

## Case Study 3

# Rest goes wrong

## Human Performance Limitations

Fatigue has been a factor in many incidents, even though mitigation measures have been put in place in the maritime sector in recent years. The following case study looks at human performance and the impact that sleep inertia has on it.



### Summary

A Boeing 767 with 95 passengers and 8 crew was flying from Toronto to Zurich with a planned flight time of 8 hours. Approximately halfway across the Atlantic, during the hours of darkness, the aircraft experienced a pilot induced change that caused the aircraft to deviate 400 ft below its assigned altitude of 35,000 ft. The corrective action resulted in the aircraft climbing 400 ft above the assigned altitude and during the rapid change in altitude there were several passenger and crew injuries.



### Detail

The crew reported for duty at 19:35 and departed at 21:09. The flight preparation was uneventful.

At 00:40, the first officer (1/O) expressed the need for a rest. The Commander agreed and the 1/O should commence a controlled rest (permitted napping on the flight deck).

As the 1/O rested, the Commander increased the cockpit lights to review aircraft manuals in preparation for some future training he was due to undertake.

At 01:18, the Commander turned on the seatbelt sign in anticipation of forecasted turbulence. Up to this point, there had been no turbulence.

At 01:55, the Commander made a mandatory position report with the Oceanic Control Centre. This conversation woke the 1/O, who was sleeping in his seat. The 1/O had rested/slept for 75 minutes, but on awakening reported to the Commander that he was not feeling well.

Coincidentally, a military aircraft was coming in the opposite direction at 34,000 ft. It appeared as a traffic alert and as a collision avoidance system (TCAS) target on the navigational display (ND). The Commander informed the 1/O about this traffic.

Over the next minute or so, the Commander adjusted the map scale on the ND to view the target and occasionally looked out of the forward windscreen to acquire the aircraft visually.

The 1/O initially mistook the planet Venus, which was slightly above his eye line and at the 12 o'clock position, for an aircraft. The Commander advised again that the target was at the 12 o'clock position and 1,000 ft below.

The 1/O continued to scan visually for the aircraft, but when he saw it, he interpreted its position as being above and descending towards them.

The 1/O reacted to the perceived imminent collision by pushing forward on the control column.

The Commander saw the control column moving forward and the altimeter beginning to show a decrease in altitude. He immediately disconnected the autopilot and pulled back on the control column to regain altitude while the oncoming aircraft passed beneath them.



## Analysis

### **Flight crew – rest prior to the flight**

The 1/O, who had young children, normally slept approximately 6–7 hours per night, a sleep that was frequently interrupted. Often, the 1/O would take a nap early in the afternoon for an hour to make up for lost sleep. The 1/O followed a normal sleep pattern during the 2 non-working days before the occurrence. The morning of the flight the 1/O awoke at 06:00. He then took a 2 hour nap in the afternoon before reporting for duty at 19:35 feeling well rested.

### Perception of oncoming aircraft at night

The assessment of relative position during flight at night is difficult as there are few external references (visual cues) by which the position and motion of objects can be assessed. Visual cues are further reduced if the cockpit lights are turned on full, as they were in this case.

There is no horizon by which to assess the relative motion. When an aircraft is distant it appears as a single point of light with no motion relative to the observer. Based on tests conducted in a flight simulator, no distinct motion up or down the field of view of an oncoming aircraft is detectable until aircraft are 15 seconds apart at a closing speed of 900 knots. An oncoming higher aircraft then moves up the visual field and an oncoming lower aircraft moves down the visual field.

### Sleep inertia

Sleep inertia refers to the post-sleep performance reduction that occurs immediately after awakening. Sleep inertia is a transient physiological state characterised by confusion, disorientation, low alertness, and deficits in various types of cognitive and motor performance.

Although the duration of sleep inertia is usually short, from 1 to 15 minutes, some effects can last 30 minutes or longer.

Research indicates that the duration and severity of sleep inertia can be worse if:

- Naps are longer, leading to the nap containing or ending with slow-wave sleep. Slow-wave sleep is our deepest phase of non-rapid eye movement (NREM) sleep
- naps occur during the circadian rhythm trough or circadian low (normally in the middle of the night for someone with a 'normal' sleep pattern)
- the person is sleep deprived or has been awake for an extended period.

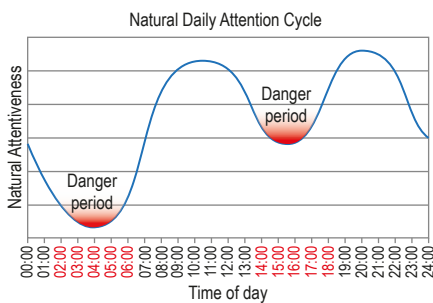


Figure 2: Graph indicating attention levels based on circadian rhythms

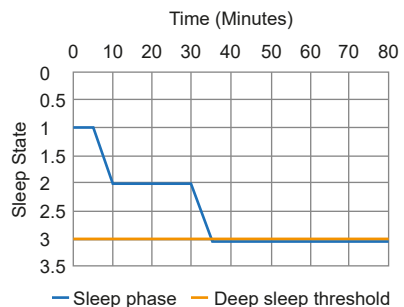


Figure 3: Sleep state

### Effects of sleep inertia:

- A decrease in cognitive processing speed. For example, it takes longer than normal for a person experiencing sleep inertia to filter out irrelevant visual information
- confusion and disorientation are characteristic of sleep inertia which may result in a propensity for visual distraction as well as reduced ability to filter out irrelevant visual information.

*Source: Transport Safety Board of Canada*

### **Controlled rest**

Controlled rest is a fatigue mitigation measure that permits strategic napping on the flight deck during periods of low activity. It is aimed at improving crew alertness during the critical phases of flight. The rest periods are a maximum of 40 minutes in length and must be completed 30 minutes before the start of descent. The senior cabin crew member must be informed and given check-in times to contact the cockpit. The napping pilot should be given a period to wake (usually around 15 minutes) and then briefed on the current situation before taking on normal duties. In this case:

- The 1/O felt fit for flight at the time of reporting for duty at 19:35, which likely coincided with a circadian high<sup>1</sup>. However, the interrupted sleep obtained in the 24 hours immediately preceding the flight increased the likelihood that the 1/O would feel fatigued during the overnight flight, particularly when a circadian low<sup>1</sup> was reached
- the rest period taken by the 1/O exceeded the recommended maximum so that he entered a 'deep sleep' state
- the situation with the oncoming aircraft occurred when the 1/O was under the effects of sleep inertia. He was likely confused and disoriented and perceived the aircraft on an imminent collision course, leading to his actions.

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<sup>1</sup> The circadian rhythm is a natural process driven by our circadian clock that regulates our sleep-wake cycle every 24 hours. At our circadian high we feel most alert and at our circadian low, we feel most tired.



## How might this apply in maritime operations?

How often are decisions or actions put at risk by the effects of sleep inertia?  
Consider situations such as:

- The Chief Officer taking a short rest during cargo operations then being called just before completing cargo
  - *have you considered how much time you need to adequately wake up before going to the cargo control room?*
- the Chief Engineer being called in the middle of the night due to an issue in the engine room
- when the Master is called to the bridge on short notice to assist with a difficult traffic situation
  - *if you are the OOW, have you called the Master early?*
- reporting to mooring stations at short notice
  - *when you expect to be called at some point during the night, how much time do you realistically require to familiarise yourself with the situation?*
- when a crew member is awoken by the ship's emergency alarm or musters, and is expected to immediately perform their duties
- when a deck officer is late to the bridge to take over the watch
- the cumulative effect of fatigue, insufficient sleep and remaining alert during long watchkeeping periods.

Having taken a rest period, particularly a short duration of sleep, we are prone to the effects of sleep inertia where we suffer from cognitive impairment for a short period of time and should not be involved in critical operations.

It is important to:

- Control the length of fatigue mitigation naps
- allow adequate recovery time after a nap to offset the effects of sleep inertia
- carefully consider the compromise between calling a crew member early enough to acclimatise to the work activity, against the need to ensure sufficient rest, as well as the impacts on other crew being relieved or assisted.



## Maritime comparisons

### 'Danio'

The general cargo ship 'Danio' was on passage from Perth, Scotland to Genk, Belgium. The ship grounded at 03:30 in the Farne Islands nature reserve. The cause was a failure to monitor the navigation of the ship as the Chief Officer, who was on watch, had fallen asleep. The ship sustained extensive damage but fortunately there was no pollution and no one was injured.

The incident investigation determined that the Chief Officer was subject to cumulative fatigue, owing to a combination of a 6 hours on/6 hours off watchkeeping regime for three months, with a very significant workload. Additionally, important safety barriers were routinely circumvented on the ship, eg the bridge navigational watch alarm system (BNWAS) had been switched off. The need for effective rest periods and for companies to reduce excessive working hours was highlighted.

*Source: Marine Accident Investigation Branch – UK*



## MCRM relevance

Human Performance Limitations:

- If the pilots had been more aware of the fact that when the 1/O took his controlled rest he would be in a circadian low, they might have been more cautious when he woke and allowed an adjustment period before he returned to duty.

*[MCRM Unit 1]*