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North American pilots on overnight flights across the Atlantic are especially at risk for fatigue and related problems.

BY LINDA WERFELMAN

Struggling With Sleep

Inadequate fatigue risk management training and a longer-than-recommended nap during an overnight trans-Atlantic flight contributed to an altitude deviation as a sleepy airline pilot confused the bright light of Venus for an aircraft landing light and then misjudged the location of a military transport aircraft, investigators say.

The Transportation Safety Board of Canada (TSB) said in its final report that the incident occurred in the early morning of Jan. 14, 2011, when the Air Canada Boeing 767 was about halfway across the Atlantic Ocean on a flight from Toronto to Zurich, Switzerland.

The flight left Toronto/Lester B. Pearson International Airport at 2138 local time Jan. 13. At 0040, the first officer (FO), whose sleep the night before had been interrupted by child care responsibilities, said that he needed to rest. The captain agreed to a period of controlled rest (see "Controlled Rest," p. 31).

At 0118, the captain turned on the seat belt sign because of forecast turbulence, and at 0155, he made a mandatory position report to air traffic control. The announcement roused the FO, who had by then had 75 minutes of rest — nearly twice as much as the recommended 40-minute maximum — and "reported not feeling altogether well," the report said.

At the same time, the captain pointed out to the FO a traffic-alert and collision avoidance

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system (TCAS) alert involving a U.S. Air Force C-17 traveling the opposite direction at 34,000 ft — 1,000 ft below their 767.

"Over the next minute or so, the captain adjusted the map scale on the ND [navigational display] in order to view the TCAS target and occasionally looked out the forward windscreen to acquire the aircraft visually," the report said. "The FO initially mistook the planet Venus for an aircraft, but the captain advised again that the target was at the 12 o'clock position and 1,000 ft below.

"The captain … and the oncoming aircraft crew flashed their landing lights. The FO continued to scan visually for the aircraft. When the FO saw the oncoming aircraft, the FO interpreted its position as being above and descending towards them. The FO reacted to the perceived imminent collision by pushing forward on the control column. The captain, who was monitoring [the] TCAS target on the ND, observed the control column moving forward and the altimeter beginning to show a decrease in altitude. The captain immediately disconnected the autopilot and pulled back on the control column to regain altitude."

The C-17 then passed below the 767 without conflict.

Sixteen people — 14 passengers and two flight attendants — of the 103 aboard the airplane received minor injuries, including seven passengers who later were treated at hospitals and released.

The investigation revealed that the airplane's pitch attitude during the incident had changed from 2 degrees nose-up during cruise to 6 degrees nose-down and back to 2 degrees nose-up. The airplane's altitude decreased from 35,000 ft to 34,600 ft, and then increased to 35,400 ft before returning to 35,000 ft.

The incident occurred within the first minute or so after the first officer awakened, when he was "most likely suffering from the strong effects of sleep inertia [and] not in a state to effectively assimilate the information from both the instruments and from outside the aircraft or effectively provide an appropriate response," the report said.

Interrupted Sleep

The 14,800-hour captain had been with the airline for more than 30 years and had been a 767 captain since early 2010. The first officer, with 24 years in aviation, including 14 years with the airline, had 12,000 flight hours, including 2,000 in 767s.

The first officer said that he typically slept six to seven hours per

Incident investigators say the first officer on a trans-Atlantic Air Canada flight probably was experiencing "strong effects of sleep inertia" after a nap when he misinterpreted the position of another airplane.

night, but his sleep periods were interrupted if his children needed his care. To compensate for lost sleep, he often napped for an hour in the early afternoon. He said that the night before the incident flight, he had nearly eight hours of rest, "with some child care interruptions before waking at approximately 0600." He said that he took a two-hour afternoon nap and that when he reported for duty at 1935, he felt well-rested.

Even though he felt fine at 1935, the interruptions to his sleep increased the chances of fatigue during the overnight flight, the report said.

Circadian Lows

Fatigue consistently reduces performance levels, and the TSB incident report said that pilots based in North America are especially at risk during night flights to Europe because they experience circadian lows that "magnify performance decrements and increase desire to sleep."

Circadian lows are naturally occurring periods during a 24-hour cycle that are marked by high fatigue and poor performance. These periods occur at times when a person typically would be asleep.

"Most of these pilots fly a small number of nighttime legs per month and revert to sleeping at night when not working," the report said. "The circadian system of pilots who fly only a small number of nighttime legs will not adapt to working at night, and these pilots are likely to display performance decrements during the nighttime legs in spite of any countermeasures."

Although some pilots try to offset anticipated fatigue with a nap before an overnight flight, this is not always effective, and performance decrements persist, the report said.

The report also characterized as "soporific" the "long periods of darkness with few operational demands while [flying over the] mid-Atlantic."

The report added, "It is not until the flight approaches the coast of Europe at dawn that pilots experience reduced sleepiness as the daylight and circadian rhythms start to alleviate some of the fatigue. Nonetheless, the high-workload requirements of approach and landing have to be borne at a time when there is a significant risk of pilot fatigue."

Sleep Inertia

The report said that, after he awakened, the first officer probably experienced sleep inertia

Controlled Rest

Air Canada's *Flight Operations Manual* defines controlled rest as "an operational fatigue countermeasure that improves on-the-job performance and alertness when compared to non-countermeasure conditions," according to the Transportation Safety Board of Canada (TSB).[1]

Procedures outlined by the company describe controlled rest as "strategic napping on the flight deck." Rest periods may last no longer than 40 minutes and must be completed at least 30 minutes before top of descent — the point at which the crew begins the descent from cruise flight. At the end of a period of controlled rest, the pilot should have at least 15 minutes to become fully awake before receiving a briefing by the other pilot and resuming normal flight duties.

Pilots are required to inform flight attendants when a controlled rest period begins, and at the planned end of the rest period, a flight attendant is required to enter the cockpit "to ensure that both pilots are not asleep," the TSB said in its report on the Jan. 14, 2011, pitch excursion incident.

—LW

Note

1. TSB. Accident Investigation Report A11F0012: *Pitch Excursion, Air Canada, Boeing 767-333, C-GHLQ; North Atlantic Ocean, 55°00′N 029°00′W; 14 January 2011.*

— grogginess that can persist, sometimes for only a minute or two but other times for as long as 35 minutes, after a nap.[1]

"The severity and duration of sleep inertia are more likely to be worse if a person is awakened from slow-wave sleep [also called deep sleep], especially if the rest occurs at a circadian low and when the person is fatigued," the TSB report said. "Given the consistency between the conditions that worsen sleep inertia and the FO's sleep and controlled rest, and the observation that the FO felt unwell when awakened, it is likely that the FO was suffering from high levels of sleep inertia."

One problem associated with sleep inertia is slower cognitive processing speed — which means that a person with sleep inertia takes more time to "filter out incongruous visual information," the report said.

Slow-wave sleep develops about 30 minutes after a person falls asleep — the reason that Air Canada and other carriers that allow controlled rest say that rest periods must be no longer than 40 minutes.

The 40-minute time limit was cited in a 1994 study by sleep researchers at the U.S. National Aeronautics and Space Administration (NASA), who found that setting aside 40 minutes for rest typically allowed pilots to sleep "efficiently" for an average of 26 minutes and to awaken with "improved physiological alertness and performance," compared with another group of pilots who were not offered the controlled rest option.[2]

Other studies have found that people who took naps of 20 minutes had the best post-sleep reaction times, compared with those who took naps lasting 50 minutes or 80 minutes.

Fatigue Risk Management

Controlled rest has been adopted by 17 air carriers in Canada, including Air Canada, and several other airlines in other countries, the TSB report said. Air Canada's policy also calls for the flight crew to notify the in-charge flight attendant that controlled rest is in progress and to request that the flight attendant call the flight deck at a specified time. The guidelines said that this step is intended to "ensure that both pilots are not asleep."

When the controlled rest is over, the guidelines say the awakened pilot "should be provided at least 15 minutes without any flight duties to become fully awake before resuming normal duties, unless required to do so due to an abnormal or emergency situation. Following the 15-minute wakening period, an operational briefing must be given. This is designed to ensure that the rest is taken in a manner that minimizes risks to the flight."

Transport Canada (TC) included controlled rest as one of the "fatigue-based error mitigation" strategies — along with the use of caffeine and relief pilots — described in its guidelines for developing a fatigue risk management system (FRMS). In addition to mitigation strategies, the guidelines discuss crew scheduling designed to allow for sufficient sleep, actions to be taken by pilots to obtain sufficient sleep, monitoring on-duty fatigue and analysis of fatigue-based occurrences.[3]

Additional recommendations are being developed by the Flight Crew Fatigue Management Working Group of the Canadian Aviation Regulation Advisory Council, which will address flight and duty time limitations and rest period rules to be developed according to "the science that underpins the FRMS," the report says.

Under Canada's Commercial Air Service Standards, all pilots who engage in controlled rest are required to undergo training in the specifics of the program and the general principles of fatigue and fatigue countermeasures. Air Canada's initial training for newly hired pilots includes a discussion of controlled rest; recurrent training also addresses the subject. In 2010, both the captain and the first officer attended fatigue risk management training sessions that discussed the effects of sleep inertia.

In addition, the airline's internal flight safety magazine published an article on sleep inertia in the fall/winter 2010 issue. Neither pilot had read the article before the incident.

Knowledge Gaps

Investigators interviewed several Air Canada pilots, including the incident pilots, about their knowledge of fatigue mitigation, especially controlled rest, and found that "their general

knowledge about how to manage their rest for flights was good, but there were specific gaps," the report said.

One of the gaps involved knowledge of how sleep disturbances — including those associated with caring for young children, snoring or waking up at night — can affect sleep quality and increase fatigue risks.

Another gap involved the requirement to notify cabin crew before a controlled rest period. All of the pilots interviewed said they understood the requirement, "but they tended to rely on their own assessment of the sleepiness of the non-resting pilot in order to decide whether the cabin crew needed to be told. …

"Since pilots take controlled rest at times when they are most sleepy, which is likely to be at a similar time to the other pilot due to the circadian rhythm of fatigue, there is a high risk of nighttime controlled rest resulting in both pilots falling asleep."

The report added, "One of the reasons they were reluctant to inform cabin crew was that they knew cabin crew were not entitled to controlled rest themselves. They did not realize that by not informing the cabin crew of the controlled rest they were creating the possibility of the resting pilot being disturbed."

Misunderstanding

The report also noted that the interviews revealed a misunderstanding among pilots about the reason for the 40-minute limit on controlled rest periods.

Some of the pilots told interviewers that they believed 40 minutes was not enough time to obtain adequate rest "and believed that what was really required was a significant sleeping period — 90 to 120 minutes. Some were unaware that by sleeping longer than 40 minutes, there was a high risk of entering slow-wave sleep and increasing the severity of sleep inertia."

The pilots also had little understanding of sleep inertia, the report said, adding that they were "aware of the term but were not aware how significantly impaired a recently awakened pilot could be."

Flight Paths

Even a well-rested pilot can have difficulty determining the relative position of another aircraft, especially in an overwater environment with few external cues for assessing the position and motion of other objects, and especially if cockpit lights are bright, the report said.

Tests in a 767 simulator found that when an oncoming aircraft was far away, an observer could not detect its relative motion. The oncoming aircraft's up or down motion could not be detected until the two aircraft were 15 seconds apart at a closure speed of 900 kt, the report said, adding, "An oncoming higher aircraft then moves up the visual field, and an oncoming lower aircraft moves down the visual field."

'It is likely that the FO was suffering from high levels of sleep inertia.'

After the incident, Air Canada issued several bulletins to crewmembers, including one that emphasized the need for compliance with all components of its standard operating procedure for controlled rest. Another emphasized the importance of notifying cabin crew when a controlled rest period is in progress on the flight deck.

The airline also identified the Toronto–Zurich route as the subject of a data collection exercise to evaluate the alertness of crews on these flights.

This article is based on TSB Accident Investigation Report A11F0012: Pitch Excursion, Air Canada, Boeing 767-333, C-GHLQ; North Atlantic Ocean, 55°00'N 029°00'W; 14 January 2011.

Notes

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3. TC. TP 14575E, *Developing and Implementing a Fatigue Risk Management System*. April 2007.