rest periods to ensure that adequate ~~rest~~ sleep is ~~received~~ obtained;

~~.17 Encourage and facilitate reporting on sleep issues, fatigue and fatigue-related events that effect shipboard health and safety;~~

.18 Taking time to ~~personally verify~~ monitor that ~~watchkeeping~~ all personnel are getting adequate ~~rest~~ sleep;

.19 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 constant/irregular noise are taken care of at the first opportunity);

.20 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)~~;

.21 Promoting supportive relationships on board (good morale) and dealing with interpersonal conflict between seafarers. If there are instances of harassment and bullying, this may cause stress which can effect sleep. This should be appropriately managed;

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

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

~~6What rules and regulations are in place to prevent and deal with help manage fatigue?~~

~~67 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.~~

~~68 The following international organizations have issued various conventions and other mandatory instruments that address fatigue:~~

~~.1 *International Labor Organisation (ILO)*~~
~~*Convention Concerning Seafarers' Hours of Work and the Manning of Ships – ILO Convention No.180*[6]~~*;*

~~.2 International Maritime Organization (IMO)~~

- ~~International Convention on Standards of Training Certification and Watchkeeping for Seafarers, 1978, as amended in 1995 (STCW Convention) (STCW Convention)7; Seafarer's Training, Certification and Watchkeeping Code (STCW Code) Parts A8 and B9;~~
- ~~International Safety Management Code (ISM Code); and various guidelines/recommendations.~~
- ~~IMO Resolution A.1047(27) Principles of Minimum Safe Manning~~

~~.3 International Labor Organization (ILO)~~

- ~~Maritime Labor Convention (MLC), 2006 (Regulations, Standards and Guidelines)~~

~~69 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.~~

~~6How does fatigue relate to these ILO and IMO instruments?~~

~~70 The following ILO instruments contain guidance on fatigue related aspects:~~

~~.1 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.~~

~~.2 Other Conventions~~
~~Other ILO Conventions related to fatigue include the following convention numbers: 92, 133, 140, 141 and 147. Each introduces minimum habitability requirements (e.g. noise control and air conditioning) on board ships.~~

~~6 Not yet in force.~~

7 Mandatory instrument.
8 Mandatory instrument.
9 Recommendatory guidance.
10 Mandatory instrument.

71 The following IMO instruments contain guidance on fatigue related aspects:

.1 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.

.2 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.

.3 Resolution A.772(18) [11] – Fatigue Factors in Manning and Safety

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

72 Other Instruments

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

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Guidelines on Fatigue Module 2

FATIGUE AND THE RATING

Foreword

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

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

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

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

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

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

Guidelines on Fatigue Module 2

FATIGUE AND THE RATING

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

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

A. Physically:

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

B. Emotionally:

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

C. Mentally:

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

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

2. WHAT CAN CAUSE FATIGUE?

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

- Lack of sleep

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

- Poor quality of sleep

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

- Insufficient rest time between work periods

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

- Poor quality of rest

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

- Stress

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

- Boring and repetitive work

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

- Noise or vibration

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

- Ship movement

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

- Food (timing, frequency, content and quality)

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

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

- Medical conditions and illnesses

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

- Ingesting chemicals

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

- Jet-lag

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

- Excessive work load

Working consistently "heavy" workloads can cause fatigue. Workload is considered heavy when one works excessive hours or performs physically demanding or mentally stressful tasks. Excessive work hours and fatigue can result in negative effects such as the following:

- Increased accident and fatality rates
- Increased dependence upon drugs, tobacco or alcohol
- Poor quality and disrupted sleep patterns
- Higher frequency of cardiovascular, respiratory or digestive disorders
- Increased risk of infection
- Loss of appetite

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

A. Sleep Issues

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

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

Here is some general guidance on developing good sleep habits:

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

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

B. Rest Issues

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

C. Guidelines for maintaining performance

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

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

4. WHAT CAN MITIGATE THE EFFECTS OF FATIGUE?

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

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

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

Strategic Napping

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

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Guidelines on Fatigue Module 3

FATIGUE AND THE SHIP'S OFFICER

Foreword

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

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

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

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

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

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

Guidelines on Fatigue Module 3

FATIGUE AND THE SHIPS'S OFFICER

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

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

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

TABLE 1
EFFECTS OF FATIGUE

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

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

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

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

2. WHAT CAN CAUSE FATIGUE?

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

□ Lack of sleep

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

□ Poor quality of sleep

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

□ Insufficient rest time between work periods

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

□ Poor quality of rest

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

- Stress

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

- Boring and repetitive work

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

- Noise or vibration

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

- Ship movement

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

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- Food (timing, frequency, content and quality)

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

- Medical conditions and illnesses

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

- Ingesting chemicals

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

- Jet-lag

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

- Excessive work load

Working consistently "heavy" workloads can cause fatigue. Workload is considered heavy when a person works excessive hours or performs physically demanding or mentally stressful tasks. Excessive work hours and fatigue can result in negative effects such as the following:

- Increased accident and fatality rates
- Increased dependence upon drugs, tobacco or alcohol
- Poor quality and disrupted sleep patterns

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

3. HOW CAN PEOPLE PREVENT THE ONSET OF FATIGUE?

Sleep Issues

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

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

- Duration

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

- Continuity

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

- Quality

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

Here are some general guidelines on developing good sleep habits:

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

Rest Issues

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

C. Guidelines for maintaining performance

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

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

4. WHAT CAN MITIGATE THE EFFECTS OF FATIGUE?

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

- Interest or opportunity

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

- Environment (light, temperature, humidity, sound, and aroma)

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

- Food and consumption of chemicals
- Caffeine (encountered in coffee and tea and to a lesser extent in colas and chocolate) may combat sleepiness in some people for short periods. However, regular usage over time reduces its value as a stimulant and may make you more tired and less able to sleep.

Muscular activity

Any type of muscular activity helps to keep you alert; running, walking, stretching or even chewing gum can stimulate your level of alertness.

- Social Interaction

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

- Job Rotation

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

- Strategic Napping

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

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

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

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

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

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

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

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

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

- Scheduling potentially hazardous tasks for daytime hours

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

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

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

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

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

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

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

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

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

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

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

[2] Mandatory instrument.

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

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

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

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

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MODULE 4 ~~X5~~

FATIGUE AWARENESS 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 the training~~ on fatigue awareness and training.

What are the objectives of raising awareness and training on fatigue?

2 Fatigue awareness and training ~~and awareness~~ are essential components for effectively mitigating and managing the risk of fatigue ~~risk management~~. Fatigue ~~can~~ awareness and training should be ~~defined and described~~ taught ~~The goal of fatigue training is~~ in a way that can assist trainees ~~students~~ and seafarers to understand ~~the general concept of fatigue~~ and ~~be able to~~ relate to it personally. Trainees and ~~S~~seafarers ~~will at some point be required~~ may need to make operational decisions based on their knowledge of fatigue. Hence, fatigue awareness and training should be provided to all personnel who work on ships~~, including~~ (and those ashore ~~based personnel~~ who contribute to mitigating and managing fatigue) ~~risk management need to have appropriate training~~. ~~This~~ Achieving ~~this goal will create a foundation upon which the more specific topics of seafarer fatigue can be addressed~~.

[2b The STCW Code Part A (Section A-VI/1 Table A-VI/1-4) requires fatigue training before being assigned to any shipboard duties for "seafarers employed or engaged in any capacity on board ships, on the business of that ship, as part of the ships complement with designated safety or pollution prevention duties in the operation of the ship". The IMO Model Course 1.21 *Personal Safety and Social Responsibilities* (2016 Edition) contains further information to support this requirement.]

3 ~~As many known~~ Some fatigue mitigation and management strategies on board lie outside the power of most individual trainees and seafarers to implement (such as the rearrangement of watches, changing ship design, or modifying voyage schedules). Hence, fatigue awareness and training should not just be limited to trainees and seafarers but should also include shore based personnel ~~involved in overall operational risk assessment~~ whose decisions may impact the mitigation and management of fatigue and fatigue related processes (such as those involved in resource planning, manning of ships, and ~~duty~~ work scheduling decisions). ~~resource allocation on ships.~~

~~4 The content of training programs should be adapted according to the knowledge and skills required for each group, to play their part effectively in fatigue management. All groups require base education about the dynamics of sleep loss and recovery, the effects of the daily cycle of the body clock, the influence of workload, and the ways in which these factors interact with operational demands to produce fatigue. In addition, it is useful for all groups to have information on how to manage their personal fatigue and sleep issues.~~

~~5 The initial objectives is should be are to develop provide:~~

- ~~.1 both an awareness of the principle dimensions of fatigue and instill an acceptance that all people everyone experiences fatigue – it fatigue is not a personal shortcoming or weakness;~~
- ~~.2 knowhow 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.~~

6 ~~but rather a part of the human condition. It is inevitable that s~~Some trainees and seafarers ~~traineesstudents will resist or deny~~ may ignore or deny their own vulnerability to fatigue~~. the possibility of personally experiencing fatigue, but i~~It is essential that trainees and seafarers ~~students they~~ understand and accept the negative effects of fatigue on their performance. ~~become are aware of their own vulnerability to fatigue in order for~~ This will ensure ~~training to be~~ effective fatigue awareness and training ~~reach a full and desired effect~~.

6b Part of the awareness and training process should also include the knowledge of the concept of Human Performance and Limitation (HPL). HPL knowledge helps seafarers recognise when fatigue or other human element factors impact on safety.

~~7 The secondary objective is should be for students to knowcomprehend short and long-term fatigue symptoms, including its effects and possible preventive and mitigating measures, specifically regarding seafaring. Possible preventive and mitigative techniques for seafarers should be introduced only after a reasonable level of personalization and an acceptance of fatigue has been achieved.~~

8 ~~Many known fatigue preventive-measures/mitigating-techniques on board within the shipboard environment lie outside the power of an single individual or appear impossible to implement counteract (such as the rearrangement of four-on/eight-off watches, changing ship design, or modifying voyage schedules). This~~ The realisation that the trainees and seafarers may be unable to influence some fatigue mitigation and management measures (such as rearrangement of work schedules, changing ship design, or modifying voyage schedules) may be discouraging. ~~can discourage trainees and overwhelm students for whom fatigue is a new concept so.~~ For this reason, it is recommended ~~to~~ that instructors ~~reserve~~ avoid using these very solutions as examples for the initial introduction ~~of~~ to fatigue. ~~However, t~~These ~~particular solutions~~ examples ~~might~~ may be better ~~very well~~ suited for Company ~~shipowner/manager's s or ship and management level training sessions~~.

~~9 The tertiary objective is for traineesstudents to develop strategies for preventing or minimizing fatigue within their places of work. All points and issues raised during earlier discussions should be usedintegrated~~.

What approaches and techniques are successful for raising awareness and training ~~teaching~~ on fatigue?

~~10 Training in fatigue awareness 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 maritime training courses, or as specialized short courses. It can be taught ashore or afloat. It can be included in refresher or revalidation training.~~

9 Awareness and training is most effective when introduced topics are integrated into a meaningful and useful way for trainees and seafarers to implement in their own lives. Because of this, it is helpful to use points and issues raised during earlier discussions.

11 Part of the awareness and training ~~education~~ process should be to ensure that trainees, seafarers ~~crew~~ and shore-based personnel whose decisions may impact the management of fatigue and fatigue related processes ~~contribute to fatigue management~~ understand the necessity of getting regular rest and sleep.~~, and the~~ They should also understand the implications of being fatigued (both to themselves and to the safety of the ship and/or those working with them).

12 A wide variety of teaching techniques may be employed in order to accomplish the objectives referenced above. While the concepts of fatigue, its mitigation and management, ~~and prevention~~ must be equally stressed, it remains most important that trainees and seafarers ~~students~~ learn to

personalisze or "own" these concepts. Otherwise, the desired results will not be ~~nearly impossible to~~ achieved.

~~Classroom~~ Fatigue awareness and training outline

13 ~~It is imperative that instructors p~~Personalizseing the concept of fatigue by engaging ~~students~~ trainees and seafarers early on ~~(the initial objective).~~ and encouraging them to share their understanding of fatigue in their own words enhances learning. After trainees and seafarers have had an opportunity to share their understanding, they should develop a consensus definition of fatigue. ~~For the first objective one, gGroup discussion should be begun by inviting trainees students to share, in their own words, what they their understanding of fatigue.~~

14 ~~Once various descriptions are shared, a consensus about defining, fatigue should be reached.~~ Trainees and seafarers should ~~then~~ be encouraged and invited to share their own experiences. It is important to ~~R~~remind~~ing~~ them ~~class of the fact~~ that ~~all people~~ everyone experiences fatigue. ~~may help encourage those who previously denied any experience to acknowledge their own. In the end,~~The aim should be that ~~it is very important that~~ This process will help each individual accepts the concept of fatigue and ~~is~~ be able to relate to it personally.

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

16 Initial fatigue-related awareness and training efforts should establish a common base level of understanding ~~among seafarers and shore based Ccompany employees~~ about fatigue and the impairment it causes. This awareness and training should be provided to all trainees, seafarers and shore based personnel whose decisions may impact the mitigation and management of fatigue and fatigue related ~~processes involved in manning and duty scheduling decisions~~.

17 As a minimum ~~seafarer training should comprise~~ fatigue awareness and training for trainees and seafarers should include the following learning outcomes[2]:

Understand and take necessary actions to control fatigue

1. Importance of obtaining the necessary rest;
2. Effects of sleep, schedules, and the circadian rhythm on fatigue;
3. Effects of physical stressors on seafarers;
4. Effects of environmental stressors in and outside the ship and their impact on seafarers;
5. Effects of schedule changes on seafarer fatigue

~~.1 Ffatigue, its causes and potential consequences (contributors, consequences, high risk situations);~~

~~.2 Ssleep (circadian rhythms, body clock, sleep process, circadian low; sleep debt; 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~~

[2] As specified in the STCW Code Part A Table A-VI/1-4 and the IMO Model Course 1.21 *Personal Safety and Social Responsibilities* (2016 Edition)

fatigue (i.e. limitations of mere compliance as a fatigue mitigation strategy as opposed to a full fatigue risk management system and risk management systems);

.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.

18 Those successfully completing the above topics should be able to define fatigue, relate to fatigue on a personal level, and recognize the signs of fatigue. They will also be able to recognize and understand the characteristics of short term and long term fatigue including its effects and consequences on the seafarer. They should be aware of techniques presently known which can prevent or mitigate the effects of fatigue on ships and integrate their knowledge of fatigue risk management strategies into the workplace.

19 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.

Recommended advanced training [for shipboard management seafarers and shore base personnel whose decisions may impact the mitigation and management of fatigue and fatigue related processes]

20 Decisions on watch work schedules can affect operational fatigue mitigation and management. hHence training and awareness about factors that contribute to fatigue and how duty and watch work schedule design is crucial to fatigue risk mitigation and management should be part of more comprehensive training. This training should be directed to shipboard management level seafarers officers (master and officers) and shore based personnel whose decisions may impact the mitigation and management of fatigue and fatigue related processes. involved in manning and duty scheduling decisions. This can be integrated as part of leadership and teamworking skills as required under Section A-II/1 and Section A-III/1 of the STCW Code.

21 As a minimum, training for these personnel should comprise:

.1 Seafarer training on fatigue as indicated above;

.2 Their role in relation to fatigue hazard identification, risk assessment, evaluation and reporting;

.3 Resource allocation for workload optimizations; 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 changes can have on fatigue);

.4 Scheduling of work to minimize the effects of fatigue; The use and limitations of any duty and watch scheduling tools and models used to predict the levels of crew fatigue/alertness;

- .5 Mitigating and managing alongside activities to reduce the risk of fatigue; Processes and procedures for assessing the potential fatigue impact of planned

~~scheduling changes.~~

- .6 Enhancing the ship environment/design to provide adequate opportunity for sleep and rest.

22 ~~As in all training, the subject matter~~ Training material 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.~~ It can be taught as part of general maritime training courses, or as specialised short courses. It can be taught ashore or afloat. It can be included in refresher or revalidation training.

Why include case studies/examples?

23 It is important to incorporate case studies/examples into fatigue awareness and ~~the~~ training. These cases serve to support the "lessons learnt". Judicious use of ~~C~~case studies from all transportation industries are useful, but the majority should focus on the maritime sector as these can augment the awareness and training. ~~and preferably that sector with which the student is involved (coastal or ocean-going ships, barges, ratings, officers, etc.).~~ The cases can be used to provide a picture of what happened, probable causes, and what can be done differently to prevent a reoccurrence.

~~24 Case studies are available from a number of sources. Insurance companies (particularly the P&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 highlighted 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.~~

~~25 A final practical example could be an examination of the fatigue aspects of training itself, as part of the overall workload for both trainer and for trainees. Considerations should be given to how and where the training will be carried out. For example:~~

~~.1 Ashore and/or on the ship;~~

~~.2 Initial and refresher training;~~

~~.3 Practical and paperwork;~~

~~.4 Online training.~~

~~26 Training should be conducted on an initial (e.g. prior to commencing any operational duty) and recurrent basis. The company should decide on how best to organize and provide refresher training. A training interval of not more than 5 years is recommended, however, where the need for training is identified at closer intervals, this should be acted upon.~~

~~27 As in all training, the subject matter can be greatly enhanced by use of computers, video presentations and similar audio-visual aids.~~

~~28 The success of the training is directly related to whether or not the students personalize the concept. The instructor's professional opinion is the best way to measure the progress of the students. Likewise, it is the instructor who can best provide emphasis as needed to reach each student. Computer Based Training (CBT) could prove a valid method of delivery, but it would require careful design to ensure that each student "personalizes" the concept before s/he progresses to the secondary and tertiary objectives. It is true that any increased level of awareness is better than no~~

awareness, but a truly effective training session must involve student feedback and should gauge their progression. No matter what pedagogical approach is chosen, the subject matter of this training can be greatly enhanced by video presentations and similar audio-visual aids.

What can be learnt from experience?

29 Objective three: Crew will all Seafarers come with their personal experience of duty and watch work scheduling, and perception of fatigue and its mitigation and management how to mitigate it. It is very important to develop share a common understanding on of fatigue issues and on its their mitigation and management. Hence, earlier training should be integrated with shipboard experience The final summary stage of training integrates the initial and secondary objectives and and focuses on what on the trainee's action student will do after completion of the training. leaving the training session (the tertiary objective). Ideally, this new knowledge will be taken back to the workplace and put into practice in the seafarer's daily life. Prevention measures and mitigation and mnagement techniques measures can become a way of life for those the student who appreciate grasps the concept of fatigue and its effects on seafaring.

30 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 trainee students see them. The focus should then shift toward specific experiences (case studies as indicated above) within the seafarer's workplace to show what fatigue risk management strategies should be adopted upon returning to the workplace At this time, select case studies will also be instrumental in to showing what each trainee student fatigue risk management strategies should be adopted try to do upon returning to the workplace.

31 Course outline (merge with class room training outline above)

32 Three general learning objectives with desired training outcomes form the basis for a course class outline or syllabus: PUT BETWEEN SECTIONS 1 and 2

33 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.

34 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.

35 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.

4How can we disseminate the lessons learnt?

36 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."

37 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.~~

~~WHY INCLUDE CASE STUDIES/EXAMPLES? THIS SECTION COULD BE MOVED ABOVE TO WHERE THE COURSE OUTLINE IS~~

~~38 As seen in the tertiary objective,~~ The development of strategies for "life after the training session" is vital. ~~critically important. In this regard, it is necessary to incorporate case studies/examples into the training. These cases serve to support the "lessons learnt" portion of the training. Case studies from all transportation industries are useful, but the majority should focus on the maritime sector and preferably that sector with which the student is involved (ships, barges, ratings, officers, etc.). The cases can be used to provide a picture of what happened, probable causes, and what can be done differently to prevent a reoccurrence.~~

~~39 training sessions. It is hoped that the results of some of the reports can be shared in a "case study" manner.~~

~~40 A final practical example could be an examination of the fatigue aspects of training itself, as part of the overall workload:~~

~~.1 For both trainer and for trainees~~
~~.2 Ashore and afloat~~
~~.3 Initial and refresher training~~
~~.4 Practical and paperwork.]~~

[***References***

1. IMO – *Training Course for Instructors*

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

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

4. Grech, M. R., (2015). *Working on Board: Fatigue*, in *Human Performance and Limitations for Mariners*, Squire, D., Editor. The Nautical Institute: London. p. 96.]

Guidelines on Fatigue

Module 7

SHIPBOARD FATIGUE AND THE NAVAL ARCHITECT/SHIP DESIGNER

Foreword

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

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

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

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

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

Module 7 contains practical information intended for the Naval Architect/Ship Designer, such as information on design guidance and applicable regulations.

GUIDELINES ON FATIGUE

MODULE ~~7~~5

~~SHIPBOARD~~ FATIGUE AND ~~THE NAVAL ARCHITECT/~~SHIP DESIGN~~ER~~

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

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

Why do ship designers need to know about shipboard fatigue?

~~2 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 threatens ship safety and can cause accidents [1, 2] 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 fatigue plays a part in maritime accidents has been provided by recent a number of submissions accidents (*Fingal (2007*); *Antari (2008); Shen Neng 1 (2010)*; *Spring Bok (2012))* to IMO, e.g. those made by Japan (MSC 71/INF.8; MSC 69/INF.16);and Finland (MSC 68/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 and international studies [3-8]. Whatever the cause, the effect of fatigue on performance is serious, threatening safe operations which rely on alertness and concentration. In addition to the threat of to safe and secure operation of a ship ship safety, shipboard fatigue can jeopardise negatively affect seafarers' physical and psychological health, at a high cost to the individual and the industry.~~

Fatigue is a hazard that affects safety, health and well-being. This presents a considerable risk to, safety of life, property, health, security and protection of the marine environment.
Because seafarers live and work aboard ships sometimes for an extended period of time, they may be exposed to conditions that cause fatigue. Therefore, the design, layout and arrangement of working and living areas should be considered as part of mitigating and managing the risk of fatigue on board ships.

~~3 Fatigue can result in long term effects on health and clinical illnesses, increasing the risks of pain, stress, obesity, coronary heart disease, gastrointestinal disorders and diabetes. Long term effects also point to mental health problems such as negative mood states and depression. Seafarers work in a physically demanding environment that requires a high degree of alertness and concentration. Exhausted seafarers are also more vulnerable to the many hazards on board ships, resulting in slips, trips 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.~~

4 As highlighted in Module 1, ~~fatigue can arise from a range of factors but is primarily affected by inadequate restorative sleep, excessive wakefulness, work/sleep at inappropriate times of the body clock (circadian cycle) and demanding mental and/or physical work (including keeping balance in heavy sea states). Even the boredom of watchkeeping in the still of the night can cause fatigue. I~~inadequate restorative sleep (~~duration~~ both quantity and quality) ~~deprivation~~ is among the main causes of ~~seafarers'~~ fatigue ~~but it is not the sole cause. Crew also become fatigued as a result of Amongst others, sleep~~ and can be ~~is~~ affected by the living and working environment onboard.

Hence, ship design plays an important role in ensuring that restorative sleep is achieved. ~~[9, 10]. living and working onboard [9, 10].~~ ~~This module will concentrate on guidance for improving the ambient environmental conditions onboard ship, as this is the main area where class rules and guidance can be used to alleviate fatigue. However, there is a limit on what can be achieved through design intervention with regards to the ambient environment. In light of this, the working environment and the working practices should be designed to reduce or compensate for crew fatigue. This module deals with design impacts and should therefore be read in conjunction with the other modules.~~

~~5 Reducing shipboard fatigue will require orchestrated action by many groups, including flag states, shipowners and operators~~ companies, seafarers and administrations. Naval architects and ship designers need to make their ~~unique~~ ~~contribution by~~ improving the design of shipboard conditions and incorporating 'fatigue proofing' into ship and equipment design to reduce potential to cause fatigue. ~~improving the design of shipboard conditions.~~

~~HOW DOES FATIGUE AFFECT CREW PERFORMANCE?~~

~~6 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:~~

~~.1 Causes drowsiness~~
~~.2 Impairs perception (e.g. causing failure to detect visual or auditory stimuli)~~
~~.3 Clouds judgement~~
~~.4 Slows reactions (physical and mental)~~
~~.5 Reduces motivation, encouraging apathy~~

~~7 The effect fatigue has on seafarers' performance is now well-understood thanks to comprehensive studies which were undertaken on the subject:~~

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

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

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

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

~~8 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:~~

~~9 "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.).~~

~~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)~~

11 ~~In controlling and managing the risks of fatigue at sea~~ ~~the consideration of~~ Additionally shipboard ergonomics and the environmental ~~improvement of~~ conditions on board are important considerations ~~ability~~ in ensuring seafarers are provided with the best opportunity to:

~~.1 gain an adequate quality of sleep quality onboard; and~~

.2 maintain safe levels of alertness and performance during ~~duty~~ work periods; and ~~the improvement of shipboard conditions.~~

.3 maintain good health and resilience to fatigue through the provision of adequate recreational and exercise facilities.

~~12 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~~ aspects of ship design can influence fatigue ~~can be influenced by design~~?

13 There are various aspects of fatigue that can potentially be influenced by the ~~seafarers' fatigue. that can potentially be influenced in by the~~ design of the living, sleeping and working environment. ~~process.~~ Excessive noise, heat or cold, light, too much or too little humidity and poor air quality, amongst others, ~~exchange in enclosed spaces~~ where people live and work can cause fatigue. ~~Fatigue that results from the working and living environment can be alleviated by design improvements to the design of the living and working environment~~. ~~The following aspects should be considered in design [9]:~~

~~***14 Sleep area (Design to promote for sleep)***~~

~~.1 Cabin cool, ventilated, quiet, and dark~~
~~.2 Bunk design, and layout, add sofa – different orientation;~~
~~.3 Mattress, bedding,~~
~~.4 Insulate and/or isolate sleeping areas.~~

~~15 ***Ship seakeeping – (Design to promote alertness minimise in living and working spaces)***~~

~~.1 ship movement);~~
~~.2 Vibration; and~~
~~.3 Noise.~~

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

Appropriate noise levels (SOLAS regulation II-1/3-12) support effective communication and reduce mental workload while on duty, and enhance 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 effective design and layout for noise and vibration control and mitigation.

[***16 Accommodation spaces and layout design (Design to promote rest and well-being ~~for~~ personal needs and comfort)***

Location of ~~C~~crew accommodation is often ~~usually~~ ~~located in a far from ideal location. It is~~ built around the operation of the ship, with little consideration for crew comfort. This results in accommodation location usually being decided after that of primary functional and structural options (engine, cargo, navigation and lookout). ~~placed directly over the engine room,~~ This can lead to vibration and noise exposure. Where-ever the accommodation is located care also needs to be taken to control noise levels induced by the heating, ventilating and air conditioning systems

(HVAC). ~~This area does not give the best quality of ride. In addition, it can be noisy.~~ Consideration should be given to:-

~~———~~.1 Cabins are cool, ~~ventilated,~~ quiet, ~~and~~ dark and well ventilated;
.2 Bunk design, ~~and~~ layout~~, add sofa – different~~ and orientation;
.3 Mattress, bedding, padding for ship movement, headroom clearance especially upper bunk/deckhead;
.4 Insulate and/or isolate sleeping areas;
.5 use of colour and artwork in the cabins could be considered; and
.6 use of acoustic insulation and/or other noise-abatement measures.

Notwithstanding the above consideration must be given to sounds that must be heard e.g. fire alarms.]

[17 ~~Acoustic insulation could~~ can be used to reduce noise in this area, but it must also be ~~consideration should be given ed in conjunction with measures to increase sleep disturbances 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.]

17a Consideration ~~could~~ should be given to providing an accommodation area that is conducive to rest ~~ensure that the accommodation area is restful~~ and that it aides in recovery ~~from fatigue, e.g. in terms of decor, easy to tidy and clean~~. As far as reasonably practicable, ~~T~~the following should be considered:

.1 Design for minimal crew flow in sleeping quarters;
.2 Consider laundry, changing, hygiene, privacy;
.3 Insulation or isolation from cargo, engine, other disturbances (noise and vibration);
.4 Design lighting to support day and night sleep (Lighting/dimmers and block-out) ~~(design for sleep)~~;
.5 Ventilation/air quality; ~~exchange;~~
.6 Temperature locally adjustable and humidity (design for sleep);
.7 ~~Design for natural light access~~
.8 Location and layout of Galley & mess room/s;
~~.9 Design of napping stations;~~
~~.10 Appropriate medical facilities.~~

It is also important to consider design for recreation and recovery. Aspects to consider include:

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

A. Workplace design (Design for alertness and performance)

18 Workplace design, particularly for tasks ~~those~~ that require ~~unnecessary~~ sustained physical or mental exertion ~~(physical or mental~~), should consider the following aspects: ~~can be offset by better design of the workplace or by better upkeep of the original condition of the ship. Aspects to consider include~~:

- .1 ~~Layout of workspaces for efficient work;~~

Design of the workplace and workflow —for optimum layout (placement, storage, adjustable, visibility, ease of communication, ease of movement, noise, vibration, temperature, humidity); ~~Natural light access;~~

~~.2 Design for workflow~~

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

~~.5 Lighting (design for alertness) [11];~~

.6 Usability (~~Ease of access to all~~ displays and controls ~~and reading of displays~~ ~~(~~incorporate ergonomic and task requirements ~~human machine interface principles~~); [Maintenance (coordination, marking, documentation, interlocks, barriers)] [Maintenance – Design for maintainability (access envelopes accounting for required tools and motions, etc.)]

~~.7 Ventilation/ air exchange;~~

.8 Protection from hazards (e.g. provide suitable hand holds, barriers, signs, stairs and surfaces to allow easy movement in bad weather); ~~Exposure to chemicals;~~

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

~~.9 Noise and vibration;~~

~~.10 Temperature and humidity (design for alertness).~~

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

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

~~***.1 Recreation and recovery***~~

~~f. Privacy and social life;~~
~~g. Minimal "housekeeping";~~
~~h. Gym/training facilities;~~
~~i. Library, media rooms,.~~

~~.2 Harsh ambient environmental conditions~~

~~a. 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.~~

~~.3 Boredom~~

~~a. 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~~

~~.4 Onboard facilities~~

~~a. Recovery from fatigue can be assisted or hampered by favourable or unfavourable crew onboard facilities including the design of features within:~~
~~– accommodations~~

- recreational facilities
- galleys, mess rooms, food preparation and storage areas
- hygiene facilities
- medical facilities

.5 Ship motions

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

20 General 'eErgonomic' principles should be used and have been developed to aid designers . These are examined in the next section.

What does How can ergonomics support the mitigation and management of fatigue on ships have to do with shipboard design?

21 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 and safe (i.e. designed for human use and meets operational requirements safely). Ergonomics has been defined a[3]:

22 "*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*."
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."

23 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.

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[4].

24 The ergonomics approach to design is human-centred. 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;
.2 the task, goal or intended outcome of the system, product or service; and
.3 the environment in which the design is to function.

[3] As defined in MSC.1/Circ.1512 *Guidelines of software quality assurance and human centred design for e-navigation.*

[4] As defined in MSC.1/Circ.1512 Guidelines of software quality assurance and human centred design for e-navigation.

[25 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 of subjective assessment.

.4 The design of the work process shall safeguard workers' health and safety, promote their well-being, and facilitate task performance, in particular by avoiding overloading and underloading. ~~Overloading and underloading~~ This 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.]

26 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.

27 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. ~~Those affected by the design (the seafarers) should be involved throughout the whole design process, including evaluation. This will help to optimize solutions (e.g. by providing specific experience and requirements). Their~~ eEarly and continued participation and involvement is regarded as an efficient design strategy within ergonomics since, in addition to improving the design, it reduce late-stage re-work and increases user acceptance.

28 Ergonomic design is ~~T~~task-oriented, it ~~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.

29 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 is ~~are~~ dependent on individual characteristics (e.g. body size [~~12~~], age, capacities, abilities, skills, etc.).

30 ~~Appropriate standards are referenced throughout the following sections.~~ A few standards give guidance on how to incorporate ergonomics into the design process [~~i.e. [13]]~~, e.g. ergonomic principles in the design of work systems. A list of appropriate standards are included in the reference

list. ~~The remaining sections also look at specific help that is available to the ship designers wanting to reduce seafarer's fatigue to incorporate "fatigue proofing" strategies into design. This "help" takes the form of tools, guides, standards, regulations and rules.~~

What tools are available for designing/building fatigue resistant ships?

~~31 Unfavorable 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.)~~

32 ~~The~~ The application ~~of E~~ergonomic standards and guidance is ~~a major are~~ effective ~~tools~~ for improving the working environment, particularly those that deal with environmental conditions (such as temperature, [noise], vibration, ventilation, etc.).

33 ~~Tools that support ergonomic design include the use of c~~Computer simulation can be used to support ergonomic design. ~~tools~~. 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 ~~(examples are JACK; SAMMIE; etc.)~~. Use of ~~such~~ 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. Wherever possible, and if available anthropometric data and standards should be utilised to support ergonomic design.

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

35 ~~There are a variety of design tools available for this and include recommended guides, prescriptive and evaluation standards. Design software such as Finite Element Analysis (FEA) which can assist the ship designer in ensuring that the specified limits specified by shipowners are not exceeded.~~ Finite Element Analysis (FEA) and noise prediction tools are generally more cost effective than post construction noise mitigation strategies. These tools can be used for:

.1 Calculating noise limits;
.2 Calculating vibration limits;
.3 Calculating seakeeping qualities/quality of ride;
.4 Analysing ventilation flows; and
.5 Performing model tests.

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

36 There are 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 t~~This is a developing ~~area many of the measures referenced here are provisional~~ field and the designer should check for new material.

~~A Accommodation~~

37 Some aspects of crew accommodation, for instance minimum size and acoustic insulation, are subject to regulation such as the International Labour Organization (ILO), Maritime Labour Convention (MLC) 2006. The ~~ILO Conventions~~ MLC, 2006 ~~that~~ addresses crew accommodation ~~are as follows~~ in Title 3 (Accommodation, Recreational Facilities, Food and Catering). ~~The purpose is to ensure that seafarers have decent accommodation and recreational facilities on board. Regulation 3.1 – Accommodation and recreational facilities and Standard A3.1 – Accommodation and recreational facilities, incorporates prescriptive requirements for accommodation spaces (i.e. crew will have for example fewer or no cabin mates, a larger cabin floor area and more convenient access to showers, water closets, and lavatories).~~

[38 The MLC, 2006 as it relates 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~~s~~ improved crew accommodation design.]

[39 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)~~

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

~~B Environmental conditions in crew only in living and working spaces~~

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

~~.1 Passenger (e.g. cruise, Ro-Ro ferries)~~

~~.2 High speed craft (e.g. Surface Effect Ships, wave piercing catamarans, hydrofoil)~~

~~Yachts~~

~~42 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 assessment criteria include crew-only spaces as well as passenger spaces. Crew-only spaces are defined as the following follows:~~

~~.1 accommodation spaces (e.g. cabins, corridors, offices, mess rooms, recreation rooms)~~
~~.2 work spaces~~
~~.3 navigation spaces~~

~~43 These Rules are contained in:~~

~~*.1 Comfort Class: Tentative Rules* for Classification of Ships. Part 56, Chapter 1233. Det Norske Veritas (DNVGL). July January 1995 2014~~
~~*.2 Provisional Rules for Passenger and Crew Accommodation Comfort*. Part 7, Chapter 12. February 1999 July 2014. Lloyd's Register of Shipping~~
~~*.3 Rules for the Evaluation of Noise and Vibration Comfort on Board Passenger Ships*. January 1999. Registro Italiano Navale []~~

Noise and Vibration

~~44 Several~~ IMO ~~developed~~ has implemented requirements and resolutions aimed to protect the seafarer from unacceptable levels of noise:

.1 SOLAS Regulation II-1/3-12 Protection against noise.
~~.2 IMO~~ 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).
.3 Resolution A.468(XII) (1981), Code on noise levels onboard ships fixes permissible maximum limits of noise depending on the type of space.

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

~~.1 ISO 2923:1996 Acoustics - Measurement of noise onboard vessels~~

~~.2 ISO 1999:2013 Acoustics - Determination of occupational noise exposure and eEstimation of noise-induced hearing impairment loss~~

~~.3 ISO 717-1; 717-2: 2013 Acoustics - Rating of sound insulation in buildings and of building elements:~~
~~- Part 1: Airborne sound insulation in building and interior elements.~~
~~- Part 2: Impact sound insulation.~~

~~.4 ISO 15186-2:2003 Acoustics - Measurement of sound insulation in buildings and of building elements using sound.~~

- Part 24: Field measurements

.5 ISO 140-5:1998 Acoustics - Measurement of sound insulation in buildings and of building elements.
- Part 7: of airborne sound insulation between rooms Part 5 Field measurements of airborne impact insulation of floors

.6 IEC Publication 60651 Sound level meters

.7 IEC Publication 60225 Octave, half-octave and third-octave band filters intended for the analysis of sound and vibrations

.8 IEC Publication 60804:Ed. 2.0 and amendment No.1, 1989 Integrating-average in sound level meters

.9 IEC Publication 60942:2003 Electroacoustics Sound calibrators

Other Standards on Vibration

.1 ISO 2041:2009 Mechanical vibration, shock and condition monitoring Vibration and shock vocabulary

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

.3 ISO 20283 Mechanical vibration - Measurement of vibration on ships.

- Part 2 (2008): Measurement of structural vibration
- Part 3 (2006): Pre-installation vibration measurement of shipboard equipment
- Part 4 (2012): Measurement and evaluation of vibration of the ship propulsion machinery

.4 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

Classification Societies' Guidelines for Noise and Vibration

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

.1 NK Noise and Vibration Guideline, July 2011
.2 NK Guide to ship noise control, 1982
.3 ABS Noise and Vibration control for inhabited spaces, July 2014
.4 ABS Guidance notes on ship vibration, April 2006
.5 KR Guide to control of ship vibration and noise, 2nd edition, 1997
.6 IACS Unified Interpretation SC82 Protection against noise, 1993
.7 BV Recommendation designed to limit the effects of vibrations onboard, Guidance note, NI38 A-RD3, 1979
.8 VERITEC Vibration control in ships, 1985
.9 LRGuidance notes on acceptable vibration levels and their measurement, 1990

~~46 In addition to the guidelines above, classification societies have guidelines for crew Habitability on ships, offshore installations, workboats and mobile offshore drilling units, developed with the objective of improving the quality of crew member performance and comfort by improving working and living environments in terms of accommodation area design as listed below:~~

~~.1 ABS Guide for crew habitability on ships, July 2012~~

~~.2 ABS Guide for crew habitability on offshore installations, September 2012~~

~~.3 ABS Guide for crew habitability on workboats~~

~~.4 ABS Guide for crew habitability on mobile offshore drilling units (MODUs), September 2012~~

Working spaces

47 Regulations and standards exist for dealing with improvements to working spaces which may help in reducing fatigue and its effects. These are developed by organizations such as, IMO, ISO/IEC and Classification Societies. Reference to these standards in ship design is encouraged (see reference section). ~~Some of the relevant ISO and CEN standards dealing with general ergonomics are included below. 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**~~

~~.1 48IMO MSC/Circular.982, Guidelines on Ergonomic criteria for bridge equipment and layout~~

~~.2 ISO 8468:2007 Ships and marine technology - Ship's bridge layout and associated equipment - Requirements and Guidelines~~

~~.3 IACS Unified N1 requirements for One Man Bridge Operated (OMBO) Ships. International Association of Classification Societies. 1992~~

~~.4 ABS Guidance notes on Ergonomic Design of Navigational Bridges, Oct 2003~~

~~.5 IMO Resolution A.708(17), Navigation bride visibility and functions, adopted on 6 November 1991~~

~~.6 SOLAS Bridge Design, Equipment arrangement and procedures (BDEAP)~~

~~.7 MSC.1/Circ. 1512 Guidelines of software quality assurance and human centred design for e-navigation.~~

~~**Engine-Rooms**~~

~~.1 IMO MSC/Circular.834, Guidelines for engine-room layout, design and arrangement.17~~

~~.2 ISO 8861 Shipbuilding -- Engine-room ventilation in diesel engine ships -- Design requirements and basis of calculations. ISO 8861~~

~~**General Ergonomics**~~[5]

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

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

.2 CEN EN 614-1 (2006) Safety of machinery - Ergonomic design principles Part 1: Terminology and general principles. EN 614-1, (1994)

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

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

.5 ISO 26800:2011 Ergonomics -- General approach, principles and concepts.

.6 ISO/TS 20646:2014 Ergonomics guidelines for the optimization of musculoskeletal workload.

.7 ISO 6385:2004 Ergonomics principles in the design of work systems ISO 6385 (Draft)

.8 ISO 10551:1995 Ergonomics of the thermal environment -- Assessment of the influence of the thermal environment using subjective judgment scales. ISO 10551

.9 ISO 11399:1995 Ergonomics of the thermal environment -- Principles and application of relevant International Standards. ISO 11399

.10 ISO 9241-110:2006 Ergonomics of human-system interaction -- Part 110: Dialogue principles

.11 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

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

.13 ISO 15535:2012 General requirements for establishing anthropometric databases

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

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

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

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

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

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

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.3 ISO 717-1; 717-2: 2013 Acoustics - Rating of sound insulation in buildings and of building elements:
- Part 1: Airborne sound insulation in building and interior elements.
- Part 2: Impact sound insulation.

.4 IEC 61260 Sound level meters- Electroacoustics - Sound level meters
.5 IEC 61260 Electroacoustics - Octave -band and fractional-octave-band filters.
.6 ISO 2041:2009 Mechanical vibration, shock and condition monitoring Vibration and shock vocabulary
.7 ISO 2631 (Series) Mechanical vibration and shock – Evaluation of human exposure to whole-body vibration
.8 ISO 20283 Mechanical vibration - Measurement of vibration on ships.
- Part 2 (2008): Measurement of structural vibration
- Part 3 (2006): Pre-installation vibration measurement of shipboard equipment
- Part 4 (2012): Measurement and evaluation of vibration of the ship propulsion machinery

.9 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
.10 LR. Ship Vibration and Noise, Guidance Notes, Rev 2.1, 2006
.11 NK Noise and Vibration Guideline, July 2011
.12 ABS Noise and Vibration control for inhabited spaces, July 2014
.13 Health and Safety Executive ~~n~~Noise and ~~v~~Vibration, Offshore Technology Report 2001/068 () [need to update]

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.2 Ergonomics -- General approach, principles and concepts.
.3 Ergonomics guidelines for the optimization of musculoskeletal workload.
.4 ISO 6385:2016 Ergonomics principles in the design of work systems.
.5 ISO 9241-110:2006 Ergonomics of human-system interaction -- Part 110: Dialogue principles.
ISO 9241-210:2010 Ergonomics of human-system interaction -- Part 210: Human-centred design for interactive systems.
ISO TS 18152:2010 Ergonomics of human-system interaction -- Specification for the process assessment of human-system issues.
.6 ISO 9241-5:1998 Ergonomic requirements for office work with visual display terminals (VDTs) - Part 5: Workstation layout and postural requirements.

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

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

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

.8 ISO 15535:2012 General requirements for establishing anthropometric databases.

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

Module ~~8~~6

FATIGUE, ~~AND~~ THE ~~MARITIME PILOT~~ ADMINISTRATION AND PORT STATE AUTHORITIES

1 ~~Administrations have an important role to play in mitigating the risks of fatigue at sea.~~ 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.) ~~and~~ This module provides guidance for considering fatigue ~~and its management~~ in port and flag state requirements [regarding the impact of their actions on seafarer fatigue and approaches and considerations for mitigating fatigue on board ships.] It is also recommended that Administrations and Port State authorities become familiar with ~~m~~Modules 1 to 5.

Fatigue and the Administration
~~Responsibility of Administrations~~

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 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 every seafarers' 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 for noise and vibration are enforced in the design and construction approval.

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

.3 Promote ~~and facilitate~~ 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.

~~Considerations in implementing and enforcing regulatory requirements~~

~~Administrations should take these guidelines and A.1047 into consideration when determining manning levels~~

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

[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.]

~~.1 .2 Based on information received as a result of investigating maritime casualties, Administrations should iteratively evaluate the effectiveness of their fatigue prevention program(s)~~

~~.3 Administrations should encourage companies with ships registered under their flag to incorporate fatigue risk management principles into existing safety management systems~~

~~.4 Administrations should enforce SOLAS requirements for noise, vibration, and ship design~~

Fatigue and Port State Authorities ~~Other Considerations by Administrations~~

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

.1 The need to reduce as much as possible administrative and reporting requirements related to port calls. ~~when the ships are in port.~~ 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. 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.

.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 encourage use of standardized reporting forms (e.g. IMO Facilitation Committee (FAL) forms) to avoid duplication of effort~~

.4 ~~Administrations should ensure that their~~ pPort state ~~control~~ authorities should ~~on the~~ consider ~~necessity to~~ scheduleing drills in a manner that minimizes the disturbance of rest periods and does not induce fatigue.~~, in accordance with the Section A-VIII/1 of the STCW Code.~~

[.4 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.

.5 Due consideration for arrangements is given to the ~~of 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.

.6 Limitation and consolidation of inspections should be considered whenever possible

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

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

[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:

.1 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.]

Guidelines On Fatigue Module 8

FATIGUE AND THE MARITIME PILOT

Foreword

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

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

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

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

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

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

Guidelines on Fatigue Module 8

FATIGUE AND THE MARITIME PILOT

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

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

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

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

2. WHAT CAN CAUSE FATIGUE?

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

Work Related

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

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

Non-work Related

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

3. HOW DOES FATIGUE AFFECT PILOTAGE PERFORMANCE?

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

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

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

TABLE 1
Effects of Fatigue

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

6. CASE STUDIES

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

The following casualty investigation reports are provided as illustrative examples:

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

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

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

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

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Guidelines on Fatigue Module 9

FATIGUE AND TUGBOAT PERSONNEL

Foreword

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

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10. Appendix Fatigue related documentation

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

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

Module 9

FATIGUE AND TUGBOAT PERSONNEL

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

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

A. Physically

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

B. Emotionally

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

C. Mentally

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

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

2. WHAT CAN CAUSE FATIGUE?

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

- Lack of sleep

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

- Poor quality of sleep

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

- Insufficient rest time between work periods

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

- Poor quality of rest

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

- Stress

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

- Boring and repetitive work

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

- Noise or vibration

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

- Ship's movement

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

- Food (timing, frequency, content and quality)

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

- Medical conditions and illnesses

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

- Ingesting chemicals

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

- Jet-lag

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

- Excessive work load

Working consistently "heavy" workloads can cause fatigue. Workload is considered heavy when one works excessive hours or performs physically demanding or mentally stressful tasks. Excessive work hours and fatigue can result in negative effects such as the following:

- Increased accident and fatality rates;
- Increased dependence upon drugs, tobacco or alcohol;
- Poor quality and disrupted sleep patterns;
- Higher frequency of cardiovascular, respiratory or digestive disorders;
- Increased risk of infection; and
- Loss of appetite.

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

A. Sleep Issues

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

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

Here is some general guidance on developing good sleep habits:

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

B. Rest Issues

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

C. Guidelines on maintaining performance

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

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

4. WHAT CAN MITIGATE THE EFFECTS OF FATIGUE?

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

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

Strategic Napping

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

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

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

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

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

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~~APPENDICES~~

~~Foreword~~

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

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5. ~~Module 5 Fatigue and the Training Institutions and Management Personnel in charge of Training~~
6. ~~Module 6 Shipboard Fatigue and the Owners/Operators/Managers~~
7. ~~Module 7 Shipboard Fatigue and the Naval Architects~~
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, which contains general information on the subject of fatigue, prior to using the rest of the Modules.~~

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

[~~APPENDIX 1~~

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Appendices

Appendix 1

Fatigue Risk Management System

22 Fatigue hazards should be identified, effectively managed and assessed, just like any other shipboard hazard, according to the principals of risk management. **Figure 2.1** provides an example holistic framework for a maritime Fatigue Risk Management System (FRMS).

23 FRMS is composed of two principal processes, containing 5 layers of defences which underpin the key measures of fatigue hazard identification and risk management. These processes include:

.1 FRMS controls; and

.2 FRMS safety assurance.

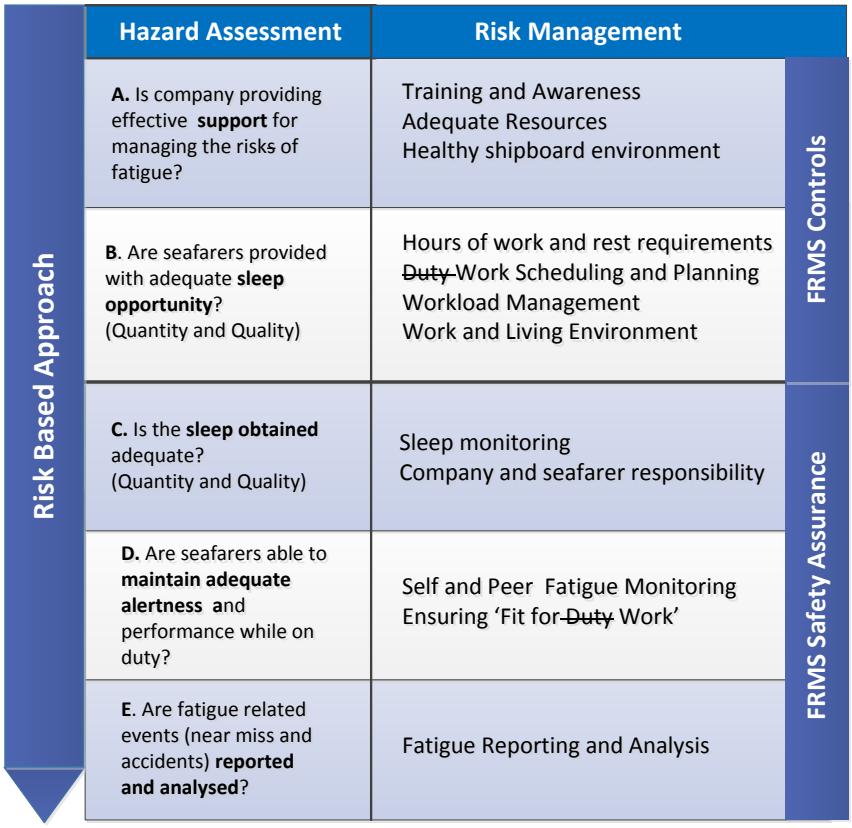


Figure 2.1: Fatigue Risk Management System Framework

FRMS Controls

24 FRMS controls deal with layer 1 and layer 2 - the principle strategies required to control and manage fatigue related risks:

.1 Layer 1 requires effective **company support** and commitment for managing and controlling the risks of fatigue;

.2 Layer 2 requires that seafarers are provided with **adequate opportunity for sleep**. This ensures that both quantity and quality of sleep are considered.

Safety Assurance

25 FRMS safety assurance deals with layers 3, 4 and 5 and provides the data driven feedback (assessment and evaluation) through monitoring, to assure that the controls are working effectively:

.1 Layer 3 ensures that any issues affecting seafarers' quantity and quality of sleep, even though adequate sleep has been provided, are being effectively captured. This entails **monitoring and assessing sleep obtained** and provides for the implementation of controls when issues are identified;

.2 Layer 4 ensures that seafarers obtain what is considered, on average, sufficient sleep and are able to **maintain adequate alertness and performance** on duty (that is they are fit for work). This entails monitoring and assessing levels of fatigue and fitness for work; and

.3 Layer 5 ensures that processes are in place for identifying and assessing **fatigue related events** or accidents. This layer relies on having an effective safety reporting culture (i.e. just culture).

26 The combination of controls and safety assurance allows for continuous improvement and identify areas for improvement.

Recommended tools and resources to support the FRMS are included in this Appendix.

The following provides recommended guidance on each of the levels that can be effectively implemented.

D Effective Company Support

35 The company should provide adequate level of support for managing the risk~~s~~ of fatigue. This establishes the core risk control measure of a FRMS. This needs to be supported by appropriate systems and processes, so that the risk of fatigue can be managed in a way that supports safe, compliant and productive operations. Importantly, fatigue risk control measures forming part of company support include the need to ensure:

.1 Development and implementation of FRMS documentation;
.2 Company-wide fatigue training and awareness;
.3 Availability of adequate resources to conduct all ship operations safely; and
.4 The provision of a healthy shipboard environment.

37 Seafarers and shore based personnel should be consulted and involved in the FRMS development process, including the opportunity to provide feedback.

The company should develop a fatigue risk management policy which expresses support, commitment and responsibilities and make it available to all personnel.
~~The FRM documentation should set the basis for company support and commitment for managing the risks of fatigue. The company should develop FRM policy, integrating this to the ship's SMS.~~
The FRMS policy should:

.1 reflect C~~c~~ompany support and commitment;

.2 include fatigue training and awareness programmes ~~and training requirements~~;

.3 ~~must~~ include records of planned and actual daily hours of work and rest, with reasons for significant deviations noted ~~(Section A-VIII/1, paragraph 7 of the STCW Code and Standard A2.3-12 of the MLC)~~;

.4 may include ~~FRM~~ safety assurance outputs including findings from collected data, recommendations, and actions taken;

.5 include C~~c~~ompany commitment to effective safety reporting ~~(which is already an integral part of the SMS)~~.

41 With regards to training it is important to note that as the management of fatigue matures, training material can be expanded to include such content as the use and limitations of any scheduling tools and fatigue predictive modelling tools that may be used to predict the levels of fatigue and performance across work schedules.

B. Ensuring Adequate Sleep Opportunity

62 Planning tools based on fatigue science as well as operational requirements can provide predictive identification of fatigue hazards in work scheduling. These may include a simple paper based tool such as the Fatigue Risk Assessment Tool in Appendix 2 or the use of Fatigue Predictive Software Tools. To mitigate and manage the risk of fatigue a list of work schedule design principles is included in Appendix 3.

C. Ensuring Adequate Sleep is Obtained

72 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.

73 A valuable and commonly used measure for proactive fatigue hazard identification is sleep monitoring. This may involve a planned sleep data collection process that includes a few days or weeks, possibly repeated a few times annually. Sleep monitoring can be implemented through relevant procedures of the ship's safety management system. Verbal feedback through the ship's safety committee can also be used. Whatever the method, this layer of defence within the FRMS safety assurance enables the Company to determine whether adequate sleep is actually obtained. It further provides a retrospective safety assurance that the FRMS controls (layers 1 and 2) are working effectively.

75 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. Recommended tools include:

.1 Subjective self-reporting tools: are the simplest methods used for monitoring sleep. In general, they provide reasonable information at the group level. They include a daily sleep dairy in which seafarers' record when they sleep and wake, and rate the quality of their sleep. Appendix 4 is an example of a subjective **sleep diary** that can be used to record and monitor sleep by individual seafarers.

.2 Objective tools: include the use of wrist worn activity devices. There are a number of manufacturers of these devices, and each type comes with specific software that estimates when the wearer was asleep and awake (based on a validated algorithm). They also provide some indication of sleep quality (that is how disruptive the sleep period was). Wrist worn activity devices are designed to record continuously for several weeks so they are valuable tools for monitoring sleep and wake patterns at sea.

D. Ensuring Adequate Alertness and Performance while on Duty

79 This safety assurance layer of defence aims to:

.1 identify seafarers who continue to exhibit signs of fatigue despite being provided with and getting sufficient sleep; and
.2 monitor and assess the effectiveness of the other layers of defences.

80 Several tools are available for monitoring and assessing levels of fatigue. Examples include:

.1 Self-monitoring through subjective fatigue and sleepiness ratings: Subjective sleepiness and fatigue ratings are particularly useful for gathering data fairly quickly to decide whether additional control strategies are needed. Appendix 5 describes two standard fatigue and sleepiness rating scales that can be easily applied for monitoring purposes. Seafarers can complete these fatigue and sleepiness ratings at specific intervals within and across days. The tools in Appendix 5 include the Karolinska Sleepiness Scale (KSS) and the Samn-Perelli Crew Status Check. These scales have been scientifically validated and are designed to be completed at multiple points within and across days.

.2 Fatigue Self-Assessment Tool: Appendix 6 is an example easy to use personal fatigue assessment tool to supports the seafarer with the identification of fatigue.

.3 Peer monitoring: can be undertaken in a number of ways. The fatigue signs and symptoms table in Module 1 can be used as a peer monitoring tool by seafarers to assess if any fatigue signs and symptoms are observed in any of their peers. Alternatively, peer monitoring can be undertaken using the 'fatigue self-assessment' tool in Appendix 6. For example, during duty hand-over the outgoing officer-of-the-watch can ask the incoming officer-of-the-watch whether they have had adequate sleep and they are fit for duty, using the "self-assessment" tool as a checklist.

F. Encouraging Reporting of Fatigue Related Events

81 Companies should promote reporting of fatigue related events.

82 Seafarers should be encouraged to report such events in the following instances:

.1 through a voluntary reporting system when something in the operating environment is likely to impact on their, or other seafarer's, alertness to such an extent that safety margins could be reduced to unsatisfactory levels;

.2 through the ship's reporting system when an incident or event has occurred where fatigue may have been a contributory factor. To enable this, it is preferable for there to be a fatigue reporting facility or prompt on the Company's incident reporting forms.

Appendix 7 is an example of information that can be included in such a reporting form.

85 Lessons learnt play a key role in helping to develop fatigue risk management strategies for the workplace. They are useful in reinforcing awareness of fatigue among seafarers. Some of these reports and incidents together with lessons learnt could be circulated on a ship-by-ship basis. Distributing these lessons learnt will allow administrations, companies, and seafarers to demonstrate their commitment to the awareness and prevention of fatigue.

86 FRMS should have mechanisms in place to evaluate whether the control strategies are working well and to identify any areas for improvement.

76 The success of monitoring sleep and fitness for work ~~this layer of defence and others (see below),~~ depends on the willingness of seafarers to participate ~~in the data collection process~~. Participation reflects their level of understanding of their roles and responsibilities in managing the risk of fatigue ~~FRM system~~ and their confidence that the purpose ~~of the data collection~~ is to improve safety. In this type of 'just culture', concerns about whether some seafarers might exaggerate in their responses, for personal or industrial reasons, should be minimal. ~~In addition, extreme ratings become obvious when compared with group averages.~~

~~APPENDIX~~ Appendix ~~1~~ 2

Fatigue Risk Assessment Tool

Table 1~~X~~: Fatigue risk assessment matrix

No	Risk Factor	Lower~~-~~ Risk ~~(2 points)~~	Significant Risk ~~(4 point)~~	Higher~~-~~ Risk ~~(8 points)~~
1	Maximum ~~Total~~ work hours per 7 days	< 55~~0~~	55~~0~~-72~~0~~	> 72~~0~~
2	Hours of work (work period) per 24 hour period~~)~~	≤9	10-12	> 12
3	Rest hours (rest periods) ~~Hours of rest,~~ between ~~duty~~ work periods	> 12	7-12	≤ 7
4	~~Number of consecutive~~ nNight watch ~~shift work duties~~ per 7 days (between 2100-0900)	0-3~~1~~	~~2~~-3-6	≥ 7~~-4~~
5	~~Number of~~ sShort breaks within ~~duty~~ work periods	≥ 3 (~~around~~ 10-15 minutes)	1-2	0
6	Reset breaks in hours (continuous long break per 7 days)	≥ ~~30~~ 24	12-24~~-30~~	< 12 ~~24~~

How to Use This Tool

With respect to the above, the colour of the answers indicates the fatigue category, outcome and the action(s) required in the next table.

- If four or more of your answers are **Green**, your Fatigue Category is **Green.**
- If three or more of your answers are **Red**, your Fatigue Category is **Red**.
- For any other combination, your Fatigue Category is **YELLOW** (i.e. 2 Green, 2 Red and 2 Yellow)

The fatigue risk assessment tool provides a simple matrix ~~scoring system based on validated research~~ which may assist in assessing risks in relation to a particular ~~duty~~ work schedule.

~~Lower risk elements are worth 0 points, significant risk 2 points and higher risk 4 points.~~

~~The table below~~ Table 2 summarises the scoring system recommended control measures depending on the fatigue category ~~(maximum possible score=24)~~. The ~~risk scores~~ recommended actions need to be evaluated in conjunction with type and context of the work being undertaken. Recommended actions may be considered in conjunction with the work schedule design principles in **Appendix 3.**

Table 2: Fatigue risk category, outcome ~~score ratings~~ and control measures

~~Risk level~~ Fatigue ~~Risk~~ Category ~~Scores~~	~~Level of Risk~~	~~Performance, Health and Well being~~ Outcome	Recommended Actions ~~Control Measures~~ (in Work Context)
0~~-8~~	**GREEN** ~~Lower Risk~~	Risk may change to significant or higher if no reset break provided at least every 14 day period. Both performance and health issues may become evident.	• ~~12-~~Monitor and review
9~~-12~~	**YELLOW** ~~Significant Risk~~	If continued for 14 days or more this ~~will type of duty~~ work schedule may affect performance and health (both physical and mental)	• ~~Include above controls~~ • Monitor and review • Supervision may be required and this should be commensurate with the complexity and safety criticality of tasks being undertaken. • Appropriate training is essential. Ensure appropriate fatigue training has been provided, including company fatigue risk management processes. ~~FRMS.~~ This includes understanding and recognising sleep debt and fatigue circumstances. • Enable critical self-assessment in terms of fitness for duty. • Implement facilities and policies for short breaks during duty schedules or short naps within long ~~duty~~ work schedules (10-12 hours)
13~~-24~~	**RED** ~~Higher Risk~~	If continued for 14 days or more this type of ~~duty~~ work schedule will effect performance and health (both physical and mental)	• Consider recommended actions in **YELLOW** • Re-evaluate and re-design duty schedules. Utilise ~~duty~~ work schedule design principles in Module 2 • ~~Include also above controls.~~

~~As an example, a duty schedule of 0900 to 1700 hours per day (7 days in a row) with 3 short breaks of 15 minutes within the duty period would produce a score of 6. On the other hand, a duty schedule of seven continuous 4 hour night duties between 0000-0400 (4on/8off – 3 watch cycle) without short rest breaks would produce a score of 16.~~

Although the risk assessment tool is based on a 7-day cycle the hazards of significant and higher risk ~~duty~~ work schedules are cumulative. For example if applied to a 14-day period or more the items in the higher risk column create a greater risk the longer they are present. For example, if less than half of any sleep is able to be taken at night over a long period then the effects of sleep deprivation may be evident in work performance and on individual health.

~~APPENDIX~~ppendix ~~2~~3

~~Duty~~ Work Schedule Design Principles

The following research based performance principles provide recommended aspects to consider in ~~should underline~~ the design of ~~duty~~ work schedules:

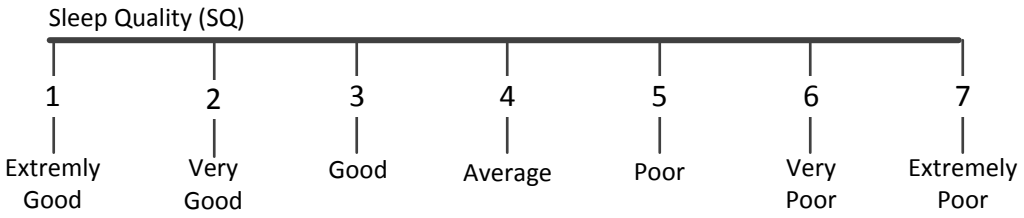
Plan ~~duty (~~work~~)~~ schedules based on the actual hours worked
Develop a working-hours policy on daily ~~duty~~ work hours and maximum average weekly hours. If possible, a work week should not exceed 70 hours
Minimize occasions in which seafarers work more than 12 hours in a ~~duty~~ work period per 24 hours.
Limit the use of overtime, especially unscheduled overtime. Avoid working arrangements that provide incentives to work excessive hours
Ensure that any period of extended work hours is compensated with a longer break before resuming the next ~~duty~~ work period
Keep sequential night watches ~~shifts~~ to a minimum (if possible, no more than four nights in a row)
Ensure that longer rest periods are provided between and following night watches ~~duty~~
Account for 'covering' contingencies caused by sea sickness or illnesses
Use forward rotation (i.e. day-afternoon-night shift changes)
Utilize the fatigue assessment tool (Appendix 1) and/or fatigue prediction software to verify new ~~duty~~ work schedules are within safe limits
When possible, eliminate the use of night time work for non-essential tasks or activities (i.e. between 0000-0600)
When possible, schedule complex tasks for daytime (i.e. not between 0200 and 0600, to a lesser degree, between 1500 and 1700)
Avoid scheduling high risk tasks on the first night of a night watch work ~~duty~~ period. If unavoidable, when planning the task consider additional controls
Allow seafarers who work regular nights, periods of normal night's sleep to catch up on their sleep deficit
Factor in sleeping, eating, washing and wind-down time in rest periods
Whenever possible, ~~E~~ensure rest periods allow for a minimum of six hours uninterrupted sleep
When a minimum of 7-8 hours of sleep is not possible, compensate for any sleep loss with daily naps of up to 90 minutes in length (allowing 30 minutes between a nap and returning on duty for sleep inertia)
Provide for short breaks during ~~duty~~ work periods (coffee, meals, etc.). If possible, allow short breaks to be individually self-managed
When possible, provide reset breaks of 24 consecutive hours every 7 days in which unrestricted sleep is possible

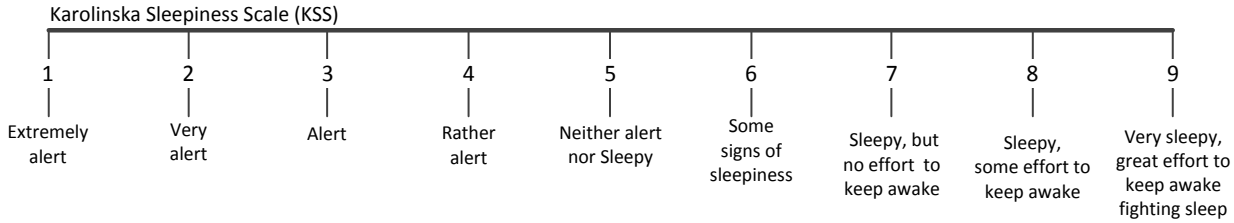
In some cases these design principles will not accord with operational demands hence companies should ensure that any risks are appropriately managed. For example, permanent night work arrangements may achieve the outcome of minimizing night shift for others. Similarly, long cycle night shifts with long breaks following may be used to provide predictability in work scheduling.

~~APPENDIX~~ Appendix ~~34~~

Sleep Monitoring using ~~Subjective~~ Sleep Diary

Date	I went to bed at:	I got out of bed at:	I slept for a total of (hours):	My sleep quality was (use SQ scale below)	When I woke up I felt (use KSS below)
Day 1 Date:					
Day 2 Date:					
Day 3 Date:					
Day 4 Date:					
Day 5 Date:					
Day 6 Date:					
Day 7 Date:					
Weekly Total					
Daily Average					

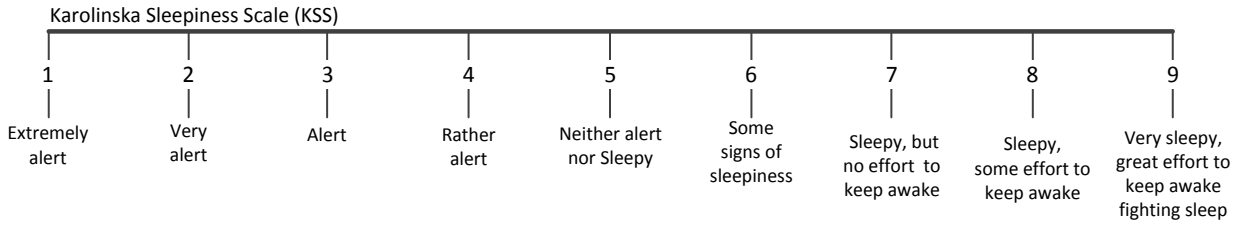




~~APPENDIX~~ Appendix 45

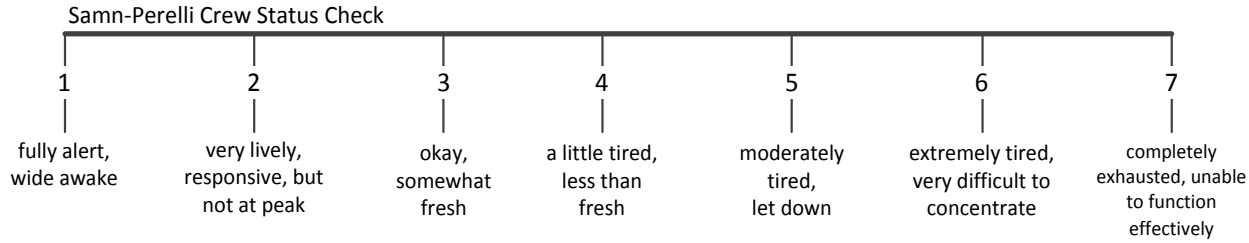
~~Subjective~~ Self-monitoring through ~~F~~fatigue and Ssleepiness ~~R~~ratings

The Karolinska Sleepiness Scale (KSS)



This scale asks people to rate how sleepy they feel right now. Any of the values from 1 to 9 can be ticked, not only those with a verbal description.

The Samn-Perelli Crew Status Check



This scale asks people to rate their level of fatigue right now, and is a simplified version of the Samn-Perelli Checklist.

Appendix ~~56~~

Fatigue Self-Assessment Tool

This tool supports the seafarer in the identification of fatigue with an easy to use one minute self-assessment. This can be used individually or during hand-over.

Fitness for Duty	**Do you believe you are for for duty?**
	No
	Yes, with additional risk controls
	Yes

Current Fatigue State	**How do you feel right now?**
	Very fatigued, having difficulty staying alert
	A bit tired, effort required to stay alert
	Very alert – wide awake

Sleep Quantity	**Did you sleep in the last 24 hours**
	No
	Yes, but I did not get my ideal amount of sleep
	Yes, I got at least my ideal amount of sleep

Sleep Quality	**How would you rate the quality of that sleep**
	Poor
	Average
	Good

Signs of Fatigue	**Have you experienced any physical signs of fatigue immediately before or during this duty period (i.e. microsleeps)?**	
	Yes	**No**
	Have you experienced any mental signs of fatigue immediately before or during this duty period (i.e. difficulty concentrsting)?	
	Yes	**No**

Adapted from @ Integrated Safety Support, www.integratedsafety.com.au

How to Use This Tool

With respect to the above questions, the colour of the answers indicates the Fatigue Category and the action(s) required in the next table.

- If one or more answer is **Red**, your Fatigue Category is **Red**.
- If one or more answer is **Amber**, your Fatigue Category is **Amber**.
- Otherwise, if your answers are **Green**, your Fatigue Category is **Green**.

Fatigue Category	Action required
Red	As soon as it is safe to do so, suspend any safety critical tasks that have been started. Report now to your immediate supervisor or Master.
Amber	Before commencing your duty period or assigned tasks, or before continuing work on a task that has been started, report to your immediate supervisor or Master and implement fatigue risk controls as required.
Green	Monitor for signs of fatigue; no additional risk controls required

Appendix ~~67~~

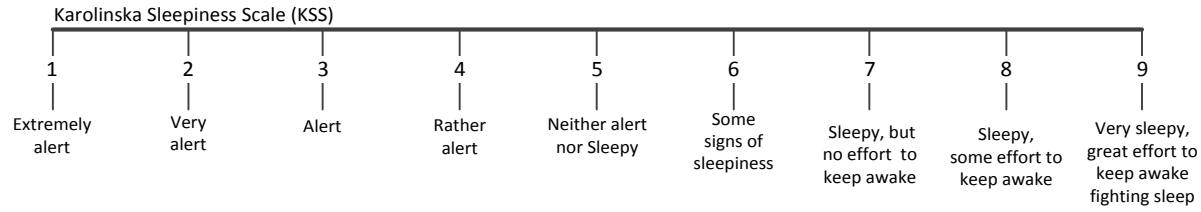
Example of a Fatigue Event Report Information ~~Form~~

This provides recommended information that can be included in fatigue event reporting. Companies may decide to utilise parts of this information within their current incident reporting system.

~~If confidentiality required tick here~~	~~Fatigue Event Report Form – Example~~		
~~Name:~~			
Time of event (When did it happen?)	Time of event:		
	Hours from report time to when fatigue occurred:		
Describe event (What Happened?)	Describe event:		

Describe how you felt (or what you observed):

Please circle how you felt when the event occurred:



~~Please circle how you felt when the event occurred:~~	
~~Fully alert, wide awake~~	~~1~~
~~Very lively, somewhat responsive, but not at peak~~	~~2~~
~~OK, somewhat fresh~~	~~3~~
~~A little tired, less than fresh~~	~~4~~
~~Moderately let down, tired~~	~~5~~
~~Extremely tired, very difficult to concentrate~~	~~6~~
~~Completely exhausted~~	~~7~~

Please mark the line below with an 'X' at the point that indicates how you felt

Alert----------Drowsy

Relevant Information			
Fatigue prior to starting work ~~duty~~?	Yes/No	How long had you been awake when the event happened?	hours…..mins
Fatigue during work ~~duty~~?	Yes/No	How much sleep did you have in the 24 hours before the event?	hours mins
Disrupted sleep?	Yes/No	How much sleep did you have in the 72 hours before the event?	hours mins
Suggestive corrected actions ~~Other Comments~~			

What did you do?	Actions taken to manage or reduce fatigue (for example, nap, breaks)
What could be done?	Suggested corrective actions

~~**Appendix 7**~~

~~**MODEL FORMAT FOR TABLE OF SHIPBOARD WORKING ARRANGEMENTS**~~[7]

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

Model format for table of shipboard working arrangements[8]

Name of ship: _____ Flag of ship: _____ IMO number (if any): _____ Latest update of table: _____ ( ) of ( ) page. The maximum hours of work or minimum hours of rest are applicable in accordance with : _____ (national law or regulation) issued in conformity with ILO's Maritime Labour Convention, 2006 and with any applicable collective agreement registered or authorized in accordance with that Convention and with the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978, as amended, (STCW Convention).

Maximum hours of work or minimum hours of rest[2][9]: _____

Other requirements: _____

Position/Rank[10]	Scheduled daily work hours at sea		Scheduled daily work hours in port		Comments	Total daily work/rest[3] hours	
	Watchkeeping (from - to)	Non-watchkeeping duties (from - to)[11]	Watchkeeping (from - to)	Non-watchkeeping duties (from - to)[5]		At sea	In port

Signature of Master _____

8 The terms used in this model table are to appear in the working language or languages of the ship and in English.

9 Delete as applicable.

10 For those positions/ranks that are also listed in the ship's safe manning document, the terminology used should be the same as in that document.

11 For watchkeeping personnel, the comments section may be used to indicate the anticipated number of hours to be devoted to unscheduled work and any such hours should be included in the appropriate total daily work hours column.

STCW Convention

Section A-VIII/1 of the STCW Convention

Fitness for duty

1 Administrations shall take account of the danger posed by fatigue of seafarers, especially those whose duties involve the safe and secure operation of a ship.

2 All persons who are assigned duty as officer in charge of a watch or as a rating forming part of a watch and those whose duties involve designated safety, prevention of pollution and security duties shall be provided with a rest period of not less than:

.1 a minimum of 10 hours of rest in any 24-hour period; and

.2 77 hours in any 7-day period.

3 The hours of rest may be divided into no more than two periods, one of which shall be at least 6 hours in length, and the intervals between consecutive periods of rest shall not exceed 14 hours..

4 The requirements for rest periods laid down in paragraphs 2 and 3 need not be maintained in the case of an emergency or in other overriding operational conditions. Musters, fire-fighting and lifeboat drills, and drills prescribed by national laws and regulations and by international instruments, shall be conducted in a manner that minimizes the disturbance of rest periods and does not induce fatigue..

5 Administrations shall require that watch schedules be posted where they are easily accessible. The schedules shall be established in a standardized format* in the working language or languages of the ship and in English.

6 When a seafarer is on call, such as when a machinery space is unattended, the seafarer shall have an adequate compensatory rest period if the normal period of rest is disturbed by call-outs to work.

7 Administrations shall require that records of daily hours of rest of seafarers be maintained in a standardized format, in the working language or languages of the ship and in English, to allow monitoring and verification of compliance with the provisions of this section. The seafarers shall receive a copy of the records pertaining to them, which shall be endorsed by the master or by a person authorized by the master and by the seafarers.

8 Nothing in this section shall be deemed to impair the right of the master of a ship to require a seafarer to perform any hours of work necessary for the immediate safety of the ship, persons on board or cargo, or for the purpose of giving assistance to other ships or

persons in distress at sea. Accordingly, the master may suspend the schedule of hours of rest and require a seafarer to perform any hours of work necessary until the normal situation has been restored. As soon as practicable after the normal situation has been restored, the master shall ensure that any seafarers who have performed work in a scheduled rest period are provided with an adequate period of rest.

9 Parties may allow exceptions from the required hours of rest in paragraphs 2.2 and 3 above provided that the rest period is not less than 70 hours in any 7-day period.

Exceptions from the weekly rest period provided for in paragraph 2.2 shall not be allowed for more than two consecutive weeks. The intervals between two periods of exceptions on board shall not be less than twice the duration of the exception.

The hours of rest provided for in paragraph 2.1 may be divided into no more than three periods, one of which shall be at least 6 hours in length and neither of the other two periods shall be less than one hour in length. The intervals between consecutive periods of rest shall not exceed 14 hours. Exceptions shall not extend beyond two 24-hour periods in any 7-day period.

Exceptions shall, as far as possible, take into account the guidance regarding prevention of fatigue in section B-VIII/1.

Prevention of fatigue

1 In observing the rest period requirements, "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.

2 Although there is no universally accepted technical definition of fatigue, everyone involved in ship operations should be alert to the factors which can contribute to fatigue, including, but not limited to those identified by the Organization,26 and take them into account when making decisions on ship operations.

3 In applying regulation VIII/1, the following should be taken into account:

.1 provisions made to prevent fatigue should ensure that excessive or unreasonable overall working hours are not undertaken. In particular, the minimum rest periods specified in Section A-VIII/1 should not be interpreted as implying that all other hours may be devoted to watchkeeping or other duties;

.2 the frequency and length of leave periods, and the granting of compensatory leave, are material factors in preventing fatigue from building up over a period of time;

.3 the provisions may be varied for ships on short-sea voyages, provided special safety arrangements are put in place.

~~4 Exceptions provided for in section A-VIII/1, paragraph 9, should be construed to mean the exceptions laid down by the ILO Convention on Seafarers' Hours of Work and the Manning of Ships, 1996 (No.180) or the Maritime Labour Convention, 2006, when it enters into force. The circumstances under which such exceptions are applied should be determined by the Parties.~~

~~5 Based on information received as a result of investigating maritime casualties, Administrations should keep their provisions on prevention of fatigue under review.~~

~~**Appendix 8**~~

~~**MODEL FORMAT FOR RECORDS OF HOURS OF WORK OR HOURS OF REST OF SEAFARERS**~~[25][12]

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

Model format for record of hours of work or hours of rest of seafarers[1]

Name of ship: _____ IMO number (if any): _____ Flag of ship: _____ _____

Seafarer (full name): _____ Position / rank: _____

Month and year: _____ Watchkeeper:[2] yes ☐ no ☐

Record of hours of work/rest[3]

Please mark periods of work or rest, as applicable, with an X, or using a continuous line or arrow.

COMPLETE THE TABLE ON THE REVERSE SIDE

The following national laws, regulations and/or collective agreements governing limitations on working hours or minimum rest periods apply to this ship:

_____

I agree that this record is an accurate reflection of the hours of work or rest of the seafarer concerned.

Name of master or person authorized by master to sign this record _____

Signature of master or authorized person _____ Signature of seafarer _____

A copy of this record is to be given to the seafarer. This form is subject to examination and endorsement under procedures established by _____
(name of competent authority)

_____

[1] The terms used in this model table are to appear in the working language or languages of the ship and in English.

[2] Check √ as appropriate.

[3] Delete as appropriate.

Please mark periods of work or rest, as applicable, with an "X", or using a continuous line or arrow			NOT TO BE COMPLETED BY THE SEAFARER[1]	
Hours 00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23	Hours of rest in 24-hour period	Comments	Hours of work or rest, as applicable, in any 24-hour period[2]	Hours of work or rest, as applicable, in any 7-day period[2]
Date				
Hours 00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23				

[1] For completion and use in accordance with the procedures established by the competent authority in compliance with the relevant requirements of the Seafarers' Hours of Work and the Manning of Ships Convention, 1996 (Convention No. 180).

[2] Additional calculations or verifications may be necessary to ensure compliance with the relevant requirements of the Seafarers' Hours of Work and the Manning of Ships Convention, 1996 (Convention No. 180) and the International Convention on Standards of Training, Certification and Watchkeeping, 1978, as amended (STCW Convention).

~~Appendix 9~~

~~RELEVANT REQUIREMENTS OF THE INTERNATIONAL SAFETY MANAGEMENT CODE (ISM CODE)~~

~~6. Resources and Personnel~~

~~6.1 The Company should ensure that the master is:~~

~~1. properly qualified for command;~~

~~2. fully conversant with the Company's SMS; and~~

~~3. given the necessary support so that the master's duties can be safely performed.~~

~~6.2 The Company should ensure that each ship is manned with qualified, certificated and medically fit seafarers in accordance with national and international requirements.~~

~~6.3 The Company should establish procedures to ensure that new personnel and personnel transferred to new assignments related to safety and protection of the environment are given proper familiarisation with their duties. Instructions which are essential to be provided prior to sailing should be identified, documented and given.~~

~~6.4 The Company should ensure that all personnel involved in the Company's SMS have an adequate understanding of relevant rules, regulations, codes and guidelines.~~

~~6.5 The Company should establish and maintain procedures for identifying any training which may be required in support of the SMS and ensure that such training is provided for all personnel concerned.~~

~~6.6 The Company should establish procedures by which the ship's personnel receive relevant information on the SMS in a working language or languages understood by them.~~

~~6.7 The Company should ensure that the ship's personnel are able to communicate effectively in the execution of their duties related to the SMS.~~

Appendix 10

RELEVANT REQUIREMENTS OF THE INTERNATIONAL CONVENTION ON STANDARDS OF TRAINING, CERTIFICATION AND WATCHKEEPING FOR SEAFARERS, AS AMENDED IN 1995

Regulation VIII/1
Fitness for duty

1 Each Administration shall, for the purpose of preventing fatigue:

.1 establish and enforce rest periods for watchkeeping personnel and and those whose duties involve designated safety, security and prevention of pollution duties in accordance with the provisions of section A-VLLL/1 of the STCW Code; and

.2 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.

Section A-VIII/1
Fitness for duty

1. Administrations shall take account of the danger posed by fatigue of seafarers, especially those whose duties involve the safe and secure operation of a ship.

2. All persons who are assigned duty as officer in charge of a watch or as a rating forming part of a watch and those whose duties involve designated safety, prevention of pollution and security duties shall be provided with a rest period of not less than:

.1 a minimum of 10 hours of rest in any 24-hour period; and
.2 77 hours in any 7-day period.

3 The hours of rest may be divided into no more than two periods, one of which shall be at least 6 hours in length, and the intervals between consecutive periods of rest shall not exceed 14 hours.

4 The requirements for rest periods laid down in paragraphs 2 and 3 need not be maintained in the case of an emergency or in other overriding operational conditions. Musters, fire-fighting and lifeboat drills, and drills prescribed by national laws and regulations and by international instruments, shall be conducted in a manner that minimizes the disturbance of rest periods and does not induce fatigue.

5 Administrations shall require that watch schedules be posted where they are easily accessible. The schedules shall be established in a standardized format* in the working language or languages of the ship and in English.

- When a seafarer is on call, such as when a machinery space is unattended, the seafarer shall have an adequate compensatory rest period if the normal period of rest is disturbed by call-outs to work.

7 Administrations shall require that records of daily hours of rest of seafarers be maintained in a standardized format, in the working language or languages of the ship and in English, to allow monitoring and verification of compliance with the provisions of this section. The seafarers shall receive a copy of the records pertaining to them, which shall be endorsed by the master or by a person authorized by the master and by the seafarers.

8 Nothing in this section shall be deemed to impair the right of the master of a ship to require a seafarer to perform any hours of work necessary for the immediate safety of the ship, persons on board or cargo, or for the purpose of giving assistance to other ships or persons in distress at sea. Accordingly, the master may suspend the schedule of hours of rest and require a seafarer to perform any hours of work necessary until the normal situation has been restored. As soon as practicable after the normal situation has been restored, the master shall ensure that any seafarers who have performed work in a scheduled rest period are provided with an adequate period of rest.

9 Parties may allow exceptions from the required hours of rest in paragraphs 2.2 and 3 above provided that the rest period is not less than 70 hours in any 7-day period.

Exceptions from the weekly rest period provided for in paragraph 2.2 shall not be allowed for more than two consecutive weeks. The intervals between two periods of exceptions on board shall not be less than twice the duration of the exception.

The hours of rest provided for in paragraph 2.1 may be divided into no more than three periods, one of which shall be at least 6 hours in length and neither of the other two periods shall be less than one hour in length. The intervals between consecutive periods of rest shall not exceed 14 hours. Exceptions shall not extend beyond two 24-hour periods in any 7-day period.

Exceptions shall, as far as possible, take into account the guidance regarding prevention of fatigue in section B-VIII/1.

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~~**Section B-VIII/1**~~

~~**Guidance regarding fitness for duty**~~

~~**Prevention of fatigue**~~

~~1 In observing the rest period requirements, "overriding operational conditions" should be construed to mean only essential shipboard work which cannot be delayed for safety or environmental reasons or which could not reasonably have been anticipated at the commencement of the voyage.~~

~~2 Although there is no universally accepted technical definition of fatigue, everyone involved in ship operations should be alert to the factors which can contribute to fatigue, including, but not limited to those identified by the Organization,[13] and take them into account when making decisions on ship operations.~~

~~3 In applying regulation VIII/1, the following should be taken into account:~~

~~.1 provisions made to prevent fatigue should ensure that excessive or unreasonable overall working hours are not undertaken. In particular, the minimum rest periods specified in Section A-VIII/1 should not be interpreted as implying that all other hours may be devoted to watchkeeping or other duties;~~

~~.2 the frequency and length of leave periods, and the granting of compensatory leave, are material factors in preventing fatigue from building up over a period of time;~~

~~.3 the provisions may be varied for ships on short-sea voyages, provided special safety arrangements are put in place; and~~

~~4 Exceptions provided for in section A-Vlll/1, paragraph 9, should be construed to mean the exceptions laid down by the ILO Convention on Seafarers' Hours of Work and the Manning of Ships, 1996 (No.180) or the Maritime Labour Convention, 2006, when it enters into force. The circumstances under which such exceptions are applied should be determined by the Parties.~~

~~5 Based on information received as a result of investigating maritime casualties, Administrations should keep their provisions on prevention of fatigue under review.~~

[13] See the annex to IMO resolution A.722(18) on Fatigue factors in manning and safety, paragraphs 2 to 4.4.1, and MSC/Circ.1014 on Guidance on fatigue mitigation and management.

Appendix 11

RESOLUTION A.772(18)
adopted on 4 November 1993

FATIGUE FACTORS IN MANNING AND SAFETY

1 INTRODUCTION

1.1 The purpose of this document is to provide a general description of fatigue, to identify the factors of ship operations which may contribute to fatigue, and to classify those factors under broad categories to indicate the extent to which the factors may be related.

1.2 The objective is to increase awareness of the complexity of fatigue and to encourage all parties involved in ship operations to take these factors into account when making operational decisions.

2 GENERAL DESCRIPTION OF FATIGUE

2.1 Fatigue results in the degradation of human performance, the slowing down of physical and mental reflexes and/or the impairment of the ability to make rational judgements.

2.2 Fatigue may be induced by factors such as prolonged periods of mental or physical activity, inadequate rest, adverse environmental factors, physiological factors and/or stress or other psychological factors.

3 CLASSIFICATION OF FATIGUE FACTORS IN RELATED GROUPS

3.1 In the case of seafarers, among the most commonly recognized and documented causes of fatigue are poor quality of rest, excessive workload, noise and interpersonal relationships. The contributory factors that lead to the above are many and varied. The significance of these factors as contributory causes of fatigue will vary depending on operational circumstances. Some factors will be more manageable than others. Such factors can be grouped as follows:

3.1.1 Management ashore and aboard ship, and responsibilities of Administrations:

- scheduling of work and rest periods;
- manning levels;
- assignment of duties;
- shore-ship-shore support and communication;
- standardization of work procedures;
- voyage planning;
- watchkeeping practices;
- management policy;
- in-port operations;
- recreational facilities;
- administrative duties.

3.1.2 Ship-specific factors:

- level of automation;
- reliability of equipment;
- motion characteristics;
- vibration, heat and noise levels;
- quality of working and living environment;
- cargo characteristics/requirements;
- ship design.

3.1.3 Crew-specific factors:

- thoroughness of training;
- experience;
- crew composition - cohesiveness;
- crew competency and quality.

3.1.4 External environmental factors:

- weather;
- port conditions;
- ice conditions;
- density of vessel traffic.

4 GENERAL DISCUSSION

4.1 Management ashore, aboard ship, and also the responsibilities of Administrations

4.1.1 The prevention of fatigue in the areas of scheduling of shipboard work and rest periods, manning levels, watchkeeping practices and assignment of duties could largely be accomplished by sensible shore-based management and on-board management techniques. It is also recognized that Administrations have an equally important role to play with respect to legislation leading to acceptance, implementation and enforcement in those areas covered by international conventions. Guidelines and provisions should take into account the relationships between work and rest periods to ensure adequate rest. These considerations should include a review of the voyage length, length of port stay, length of service of individual crew members, periods of responsibility and watchkeeping practices.

4.1.2 It is essential that management should provide clear, concise written policy guidance to ensure that ships' crews are familiar with ships' operational procedures, cargo characteristics, voyage length, destination, internal and external communication practices and ship familiarization procedures.

4.1.3 Management should recognize that crews joining a ship need to be adequately rested before assuming on-board duties.

4.2 Ship-specific factors

4.2.1 In designing or modifying ships, existing requirements, recommendations, standards and publications pertaining to the listed factors should be taken into account.
Additionally, allowance should be made in designing ships for the adoption of ergonomic practices to prevent fatigue from these factors.

4.3 Crew-specific factors

4.3.1 Thoroughness of training is considered to be important in the prevention of fatigue. Fitness for duty, including medical fitness, proper working experience and the qualifications and quality of crew members are also considered important in this context.

4.3.2 It is important that management recognizes the potential problems stemming from the employment of multinational crews on the same vessel, a practice that might result in language barriers and in social, cultural and religious isolation, all of which may lead to safety problems.

4.3.3 Special emphasis should be placed by management on issues of interpersonal relationships, loneliness, social deprivation and increased workloads which may occur as a result of small crew complements.

4.3.4 Boredom can contribute to fatigue, and it is therefore necessary to provide seafarers with appropriate stimulation.

4.4 External environmental factors

4.4.1 In respect of the listed external environmental factors, it should also be recognized that they could contribute to fatigue.

~~APPENDIX 12~~

~~PERTINENT IMO INSTRUMENTS RELATING TO FATIGUE~~

~~The following IMO instruments were reviewed with regard to their applicability to crew fatigue:~~

~~CONVENTIONS and CODES~~

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

~~Seafarers' Training, Certification and Watchkeeping Code (STCW Code)~~

~~International Code of Safety for High Speed Craft (HSC Code)~~

~~The International Safety Management (ISM) Code~~

~~ASSEMBLY RESOLUTIONS~~

~~**A.1047(27)** Principles of Safe Manning~~

~~**A.772(18)** Fatigue Factors in Manning and Safety~~

~~**A.792(19)** Safety Culture In and Around Passenger Ships~~

~~**A.947(23)** Human Element Vision, Principles and Goals for the Organization~~

~~MARITIME SAFETY COMMITTEE (MSC) CIRCULARS~~

~~**MSC/Circ.493** Recommendation Related to the Fatigue Factor in Manning and Safety~~

~~**MSC/Circ.565** Fatigue as a Contributory Factor in Maritime Accidents~~

~~**MSC/Circ.566** Provisional Guidelines for Conducting Trials in which the Officer Of The Navigational Watch Acts as the Sole Look-Out in Periods of Darkness~~

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

~~[27] Amendments pending adoption by the Assembly at its 21st session.~~

~~**MSC/Circ.813**
MEPC/Circ.330 List of human element common terms~~

~~**MSC/Circ.834** Guidelines for Engine-Room Layout, Design and Arrangement~~

~~**MSC/Circ.982** Guidelines on Ergonomic Criteria for Bridge Equipment and Layout~~

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