

Fatigue Advisor Resource



Get your sleep
Reduce your risk

FATIGUE ADVISOR RESOURCE

Part 1: Facts and safety strategies

Part 2: Writing a fatigue management
plan

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FATIGUE ADVISOR RESOURCE

Part 1: Facts and safety strategies

1 INTRODUCTION

1.1 Who should read this resource

This guide is for those who will act as advisors on fatigue management in the maritime industry. This includes:

- Maritime New Zealand staff
- Safe Ship Management companies
- managerial and rostering staff of major operators
- specialist industry advisors.

1.2 Aims of this resource

This guide provides:

- essential information about the causes and consequences of fatigue
- guidance on specific fatigue management strategies that could be used in a fatigue management plan.

Part 2 of this guide, Writing a Fatigue Management Plan, outlines how to develop and implement a fatigue management plan.

1.3 Summary of key points

1.3.1 The science of sleep and fatigue

Fatigue occurs when the balance is lost between physical and mental effort when awake, and the need to recover from that effort. The brain and body both need sleep to recover after normal and exceptional effort, after sleep is limited, and after being awake too long.

The need to sleep is basic to our biology – we cannot train ourselves to override it. We naturally want to sleep at night, especially in the early morning hours, and tend to feel sleepy again during mid-afternoon. We are also naturally alert at some times of the day – in the late morning and early evening.

Sleep need varies between individuals, with most people requiring 7-8 hours sleep per night to be fully rested. Most people can get by on 6 hours of undisturbed sleep per night for a few nights, before the pressure for sleep increases to risky levels. Eventually the brain's need for sleep becomes so strong that people fall asleep uncontrollably, but prior to this there is a gradual worsening of many kinds of performance. The accumulation of 'sleep debt' is commonly associated with maritime accidents.

The body clock does not fully adjust to shiftwork. Typically, night workers sleep 2-3 hours less per 24 hours than they need to be fully rested. Predictable routines, such as regular trips and rosters, help seafarers keep track of their roster commitments and plan their family and social life. Being on call makes work unpredictable and increases the difficulty of planning sleep.

1.3.2 Strategies to mitigate the effects of fatigue

Both management and seafarers are better placed to deal with fatigue if they have a shared understanding of fatigue and how to lessen its effects. Families have an important role in helping shift workers get quality sleep at home.

Sleep on board vessels is generally not as restorative as sleep at home because sleep periods are often short and/or sleeping environments tend to be of poor quality. This means that fatigue can accumulate rapidly.

Safe limits for maximum hours of work and minimum hours of rest will vary with the conditions of work and the type of task seafarers are engaged in. Maritime New Zealand recommends a minimum of 77 hours rest in a seven day period, with two consecutive nights available for sleep between 10.00 pm-8.00 am at least fortnightly, and preferably once per week. In practice, each situation needs to be

analysed to determine the risks associated with a given work pattern, with the final plan being monitored to determine how well it works.

Sleep quality is improved by making the sleeping environment dark and quiet, reducing vibration and motion to the extent possible, and giving the sleeper control over the temperature. The consumption of caffeine, alcohol and nicotine near bedtime can result in poorer quality sleep. Good nutrition is particularly important for shift workers.

Breaks allow for some recovery during work. The use of naps, if circumstances permit, can assist in deferring the onset of fatigue.

In a number of maritime situations alertness needs to be maintained in difficult circumstances, eg a solo night watch. Companies are encouraged to have a policy on maintaining crew alertness in such situations. That includes short breaks, activities to keep the watchkeeper active, strategic use of caffeine-based drinks, and use of a watchkeeper alarm.

2 THE SCIENCE BEHIND FATIGUE MANAGEMENT

2.1 Defining fatigue

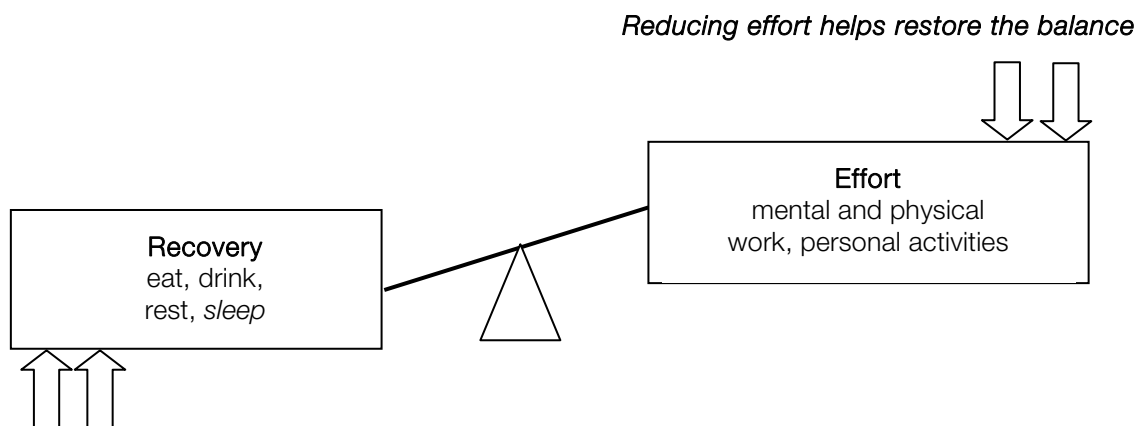
According to the International Maritime Organization, seafarer fatigue is:

“A reduction in physical and or mental capability as the result of physical, mental, or emotional exertion which may impair nearly all physical abilities including: strength; speed; reaction time; co-ordination; decision making; or balance”.

Basically, fatigue occurs when the balance is lost between:

- the physical and mental effort used during all waking activities (work and personal activities)
- the recovery of the brain and body after that effort.

The most important aspect of recovery is getting enough sleep on a regular basis. Recovery also includes taking short breaks from demanding work, eating properly, and drinking enough to avoid dehydration.



Improving recovery helps restore the balance

Traditionally, strategies to manage workplace fatigue have focused on limiting the effort - by limiting the number of hours on duty, and in some cases requiring breaks during work and minimum breaks between duty periods. Recently, however, the focus has started to shift. Not getting enough quality sleep is proving to be the main contributor to fatigue, not only in maritime transport but also in other transport modes.

2.2 Why sleep is important

This section discusses basic facts about sleep. Understanding these basic facts is a 'must' for being able to design, implement and manage a fatigue management plan successfully. While fatigue can arise for a number of reasons (physical or mental effort, hunger, thirst) by far the most important from a safety perspective is insufficient and/or poor quality sleep. Therefore, the emphasis in this guide is on sleep.

2.2.1 The brain needs sleep to recover – effects on performance

Going for a few nights without enough sleep affects the way a person's brain functions. Life without sleep is impossible.

Not getting enough sleep leads to:

- feeling sleepier – eventually involuntary lapses into sleep begin to occur
- difficulty staying alert
- getting irritable
- slower reactions
- poorer co-ordination
- slower thinking
- getting fixated on part of a problem and losing the big picture
- less creative problem-solving
- lower standard of performance becoming acceptable
- performance becoming increasingly inconsistent.

Sleep loss is a safety issue.

2.2.2 The body needs sleep to recover – effects on health status

Going for a few nights without enough sleep affects the way a person's body functions.

In experiments that restrict the sleep of healthy young adults for 2-6 nights:

- appetite increases, because of a decrease in the hormone (leptin) that makes people feel full, and an increase in a hormone (ghrelin) that increases appetite. This suggests that people who regularly miss out on sleep are more likely to put on weight.
- the body becomes less able to handle glucose (it starts to become resistant to insulin). This suggests that people who regularly miss out on sleep may be more likely to end up with type II diabetes.
- the body's ability to fight infection decreases. This suggests that people who regularly miss out on sleep are more likely to pick up infections in wounds, or get sick with things like colds and flu.
- Other studies show that sleep restriction causes changes that could lead to high blood pressure in people who regularly miss out on sleep.

Sleep loss is a health issue.

2.3 How much sleep?

2.3.1 How much sleep is enough?

People vary in how much sleep they require in order to be fully rested. Most people probably need around 7-8 hours sleep per night to be fully rested, but a few need more sleep than this and a few may need less.

It is common, especially when working at sea, not to get enough sleep to be fully rested. The question then is: how much sleep is enough to reasonably get by on?

Laboratory experiments suggest that most people are not too severely affected the next day if they get 6-7 hours of sleep at night. (But this amount of sleep loss has cumulative effects if it continues for several nights – see section 2.3.2). On the other hand, most people are severely affected the next day if they get less than 5-6 hours of sleep on one night.

There is widespread agreement among sleep specialists that 6 hours sleep in a single episode (not split) should be the minimum per 24 hours for transport workers. However, 6 hours sleep per night is not enough on an ongoing basis. To prevent the effects of sleep loss accumulating, sleep experts have also recommended a minimum of 14 hours sleep in 48 hours.

Cumulative sleep loss is a safety and health issue.

2.3.2 Effects of sleep loss accumulate

The effects of sleep loss over successive nights are cumulative. This is known as sleep debt. The pressure for sleep builds as a person continues day after day not getting enough sleep. It becomes harder and harder to fight sleep, and performance gets progressively worse. His or her ability to judge how well he or she is functioning also deteriorates, so the impression of conquering fatigue after several days of restricted sleep may be misleading.

Eventually, the pressure for sleep is so great that it cannot be resisted. The brain takes uncontrollable “microsleeps”, shutting itself off from the environment for brief periods. Eventually, these microsleeps develop into continuous sleep, if circumstances permit.

The pressure for sleep increases predictably at certain times of day. It is strongest in the early hours of the morning, and increases again in the middle of the afternoon (siesta time). Microsleeps are also more likely to occur at the daily times when the pressure for sleep is high (section 2.6.1 explains why this happens).

Microsleeps can be associated with behaviour such as blank staring, or head snapping when the person wakes up. They can happen with eyes open, and people are often not aware that they have occurred. Most experts agree that we are not good judges of how close we are to falling asleep uncontrollably.

Individuals cannot train themselves to need less sleep by repeatedly restricting their sleep. Sleepiness will be uncontrollable if it is ignored for too long.

In 1998 Captain Filor, the Australian Inspector of Maritime Accidents, made the following observation¹:

“In investigating marine casualties...experience has led us to believe that chronic fatigue is the most common and insidious form. Chronic fatigue could explain what is often inexplicable, why a person’s performance is below that which one might reasonably expect.”

¹ Proceedings of the 3rd International Conference on Fatigue and Transportation, Freemantle, 9-13 February, 1998.

2.3.3 Experiments on sleep loss

Many laboratory experiments have been carried out to try to measure the effects of sleep loss on how people function. One recent experiment clearly demonstrates the effects of not getting enough sleep night after night.² In this study, 66 participants (50 men, average age of 37 years, 16 women average age of 43 years) spent 14 days (13 nights) living in a sleep laboratory.

- For the first 3 nights they were allowed 8 hours in bed (the baseline or 'B' section of Figure 1).
- They were then split into 4 groups. For 7 days nights they were allowed either 9 hours in bed, 7 hours in bed, 5 hours in bed, or 3 hours in bed (the experimental or 'E' section in Figure 1).
- All groups were then allowed 3 nights of 8 hours in bed (the recovery or 'R' section in Figure 1).

Participants had to complete performance tests 4 times a day on each day of the study. The following figure shows their average reaction speed each day, on a 10-minute vigilance and reaction time task.

Figure 1 - Performance as a function of sleep loss

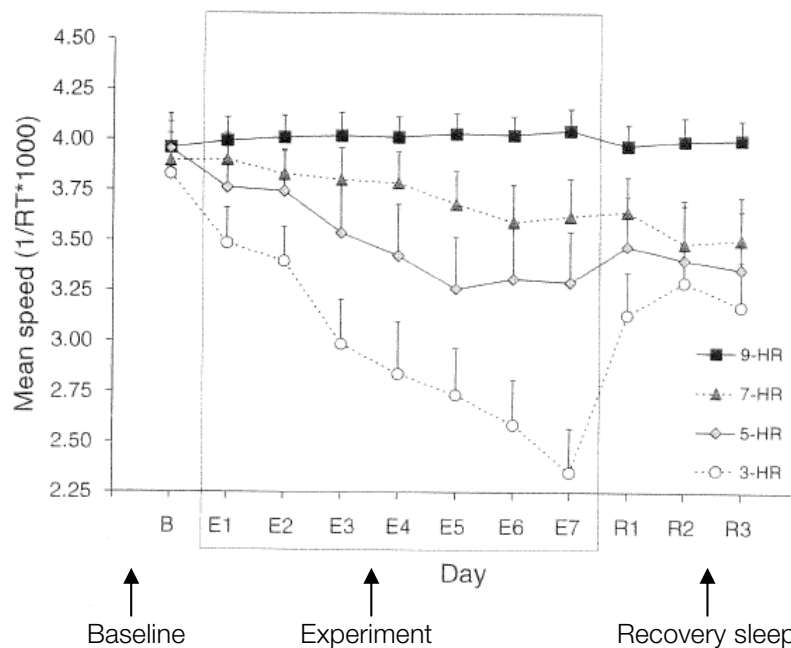


Figure 3. Mean psychomotor vigilance task speed (and standard error) across days as a function of time in bed group.

In the groups allowed 7 hours or 5 hours in bed across the experiment, performance got progressively worse for about 5 nights and then seemed to level off. The levelling off might mean that the brain is somehow compensating to maintain performance at a steady level, although not as good as when people are fully rested. However, the group allowed only 3 hours in bed continued to get worse every night. Another interesting feature of this study was that 3 nights of 8 hours in bed did not seem to be enough for the groups with restricted sleep to fully recover.

Another study³ compared the effects of losing sleep fast versus losing sleep slowly. This study included 12 healthy young people aged 21-35 years (5 women), who each went through four different laboratory experiments. Each time, they had a baseline night where they were allowed 8 hours in bed, followed by:

- 4 nights where they were allowed 8 hours in bed (no sleep debt) or
- 4 nights where they were allowed 6 hours in bed (slow accumulation of an 8-hour sleep debt) or
- 2 nights where they were allowed 4 hours in bed (medium accumulation of an 8-hour sleep debt) or

² Belenky, G., Wesensten, n. J., Thorne, D. R., Thomas, M. B., Sing, H. C., Redmond, D. P., Russo, M. B. and Balkin, T. J. Patterns of performance degradation and restoration during sleep restriction and subsequent recovery: a sleep dose-response study. *Journal of Sleep Research*, 2003, vol.12, 1-12. Permission to reproduce from Blackwell Publishing.

³ Drake, C. L., Roehrs, T. A., Burduvali, E., Bonahoom, A., Rosekind, M. and Roth, T. Effects of rapid versus slow accumulation of eight hours of sleep loss. *Psychophysiology*, 2001, vol.38, 979 – 987.

- 1 night with no sleep (rapid accumulation of an 8-hour sleep debt).

The rapid accumulation of sleep debt had the greatest effects on alertness, memory, reaction time, and self-rated fatigue. Having only 4 hours in bed for 2 nights had an intermediate effect. Having 6 hours in bed for 4 nights lead to the least impairment. Like the study above, slow accumulation of sleep debt showed a levelling off of the effect, suggesting some kind of adaptation to restricted sleep, but the participants still performed worse than when they were allowed 8 hours in bed for 4 nights.

It is not uncommon for a seafarer to a seafarer to be getting by on less than the desirable level of sleep, with somewhat reduced alertness and performance, and then something happens that results in a very short sleep or a disturbed sleep. While there has not been an experiment to test what happens in this situation, the two experiments described above suggest that alertness and performance will be seriously affected.

This means that thinking about things that can go wrong at sea, and having contingency plans to deal with them, is one of the critical parts of a fatigue management plan.

2.4 Sleep quality

2.4.1 The internal structure of sleep

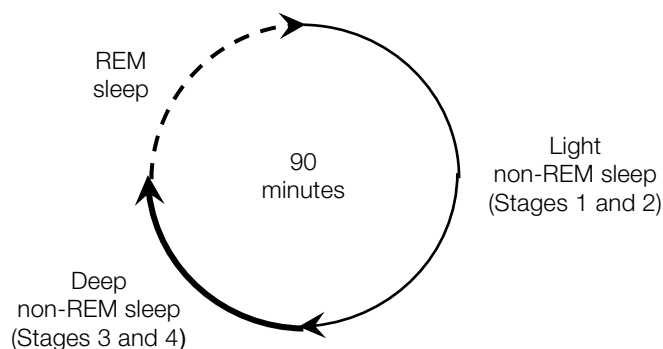
Sleep involves a series of cycles. Disruption of these reduces the recovery value of sleep, so understanding them is important if sleep and fatigue are to be effectively managed.

Good quality sleep involves regular cycles through two different types of sleep:

- Non-rapid eye movement sleep (non-REM sleep), where brain activity is slowed compared to waking. Non-REM sleep is divided into four stages, with stage 4 corresponding to the slowest brain activity and the deepest sleep (it is hardest to wake someone up from stage 4).
- Rapid eye movement sleep (REM sleep), where brain activity is similar to waking. From time to time the eyes dart around under closed eyelids, and heart rate, breathing and blood pressure surge. This is the type of sleep associated with active dreaming. At the same time, people cannot move voluntarily, so they cannot act out their dreams.

A full non-REM/REM sleep cycle takes roughly 90 minutes. Sleep needs to be long enough to go through 4-5 of these cycles to be fully restorative. Sleep that is fragmented by multiple awakenings breaks up the non-REM/REM cycles and is less restorative than continuous sleep.

Figure 2 - The non-REM/REM sleep cycle



2.4.2 Factors affecting sleep quality

- Broken sleep is less restorative than continuous sleep, even for the same number of hours slept.
- Seafarers who live on board face a unique set of challenges to sleep quality, including vibration, noise, and motion of the vessel, particularly in bad weather.
- In addition, even when routine sleep schedules are planned, it is not unusual for work demands to intrude - such things as emergency drills, unanticipated repairs, navigating in and out of port, cargo handling in port, and paperwork.
- Split duty periods (more than one per 24 hours), and living in the workplace for an extended time, have also been identified as specific contributors to poor-quality sleep on board.
- Alcohol, caffeine and drugs can all make sleep quality worse.
- As we get older (particularly over 50 years of age), sleep becomes more broken.

In a survey in 2003 by the former Maritime Safety Authority (MSA):

- 60% of seafarers slept on board at least sometimes.
- Of these, 33% reported not getting enough sleep on at least half of their last five trips.
- 47% of seafarers rated the level of general noise in their onboard sleeping accommodation as fair/poor. Fair/poor ratings were also given by 40% of seafarers for engine noise; 34% for bed size; 33% for ships movement; 33% for vibration; 30% for temperature; 16% for the mattress/pillow and 10% for light in their onboard sleeping accommodation.

A 2000 survey of masters and mates on the inter-island ferries found that:

- While on board, officers were more likely to nap, to wake multiple times during their main sleep episode, and to report never/rarely getting enough sleep or waking refreshed, compared to when they slept at home.
- The main factors disturbing sleep on board were: ship's motion (identified by 33% of officers); unspecified noise/disturbances (33%); bow thruster/engine noises (23%); weather (21%); needing to go to the toilet (14%); people walking/talking (14%); and manoeuvring/anchoring/loading (12%).

2.4.3 Sleep problems

Many people from all walks of life have problems sleeping from time to time. The causes may be biological, behavioural, due to factors in the environment, or a combination of these.

As sleep problems are fairly common, they are a hazard that owners and fleet managers need to recognise and have strategies to manage. A survey of New Zealand adults suggests that 29% of Maori adults and 25% of non-Maori adults have chronic sleep problems.

The most common sleep complaint is insomnia, which is having trouble either going to sleep (or getting back to sleep), staying asleep, unrefreshing sleep, or some combination of these. Insomnia symptoms can be caused by a wide range of factors.

The most common type of sleep disorder is Obstructive Sleep Apnoea. This is when the airway collapses repeatedly during sleep and the person has to wake up to breathe again – sometimes hundreds of times per night. Generally, they do not remember waking up, but daytime sleepiness is common because sleep is fragmented by having to wake up to breathe.

Employers should encourage employees to report sleep problems to their own doctor, and encourage them to seek assistance.

A wide range of factors in personal lives can adversely affect sleep quality, eg a new baby, poor or broken relationships, financial worries and other sources of stress. If an employee has a factor in his or her personal life that causes poor sleep, and fatigue becomes a safety issue, then a safety strategy for that employee may be necessary.

There are a number of specialist sleep clinics in New Zealand and these are listed on Maritime New Zealand's website: www.maritimenz.govt.nz

2.5 Recovering from sleep loss

Sleepy people have fewer mental and physical reserves to draw on. They get progressively worse until eventually they reach the point where they can no longer force themselves to stay awake, regardless of what they are trying to do at the time. The only way to reverse these effects is to get adequate recovery sleep.

Lost hours of sleep do not need to be recovered hour-for-hour.

Recovery sleep is deeper and sometimes slightly longer than normal. On the first night of recovery sleep, people tend to spend a lot of extra time in deep non-REM sleep. The second night of recovery sleep may include extra REM sleep. By the third night of recovery sleep, sleep is usually back to normal.

This has led to the recommendation that **2 nights of unrestricted sleep are needed to recover from the effects of sleep loss**. This is not the same as 48 hours off. For example, 48 hours off starting at 3.00 am allows only one full night of sleep.

However, this recommendation may be overly-optimistic. Recent lab studies with 1-2 weeks of sleep restriction suggest that it may take more than 3 nights of recovery sleep for people to return to their normal level of waking function (see above). At present, it is not clear how long it takes to recover fully from long periods of restricted sleep. It may be different for different types of task.

Sleep is a complex process that the brain and body need to go through to be restored from the efforts of waking activities. Rest without sleep does not provide the same recovery.

How often people need an opportunity for recovery sleep will depend on how much sleep they are losing across a work cycle or roster.

2.5.1 Sleep inertia

Sleep inertia is a feeling of grogginess or disorientation that sometimes occurs on waking. It is often associated with temporary impairment, including slower reactions, poorer physical co-ordination, and poorer decision-making. These effects normally only last a few minutes, and they tend to be more severe if waking suddenly out of deep sleep than if naturally waking out of lighter sleep. For working-age people, limiting the time for a nap to 40 minutes has been shown to give an average of about 20 minutes sleep and minimize the chances of waking out of deep sleep.

For longer naps, sleep inertia should be reduced if the sleeper can wake at the end of a non-REM/REM sleep cycle. Allow about 2 or 3.5 hours of sleep for 1 or 2 complete cycles.

2.6 Daily cycles of sleepiness and alertness

2.6.1 The body clock

Sleeping at night is not just a social convention. Like most species on Earth, we have an internal pacemaker – the circadian body clock– that alters the way our brains and bodies function, in step with the day/night cycle. It programmes us for sleep at night and active wakefulness during the day.

This body clock causes sleepiness to be strongest during the early hours of the morning (around 3.00-5.00 am for most people). It also causes sleepiness to increase mid-afternoon (around 3.00-5.00 pm for most people). Conversely, in the late morning and early evening the body clock causes alertness to be high, and it is hard to sleep at these times.

Variations in the clock (including in the “clock” genes) make some people more morning-type (larks) and others more evening-type (owls). For people interested in knowing what type they are, there is a standard morningness/eveningness questionnaire available on Maritime New Zealand’s website: www.maritimenz.govt.nz

2.6.2 Time cues: body clock and shiftwork problems

The body clock is sensitive to particular time cues, including light/dark, work/rest patterns, and interactions with other people. Without these time cues, most people’s body clocks tend to run a bit slow (their “biological day” is a bit longer than 24 hours).

Regular patterns of activity and sleep enable the body clock to lock into step with the 24-hour day/night cycle. On the other hand, working at unusual times, or changing shifts, sets up conflicting messages to the body clock.

For example, when people go onto night work, the day/night cycle does not change, and neither do the other people in their lives who are active during the day. So, while their work pattern is requiring them to be active at night, the other cues in the environment are telling the body clock that they should be asleep at night.

Because of conflicting time cues, the body clock does not adapt fully to shiftwork. On days off, most people also change back to sleeping at night and being active during the day, which helps bring the body clock back to its preferred pattern.

Unusual work times also mean that people can be trying to sleep when factors such as noise and light are more likely to disturb them, and when there are other demands on their time, like family responsibilities, or leisure activities. These external factors can also reduce both the amount and the quality of sleep they are able to get, in addition to the effects of trying to sleep at a less optimal time in the body clock cycle.

- From a biological point of view, shiftwork is any work pattern that requires someone to be awake and active when he/she would normally be asleep.
- Trying to work out of step with the body clock makes people less functional (more error prone) when they are awake, and makes it harder to get enough good quality sleep.

2.6.3 Consequences for safety

The influence of the body clock means that there are certain times of day when people are more error prone, and more likely to fall asleep uncontrollably, particularly if they are carrying a sleep debt (Figure 3). Figure 4 shows the time of day of 14 fishing accidents (13 groundings and one collision) where the former MSA determined that the watchkeeper fell asleep. Numerous other studies confirm the pattern of increased risk between midnight and 8.00 am.

There is also an increased risk of falling asleep unintentionally in the middle of the afternoon (siesta time). Tasks that require alertness and vigilance (like driving a car) often show a slump in performance at this time. If people have not had enough sleep, it will be particularly difficult for them to stay awake through the afternoon.

Figure 3 - Pattern of sleepiness across the 24-hour day

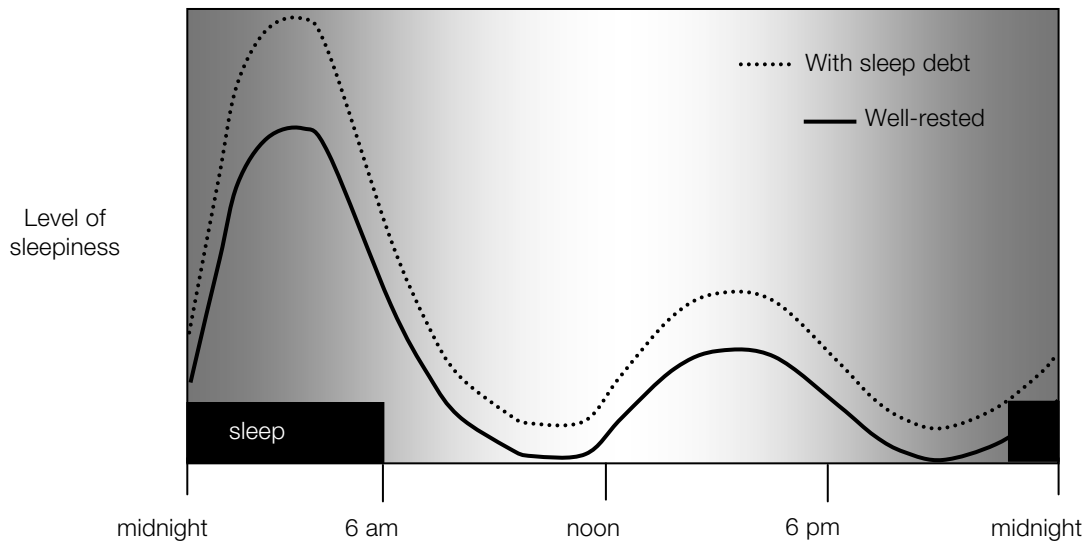
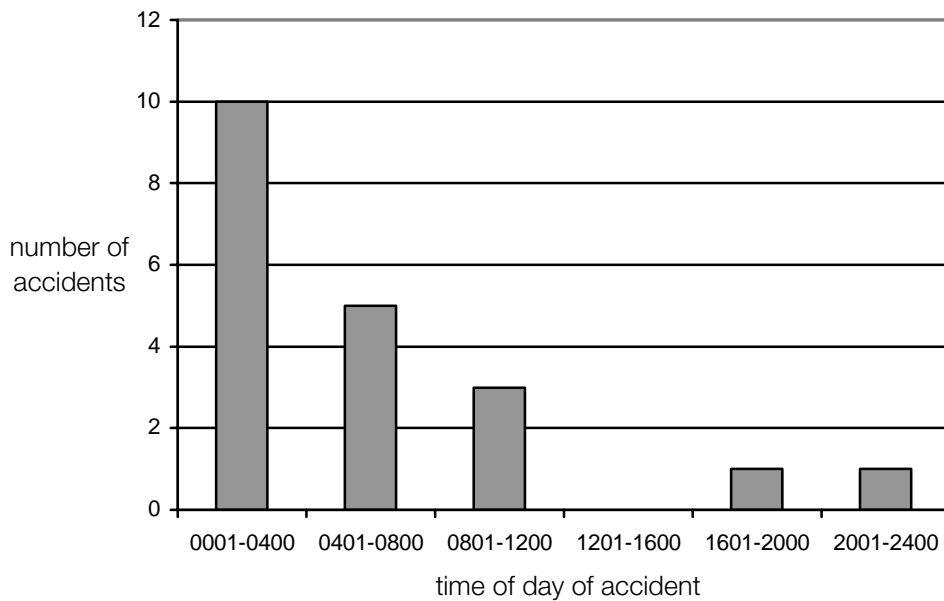


Figure 4 – Timing of 20 fishing accidents where watchkeepers fell asleep



2.6.4 Length of time awake

Sleep is also regulated by how long a person has been awake (the homeostatic sleep drive). From the time of waking up, the pressure to sleep slowly builds to a point where it is easy to fall asleep. This is usually after about 16 hours awake, if there has been good prior sleep. From the time of falling asleep, the pressure for sleep decreases rapidly (exponentially).

The homeostatic sleep drive works with the body clock to determine when people are either alert or sleepy. Being awake for more than 16 hours and working at the low alert times (3.00 – 5.00 am and 3.00 – 5.00 pm) increase the risk of falling asleep. For instance, a seafarer wakes at 11.00 am and works from noon to 3.00 am. This is 16 hours after waking. Both drives act to bring on sleep, as it is the low point in the biological clock and he has been awake for 16 hours.

It is virtually impossible to sleep if a person has been awake for a short time and is trying to sleep at the alert times of the day. For instance, a seafarer wakes at 5.00 am and tries to get some sleep at 11.00 am before a new shift starts. The homeostatic drive (time awake) is low and the biological clock is in the alert phase. Sleep is impossible.

2.7 Work factors that affect fatigue

2.7.1 Extended hours of work

Employees often work additional hours in the maritime industry. There are busy periods, unexpected demands, and at times simply too much work to do in the scheduled work hours. At times, an employee may be asked to work the additional hours or is simply expected to do so. At other times, an employee or group of employees will choose to work long hours, as a matter of preference, if they are offered the choice.

Regardless of the situation that leads to additional hours being worked, the employer has a duty of care under the Health and Safety Act 1992. Where there is a possibility of employees working long hours, the work should take place within limits set by the company fatigue or safety policy (even if employees volunteer to work long hours). Similarly, a principal's duty to take all practicable steps to prevent harm is not negated by a contractor, or an employee of a contractor, choosing to work long hours.

How long can a person work safely? This is a complex question that depends on a number of factors, such as:

- the level of fatigue going into the shift, which depends on prior sleep history, particularly in the last few days
- the time of day that the shift covers, and through what part of the body clock cycle it occurs
- how hard the person has to work (workload), and whether it is possible to take short breaks
- how familiar the person is with the task
- the likelihood of making mistakes, and the consequences of making mistakes.

The unique factors associated with each job make it difficult to provide specific advice as to what the maximum hours of work should be. For instance, working long hours for days at a time may result in a different risk to a “one-off” long day. The safety risks will be different for watchkeepers and deckhands. Long hours of work also take up time that people usually use for personal or social activities. Most people will want to engage in at least some non-work activities, which can put even more pressure on the time available for sleep.

The risks associated with working extended hours can only be determined by measuring fatigue in the workplace and assessing the risks.

Operational knowledge is essential for making sensible decisions about safe shift lengths for a given job. Science can only provide general guidance.

2.7.2 Short breaks during work

During long periods of work, short rest breaks are useful for relief of boredom and monotony, and provide opportunities to use fatigue countermeasure strategies (such as taking a nap or drinking coffee).

There is not much research on the best timing and duration of breaks at work, although it is clear that more frequent breaks should be taken during night work. The timing and length of breaks need to be tailored to the type of work and the work environment. People who know the job well may be able to provide guidance on this.

2.7.3 Shiftwork

Shiftwork is a fact of life for many seafarers. As discussed in section 2.3.1, the human body is designed for unrestricted sleep at night, and anything else is a compromise. There is no such thing as the perfect shift or roster.

Shift workers rarely adapt fully to shiftwork, in terms of their circadian rhythms. The more work overlaps with a person's preferred sleep time, the faster they will accumulate a sleep debt across a roster. In general, people working nights will have 2-3 hours less sleep per 24-hours than what they need to be fully rested.

Early morning starts (ie earlier than 7.00 am) can cut sleep short and, therefore, add to sleep debt. Similarly, duty periods that finish later than usual bedtime (eg 10.00 pm) can restrict sleep and add to sleep debt.

Strategies to manage shiftwork-related fatigue involve careful managerial planning. There should be sufficient time between shifts or voyages to allow time for other life activities in addition to sleep, including travel, meals, personal hygiene and family and leisure time. Predictable duty schedules help seafarers keep track of their roster commitments and plan their family and social life.

Also, to minimise the risk of fatigue-related accidents, night shifts should be planned so that watchkeepers who have just worked through the night are not required to commute in heavy morning traffic.

With a system of 2 x 12-hour shifts, the sleep opportunities of one shift are being traded off against those of the other shift. For example, if there are safety concerns about the functioning of crew by the end of a 12-hour night shift, then one solution is to end their shift earlier, allowing more time for sleep in the morning. However, this also means that the day crew have to get up earlier, potentially reducing their sleep.

In terms of personal strategies for dealing with shift work-related fatigue, when seafarers finish night shift they should get to sleep as soon as possible. This is because their body clock is likely to wake them later in the morning, before their optimal amount of sleep is obtained.

Many factors can affect how well a person copes with a given work pattern, including gender, age, and circumstances in life outside work. For owners and vessel operators, there are safety and other work issues if an individual cannot adapt to a roster system that others cope with well. Having a trial period for people starting shiftwork may be worthwhile.

2.7.4 On-call duty

Some seafarers work in positions that involve being “on call”. This means having to be available to work for a specified period of time, during which they will be called in if needed.

Being on call makes work unpredictable and increases the difficulty of planning sleep and other non-work activities.

For unscheduled call-backs, it is useful to keep an up-to-date record of actual duty hours, to be able to identify which crewmembers are likely to be best rested to take the extra work. All workforces have the “hungry few” who will take any additional work that is on offer. A policy should be in place to limit the amount of extra time crew can work.

2.7.5 Commuting

Seafarers who do not sleep on board have to commute to and from their homes at the start and end of voyages. Commuting can be a high-risk activity, as driving a motor vehicle requires continuous vigilance, which is badly affected by fatigue. Early morning starts not only reduce a seafarer’s sleep, but also result in driving before body and brain are fully into the waking part of the body clock cycle. These two factors increase the risk of a fatigue-related accident.

Finishing work either after a very long day’s work and/or in the early hours of the morning also places the seafarer at increased risk of a fatigue-related traffic accident. Risk is increased by extended time awake, and by cumulative fatigue.

2.8 Non-work factors that affect fatigue

2.8.1 Lifestyle

A person's lifestyle affects both the amount and quality of their sleep.

Common lifestyle factors that affect the amount and quality of sleep include:

- family demands on a seafarer's time
- noise made by others (family, friends, flatmate) when trying to sleep during normal awake hours
- living with young children
- use of recreational time (eg late nights, partying)
- alcohol and drug use
- other jobs that impact on sleep and recovery opportunities.

2.8.2 Individual factors

People vary in their ability to cope with fatigue and the effects of different work patterns, and this may change with changes in personal circumstances.

Individual factors that affect fatigue include:

- Stress. This can interfere with both the amount and quality of sleep. Stress can arise from a number of factors including personal relationships, work demands and management style.
- Sleep need. Most people need 7-8 hours sleep per night to be fully rested. If a skipper believes he or she needs less sleep than the crew, he or she must take into account their needs, if acceptable safety levels are to be maintained.
- Sleep problems. Older workers generally tend to have more sleep problems both in association with other health problems and because sleep tends to get lighter and shorter after about age 50 years.
- Morningness/eveningness. This changes across the lifespan. Teenagers tend to have more delayed sleep times, not only for social reasons but also as part of going through puberty. Most people swing back to a more normal sleep time by their early-mid twenties, and become increasingly morning-type right across adulthood.
- Personal limits for working when under stress from fatigue. Skippers and colleagues need to be aware of changes in a person's behaviour that point to potential problems.

2.9 Physical environment

A stressful physical environment will add to fatigue, if it exists for some time. Heat, cold, high humidity, noise, whole body movement and motion sickness can all add to fatigue.

The physical setup of the sleeping environment influences both the amount and quality of sleep. It is important to ensure that:

- the temperature of the sleeping environment is cool rather than warm
- light and noise are blocked out
- there is good ventilation
- the mattress is comfortable.

3 STRATEGIES FOR MANAGING FATIGUE

Company strategies to manage fatigue are based on:

- managing physical and mental demands, particularly at high risk times
- making sure that work patterns allow sufficient time for sleep and other life activities
- ensuring that onboard sleep occurs in the best possible environment.

This part of the guidelines describes fatigue management strategies that owners and operators can use. However, there is no magic formula for fatigue management because each individual is unique, and work demands vary between jobs and across time within a given job. A key strategy for fatigue management is to monitor how the skipper and crew respond to the strategies put in place. If fatigue has been identified as an on-going hazard, its effects must be monitored (Health and Safety in Employment Act 1992 - section 10 (2)).

3.1 Education

Education is a key strategy and is the foundation of fatigue management. The experience of many industries, including the maritime industry, is that both management and the workforce are better placed to deal with fatigue if everyone shares an understanding of what influences sleep and fatigue.

Owners/operators, shore-based management, shipboard management, and all maritime workers need a common understanding of:

- the risks associated with fatigue in their particular environment
- the effects of work demands on the body and brain, particularly in relation to sleep
- proven personal strategies that can be used to improve sleep and reduce other causes of fatigue
- company policies and practices for fatigue management.

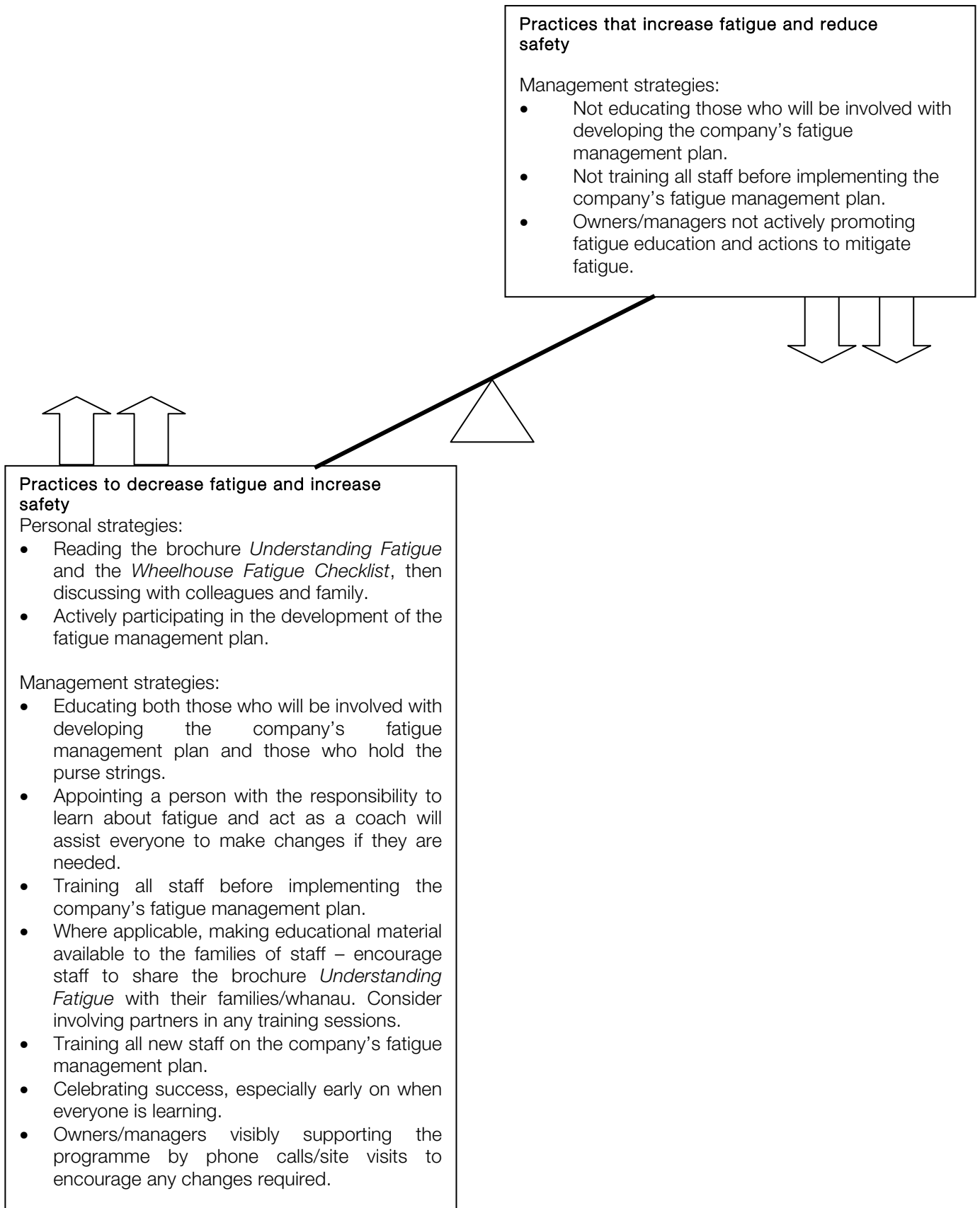
Introducing a fatigue management plan can be challenging. Typically, both management and staff have to learn about the nature of sleep and fatigue to appreciate why control measures are needed and which ones work best. Many mariners have worked in the industry for a long time, with fatigue being a regular feature of their working lives. This leads many to believe that seafarers can successfully cope with ongoing adverse conditions without satisfying normal sleep and other needs. On-going accidents have demonstrated this is not true.

Education at an early stage is recommended – especially for all staff who are involved in developing the fatigue management plan. For small companies this may mean educating all staff from the beginning. For larger companies it may mean at first providing education only to those who will be directly involved in developing the fatigue management plan.

Prior to implementation of a company's fatigue management plan, all staff will require education on fatigue management and the company's plans to manage it. While staff should be encouraged to read the information available, particularly the brochure *Understanding Fatigue*, running a specific training session on fatigue has been shown to be an effective approach. The training will work best if it is conducted in a group situation. As an advisor, you are well placed to run short training sessions with industry.

The people who live with a seafarer on shore are affected by his/her fatigue and can have a key role in helping to manage it, particularly if the seafarer needs to sleep at unsociable hours. Giving seafarers take-home education materials is a strategy that can help improve the understanding and support of others in the household. Involving partners in fatigue education through company meetings is a positive way of providing support to both seafarers and their families/whanau.

A range of materials is available for both advisors and industry to use. A full list is available on Maritime New Zealand's website: www.maritimenz.govt.nz



3.2 Minimum rest and maximum hours of work

New Zealand seafarers work on a wide range of vessels and in very different circumstances. Some have regular work hours, others are on call, while others have work demands that vary. Some work long hours for a day or so, others work long hours for long periods of time. Some are based on the ship, others are walk on/walk off and also have to commute. The most consistent thing over this wide variety of vessels and work is the biology of the seafarer.

Apart from watchkeepers on ISM ships, New Zealand does not have regulations limiting hours of work or prescribing minimum rest periods. However, a number of other countries have recently developed regulations and codes of practice for the maritime sector that include minimum hours of rest and maximum hours of work.

3.2.1 Overseas daily levels of minimum rest

Denmark, France, the UK, and the USA have the following minimum levels of rest in a 24-hour period:

- a minimum of 10 hours rest in any 24-hour period, which can be split into no more than two rest periods, one of which must be at least 6 hours
- a maximum of 14 hours between two rest periods.

The UK, France, and the European Union, apply these same daily levels to employed fishermen.

The UK regulations allow that the master may require seafarers to work any hours necessary in emergencies. However, if normal rest periods are disturbed by emergency drills or emergencies, then compensatory rest must be provided.

The US regulations for watchkeepers allow the minimum 10-hour rest period to be reduced to 6 hours, as long as no reduction extends beyond 2 days. They also specify that during rest periods, seafarers must be allowed to sleep without being interrupted, ie they cannot be required to work. The master is responsible for seeing that these requirements are met. Nevertheless, he or she can require any part of the crew to work when they are needed for:

- manoeuvring, shifting berth, mooring, unmooring
- performing work necessary for the safety of the vessel, or the vessel's passengers, crew, or cargo
- saving life on board another vessel in jeopardy
- performing fire, lifeboat, or other drills in port or at sea.

The Canadian Crewing Regulations have a slightly different approach, and require:

- a rest period of not less than 6 consecutive hours in every 24-hour period
- at least 16 hours of rest in every 48-hour period. Between rest periods, a minimum of 6 hours and a maximum of 18 hours is allowed. In contrast to the UK, time spent during a rest period for attending to an emergency or participating in an emergency drill is counted as part of the rest period.

Some countries require more daily rest for seafarers younger than 18 years. For example, French fishermen under the age of 18 must have a minimum of 12 hours of uninterrupted rest per 24 hours. In Denmark:

- seafarers younger than 18 must have at least 12 hours of rest per day and the rest period must normally be between 8.00 pm and 6.00 am
- if a seafarer younger than 18 years is on watch, the rest can be split into no more than two rest periods, one of which must be at least 8 hours between 8.00 pm and 6.00 am.

Because sleep is vital for recovery from fatigue, in many industries the focus is moving from providing minimum rest to providing minimum sleep opportunities. These are not the same thing. For example, in an 8-hour break from 10.00 pm to 6.00 am most people will get a lot more sleep than they can in an 8-hour break from 10.00 am to 6.00 pm. Clearly, there is a balance between how many hours can be worked in a day, and how many hours of sleep can be obtained.

Maritime New Zealand recommends the following minimum sleep:

- a minimum of one block of 6 hours sleep per 24 hours and
- 14 hours sleep in 48 hours. On a regular basis, 7-8 hours sleep per 24 hours is desirable for most people (see section 2.3).

These recommendations are based on suggested minimums for other transport workers. They are mostly based on studies with healthy adults (usually in their twenties) who have their sleep restricted in a comfortable, quiet sleep laboratory. Participants in these studies are not required to be particularly active, physically or mentally, while they are awake. The amount of sleep that they can manage with may well be less than what older people need, or those whose work days are much more demanding, or who are sleeping in less ideal conditions, such as on board a vessel. Outside the laboratory, truck and car crash studies have also shown that the risk of crashing is significantly higher among people who have had less than 5-6 hours of sleep in the last 24 hours.

Where minimum rest periods cannot be respected, owing to unforeseen circumstances, it is important to remember that:

- seafarers' sleepiness and risk of error will continue to increase until they have the opportunity to recover; and
- recovery will take at least 2 nights of unrestricted sleep in a row (no work requirements from 10.00 pm to 8.00 am).

Maritime New Zealand recognises that scheduled rest periods cannot always be respected. It recommends that:

- if scheduled rest periods are disturbed by emergency drills or emergencies then compensatory rest should be provided as soon as practicable.

Note: In managing an emergency at sea and the time that follows (recovery opportunity), a master must consider the requirements of the Health and Safety in Employment Act 1992.

Remember: Minimum hours of sleep are not the same as minimum hours of rest.

3.2.2 Managing fatigue across a trip or roster cycle.

Many work patterns required of seafarers will result in fatigue. This does not mean that they are unsafe – but recovery opportunities must be provided often enough to prevent fatigue accumulating to unsafe levels.

Overseas limits on weekly work hours provide some guidance on safe limits. When using these limits, the quality of sleep that crewmembers are able to obtain must be considered. If sleep is of poor quality, as often occurs on board, longer rest breaks will be required for full recovery.

- Denmark, France, and the UK require that seafarers have at least 77 hours rest in a 7-day period.
- The USA requires 70 hours minimum rest in a 7-day period, with the condition that rest periods must allow for uninterrupted sleep.

In New Zealand the only specified requirement for minimum hours of rest is for vessels governed by the *IMO Standards of Training, Certification and Watchkeeping for Seafarers*, 1995 (watchkeepers only). There is no specific number of minimum required hours of rest specified in New Zealand legislation for those working on other types of vessels. However, the owner and master must establish and implement procedures to ensure that all crew are fit for duty when keeping a watch (Rules 31A, B & C). For all employees, the employer must take steps to ensure the safety of employees at work (Health and Safety in Employment Act 1992).

To assist owners/masters/employers meet these obligations when developing their fatigue management plans, Maritime New Zealand recommends the following limits to assist recovery from accumulated fatigue:

- a minimum of 77 hours rest in a 7-day period and
- two consecutive nights available for sleep between 10.00 pm and 8.00 am, at least fortnightly and preferably once a week.

Most countries allow their rest limits for seafarers to be waived temporarily for emergencies at sea, and in some cases groups can present a case for working outside the limits, as long as principles of occupational safety and health are maintained.

It is widely accepted that annual leave is important for reducing chronic fatigue, although there is a lack of scientific evidence testing this. Shift workers, in particular, report anecdotes such as life being “in colour again” after a few weeks off. A number of industries provide additional annual leave allowances for shift workers. In part, this recognises the unsociable nature of their work patterns, and the importance of the family and social support networks that help people cope with work demands. A similar argument could be made for some maritime operations.

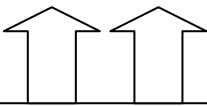
Practices that increase fatigue and reduce safety

Personal strategies:

- Not getting one sleep of at least 6 hours in 24 hours.
- Not using rest periods to sleep, especially over consecutive days.
- Volunteering to work very long hours.

Management strategies:

- Allowing split shifts (especially where there is no sleep period of at least 6 hours).
- Providing limited sleep opportunities on consecutive days, thus allowing a rapid increase in fatigue.
- Assuming that seafarers can sleep for the whole of a rest break. (Rest breaks must allow time for eating, personal hygiene, and other non-work activities. How much sleep a seafarer can obtain will also depend on how much of the rest break occurs during the best part of the body clock cycle for sleep.)



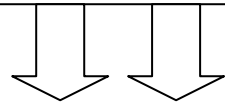
Practices to decrease fatigue and increase safety

Personal strategies:

- Using recovery periods to obtain enough sleep to recover from fatigue.

Management strategies:

- Minimising work hours that cut across usual sleep times.
- Ensuring a minimum of 10 hours rest per 24 hours.
- Setting a “maximum hours of work” policy and monitoring hours of work (or fatigue levels) for compliance.
- Considering the impact of administrative duties on the work hours of those with responsibilities.
- When setting hours of work and rest, considering the implications of commuting.
- Considering whether any seafarer has a high need for sleep compared with others or has particular events in his or her life that need to be considered.
- Implement a policy on the use of computer games, video players etc that distract crew from taking sleep.
- Ensuring an opportunity for 2 full nights of sleep after each period of night shift, to allow sufficient time to overcome the sleep debt produced during night shift. This may be combined with day work that does not cut across normal sleep times (either by early start times or by late finishing times).
- If fatigue accumulation is gradual, limiting days worked to 5-6 (with appropriate risk management if work is at critical sleep times and the nature of work is risky).
- If fatigue accumulation is fast, limiting days worked to 1-3, depending on how fast fatigue accumulates.
- Having a policy to ensure additional rest after unexpected longer hours are worked.



3.3 Improving sleep quality

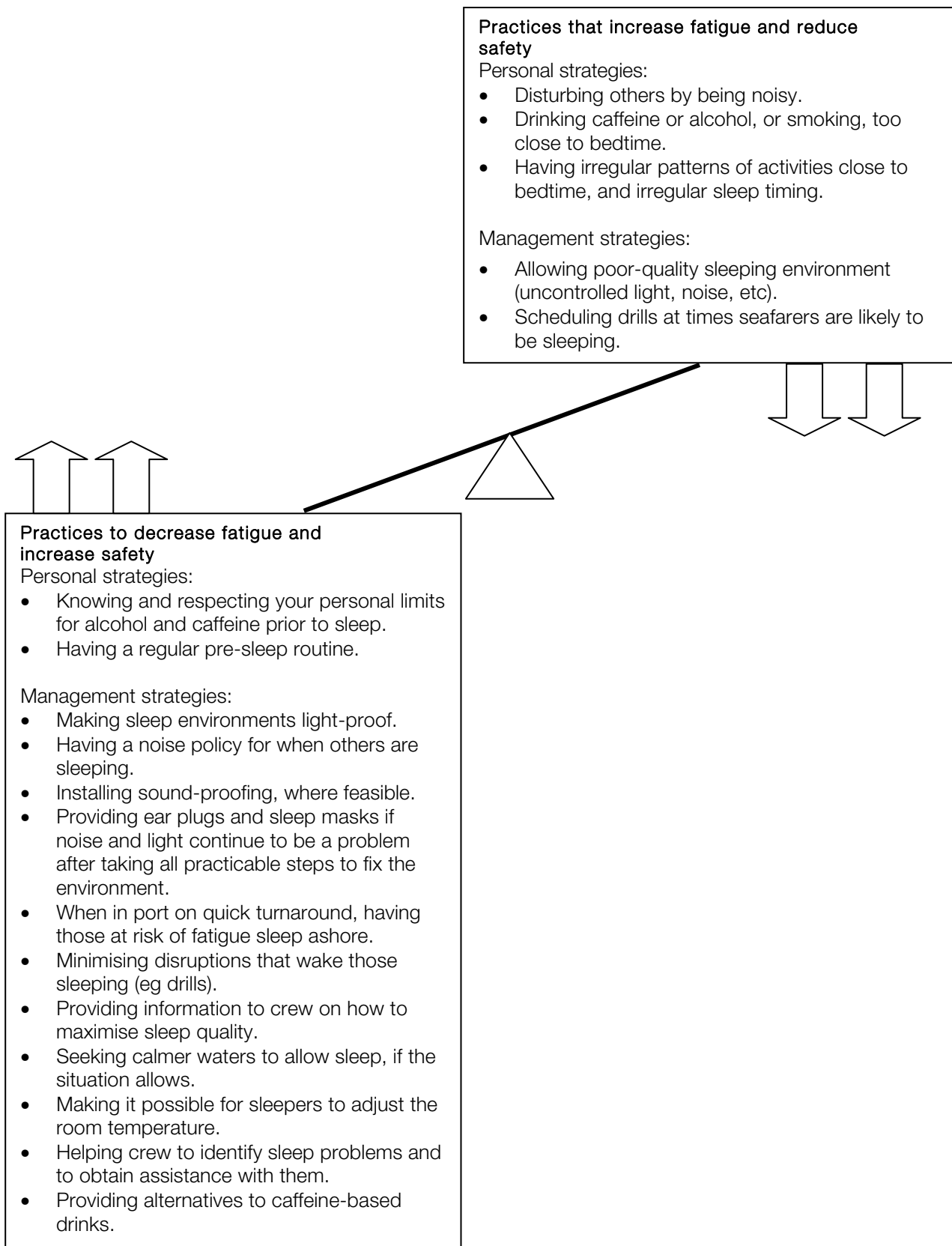
It is vital to remember that sleep, not rest, is the key to recovery from most kinds of fatigue.

For sleep to be fully restorative, it needs to be undisturbed and long enough to go through about 4-5 non-REM/REM sleep cycles (see section 2.4). A number of factors can disturb sleep cycles and reduce the restorative quality of sleep:

- Environmental factors, such as cold, heat, motion, vibration, and sudden noise, can wake a person or lighten sleep, disrupting the sleep cycle.
- Being on call, or being worried about work or personal responsibilities, can reduce the restorative value of sleep.
- Sleep that falls outside the preferred part of the body clock cycle is likely to be shorter and possibly more disturbed.
- Caffeine, if drunk too close to going to bedtime, makes it harder to fall asleep and lightens sleep (for most people it is best not to drink caffeine within 4 hours of going to bed).
- The nicotine in cigarettes is also a stimulant that can interfere with sleep. Specialists strongly recommend against having a cigarette when having difficulty getting to sleep.
- Although alcohol can help a person to relax and fall asleep, it can also result in disturbed sleep in the second half of the sleep period. This is because alcohol suppresses REM sleep until it is cleared from the bloodstream, after which there is a rebound in REM sleep.

When sleep is restricted day after day, the amount of deep non-REM sleep is preserved. Thus, after a while, shortened sleeps tend to become deeper. Less time is spent in the lighter stages of non-REM sleep. If necessary, REM sleep is also restricted.

For people who regularly have difficulty falling asleep, establishing a regular bedtime routine and learning a relaxation technique can be helpful.



3.4 Diet and fitness

Good physical health and fitness are widely accepted as an important part of managing fatigue, particularly when work is physically and mentally demanding. Regular physical exercise can improve the quality of sleep by increasing deep non-REM sleep, which reduces the likelihood of sleep being disturbed by noise and other environmental factors. It is generally recommended that exercise should be completed at least 3-4 hours before bedtime – not always possible where people are working long days.

Good diet is clearly an important part of maintaining good health. Furthermore, recent experimental studies have shown that when sleep is restricted, the hormones that control appetite are disturbed, making people want to eat more than they need. This may help explain why shift workers tend to be more likely to gain weight than day workers doing similar jobs. In addition, shift workers have a higher risk of developing digestive problems (everything from gas to peptic ulcers), partly because their eating patterns do not match the body's daily rhythms in digestion. Thus, good diet is particularly important for shift workers.

3.4.1 Working with owners and crew

Establishing links with a local dietician who can provide advice relevant to the owners and seafarers you are working with is a useful strategy. Dieticians can be found via the Yellow Pages or by looking on www.dietitians.org.nz. If you have difficulty finding a dietician by either of these methods, check with the main hospital in your area. There should be someone there who can give advice.

By working with a dietician and one or two clients who are interested in making improvements to their onboard diets, you will build knowledge, especially on foods and recipes that can be passed to others.

As fatigue can have an impact on health status, encouraging or co-operating with staff on funding annual health checks can be a useful strategy for picking up warning signs and health problems. However, privacy issues would need to be addressed.

3.4.2 Resources

Ministry of Health resources, which are free, can be ordered via this website: www.healthed.govt.nz Click the "Nutrition and physical activity" link. The two recommended resources are:

- *Eating for healthy adult New Zealanders*
- *Healthy weight for adults*

The International Committee on Seafarers' Welfare has release guidance material on "healthy food". While some of the specific advice may not be the same as that of the Ministry of Health, you might find it useful to read the information on this website: www.seafarershealth.org/

3.4.3 Dehydration

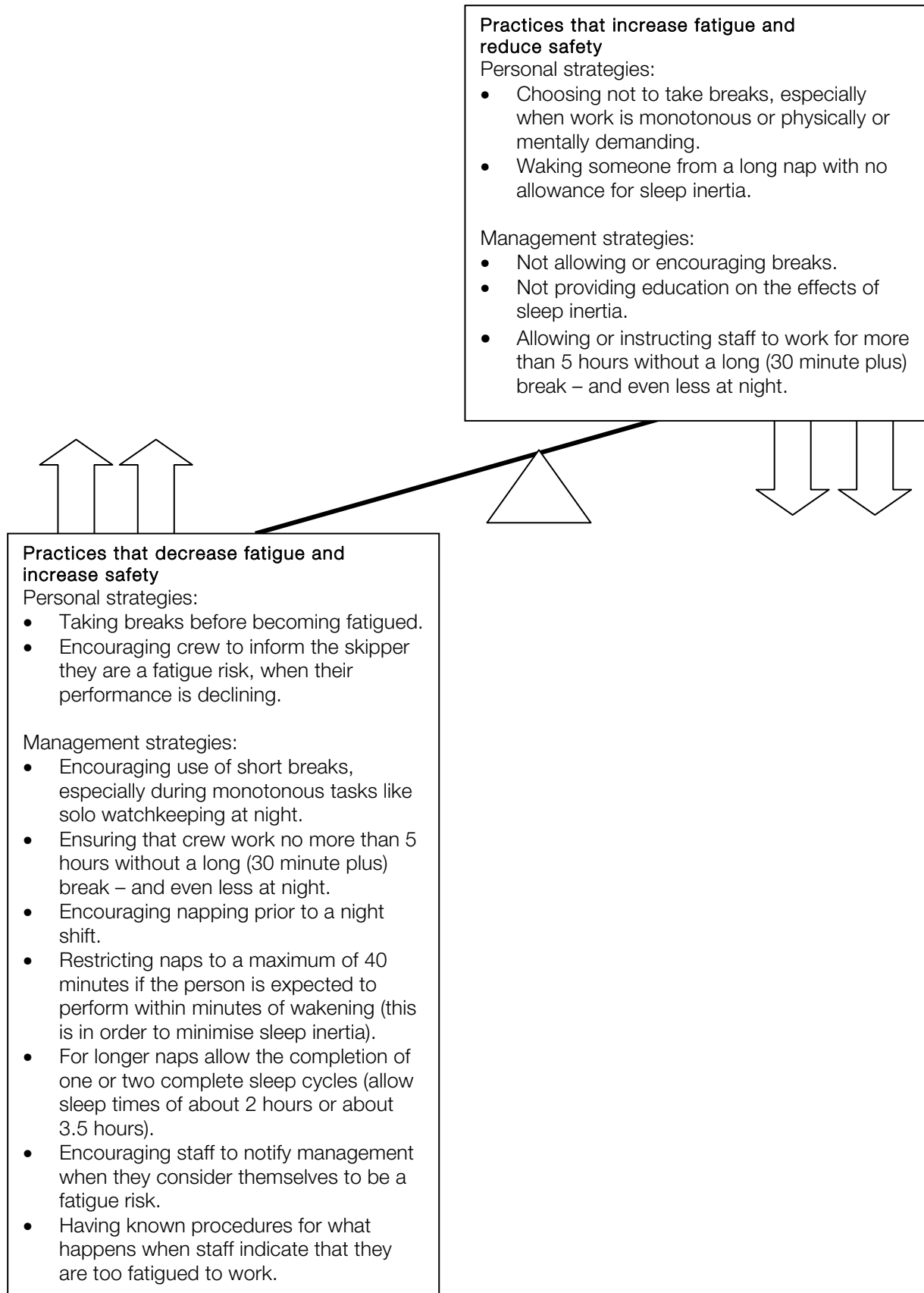
Promoting increased drinking where people are working physically or in hot conditions assists in avoiding dehydration.

- Cold water is the best fluid, though varying it with sports drinks provides variation.
- Encourage drinking small amounts frequently.
- Limit caffeinated drinks, drinks with high sugar content and alcohol.
- In cold conditions hot chocolate is a good hot drink to use.
- Recommend that those on the vessel look at how they can position drink containers in easy to access places.

3.5 Managing fatigue and alertness during duty

3.5.1 Breaks

Seafarers need breaks during the working day. They need to eat, use the toilet and refresh themselves by having a break from the work task. Seafarers who are unable to get enough sleep may benefit from having a nap, where this is feasible.



3.5.2 Managing alertness

During the course of a duty period, alertness fluctuates with the highs and lows of the body clock cycle. It also decreases the longer a person remains awake, and the longer they stay on task without a break. For monotonous tasks, such as watchkeeping, it is impossible to maintain alertness for long periods. Particularly at night, sleepiness becomes evident.

Strategies are needed to maintain alertness and safe performance in the face of both task fatigue and sleep-related fatigue. **It is important to remember that these strategies have a temporary effect only. They are not a substitute for recovery sleep.**

For caffeine drinkers, caffeine can be used strategically to increase alertness when it is most needed.

- Caffeine is a stimulant that has a positive effect on alertness.
- Caffeine usually takes 15-45 minutes to start improving alertness. It is best drunk a little ahead of when its benefits are required.
- The more caffeine a person drinks, the less effective it becomes – avoid its use when alert, only use it when it is needed.
- The stimulant effects wear off after around 3-5 hours. It is best not used within 4 hours prior to sleep. In addition, for those trying to stay awake during the circadian low point in the early morning hours, caffeine is best not used 3-5 hours prior to this point.
- Very heavy caffeine drinkers may be able to fall asleep shortly after drinking coffee or energy drinks, but their sleep will still be disturbed while the stimulant effects of caffeine last.

Maintaining alertness during watchkeeping at night can be particularly difficult. The watchkeeper is generally on his or her own and the wheelhouse is conducive to sleep – with low light and a warm temperature. In the early 1990s, UK researchers observed watchkeepers at night and noted that

“[f]or 90% of the time on-watch, people did absolutely nothing, not even move.”

The researchers also observed that on the night shift the watchkeeper “turned off” as he entered the bridge environment

“...because this is a place where nothing happens most of the time.”

Maritime New Zealand recommends watchkeeper alarms are installed on all vessels that will sail with a solo watchkeeper after midnight. When a watchkeeper alarm is installed, it is recommended that:

- there is a firm company policy on the use of the alarm (when and how)
- the alarm be used in such a way that the watchkeeper cannot turn it off or muffle it (both these actions can occur when watchkeepers are tired)
- the watchkeeper alarm is viewed as a fatigue countermeasure of last resort (the ambulance at the bottom of the cliff). It is not a substitute for the other strategies described in this guide.

A common strategy used by skippers of small vessels is to leave firm instructions that the skipper is to be called if the watchkeeper feels too tired to continue. While this has some merit, in practice watchkeepers only rarely wake the skipper when they are feeling tired. On ships with small crews, all crew members are aware that if one is tired the others probably are as well. Thus, calling a tired skipper is a strategy that crew can be reluctant to use.

Exercise can slightly improve alertness, but the effects appear to be short-lived. Very vigorous exercise may lead to increased fatigue later on, and vigorous exercise too close to bedtime can make it difficult to relax and fall asleep. However, providing watchkeepers with the opportunity to take small bouts of light exercise can also break the monotony of watchkeeping at night.

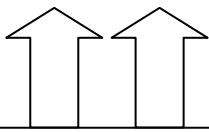
Practices that increase fatigue and reduce safety

Personal strategies:

- Sitting for long periods in a comfortable chair in a warm wheelhouse.
- Remaining inactive for long periods of time.

Management strategies:

- Having no policy on watchkeeping practices to maintain alertness.



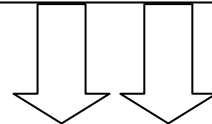
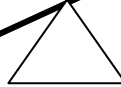
Practices to decrease fatigue and increase safety

Personal strategies:

- Encouraging crew to read the brochure *Understanding Fatigue* and to work through situations to identify alertness strategies that will improve their performance and safety.

Management practices:

- Encouraging use of short breaks with physical activity, particularly during monotonous tasks like solo watchkeeping at night.
- Encouraging use of naps.
- Supporting the strategic use of caffeine (coffee and energy drinks).
- Having a policy on watchkeeping and how the watchkeeper is expected to maintain alertness (requiring plotting of charts and making radio calls provides activities that can be monitored).
- Installing a watchkeeper alarm as a strategy of last resort.
- Rostering short watches immediately after departing a port.
- Delaying a port departure if this will ensure adequate sleep prior to departure.



3.6 Fatigue management strategies being used in New Zealand

This section summarises fatigue management strategies reported by participants in a survey of New Zealand seafarers, sponsored by the Maritime Safety Authority in 2003/2004. The information is presented here to give some practical pointers to start the discussion in an organisation.

The survey asked owners/managers about their use of specified fatigue management strategies, and whether or not they were considered effective. The following table summarises the strategies being used, and the percentage of those using each strategy who rated it as quite effective or very effective. Adventure tourism owners/operators were more likely to use strategies focused on recruitment, manning, rostering, and refresher training.

The survey also asked seafarers and adventure tourism employees for their suggestions on how fatigue could be reduced. Different strategies were emphasized by the two groups. Among seafarers, the most common strategies suggested were: ensuring that crew rest when off duty (suggested by 15%); getting adequate sleep (12%); and having adequate staff numbers (7%). Among adventure tourism employees, the most common strategies suggested were: regular physical exercise (suggested by 24%); adequate staff numbers (14%); being aware/honest about one's own state of mind (14%); no alcohol prior to trips (10%); providing food and refreshments (10%); ensuring that staff rest when off duty (10%); and obtaining adequate sleep (10%). About half of the seafarers surveyed (48%), and 24% of adventure tourism employees had no suggestions for fatigue management strategies.

Strategies currently used by owners/managers to reduce seafarer fatigue and ratings of their effectiveness

Strategy	Percentage of vessel operators/managers using the strategy	Percentage of adventure tourism operators/managers using the strategy	Overall percentage operators/managers rating the strategy as effective
Providing a quality sleeping environment	38%	-	92%
Having enough crew so that everyone gets enough rest	42%	68%	90%
Monitoring when and how long crew work	35%	71%	89%
Providing transport to and from work	16%	14%	75%
Having optimal rosters	32%	50%	90%
Providing refresher training to all personnel	13%	46%	73%
Having deadman alarms for all single man watches	10%	-	68%
Using health and safety teams to address fatigue issues	12%	7%	71%
Having more crew	11%	-	72%
Recruiting/screening new personnel	22%	43%	86%
Having a trial period to see if a person can cope with work	34%	57%	96%
Providing training on managing fatigue to new recruits	19%	14%	76%
Question not answered	21%	14%	
Number of responders	194	28	

FATIGUE ADVISOR RESOURCE

Part 2: Writing a fatigue management plan

1 SETTING THE SCENE

1.1 When is a fatigue management plan necessary?

Fatigue is possible in any operation under exceptional circumstances, and in some operations is routine. Fatigue is likely to be an issue if:

- work (plus commuting) cuts across the times that people would normally be sleeping, for example work starting before 7.00 am or finishing after 10.00 pm
- people have to sleep on board the vessel
- there are demanding environmental stressors, eg excessive noise, vibration, heat, cold, rough sea conditions, bad weather
- work demands are unpredictable (especially the timing of work)
- work is physically or mentally demanding
- employees commute for long distances
- employees have health problems or personal issues that negatively affect their sleep
- employees report feeling excessively tired at work.

Fatigue may be an issue on some trips and not on others. Seafaring is an occupation where work demands can vary tremendously.

If any of the above conditions apply (even only sometimes), a fatigue management plan is necessary to manage the risks associated with them.

The law requires employers and their staff to manage safety. This includes fatigue. Safety management requirements are found in the Health and Safety in Employment Act 1992 (HSE Act), Maritime Safety Rules, and the New Zealand Safe Ship Management Code (SSMC). These are outlined in Part 5: Legal Obligations. One way of meeting these requirements is to have in place an effective, well-monitored fatigue management plan.

1.2 Fatigue and Safe Ship Management

1.2.1 Getting a new vessel into Safe Ship Management

The process of development and approval of a fatigue management plan for a new vessel is:

1. A fatigue management plan is developed by the owner. (Often this is done with the assistance of the SSM company.)
2. A 3-month Exemption Certificate is obtained from Maritime New Zealand.
3. During the period of operation under the Exemption Certificate, the owner documents the actual hours worked, fatigue problems discovered, solutions proposed, and how the crew were involved in their discovery and development.
4. A revised fatigue management plan is included in the SSM manual and submitted for approval as part of the initial audit, which is conducted by Maritime New Zealand.

1.2.2 Vessels already in Safe Ship Management

Owners of vessels already issued with a full-term SSM Certificate will also be required to demonstrate that they have an effective fatigue management plan in place. This will be checked as part of the SSM company audits and Maritime Safety Inspector risk assessments, as these fall due.

Depending on the operation, writing a fatigue management plan may be simple, or “easier said than done”. Regardless of how easy it is to write, the chances are that it won’t be 100 percent right when first written. That is why it is essential to follow these three steps:

1. Write a draft fatigue management plan.
2. Trial the plan.
3. Revise the plan.

1.3 Who should develop the fatigue management plan?

1.3.1 Key people to develop the fatigue management plan

There are four groups of people who should have input into developing the fatigue management plan. These are:

- those who work in the operation – the owner, managers, skippers and seafarers
- the partners of those who work long hours or who work at night
- suppliers, customers and shareholders, who may be able to adjust the way they impact on the business
- advisors with special knowledge about fatigue, who can provide expert advice.

Note: The HSE Act requires every employer to provide reasonable opportunities for employees to participate effectively in ongoing processes for improvement of health and safety in the place of work (see Part 5: Legal Obligations).

1.3.2 Is the process the same for small and large companies or vessels?

The answer is both yes and no: yes, in the sense that the law has the same requirements of all employers or vessel owners (See Appendix 5 for the legal requirements); no, in the sense that with a smaller operation there is less detail to consider.

Many small vessels in New Zealand are owned and operated by the same person. Even where an owner operates several vessels, crew sizes can be small. For many small operators, developing a formal fatigue management plan can seem over the top. However, in New Zealand, most fatigue-related accidents involve vessels with just 2-3 crewmembers. Small crews do not have others to fall back on and are particularly at risk from fatigue.

1.3.3 Different size operations – who can contribute

Best practice suggests that the following people should be involved in developing fatigue management systems. These people are suggested because they either experience fatigue or can do something about managing it.

For small operators (eg a two-three person fishing boat, a one-person charter boat)

- the owner
- the master
- all the crew
- any shore support staff who work with the vessel
- where possible, partners of those who work on board should be consulted. This may be controversial with the crew, but partners see the effects of fatigue at home and can have realistic views on these effects and the risks associated with them.

This exercise should still be done in the case of a one-person operation, if fatigue is likely to be an issue. For one-person operations it is important to get a “fresh pair of eyes” involved. This could be the SSM advisor, or others who are familiar with one-person operations.

A company with several small vessels

- for each vessel all of the above
- to have a consistent company-wide policy have a group that includes a range of people from across all or most of the vessels. Be sure to have a mix of skippers and crew positions.

A medium or large size vessel

- one or two company officers
- the master
- bridge officers/engineers
- departmental chiefs
- crew from different parts of the vessel.

Note: For a larger operation, involve both long-term employees and those who are relatively new, as this encourages a range of ideas.

Having a “partners evening” can be a useful way of helping partners understanding the sleep needs of the crew, as well as obtaining their input into identifying fatigue issues. This particularly applies to sleep problems, as those with sleep problems often need assistance in identifying that they have a problem.

1.3.3.1 Why consult staff?

The survey of seafarers by the former Maritime Safety Authority in 2003 clearly showed that owners, skippers, and seafarers all had different impressions as to how much fatigue occurs in the maritime industry. It is important that, as far as possible, a common view is developed. Other reasons for involving staff are:

- one person can't be an expert on everyone else's problems
- fatigue is not always easy to identify in other people
- fatigue comes not only from working conditions but also from personal sleep needs, health status, and activities outside work. Thus, a range of experience is needed to identify fully all the fatigue issues.

1.3.3.2 The partners of staff can make a useful contribution

The partners of staff are in a special position, in that they have to support the staff member in obtaining good restorative sleep. They need to understand the work demands on the seafarer, and what he or she needs in the way of support at home. At the very least, partners should be encouraged to read the brochure *Understanding Fatigue*.

Experience shows that workers in many industries – including seafaring – either underestimate the effect of fatigue on their lives or are simply unaware of it (fatigue has that effect). Partners have a way of pointing out the obvious. While some staff will object to them being asked to contribute, gaining their input is useful in building an understanding the fatigue situation on a vessel.

In other industries, including workers' partners in the fatigue education process has led to a better understanding of how activities outside of work contribute to accident risk at work. This is important, given that six out of ten seafarers reported being tired when resuming work as a result of being busy in their own time away from the vessel.

1.3.3.3 Customers, suppliers and shareholders can affect fatigue

Customers, suppliers and shareholders all have an impact on the way a business is conducted. Their requirements can impact on fatigue.

A useful exercise is to examine the requirements of customers, suppliers and shareholders. In what way do they impact on a business? How does this create conditions that promote fatigue? If the requirements of customers, suppliers and shareholders create conditions that promote fatigue, can anything be done to mitigate these effects?

There may be times when it is difficult to meet the demands of customers (eg bad weather, mechanical breakdown, staff shortages). This can result in high levels of fatigue. Where possible, there should be discussions with customers, suppliers and shareholders to develop a clear understanding as to when it will be difficult to deliver a service. This should include situations when fatigue levels make it unsafe to operate.

By starting with an analysis of the major influences on a business, everyone will be better placed to understand what causes fatigue and where to look for possible solutions.

1.3.3.4 Someone to help make it work – appoint a fatigue management coach

Successful implementation of the fatigue management plan requires people (ship and shore) to change their work practices. Appointing an on-board coach is a method that the US Coast Guard has found works well for helping crew to make adjustments to the new work practices. This can work even with

small crews – given the fatigue risk with small crews, having a fatigue coach may prove very useful in breaking old habits.

The on-board “coach” will take responsibility for both encouraging change, and monitoring that the fatigue management plan is working. While this may often be the skipper, it does not have to be the skipper – a volunteer who takes the task ‘on board’ may be best.

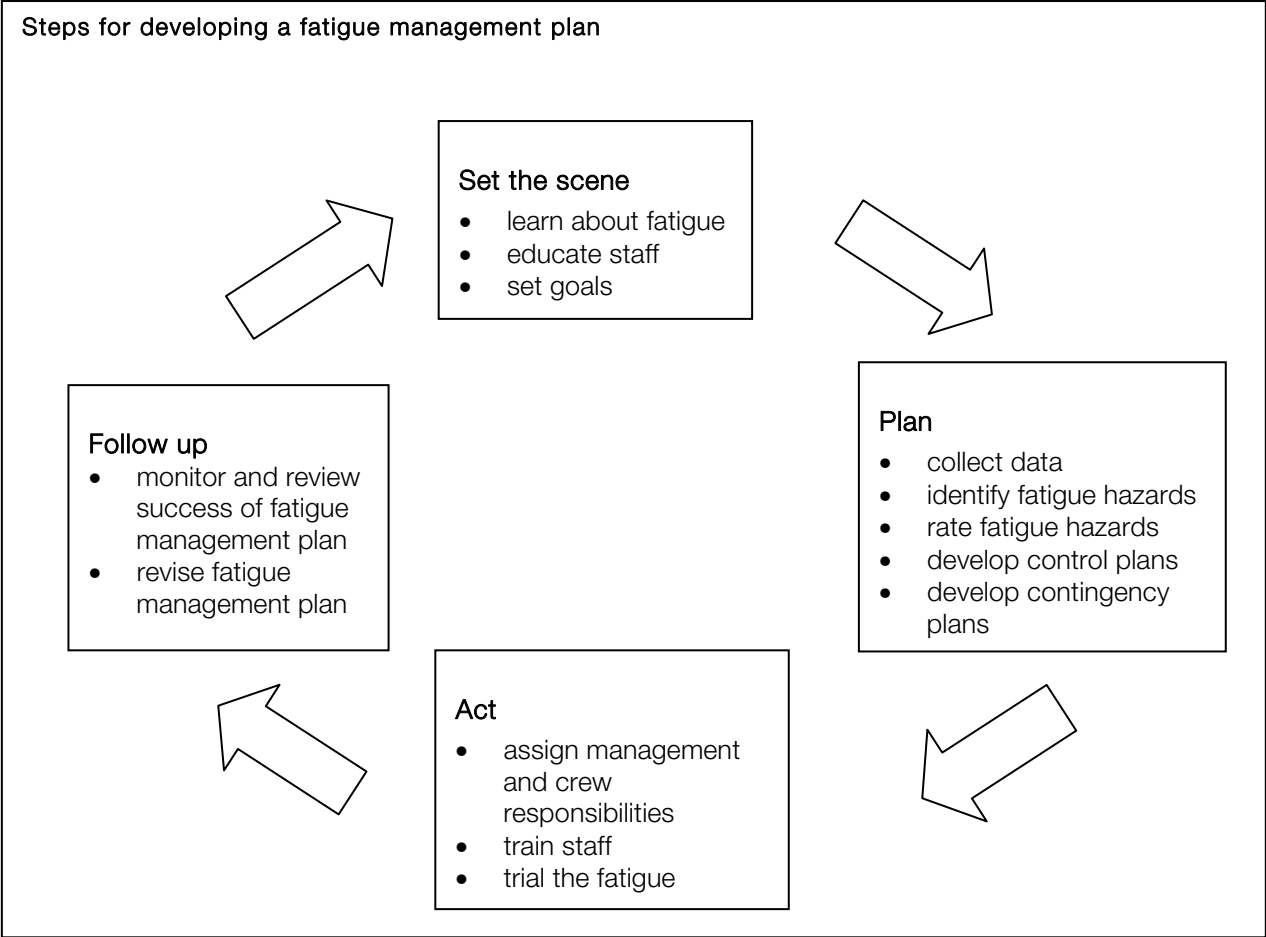
The coach needs to have a good understanding of what causes fatigue, its signs, its effects, and how to manage it. The Maritime New Zealand website has a list of readings and websites, for those interested in learning more about fatigue management.

The coach, with the skipper or other senior officer, keeps a day-to-day eye on how the fatigue management plan is put in place. Encouraging people to make changes (to what for some will be life-long habits) may take time.

The owner should schedule meetings with the coach. These should be held frequently when the fatigue management plan is first put in place. Later on, less frequent, but regular, meetings should be scheduled.

2 WRITING THE FATIGUE MANAGEMENT PLAN

2.1 Steps for writing a fatigue management plan



2.2 Set the scene

2.2.1 Educate about fatigue

While we have all experienced fatigue, the evidence from accident investigation is that many seafarers and vessel owners do not have a good understanding of what drives fatigue or how to manage it.

2.2.1.1 Other publications to assist

Maritime New Zealand has developed a set of material designed to give everyone who is involved with vessel management and operation the basic information that they need to play their role in fatigue management.

The brochure *Understanding Fatigue* gives an overview of the causes and nature of fatigue. All those involved in writing the plan should have their own copy and be encouraged to read it.

The *Guide to Fatigue Management for Fishing Boats*, *Guide to Fatigue Management for Charter Boats*, *Guide to Fatigue Management for Work Boats*, and *Guide to Fatigue Management for Harbour Ferries* give an example or two of a fatigue management plan from those sectors and list the main fatigue hazards and ways of responding to them. Using the relevant guide will give vessel owners and their staff a good idea as to what is required of them.

The *Fatigue Tools for Vessel Owners* provides additional ideas. You may find it useful to suggest particular parts of these to suit the needs of the vessel owner.

The *Wheelhouse Checklist* lists signs and symptoms of fatigue. At least one copy should be on the vessel.

2.2.1.2 Provide training

A short training session about the nature of fatigue in the maritime industry can assist vessel owners to develop a better understanding about the problems associated with fatigue and how it can be successfully managed. Bringing together all those who will have input into the fatigue management plan and making a presentation is a useful first step. Providing training to all those who work on the vessel (if a large operation) is a useful second step.

Where the vessel owner has a small operation, consider running a training session that includes several owners. This not only saves time and money, it can make it a more interesting experience, due to the diversity of industry experiences.

In the training sessions:

- use posters as way of drawing attention to key messages
- use the Maritime New Zealand sector guides (*Guide to Fatigue Management for Fishing Boats*, *Guide to Fatigue Management for Charter Boats*, *Guide to Fatigue Management for Work Boats* and *Guide to Fatigue Management for Harbour Ferries*) as a way of focusing discussion on problems that seafarers face
- encourage discussion
- lead the discussion to practical steps the vessel owners will take.

Overseas experience shows that for the programme to succeed, the person who holds the purse strings needs to be knowledgeable about fatigue management.

2.2.2 Set goals

Goals or expectations provide a standard against which to judge:

- how well fatigue is managed prior to the fatigue management plan being developed
- any plans put forward
- how fatigue is managed on an ongoing basis once the plan has been implemented, including, the management of unusual or high-demand situations.

Having goals is one way of managing risks.

2.2.2.1 Who sets the goals?

Owners should be encouraged to develop their own fatigue management goals or expectations. This way they are taking ownership of a key safety issue.

There are, however, advantages in including the skipper, crew and shore staff in developing what these goals should be. They are likely to have useful ideas to contribute, it makes sense to take advantage of this. Discussing the goals with them can clarify the owner's ideas. The discussion also provides an opportunity for the owner to share his or her ideas and priorities.

Ultimately, the owner is responsible for the safe operation of the vessel. Making expectations clear and providing the means for the skipper and crew to achieve them goes a long way to making a safe operation.

2.2.2.2 Advisor's role

It is not the advisor's role to set the goals. The goals belong to the owner. The advisor should encourage owners to consider their goals in their widest possible sense. Setting goals can require time. Even if there is good agreement at the first meeting as to what the fatigue management goals will be, it is worthwhile taking some time to reflect on them.

2.2.2.3 Setting goals

It is important that goals are expressed clearly, so everyone understands exactly what they mean. A useful technique to help others think about goals is to ask them to write down a few examples of what people do, if they are meeting the goal. It can also be useful to write down examples of what people are doing when not meeting the goal.

Examples of goals that could be pursued:

- All fatigue risks will be listed in the hazard register and the preferred control action stated.
- If seafarers end up operating under high-risk situations for falling asleep, there are always back-up systems in place if they go to sleep.
- Staff do not work so hard or for so long that they drive home in an unsafe state.
- Staff report fatigue problems to the skipper/shore management.
- All problems (incidents, accidents, self-reports) related to fatigue will be investigated, to track down and address their causes.
- Seafarers will not work in situations where fatigue increases their risk of injury.
- Contingency plans for extraordinary circumstances will be developed and followed.

2.3 Plan

2.3.1 Collect data

To assist in identifying what results in people being fatigued information has to be collected. *Fatigue Tools for Vessel Owners* gives examples of survey methods that can be used to gather information:

- involving owners/skippers/crew/shore staff in discussion
- consulting with the partners of skippers and crew
- undertaking employee surveys and interviews
- examining how customers, suppliers and shareholders impact on fatigue
- using the sector guides
- doing an inspection when the vessel is operating.

Any accidents and incidents experienced with the vessel and its operation should be examined to establish what information can be gained.

2.3.2 Identify fatigue hazards

During this first stage, the idea is to identify all conditions that promote fatigue, regardless of their significance.

The sector guides list the hazards typically found in that industry. This is a good place to start; however, it should not be regarded as definitive. Each vessel is different, as is its work and crew. Discussion should be encouraged to bring out what really drives fatigue for each vessel.

Under the HSE Act, employees must be given reasonable opportunity to be involved in the hazard identification process. It also makes good sense to do so. Employees are likely to have a good understanding of the hazards they face in the job. With fatigue often being a private experience, their involvement in identifying fatigue hazards is particularly important.

Some fatigue problems will occur regularly, like working at night on a 24-hour operation. Other hazards that result in fatigue occur occasionally. For many of these problems, such as bad weather, or a new baby in the family, it is possible to anticipate *what* will happen but not *when* it will happen. Having two lists of hazards (predictable and unpredictable) is a useful way of organising the hazard register.

2.3.3 Register significant fatigue hazards

The HSE Act requires employers to rate hazards as either significant or not significant. A significant hazard is one that is likely to result in harm (physical injury or illness or mental harm) or serious harm (death or loss of bodily functions). The employer makes a judgement as to whether or not a hazard is a significant hazard (this should involve discussion with employees).

Put all significant hazards in the hazard register.

2.3.4 Monitor other hazards

Hazards that are rated “not significant” must be monitored to see if they develop into significant hazards. A programme for revisiting hazards should be put in place, recorded in the Safe Ship Management manual and followed.

2.3.5 What makes hazards dangerous

Risk is a combination of the *likelihood* that something will go wrong and the *seriousness* of the consequences of it going wrong. Estimating the risk of each hazard gives people a way of prioritising their actions.

The likelihood of an incident is determined by a range of factors that include the following:

- how often the situation occurs, eg loading heavy cargo (physical fatigue)
- how many people are exposed, eg how many people process fish?
- skill of the people doing the task, eg are they formally trained?
- special characteristics of those concerned, eg is their eyesight good?

- duration of exposure, eg how long does a monotonous watch last?
- how close to the hazard people work, eg how close to a noisy machine?
- stress such as time pressure, eg running behind schedule
- environmental conditions, eg rough seas affecting footing
- condition of equipment, eg poorly maintained equipment is more likely to break
- effectiveness of existing control measures, eg are they known, used, and of a good standard?

For those wanting to use a formal approach to risk management, see the Australia/New Zealand Risk Management Standard (AS/NZS 4360: 2004) and Guidelines. Available from Standards New Zealand.

2.4 Managing hazards

2.4.1 Health and Safety in Employment Act 1992 requirements

As the advisor, you should emphasise the systematic way in which hazard identification and development of control options is required to take place. See also the Maritime New Zealand publication *Health and Safety: A Guide*.

Under the HSE Act, employers are required to take all practicable steps to ensure the safety of employees at work – and others who may visit the worksite.

According to the Act:

- A step is practicable if it is possible or capable of being done.
- Whether a step is reasonable takes into account:
 - the nature and severity of any injury or harm that may occur
 - the degree of risk or probability of injury or harm occurring
 - how much is known about the hazard and the ways of eliminating, isolating or minimising it
 - the availability and cost of safeguards.

2.4.1.1 Risk hierarchy

Any on-vessel control measures should be considered against the goals set for the fatigue management plan, Safe Ship Management requirements and the legal requirements of the HSE Act. The Act provides a hierarchy of control for addressing risks that should be managed. The order of controls is to:

1. Eliminate the hazard eg eliminate early starts.
2. Isolate the hazard eg light-proof sleeping quarters.
3. Minimise the hazard, where neither of the above can be applied eg install watchkeeper alarms.

This hierarchy of controls is mandatory. It means that while minimising the effects of a hazard may be a practical approach to take, if it is also possible to eliminate the hazard, then the hazard must be eliminated. For instance, while watchkeeper alarms may be a reasonable safety measure, using watchkeeper alarms is not an excuse for failing to give crew proper rest and recovery periods.

2.4.2 Planning for the extraordinary - contingency plans

Contingency plans are one of the most important parts of the fatigue management plan. Contingency plans provide tired skippers and crew with a way to make safe decisions that reflect the safety options chosen by the owner. Where owners do not provide guidance to skippers and crew for hazardous situations that can be predicted, they are failing to exercise their responsibilities.

When hazards are known to occur occasionally, contingency plans should be developed. Without contingency plans, individuals can be suddenly put in an unfamiliar situation without guidance on what to do, and are liable (especially when they are fatigued) to make poor decisions.

Key features of contingency plans include:

- vessel owners/operators should have a clear policy on the course of action that should be taken when an unexpected problem arises
- contingency plans are only of use if they are readily available to the skipper and crew (and shore support staff if involved)
- contingency plans should be in the Safe Ship Management manual
- the crew should be trained in their use.

A useful standing order is to require the skipper to call back to shore when the situation becomes unusual. As fatigue does affect decision-making, discussing the situation with someone on shore allows for a second opinion.

Example: A skipper on a fishing boat is working 6 on/6 off. He operates the lifting gear, on signal from a crew member. One night he sleeps badly and is seriously affected by fatigue. There is a strong imperative to continue to fish. What, if any, compromises should be made to that day's fishing operation? Before the skipper and crew end up in the situation where one of them is dangerously

fatigued, the owner should have considered the situation and set out orders as to how to respond. Part of this requirement could be to phone the owner to discuss what the best course of action is. This could, for example, range from cancelling the day's fishing to cancelling half a day's fishing (so some sleep can be had) to perhaps working at a slower pace with fewer crew, if this is possible.

2.4.3 Developing control measures

Many risks will have obvious solutions, while for other risks a range of options may need to be explored. The following approaches may give you some useful ideas to assist owners/skippers/crew/shore staff in developing control measures:

- Encourage a brainstorming session (see *Fatigue Tools for Vessel Owners*).
- Talk to other companies that have similar operations.
- See section 3: Practical Hints in this guide.
- See the Maritime New Zealand industry sector fatigue guides.

2.4.4 Principles that help when designing duty schedules

From a biological point of view, the perfect duty schedule is day work only, with time for unrestricted sleep at night. Any other pattern requires finding the best compromise between:

- the work needed to get the job done
- the risks involved in the work
- how well seafarers are likely to be functioning at any point in time. This varies according to how long they have been awake, how much sleep they have had recently, and where they are up to in their circadian body clock cycle.

The following duty schedule design principles arise from this understanding:

- Each person reacts differently to any given duty schedule. We each have unique profile in terms of our biology, job skills and experience and life away from work.
- Managing sleep is the key to safe, productive duty schedules.
 - Delaying sleep (staying awake for extended periods of time) increases sleepiness and the risk of fatigue-related mistakes.
 - Restricting the time available for sleep, or moving it from preferred night-time hours, will cause sleep loss.
 - The effects of sleep loss accumulate into a sleep debt. As sleep debt increases, so does the risk of fatigue-related mistakes.
 - The duty schedule must offer regular opportunities for recovery from sleep debt (at least two nights in a row of unrestricted sleep).
 - The more that work overlaps with usual sleep time, the faster sleep debt will accumulate. For example, seafarers working a series of night duties will build up a sleep debt faster than seafarers working a series of daytime duties, so those on night duties will need recovery opportunities more often.
 - The quality of sleep on board is often not optimal. Factors such as a spell of bad weather or rough sea conditions may reduce the recovery value of sleep and increase the risk of fatigue-related mistakes.
- The risk of fatigue-related mistakes is greater when seafarers are working during their normal sleep times, because this corresponds with the least functional time in the body clock cycle.
- Making work patterns as regular and predictable as possible makes it easier for seafarers to plan sleep.
- Making work patterns as regular and predictable as possible makes it easier for seafarers to plan family and leisure activities.
 - Family and social support are important for coping successfully with work demands.
- Seafarers have a practical understanding of risks in their particular workplace. They must also balance work demands and their life away from work. Their input in roster design is vital.

Scheduled 24-hour operations involve trade-offs between different shifts or watches, since everyone cannot be asleep through the optimum time in the body-clock cycle. A compromise must be found to provide adequate sleep opportunities for each watch, with regular recovery opportunities to minimise the risk of chronic fatigue setting in.

Attention to recovery sleep is particularly important in contingency planning, for example in the return to normal operations after an emergency or after an extended period of intensive fishing. Many maritime accidents have resulted from having nobody on board who can stay awake long enough to be a safe watchkeeper on the way home.

Watchkeeping on small vessels is often arranged only a short time ahead. As circumstances demand more of everyone, effective decision-making becomes less likely.

This is where having a prepared contingency plan assists the skipper and crew make a sensible decision on how to schedule their time – in particular, whether or not to take additional rest. When the circumstances can reasonably be foreseen, the owner should provide guidance to assist the skipper make decisions.

2.4.5 Posting duty schedules and keeping records

Maritime Rule 31B [*Crewing and watchkeeping offshore, coastal and restricted (non-fishing)*] and Maritime Rule 31C [*Crewing and watchkeeping fishing vessels*] require the owner and master to implement procedures for ensuring a seafarer’s fitness for duty, including a consideration of the impact of fatigue on watchkeeping performance. Maritime Rule 31A [*Crewing and watchkeeping unlimited, offshore, and coastal (non-fishing)*] has requirements for posting and retaining watch schedules. This does not apply to the duty patterns of non-watchkeepers.

Depending upon the type of work, work rosters may be allocated days ahead, or there may be a series of short-term rosters as work circumstances vary. Regardless of the work circumstances, consideration must be given to fatigue. Fatigue can affect all persons on a ship. To the extent possible, duty schedules should be in effect for all on board.

Some form of roster planning, some way to inform crew of their duties, and record-keeping are a key part of any fatigue management plan. Formal duty schedules offer a way to fulfil all of these requirements at once, although they may not be appropriate for all vessels.

- Planning allows for consideration of those factors that make people fatigued and for a balanced approach to be taken across the crew.
- Informing crew of their duties allows them to plan more effectively the use of their own rest time.
- Keeping a record of hours worked makes it easier for those responsible for allocating duties to do so in a way that will manage fatigue.
- Record-keeping also helps owners meet their obligations (particularly under the HSE Act) to monitor hazards in the environment, which include fatigue. This is particularly applicable if the timing and duration of work are identified as hazards.
- When there are disruptions to the normal pattern of work, or personal problems arise that affect sleep and fatigue, there is often increased risk of fatigue. Keeping good records of these events, and the responses to them, are an important aspect of managing risks to safety and the organisation, and should be a priority.

The minimum paperwork that a prudent owner/operator should require is the name of the person on watch, a signed accurate record of hours worked – and, if the work is demanding, the type of work.

For instance, for a small fishing vessel the watchkeeping log could be as simple as:

Date	Signature	Time on	Time off

Keeping a record of hours worked gives the owner/operator an opportunity to examine what is happening on each vessel and to take appropriate steps to manage fatigue.

2.5 Act

2.5.1 Assign management and crew responsibilities

For fatigue management plans to be implemented effectively, the vessel owner/operator must assign responsibilities and provide any necessary training.

Any measure that crew take to control fatigue should always be matched with a management action. This helps confirm to crew that the measure is important. It also helps ensure that the measure is implemented effectively. Management actions and a way to record they have been carried out should be in the Safe Ship Management manual or in shore-based procedures.

Example: A ship operating on a 24/7 basis has two watchkeepers, neither of whom obtains sufficient sleep, especially with frequent port visits placing additional demands on them.

Reducing the likelihood of the watchkeeper going to sleep

The on-vessel intervention is having three watchkeepers sharing watchkeeping duties.

The management action is inspecting the record of hours worked, to ensure that all three watchkeepers obtain a reasonable amount of recovery time.

Reducing the consequences of the watchkeeper going to sleep

The on-vessel intervention is installing a watchkeeping alarm.

The management action is monitoring the use of the watchkeeping alarm.

2.5.2 Train staff

The Maritime Transport Act 1994 (section 17 (4) (b)) requires employees to be trained and supervised so they can maintain compliance with relevant standards and any conditions attached to a document. This includes an approved fatigue management plan.

Effective training is more than simply giving staff a copy of information, such as the brochure *Understanding Fatigue*. At a minimum there should be a discussion about fatigue led by the owner or skipper. A presentation by the SSM company advisor is a particularly useful way of training staff.

2.5.3 Trial the fatigue management plan before approving it

Getting fatigue management right the first time is not easy. There is a good chance that some part of the plan will not work as well as expected. When a vessel is new to SSM there is a “shakedown” period, during which the SSM manual is modified, based on experience. It is important to test the fatigue management plan during this period.

When a vessel is already in SSM, a 2-3 month trial period should be allowed for the fatigue management plan to be trialled and revised.

During the shakedown period there should be regular monitoring as to how well the fatigue management plan is working. This should cover both on-board and shore staff. Ways to do this would include:

- asking for post trip reports
- asking for shift changeover reports
- if any of the fatigue tools are used to write the plan, run them again after the new plan has been in for a few weeks
- toward the end of the review period have a meeting with staff to discuss how it has gone
- be sure to include a range of staff

Do not approve the plan until the end of the trial and after any revisions are made,

2.6 Follow up

2.6.1 Schedule monitoring opportunities

It can be easy to overlook monitoring how the fatigue management plan is working – which means that the legal obligation⁴ to monitor is not being met. Creating a schedule as to when and how the fatigue management plan is monitored assists owners to meet their obligation.

For a small operation, make fatigue a standing item at regular safety meetings - make notes as to what was raised and decided. In addition, encourage staff to report any events at home *or* at work that might impact on their fatigue and safety at work.

For larger operations, the following may also be useful, in addition to meeting with employees:

- survey employees occasionally
- survey employees after busy periods
- periodically do a “walk through” or audit of the operation.

2.6.2 Confidential reporting systems

There may be times when seafarers have a fatigue problem and it would be useful for them to report this. Having a way they can do this without penalty is a proven way to improve safety. The seafarer needs confidence that he/she will not be disadvantaged for doing so, and that the information will be taken seriously. Owners will need to be assured that seafarers will not use a fatigue-reporting system as unfair leverage in industrial issues.

The strength of fatigue reporting systems is that they can identify where fatigue-related risk is high, without an accident needing to happen first. For example, Air New Zealand has for some years run a fatigue management system where pilots can make fatigue reports about trip patterns or other aspects of duty that they believe may cause excessive fatigue. These reports are considered regularly by a group consisting of managers, crew representatives, and safety and medical personnel. Particularly when multiple reports are received about an issue, the group can decide to investigate further, with various types of agreed monitoring (crew surveys, sleep diaries, activity monitoring devices, performance testing at critical times, etc). If certain agreed triggering conditions are reached, then the duty schedule can be changed, or other strategies put in place to reduce the fatigue-related risk. The decisions of the group are reviewed regularly by an independent panel of scientific and operational experts. The pilots are also kept informed of the group’s decisions, so that they do not see filling out fatigue reports as a waste of time.

Recent maritime codes of practice have proposed a variety of management structures for fatigue management systems. The US Coast Guard Crew Endurance Management (CEM) programme uses a similar approach to the Air New Zealand example, with a CEM working group that includes representatives of all those likely to be affected by the CEM programme. The working group is responsible for:

- identifying the risk factors relevant to the vessel
- creating a collaborative network to facilitate implementing a CEM programme aboard the vessel
- devising and deploying a CEM plan specific to the vessel. This includes an evaluation of the plan’s effectiveness.

2.6.3 What about accidents and incidents?

Incident/accident investigation and reporting is a key strategy for identifying areas of high risk for fatigue-related problems, and for developing ways to reduce the risk.

The HSE Act requires that accidents are investigated to find out if there is a significant hazard in the workplace. If there is, the employer must take all practicable steps to manage it.

⁴ Under the HSE Act, employers are required to monitor the health of employees (with the employee’s consent), as it relates to significant hazards that cannot be eliminated or isolated. The results of the monitoring must be given to employees.

It is usually not easy to tell if fatigue was a factor in an accident (unless the person was clearly asleep). Immediately after an accident, if people are not injured, they are likely to be experiencing an adrenaline rush and may not show obvious signs of fatigue. Even under ordinary circumstances, we are not very reliable at judging how much our performance is being affected by fatigue (it can be somewhat like being drunk). People's recollection after a traumatic event like an accident is likely to be even less reliable.

One of the clearest and most detailed guides for analysing the role of fatigue in accidents has been produced by the Canadian Transportation Safety Board.

The Canadian Transportation Safety Board guidelines for fatigue analysis suggest four initial questions to decide whether or not fatigue was a contributing factor to an occurrence:

1. At what time of day did the occurrence take place?
2. Was the operator's normal circadian rhythm disrupted?
3. How many hours had the operator been awake at the time of the occurrence?
4. Does the 72-hour sleep history suggest a sleep debt?

If the answer to any **one** of these questions indicates a problem, then fatigue should be investigated in depth.

To establish that fatigue was a contributing factor, it must be demonstrated that:

- a) the person or crew was in a fatigued state; **and**
- b) that the unsafe act or decision is consistent with the type of behaviour expected of a fatigued person or crew.

Maritime New Zealand can provide guidance to owners/skippers as to how they can investigate fatigue as a causal factor in vessel operations.

However, information on the role of fatigue in accidents is of no practical value unless it is acted upon.

2.7 Review

The fatigue management plan should be reviewed periodically. A number of companies have found it useful to do this either annually or after a busy season has finished.

The review should involve the range of people affected by fatigue and its management.

2.8 What happens when a seafarer poses a risk due to fatigue?

A fatigue management plan must include processes for identifying and managing individuals who are fatigued, and whose behaviour is putting themselves or others in danger in the workplace. This includes those who identify themselves as fatigued.

The *Wheelhouse Checklist for Fatigue* should be readily available to all. If the crew do not regularly visit the wheelhouse, a copy should be placed where they can easily see it.

2.8.1 Seafarers who are at immediate risk from fatigue

The *Wheelhouse Checklist for Fatigue* provides a checklist that can be used to help decide whether to take a seafarer off duty immediately.

Contingency plans should be made and checklists provided with action to take.

2.8.2 Seafarers who are at long-term risk from fatigue

For those seafarers who are regularly fatigued, a staged approach is required.

The first step is to examine the seafarer's working conditions. The priority must be to change these, if they are found to be contributing to the seafarer's fatigue. As a first step, if the seafarer is employed on tasks which become more risky when the seafarer is fatigued, he or she should be placed in a situation where safety will not be compromised as a result of fatigue. For example, a seafarer who regularly falls asleep whilst working should not be allowed to operate machinery when this would result in unnecessary risk.

If a close examination of the working conditions (which includes consultation with the seafarer) concludes that the seafarer has a personal fatigue problem (not related to the task), this will need to be addressed. A course of action can be suggested to an individual informally, then recommended in writing if no action has been taken.

Some organisations will already have resources that can be tapped into for working with staff who have problems – for example, in-house occupational safety and health staff, employee assistance programmes, or union support services. Follow existing company procedures as for any other form of incapacitation/impairment in the workplace. Investigate reasons and decide on a rehabilitation programme if appropriate, but have known criteria for dismissal as a last resort.

2.9 Medical examinations

Around one quarter of New Zealand adults report having a chronic sleep problem. Those who always snore and have large neck sizes may be at risk of obstructive sleep apnoea – they literally cannot sleep and breathe at the same time. People over 50 years of age are at increasing risk of less restorative sleep.

If it becomes apparent that a seafarer has a sleep problem that appears to be affecting his or her ability to work safely, it should be discussed with the seafarer. Any such discussions need to be conducted in a confidential and sensitive way.

Some seafarers may not be aware that sleep problems can be treated. If you both agree that the seafarer may have a sleep problem, he or she should be encouraged to seek medical assistance.

There are a number of fairly common sleep disorders that prevent people from getting restorative sleep, even if they have enough time to sleep. Sleep disorders medicine is a new field that is expanding rapidly, and not all doctors are up to date with it.

If you or someone you know has a chronic problem with sleeping, it may be advisable to ask your GP to refer you to a local specialist sleep clinic. Contact details for these clinics are on the Maritime New Zealand website www.maritimenz.govt.nz

Remember that information discussed between doctors and patients is confidential. The only information that may be passed on to an employer (with the consent of the employee) is if a person is unfit to work.

If a seafarer has a sleep problem, owners/skippers should be encouraged to discuss whether the seafarer's duties should be adjusted until such time as the situation is clarified.

3 PRACTICAL HINTS

Here are some practical hints that others have found useful. They supplement those in the vessel-specific guides.

Topic	Hint
Reinforcing watchkeeper rules	Every vessel should have watchkeeper rules spelled out in standing orders. Solo watchkeepers should have these restated for every watch.
Sleep recovery	<p>Rostered time off is not the same as sleep time. When determining shifts and calculating how much fatigue might have accumulated over a number of days, work scheduling should take into account sleep time, not time off.</p> <p>After a stint at sea, allow for good quality night sleep before going back. If a short time alongside is desired and it is a poor sleeping environment, then put the watchkeeper up on shore.</p>
Poor night's sleep	<p>Develop contingency plans for coping if one person or everyone gets a poor night's sleep. People make poor decisions about risk when fatigued, so a pre-determined policy makes for safer decision-making.</p> <p>Encourage reporting of poor sleep - it is a risk to be managed.</p>
Light-proof sleeping quarters	Light-proofing should stop all light coming in.
Alarms	<p>Have a clear company policy on their use.</p> <p>Use a standalone watchkeeper alarm. It should:</p> <ul style="list-style-type: none"> • be tamperproof • have its own internal power • give low-level signals, eg a light, low beep before making a loud noise • to operate, require the watchkeeper to move to it and push a substantive button or similar • be loud enough to wake other crew up, if the watchkeeper fails to respond to it. <p>If one is used, make it impossible for the watchkeeper to turn it off.</p> <p>Don't rely on low noise navigational alarms – they are not loud enough to wake a sleeping watchkeeper.</p> <p>If approaching the coast and the skipper wants to be woken as it is neared, take a timer alarm to bed as a safeguard as well as leaving instructions to be woken.</p> <p>If moving toward or along the coast, pre-set the depth sounder to go off a safe distance away from shore. If it does not make a loud noise, have this changed.</p>
Keeping active and the autopilot	<p>Have a company policy that requires solo watchkeepers to do something active. Maritime NZ accident reports indicate low levels of chart plotting and moving about by the watchkeeper as a factor in fall-asleep accidents.</p> <p>During the night hours, insist on paper chart plotting and conducting any other routine that will keep the watchkeeper alert and moving about (but not too distracted from watchkeeping). Chart plotting every 15 minutes is suggested.</p> <p>Short periods of exercise have been shown to increase alertness temporarily when people are at risk of going to sleep. Solo watchkeepers should be encouraged to walk around the wheelhouse regularly during the night watches – if it is safe to do so. This also allows them to have a better view of any other vessels that may be present.</p>

Topic	Hint
	<p>Have a company policy on when the autopilot should and should not be used. Fishing vessels that are heading back to the coast, out of port and along the coast, are particularly at risk. Chairs that can be pulled back from the wheel are preferred, as a watchkeeper is at less risk of falling asleep when standing. A number of accidents are associated with the “Specific End Effect.” This is where a person falls asleep as the vessel nears its destination (commonly known as ‘letting down your guard’).</p>
Caffeine and energy drinks	<p>These can help keep people alert for short periods of time.</p> <p>Caffeine “kicks in” 15-45 minutes after being drunk, so it needs to be used a little ahead of when its effects are desired. At the start of a shift or straight after a nap is too early.</p> <p>At night, keep a jug of coffee in the wheelhouse.</p> <p>Remember, though, caffeine can also disturb sleep. Generally, sleep experts recommend not drinking caffeine from at least 4 hours before going to bed.</p>
Napping	<p>The strategic use of napping can be a useful way of keeping people alert.</p> <p>Napping works best at times people naturally want to sleep – 3.00 pm to 5.00 pm and after midnight. Napping does not work well at those times we are most alert – in the morning and early evening.</p> <p>People can wake with sleep inertia if a nap is the wrong length of time. A short nap should be no more than 40 minutes lying down in total. Longer naps should mean lying down for either 2 hours or 3.5 hours, with a 15 minute “wake up” period.</p> <p>Napping before coming on a shift can be beneficial and should be close to the start of the shift. A long nap is best.</p> <p>Short naps are OK when on duty, if there is a reliable way to wake a person up and nothing dangerous will happen when he or she is asleep. Walking around helps with becoming alert, if a person wakes with sleep inertia.</p> <p>A common fatigue-related accident situation is three fishermen, having finished stowing away the catch in the middle of the night, leaving one person on watch while they head back to shore. After what may be several hours of work, the watchkeeper falls asleep. It would be better to give the watchkeeper a 30-40 minute nap (longer is better, if time for getting over sleep inertia is allowed) while the other two are up. But don’t expect the watchkeeper to be able to stay on watch for several hours – keep duty times short. The next person on watch should have either a maximum of 40 minutes nap, or have a 2-hour sleep (includes a 15 minute wake up period).</p> <p>Everyone getting a good sleep before heading in is, of course, the safest option.</p>
New employees	<p>Sleep needs vary a lot from person to person. Vessel owners and operators cannot assume that a new employee will be able to cope with night work – particularly extended night work.</p> <p>Where possible, start with shorter work hours and monitor the employee to see how he or she adapts to night work. An alternative would be to have a buddy system, especially in larger ships, where someone could be a mentor for the new person.</p>
“Wake me if you have a problem staying awake”	<p>In accidents where someone other than the skipper was on watch, this is what all the skippers said before going to bed. Not one of the watchkeepers called the skipper. Never rely on this strategy.</p>

Topic	Hint
High-risk tasks	<p>Some tasks are higher risk than others. While some must be undertaken at a particular time, others can wait for a more suitable time. Fatigue can result in people making poor decisions and having lapses in attention. Mistakes happen. These mistakes can be reduced by scheduling high-risk tasks when people are the most alert.</p> <p>Try to avoid doing high-risk tasks at night. Late in a shift is higher risk than earlier. Crew will be less fatigued earlier on a voyage than later on.</p>
Monitoring	<p>Under SSM, the owner and master must monitor crew size to ensure that there are sufficient alert watchkeepers. The owner has to carry out audits to verify safety practices.</p> <p>Maintain records of individuals' rest or work periods.</p> <p>Actively encourage use of an incident and accident log as a basis to explore how well company procedures are resulting in safe practices.</p> <p>Periodically discuss with employees how things are going and when there might be instances of high risk. Revise appropriately.</p>
Rosters	<p>There is no "ideal roster", but there are a few principles that should be taken into account when designing a roster:</p> <ul style="list-style-type: none"> • When determining how many night shifts should be worked in a row, consider how much sleep debt will accumulate, and the risks associated with the work being done. • When crew are exposed to extreme temperature conditions, work periods should be monitored to see what is safe. • Those who design rosters should have training on the effects of shiftwork and its management. • Those who work shifts should have opportunity to participate in shift design. • Care needs to be taken by owners/employers that some employees are not rostered extra work – even though they may ask for it due to financial incentives – when this would place them and others at increased risk. • Monitor actual hours worked, not just those scheduled. • Employees should receive education on the effects of shiftwork and personal coping strategies. • Roster change can create significant disruption, on board and ashore and should not be undertaken lightly. If a particular safety issue is linked to the roster, roster change should be considered, but only after consultation with those affected. • It is important to monitor the effects of any roster change, as new problems can be created unintentionally. • For solo watches at night, have a 10-minute 'change-over period' to assist the new watchkeeper to wake up – rapidly going back to sleep as a result of sleep inertia has been a factor in a number of accidents.
Clothing	<p>Wear three layers when conditions are cold:</p> <ul style="list-style-type: none"> • synthetic next to the skin to take away moisture • wool or synthetic-pile for warmth • windproof material. <p>Keep the head covered - it is where most heat is lost from.</p> <p>Wear layered socks and insulated boots to keep feet dry and warm.</p>
Joining the ship	<p>Use rested personnel to cover those who have travelled long hours to join the ship.</p>

Topic	Hint
Ensuring seafarers are well-rested	<p>Point out their obligations under the HSE Act.</p> <p>Be explicit in pointing out what is unacceptable behaviour (eg late night partying prior to an early shift).</p>
Situations where people work long and irregular hours	<p>Create an open communication system for fatigue issues to be raised.</p> <p>Record hours of work and rest.</p> <p>Discuss fatigue at regular safety meetings.</p> <p>Educate seafarer's partners and families.</p>



Get your sleep Reduce your risk

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