Safety Risk

MARITIME NEW ZEALAND

ACUTE FATIGUE

SLEEP IN LAST 24 HOURS
- Not enough sleep
- Split sleep
- Sleep quality – personal factors
  alcohol/drugs, stress, sleep problems
- Sleep quality – environmental factors
  noise, vibration, motion, light, mattress comfort, restraining systems
- Changes to work or sleep schedule, on-call
  unpredictable sleep
- Use of rest time

CONDITIONS ON THE DAY
- Time of day
- Time since last sleep
- Environmental conditions
  heat, cold, noise, motion, wet deck
- Time since last break
- How hard working since last break
- Food and liquid intake
- Alcohol/drugs

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ACCUMULATED FATIGUE

LAST 72 HOURS
- Sleep loss – more than 2 hours per 24 hours
- Split sleep
- Sleep quality – personal factors
  alcohol/drugs, stress, sleep problems
- Sleep quality – environmental factors
  noise, vibration, motion, light, mattress comfort, restraining systems
- Changes to work or sleep schedule, on-call
  unpredictable sleep
- Use of rest time
- Operating conditions, last 3 days

Risk of seafarer fatigue

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TASK CHARACTERISTICS

- task difficulty (complexity, monotony)
- task duration
- likelihood of making a mistake
- consequences of a mistake

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Fatigue-related safety risk

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RISK MITIGATION MEASURES

TASK-RELATED
- owner expectations
- staff choosing to work long hours
- watchkeeping alarms
- incentive systems
- hazard identification procedures
- risk management policies

SLEEP-RELATED
- education/training in fatigue management
- work and rest scheduling methods
- owner expectations regarding sleep
- systems to manage sleep after disruptions to regular work patterns
- allocation of resources to a quality sleeping environment
- on board distractions from sleeping

Biological Sleep Drivers

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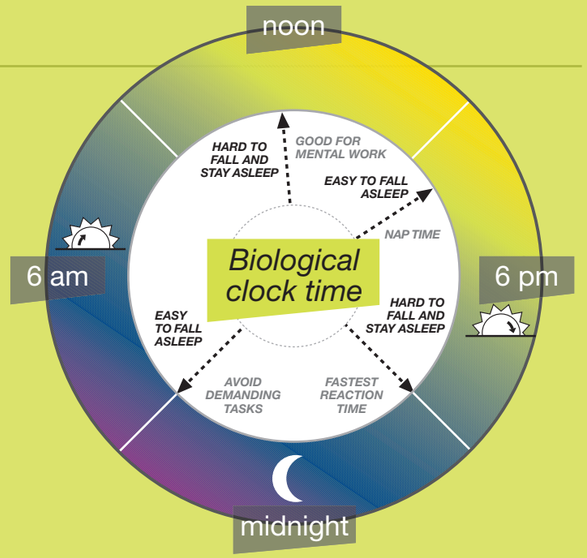
There are two biological drivers of sleep. Sometimes they work together to make you tired or alert, at other times they conflict.

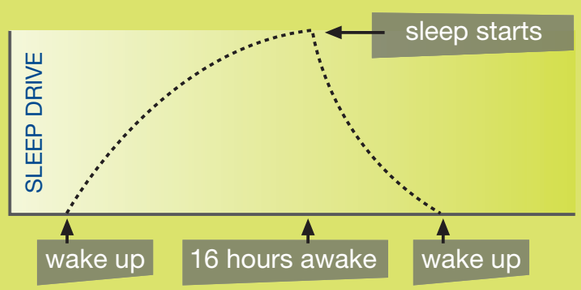
The biological clock: time of day

The biological clock makes us alert and sleepy at different times of the day.



Homeostatic sleep drive

After about 16 hours awake our need for sleep gets to the point where the sleep drive is strong enough to induce sleep. As we stay awake the drive gets stronger.



Some people are owls and their clock means they wake and sleep an hour or two later. Others are larks and their clock means they wake and sleep and hour or two earlier.

Alertness levels and performance after a normal sleep at night (wake at 6 am, asleep at 10 pm)

Homeostatic sleep drive

Time	Body clock	How the body clock and homeostatic drive work	Risk of going to sleep and effect on performance
0000 – 0300		Body clock changing toward increased sleepiness. Homeostatic sleep drive decreasing as sleep occurs.	Asleep.
0300 – 0600		Lowest time for the body clock, especially 0300 – 0500. Homeostatic drive discharged at end of sleep period.	Asleep.
0600 – 0900		Alertness phase of the clock increases rapidly. Homeostatic drive is at lowest point after 8 hours sleep.	Sleep risk is minimal. Wakes up, active.
0900 – 1200		Alertness phase of the clock continues to increase. Homeostatic drive is low.	Sleep risk is minimal. Performance good, especially memory tasks.
1200 – 1500		Clock is moving toward a high alert time. Homeostatic drive very low.	Sleep risk minimal. Performance good.
1500 – 1800		Clock has the mid-afternoon low point, especially 1500 – 1700. Homeostatic drive starts to rise more rapidly.	Sleep possible (nap window). Performance good, though somewhat easier to make mistakes.
1800 – 2100		Clock at high alert time. Homeostatic still increasing rapidly.	Sleep is difficult. Performance good.
2100 – 2400		Clock allows sleep during this period. Homeostatic drive reaching the normal high point.	Sleep begins during this period.

Biological Sleep Drivers

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Get your sleep Reduce your risk

Risk of falling asleep when continuing to stay awake

What happens when we stay awake beyond our usual sleep time? It depends very much on the environment, what you are doing and how much sleep you have had in the past few days. If you continue to try and stay awake, eventually you will fall asleep, whether you want to or not. It is important to note that you cannot train yourself to need less sleep by repeatedly restricting your sleep.

People are not good at predicting if they are going to fall asleep, when they are pushing the limits. This is the clear lesson from accident investigation. The decrease in self-awareness, combined with inconsistency when you fall asleep, makes it very easy to unexpectedly fall asleep in these circumstances.

Two factors work together that result in people unexpectedly falling asleep:

- inconsistency in a person's ability to stay awake and perform well
- a decrease in self-awareness, especially about the effects of fatigue on performance.

These result in the "fatigue trap", that is commonly seen in maritime accidents. The fatigue trap occurs when the decline in self-awareness traps a person into acting in ways that increase risk when fatigued. The fatigue trap is made more difficult to judge when the nature of the task, and the environment it is done in, changes. Monotonous tasks induce sleep, interesting tasks help you stay awake. As well, changes from interesting tasks to monotonous tasks, when tired, can result in rapidly falling asleep.

The work environment can have a strong effect on when a person will fall asleep. Some environments (eg heat, as with a warm wheelhouse) make you sleepy. Other environments (eg cold, good company) help alertness. The same applies to what a person eats and drinks. Dehydration increases fatigue, caffeine increases alertness.

Effects on performance when staying awake or there is cumulative fatigue

When sleep loss is small the effects of fatigue on performance are not large, though more time may be needed to complete tasks. However, as people continue to stay awake or build cumulative fatigue, performance can suffer. The aspects of performance that are affected the most are to do with attention and thinking skills:

- difficult to sustain attention
- problem solving ability declines
- self-monitoring is poor
- more difficult to track events and update strategies
- more difficult to develop innovative solutions
- more difficult to avoid distractions
- performance declines often in short bursts
- less concerned with negative consequences
- communication deteriorates
- less willing to apply effort.

The effects are greater the more a person is sleep deprived and if sleep deprivation occurs rapidly. Older workers (40 plus) are at more risk than younger workers.

Sleep Cycles

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The sleep cycle

There are two very different types of sleep:

1. Rapid Eye Movement or REM sleep, which is associated with fast brain activity and active dreaming; and
2. Non-REM sleep, which is associated with slower brain activity and divided into 4 stages:
   - ›› Stages 1-2 light sleep
   - ›› Stages 3-4 deep slow-wave sleep.

All these combine to make the non-REM/REM sleep cycle, which is about 90 minutes long on average, but can be up to 120 minutes.

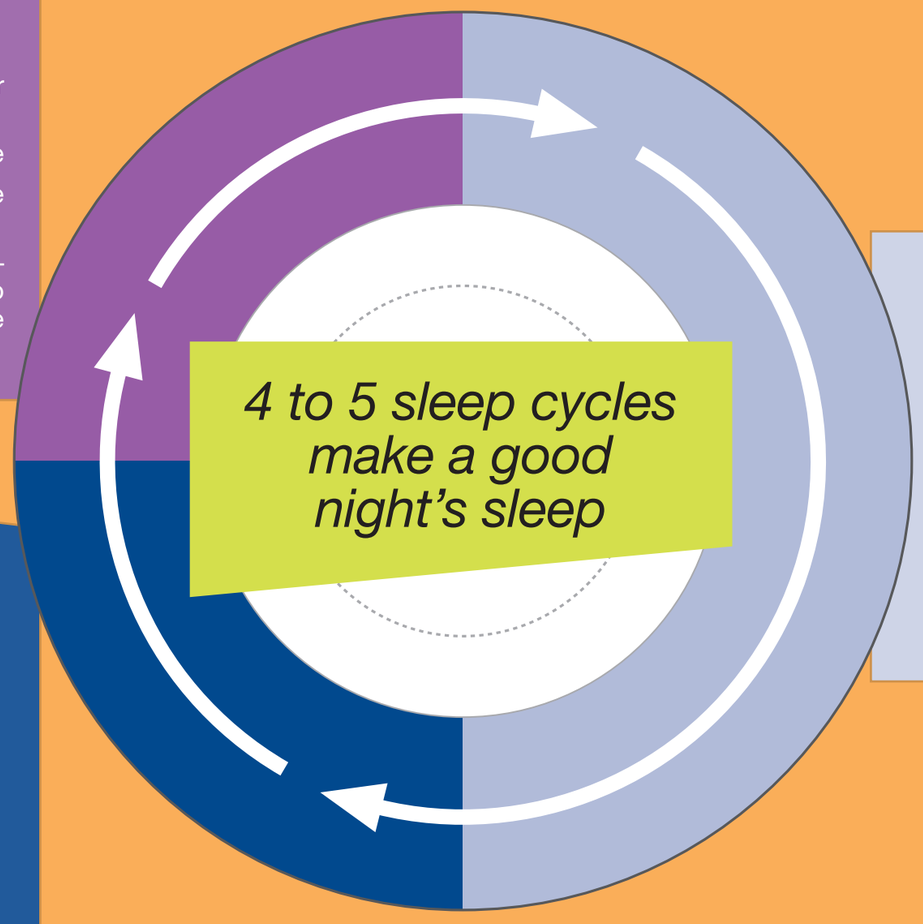
For most people, a good night's sleep is around 4 – 5 cycles long.

Good quality sleep requires both non-REM and REM sleep in uninterrupted cycles.

Rapid Eye Movement (REM)

REM
SLEEP

- Eyes move rapidly under closed eyelids
- Most dreaming occurs here
- Brain is active, muscles are relaxed
- Can't move voluntarily – signals from the brain to the postural muscles are blocked



LIGHT
NON-REM SLEEP

- Stages 1-2
- May drift in and out of sleep several times at the start
- Easy to wake up, disturbs easily

DEEP
NON-REM SLEEP

- Stages 3-4
- Difficult to wake up
- Sleep inertia when woken

Sleep Cycles

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Get your sleep Reduce your risk

What happens when you get plenty of regular sleep at night

- Most deep non-REM sleep in the 1st two cycles of the night.
- Most REM in the 4th-5th cycles, towards morning.

What happens to sleep when you have a sleep debt?

When sleep is shorter than needed, light non-REM is sacrificed first, then REM. Deep non-REM sleep is conserved.

- 1st recovery night – deep non-REM sleep is recovered first, sometimes leaving little time for light non-REM or REM sleep.
- 2nd recovery night – often contains extra recovery REM.
- 3rd recovery night – non-REM/REM cycles usually back to normal.

Aging and sleep

As teenagers, we naturally sleep later (not only for social reasons), then we get progressively more morning type across adulthood.

Teenagers tend to be chronically sleep-deprived because they often can't sleep in as late as they need to.

At around age 50 years, sleep at night starts to become lighter (less deep non-REM sleep) and more easily disturbed. As night time sleep becomes more broken, people become sleepier during the day. Taking an afternoon nap is a natural way to handle this.