© Ronald Fernandez/iStockphoto

Bucking Convention

Symposium showcases innovations to reduce crew turbulence injuries and hold accountable passengers who impede safety.

BY WAYNE ROSENKRANS

The sheer number of hours spent moving about an aircraft cabin leaves flight attendants more vulnerable than passengers to the risk of injury from a severe turbulence encounter. Several presenters explored this safety disparity during the International Aircraft Cabin Safety Symposium (CSS) conducted by the Southern California Safety Institute in February 2009 in Torrance, California, U.S.

In February 2008, serious injuries to two flight attendants aboard a Boeing 737-600 prompted Scandinavian Airlines (SAS) Norway to institute several changes, said Anne Lea Wittrup-Thomsen, an air purser, cabin safety coordinator and cabin investigator assigned to assist the Accident Investigation Board Norway for this accident.

"About 10 minutes to landing at Trondheim, Norway, the 'FASTEN SEAT BELT' sign had been switched on at 12,000 ft and the aircraft was crossing over a lake at approximately 7,000 ft," Wittrup-Thomsen said. "The two aft cabin crewmembers were making final preparations before landing and were about to sit down. One had reported 'cabin clear' [to the flight deck] when they could feel several hard shaking [forces] from the tail of the aircraft, later described as a sideways shaking … and both cabin crewmembers were lifted from the floor and hit their heads against the ceiling. Both came around on the floor after a little while."

One then told the other that she had pain in her tailbone and back; she crawled along the aisle and called for help from passengers. The other flight attendant whispered to her colleague that she was having difficulty breathing. A nurse and a physician on the flight immediately assisted them, including administering oxygen.

The flight attendant who had difficulty breathing, initially considered the most serious case, was treated for broken ribs at a hospital and released the same day to a hotel; she returned to her home base city the following day but remained off duty for about six weeks. "The other cabin crewmember had swelling and fluid in her spine which made [her condition] difficult to diagnose," Wittrup-Thomsen said. "She returned to base in the afternoon of the same day. A full body X-ray detected a week later that she had a broken vertebra. She was off on sick leave for two months."

Policy and procedures were revised in mid-2008 to require that cabin crews complete all cabin duties, occupy their jump seats and fasten their harnesses by the time the flight crew signaled descent below 15,000 ft. "Turbulence is more serious in the aft than in the front, and we opened up a dialogue so cabin crew working in the aft can call the flight deck and tell the pilots to switch on the 'FASTEN SEAT BELT' signs when they experience turbulence," Wittrup-Thomsen said.

Lufthansa also has tackled this risk of injury. The airline now *requires* — not *recommends* — that passengers keep their seat belts fastened whenever they occupy their seats. This policy was implemented in 2008, said Matthias Honerkamp, a captain, check pilot on Airbus A330 and A340 fleets, and manager of training standards and crew safety training, and Grit Matthiess, a purser for the airline.

"FASTEN SEAT BELT" signs formerly had been illuminated by the flight crew — often without a public address announcement — to signal passengers to be seated even during light chop and meal service typically was continued. Each time, however, the cabin crew had to walk the aisles, sometimes interrupting meal service or leaving the security of their jump seats, to check that passengers had fastened their seat belts. The signs so often were illuminated for long periods without an explanation that they lost their warning effectiveness.

"Our key case in August 2003 was an A340 accident during a climb to Flight Level 240 [about 24,000 ft] on the way to Houston," Honerkamp said. "The aircraft was lifted up with 2.3 g [2.3 times acceleration by gravity] and then was pushed down with minus 0.9 g within two seconds. We had two passengers with serious injuries and [40] passengers and three cabin crewmembers with minor injuries. One finding was that the seat belt signs had been switched on before the encounter, but despite that, many people had their seat belts unfastened."

Lufthansa's new policy requires a public address announcement with each illumination and guides flight crews on when to illuminate the signs. "If we expect moderate turbulence or we encounter moderate turbulence, we are required now to switch on the 'FASTEN SEAT BELT' signs," Honerkamp said. The legal authority behind the policy comes from a brief change to contractual terms and conditions of carriage accessible via a link on the home page of the Lufthansa Web site.

Auditing allows trained observers to see how time constraints in line operations affect readiness for turbulence encounters and performance of other safety duties, said Nina Haubold, manager cabin audit, Flying Operations Audit, Qantas. "For unanticipated turbulence during

Below, foreground left-right, Karen Allbright, Bernadette Jean, Brian Buchanan and Julie Pelletier of the Air Canada Component, Canadian Union of Public Employees; below right, Wittrup-Thomsen.

Photos: Wayne Rosenkrans

flight, cabin auditors really look at what is out there in our cabins during service time that potentially can harm the cabin crew and our passengers," Haubold said.

A line operations safety audit (LOSA) program for the cabin has made 360 observations since 2005, with each aircraft fleet audited at intervals of 18 to 24 months, she said. The 20 Qantas cabin safety auditors — each observing four sectors per year — are fully qualified, current and operational cabin crew who have received formal training in systemic threat and error management (TEM) principles and how to code qualitative human factors as threats, errors and undesired aircraft states.

After the cruise phase of flight, the highest rate of threats has been observed during the period from the preflight briefing until the final door has been closed for departure. "The high-ranking errors are failures to complete [all components of] the emergency equipment–effective checks preflight," Haubold said.

Benefits of cabin LOSA audits have included higher awareness of safety responsibilities among cabin crew; enhanced policies and procedures; new recurrent training on normal operating procedures; updated, reorganized and tightly controlled content revisions in cabin crew manuals; new cabin standard orders that supersede manuals between revisions; upper management tracking of agreed actions to fix issues noted in audit findings; improved communication; and more disciplined cabin safety operations committee meetings.

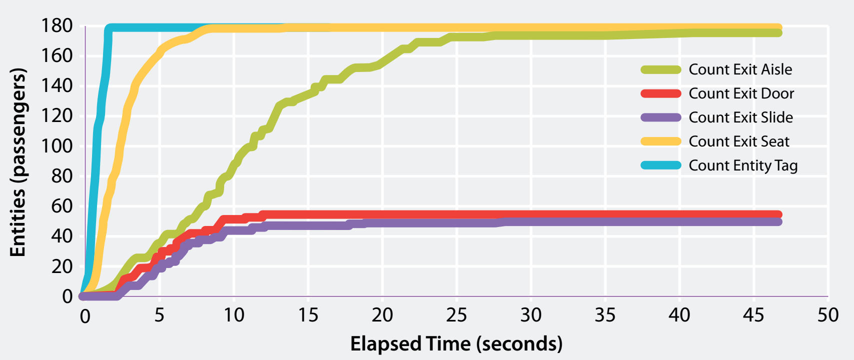
U.S. airlines can gain expanded flexibility to design their training under the voluntary Advanced Qualification Program (AQP) of the Federal Aviation Administration (FAA) compared with following the regulations for standard flight attendant training, said Chris Hallman, founding principal of Great Circle Consulting. Among major differences are the AQP requirements to collect and analyze data about scenario-based flight attendant performance and proficiency, and elimination of inflexible programmed hours of training for greater efficiency under AQP.

"AQP programs also require a specific, rigorous instructional design foundation and focus on training instructors and evaluators … and building the idea of systems thinking," Hallman said. Nevertheless, the program is not for all airlines because of the two-year start-up and ongoing commitment of full-time technical staff, especially to handle data management, analysis and reporting to the FAA and management; rewriting of operational training manuals; and the difficulty of returning to conventional training.

Other presentations of the 2009 CSS also showcased innovations. For example, airlines of Japan since 2004 have collaborated frequently with police to manage unruly/disruptive behavior aboard commercial aircraft through safety-focused laws, clear warnings and procedures, rapid enforcement and stiff penalties, said Akemi Inukai, manager, corporate safety, for All Nippon Airways (ANA). "With this amendment to the law, we can take a more firm attitude toward any unruly behavior and will not hesitate to report it to the police or to another appropriate law enforcement authority if necessary," Inukai said. "The captain has the right to issue a prohibition order to cease [eight acts impeding safety aboard aircraft]. If acts are continued or repeated despite the prohibition order, the passenger is violating the law and may be subject to a fine up to ¥500,000 [about $5,090]." From 2004 to 2006, the major issues at ANA were smoking in the lavatories, using improper electronic devices and interfering with cabin crew duties, she said.

Innovative approaches also have improved medical diagnosis of adverse health effects in flight crews and cabin crews from workplace exposure to bleed air contaminants, defined as pyrolized engine oils and hydraulic fluids that leak

Visualizing Emergency Exit Congestion



Note: In this simulation of a large commercial jet evacuation based on queuing theory, all 180 passengers exited from seats after five seconds and aisles after about 25 seconds. Under crash conditions input to the evacuation model, however, only about 50 passengers could exit from doors and slides because of congestion at doors. The software actually plotted individual entities adjacent to others, overlapping or spread out along these five colored lines.

Source: Adapted from airplane evacuation graphics generated by Embry-Riddle Aeronautical University using Micro Saint Sharp, a product of Alion Science and Technology

Figure 1

into the aircraft cabin and flight deck air supply systems (*ASW*, 4/08, p. 48). Robert Harrison, a physician and clinical professor of occupational and environmental medicine at the University of California San Francisco, told the symposium that "better engineering and maintenance … elimination of the possibility that these [aircraft mechanical] systems could fail" will be a key to resolving this contentious issue.

As a member of the FAA-funded Occupational Health Research Consortium in Aviation and in collaboration with the FAA's Airliner Cabin Environment Research Center of Excellence, he participated in the August 2008 publication of the free 24-page *Exposure to Aircraft Bleed Air Contaminants Among Airline Workers: A Guide for Health Care Providers.* In February 2009, a new two-page reference guide also was posted at <www.ohrca.org> for use by crewmembers.

"The initial symptoms have to happen within 48 hours of exposure," Harrison said. "This is important because — if someone has a delayed effect and says, 'I had an exposure three months ago … I was fine, but now I have a problem' — I don't think we can consider that work-related. To my knowledge, there is no latency, no delayed effect."

To proponents of evacuation simulation technology, the A380 evacuation demonstration that Airbus conducted in 2006 represents more than a step toward launching a new airplane type, said Brian Peacock, a professor at Embry-Riddle Aeronautical University–Prescott [Arizona, U.S.] and a specialist in ergonomics engineering (*ASW* 1/07, p. 46, and *ASW* 4/08, p. 47). An evacuation demonstration only demonstrates one set of conditions, Peacock said.

"The trick is to simplify the model and then run it just like a demonstration — but we can run it over and over again with many different conditions," Peacock said. Operators ideally could model and consider factors such as disability, incapacitation, immobility, stumbling, reverse flows, aggression, cooperation, panic, kin behavior — individuals such as family members who try to stay together during an evacuation — and passengers who impede themselves and others by taking their carry-on baggage.

Using queuing theory, the variables can be expressed as relationships among the number of entities, that is, passengers and crewmembers; queue length; queue logic; entity speed from 1 to 6 mph (1.6 to 9.7 kmh); resources such as doors, aisles and flight attendant flow management and redirection; release conditions for when an unavailable resource becomes available; service activity constraints and rates; queue discipline; statistical distributions; branching within queues from jockeying, balking and reneging; and optimal throughput rates (Figure 1).

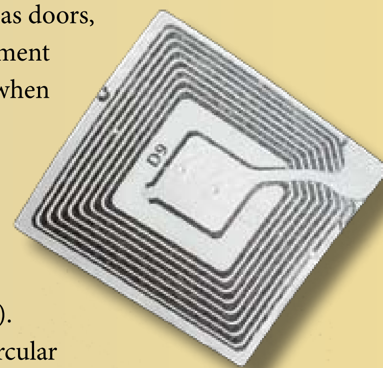
Since the publication of Advisory Circular 20-162, *Airworthiness Approval and Operational Allowance of RFID Systems,* in September 2008, the FAA has conducted an educational outreach to help flight attendants and other aviation professionals understand the nature of radio frequency identification (RFID) devices — often called *tags* — that look like a small foil strip or stamp with a microcircuit and possibly a battery or solar cell.

This part-marking technology will be used increasingly on galley/service carts, line-replaceable units in the electronics and equipment bay, baggage, mail containers and cargo devices. In the cabin, flight attendants may encounter RFID tags on passenger convenience items.

Tim Shaver, assistant manager of the Avionics System Branch, FAA Aircraft Certification Engineering Division, told the symposium that data stored in *passive RFID* tags can be collected when a reader or interrogator is nearby. In contrast, a *low-power active RFID* tag continuously transmits this data to readers or interrogators from a longer distance. Passive RFID tags inherently pose no risk to aircraft systems, but the designs of low-power active tags have to pass safety tests before they can be used aboard aircraft.

"If you have an RFID tag installed on every life vest on the airplane, a mechanic could walk through with a reader," Shaver said.

To read an enhanced version of this story, go to <www.flightsafety.org/asw/apr09/cabinsymposium.html>.



Top: © RA Photography/iStockphoto; bottom: © RF Code

Radio frequency identification devices (RFIDs) include the passive RFID, top, and the low-power active RFID.