MARINE **SAFETY** and **SECURITY**

SÉCURITÉ et **SÛRETÉ** MARITIMES

Fatigue Management Training

Government of Canada Gouvernement du Canada

Canada

Topics for Discussion

1. Life at sea: the demanding nature of seafaring jobs
2. An overview of fatigue: causes and effects
3. The rules and regulations dealing with fatigue
4. Responsibilities of companies and seafarers in fatigue management
5. Personal strategies for seafarers to mitigate fatigue

By the end of the training, you will be able to:

- Understand the concept of fatigue, its causes and potential consequences;
- Prevent the risks of fatigue by identifying the effects and signs of fatigue;
- Recognise that the rules and regulations present one line of defence in managing the risk of fatigue;
- Understand the responsibilities of companies and seafarers in fatigue management; and
- Understand and apply personal strategies to minimize fatigue risks.

Life at sea

- https://www.sirc.cf.ac.uk/Multimedia_Resources.aspx



The demanding nature of shipping

- Long and irregular working hours for seafarers.
- Extended periods of time away from home.
- The ship is both seafarers' workplace and their home while on board.
- Unpredictable hazards at sea: extreme weather and sea conditions.

Life on board

- Ships operate 24 hours a day and 7 days a week.
- The working day at sea is broken into watches (shifts) for navigation and engineering responsibilities:
  - 4 on 8 off (4 hours on duty and 8 hours off)
  - 6 on 6 off (6 hours on duty and 6 hours off)
  - 12 on 12 off (12 hours on duty and 12 hours off)
- While ships are in port loading cargo, the vessel will revert to “day work” or to specific cargo watches.
- The extended service periods are usually ranging from 6 weeks to 3 month for short-sea shipping. For deep sea shipping, the service periods are usually longer, with a maximum period of 11 months.



Watch Systems

Watch System	Duty time (nominal)	Responsibility	Comment
4 on 8 off	0000 to 0400 0400 to 0800 0800 to 1200	1st Watch standing Officer 2nd Watch standing Officer 3rd Watch standing Officer	Usually senior watch keeper has middle watch. Usually be combined with 3 month on and 1 month off leave system.
6 on 6 off	0000 to 0600 0600 to 1200	1st Watch standing Officer 2nd Watch standing Officer	Used where only watch standers Usually be combined with 6 weeks on and 6 weeks off leave system.
12 on 12 off	1800 to 0600 0600 to 1800	Night crew Day Crew	Usually used in offshore sector



Beyond navigation and engineering watches…

- Shipboard routine maintenance.
- On-board administrative work.
- Life saving and emergency drills and onboard training.
- In port, dealing with inspections, surveys and visits from class societies, flag states, port states, customs, shipowners and insurers.
- Dealing with suppliers and repairs.



Technology and work at sea

- Technology is a way to improve the efficiency of work systems.
  - Automated ship control systems
  - Reduction in the number of crewmembers on board
- Technology changes the nature of work, alters workload, and it also impacts the crew workload and fatigue level.

Fatigue in the Shipping Industry

- The UK Marine Accident Investigation Branch (MAIB) investigation in 2004 (using data from 1989 to 1999), identified fatigue to be the major contributing factor in 82% of the 66 recorded groundings and collisions occurring between 0000 and 0600 hours.
- Between 1990 and 2018, the Transportation Safety Board of Canada has identified fatigue as a casual or contributing factor or a source of risk in 93 investigations and 28 in the marine sector. Fatigue is on the TSB 2018 watchlist of key safety issues for the transportation industry.

Definitions of Fatigue (1)

- "A state of physical and/or mental impairment resulting from factors such as **inadequate sleep**, **extended wakefulness**, **work/rest requirements out of sync with circadian rhythms** and **physical, mental or emotional exertion** that can impair alertness and the ability to safely operate a ship or perform safety-related duties." (International Maritime Organisation 2019)

Fatigue Definitions (2)

- Fatigue is the biological symptom of the unsatisfied need for sleep. Obtaining an **insufficient quantity or quality of sleep** results in fatigue, which impairs performance and, in the extreme, inevitably leads to **falling asleep**. A number of factors can increase a person's level of fatigue, including the **nature of the work being undertaken**, having **a poor sleep environment**, and **working a 6-on, 6-off shift schedule** (TSB Recommendation M18-02, May 2018).

Fatigue as a hazard

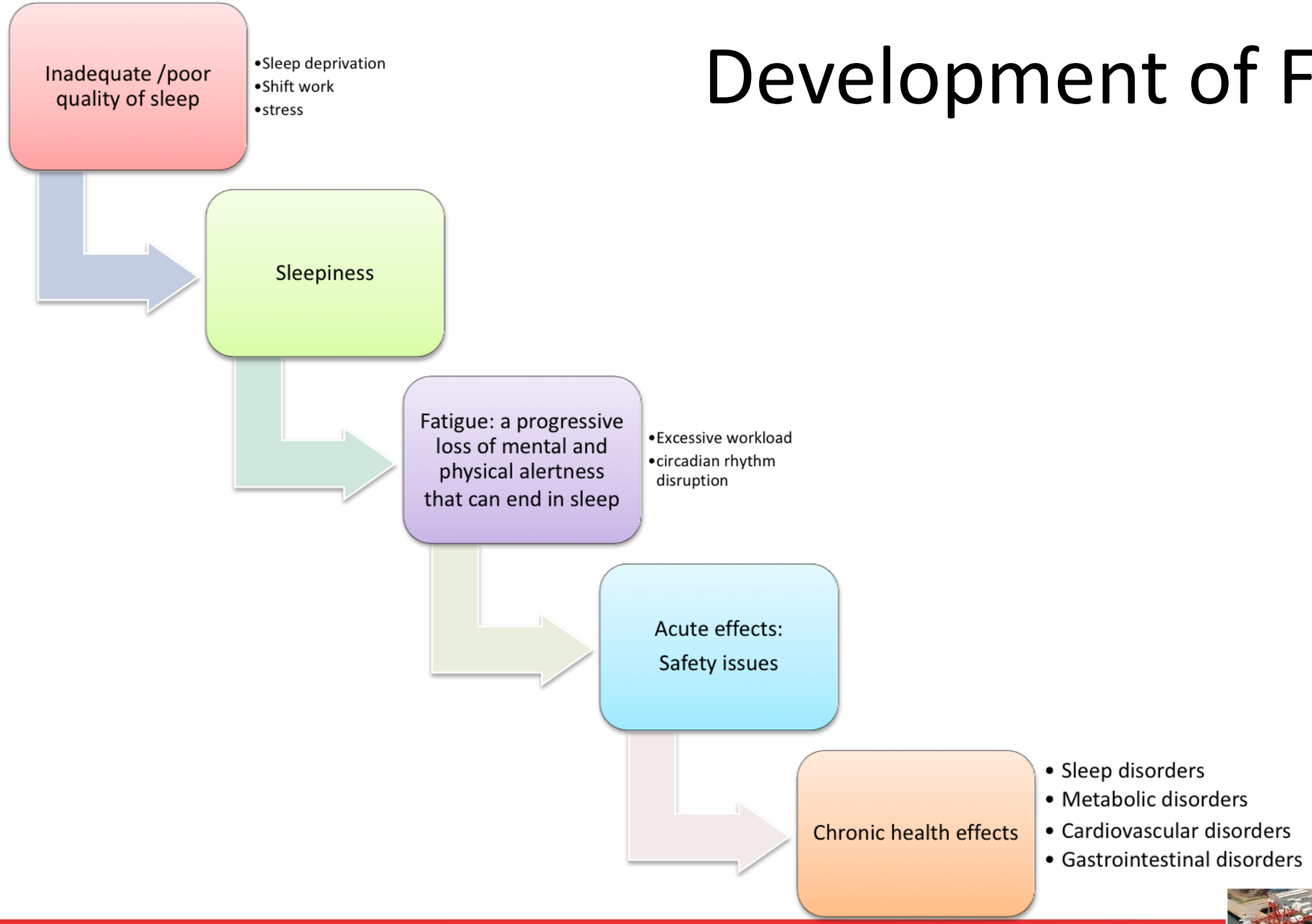
- A problem for all 24-hour-a-day transportation modes and industries, including the maritime industry.
- The difference between fatigue and sleepiness.
- Physical fatigue and mental fatigue.
- Fatigue is not a personal shortcoming or weakness.

Primary Causes of Fatigue

- Lack of sleep, i.e. inadequate restorative sleep
- Poor quality of sleep and rest
- Work or sleep at inappropriate times of the body clock (circadian rhythm disruption)
- Staying awake for long periods
- Stress
- Excessive workload (prolonged mental and/or physical exertion).

(International Maritime Organisation 2019)

Development of Fatigue



Case Study: *Nathan E. Stewart*

Nathan E. Stewart

- On 13 October 2016, shortly after 0100 PDT, the articulated tug-barge composed of the tug *Nathan E. Stewart* and the tank barge *DBL 55* went aground on Edge Reef near Athlone Island, at the entrance to Seaforth Channel, approximately 10 nautical miles west of Bella Bella, British Columbia.
- The tug's hull was eventually breached and approximately 110 000 L of diesel oil were released into the environment. The tug subsequently sank and separated from the barge. The tug was removed from the environment 33 days after the occurrence. Seven 208 L drums of diesel oil–soiled absorbent pads were collected from the site.



Review of the Second Mate's Hours of Rest and Work

- The second mate has been on board for 23 days.
- The restorative sleep was primarily obtained during his morning hours, while during the afternoon off hours, he could rarely fall asleep in the shared cabin.
- At the time of the grounding, the second mate had been awake for up to 13 hours.
- It was estimated that the second mate's performance was equivalent to a normal nighttime sleeper who had missed one night of sleep.

Fatigue-related findings in the accident

Fatigue as a cause

- The second mate, who was working alone on the bridge, was fatigued and fell asleep.
- As a result, he did not make the planned course alteration, and the articulated tug-barge struck and grounded on a reef.

Fatigue as a risk

- If a 6-on, 6-off shift schedule is used without fatigue-mitigating measures, there is a risk that crew members will carry out their duties while impaired by fatigue.

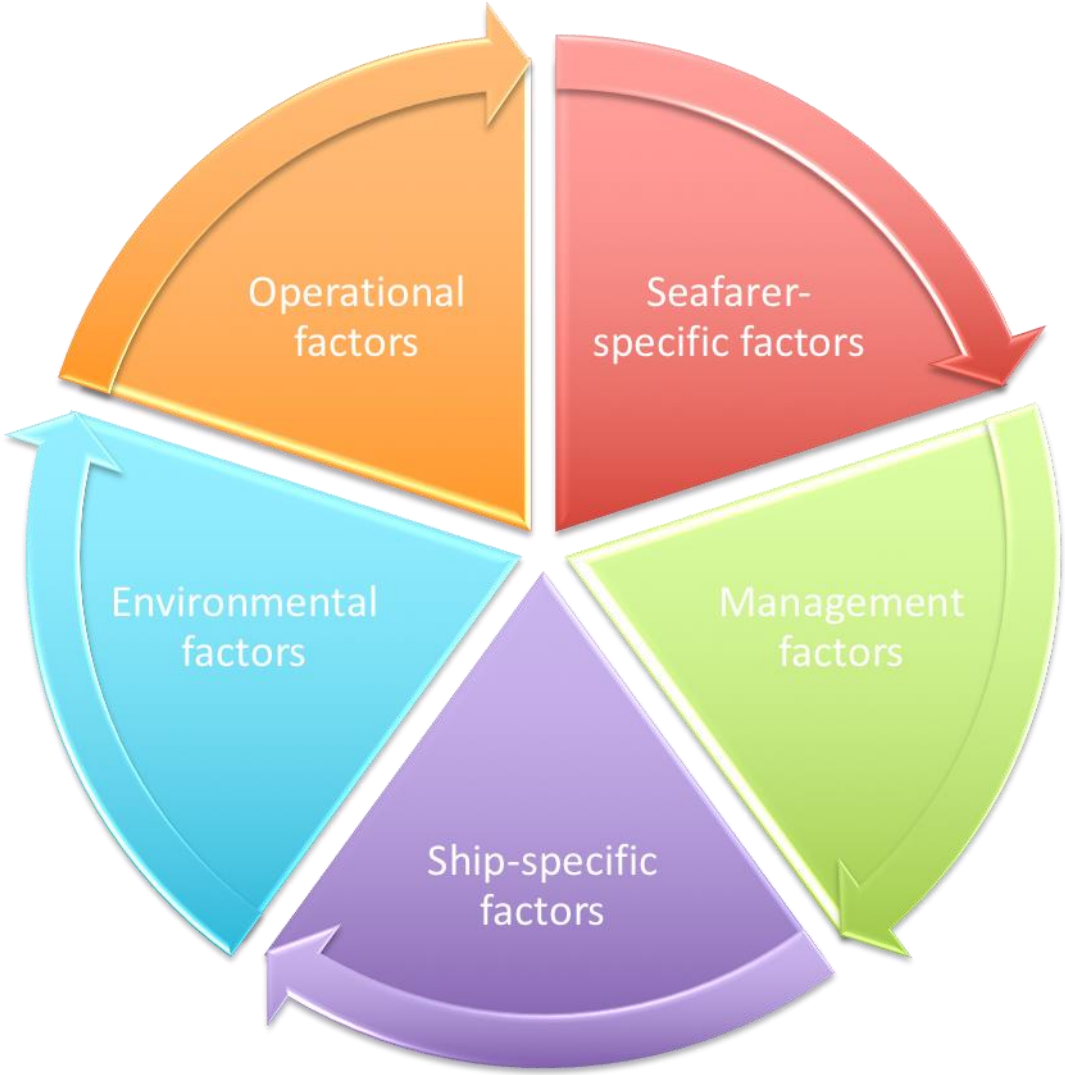
(Marine Transportation Safety Investigation Report M16P0378)

TSB Recommendations

"the Department of Transport require that watchkeepers whose work and rest periods are regulated by the *Marine Personnel Regulations* receive **practical fatigue education and awareness training** in order to help identify and prevent the risks of fatigue."(M18-01)

"the Department of Transport require vessel owners whose watchkeepers' work and rest periods are regulated by the *Marine Personnel Regulations* to **implement a comprehensive fatigue management plan tailored specifically for their operation, to reduce the risk of fatigue**."(M18-02)

Categories of Causes of Fatigue



Seafarer-specific factors

1) Sleep and rest
2) Body clock/Circadian rhythms
3) Psychological and emotional factors
4) Health and well-being
5) Stress
6) Medication and substance use
7) Age
8) Shift work and work schedules
9) Workload (mental/physical)
10) Jet lag

Management factors - Organizational

1) Manning policies, levels, and retention
2) Role of shore personnel
3) Administrative work/reporting/inspection requirements
4) Economics
5) Duty schedule-shift, overtime, breaks
6) Company procedures, culture and management style
7) Shore-based support
8) Rules and regulations
9) Other resources
10) Maintenance and repair of the ship
11) Drill schedules and training of crew

Management factors – Voyage factors

1) Frequency and duration of port calls
2) Time between ports
3) Routing
4) Weather and sea conditions on route
5) Traffic density on route
6) Nature of duties/workload while in port and at sea
7) Availability of shore leave.

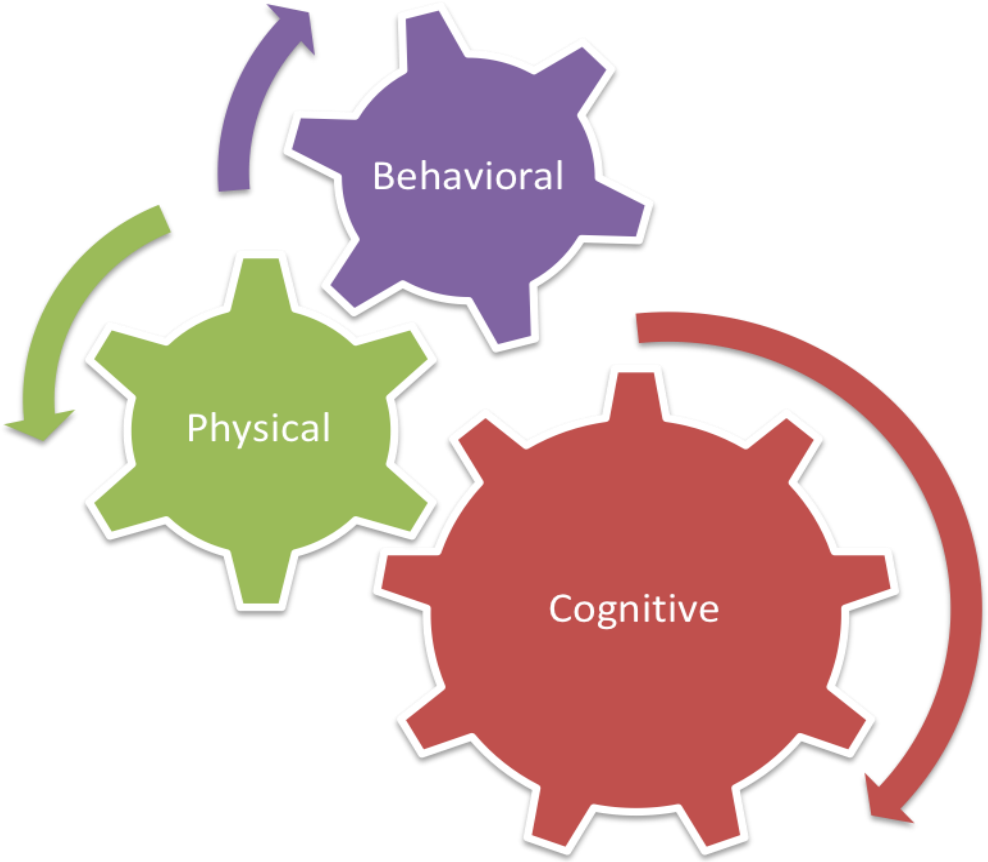
Ship-specific factors

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

Environmental Factors

- Noise
- Vibration
- Light
- Ship motion
- Temperature and humidity
- Ventilation/air exchange

Effects of Fatigue



Cognitive effects: Signs/Symptoms

- **Inability to concentrate**
  - unable to organize a series of activities
  - preoccupied with a single task
  - lapse of attention
- **Diminished decision-making ability**
  - misjudging distance, speed and time
  - choose risky options
  - greater indecisiveness
- **Poor memory**
  - fails to remember the sequence of a task
  - difficulty remembering events of procedures
  - forgets to complete a task or a part of a task
- **Slowing of cognitive processes**
  - Responds slowly to normal, abnormal or emergency situations

Physical Effects: Signs/Symptoms

Involuntary need to sleep

- slow eyelid closures, droopy eyelids, and itchy eyes.
- nodding off
- inability to stay awake

Loss of control of bodily movements

- Affected speech, which may be slurred, slowed or garbled
- Feeling heaviness of arms and legs, tremors
- Clumsiness, difficulty with hand-eye coordination skills

Health issues

- Headaches, giddiness, and rapid breathing
- Digestion problems, leg pains or cramps, and insomnia
- Sudden sweating fits, heart palpitations, loss of appetite

Behavioral Effects: Signs/Symptoms

Mood Change

- Quieter, less talkative than usual
- Unusually irritable
- Decreased tolerance and anti-social behaviour
- Depression

Attitude Change

- Fails to anticipate danger, to observe and obey warning signs
- Seems unaware of own poor performance
- Ignore normal checks and procedures
- Less desire to socialize

Instruments related to fatigue: one line of defense

- IMO Instruments
  - International Convention on Standards of Training Certification and Watchkeeping for Seafarers (STCW), 1978, as amended
  - International Safety Management (ISM) Code
  - Principles of minimum safe manning (resolution A.1047(27))
  - Fatigue factors in manning and safety (resolution A.772(18))
- ILO Instrument
  - Maritime Labour Convention (MLC), 2006

STCW, 1978, as amended

- Chapter VIII, Section A - VIII/1 (Fitness for duty)

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.

International Safety Management (ISM) Code

- Section 1.4: develop, implement and maintain a safety management system. (fatigue management plan)
- Section 6.2: ensure that each ship is manned with qualified, certificated and medically fit seafarers in accordance with national and international requirements and is appropriately manned in order to encompass all aspects of maintaining safe operations on board.
- Paragraph 6.1.3: ensure necessary shipboard support is provided so that the master's duties can be safely performed.
- Section 6.3, 6.4, 6.5: provide familiarization and training for shipboard personnel

Principles of minimum safe manning (Resolution A.1047(27))

- Ensuring ”fitness for duty” (paragraph 1.4.2 of annex 2)
  - "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."

Marine Personnel Regulations

- Section 320 requires that the master and every crew member of Canadian vessels engaged in domestic voyages have
  - (i) at least six consecutive hours of rest in every 24-hour period, and
  - (ii) at least 16 hours of rest in every 48-hour period; and
- The master shall also ensure that not more than 18 hours but not less than six hours elapse between the end of a rest period and the beginning of the next rest period.

Maritime Labour Convention, 2006

- Regulation 2.3: To ensure that seafarers have regulated hours of work or hours of rest.
- Regulation 2.4: To ensure that seafarers have adequate leave.
- Regulation 2.7: To ensure that seafarers work on board ships with sufficient personnel for the safe, efficient and secure operation of the ship.
- Regulation 3.1: To ensure that seafarers have decent accommodation and recreational facilities on board.
- Regulation 3.2: To ensure that seafarers have access to good quality food and drinking water provided under regulated hygienic conditions.
- Regulation 4.3: To ensure that seafarers' work environment on board ships promotes occupational safety and health.

Responsibilities of companies in fatigue management

- Identify and assess fatigue risks;
- Assess operational workload requirements in accordance with the principles of minimum safe manning (resolution A.1047(27));
- Ensure that manning and resources are adequate and available for assessed workload requirements and to conduct all ship operations safely;
- Ensure company-wide awareness of the risk of fatigue;
- Ensure a healthy shipboard environment

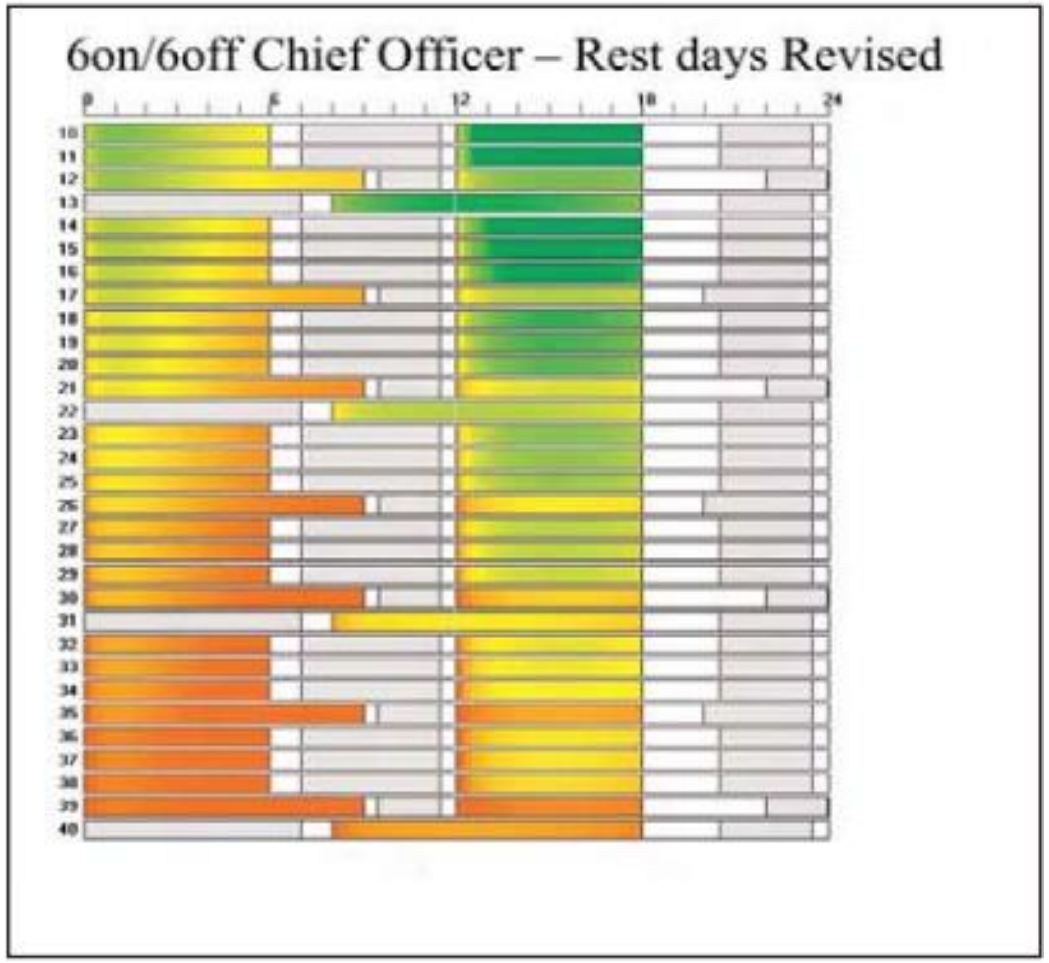
(International Maritime Organisation 2019)

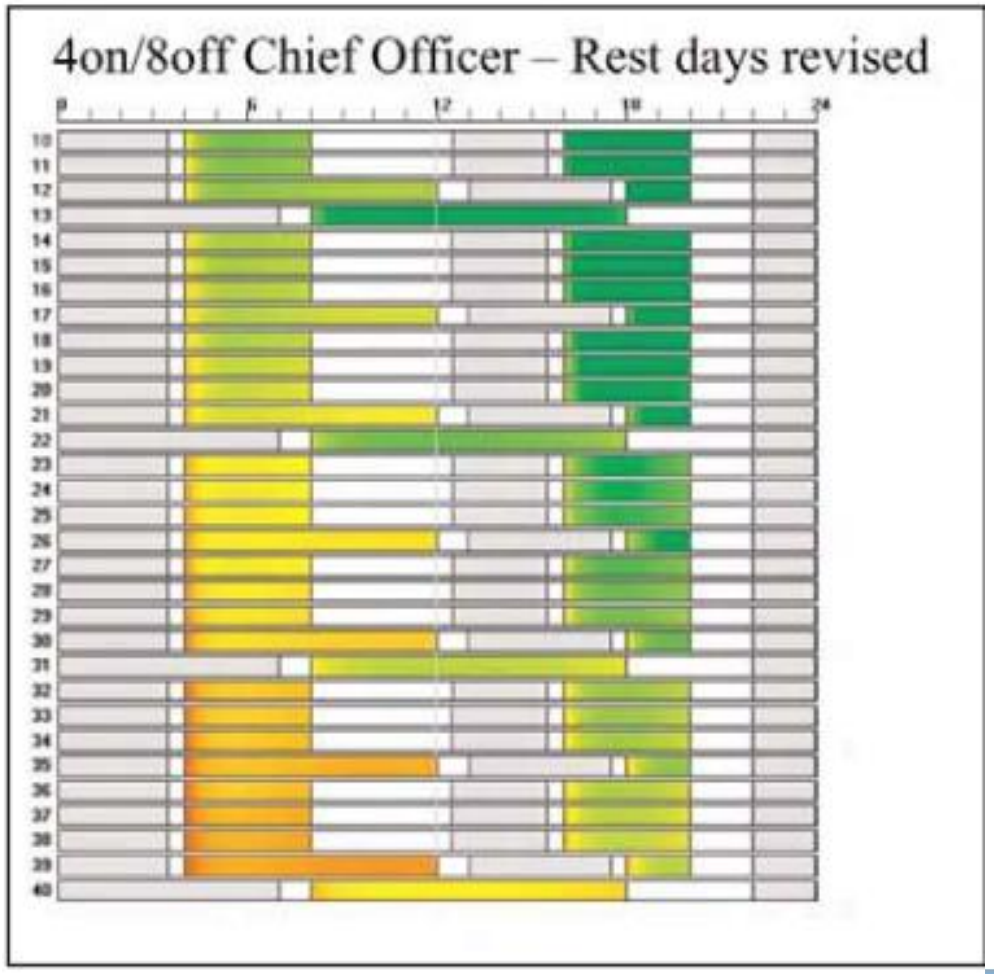
Mitigation strategies recommended by TSB

An organization can help prevent fatigue by:

1. Educating employees on the causes and mitigation of fatigue;
2. Defining appropriate policies and procedures;
3. Ensuring that the working environment and scheduling system minimize the risk of fatigue;
4. Striving for continual improvement in reducing the risk of fatigue.

6 on/6 off and 4 on/8 off





Green: not fatigued
Yellow: some fatigue

Orange: Badly Fatigued
Red: Dangerously fatigued

(UK Marine Accident Investigation Branch 2005)

Commuting fatigue

- Many seafarers may be required to travel or drive long distance to the ship and then have to work.
- For seafarers living on Canada’s East and West coasts, commutes to ship can take more than 7 hours.
- To provide rest opportunities for seafarers before joining ships, may help to mitigate fatigue risk.

（IMO 2019，Shan and Neis 2020）

Framework to mitigate the risk of fatigue

Hazard Assessment	Risk Mitigation
A. Is company providing effective **support** for managing the risks of fatigue?	Fatigue Training Awareness Adequate resources Healthy shipboard environment
B. Are seafarers provided with adequate **sleep opportunity**? (Quantity and Quality)	Hours of work and rest requirements Duty scheduling and planning Workload management
C. Is the sleep obtained by seafarers adequate?	Company and seafarer responsibility
D. Are seafarers able to **maintain adequate alertness** and performance while on duty?	Self and peer fatigue monitoring ensuring “fit for duty”
E. Are fatigue related events (near miss and accidents) **reported and analysed**?	Fatigue reporting and analysis



International Maritime Organisation (2019)

Responsibilities of seafarers in fatigue management

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

Personal Strategies for seafarers to mitigate fatigue

- Short rest breaks within duty periods
- Strategic napping
- Strategic use of caffeine
- Nutrition and hydration
- Environment
- Physical activity
- Social interaction
- Job rotation when practicable

Mitigating fatigue risks: a shared responsibility

APPENDIX 2

EXAMPLE OF A FATIGUE EVENT REPORT INFORMATION

This appendix provides recommended information that can be included in fatigue event reporting. Companies may decide to utilize parts of this information within their current incident reporting system.

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:

Karolinska Sleepiness Scale (KSS)

1	2	3	4	5	6	7	8	9
Extremely alert	Very alert	Alert	Rather alert	Neither alert nor Sleepy	Some signs of sleepiness	Sleepy, but no effort to keep awake	Sleepy, some effort to keep awake	Very sleepy, great effort to keep awake fighting sleep

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?	Yes/No	How long had you been awake when the event happened?	hours	mins
Fatigue during work?	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

What did you do?	Actions taken to manage or reduce fatigue (e.g. nap, breaks)
What could be done?	Suggested corrective actions

Further references

- IMO (2019) Guidelines on fatigue. MSC.1/Circ.1598. http://www.imo.org/en/OurWork/HumanElement/Documents/MSC.1-Circ.1598.pdf
- Fatigue Management Guide for Canadian Marine Pilots (TP 13959) and the Trainer's Handbook TP 13960.

Thank You
and
Questions