

4 Sleep, Fatigue and Circadian Rhythms

4.1 What Is Sleep?

Man, like all living creatures has to have sleep. Despite a great deal of research, the purpose of sleep is not fully understood. Sleep is a natural state of reduced consciousness involving changes in body and brain physiology which is necessary to man to restore and replenish the body and brain.

Sleep can be resisted for a short time, but various parts of the brain ensure that sooner or later, sleep occurs. When it does, it is characterised by five stages of sleep:

Stage 1: This is a transitional phase between waking and sleeping. The heart rate slows and muscles relax. It is easy to wake someone up.

Stage 2: This is a deeper level of sleep, but it is still fairly easy to wake someone.

Stage 3: Sleep is even deeper and the sleeper is now quite unresponsive to external stimuli and so is difficult to wake. Heart rate, blood pressure and body temperature continue to drop.

Stage 4: This is the deepest stage of sleep and it is very difficult to wake someone up.

Rapid Eye Movement or REM Sleep: Even though this stage is characterised by brain activity similar to a person who is awake, the person is even more difficult to awaken than stage 4. It is therefore also known as paradoxical sleep. Muscles become totally relaxed and the eyes rapidly dart back and forth under the eyelids.

Stages 1 to 4 are collectively known as non-REM (NREM) sleep. Stages 2-4 are categorised as slow-wave sleep and appear to relate to body restoration, whereas REM sleep seems to aid the strengthening and organisation of memories. Sleep deprivation experiments suggest that if a person is deprived of stage 1-4 sleep or REM sleep he will show rebound effects. This means that in subsequent sleep, he will make up the deficit in that particular type of sleep. This shows the importance of both types of sleep.

As can be seen from Figure 1, sleep occurs in cycles. Typically, the first REM sleep will occur about 90 minutes after the onset of sleep. The cycle of stage 1 to 4 sleep and REM sleep repeats during the night about every 90 minutes. Most deep sleep occurs earlier in the night and REM sleep becomes greater as the night goes on.

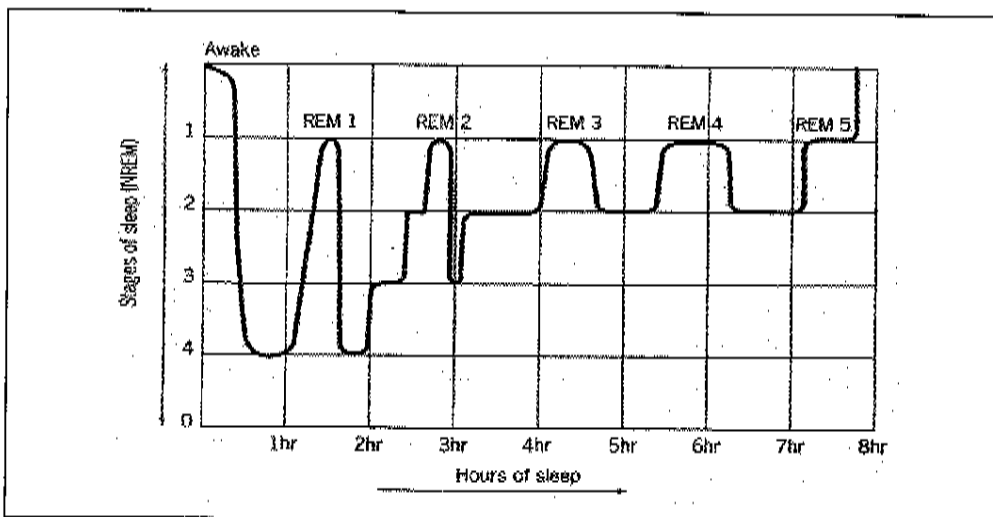


Figure 1 Typical Cycle of Stage 1-4 (NREM) sleep and REM Sleep in the Course of a Night

Fatigue is typically caused by delayed sleep, sleep loss, desynchronisation of normal circadian rhythms and concentrated periods of physical or mental stress or exertion. In the workplace, working long hours, working during normal sleep hours and working on rotating shift schedules all produce fatigue to some extent.

Symptoms of fatigue (in no particular order) may include:

- diminished perception (vision, hearing, etc.) and a general lack of awareness;
- diminished motor skills and slow reactions;
- problems with short-term memory;
- channelled concentration - fixation on a single possibly unimportant issue, to the neglect of others and failing to maintain an overview;
- being easily distracted by unimportant matters;
- poor judgement and decision making leading to increased mistakes;
- abnormal moods - erratic changes in mood, depressed, periodically elated and energetic;
- diminished standards.

The Centre for Human Sciences at Farnborough has developed a sophisticated fatigue model which predicts when flight crew are likely to become fatigued, and the level of that fatigue, depending on what rosters they fly¹.

5.1 **Fatigue Management**

Most individuals need approximately eight hours sleep in a 24 hour period, although some individuals will know that they need more or less than this to be fully refreshed. People can usually perform adequately with less than eight hours sleep for a few days, building up a temporary sleep 'deficit'. However, any sleep deficit will need to be made up, otherwise performance will start to suffer. A good rule of thumb is that one hour of high-quality sleep is good for two hours of activity.

Publications exist which advise on how to manage sleep and rest, particularly when circadian disruption occurs during long haul flights.

6 **Alcohol and Medication**

All pilots should be aware that their performance may be affected by alcohol, medication or illicit drugs. Both UK and JAA legislation precludes the consumption of alcohol or the use of illicit drugs by flight crews when working. Readers are referred to JAR-FCL 3 for details of the current requirements and restrictions regarding alcohol, medication and drugs.

6.1 **Alcohol**

Alcohol acts as a depressant on the central nervous system, dulling the senses and increasing mental and physical reaction times. It is known that even a small amount of alcohol leads to a decline in an individual's performance and causes their judgement (i.e. ability to gauge their performance) to be hindered.

Alcohol is removed from the blood at a fixed rate and this cannot be speeded up in any way (e.g. by drinking strong coffee). In fact, sleeping after drinking alcohol can slow down the removal process, as the body's metabolic systems are slower.

1. References to recently published reports on this CAA sponsored research may be found in the "Blue Book", www.caa.co.uk