The Science of

Regulators see a larger role for non-traditional methods of mitigating pilot fatigue and preventing fatigue-related accidents.

© Jack Hollingsworth/Corbis

Moving toward a systems approach to preventing fatigue in aviation operations, the U.S. Federal Aviation Administration (FAA) says that, like other civil aviation authorities, it is going beyond traditional programs that limit the number of hours worked in favor of more comprehensive plans to help operators identify fatigue and mitigate its risks.

"While fatigue may not have been called out by name, it's been … lurking in many of the accidents we've faced over the years," Acting FAA Administrator Robert A. Sturgell told a fatigue safety forum convened by the agency in June to consider "new ways to manage fatigue."[1]

The FAA characterized the safety forum as an early step in its development of a new approach to handling fatigue and its revision of existing policies, which have been in effect with relatively few changes for 50 years.

"Even with an outstanding safety record, we're not where we need to be when it comes to understanding and dealing with fatigue," Sturgell said.

The solution is not necessarily "adopting prescriptive criteria for fatigue risk abatement," he said, adding, "We need to address all levels of fatigue and put appropriate mitigations in place — mitigations that are proportionate to the risk."

Plans call for the proceedings of the symposium to be published in late 2008 in an effort to widely disseminate information about fatigue and fatigue mitigation.

The FAA's plans — outlined in August, in response to safety recommendations by the U.S. National Transportation Safety Board (NTSB) — are to "educate the industry on the reality of fatigue and ways to effectively mitigate its dangers." The FAA said it would first develop guidance for fatigue management in ultra-long-range (ULR) operations — flights longer than 16 hours — and then apply that guidance to other flight profiles.

ULR fatigue-management guidance currently exists in the form of recommended guidelines published in 2005 by the ULR Crew Alertness Initiative, sponsored by Airbus, Boeing Commercial Airplanes and Flight Safety Foundation.[2]

In addition, the FAA said that data gathering will continue on the fatigue aspects of ULR flights and other flight operations, and that the new data will be essential in the development of fatigue guidance documents and standardized protocols for data gathering.

Fatigue

BY LINDA WERFELMAN

These standardized protocols will provide "reliable tools to validate air operators' fatigue management actions and also will give solid basis for policy guidance to the industry," the FAA said.

The NTSB recommendations, issued after investigations of several recent fatigue-related accidents and incidents — including a Pinnacle Airlines Bombardier CRJ200LR runway overrun at Traverse City, Michigan, on April 12, 2007 (see p. 20) — called on the FAA to "develop guidance, based on empirical and scientific evidence, for operators to establish fatigue management systems" and to "develop and use a methodology that will continually assess the effectiveness of fatigue management systems[3] implemented by operators, including their ability to improve sleep and alertness, mitigate performance errors and prevent accidents and incidents" (see "Recent Fatigue-Related Events," p. 41).

The NTSB defines fatigue management systems as incorporating various fatigue-management strategies, including scheduling practices, attendance policies, education, medical screening and treatment, "personal responsibility

A preliminary incident report says a Go! Bombardier CL-600 flew past its destination airport in Hilo, Hawaii, U.S., because the flight crew fell asleep.

Fatigue was identified as a factor in the crash of a Jetstream 32 in Kirksville, Missouri, U.S., top photo, and may have affected a TNT Airways Boeing 737-300 crew in a June 15, 2006, accident at England's Nottingham East Midlands Airport. No one was hurt in the accident, in which the right main landing gear separated from the airplane.

during non-work periods," task/workload issues, rest environments, commuting policies, and/or napping policies.

According to the NTSB recommendations, the new guidance would supplement flight- and duty-time regulations — not replace them.

"Although scheduling practices and flight- and duty-time limits still need to be addressed, the [recent fatigue-related accidents and incidents] have clearly shown that other issues contribute to human fatigue in aircraft operations and that a comprehensive approach that includes company policies and crewmember responsibilities is needed to effectively mitigate the hazards posed by fatigue in the aviation environment," the NTSB said in a letter conveying its safety recommendations to the FAA.[4]

© Al Maglio/Associated Press

U.K. Air Accidents Investigation Branch

The fatigue management system concept already is in place in several civil aviation authorities, including New Zealand, where regulations were implemented in 1995 to require air carriers to either comply with traditional flight- and duty-time limitations or with a fatigue management system approved by the Civil Aviation Authority. The regulation establishes maximum monthly and yearly flight hours for flight crewmembers and specifies that operators must not allow crewmembers to fly if their condition could present a risk to flight safety.

In addition, the International Civil Aviation Organization (ICAO) is developing a document that will discuss fatigue management systems and will prescribe them as an alternative to flight- and duty-time limits.

Fatigue risk management systems (FRMS) also are in place in some airlines.

One of the first airlines to adopt an FRMS was easyJet, which began the system as a research program to gather data on pilots' sleep and fatigue-related performance. The research effort led to revised work schedules, continuing data collection and research on fatigue risks, a procedure for crewmembers to report fatigue within a just culture, and a process for investigating the role of fatigue in all incidents.[5]

Often, an FRMS is one element of an airline's safety management system (SMS), and many of the FRMS components — such as a just safety culture and non-punitive safety reporting — are also integral parts of an SMS. This is the approach taken by Transport Canada (TC), which has published a series of reports on how a fatigue management system should be implemented and why.[6]

"Managing fatigue-related risk under an SMS framework involves developing comprehensive defenses against the hazard of fatigue based on a formal assessment of risk," TC says. "Organizations can decide to do as much or as little as necessary to manage their own levels of risk. ... An effective … fatigue risk management system should use multiple, overlapping and redundant defenses against a given hazard.

Recent Fatigue-Related Events

Among the recent accidents and incidents cited by the U.S. National Transportation Safety Board (NTSB) as examples that highlight the risks of human fatigue in airline operations are the following:[1]

Feb. 13, 2008 — An incident in which a Go! Bombardier CL-600 en route from Honolulu to Hilo, Hawaii, flew past the destination airport while still in cruise flight. Air traffic control (ATC) tried repeatedly to contact the crew but received no response for 18 minutes as the airplane, operated by Mesa Airlines, flew 26 nm (48 km) past Hilo. Then the crew contacted ATC, complied with instructions for their return to Hilo and safely landed the airplane. The three flight crewmembers and 40 passengers deplaned safely.

A preliminary investigation found that "both pilots unintentionally fell asleep during cruise flight," the NTSB said in a safety recommendation letter to the U.S. Federal Aviation Administration (FAA). Although the crew had been on duty less than 4.5 hours when the incident occurred, "the pilots were on the third day of a trip schedule that involved repeated early start times and demanding sequences of numerous short flight segments," the NTSB said. In addition, the NTSB said, one pilot was diagnosed after the incident with obstructive sleep apnea, which can result in poor sleep quality, excessive daytime fatigue and, for some people, memory problems.

April 12, 2007 — An accident in which a Pinnacle Airlines Bombardier CRJ200LR ran off the end of the landing runway at Cherry Capital Airport in Traverse City, Michigan, U.S. The airplane was substantially damaged, but none of the 49 passengers and three crewmembers was injured in the crash, described in detail on p. 20.

Feb. 18, 2007 — An accident in which a Delta Connection Embraer ERJ-170, operated by Shuttle America, ran off the end of a runway at Cleveland Hopkins International Airport while landing in a snowstorm. None of the 75 people in the airplane suffered serious injury, but the airplane was substantially damaged. The NTSB said that the probable cause of the accident was the flight crew's failure to conduct a missed approach "when visual cues for the runway were not distinct and identifiable." Contributing factors included the captain's fatigue (*ASW*, 9/08, p. 22).

"The captain had been suffering from intermittent insomnia during the months preceding the accident," the NTSB said, noting that the captain told investigators that, at the time of the accident, he had been awake for 31 of the preceding 32 hours. The captain said that, although he told other crewmembers about his fatigue, he did not remove himself from duty or tell his company because he believed that he would have been fired.

"As a result, he placed himself, his crew and his passengers in a dangerous situation that could have been avoided," the NTSB said. "Shuttle America had an official attendance policy that allowed pilots to remove themselves from duty because of fatigue, but … in practice, the administration of this policy did not permit flight crewmembers to call in as fatigued without fear of reprisals."

Oct. 19, 2004 — An accident in which a Corporate Airlines BAE Systems Jetstream 32 crashed short of the landing runway in Kirksville, Missouri, U.S. The crash occurred as the pilots — at the end of a 14.5-hour duty day — were conducting a nonprecision approach in nighttime instrument meteorological conditions. Thirteen of the 15 people in the airplane were killed, and two received serious injuries. The NTSB said that the probable cause of the accident was "the pilots' failure to follow established procedures and properly conduct the approach and to adhere to established division of duties." Their fatigue "likely contributed to their degraded performance," the NTSB said.

— LW

Note

1. NTSB. Safety Recommendation Letter in reference to Recommendations A-08-44 and A-08-45. June 12, 2008.

In a multi-layered system, an incident can occur only when all the defensive systems fail."

'Best Practices' Attendance

The Pinnacle Airlines accident and other fatigue-related accidents and incidents illustrate the risks of fatigue, as well as the need for the industry to address fatigue-related factors in company policies and crewmember responsibilities, the NTSB said. Although industry and regulators often have relied on flight- and duty-time limits — such as the FAA's current regulatory requirement that a two-member flight crew be limited to eight scheduled flight hours between mandatory rest periods[7] — the NTSB and others say that these limitations alone are not sufficient to mitigate the risks of fatigue.

Among other things, the NTSB has recommended that the industry develop a "best practices attendance policy" to allow flight crewmembers to decline assignments if they believe that they are impaired by insufficient sleep.

In the final report on the Pinnacle Airlines accident, the NTSB said that long duty days can result in pilot fatigue and degraded performance.[8]

"Aviation accident data show that human performance–related airline accidents are more likely to happen when pilots work long days," the report said, citing a 1994 NTSB study that found that captains who had been awake longer than 12 hours made "significantly more errors" than those who had been awake for a shorter time period.

"Such errors included failing to recognize and discontinue a flawed approach; pilots often exhibited a tendency to continue the approach, despite increasing evidence that it should be discontinued," the report said. "Research and accident history also show that fatigue can cause pilots to make risky, impulsive decisions; become fixated on one aspect of a situation; and react slowly to warnings or signs. … Additionally, research shows that people who are fatigued become less able to consider options and are more likely to become fixated on a course of action or a desired outcome."

When accident investigators questioned how widespread fatigue was among Pinnacle pilots, the FAA principal operations inspector who oversaw Pinnacle operations estimated that 60 to 70 percent of company pilots who submitted event reports through the aviation safety action program (ASAP) cited fatigue as a factor in the event.

The report said that scientific studies indicate that people "typically underestimate their level of fatigue, especially when they are busy." For example, the report quoted the Pinnacle pilots as saying that they had not realized how tired they were until the airplane was established in cruise — a phase of flight in which workload typically is low. The report theorized that, if they had recognized the extent of their fatigue earlier, the accident pilots might have invoked a Pinnacle policy that allowed flight crewmembers to remove themselves from trips because of fatigue.

'Company Resistance'

In its final report on another runway excursion accident in which fatigue was cited as a factor, the NTSB reviewed 5,200 reports by air carrier pilots involving fatigue-related events. The reports, filed with the U.S. National Aeronautics and Space Administration Aviation Safety Reporting System (ASRS) from 1996 to 2006, included discussions of 30 incidents in which pilots called in sick or fatigued.[9]

The outcomes of those calls varied. "Some of the air carrier pilots reported using such programs successfully, whereas other pilots reported that they hesitated to use such programs because of fear of retribution," the NTSB report said. "In addition, other pilots reported that they attempted to call in as fatigued but encountered company resistance."

The report cited as an example a February 2006 ASRS report in which a regional jet captain said that, after three consecutive early-report times, she and her first officer were "sort of robotic and tired." The first officer added, "I even called scheduling and spoke to a supervisor (twice), asking him to take me off the rest of the trip because I was so exhausted. He tried to work that out but said we were short-staffed. … I told him that I wouldn't call in fatigued because they didn't have the staffing."

Notes

1. Sturgell, Robert A. "No Rumble Strips." Opening remarks to *FAA Aviation Fatigue Management: Partnerships for Solutions Symposium*, Tysons Corner, Virginia, U.S. June 17–19, 2008.
2. ULR Crew Alertness Steering Committee and FSF Editorial Staff. "Lessons From the Dawn of Ultra-Long-Range Flight." *Flight Safety Digest*. Volume 24 (August–September 2005).
3. Fatigue management systems are referred to by several other names, including fatigue risk management systems, fatigue management schemes, fatigue countermeasures programs and alertness management programs.
4. NTSB. Safety Recommendation Letter in reference to Recommendations A-08-44 and A-08-45. June 12, 2008.
5. Stewart, Simon; Holmes, Alex. "The easyJet Fatigue Risk Management System (FRMS)." Paper presented at *FAA Aviation Fatigue Management: Partnerships for Solutions Symposium*, Tysons Corner, Virginia, U.S. June 17–19, 2008.
6. TC. *Developing and Implementing a Fatigue Risk Management System. TP 14575E*. April 2007.
7. Limited exceptions are permitted in case of "circumstances beyond the (operator's) control," such as inclement weather.
8. NTSB. *Runway Overrun During Landing, Pinnacle Airlines Flight 4712, Bombardier/Canadair Regional Jet CL600-2B19, N8905F, Traverse City, Michigan, April 12, 2007*. NTSB/AAR-08/02.
9. NTSB. *Runway Overrun During Landing, Shuttle America, Inc., Doing Business as Delta Connection Flight 6448, Embraer ERJ-170, N862RW, Cleveland, Ohio, February 18, 2007*. NTSB/AAR-08/01.

Further Reading From FSF Publications

Werfelman, Linda. "If You Don't Snooze, You Lose." *Aviation Safety World* Volume 1 (November 2006): 13–17.

Caldwell, J. Lynn. "Managing Sleep for Night Shifts Requires Personal Strategies." *Human Factors & Aviation Medicine* Volume 46 (March–April 1999).

Flight Safety Foundation Fatigue Countermeasures Task Force. "Principles and Guidelines for Duty and Rest Scheduling in Corporate and Business Aviation." *Flight Safety Digest* Volume 16 (February 1997).