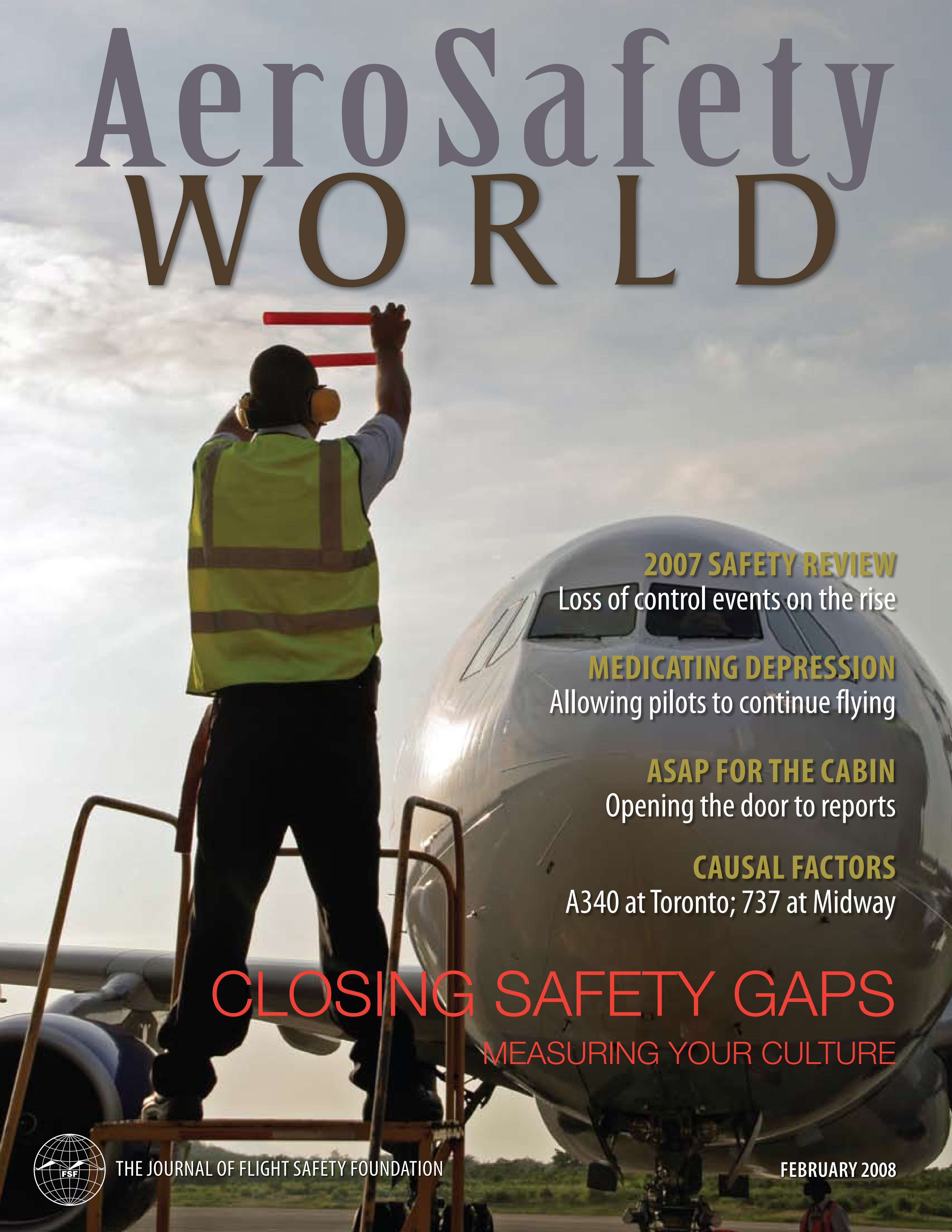
AeroSafety WORLD



2007 SAFETY REVIEW
Loss of control events on the rise

MEDICATING DEPRESSION
Allowing pilots to continue flying

ASAP FOR THE CABIN
Opening the door to reports

CAUSAL FACTORS
A340 at Toronto; 737 at Midway

CLOSING SAFETY GAPS
MEASURING YOUR CULTURE

THE JOURNAL OF FLIGHT SAFETY FOUNDATION

FEBRUARY 2008

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Achilles' Heel

Growth is good, but a consensus is forming that the lack of qualified personnel is a major challenge to that growth. International Air Transport Association estimates that its member airlines will need 17,000 new pilots a year over the next 20 years. Boeing estimates look for 360,000 new pilots over the same time period, and that doesn't include business aviation, the very light jet market and so on.

That's a lot of pilots. So, how do we decide when new pilots are ready to go on the line flying jets? Current international regulations are not much help. The minimum legal requirement is an instrument rating and a commercial pilot license; a commercial pilot license earned on small piston-engine airplanes may have made sense 60 years ago, but it doesn't do much to prepare a first officer for an RJ or an Airbus A320.

In the past, this hasn't mattered; the military, the marketplace and the legacy airlines set standards far above the legal requirements. During the '70s and '80s, big militaries with high turnover supplied lots of pilots to the civil aviation market. Places like North America and Australia could count on the rich reservoir of their large general aviation segments for experienced personnel, while legacy airlines in Europe and Asia invested heavily in ab initio training programs to produce pilots at a controllable rate.

Things have changed. The flow of military pilots has slowed. The industry is only a few years into this new expansion, and the pool of highly qualified general aviation pilots is largely gone. The world that was dominated by legacy carriers is increasingly influenced by start-up airlines whose expansion plans do not allow for the time or overhead costs associated with ab initio programs.

The burden of deciding who enters the air transport business, and at what skill level, now falls on the shoulders of overburdened chief pilots and training managers at hundreds of regional airlines and developing low-cost carriers. They typically have few resources and must cope with massive turnover rates as their pilots get hired away by the pilot-needy legacy carriers. But somehow they have to deal with a succession of new pilots, some with minimum qualifications, and teach them to fly transport category jet aircraft while maintaining a perfect level of safety. Some have to cope with trainees that may speak different languages, come from incompatible cultures and hold certificates of questionable origin. When you step back and look at this, it doesn't make much sense: Some of the most constrained people in our business are being asked to do something that is nearly impossible yet at the same time is absolutely essential.

What can we do? First, we had better lend these people a hand. They need the best practical tools and advice, and when they say the system is being pushed too far, we need to listen. Second, this industry should take another look at how we want to set competency and qualification requirements and put in place a sensible system of regulation that matches the demands of this century. More could be done, but that would be a good start.

William R. Voss
President and CEO
Flight Safety Foundation

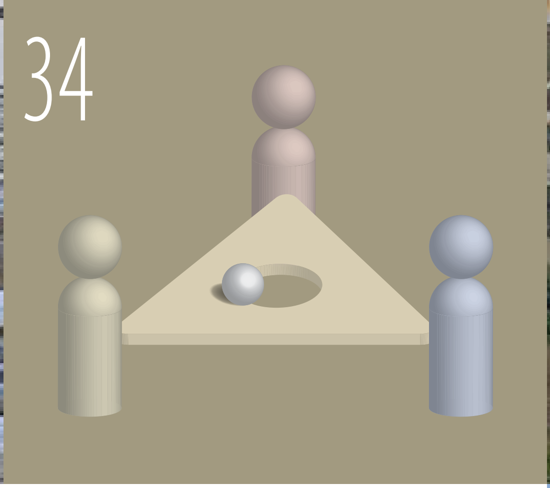
AeroSafetyWORLD

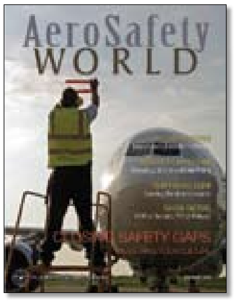
contents

February2008 Vol 3 Issue 2

features

departments





About the Cover
Measuring a safety culture enables management.
Photo: © Brett Charleton/iStockphoto

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If you have an article proposal, manuscript or technical paper that you believe would make a useful contribution to the ongoing dialogue about aviation safety, we will be glad to consider it. Send it to Director of Publications J.A. Donoghue, 601 Madison St., Suite 300, Alexandria, VA 22314-1756 USA or donoghue@flightsafety.org.

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MANAGEMENT Risk

Change happens, as they say, and success largely is a measure of how change is anticipated and ultimately handled.

When it comes to safety culture, whether change is good or bad depends on the starting point. Naturally, we applaud changes for the better. However, I cringe at the harmful change that could be inflicted by management hotshots arriving in their new executive positions not simply full of ideas, but with firmly held beliefs that they know all they need to know. When they encounter issues beyond their experience, some tend to discount the importance of what is not already in their operating plan.

The company does not have to be in trouble for a new manager to have this mindset; the very fact that the new manager has not been in charge is sufficient evidence for some to believe that major changes are essential.

While I am concerned mostly about conscious management actions, harm also may be done without a conscious decision — to slight this safety program or that aspect of the safety culture — by allowing a small wedge of neglect to begin a drift away from best practices and proven procedures. This discussion applies mostly to corporate aviation departments, suppliers and maintenance operations, but this drift has occurred at major airlines with sterling technical reputations; no organization is immune.

The defense of safety programs is made difficult by the fact that when they are performing well, there is an absence of accidents and incidents. A new leader may come to the conclusion that since there is no safety problem, safety is not a problem. And while a safety management system (SMS) or a flight operational quality assurance program is not costly in the big scheme of things, it is difficult from a traditional beancounter point of view to clearly identify a program's cost-benefit justification for a newcomer who lacks an appreciation of the real risks that aviation presents. Difficult, that is, until something regrettable happens, the kind of proof we are working to avoid.

A safe operation is the product of dedicated, relentless efforts. Guarding against a reduction of those efforts is one of the reasons that SMS involves the firm's CEO (*ASW,* 1/08, p. 18). The CEO's direct involvement, along with endowing the SMS with the blessing of the top corporate officer, helps to eliminate the possibility that a lower-level manager will make unilateral decisions that might degrade an effective safety culture.

A written safety policy statement from the CEO also provides protection from tampering from lower levels and can serve as a legacy document to influence future CEOs, impressing upon them the importance of maintaining the effort. It strikes me that getting some buy-in from the chairman of the board and several board members also would be beneficial in deeply embedding the safety focus into the corporate DNA of any organization.

The last line of defense against potentially risky corporate trimming is the operational people, those with the deep knowledge of aviation and its lurking threats, those with a vested interest in maintaining the culture. The fight for aviation safety generally is in ascension, but episodic retreats must be anticipated and battled.

J.A. Donoghue
Editor-in-Chief
AeroSafety World

ALAR Tools 'On the Shelf'?

The recent report (see p. 40) concerning the A340 overrun accident at Toronto Pearson Airport recommends more training "to better enable pilots to make landing decisions in deteriorating weather."

The thorough and well-balanced report also observes that if the trend in the number of recent overrun accidents with similar factors involved continues, then "the resultant risk of loss of life and damage to property and the environment will increase considerably. This is worrisome because it is a clear indication that, in spite of the efforts of all concerned, and although we are learning from these accidents or the experiences of others, we seem unable to develop adequate tools to mitigate this specific risk."

The comment above appears to belittle the value of the FSF *Approach-and-Landing Accident Reduction (ALAR) Tool Kit* and the continuing efforts of the ALAR team and their worldwide workshops, particularly so as the accident report referenced the *ALAR Tool Kit* in the analysis.

This view might identify a problem with the use of the tool kit, where its full potential has yet to be achieved in daily operations. The industry cannot afford to have such a good safety tool "sitting on the shelf" as occurred with some previous initiatives. Thus, in this respect I hope that the Foundation can restate the need for all national authorities to reference the *ALAR Tool Kit* in their training programs and, together with operators, ensure that the ALAR materials are both made available to every pilot and used in daily operations.

Dan Gurney
FSF CFIT/ALAR Action Group

AeroSafety World encourages comments from readers, and will assume that letters and e-mails are meant for publication unless otherwise stated. Correspondence is subject to editing for length and clarity.

Write to J.A. Donoghue, director of publications, Flight Safety Foundation, 601 Madison St., Suite 300, Alexandria, VA 22314-1756 USA, or e-mail <donoghue@flightsafety.org>.

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Flight Safety Foundation is an international membership organization dedicated to the continuous improvement of aviation safety. Nonprofit and independent, the Foundation was launched officially in 1947 in response to the aviation industry's need for a neutral clearinghouse to disseminate objective safety information, and for a credible and knowledgeable body that would identify threats to safety, analyze the problems and recommend practical solutions to them. Since its beginning, the Foundation has acted in the public interest to produce positive influence on aviation safety. Today, the Foundation provides leadership to more than 1,170 individuals and member organizations in 142 countries.

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Safety News

Runway Distance Markers


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The U.K. Air Accidents Investigation Branch (AAIB) has recommended a reassessment of runway distance markers for runways with "a profile that prevents the end of the paved surface from being in view continuously from the flight deck."

The AAIB said that the International Civil Aviation Organization (ICAO) should conduct a reassessment of the advantages and disadvantages that the distance markers present for runway situational awareness. If the reassessment indicates that advantages would outweigh disadvantages, ICAO should encourage installation of the distance markers at "relevant civil airports," the AAIB said.

The recommendation was one of seven that resulted from the AAIB investigation of a runway overrun that followed a brake failure on an Airbus A320 at Leeds Bradford International Airport in England. The AAIB final report on the accident said that the airplane, registered in Jordan and being operated for a Spanish charter airline, had touched down just beyond the marked touchdown zone, with low autobrake selected. The pilots began manual wheel braking soon after the main wheels touched down, but the brakes stopped operating for about 17 seconds.

"A pronounced dip in the runway surface initially prevented the pilots from seeing the runway end," the report said. The pilots used nosewheel steering to turn the airplane to the right, and it skidded to a stop with the nosewheels off the runway "shortly before the end of the paved surface and the start of a steep downslope," the report said.

The 178 people in the airplane were not seriously injured. The AAIB said that the cause of the brake failure was "consistent with the effects of excessive noise in the electrical signals from the main wheel tachometers used to sense groundspeed." Other AAIB recommendations called for the European Aviation Safety Agency to require replacement of the tachometer drive shafts and to require Airbus to "take measures aimed at ensuring that anomalies in A318/319/320/321 aircraft braking systems that may lead to loss of normal braking are clearly indicated to the flight crew."

Radar Altimeter Requirement


U.S. Air Force

All emergency medical services (EMS) helicopters used in nighttime operations should be equipped with functioning radar altimeters, the U.S. National Transportation Safety Board (NTSB) says.

The NTSB cited two recent nighttime accidents involving EMS helicopters, noting that both aircraft had "inoperative or erratically operative" radar altimeters. As a result of its investigations of those accidents, the NTSB issued two safety recommendations to the U.S. Federal Aviation Administration (FAA) to require operators to install radar altimeters and to ensure that minimum equipment lists for helicopters used in EMS specify that radar altimeters be operable during nighttime flights.

"Radar altimeters are needed to maintain ground clearance when visual references to terrain are limited during night conditions," the NTSB said. "During low-altitude flight, a functioning radar altimeter provides a pilot with constant information about the helicopter's height above ground level and has an alerter function that can visually and/or aurally alert a pilot when the helicopter approaches and then descends below a pre-selected altitude."

The two accidents cited were:

- The Jan. 10, 2005, controlled flight into terrain (CFIT) crash of a Eurocopter EC 135P2 into the Potomac River near Oxon Hill, Maryland, in nighttime visual meteorological conditions (VMC). The pilot and flight paramedic were killed, and the flight nurse received serious injuries. The NTSB said that the probable cause was the "pilot's failure to identify and arrest the helicopter's descent, which resulted in CFIT." One of the contributing factors was the lack of an operable radar altimeter.
- The April 20, 2004, CFIT crash of a Bell 206L-1 in Boonville, Indiana, during a patient transport flight in nighttime VMC. The patient was killed, and the pilot, paramedic and flight nurse received serious injuries. The NTSB said that the probable cause was "the pilot's inadequate planning/decision, which resulted in his failure to maintain terrain clearance." The NTSB said that the pilot who had flown the helicopter before the accident flight reported that the radar altimeter was "operating erratically."

Inspections Recommended

Operators of Boeing 777s should be required to conduct regular inspections of external power receptacles and their protective cover guards to detect and repair worn or overheated pins and thermal damage, the U.S. National Transportation Safety Board (NTSB) says.

The safety recommendation, as well as several accompanying recommendations, follow the investigation of a Nov. 15, 2004, fire in the electrical/electronic equipment center compartment of a British Airways 777-200ER after the airplane arrived at Boston Logan International Airport. No one was injured in the incident, which the NTSB said was caused by "a combination of electrical arcing between the lower terminal studs at the primary power receptacle and misting hydraulic fluid from a ruptured nose landing gear (NLG) hydraulic line." There was extensive thermal damage to the power receptacle, its protective cover guard, wiring and the hydraulic line.

The operator's subsequent inspection found indications of overheating on contact pins in 55 percent of the 43 777s in its fleet. Twelve percent of the receptacles contained loose contact pins that displayed indications of melting.

The NTSB said that it was concerned that "the proximity of the NLG hydraulic line to the primary and secondary power receptacles makes it susceptible to damage resulting from uncontained electrical arcing that may occur."

In August 2007, Boeing issued Service Bulletin 777-29-0032, which recommended installing fire-resistant tape around the hydraulic line in the area next to the receptacles. The NTSB said that the U. S. Federal Aviation Administration should issue an airworthiness directive to require operators to comply with the service bulletin.

The NTSB also called on the FAA to require Boeing to modify — and air carriers to install — protective cover guards for 777 primary and secondary external power receptacles to "eliminate the possibility of debris entering the receptacles and causing electrical shorting and arcing between the receptacle studs."

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Analyzing Pilot Error

Pilot error has declined as a cause of airline accidents, according to public health researchers who analyzed data from 558 airline mishaps that occurred in the United States between 1983 and 2002.

The report by researchers at the Johns Hopkins Bloomberg School of Public Health in Baltimore said that the overall rate of airline mishaps remained stable during the period studied, the proportion involving pilot error decreased by 40 percent and the rate of mishaps involving poor decision making by pilots decreased 71 percent.

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The report, published in the January issue of *Aviation, Space, and Environmental Medicine*, said that the reduction in pilot error resulted from improved training and technology that aided pilot decision making.

The decrease in mishaps resulting from pilot error was offset by increases in mishaps involving other causes, including errors by air traffic controllers or ground personnel, the report said.

Researchers found an increase — from a rate of 2.5 to 6.0 per 10 million flights — in mishaps that occurred while aircraft were motionless on the ground or during pushback.

They also found decreases of about 70 percent each in mishaps related to weather, mishaps that involved "mishandling wind or runway conditions" and mishaps related to poor crew interaction.

CFIT in Australia

© Jean-Marie Maillet/Fotolia.com

Controlled flight into terrain (CFIT) occurs rarely in Australia, but of 25 CFIT accidents between 1996 and 2005, 60 percent were fatal, the Australian Transport Safety Bureau (ATSB) says.

The ATSB report said that only one of the 25 CFIT accidents and two CFIT incidents involved regular public transport operations — the May 7, 2005, crash of a Transair Fairchild Metro 23 near Lockhart River in Queensland (*ASW*, 6/07, p. 28). Both pilots and all 13 passengers were killed in the crash; that number accounts for nearly one-third of all CFIT fatalities in Australia during the 10-year period.

Private/business flights accounted for 14 CFIT occurrences, charter operations accounted for eight, and "other aerial work general aviation" operations accounted for four, the report said.

"In line with international experience, nearly two-thirds of CFIT accidents and incidents in Australia occurred in the approach phase of flight, of which half … were during an instrument approach," the report said.

"Approach phase CFIT occurrences were further analyzed on the basis of whether the accident or incident occurred during a visual or instrument approach. Of the 17 CFIT occurrences in the approach phase, 53 percent were conducting an instrument approach. … The highest number of instrument approach CFIT occurrences involved satellite-based instrument approaches [67 percent, or six occurrences]. Of these, four occurrences involved an area navigation global navigation satellite system approach, which only came into service in Australia in the late 1990s, part way through the [period that was studied]. The implementation of approaches with vertical guidance would aid CFIT prevention on approaches previously only capable of providing lateral guidance."

Online Bird Strikes

Aircraft operators and airport employees in the United Kingdom now can file reports of bird strikes online. The U.K. Civil Aviation Authority (CAA) introduced its new online reporting system on Jan. 1, with a reporting form on the CAA Web site.

The CAA said that online reporting — now the preferred method of reporting a bird strike — will be a more efficient way of managing bird strike data. Reporting of bird strikes became mandatory in 2004.

"Prior to bird strike reporting becoming mandatory, there was a large degree of under-reporting," said Nick Yearwood of the CAA Aerodrome Standards Department. "We believe that this automated procedure will make it quicker and easier for pilots and aerodrome officials to file bird strike reports. This will ensure that we have a more accurate record of bird strike events that we can share with the industry in order to improve bird control procedures."

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In Other News …

Air China Chairman **Li Jiaxiang** has been named to replace **Yang Yuanyuan** as minister of the General Administration of Civil Aviation of China, published reports say. … The **U.S. National Transportation Safety Board** has called on manufacturers of lithium batteries and electronic devices to work with air carriers and other organizations to disseminate guidance to flight crews and aircraft passengers about the safe carriage of secondary (rechargeable) lithium batteries (*ASW*, 1/08, p. 9). … Regulatory changes in **Canada** will require implementation of safety management systems for airports and air traffic services (*ASW*, 1/08, p. 14). … The **Civil Aviation Safety Authority of Australia** (CASA) has warned maintenance personnel to check fuel filters in piston-engine aircraft for silicone grease contamination. CASA says the grease may lead to a rough-running engine.

Compiled and edited by Linda Werfelman.

FEB. 5–7 ➤ 16th Annual Safety-critical Systems Symposium. Centre for Software Reliability. Bristol, England. Joan Atkinson, <joan.atkinson@ncl.ac.uk>, <www.csr.ncl.ac.uk/calendar/csrEventView.php?targetId=377>, +44 191 222 7996.

FEB. 11–14 ➤ Annual International Cabin Safety Symposium. Southern California Safety Institute. Montreal. <www.scsi-inc.com/css%20 25/CSS%2025%20Program.html>.

FEB. 13–17 ➤ Lawyer Pilots Bar Association. Miami. <www.lpba.org>, +1 410.571.1750.

FEB. 14 ➤ Asian Business Aviation Conference and Exhibit (ABACE). National Business Aviation Association. Hong Kong. Donna Raphael, <draphael@nbaa.org>, <www.nbaa.org>, +1 202.783.9000.

FEB. 18 ➤ Air Transport World 34th Annual Award Ceremony. *Air Transport World*. Singapore. Barbara Rose, <brose@penton.com>, <www.atwonline.com/events/awards_singapore08.html>, +1 301.650.2420, ext. 107.

FEB. 19–24 ➤ Singapore Airshow. Singapore Airshow & Events. <www.singaporeairshow.com.sg>, +65 6542 8660.

FEB. 24–26 ➤ Heli-Expo 2008. Helicopter Association International. Houston. Marilyn McKinnis, <marilyn.mckinnis@rotor.com>, <www.heliexpo.com>, +1 703.683.4646.

FEB. 25–27 ➤ OPS Forum 2008: Fly Safe, Fly Smart, Fly Green. International Air Transport Association. Madrid, Spain. <www.iata.org/events/ops08/index.htm>.

MARCH 5–7 ➤ Airport Wildlife Management Seminar. Embry-Riddle Aeronautical University. Dallas/Fort Worth International Airport. Allen R. Newman, <newmana@erau.edu>, <www.erau.edu/ec/soctapd/wildlife-management.html>, +1 866.574.9125.

MARCH 5–6 ➤ Avionics 2008 Conference: Operating in Future Airspace. ASD-Network. Amsterdam. <www.asdevents.com/event.asp?ID=107>.

MARCH 10–12 ➤ 20th annual European Aviation Safety Seminar (EASS). Flight Safety Foundation and European Regions Airline Association. Bucharest, Romania. Namratha Apparao, <apparao@flightsafety.org>, <www.flightsafety.org/seminars.html#eass>, +1 703.739.6700, ext. 101.

MARCH 11–13 ➤ ATC Global Exhibition and Conference (formerly ATC Maastricht). Civil Air Navigation Services Organisation and Eurocontrol. Amsterdam. <www.atcevents.com/atc08/show_link1.asp>, +44 (0)871 2000 315.

MARCH 13–15 ➤ ARSA 2008 Annual Repair Symposium. Aeronautical Repair Station Association. Washington, D.C. <arsa@arsa.org>, <www.arsa.org/2008Symposiuminformation>, +1 703.739.9543.

MARCH 18–20 ➤ 2nd Civil Aviation Week India–Airport and Airline 2008 Expo. Airports Authority of India, Council of EU Chambers of Commerce in India, Business Aviation Association for India, et al. New Delhi. <www.civilaviationweek. com>.

MARCH 18–20 ➤ Aviation Industry Expo. National Air Transportation Association. Dallas. Jill Ryan, <jill.ryan@cygnusexpos.com>, <aviationindustryexpo.com/as3gse/index.po>, 800.827.8009, ext. 3349.

MARCH 18–20 ➤ Search and Rescue 2008 Conference and Exhibition. The Shephard Group. Bournemouth, England. <SC@shephard.co.uk>, <www.shephard.co.uk/SAR>, +44 1628 606 979.

MARCH 28 ➤ IS-BAO Implementation Workshop. International Business Aviation Council. San Antonio, Texas, U.S. Katherine Perfetti, <kathyhp@comcast.net>, <www.ibac.org>, +1 540.785.6415.

MARCH 31–APRIL 2 ➤ 15th Annual SAFE (Europe) Symposium. SAFE (Europe). Geneva, Switzerland. <safe.distribution@virgin.net>, <www.safeeurope.co.uk>, +44 (0)7824 303 199.

APRIL 14–17 ➤ 59th Annual Avionics Maintenance Conference. ARINC. Tulsa, Oklahoma, U.S. Samuel Buckwalter, <Samuel.Buckwalter@arinc.com>, <www.aviation-ia.com/amc/upcoming/index.html>, +1 410.266.2008.

APRIL 15–17 ➤ Maintenance Management Conference. National Business Aviation Association. Daytona Beach, Florida, U.S. Dina Green, <dgreen@nbaa.org>, <web.nbaa.org/public/cs/mmc/200804/index.php>, +1 202.783.9357.

APRIL 18–22 ➤ IFALPA 2008: 63rd Conference. International Federation of Air Line Pilots' Associations. Mexico City. <ifalpa@ifalpa.org>, <www.ifalpa.org/conference/index.htm>, +44 1932 571711.

APRIL 22–24 ➤ World Aviation Training Conference and Tradeshow. Halldale. Orlando, Florida, U.S. Chris Lehman, <chris@halldale.com>, <www.halldale.com/wats>.

APRIL 23–26 ➤ AEA Convention and Trade Show. Aircraft Electronics Association. Washington, D.C. <info@aea.net>, <www.aea.net/Convention/FutureConventions.asp?Category=6>, +1 816.373.6565.

APRIL 29–MAY 1 ➤ 53rd annual Corporate Aviation Safety Seminar (CASS). Flight Safety Foundation and National Business Aviation Association. Palm Harbor, Florida, U.S. Namratha Apparao, <apparao@flightsafety.org>, <www.flightsafety.org/seminars.html#cass>, +1 703.739.6700, ext. 101.

MAY 5–7 ➤ Airport Fire-Rescue USA: 5th International Aircraft Rescue Fire Fighting Conference and Exhibits. *Aviation Fire Journal*. Myrtle Beach, South Carolina, U.S. <www.aviationfirejournal.com>, +1 914.962.5185.

MAY 5–8 ➤ RAA Annual Convention. Regional Airline Association. Indianapolis, Indiana, U.S. Scott Gordon, <gordon@raa.org>, <www.raa.org>, +1 202.367.1170.

MAY 11–15 79th ➤ Annual Scientific Meeting. Aerospace Medical Association. Boston. Russell Rayman, <rrayman@asma.org>, <www.asma.org/meeting/index.php>, +1 703.739.2240, ext. 103.

MAY 20–22 ➤ European Business Aviation Convention and Exhibition (EBACE). National Business Aviation Association and European Business Aviation Association. Geneva. <info-eu@ebace.aero>, <www.ebaa.org/content/dsp_page/pagec/ev_ebace>, +32-2-766-0073 (Europe), +1 202.783.9000 (United States and Canada).

MAY 30–JUNE 1 ➤ Australian and New Zealand Societies of Air Safety Investigators Conference. Adelaide, South Australia. <www.asasi.org/anzsasi.htm>.

JUNE 3–5 ➤ IATA 63rd Annual General Meeting and World Air Transport Summit. International Air Transport Association. Vancouver, British Columbia, Canada. <www.iata.org/events/agm/index.htm>, +1 514.874.0202.

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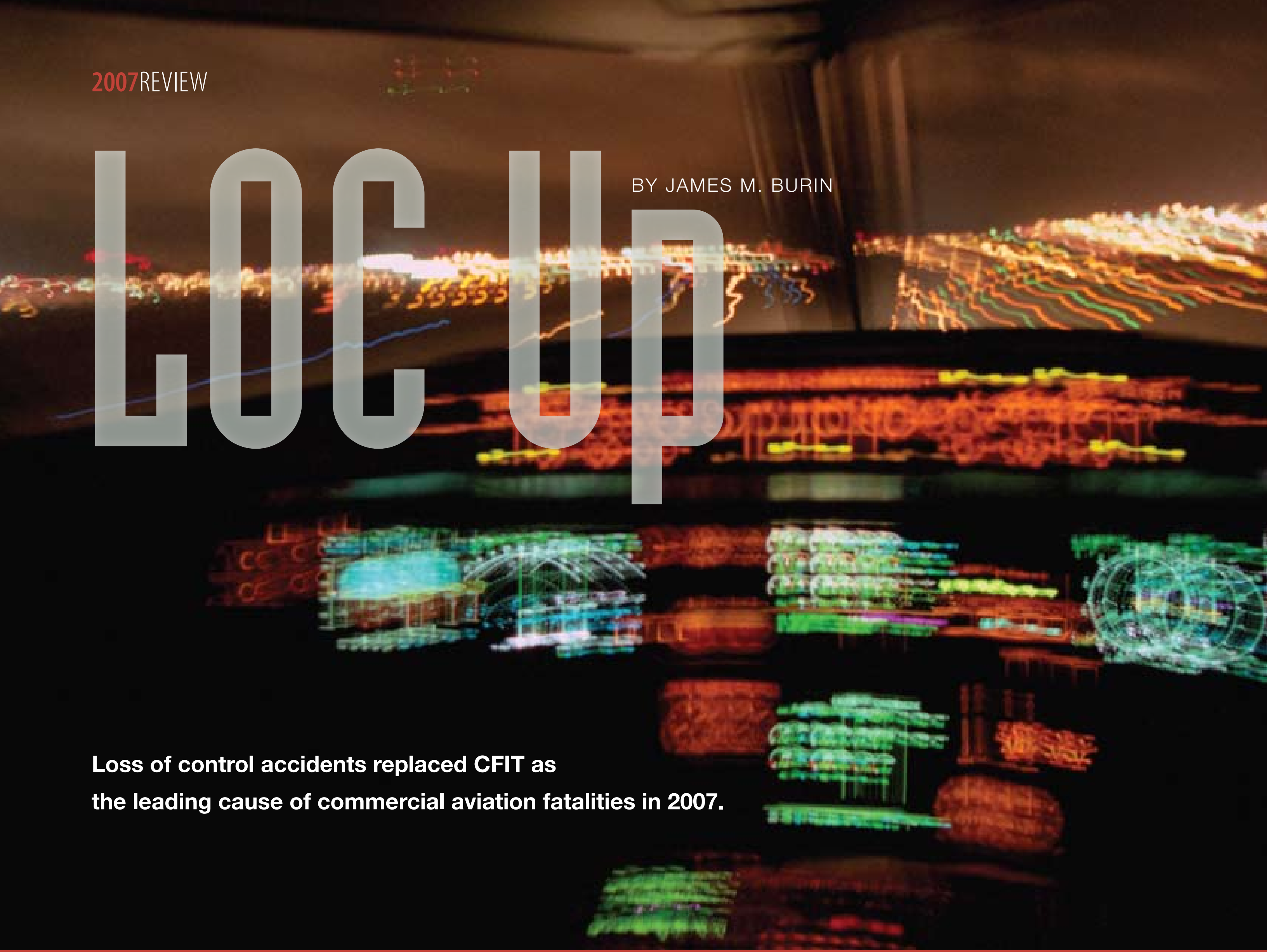
If you have a safety-related conference, seminar or meeting, we'll list it. Get the information to us early — we'll keep it on the calendar through the issue dated the month of the event. Send listings to Rick Darby at Flight Safety Foundation, 601 Madison St., Suite 300, Alexandria, VA 22314-1756 USA, or <darby@flightsafety.org>.

Be sure to include a phone number and/or an e-mail address for readers to contact you about the event.



LOC Up

BY JAMES M. BURIN

Loss of control accidents replaced CFIT as the leading cause of commercial aviation fatalities in 2007.

The overall safety of commercial jet operations worldwide remained excellent in 2007, but loss of control (LOC) accidents overtook controlled flight into terrain (CFIT) as the leading cause of fatalities. However, fatalities in accidents involving commercial jets, commercial turboprops and business aviation jets dropped to 763 from 903 in 2006.

While major commercial jet crashes increased from 11 in 2006 to 15 last year, eight accidents involved fatalities, compared with nine in 2006 (Table 1); deaths in commercial jet accidents dropped from 745 to 583. The 24 crashes of commercial turboprop aircraft in 2007 equaled the 2006 experience (Table 2); there were more fatalities in turboprop accidents, rising from 139 in 2006 to 159 last year. Business jets last year had 12 accidents that killed 21 people, compared with 10 accidents in 2006 and 19 deaths (Table 3, p. 14).

The encouraging safety picture came with a larger fleet in 2007. The total fleet of large jet transports rose 3.7 percent to 20,262, with 8 percent of that number Eastern-built. The fleet of commercial turboprops seating more than 14 passengers, 25 percent of which are Eastern-built, declined 2.1 percent to 6,350 airplanes. The number of business jets jumped 8.9 percent to 13,853. Fleets in regular commercial service are somewhat smaller; approximately 7 percent of the commercial turbojet fleet and 13 percent of the commercial turboprop fleet are inactive.

Of the 15 major accidents involving commercial jets in 2007 in all scheduled and unscheduled passenger and cargo operations, 11 were approach and landing accidents. There were two CFIT accidents and four LOC accidents.

Last year started out with only six major turboprop accidents by July. Normally, commercial turboprops average two to three times the number of commercial jet major accidents. The accident rate for the second half of the year was more typical for the turboprops.

While the major accident rate in accidents per million departures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Major Accidents, Worldwide Commercial Jets
January 1, 2007–December 31, 2007

Date	Operator	Aircraft	Location	Phase	Fatal	
Jan. 1, 2007	Adam Air	737	Sulawesi, Indonesia	Enroute	102	🟠
Jan. 13, 2007	RPX Airlines	737	Kuching, Malaysia	Landing	0	
Feb. 13, 2007	Fort Aero	CRJ-100	Vnukovo, Russia	Takeoff	0	🟠
Feb. 21, 2007	Adam Air	737	Surabaya, Indonesia	Landing	0	
March 7, 2007	Garuda Indonesia	737	Yogyakarta, Indonesia	Landing	22	
March 17, 2007	UT Air	Tu-134	Samara, Russia	Landing	6	🔵
May 5, 2007	Kenya Airways	737	Douala, Cameroon	Takeoff	114	🟠
May 20, 2007	Air Canada Jazz	CRJ-100	Toronto, Canada	Landing	0	
June 28, 2007	TAAG Angola	737	M'banza Congo, Angola	Landing	5	
July 17, 2007	TAM	A320	São Paulo, Brazil	Landing	187	
July 17, 2007	Aero República	EMB-190	Santa Marta, Colombia	Landing	0	
Aug. 20, 2007	China Airlines	737	Naha, Okinawa, Japan	Post-Taxi	0	
Sept. 16, 2007	One-Two-Go Airline	MD-82	Phuket, Thailand	Landing	90	🟠
Oct. 26, 2007	Philippine Airlines	A320	Butuan, Philippines	Landing	0	
Nov. 30, 2007	Atlasjet Airlines	MD-83	Ispara, Turkey	Approach	57	🔵

🟠 Loss-of-control accident 🔵 CFIT accident

Source: Ascend and Aviation Safety Network

Table 1

Major Accidents, Worldwide Commercial/Corporate Jets
January 1, 2007–December 31, 2007

Date	Operator	Aircraft	Location	Phase	Fatal	
Jan. 7, 2007	Ahrenkiel Consulting	Premier 1A	St. Tropez, France	Landing	0	
Jan. 9, 2007	Ameristar Jet Charter	Lear 24	Guadalajara, Mexico	Approach	2	🔵
Jan. 12, 2007	SunQuest Air Charter	Citation I	Van Nuys, CA, USA	Takeoff	2	🟠
Jan. 24, 2007	Air Trek Air Ambulance	Citation II	Butler, PA, USA	Landing	0	
May 3, 2007	Hamilton Ranches	Citation II	Dillon, MT, USA	Approach	2	🔵
June 4, 2007	Toy Air	Citation II	Milwaukee, WI, USA	Climb	6	🟠
June 30, 2007	IHR Admin Services	Citation I	Conway Field, AK, USA	Landing	1	
July 5, 2007	Jett Paquetería	Sabreliner	Culiacán, Mexico	Takeoff	3	
Oct. 7, 2007	Private	Gulfstream II	Santo Domingo, Venezuela	Landing	2	🔵
Nov. 4, 2007	Reali Táxi Aéreo	Lear 35	São Paulo, Brazil	Takeoff	2	
Nov. 11, 2007	Jetport Inc.	Global 5000	Fox Harbor, Canada	Landing	0	
Dec. 26, 2007	Jet Connection Business	CL-604	Almaty, Kazakhstan	Takeoff	1	

🟠 Loss-of-control accident 🔵 CFIT accident

Source: Ascend and Aviation Safety Network

Table 2

Major Accidents, Worldwide Commercial Turboprops (> 14 Seats)
January 1, 2007–December 31, 2007

Date	Operator	Aircraft	Location	Phase	Fatal	
Jan 9, 2007	Aeriantur-M Airlines	AN-26	Adana, Turkey	Approach	32	
March 30, 2007	Airlink	EMB-110	New Britain, PNG	Descent	2	
May 17, 2007	Safe Air Company	LET-410	Walikale, DRC	Climb	3	🟠
June 21, 2007	Karibu Airways	LET-410	Kamina, DRC	Climb	10	
June 25, 2007	PMT Air	AN-24	Sihanoukville, Cambodia	Approach	22	🔵
June 26, 2007	Business Aviation	LET-410	Brazzaville, Congo	Enroute	0	
July 1, 2007	Jet Airways	ATR-72	Indore, India	Landing	0	
July 8, 2007	Laird Air	DHC-6	Muncho Lake, Canada	Climb	1	
July 23, 2007	Djibouti Airways	AN-26	Dire Dawa, Ethiopia	Takeoff	1	
July 29, 2007	ATRAN Cargo Airlines	AN-12	Moscow, Russia	Climb	7	
Aug. 9, 2007	Air Moorea	DHC-6	Moorea-Temae, Polynesia	Climb	20	
Aug. 12, 2007	Jeju Air	DHC-8	Busan, Korea	Landing	0	
Aug. 21, 2007	SELVA Colombia	AN-26	Pasto, Colombia	Landing	0	
Aug. 22, 2007	Two Táxi Aéreo	EMB-110	Curitiba, Brazil	Enroute	2	
Aug. 26, 2007	Great Lake Business	AN-32	Kogolo, DRC	Approach	10	
Aug. 27, 2007	SELVA Colombia	AN-32	Mitu, Colombia	Ground	0	
Aug. 31, 2007	Solenta Aviation	DHC-6	Punia, DRC	Enroute	0	
Sept. 7, 2007	Transavia Service	AN-12	Goma, DRC	Landing	8	
Sept. 20, 207	Arctic Circle Air Svc	Skyvan	Mystic Lake, Alaska, USA	Climb	1	
Sept. 24, 2007	Free Airlines	LET-410	Malemba Nkulu, DRC	Landing	1	
Oct. 4, 2007	Africa One	AN -26	Kinshasa, DRC	Climb	21	
Oct. 8, 2007	Nacional de Aviación	LET-410	Cubarral, Colombia	Enroute	18	
Oct. 17, 2007	Imtrec Aviation	AN-12	Phnom Penh, Cambodia	Landing	0	
Nov. 8, 2007	Juba Air Cargo	AN-12	Khartoum, Sudan	Landing	0	

🟠 Loss-of-control accident 🔵 CFIT accident

Source: Ascend

Table 3

increased for the year, the five-year rolling average rate continues to show an encouraging slow decline (Figure 1). The major accident numbers are for both Western- and Eastern-built commercial jets, but the rate is for Western-built aircraft only because there are no reliable worldwide exposure data on Eastern-built aircraft with which to calculate rates.

The accident rate data highlight the considerable improvement made in aviation safety. If 2007 had the same rate as 1996, there would have been more than double the number of accidents during the year.

CFIT, LOC and approach and landing accidents continue to claim the majority of the aircraft and account for the majority of the commercial aircraft fatalities, with only two commercial jet CFIT accidents in 2007. The chart highlights how difficult it is to eliminate CFIT accidents, except for one fact: No aircraft equipped with a functioning terrain awareness and warning system (TAWS) has ever had a CFIT accident. Only 5 percent of the commercial jets in the world do not have TAWS, yet all of the eight CFIT accidents over the last three years came from that small fraction of the fleet.

In addition to the commercial jet approach and landing accident record, business jets were involved in seven approach and landing accidents among the year's 12 accidents, and 50 percent of the turboprop major accidents occurred during approach and landing.

Clearly, the industry must continue to focus on this critical phase of flight (Figure 2, p. 16). Most, if not all, of the causes of these accidents are well documented; interventions that would have prevented them are addressed in the Flight Safety Foundation *ALAR Tool Kit*.

LOC accidents have taken over from CFIT as the leading killer in commercial jet operations. The term "loss of control" is somewhat misleading, since the flight crew often has total control of the aircraft in this type of accident. The Foundation's definition of an LOC accident is: "an accident in which an aircraft is put into an unrecoverable position due to aircrew, aircraft or environmental factors, or a combination of these." Thus, the American Airlines Airbus A300 accident in 2001 was an LOC accident, the crew having no control after the loss of the vertical tail after takeoff from New York. Likewise, the 2004 Flash Airlines Boeing 737 accident in Egypt was an LOC accident, even though the crew had full control of the aircraft.

Runway Safety Initiative

The aviation industry today faces a major challenge in improving runway safety. Accidents on or near runways normally are high-visibility accidents since they happen at an airport, where there are a lot of people. As the numbers of other types of accidents decline, the relative importance of runway accidents has increased. When several international aviation organizations early last year asked the Foundation to coordinate a joint international effort to understand and address this challenge, the Runway Safety Initiative (RSI) was launched.

The RSI is using this definition of a runway safety issue: "Any safety issue that deals with the runway environment, or any surface being utilized as a runway, and the areas immediately adjacent to it, such as overruns or high-speed taxiways."

Runway safety issues fall into three broad categories: runway incursions (RI), runway excursions (RE) and the inappropriate use of runways — runway confusion (RC). International Civil Aviation Organization has published the following definition of a runway incursion: "Any occurrence at an aerodrome involving the incorrect presence of an aircraft, vehicle or person on the protected area of a surface designated for the landing and takeoff of aircraft." This new definition, recently adopted by the U.S. Federal Aviation Administration, brings most runway confusion incidents into the runway incursion category.

A runway incursion was the cause of the largest single aviation disaster ever, the 1977 collision of two Boeing 747s at Tenerife, Canary Islands. The worst runway incursion accident in the U.S. was at Los Angeles International Airport in 1991, resulting in 34 fatalities. The worst runway incursion accident in Europe occurred in 2001 at Linate airport, Milan, Italy, and resulted in 118 fatalities.

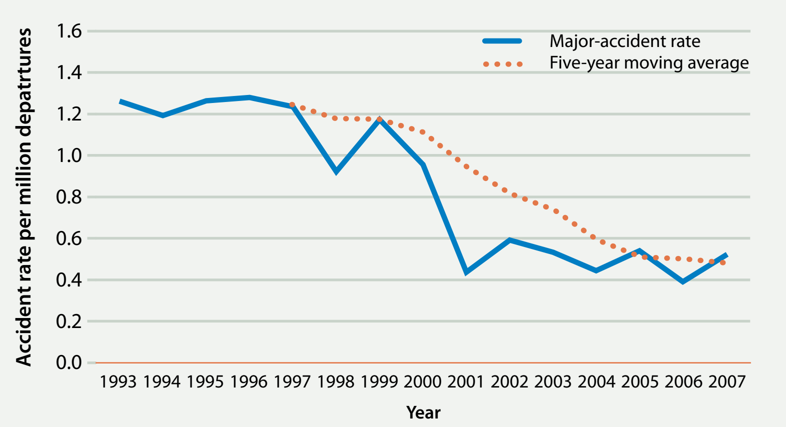
Runway incursions are part of a new breed of safety challenges in which there are not a lot of accidents — 10 in the last 14 years — but there are many incidents. Since basic risk management says risk equals probability times severity — and the severity potential of a runway incursion is high — the risk is

Accident Classification

Last year, Flight Safety Foundation changed from using "hull loss" as the primary accident criterion to a new standard, "major accident." A major accident is defined as an accident in which any of three conditions is met. The first condition is that the aircraft is destroyed or sustains major damage. Major damage is defined by the Ascend Damage Index (ADI), a measure developed by Paul Hayes of Ascend. The ADI is the ratio of the cost of repairs to the projected value of the aircraft had it been brand new at the time of the accident. If the ADI is over 50 percent, the damage is considered major. The second condition defining of a major accident is that there are multiple fatalities. The third condition is that there is one fatality and the aircraft is substantially damaged. The major accident classification criteria ensure that an accident is not determined by an aircraft's age or by its insurance coverage, and it gives a more accurate reflection of the high-risk areas that need to be addressed.

— JB

Western-Built Commercial Jet Major-Accident Rates, 1993–2007

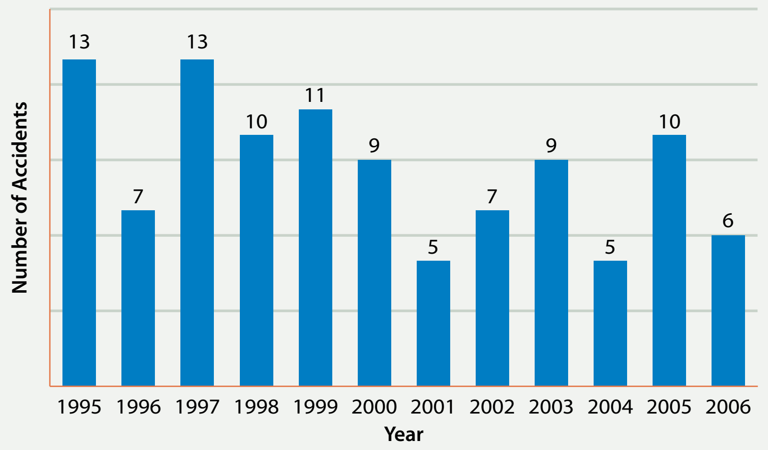


Note: Worldwide departures are estimated through Dec. 31, 2007. Total departure data are not available for Eastern-built aircraft.

Source: Ascend

Figure 1

Approach-and-Landing Major Accidents, Commercial Jets, 1995–2006



Source: Boeing, Ascend

Figure 2

high. Thus, runway incursions get a lot of attention despite the low number of accidents.

However, runway excursions, including overruns — going off the end of a runway — and veer-offs — going off the side of the runway — must not be overlooked. Many runway excursions incur minimal damage and do not cause deaths or injuries, yet in most years there are more fatalities associated with excursions than incursions. A runway excursion accident is unlike a CFIT accident, which, by definition, is "without prior knowledge of the crew." A runway excursion is normally not a total surprise to the crew.

Runway safety is influenced by many aviation industry elements. The stakeholders in this issue include almost everyone involved in aviation — manufacturers, aircraft operators, airports, air traffic control (ATC) and regulators.

Manufacturers do a great job of providing the operators with safe, reliable aircraft. They also provide operators with the data and procedures that crews need for normal and many non-normal operations. They currently are not required to provide data and procedures easily used by pilots for landing in all runway conditions. Without good data on how the aircraft will perform under certain runway conditions, landings become a series of physics experiments.

Operators must use available manufacturer information and provide crews with good standard operating procedures, to include stabilized approach criteria and a true "no fault" go-around policy. They must also provide crews with the training that will enable them to address runway safety challenges during line operations. The crews must practice good decision making, and they must have the information available to make good decisions. Although the flight crew may be the final link in the chain of runway safety, finding that the crew made an error should be the beginning of an investigation, not the end. The investigation needs to determine what role the airport, ATC, the regulator and even management played in the accident or incident.

Airports have a vital role in runway safety. Issues like airport design, lighting, approach aids, runway design, runway markings and signage, runway cleaning and clearing, runway condition measurement, and runway end safety areas are only part of a long list of items that an airport controls that can reduce the risk of a runway safety event.

ATC also plays a big role. As any pilot knows, ATC can destabilize any approach. Late runway changes and "slam dunk" approaches are just two examples of how ATC can destabilize an approach, and a stabilized approach is critical in reducing the risk of runway excursions.

Finally, the regulator plays a vital role in runway safety. It oversees all the stakeholders. It can also provide approaches with vertical guidance, critical to a stabilized approach.

The first product of the RSI is a Runway Safety Products Catalog (Table 4). This lists the material available to address certain aspects of runway safety. The RSI team has also provided data on runway safety issues. In compiling runway safety data (Table 5), runway excursions predominate in the number of both accidents and fatalities.

The RSI team has concluded that as an industry we are being effective in preventing runway incursion accidents, but the number of incidents and potential severity still present a very high risk. Runway excursions are the most common type of runway accident, and the most

Runway Safety Products Catalog

Product Title	Originator	Type Product	Target Audience
Runway incursion			
1. ICAO Runway Safety Toolkit	ICAO	CD and web	Aircrew, airports, ATM, management
2. Runway and Surface Safety	FAA	CD and web	Flight instructors, pilot examiners
3. Taxi 101	FAA	CD and web	Maintenance personnel
4. Runway Incursion Prevention	FAA, ACI, IATA, PAAST	CD and web	Aircrew, airports, ATM program
5. European Action Plan for the Prevention of Runway Incursions	Eurocontrol et al	CD and web	Aircrews, airports, ATM vehicle drivers
6. Runway Incursion Joint Safety Analysis and Implementation Team Reports	FAA (CAST)	CD	Aircrews, airports, ATM
7. FAA Runway Safety Website	FAA	Web site	Aircrews, ATM, vehicle drivers
8. Enhanced Taxiway Centerline	FAA	CD and web	Aircrews, ATM, airports
9. AOPA Runway Safety Course	FAA, AOPA	Web site	General aviation pilots
10. ALPA Runway Safety Course	FAA, ALPA	Web site	Aircrews
11. ACI Airside Safety Handbook	ACI	Handbook	Airports
12. Sporty's Pilot Guide to Runway Safety	Sporty's	CD	General aviation pilots
Runway excursion			
1. ALAR Tool Kit	Flight Safety Foundation	CD	Aircrews, ATM, airports
2. Managing Threats and Errors During Approach and Landing: How to Avoid a Runway Overrun	Flight Safety Foundation	Web	Aircrews
3. Takeoff Safety Training Aid	FAA	CD and web	Aircrews
Runway confusion			
Many runway incursion products may be applicable here.			

Note: These groups are participating in the RSI: European Aviation Safety Agency, Civil Air Navigation Services Organisation, International Federation of Air Line Pilots Associations, U.S. Federal Aviation Administration, Air Traffic Control The Netherlands (LVNL), Boeing, Airbus, Embraer, Direction Générale de l'Aviation Civile - France, International Federation of Air Traffic Controllers' Associations, National Aerospace Laboratory (NLR) - Netherlands, Airports Council International, International Air Transport Association, European Regions Airline Association, Eurocontrol, Association of Asia Pacific Airlines, U.S. National Transportation Safety Board, and Association of European Airlines.

Source: FSF Runway Safety Initiative

Table 4

common type of fatal runway safety accident. The severity of a runway excursion depends on the energy of the aircraft when departing the runway environment and on the airport layout. A major risk reduction factor is flying a stabilized approach and landing in the touchdown zone. Not every unstabilized approach ends up as an excursion — but almost every excursion starts with an unstable approach.

In preventing runway confusion, many of the interventions developed for runway incursions, such as moving maps, signage, etc., will be beneficial.

The Foundation continues to strive to make aviation safer by reducing the risk of an accident. We have had great success advancing toward that goal, but challenges remain. In an industry where the risk will never be zero, we face a constant challenge in meeting the public's expectation of perfection as the minimum acceptable standard.●

James M. Burin is FSF director of technical programs.

Runway Safety Fatality Data, 1995–2007

	Number of Fatal Accidents	Onboard Fatalities
Incursions	5	129
Excursions	31	680
Confusion	2	132
Total	**464**	**941**

Note: The total number of accidents was 1,332.

Source: FSF Runway Safety Initiative

Table 5

Culture Counts

Measuring an organization's safety culture provides an understanding of its strengths and weaknesses.

BY ANTHONY CIAVARELLI

The importance of establishing and maintaining a positive safety culture and climate in any aviation organization is now beyond debate. But little attention has been paid to measuring an organization's safety environment, an omission that is important because, as business schools preach, you can't manage what you can't measure.

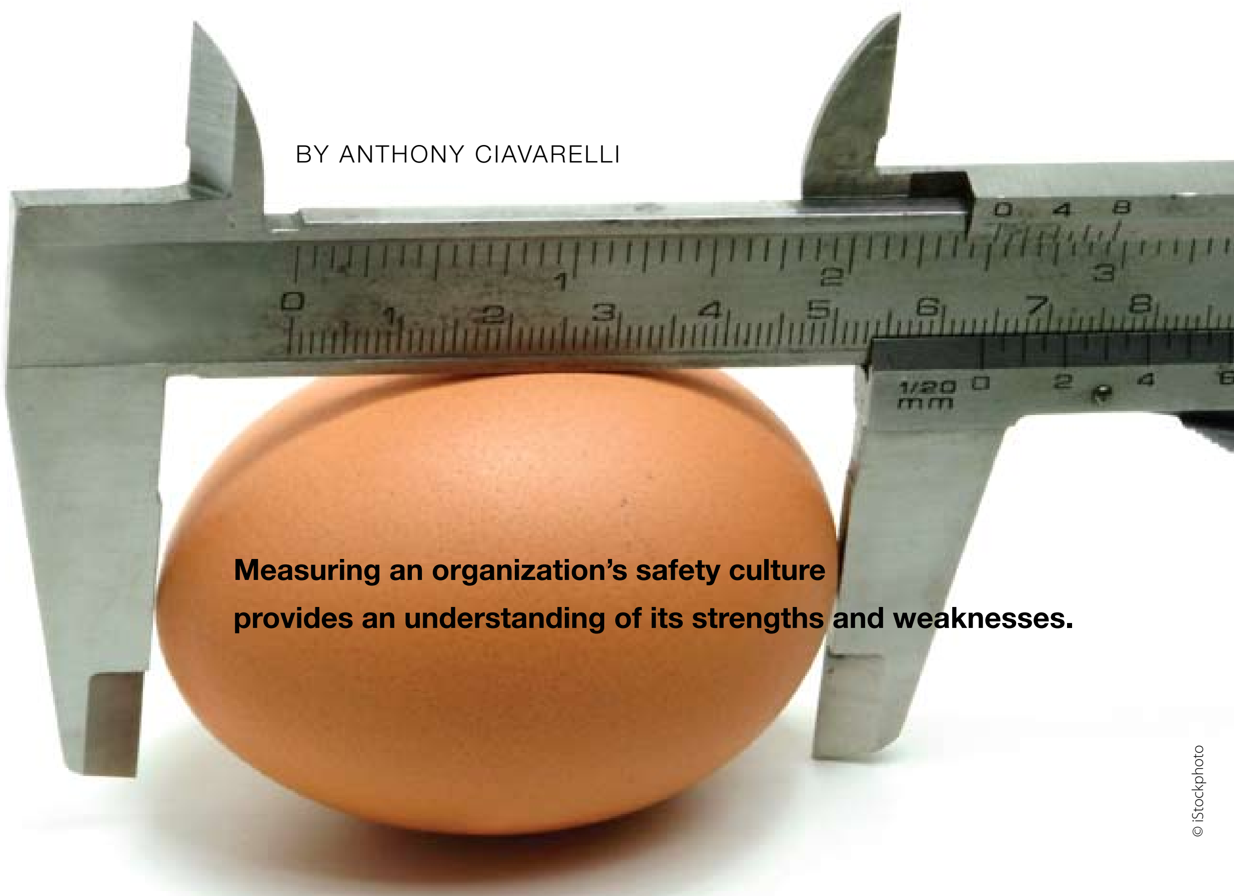
However, an assessment tool developed originally for U.S. Navy aviation units now can provide the foundation for a process of measuring and tracking an organization's safety culture.

Awareness of the existence of safety culture in aviation, and its importance, evolved over recent years through the examination of high-profile catastrophes. The first major airline accident attributed in part to organizational factors was the January 1982 Air Florida Boeing 737 crash in Washington.

The flawed decision chain that led to the accident was a consequence of the company's failure to give the flight crew adequate training, the U.S. National Transportation Safety Board (NTSB) found. This training gap led to pilot judgment error, inappropriate procedures and a breakdown in flight crew communication. This accident was among several that led airlines to develop crew resource management training.

Similarly, the chain of errors that led to the May 1996 ValuJet Airlines McDonnell Douglas MD-80 crash in Florida is one of several examples of an "organizational accident," an accident deeply rooted in a company's lack of leader commitment and support for safety.

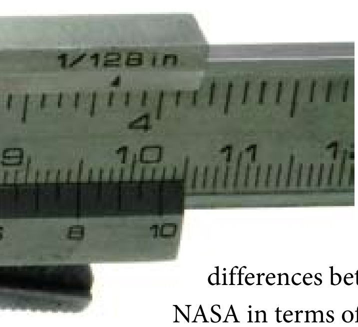
The term "safety culture" first appeared in the accident investigation report published by the International Atomic Energy Agency's (AEA) Nuclear Advisory Group following the April 1986 meltdown and steam explosion of the nuclear power plant near Chernobyl, Ukraine. The AEA concluded that the nuclear reactor was poorly designed and the people operating the plant were not properly trained or supervised. The accident, said the World Nuclear Association, was a direct consequence of Cold War isolation and the resulting lack of a safety culture.



Among the first to bring the term "culture" to the aviation community was John Lauber when he was an NTSB member. Recognizing the influence of organizational factors as the root cause of some aviation accidents, he said of the September 1991 Britt Airways Brasilia accident in Texas, "a probable cause … was the failure of this airline's senior management to establish a corporate culture that encouraged and enforced adherence to approved maintenance and quality assurance procedures."

More recently, the Columbia space shuttle accident investigation linked safety culture with the closely related concept of the "high-reliability organization" (HRO). The Columbia Accident Investigation Board (CAIB) concluded that the shuttle's breakup upon re-entry in February 2003 had as much to do with the organizational culture and structure of the U.S. National Aeronautics and Space Administration (NASA) as it did with the foam chunks that detached from the fuel tank and damaged the shuttle's heat shield during the launch.

The CAIB determined that HRO concepts would be extremely useful in describing the culture that should exist at NASA. The CAIB discussed differences between the Navy and NASA in terms of safety culture and operation as an HRO, and concluded that NASA could substantially benefit by following the Navy's example of best practices.



The most egregious aspect of the organizational accident probably is the failure of management to recognize the signs of an impending disaster. For example, ValuJet's maintenance even before the Florida accident was under scrutiny by the U.S. Federal Aviation Administration. And the Columbia accident was believed to have involved a continuation of the poor safety culture that had been revealed after the 1986 Challenger accident. In both cases, NASA employees in the working ranks had warned their supervisors about the risk of losing a shuttle crew because of known system design flaws.

Safety Culture and Aviation

In spite of the professional's use of the term and many popular notions about it, there is no widely accepted definition of "safety culture." Because there is no common metric for measuring the strength of a particular safety culture, there is no clear method by which an organization can assess its safety culture or diagnose its particular strengths and weaknesses. This results in some frustration on the part of the executives who must manage organizations that necessarily operate in hazardous environments.

The Navy responded to the challenge of measuring and managing safety culture in 1996, when its aviation squadrons experienced a rash of accidents attributed to human factors. One accident, in particular, captured the Navy's attention. An F-14 crashed on takeoff from an airport in Tennessee, killing both crewmembers and several civilians on the ground. Investigators pointed to the failure of commanders to manage the pilot, who was known to take unnecessary risks.

The accident occurred during a cross-country flight, which included a visit to the pilot's home town. With his relatives watching, the pilot attempted a dangerously high-angle takeoff, flew into low clouds, became spatially disoriented and crashed into a residential complex.

Following the F-14 accident, I served as a member of a blue-ribbon panel formed to study the underlying causes of naval aviation aircraft accidents. The panel recognized that, in the Tennessee accident and others like it, investigation boards would find known circumstances that produce risks that were not appropriately managed by the commanders.

The panel's review concluded that accidents of this type are very similar to civilian accidents like ValuJet, Chernobyl, Challenger and Columbia. This finding led to the development of the initial survey instrument designed to assess safety climate, safety culture and related organizational factors.

I also was part of a group from the U.S. Naval Postgraduate School that explored innovative methods for assessing organizational factors, including safety climate and safety culture. We worked with Professor Karlene Roberts of the University of California at Berkeley to construct an employee survey based on her theory of an HRO.

Roberts and her colleagues believe that some organizations operate more reliably than others because they place a higher value on safety and a greater focus on avoiding failure. Roberts conducted field studies on Navy aircraft carriers, at air traffic control facilities and at nuclear power plants, organizations that have learned from experience how to manage their risks. Some characteristics that typify HROs are:

- Accurate perception of hazards and operational risks;
- Commitment and involvement of all management levels in safety;
- Open reporting of unsafe conditions or risk situations;
- Good communication up and down the command chain;

- Continuous training, with high performance standards; and,
- A culture of trust between workers and their supervisors.

The safety climate survey developed on principles of HRO theory is called the Command Safety Assessment Survey (CSA). A Web-based version of the CSA is in regular use by all U.S. Navy and Marine Corps aviation units. Respondents voluntarily and anonymously provide opinions about their organization's safety climate. The similar Maintenance Climate Assessment Survey (MCAS) was developed later for aircraft maintenance personnel. To see an example of the CSA, go to <https://www.hfa-clients.com/flightsafety/login.html>.

Safety Climate and Culture

Later versions of the CSA incorporate various aspects of safety culture and safety climate derived from the work of European social scientists. These researchers greatly improved our understanding of the differences between safety culture and safety climate.

Culture is considered to be the force behind an organization's goals — it drives the means to attain goals and spells out how to achieve success. An organization's cultural values also guide decisions and processes for correcting deviations from norms and expectations.

Safety culture is defined as the shared values, beliefs, assumptions and norms that govern decision making and that may affect individual and group attitudes about danger, safety and the proper conduct of hazardous operations.

Safety climate, an important indicator of the underlying safety culture, refers to the perception of the people in an organization that their leaders are committed to safety, have taken appropriate measures to communicate safety principles and ensure adherence to safety standards and procedures.

The CSA and MCAS surveys, and later applications in civilian aviation, aerospace and health care, are designed to address key aspects of safety climate. Results from the surveys sometimes can be used in the estimation of accident risk based on the extent to which the organization exhibits HRO attributes of leadership commitment to safety, adequacy of policies, adherence to standards and other factors.

The safety climate surveys have been well received in naval aviation and serve as an important source of performance feedback that commanders use to improve the safety of squadron operations.

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Since its inception in 1997, the CSA has been administered to all Navy and Marine Corps squadrons. There are more than 80,000 survey responses in the Navy's CSA database.

This success led to the development of equivalent online survey systems that are being used worldwide in civilian aviation, aerospace and health care industries.

Over the years, safety climate and culture surveys have matured to provide organizations with reliable and valid measures that produce useful findings. An example (Figure 1) shows the results of the CSA item ratings taken from more than 10,000 respondents, with a comparison across military ranks. The chart shows that much higher ratings are given by senior commissioned officers (lieutenant commanders, commanders and captains) compared with lower-ranking officers (ensigns, lieutenants junior grade and lieutenants). This relationship also holds for the noncommissioned officers (NCOs) — higher ranking NCOs (petty officers) gave higher ratings than the lower ranks.

Ratings by an organization's senior management also have been consistently higher in the civilian aviation, aerospace and health care industries. This suggests that supervisors might not be fully aware of the thoughts and feelings of their subordinates when it comes to the organization's safety climate and the strength of its safety culture.

'Statistical Goodness'

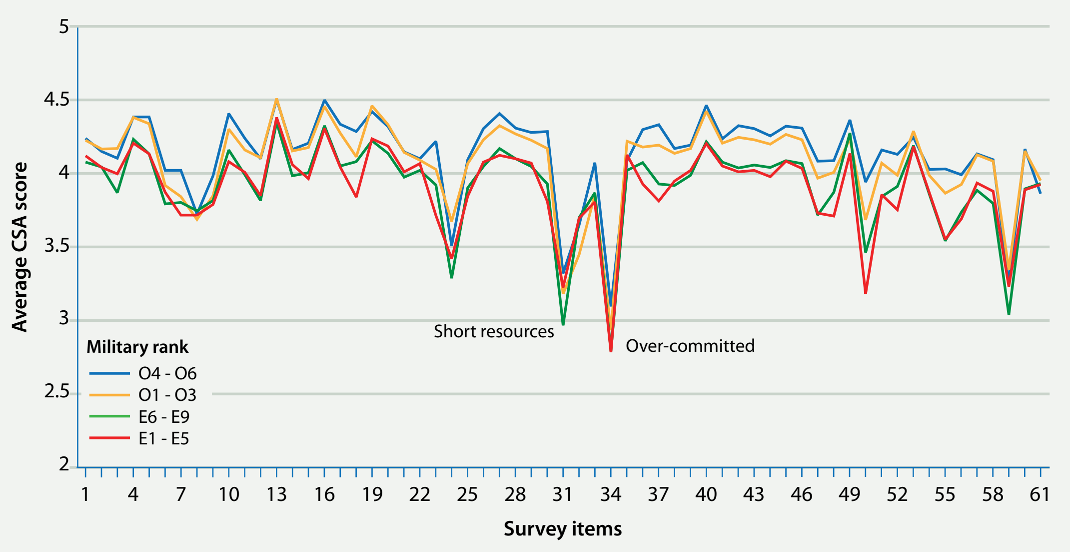
Professional survey developers place a high value on surveys in terms of "statistical goodness." Two of the important aspects of statistical goodness are the survey's reliability and validity.

Basically, when a survey is reliable, the results are relatively error free and consistent — if the survey is administered twice to the same people at the same time, the ratings would be identical.

Unless the survey can be shown to be reliable by using a variety of statistical methods, there is no point in attempting to show that the survey is valid for its purpose. If the ratings are random and unreliable, then the findings cannot be trusted. The statistical reliability of both Navy and civilian surveys was found to be very high.

The term "validity" refers to measuring what we set out to measure — in this case, safety climate and safety culture. The survey instrument must be carefully constructed to reflect the key attributes of climate and culture. This kind of validity is called "content validity" and focuses on the inclusion of

Differences in Average Ratings Across Military Ranks for Survey Items 1-61



CSA = command safety assessment

Source: Anthony Ciavarelli

Figure 1

survey items that reflect some of the underlying organizational dimensions like climate, culture or HRO attributes.

The following are examples of survey statements, selected for adherence to content validity:

- My organization has a realistic view of our operational risks.
- The leadership in this organization is very committed to safe operations.
- All levels of management are actively involved in keeping us safe.
- I am not reluctant to report an unsafe condition or a high-risk incident.
- Deliberate violations of rules or standards are very rare in my organization.
- Sometimes the goal of diagnostic analysis is achieved by organizing survey items into specific measurement areas that reflect different components of climate, culture or HRO attributes. For the CSA, the categories were adapted from studies by UC Berkeley researchers Roberts and Carolyn Libuser.

Five categories, representing different key components of an HRO, are:

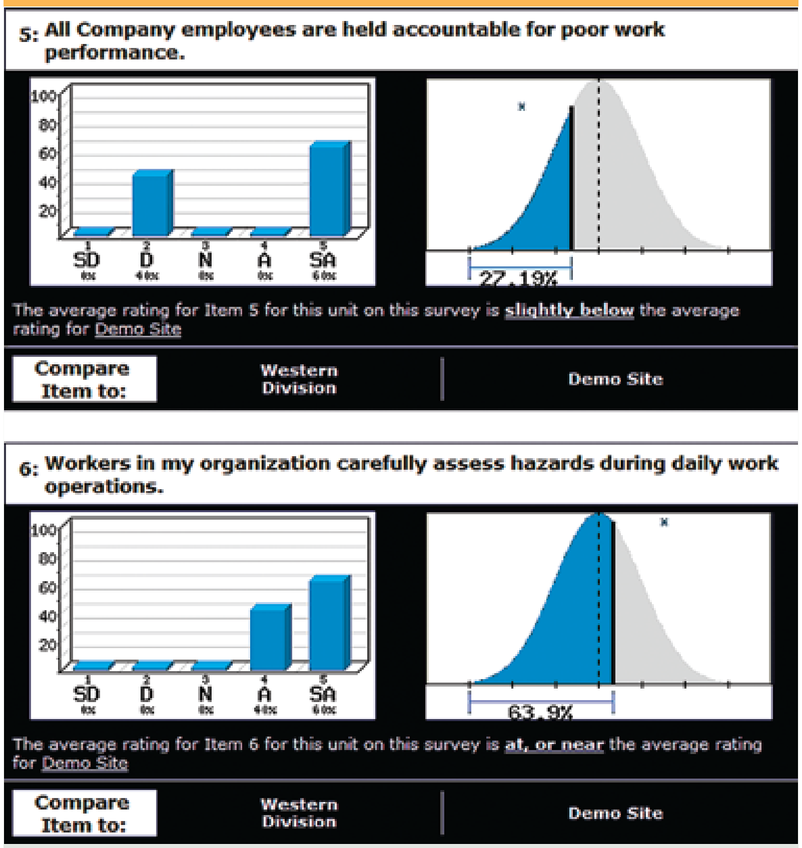
- Safety process auditing — a system of checks and reviews to monitor and improve processes;
- Safety culture and reward system — social recognition that reinforces desired behavior or corrects undesired behavior;
- Quality assurance (QA) — policies and procedures that promote high-quality performance and work performance
- Risk management (RSK MNGT) — whether or not the leaders correctly perceive operational risks and take corrective action; and,
- Leadership and supervision (LDSHP) — policies, procedures and communication processes used to improve people's skills and to proactively manage work activities and operational risk.

Using Survey Data

When completed, a survey's results can be reviewed as an overall outcome, with an average

Supervisors might not be fully aware of the thoughts and feelings of their subordinates when it comes to the organization's safety climate …

Supervisor's Display Showing Survey Item Results



Source: Anthony Ciavarelli

Figure 2

Normative information can be presented on a supervisor's display (Figure 2). The survey feedback display shows a typical bar chart with agreement percentages along a five-point Likert scale.[1] This display also shows a bell curve indicating the placement of a specific organization's average rating on the bell curve. This placement allows a particular organization — a single department within a company — to compare its average to an overall company average or norm.

Validation Process

Once a reasonable sample of survey data is obtained, another aspect of statistical goodness — predictive validity — can be addressed.

We would expect organizations with a good safety climate and strong safety culture to have a better safety record than those organizations that do not — and this is exactly what we have found in examining the safety climate ratings from surveys taken over the past few years in naval aviation.

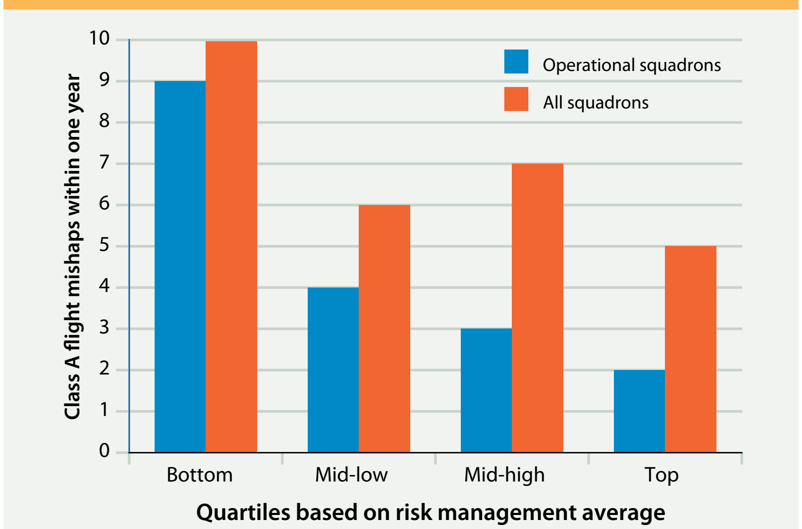
Looking at the relationship between safety climate ratings and safety performance defined in terms of accident frequency we found a much higher number of accidents for low safety climate ratings (Figure 3).

rating across all survey items, or the results can be broken down and compared for each individual HRO component.

The normal distribution curve, or "bell curve" can compare survey results to a specific average or central value in the normal distribution. Using this device, and some statistical computation, an organization can compare its results to an overall average or norm. The norm can be based on a particular company's average rating or on the average for a particular industry.

With this "normative" approach, it would be possible to establish norms for the entire airline industry or another sector of the aviation industry — for example, air traffic control — or beyond aviation to include industry sectors such as aerospace, health care and oil and gas extraction.

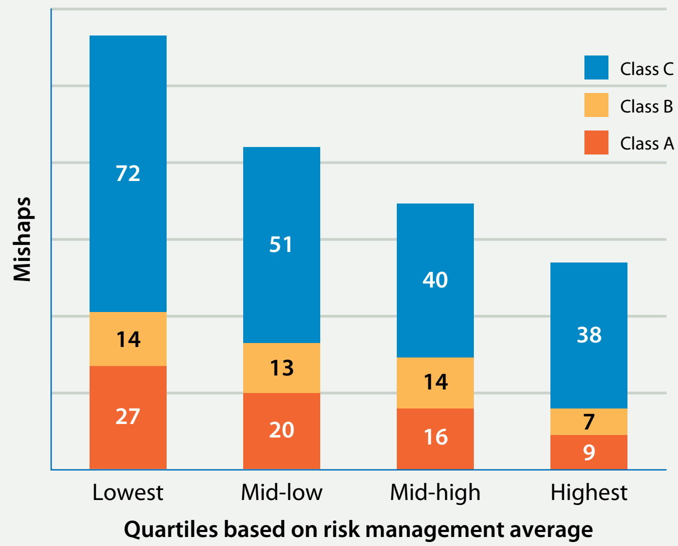
Navy Squadrons' Flight Mishaps by Risk Management Score



Source: Anthony Ciavarelli

Figure 3

Mishap Severity by Risk Management Score

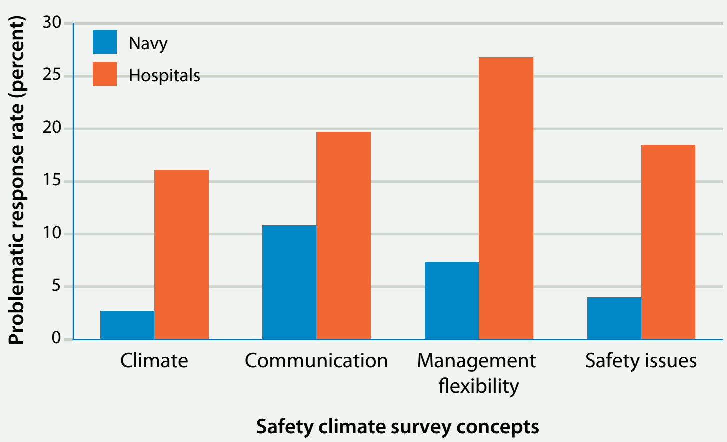


Note: A, B and C are levels of accident severity, "A" being the most severe.

Source: Anthony Ciavarelli

Figure 4

Safety Climate Survey Comparison



Notes:

Source: Anthony Ciavarelli

Figure 5

Accident frequency compared to the CSA risk management subscale also shows a clear relationship between safety climate and safety, with fewer accidents for units scoring higher on safety climate ratings (Figure 4). The units in the lowest quartile of the MCAS had nearly twice the number of accidents (94 versus 49) in the 24-month time frame.

In another application of HRO-based safety climate measurement, we compared ratings obtained from the Navy's CSA to ratings obtained from similar surveys of hospital personnel.

Figure 5 shows an example of the results obtained when 23 common Likert scale survey items used in Navy and hospital studies were compared in terms of the number of "problematic responses," that is, responses that should have been favorable but were not, indicating a fair-to-poor safety climate. The overall problematic response rate was about 6 percent for naval aviation versus 18 percent for hospitals.

A conclusion from the comparison of the Navy and hospital survey responses was that the perception of naval personnel was far more positive because the Navy has had a longer history of focusing on potential failures and has formulated specific processes over the past 60 years or so to ensure that its leadership is active in preventing accidents.

Industries such as aviation, aerospace and health care, as well as the Navy, now recognize the influence of such organizational factors as safety climate and culture on their safety performance. Measuring the state of safety climate and culture, as perceived by employees closest to the daily routines and risk issues, is important to allow managers to keep abreast of hazards and risks inherent in their organization. Survey results provide an organization with the opportunity to identify otherwise unknown risks and to intervene in time to prevent accidents. ●

Anthony Ciavarelli, Ed.D., is a professor at the U.S. Naval Postgraduate School, where he teaches and conducts research in human factors. Ciavarelli founded Human Factors Associates to expand his work to the civilian sector.

Note

1. The Likert scale, developed by psychologist and social scientist Rensis Likert, often is used in surveys. With a five-point scale, respondents are asked whether they strongly disagree, disagree, neither agree nor disagree, agree or strongly agree with survey statements.

Antidepressants in Aviation

Australian researchers found that pilots who took prescribed antidepressants were no more likely than others to be involved in accidents and incidents.

BY LINDA WERFELMAN

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Use of antidepressant medications by pilots and air traffic controllers does not increase the risk of aviation accidents or incidents, according to a study of 10 years of aviation safety data from Australia, where aeromedical authorities have allowed the supervised use of antidepressants since 1987.

The study, published in *Aviation, Space, and Environmental Medicine*, the journal of the Aerospace Medical Association (AsMA), reviewed the cases of 962 pilots and controllers, half of whom were treated with prescribed antidepressants and half of whom were not. There was no statistical difference between the number of accidents and incidents involving members of the two groups.[1]

"This study found no evidence of adverse safety outcomes arising from permitting individuals to operate as commercial or private air crew or air traffic controllers while using antidepressants, provided specific criteria are met and maintained," the report on the study said.

The criteria include having the pilot or controller interrupt flight or control duties while being introduced to the antidepressant medication and ensuring that the pilot or controller experiences only minimal side effects that do not interfere with flight or control duties, the report said.

The Civil Aviation Safety Authority of Australia (CASA) includes these criteria in assessing pilots and controllers — including those who participated in the study — along with other criteria requiring them to be under the care of a medical practitioner with experience treating depression; to be "stable on an established and appropriate dose of medication for at least four weeks" before resuming flight or control

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duties; and to have minimal side effects, no drug interactions and no allergies to the antidepressant medication.

Other CASA requirements call for those taking antidepressants to undergo a clinical review at least once a month and to submit a progress report to CASA every six months for at least the first year of treatment. In addition, CASA requires an absence of other significant psychiatric problems and no use of other psychoactive medications, along with control of all symptoms of depression; an absence of suicidal thoughts and "features of arousal," such as irritability or rage; and the presence of a normal sleep pattern.

CASA's decision to allow pilots and controllers taking antidepressants to participate in aviation operations came soon after the introduction of a class of antidepressants called selective serotonin reuptake inhibitors (SSRIs), which had fewer and milder side effects than older antidepressant medications such as monoamine oxidase inhibitors (MAOIs) and tricyclics.[2]

The side effects associated with SSRIs and a related class of antidepressants known as serotonin-norepinephrine reuptake inhibitors (SNRIs) — most common during the first days or weeks of use — are individualized, but they include decreased appetite, nausea, diarrhea, nervousness, insomnia, headache and sexual dysfunction. Tricyclics may have side effects that include sedation, decreased blood pressure, increased heart rate, dry mouth, blurred vision, constipation, difficulty urinating and confusion. MAOIs — which usually are prescribed in cases in which other classes of antidepressants have not helped — can cause a dramatic increase in blood pressure if they are taken in combination with cold and cough remedies that contain phenylpropanolamine and dextromethorphan.[3]

CASA guidelines today specify that the authority may "on a case-by-case basis" certificate applicants who are prescribed (and are taking) SSRIs sertraline (brand name Zoloft) and citalopram (brand name Celexa), and venlafaxine (brand name Effexor) — a type of SNRI.[4]

The Australian study included pilots and controllers taking all types of antidepressants and found no difference in accident or incident history based on the type of antidepressant.

Data indicated that a slightly higher number of accidents and incidents occurred among pilots and controllers immediately before the start of antidepressant medication. Although the increase was considered statistically insignificant, the report said that "the data raise the possibility that the earlier use of antidepressants might actually improve safety in a group who subsequently go on to use them. If so, early identification and treatment of this group may improve aviation safety while allowing continued flying or controlling duties."

The report added, "If there is an excess of accidents in aircrew who would benefit from antidepressants but were not [using] them at the time of the accident, this might provide an argument for wider use of antidepressants than is currently the case in Australia, and has profound implications in those jurisdictions where antidepressant use is prohibited [by] certificate holders."

Common Condition

Depression within the general population is relatively common. The United Nations World Health Organization (WHO) estimates that it affects 121 million people worldwide; other estimates have been considerably higher.[5] Symptoms include a depressed mood, loss of interest or pleasure, feelings of guilt or low self-worth, disturbed sleep, poor appetite, lack of energy and poor concentration — problems that WHO says can lead to "substantial impairments in an individual's ability to take care of his or her everyday responsibilities." Depression also can lead to suicide, which claims about 850,000 lives worldwide every year, WHO said.

WHO data show that 60 to 80 percent of people with depression can be effectively treated with antidepressant medications and "brief, structured forms of psychotherapy."

The Australian study estimated that about 4.5 percent of the adult population uses

> "There is a groundswell of opinion that supports the carefully controlled use of antidepressants."

antidepressant medications, but only about 1 percent of "aviation certificate holders" could be identified as having taken antidepressants while certificated. The study said that the lower rate among pilots and air traffic controllers "may reflect under-reporting of antidepressant use rather than different levels of medication among pilots and air traffic controllers."

CASA's requirements differ from those of most other civil aviation authorities, including those in the United States and Europe, which do not currently allow aeromedical certification of pilots taking antidepressants.

In the United States, the Federal Aviation Administration (FAA) policy is that "the medical condition of depression is disqualifying, as well as *every* medication that is used for the condition," Dr. Warren S. Silberman, manager of the FAA Civil Aerospace Medical Institute Aerospace Medical Certification Division, wrote in a 2005 *Federal Air Surgeon's Medical Bulletin*.[6] He added, however, that an FAA panel has been studying "the feasibility of granting medical certification to individuals that have been stable on SSRIs for the treatment of depression," provided the depression has not been accompanied by suicidal thoughts.

The FAA allows pilots who have been treated with antidepressants to receive medical certification if they have had no significant symptoms of depression for at least 90 days after stopping the medication. They also must be evaluated by a psychiatrist and a psychologist before issuance of a medical certificate, and reports must be forwarded periodically to the FAA.

In Europe, the Joint Aviation Authorities medical committee has agreed to a proposal that — if it receives final approval — eventually would allow commercial pilots taking "a few specific antidepressants" to continue flying, said Dr. Sally Evans, chief medical officer of the U.K. Civil Aviation Authority and head of the European Aviation Safety Agency Flight Crew Licensing Medical Core Group. The proposal would limit acceptable medications to a few SSRIs, require close monitoring of the pilots and allow medical certification only after the medication has been "well established and the depression has been fully treated," Evans said.

If the proposal is adopted, considerable time may be required to establish procedures for monitoring the pilots, she said.

"It is considered that it is safer to know that pilots are being treated for depression and being monitored rather than have pilots fly whilst depressed (not on medication) or fly whilst taking undisclosed treatment," Evans said.

Canadian Study

Civil aviation authorities in a few countries in addition to Australia already have taken steps to allow some pilots to fly while taking antidepressants.

In Canada, for example, a long-term study is being conducted involving several pilots taking specific types of antidepressants to evaluate their performance while using the medications, and authorities are continuing to review related medical literature, a Transport Canada (TC) spokeswoman said. Each of the pilots is permitted to fly only as part of a two-member crew.

The study began in the mid-1990s, and in 2001, Dr. Hugh O'Neill, then the TC director of civil aviation medicine, said that TC was "proceeding very, very cautiously" with the study while "looking for some consensus of opinion throughout the world."[7]

TC's *Handbook for Civil Aviation Medical Examiners* describes requirements similar to those outlined by CASA: Applicants for aeromedical certification "who have been treated for a depressive illness and who are on maintenance or prophylactic therapy with … SSRIs may be considered for medical certification on an individual basis after review by the CAM [the TC Civil Aviation Medicine Division] Aviation Medicine Review Board."[8]

Changing Opinions

Worldwide, the opinions of some aeromedical specialists are changing.

"There is a groundswell of opinion that supports the carefully controlled use of antidepressants, this being better than having a policy that

grounds pilots when they take any antidepressant medication," said Dr. Anthony Evans, chief of the Aviation Medicine Section at the International Civil Aviation Organization (ICAO) and no relation to the U.K. CAA's Dr. Sally Evans. "The latter policy results in pilots flying when depressed and untreated, or failing to declare their depression/treatment to an AME [aviation medical examiner] and potentially taking antidepressants that have unacceptable side effects from the flying viewpoint."

Despite the increasing tendency of specialists to believe that some use of antidepressant medications by pilots would be acceptable, debate continues about precisely what medications are acceptable and what problems should be treated by these medications, which sometimes are administered for conditions other than depression; how long pilots might be required to stop flying before and after they begin using the medications; and how these cases should be monitored. "In other words," Evans said, "the logistics of introducing such medication into the aviation system without compromising safety is not yet fully harmonized."

ICAO has begun changing its standards and recommended practices to enable the use of antidepressants by pilots and air traffic controllers if the national licensing authority determines that the medications present no significant risk to flight safety, he said.

In a 2006 preliminary, unedited version of its *Manual of Civil Aviation Medicine*, ICAO said, "In recent years, the use of SSRI … has become widespread, and there is indication that such treatment, aimed at preventing a new depressive episode, may be compatible with flying duties in carefully selected and monitored cases."[9]

AsMA has called for an end to "current absolute prohibitions against pilots flying while taking SSRIs and adoption of aeromedical protocols that include carefully controlled follow-up and review."[10]

In 2004, AsMA recommended that "all certificatory and regulatory authorities … consider immediately instituting a policy of using study groups to manage depressed aviators who require SSRI antidepressants. Protocols designed to aggressively manage the full spectrum of adverse possibilities related to SSRI use may enable the safe use of SSRIs in formerly depressed aviators who suffer no aeromedically significant side effects. In these closely managed cases of depressive disorders, special issuances or waivers for SSRI use are justified." ●

ICAO has begun changing its standards and recommended practices to enable the use of antidepressants.

Notes

1. Ross, James; Griffiths, Kathleen; Dear, Keith; Emonson, David; Lambeth, Len. "Antidepressant Use and Safety in Civil Aviation: A Case-Control Study of 10 Years of Australian Data." *Aviation, Space, and Environmental Medicine* Volume 78 (August 2007): 749–755.
2. MAOIs include phenelzine (brand name Nardil) and tranylcypromine (brand name Parnate). Tricyclics include amitriptyline (brand name Elavil), desipramine (brand name Norpramin), imipramine (brand name Tofranil) and nortriptyline (brand name Pamelor).
3. FSF Editorial Staff. "Regulations Allow Pilots With Depression to Fly After Successful Treatment." *Human Factors & Aviation Medicine* Volume 48 (January–February 2001).
4. Ross et al.
5. United Nations World Health Organization. *Depression*. <www.who.int/mental_health/management/depression/definition/en>.
6. Silberman, Warren S. "Certification Update: SSRI Policy Reminder." *Federal Air Surgeon's Medical Bulletin* Volume 43 (2005–2).
7. FSF Editorial Staff.
8. Transport Canada. *Handbook for Civil Aviation Medical Examiners*. 2004.
9. The 1985 version of the manual had said that pilots typically should not fly while taking antidepressant medication and "ordinarily … should not be allowed to return to flying unless they have been off medications for at least some months."
10. Jones, D.R.; Ireland, R.R. "Aeromedical Regulation of Aviators Using Selective Serotonin Reuptake Inhibitors for Depressive Disorders." *Aviation, Space, and Environmental Medicine* Volume 75 (May 2004): 461–470. Cited in Ross et al.

Overrun at Midway

The crew applied reverse thrust too late.

BY MARK LACAGNINA

The Southwest Airlines captain said that the weather on the night of Dec. 8, 2005, was the worst he had experienced. Visibility was near the minimum required for the approach, and braking action was being reported as both fair and poor on the runway at Chicago Midway International Airport. However, calculations derived from the on-board performance computer indicated that the Boeing 737-700 could be brought to a stop on the slippery runway.

The landing-distance calculations were based on crucial assumptions, including prompt application of reverse thrust after touchdown — which the flight crew did not know and failed to do, said the U.S. National Transportation Safety Board (NTSB).

Reverse thrust was applied late during the landing roll, and the 737 overran the runway, rolled through a blast fence and an airport perimeter fence, and struck an automobile before coming to a stop on a road. One automobile occupant was killed, one was seriously injured, and three received minor injuries. Of the 103 airplane occupants, 18 received minor injuries; the pilots, two of the three cabin crewmembers and 81 passengers were not injured. The 737 was substantially damaged.

In its final report on the accident, NTSB said that the flight crew failed to promptly apply reverse thrust because they were distracted by the autobrake system, which they were using for the first time.

"Contributing to the accident were Southwest Airlines' failure to provide its pilots with clear and consistent guidance and training regarding company policies and procedures related to arrival landing-distance calculations; programming and design of its on-board performance computer, which did not present inherent assumptions in the program critical to pilot decision making; plan to implement new autobrake procedures without a familiarization period; and failure to include a margin of safety in the arrival assessment to account for operational uncertainties," the report said. "Also contributing to the accident was the pilots' failure to divert to another airport given reports that included poor braking action and a tailwind component greater than 5 knots."

The report also said that the absence of an engineered materials arresting system (EMAS) in the nonstandard runway safety area (RSA) beyond the end of the runway contributed to the severity of the accident.

Delayed Departure

The 737, being operated as Flight 1248, departed from Baltimore two hours late because of a snowstorm in the Chicago area. It was the first flight of the first day of a scheduled three-day trip for the crew.

The captain, 59, was a U.S. Air Force pilot for 26 years before being hired as a first officer by Southwest in August 1995. He upgraded to captain in July 2000. He had about 15,000 flight hours, including 4,500 flight hours as a 737 captain.

The first officer, 34, was a Saab 340 pilot for Mesaba Airlines for six years before being hired by Southwest in February 2003. He had a 737 type rating and about 8,500 flight hours,

including 2,000 flight hours as a 737 first officer.

The pilots had completed a self-study training module distributed by the airline to familiarize crews with its forthcoming policy and procedures for the use of autobrakes. However, the implementation date had been changed several times, pending completion of autobrake system installation in all 441 of the 737s in the Southwest fleet. On the day of the accident, the airline issued a bulletin that delayed implementation until Dec. 12, 2005.

The crew of Flight 1248 told investigators that they had not noticed the changed implementation date while reviewing the bulletin and believed that the autobrake system policy and procedures already had been implemented. "A previous autobrake-related read-before-flight letter indicated that the autobrake policy would be in effect as soon as materials were available in the cockpit," the report said. "On the day of the accident, 'flow' cards and checklists with information regarding autobrake procedures had been placed in SWA [Southwest Airlines] airplanes."

Neither pilot had used autobrakes in an airplane or in a flight simulator. While discussing the procedures during the flight to Chicago, the captain expressed concern. "I don't know if I'm comfortable using the autobrakes in this situation," he said. Later, during the approach briefing, he said, "As far as the autobrakes go, I think I will use manual braking." The captain suggested that they postpone using the autobrakes for the first time until the next leg of the flight but then asked the first officer, "You want to try them into Midway?"

The first officer said that a friend who was experienced in the use of autobrakes had told him that the system is very effective. "I know they work better than we do [with manual braking]," the

first officer told the captain. "At least that's what my buddy told me. … It is going to get maximum braking out of the aircraft."

"Well, keep talking," the captain said. "I guess we could do it. Let's see what the conditions are up there. We'll do it."

Mixed Reports

A winter weather advisory with a heavy snow warning had been issued for the Chicago area. Snow began falling early in the afternoon and accumulated to 10 in (25 cm) before stopping late at night.

Visibility at Midway was 1/2 mi (800 m) in moderate snow and freezing fog. Runway visual range (RVR) for the landing runway, 31C, was reported as 4,500 to 5,000 ft (1,400 to 1,500 m). Minimum RVR required for the instrument landing system (ILS) approach to Runway 31C was 3,000 ft (1,000 m). Ceilings were broken 400 ft above ground level (AGL) and overcast at 1,400 ft AGL. Surface winds were from 090 degrees at 11 kt, and braking action was reported as "fair" on the first half of the runway and "poor" on the second half. Runway 31C is 6,522 ft (1,988 m) long, but, due to a displaced threshold, available landing distance is 5,826 ft (1,776 m); the runway is 150 ft (46 m) wide.

The airplane was nearing Midway at 1833 local time when air traffic control (ATC) issued holding instructions because the landing runway was being cleared of snow and treated with deicing fluid. The crew had used the on-board performance computer several times during the flight. While holding at 10,000 ft, the first officer again entered updated weather and runway conditions in the computer.

"The first officer entered multiple scenarios into the [computer], entering fair and poor pilot braking action reports separately because the [computer program] was not designed to accept mixed braking action report inputs," the report said. "Based on the first officer's inputs, the [computer] estimated that the airplane would stop about 560 feet [171 m] before the departure end of the runway with fair braking action and about 40 feet [12 m] before the departure end of the runway with poor braking action."

Although the computer calculations showed that the crew would be landing with an 8-kt tailwind component, the landing-distance calculations for poor braking action assumed a tailwind component of only 5 kt, because this was the limit established by Southwest. "SWA policies and flight operations manuals indicate that the company does not authorize landings on runways with more than a 5-knot tailwind component with poor braking action," the report said. If the landing-distance calculations for poor braking action had been based on the actual 8-kt tailwind, they would have shown that the airplane would stop about 260 ft (79 m) *beyond* the end of the runway.

An engineered materials arresting system was installed at the end of Runway 31C after the accident (see photo, p. 32).

Unknown Assumptions

The report noted that on-board performance computers and other types of electronic computing devices reduce pilot workload but, unlike tabular performance charts, do not show the assumptions on which the calculations are based and, thus, can foster decision-making errors.

In addition to the 5-kt tailwind component assumed for a landing with poor braking conditions, the crew did not know that the landing-distance calculations for the 737-700 assumed use of reverse thrust. The on-board performance computers for the airline's 737-300s and -500s did not assume use of reverse thrust. "Because of this, the accident pilots believed that their intended use of reverse thrust during the landing roll would provide them with several hundred feet more stopping margin than the [computer] estimated," the report said.

The crew discussed the landing-distance calculations for Midway and the more-favorable weather conditions at their alternate airports — Kansas City and St. Louis, Missouri. "Although the pilots' calculations resulted in positive stopping margins for both fair and poor braking conditions and company policy indicated that landing was authorized with any positive stopping margin, the crew was concerned about the small positive stopping margin with poor braking action," the report said. They decided to divert the flight to an alternate if the tailwind component increased above 10 kt or if braking action was reported as poor for the full length of Midway's Runway 31C.

The crew did not follow a company procedure that required pilots to use the "most critical term" provided in a mixed braking action report. "Because 'poor' braking conditions were reported for a portion of the runway and SWA guidance indicates a maximum 5-knot tailwind to land if such conditions are reported, the pilots should not have landed at Midway," the report said.

Fifteen Seconds Late

The crew was cleared by ATC to leave the holding pattern at 1854 and followed radar vectors to the ILS final approach course. After clearing the crew to conduct the approach at 1904, the controller said, "Braking action reported fair except at the end, it's poor."

The crew said that the airplane was clear of clouds after descending through 1,400 ft and that RVR was about 5,000 ft. The 737 touched down about 1,250 ft (381 m) beyond the runway threshold. "Flight data recorder (FDR) data indicated that the airplane was aligned on the runway centerline as it touched down at an airspeed of about 124 knots [and a groundspeed of about 131 kt]," the report said. "The speed brakes deployed and brake pressure increased within about 1 second. Both pilots described the touchdown as 'firm.'

"The captain stated that he tried to deploy the thrust reversers immediately after touchdown but had difficulty moving the thrust reverser levers to the reverse thrust position. He further stated that he felt the antiskid system cycle after the airplane touched down but then felt it stop cycling and that the airplane

Boeing 737-400

© Matt Coleman/Airliners.net

Produced from 1988 to 2000, the 737-400 is 10 ft (3 m) longer than the 737-300, has strengthened landing gear and can accommodate 146 to 168 passengers. Powered by CFM56-3B2 or -3C turbofan engines, maximum operating speed is 0.82 Mach, and maximum range is 2,808 nm (5,200 km). Maximum standard weights are 138,500 lb (62,824 kg) for takeoff and 121,000 lb (54,886 kg) for landing.

The accident airplane, after repairs, is shown in the photo above.

Source: *Jane's All the World's Aircraft* seemed to accelerate. He said that he subsequently applied the wheel brakes manually but made no further effort to activate the thrust reversers. He told investigators that he believed that the use of the autobrake system distracted his attention from the thrust reversers after his initial attempt to deploy them."

The first officer also sensed a decrease in deceleration and manually applied the wheel brakes. "He stated that he then looked at the throttle console and saw that the thrust reverser levers were still in the stowed position," the report said. "The first officer moved the captain's hand away from the thrust reverser levers and, about 15 seconds after touchdown, initiated deployment of the thrust reversers to the maximum reverse setting."

Groundspeed was 53 kt when the 737 overran the runway at 1914. The nosegear collapsed, and the airplane came to a stop about 500 ft (152 m) beyond the end of the runway. Aircraft rescue and fire fighting personnel arrived two minutes later and assisted in the evacuation of the passengers through the left forward cabin door and through the right rear cabin door.

"Damage to the airplane was largely limited to the forward lower fuselage, engine cowlings and components, forward portions of the wings and other wing components, with limited damage farther aft," the report said. Examination of the airplane disclosed no preimpact anomalies.

Simulation Results

Four Southwest 737s and a United Airlines Airbus A320 had been landed without incident on Runway 31C during the 25 minutes preceding the accident. The 737 landings were conducted without autobrakes but with application of reverse thrust early in the landing roll. "Three out of the four flight crews commanded maximum reverse thrust," the report said.

Simulations conducted during the investigation indicated that if the crew of Flight 1248 had promptly applied maximum reverse thrust and maintained it until stopping, the airplane could have been stopped with 271 ft (83 m) of runway remaining. Interviews of the 10 previous flight crews who operated the accident airplane revealed no difficulty in deploying the thrust reversers. Interviews of other Southwest pilots revealed that several had "difficulties deploying the thrust reversers when they tried to move the reverse thrust levers past the interlock position too rapidly," the report said. "Those pilots reported that the levers moved readily when they tried to deploy the thrust reversers again after the interlocks released."

Guidance on the use of reverse thrust differed. Although Southwest and Boeing both recommended that reverse thrust be applied as soon as possible after touchdown, the airline said that pilots should begin reducing reverse thrust after decelerating to 80 kt, while Boeing said the reduction should begin at 60 kt. After the accident, Southwest revised its procedure to be consistent with Boeing's guidance.

Investigators found that while participating in the development of the airline's autobrake program, check airmen and their first officers also had become distracted and delayed application of reverse thrust during their first few landings. After the accident, Southwest revised its training procedures to require that "pilots complete at least

Engineered Arresting Systems Corp.

EMAS installation at Midway.

four familiarization landings — two as the flying pilot and two as the monitoring pilot — on dry runways with ample stopping margins before using the autobrake system on a routine basis," the report said.

Padding the Margin

Landing performance calculations for U.S. air carrier operations typically are conducted before flight by dispatchers and before arrival by the pilots. The preflight calculations are based, in part, on landing performance demonstrated by the airplane manufacturer during certification flight tests.

"Dispatch landing distance calculations are intended to ensure that dispatched airplanes will be able to land safely at the intended destination airport or a planned alternate and are based on estimated landing weights and forecast conditions," the report said. "According to [U.S. Federal Aviation Regulations], the dry and wet/slippery landing performance data used for dispatch calculations are obtained by multiplying the numbers demonstrated during certification landings on a level, smooth, dry, hard-surfaced runway by factors of 1.67 and 1.92, respectively."

Arrival calculations are based on updated information on airplane landing weight, weather, runway conditions and other factors. "Airplane landing performance data for conditions other than bare and dry are typically calculated rather than demonstrated via a flight test," the report said, noting that no "safety margin" typically is added to arrival landing-distance calculations.

There are no regulatory requirements or standards for arrival calculations. In August 2006, the U.S. Federal Aviation Administration (FAA) issued a safety alert for operators, SAFO 06012, "urgently recommending" that all jet airplane operators develop procedures for arrival calculations. The alert further recommended that "once the actual landing distance is determined, an additional safety margin of at least 15 percent should be added to that distance."

The SAFO noted, however, that arrival calculations are not recommended before every landing. "In many cases, the before-takeoff criteria, with their large safety margins, will be adequate to ensure that there is sufficient landing distance with at least a 15 percent safety margin at the time of arrival," it said. "Only when the conditions at the destination airport deteriorate when en route [would an arrival calculation] normally be needed."

Hemmed In

The RSA beyond the end of Runway 31C — and several other RSAs at Midway — do not meet FAA standards. The Runway 31C RSA extends 82 ft (25 m) beyond the runway end; the FAA standard is 1,000 ft (305 m).

The airport operator, the Chicago Department of Aviation (DOA), told the FAA in 2004 that no practical alternatives existed for extending the Runway 31C RSA to meet the standard. It said that shortening the runway to extend the RSA would reduce the operational capacity of the airport and that acquiring land beyond the existing RSA would have a major impact on public roadways, businesses and residences.

The Chicago DOA also said that an alternative to enhance the RSA, installation of a standard 600-ft (183-m) EMAS arrestor bed, also would require shortening the runway. The FAA did not ask the airport operator to consider installation of a shorter, nonstandard EMAS bed.

Simulations conducted by an EMAS manufacturer "indicated that a nonstandard EMAS installation would have stopped the accident airplane before it departed airport property," the report said. "After the accident, the FAA approved the installation of nonstandard EMAS beds at [Midway]."

Better Data Needed

The report said that the accident showed the need for an "airplane-based" method of quantifying runway surface condition and transmitting the information for use by pilots of other airplanes in landing performance calculations. As a result, NTSB called on the FAA to explore the feasibility of "outfitting transport category airplanes with equipment and procedures required to routinely calculate, record and convey the airplane braking ability required and/or available to slow or stop an airplane during the landing roll."

Among other recommendations based on the accident investigation were that the FAA should require operators of commercial and fractional ownership aircraft to conduct arrival landing performance calculations incorporating a 15 percent safety margin before every landing and ensure that on-board electronic computing devices clearly display the critical assumptions on which calculations are based. ●

This article is based on NTSB Accident Report NTSB/AAR-07/06: "Runway Overrun and Collision; Southwest Airlines Flight 1248; Boeing 737-7H4, N471WN; Chicago Midway International Airport; Chicago, Illinois; December 8, 2005."

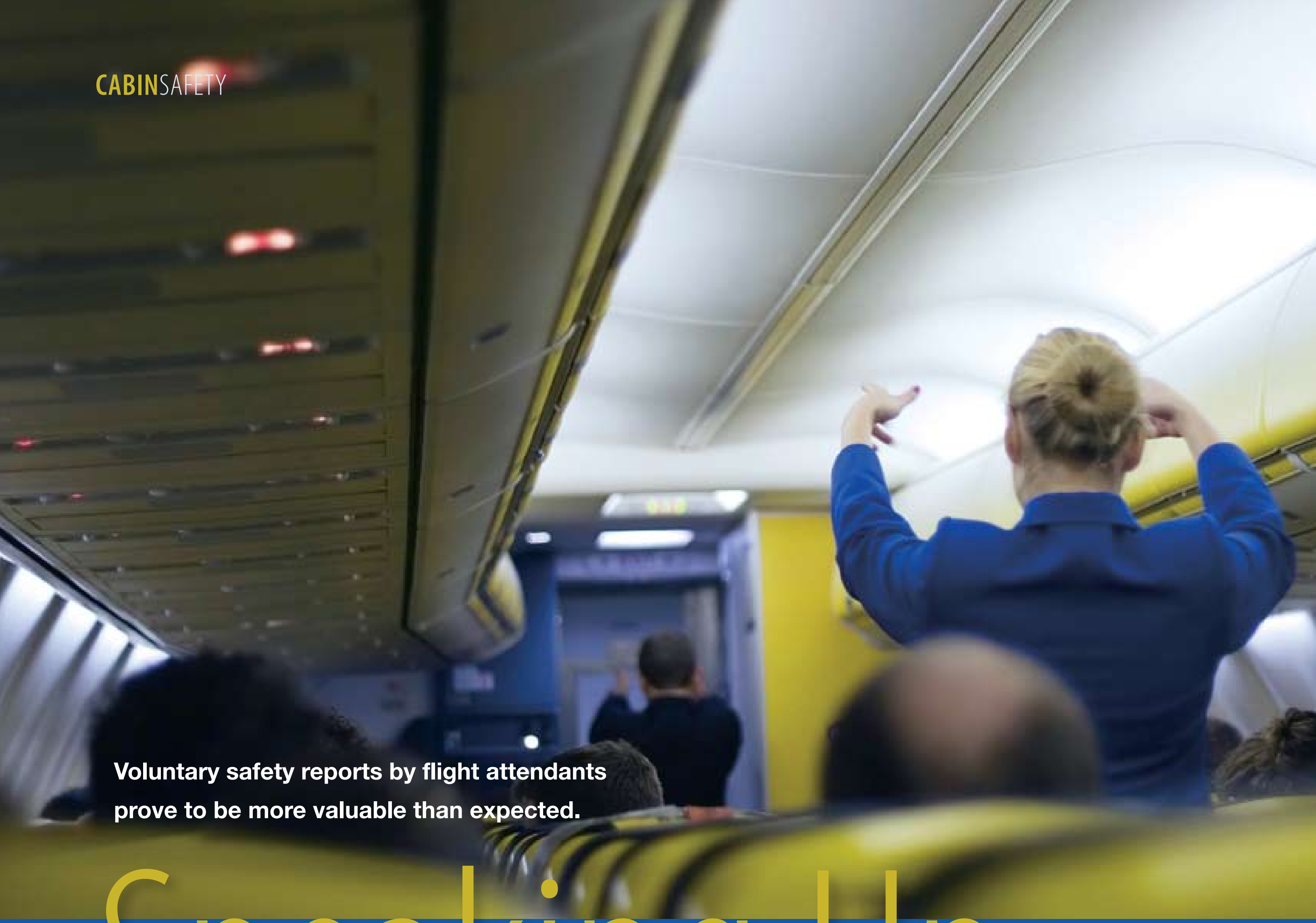
Further Reading From FSF Publications

Johnsen, Oddvard. "Improving Braking Action Reports." *ASW*, 8/07, p. 36.

Rosenkrans, Wayne. "Knowing the Distance." *ASW*, 2/07, p. 22.

Rosenker, Mark V. "Margins of Safety." *ASW*, 12/06, p. 11.

Rosenkrans, Wayne. "Rethinking Overrun Protection." *ASW*, 8/06, p. 13.



Voluntary safety reports by flight attendants prove to be more valuable than expected.

Speaking Up

BY WAYNE ROSENKRANS

With computer networks ready to pull together diverse safety information, the U.S. Federal Aviation Administration (FAA) during 2008 will keep promoting aviation safety action programs (ASAPs) — including ASAPs for flight attendants — at air carriers and major domestic repair stations. Although introduction of flight attendant versions of this voluntary program is relatively new, benefits from a handful of these ASAPs so far appear to be surpassing the expectations of participants (Figure 1).[1] The challenge slowing expansion is persuading people to step beyond outmoded safety programs that discipline employees for inadvertent errors.

In a typical ASAP, the air carrier enters a formal partnership with specially trained FAA aviation safety inspectors and the labor organization of a specific employee group. The partners create an event review committee, a non-threatening environment that invites the certificate holder's employees to voluntarily submit written reports that may prevent accidents. The mission is to identify and address safety issues wherever evidence leads, regardless of violations of federal regulations by the employee or the company.

"Under an ASAP, safety issues are resolved through corrective action rather than through punishment or discipline," says FAA Advisory Circular 120-66B, *Aviation Safety Action Program (ASAP)*. "The ASAP provides for the collection, analysis and retention of the safety data that is obtained. ASAP safety data, much of which

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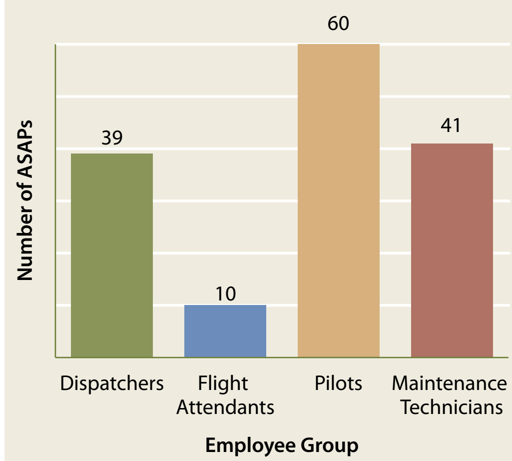
would otherwise be unobtainable, is used to develop corrective actions for identified safety concerns, and to educate the appropriate parties to prevent a reoccurrence of the same type of safety event."

FAA Order 8900.1, *Flight Standards Information Management System,* reminds aviation safety inspectors that ASAPs enable employees to tell what happened "without fear that the FAA will use reports accepted under the program to take legal enforcement action against them, or that companies will use such information to take disciplinary action." Historically, the former primarily has been a concern of airline pilots and the latter primarily has been a concern of flight attendants.

To make good on these promises and maintain trust, nearly all details of setting up and conducting an ASAP have been prescribed in FAA guidance documents, although participants can diverge from the template in preparing the required memorandum of understanding. Event review committees must determine by "unanimous consensus" (Figure 2, p. 36)[2] either that a report is acceptable or it falls under exclusionary exceptions, and learn methods of reviewing ASAP reports and reaching decisions, formulate corrective action and verify its successful completion, and know how the FAA handles exceptional situations such as when the ASAP report is not the sole source of evidence of a regulatory violation.

Committees know when and how to use FAA's enforcement decision tool and how FAA may conduct an independent investigation of an event disclosed in an ASAP report. They also learn to interpret employee conduct that raises a question of airman competence or qualification, medical certification or other employee competence/qualification issues. The safety risks/threats identified in sole-source reports must be addressed by the committee (see "ASAP Report Insights," p. 37). A key to the arrangement is that the flight attendant must successfully complete recommended corrective action to be covered by the program's protections; otherwise he or she can face a reopening of the case and referral for an FAA investigation.

Employee Groups in U.S. Aviation Safety Action Programs (ASAPs)



Note: These data from December 2007 reflect the 150 ASAPs at 68 U.S. airlines for which the U.S. Federal Aviation Administration has accepted a memorandum of understanding that authorizes an ASAP for a specific employee group.

Source: U.S. Federal Aviation Administration

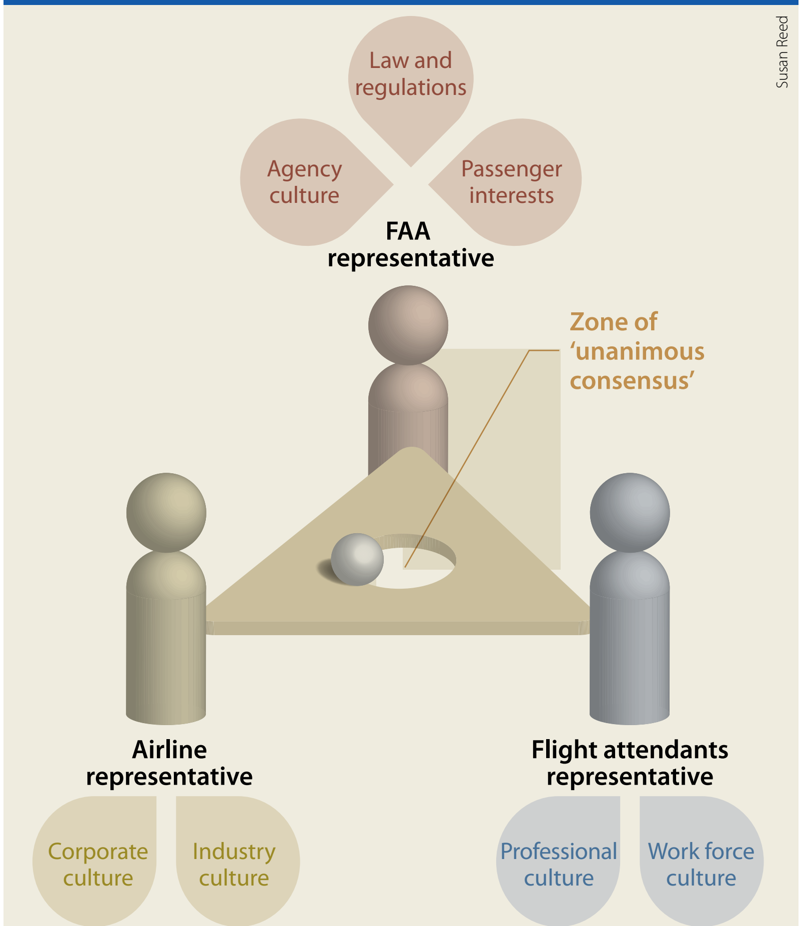
Figure 1

FAA basically expects ASAP reports involving a possible regulatory violation to be accepted if the flight attendant acted as an employee of the air carrier; the report is submitted in a timely manner, such as within 24 hours after the end of a duty day; the alleged regulatory violation is inadvertent and does not appear to involve an intentional disregard for safety; and the event does not appear to involve FAA's "big five" exceptions — criminal activity, substance abuse, controlled substances, alcohol or intentional falsification.

Conditional Union Support

Candace Kolander, coordinator, air safety, health and security, Association of Flight Attendants–Communications Workers of America (AFA), said that the union supports ASAPs for flight attendants, but on the condition that reports be sent within 10 days to the U.S. National Aeronautics and Space Administration

Event Review Committee Dynamics



Source: Sandia National Laboratories

Figure 2

(NASA) Aviation Safety Reporting System (ASRS). This practice typically protects submitters, if an ASAP report proves unacceptable, and reports become beneficial industrywide. Historically, the apparently slight risk of FAA enforcement action against flight attendants may explain the reluctance of some to submit voluntary safety reports. Unlike pilots' risk of airman certificate revocation or suspension, for example, "flight attendants don't have that big question of a violation hanging over their heads all the time," she said.

Flight attendants' feedback to AFA about current ASAPs has been positive. "One of the things they are most excited about is addressing concerns in the cabin," Kolander said. "They want FAA to be given a little 'heads up' about concerns that they have not necessarily been able to solve at the air carrier level."

Airline Experiences

Valerie Walker and Jack O'Brien, representatives of the United Airlines Onboard Service Safety Action Program implemented in March 2005, said that ASAP for flight attendants enables airlines "to gain objective feedback relating to the effectiveness of training, policies and processes." They said that they found that a critical element of success is for the senior leader of the division to "stand up before his/her leadership team and deliver a message supporting the program."[3]

Through the ASAP event review committee, the United Airlines Safety Division receives reports from flight attendants, investigates them, provides a weekly update on reports to review, maintains a log of action items, closes out ASAP reports, manages the safety database and interfaces with managers of ASAPs for pilots, dispatchers and maintenance technicians.

At Alaska Airlines, the FAA's template was followed "fairly closely" before the memorandum of understanding was accepted by the FAA in September 2006. Minor changes are expected as this ASAP evolves from a demonstration program to a continuing program in 2008, said Cassandra Bennett-Chaffee, manager, in-flight policy, safety and regulatory compliance.[4]

Reviewing 200 reports from some of the company's 2,700 flight attendants the first year was not difficult, she said, contrary to her expectation. "Right off in the first month, we had four potential violations of the Federal Aviation Regulations [FARs], and I worried that I would spend all my waking hours on this program," Bennett-Chaffee said. "It has become far more manageable because of established patterns. We are looking for trends, we would like to validate whether corrective actions are indeed working."

ASAP protections for submitters encourage event review committee members to be proactive. "To find out about safety-related events, including those that may have required an

ASAP Report Insights

Aviation safety action programs (ASAPs) for flight attendants identified the following issues in 2005–2007. The excerpts from flight attendant reports, selected from the Aviation Safety Reporting System (ASRS) Online Database, reflect a few of these issues but may or may not have originated as ASAP reports:

- **Inadequate procedures, or non-adherence to procedures, were noted when gate agents closed aircraft boarding doors.** One report said, "Once the [Boeing 737-300 overhead] bins filled up, I called to let the [gate] agent know the bins were full. … When the agent approached the door to the aircraft, I told her not to close the door as we had bags to check. Her response to me was, 'I don't want to open the [checked-baggage compartment] at this point; find some space in the middle seats where there is no one sitting.' … I again told her not to close the door; she chose to ignore my request and closed the door and pulled the Jetway. We had no choice but to violate U.S. Federal Aviation Regulations, and overload the closet on our aircraft as they were not bringing the Jetway back."[1]
- **Doors were left armed and inadvertent slide deployments occurred or were narrowly averted.** One report said, "When I went to disarm door 2L on this flight, I stood up, faced the door, and instead of immediately disarming, I bent down to check for airstairs being brought up to the door. … In making my visual sweep of the outside, I stood up and grabbed the wrong handle."[2]
- **Improper passenger selection or noncompliance with passenger briefings affected exit row seating.** One report said, "On this [Airbus A320] flight, I was flight attendant no. 2 and my responsibility was to brief the [passengers in] exit rows. Out of my 12 passengers in my exit row there was one gentleman that I was not able to communicate with at all. … [A cabin supervisor] said that they don't have to speak English. I told him that I knew that, but I picked up a safety card and showed him where it states that 'they must be able to understand crewmembers' verbal instructions.' "[3]
- **Flight attendants failed to remain at the duty station and fasten their safety belt and shoulder harness during taxi.** One report said, "While [the Boeing 737-800] taxied to the runway, I was literally thrown, right arm first, into the base of the no. 2 jump seat. … We were taxiing fast and making quick turns as we headed to the runway. … We should be warned of a quick taxi so flight attendants can take precautions, such as taking a seat and strapping in!"[4]
- **The cabin crew violated the minimum crew requirements during boarding and deplaning.** One report said, "We were three flight attendants and two pilots. … I immediately mentioned to another flight attendant that I thought we were supposed to have four flight attendants now that we were on Aircraft Y. She kind of shrugged it off. So I went to the purser and asked her. Her explanation was that because we still only had 113 passengers on board there was no problem. … I got out my flight attendant manual and saw that minimum crew on Aircraft Y was four."[5]
- **The cabin crew did not follow approved procedures for stowage of in-flight trash.** One report said, "On the front of the [main waste receptacle] door, it states that 'waste container must be installed.' … At 10 minutes prior to departure … nothing had arrived. I spoke with [the on-board service supervisor] again, who told me to 'stack things on the floor, and before landing, put the garbage in the bathroom.' … I was told that there is nothing else to do."[6]
- **Galley security — checking/using restraint devices for inserts and carts — required emphasis in training scenarios.** One report said, "[The seat belt sign was on at the time for turbulence and] I had just walked to monitor at the 2R door. … Very suddenly, the [Boeing 777-300] started to shake violently. … I saw and heard glass breaking and flying out of the business class galley into the area I was in. Inserts, carts, food, everything that was in the galley was thrown all over the floor and aisle. Shards of broken glass were everywhere. … The first class galley had broken glass, food, carts, everything in it was on the floor and broken. The passenger in 3D got up to look. He said, 'This looks like something out of a movie.' … No passengers were hurt that I observed."[7]

— WR

Notes

1. NASA ASRS report no. 697849. March 2006.
2. NASA ASRS report no. 987886. April 2006.
3. NASA ASRS report no. 683532. November 2005.
4. NASA ASRS report no. 700747. June 2006.
5. NASA ASRS report no. 714723. August 2006.
6. NASA ASRS report no. 683549. November 2005.
7. NASA ASRS report no. 705022. July 2006.

employee disciplinary measure in the past, we contact individual flight attendants and encourage them to report," she said.

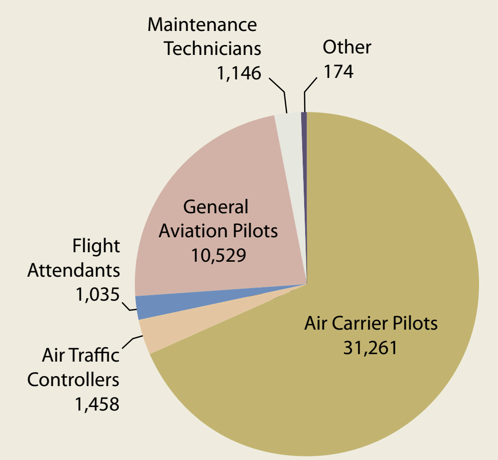
The ASAP supplements mandatory cabin safety reports, which flight attendants cannot monitor. In comparison, products of committee meetings twice a month include the quarterly ASAP report to FAA and a monthly ASAP bulletin securely distributed on line to all flight attendants at the airline. "Verbatim deidentified ASAP reports in the monthly bulletin are high value … the lessons learned have been amazing," Bennett-Chaffee said. "Some flight attendants say that a policy or procedure was not clear to them until they read somebody else's report and then they say, 'I realized why I need to follow the procedure in the manual.'"

Beyond words, ASAP-related actions by the airline have high visibility. "We see flight attendant manual changes and sometimes daily changes in procedures," she said. Since the ASAP was established, the company's cabin supervisors also have been reporting improved adherence to written procedures.

Latricia Foulger, director, InFlight, SkyWest Airlines, said that under an FAA-funded collaborative project between the airline and the Universal Technical Resource Services Aviation Consulting Group, flight attendants explain the cause and outcome of the event in their ASAP report. "Sometimes, contact by our event review committee will be for the sole purpose of counseling the flight attendant in proper procedures," Foulger said. "ASAP reports are selected for publication based on the severity or frequency of the safety concern. No names are divulged. The committee produces *ASAP Circulars* that are issued to each flight attendant through a bimonthly newsletter as well as posted on a company intranet giving details of the event and the committee's conclusion and recommended preventive measures."

American Airlines representatives Shannon Stewart and Penney Pollard told cabin safety professionals that "earning and keeping trust should be a primary goal of the [ASAP] program." Numerous safety reports generated by an ASAP for flight attendants help validate that "employees trust the process," they said.[5]

Voluntary Safety Reports in 2007



Note: The U.S. National Aeronautics and Space Administration Aviation Safety Reporting System received 55 percent of 45,603 safety reports from aviation safety action programs at 32 U.S. airlines and 45 percent directly from these aviation professionals.

Source: NASA ASRS

Figure 3

ASRS Magnifies Impact

In 2007, reports received from 68 ASAPs at 32 U.S. airlines surpassed the total ASRS reports received directly from air traffic controllers, dispatchers, flight attendants, maintenance technicians and pilots, said Linda Connell, program director of ASRS at the NASA Ames Research Center (Figure 3). "We are the largest repository of ASAP information," Connell said. As of December 2007, three airlines with six ASAPs for flight attendants were submitting their reports to ASRS. Data for total intake of reports "absolutely show increasing interest" from flight attendants in voluntary safety reporting (Figure 4), she said.

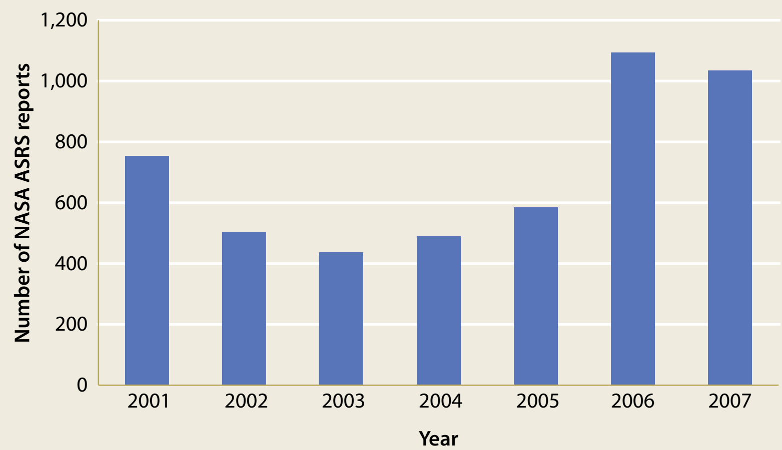
Connell considers ASRS and ASAPs as complementary, neither a sufficient replacement for the other. A past disadvantage of ASAPs was separation of programs by employee group so that events and concerns became "stove-piped" (segregated) within and among airlines instead of being aggregated, she said. FAA and NASA are addressing this, realizing that some aviation safety specialists prefer ASAP reports because they involve internal investigations, corrective actions and permanent access to a record, protected from public disclosure by federal law, with only the submitter's name deleted. Underscoring this point, the FAA said, "The value of ASAP for safety enhancement lies in its capacity to retain specific information on individual events, including, for example, specific information on aircraft make, model and series."[6]

SMS-Ready

Under the FAA's Voluntary Aviation Safety Information-Sharing Process, work has been under way since 2004 to develop a "technical process to extract deidentified data from any participating airline flight operations quality assurance [program] or [ASAP], aggregate it through a distributed database and make it accessible to appropriate industry stakeholders for analysis."[7] FAA therefore encourages ASAPs to develop data acquisition, event categorization and risk analysis methods that gradually will enable voluntary national sharing of ASAP information from multiple programs, a common taxonomy (classification scheme) tailored to the types of events, and classification of corrective actions for flight attendants and other specific employee groups. In May 2008, the Voluntary Aviation Safety Programs Conference in San Diego will include presentations on how ASAP, ASRS and related programs can be integrated into an airline's safety management system (SMS) and how voluntary safety information can be shared by airlines and the FAA. ●

For an enhanced version of this story, go to <www.flightsafety.org/asw/feb08/cabin-asap.html>.

Flight Attendant Voluntary Safety Reports Increase



NASA = U.S. National Aeronautics and Space Administration; ASRS = Aviation Safety Reporting System

Note: Since 2002, NASA ASRS has received reports from aviation safety action programs (ASAPs) for airline pilots, dispatchers and maintenance technicians in addition to the ASRS reports submitted directly by these employee groups and by air traffic controllers, general aviation pilots and other sources. New ASAPs for flight attendants at 10 airlines, including three that began sending reports to ASRS in 2006-2007, will help the industry and government to monitor cabin safety issues.

Source: NASA ASRS

Figure 4

Notes

1. As of December 2007, the FAA had accepted 10 memorandums of understanding authorizing ASAPs for flight attendants at Alaska Airlines, Eos Airlines, Horizon Air, PACE Airlines, Pinnacle Airlines, Skyway Airlines, SkyWest Airlines, Swift Air Group, United Airlines and USA3000 Airlines.

2. Ganter, John H.; Dean, Craig D.; Cloer, Bryon K. *Fast Pragmatic Safety Decisions: Analysis of an Event Review Team of the Aviation Safety Action Partnership.* Sandia National Laboratories. Report no. SAND2000-1134. May 2000. Researchers said, "Potential corrective action can be visualized as a steel ball on [a tilt table]. In order for this potential action to be implemented, the ball must pass through a hole at the center: the zone of unanimous consensus. The representatives must cooperate in achieving a reasonably balanced table."

3. Walker, Valerie; O'Brien, Jack. "Safety Action Program in a Flight Attendant Environment." In proceedings of the 23rd annual International Aircraft Cabin Safety Symposium. Oklahoma City, Oklahoma, U.S.: Southern California Safety Institute, 2006.

4. Bennett-Chaffee, Cassandra. "Value of the Cabin Crew Aviation Safety Action Program (ASAP) at Alaska Airlines." Paper and presentation to the Air Transport Association of America. October 2007.

5. Stewart, Shannon; Pollard, Penney. "Cabin ASAP: The International and Non-Labor Perspective." In proceedings of the 23rd annual International Aircraft Cabin Safety Symposium.

6. FAA. Order 8000.82, *Designation of Aviation Safety Action Program (ASAP) Information As Protected From Public Disclosure Under 14 CFR Part 193.* Sept. 3, 2003.

7. Chidester, Thomas R. *Voluntary Aviation Safety Information-Sharing Process: Preliminary Audit of Distributed FOQA and ASAP Archives Against Industry Statement of Requirements*. FAA Office of Aerospace Medicine. Report DOT/FAA/AM-07/7. April 2007.

BLINDSIDED

BY LINDA WERFELMAN

The pilots of an Airbus A340 did not anticipate the 'severe deterioration' of weather as they approached the runway threshold at Toronto.

The Air France Airbus A340-300 was high and fast when it crossed the threshold of Runway 24L at Toronto/Lester B. Pearson International Airport during a thunderstorm, with heavy rain and lightning strikes that significantly reduced visibility before the touchdown 3,800 ft (1,159 m) down the 9,000-ft (2,745-m) runway. The crew selected reverse thrust 12.8 seconds after touchdown and full reverse 16.4 seconds after touchdown but was unable to stop the airplane before it departed the far end of the runway at 80 kt, crossed two roads, plowed into a ravine and burned.

The airplane was destroyed in the crash at 1602 local time Aug. 2, 2005, and 12 of the 309 occupants received serious injuries during the crash and subsequent evacuation.

The Transportation Safety Board of Canada (TSB) said in its final report on the accident that, "in hindsight, the risk presented by the rapidly deteriorating weather conditions was greater than most pilots would deem acceptable. However, when the [pilots] assessed the available weather information and the traffic flow into the airport, they did not expect that such a severe deterioration in the weather was imminent."

Among the causes of the accident and the contributing factors, the TSB cited the approach and landing during the thunderstorm, with greatly reduced visibility, lightning strikes and shifting winds — including a 10-kt tailwind component for part of final approach and a crosswind that, because the runway was contaminated by water, exceeded the airplane's landing limits.

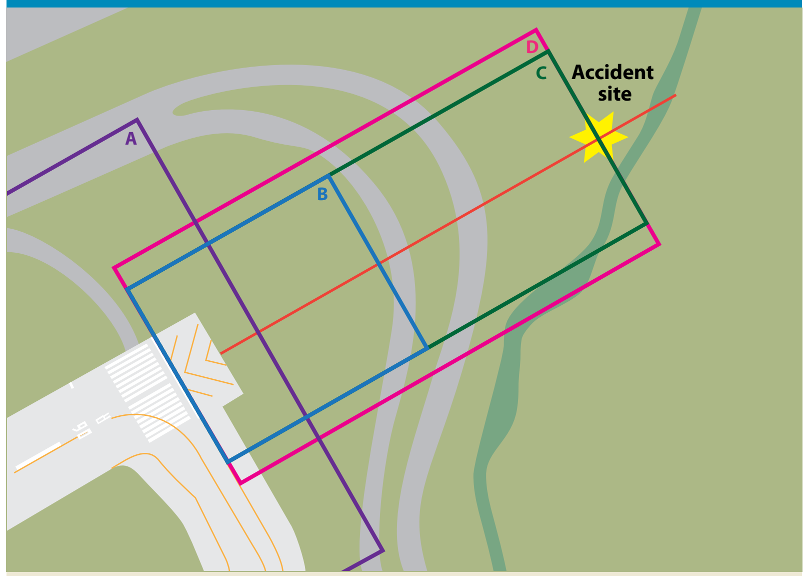
Transportation Safety Board of Canada

Transportation Safety Board of Canada

Other factors included the absence of Air France procedures for distance required from thunderstorms during approach and landing; the crew's belief, as the airplane neared the runway threshold, that a go-around was no longer an option; and the crew's delays in selecting the thrust reversers and applying full reverse thrust.

The crew did not calculate the landing distance required and "consequently, they were not aware of the margin of error available … [or] that it was eliminated once the tailwind was experienced," the TSB said. In addition, "there were no landing distances indicated on the operational flight plan for a contaminated runway condition" at the airport, and although the first 500 ft/150 m beyond the departure end of the runway complied with Transport Canada (TC) standards, "the topography of the terrain beyond this point, along the extended runway centerline, contributed to aircraft damage and to the injuries to crew and passengers," the TSB said (Figure 1).

Runway 24L Safety Areas, Actual and Recommended



FAA = U.S. Federal Aviation Administration; ICAO = International Civil Aviation Organization; RESA = runway end safety area; RSA = runway safety area

Notes:

A. Runway strip: Area extending 200 ft/60 m from end of runway, 500 ft/150 m from either side of centerline. Transport Canada standard, in place at Runway 24L.

B. RESA: Area extending 300 ft/90 m from end of runway, twice runway width. ICAO standard, TC recommendation, not in place at Runway 24L.

C. RESA: Area extending 1,000 ft /300 m from end of runway, twice runway width. ICAO recommendation, not in place at Runway 24L.

D: RSA: Area extending 1,000 ft/300 m from end of runway, 250 ft/75 m either side of center line. FAA standard, not in place at Runway 24L, not applicable outside U.S.

Source: Transportation Safety Board of Canada

Figure 1

Eight-Hour Flight

The crash occurred after an eight-hour flight from Charles de Gaulle International Airport in Paris. Before leaving Paris, the flight crew obtained a weather forecast for Toronto that included possible thunderstorms; as a result, additional fuel was added to the tanks to allow for an extra 23 minutes of holding time in Toronto.

About seven hours into the flight, the pilots made their initial contact with the Toronto Area Control Centre (ACC), asked about the weather, and told Air France operations personnel in Toronto that, because of thunderstorms near their alternate airport — Niagara Falls (New York, U.S.) International — they were designating Ottawa Macdonald-Cartier International Airport as their new alternate.

Soon afterward, the crew discussed the weather with air traffic control (ATC). The crew subsequently was told to reduce speed because of landing delays at Toronto. They requested and received vectors to avoid weather and also received an aviation routine weather report, which included information about thunderstorms and

Airbus A340

© Frank Robitaille/Airliners.net

The Airbus A340, first flown in 1991, is a large-capacity, widebody, medium/ultra long-range airliner. It is closely related to the A330. The A340-300 began service in 1993.

The A340-300 can seat as many as 440 passengers; the accident airplane was configured to seat 291 passengers. It has four CFM 56-5C2 turbofan engines and a maximum operating speed of 0.86 Mach. Typical standard range with fuel reserves is 12,223 km (6,600 nm). Maximum standard weights are 257,000 kg (566,582 lb) for takeoff and 186,000 kg (410,056 lb) for landing.

Source: *Jane's All the World's Aircraft*

heavy rain. They briefed the wind shear approach, planning to conduct a missed approach if they encountered wind shear.

At 1528, they were cleared for the Simcoe 2 arrival to Toronto; at the time, they had 9.3 metric tons (10.3 short tons) of fuel remaining, and the airplane was 137 nm (254 km) from Toronto. Having determined earlier that, with Ottawa as their alternate, a diversion would require 7.3 metric tons (8.0 short tons), with 14 minutes of fuel for holding at Toronto, they reviewed company procedures on when to declare minimum fuel.

At 1533, automatic terminal information service (ATIS) information indicated that Toronto had reduced visibility in thunderstorms and heavy rain, and rapidly changing weather conditions. After reviewing weather reports from possible alternate airports, they selected Ottawa — a decision that meant they would have fuel for six minutes of holding in Toronto.

They conducted a briefing for the instrument landing system (ILS) approach to Runway 24L but did not discuss runway length, missed approach procedure or landing distance calculations for a wet or contaminated runway, the report said.

Around 1540, some pilots on the same radio frequency told ATC that they were proceeding to alternate airports, but by 1549, when the accident crew requested and received a deviation because of weather on the approach, airplanes were landing.

'Pretty Bad' Weather

At 1553, "the number one aircraft on approach [the accident airplane was number three] was asked by ATC about their likelihood of being able to land," the report said. "The reply was that the weather was to the north and looking pretty bad."

The two airplanes ahead of the accident airplane were landed without incident.

At 1558, the report said, the accident airplane was "at the approach speed on final approach. The previous aircraft had reported that braking action was poor, the tower wind instruments were not functioning because they were knocked off line during thunderstorm activity, the last wind available in the tower was 230 degrees at 7 kt, and there was lightning all around the airport."

The crew of a regional jet landing ahead of the accident airplane reported winds from 290 degrees at 15 to 20 kt and said that braking action was poor until the airspeed decreased to less than 60 kt.

The crew of the accident airplane delayed the pre-landing checklist because the landing memo had not yet been displayed on the electronic centralized aircraft monitor (ECAM), and although they had acted on all items on the challenge-and-response checklist, the checklist itself was not completed before landing.

For the remainder of the approach, weather conditions fluctuated, but portions of the approach were conducted in "very dark clouds, turbulence and heavy rain," the report said.

"The runway was covered with water, producing a shiny, glasslike surface," the report added. "There was lightning on both sides and at the far end of the runway."

The airplane's navigation display indicated a right crosswind of 70 to 90 degrees at 15 to 20 kt. Autopilot and autothrust were engaged during the approach, and the airplane was stabilized on the localizer and glideslope at the targeted airspeed of 140 kt. At 1601, as the airplane descended through 323 ft above ground level (AGL), the first officer — the pilot flying (PF) — disengaged the autopilot and autothrust and increased engine thrust from about 42 percent of N1 (engine compressor speed) to 82 percent of N1 "because he sensed that the airspeed was decreasing and the aircraft was sinking," the report said.

"The aircraft then began to deviate above the glideslope, [and] the wind direction shifted, changing from a 90-degree crosswind component to an increasing tailwind component of up to 10 kt."

The airplane was 40 ft above the glideslope when it crossed the runway threshold and entered an area of heavy rain and lightning strikes; visual contact with the runway environment was "severely reduced," the report said. The PF began the flare when the airplane was 40 ft above the runway (Figure 2).

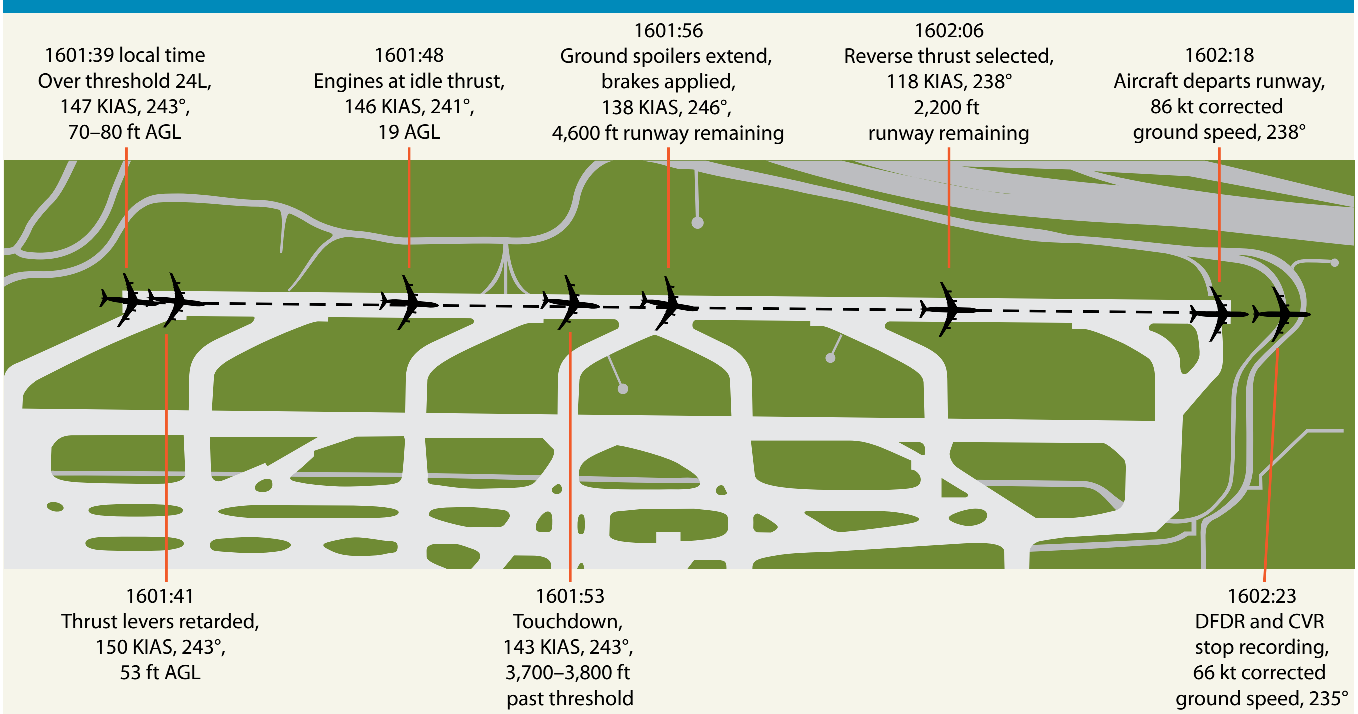
"From this point to touchdown, there were numerous and sometimes significant pitch inputs made on the PF side stick, and the aircraft leveled off at approximately 25 ft for a period of 2 ½ seconds," the report said. "There were also regular and sometimes large inputs in roll on the PF side stick. Combined, these inputs would indicate that significant workload and attention were required on the part of the PF to control the aircraft."

Throttle levers were moved to the idle position when the airplane was 20 ft above the runway.

After touchdown, the captain did not make the standard callouts for deployment of spoilers and reversers. The airplane was traveling at a groundspeed of 80 kt when it departed the end of the runway. Within seconds after the airplane stopped in the ravine, the cabin crew saw flames and ordered an evacuation.

Both flight crewmembers had airline transport licenses and Class 1 medical certificates. The captain had 15,411 flight hours, including 1,788 on

Key Events in Landing Sequence



AGL = above ground level; CVR = cockpit voice recorder; DFDR = digital flight data recorder; KIAS = knots indicated airspeed

Source: Transportation Safety Board of Canada

Figure 2


© Ernie Horvath/Airliners.net

[aircraft flight manual] and the aircraft touching down at the recommended speed, the aircraft would have used 5,574 ft (1,699 m) of runway." From the point that the accident airplane touched down, however, only 5,200 ft (1,586 m) of runway stopping distance remained.

Analysis of weather radar data found that, although there had been a downburst about eight km (five mi) northeast of Runway 24L at the time of the accident, wind conditions at the time were not those typically associated with microburst. Conditions precluded any significant upward wind component at the runway, the report said. Numerous lightning strikes occurred just before touchdown, including nine cloud-to-ground strikes at the end of the runway that were recorded in just one second.

Departures had been halted by a "red alert" — a warning of numerous lightning strikes at or near the airport …

type, and had been employed since 1997 by Air France, where he had a "good reputation for being easy to fly with," the report said.

The first officer had 4,834 flight hours, including 2,502 on type. He was hired by Air France as a cabin crewmember in 1985; he became a pilot for the company in 1997 and was considered "solid and competent," the report said.

The accident airplane was built in 1999. Total airframe time was 28,426 hours. The investigation found that all aircraft systems were working as intended and that weight and balance at the time of the accident were within normal limits.

Investigators calculated required stopping distances for Runway 24L using the environmental conditions present at the time of the landing and determined that, "for the actual touchdown speed of 143 KIAS [knots indicated airspeed], with a 10-kt tailwind and the actual deployment of thrust reverser time of 16.4 seconds, the aircraft would have stopped in 6,674 ft (2,034 m) after touchdown. … With full reverse thrust selected after touchdown in accordance with the AFM

'Red Alert'

At the time of the accident, Runway 24L was in use because other flight crews had refused to operate on Runway 23 — at the far end of the airport terminals, more than 3,500 ft (1,068 m) to the northwest — citing storms on the approach. Lightning strikes had rendered the ILS for Runway 24R and other runways unserviceable at various times in the hours before the accident. Departures had been halted by a "red alert" — a warning of numerous lightning strikes at or near the airport typically accompanied by operators' discontinuation of ground activities to protect ground personnel from lightning.

"During the course of the investigation, it was determined that a perception existed among both the occurrence pilots and other pilots that airports could be closed if weather conditions were too severe to allow approaches and landings to be conducted safely," the report said. "ATC may restrict the flow of aircraft into a particular airport due to weather conditions, but the ultimate decision to conduct an approach or landing rests with the pilot."

The report said that, although there have been numerous reports and studies on runway overrun accidents and many recommendations on how best to avoid them — including the Flight Safety Foundation *Approach and Landing Accident Reduction (ALAR) Tool Kit* — and although Air France recognized the potential for overrun accidents and took steps to prevent them, this accident "essentially fits the pattern of the accident these programs and training procedures were aimed at preventing."

The report said that only after the airplane was on very short final — when the airplane encountered intense precipitation and reduced visibility and departed from the glideslope — were there clear indications to the crew that a landing was unadvisable.

"The crew had two courses of action with potentially undesirable outcomes: proceed with an approach that was becoming increasingly difficult or conduct a missed approach into potentially dangerous conditions," the report said. "At that moment, although Air France procedures called for a go-around any time the ideal trajectory is not maintained up to thrust reverser deployment, the captain, doubting that a go-around could be conducted safely, committed to continue with the landing."

At the time, Air France procedures said that only the captain could call for a missed approach; after the accident, procedures were changed to allow either pilot to make the call.

Although Air France had guidelines about the distance required from convective activity during cruise flight, the airline — like many others — had no such guidelines for approach and landing, the report said. Air France had considered such guidelines after an earlier accident but concluded that their adoption would be "contrary to the goal of enabling crews to make decisions based upon each specific situation," the report said.

"However, some companies do provide such guidelines and, in some cases, directives related to approaches around thunderstorms. Previous accident investigations have recognized their value to assist crews in making decisions in situations where the choices before them are less than obvious."

After the accident, Air France revised sections of its operations manual that discussed thunderstorms. The TSB recommended that TC establish standards to restrict approaches and landings during thunderstorms and that TC and other civil aviation authorities require flight crews to "establish the margin of error between landing distance available and landing distance required before conducting an approach into deteriorating weather."

More Training

Another recommendation called for TC and other civil aviation authorities to require air transport pilots to undergo training "to better enable them to make landing decisions in deteriorating weather."

The report added, "Crews need to be more acutely aware that an approach near convective weather is a hazardous situation. … They must acquire a better understanding of all the conditions that they may expect to be faced with on final approach. They must be ready to conduct a missed approach at any time one of these conditions escapes their control or understanding. They must not get themselves into a situation where the missed approach option is no longer available."

The asphalt blast pad and grassy area beyond the departure end of Runway 24L extend for 200 ft/60 m, the minimum length required by TC but shorter than the 1,000-ft/300-m runway end safety area (RESA) recommended by the International Civil Aviation Organization (ICAO), the report said. If the Runway 24L RESA had been constructed in accordance with the ICAO recommendation, "an obstacle-free overrun area, free of hazardous ruts, depressions and other surface variations, would have extended to … approximately 75 m [246 ft] beyond Convair Drive [about the point where the accident airplane stopped]. Similarly, if the requirement had been the same as those established by the U.S. Federal Aviation Administration (FAA) — calling for either a 1,000-ft /300-m RESA or a 600-ft/200-m engineered materials arresting system (EMAS) — "the damage to aircraft and injuries to the passengers may have been reduced," the report said.

After the accident, TC said that, after a review of RESA specifications and related information, it would require all airports to construct RESAs. The TSB issued a safety recommendation calling on TC to require construction of a 1,000-ft/300-m RESA at the end of all runways longer than 2,400 m (7,874 ft), or an alternative means of "stopping aircraft that provides an equivalent level of safety." ●

This article is based on TSB Aviation Investigation Report A05H0002, "Runway Overrun and Fire, Air France, Airbus A340-313 F-GLZQ, Toronto/Lester B. Pearson International Airport, Ontario, 02 August 2005."

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Lighting Strikes

Realistic lighting conditions are crucial to tests of the readability of flight deck displays.

BY CLARENCE E. RASH

When pilots are taxiing their aircraft to a runway for takeoff, little if any thought is given to the effort that has gone into ensuring that the instruments are readable — that is, until they aren't. One of the most challenging display lighting situations occurs during the day, with full sunlight reflecting off the displays. Another occurs at night, for helicopter pilots using night vision goggles (NVGs). Inadequate instrument lighting design can make reading the displays impossible in either situation.

Flight decks are affected by a range of lighting conditions, often during a single flight. The lighting environment is derived from three sources:

- Outside ambient lighting, which can be both natural and artificial, is dominant. Natural contributors are the sun, the moon and stars. Outside artificial light sources include runway lights, surrounding operational lighting and city/industrial background lights;
- Interior compartment lighting, which may include instrument-panel lights and overhead lights; and,
- Supplemental utility lighting, which pilots may introduce in the form of flashlights, chemical light sticks and other auxiliary lighting.

Whatever the lighting environment, pilots must be able to access instrument data whenever it is needed. During the day, there must be sufficient illumination without glare, adequate contrast between the displayed information and the background, and acceptable color rendition.[1]

At night, flight deck lighting must provide uniform illumination throughout the crew station and a minimal level of illumination to allow pilots to acquire information, to activate switches and controls, to consult navigational charts and yet not degrade the ability to perform additional visual tasks outside the flight deck, such as detecting and identifying obstacles, locating landmarks and scanning for other aircraft.

Instrument lighting must not interfere with the operation of NVGs.

Evaluation Challenge

The many types of display technologies, lighting conditions and visual tasks in today's aircraft place great demands on the lighting designer. Designs are driven and complicated by the limited space of the modern crew station, the differing operating principles of various display technologies and the wide range of ambient lighting conditions under which displays are used. Nevertheless, the actual lighting values achieved on the flight deck are most important. Test and evaluation engineers validate whether the displays provide the required luminance (brightness), contrast, color and other visual display characteristics that define acceptable readability.

The necessary validation must be accomplished through a set of assessments using quantitative tests and operator evaluations of readability and legibility in an authentic set-up of all flight deck displays, instruments and control panels under a comprehensive complement of realistic ambient lighting conditions.[2]

These quantitative assessments require instruments to measure visible light, color and specific forms of light energy. The first analysis of display performance involves basic measurement of the aircraft instruments themselves, conducted in darkened laboratories. These results are compared with specifications and assigned a pass/fail rating. If the instrument display passes the qualification tests, it next may undergo limited user acceptance tests in flight deck mock-ups. Well-designed human factors studies and surveys are used to evaluate user performance in these controlled but not very realistic settings.

Although the tests can be arduous and require meticulous effort, they also are straightforward. Lighting measurements of any kind often are considered half science and half art, and the skills required to conduct the measurements are obtained more through experience than through training. But even the best test and measurement approach in artificial environments is an approximation of the actual performance that will be achieved in the real-world environment. This is especially true in aviation lighting.

The real challenge in validating the true performance of instrument displays lies in reproducing realistic lighting conditions that represent the lighting environments of full sunlight, dawn/dusk, moonlight and starlight.

Simulating the Sun

To provide realistic lighting conditions in a testing facility and to minimize the costs of testing, Alenia Aeronautica designed and built a sophisticated test and evaluation lighting facility at Turin (Italy) International Airport. The facility provides a cost-effective methodology for evaluating actual, full-scale, state-of-the-art aircraft displays under virtually the full range of ambient lighting conditions.[3]

The Alenia Aeronautica facility Sky Light Simulator (SLS) consists of 79 lighting panels and 112 reflective panels, a sun simulator and a cooling system. The lighting panels each contain a variable number of fluorescent tubes to reproduce the appropriate lighting condition. All panels are controlled by computer and can be configured for a specific sky luminance pattern. Lamp performance is stabilized and prolonged by a cooling system that recirculates the ambient air 60 times per second while maintaining the dome environment at 50 percent humidity and from 59 degrees F to 77 degrees F (15 degrees C to 25 degrees C).

The sun simulator uses a 12-kW lamp to illuminate the dome center. The simulator can be operated in two modes, either to reproduce the effect of direct sunlight into the cockpit or to reproduce a solar disk of the correct apparent size. An approximately 29-ft (9-m), two-axis, moveable mechanical arm allows the lamp of the sun simulator to be positioned at any location around the aircraft.

The effects of clouds are simulated by two lamp projectors used in conjunction with the light panels. This is most useful in evaluating a pilot's ability to discern symbology presented on head-worn — or helmet-mounted — displays.

Dawn and dusk illumination conditions are achieved by using another light projector.

By combining the various lighting simulations, many "worst case" lighting scenarios such as these can be created and tested:[4]

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- A daytime combination of direct sunlight, sky diffuse light and cloud-diffused light;
- A nighttime combination of moonlight and starlight;
- High ambient lighting, rear sun position;
- High ambient lighting, front sun position;
- Dawn/dusk, front sun position; and,
- Low ambient lighting, with or without NVGs.

Moon and Stars

With the emergence of NVGs in the civilian cockpit, lighting and its effects on pilot performance take on a new emphasis. Because modern NVGs amplify the intensity of light approximately 2,000 times, even small levels of light that cannot be detected by the human eye can greatly affect NVG performance — and, as a result, pilot performance.

NVGs are designed to allow pilots to view outside scenes under lighting conditions that extend down to the overcast starlight range. NVGs have automatic circuitry that increases or decreases their light amplification, or gain, in response to the level of outside ambient light. Unfortunately, NVGs are unable to differentiate between light originating outside the aircraft and inside. As a consequence, inadequate interior lighting design can negatively affect NVG performance by unintentionally reducing the amplification of exterior light as the NVGs respond to the specific cockpit instrument lighting. The possible outcome is that pilots have a reduced capability to view critical outside scenes, an outcome that may go unnoticed by the pilots.[5]

This unobserved effect of flight deck lighting on NVG/pilot performance makes evaluation essential when NVGs are the primary source of visual flight information. This simulation and testing under nighttime lighting conditions is one of the most difficult procedures.

To provide the unique lighting requirements needed for testing pilot performance with NVGs, the night system used by Alenia Aeronautica employs a dedicated specialized light source to simulate the nighttime moon and star conditions.

The nighttime projector consists of dual sets of halogen lamps and illuminates the flight deck indirectly. Black curtains reduce stray light — an essential quality for NVG evaluations — by blocking external light and absorbing internal reflections.

Aircraft, Trains and Automobiles

The SLS also tests actual, full-size aircraft over the simulator's full range of lighting conditions. Anna Russo, aerospace engineer with Alenia Aeronautica, said that the facility "can host a multitude of aircraft, both fixed- and rotary-wing, as well as automobiles and train locomotives." The facility is built on a 30-ton (27-metric ton) steel frame supporting a 12-m (39-ft) diameter spherical dome above a cylindrical drum.[6]

The structure has a specialized opening — about 10 m by 6 m (33 ft by 20 ft) — that accommodates the front fuselage of an aircraft. A customized system of doors and curtains completes the light-tight sealing needed for the lighting tests.

By reproducing an array of fully controllable lighting environments and presenting these conditions directly onto actual aircraft, the SLS has several advantages, including its availability regardless of outside weather conditions, its objectivity and repeatability in measurements and a full range of computer-controllable illumination levels.[7]

In addition to supporting lighting tests and evaluations for the aircraft industry, the SLS is a laboratory for other lighting testing activities, including architectural assessments, vision and psychophysical research, aeromedical research, and human factors and ambient lighting interactions.

To ensure safety during testing and evaluation activities, a number of sensors are deployed. Included are fuel vapor detectors and fire detectors located in the dome region and smoke and fuel detectors in the air-cooling system. A fire-suppression system incorporates foam dispensers and water sprinklers. ●

Clarence E. Rash is a research physicist at the U.S. Army Aeromedical Research Laboratory at Fort Rucker, Alabama, U.S. He has three decades of experience in aviation safety, operational performance and human factors issues.

Notes

1. Godfrey, G.W. *Principles of Display Illumination Technologies for Aerospace Crew Stations*. Tampa, Florida, U.S.: Aerospace Lighting Institute, 1991.
2. Russo, A.; Fabbri, M. "Ambient Lighting Simulation for Human-Vehicle Integration Purposes: The Alenia Aeronautica Sky Light Simulator." Presented at North Atlantic Treaty Organization Human Factors and Medical Conference (HFM-141), Crete, Greece, 2007.
3. Alenia Aeronautica. *Sky Light Simulator*. 2006.
4. Ibid.
5. Rash, C.E.; Verona, R.L. *Cockpit Lighting Compatibility with Image Intensification Night Imaging Systems: Issues and Answers*. Fort Rucker, Alabama, U.S.: U.S. Army Aeromedical Research Laboratory. USAARL Report No. 89-6, 1989.
6. Alenia Aeronautica.
7. Ibid.

Making Headway on the Runway

The FAA is meeting its performance targets for limiting runway incursions.

BY RICK DARBY

"For each of the FYs [fiscal years] 2003 through 2006, the FAA met its performance targets to reduce the most severe (category A and B) runway incursions," the U.S. Federal Aviation Administration (FAA) says in its latest report.[1,2] "The category A and B incursion rate for FY 2006 was 0.51 incursions per million operations, which is 7 percent less than the FY 2006 performance target of 0.55 incursions per million operations."

The FAA analyzes incursions according to safety metrics that include frequency, severity and type. Frequency is expressed both as numbers and rates. Severity considers factors such as the speed and performance characteristics of the aircraft involved, the proximity of the aircraft to another aircraft, vehicle, person or object, and the evasive action taken (Figure 1).

The FAA performance target is to limit category A and B incursions to a rate of no more than 0.45 per million operations by 2010 and maintain or improve that rate through 2011.[3]

FAA Severity Categories of Runway Incursion

Increasing Severity →

Category D	Category C	Category B	Category A
Little or no chance of collision but meets the definition of a runway incursion	Separation decreases but there is ample time and distance to avoid a collision	Separation decreases and there is a significant potential for collision	Separation decreases and participants take extreme action to narrowly avoid a collision, or the event results in a collision

FAA = U.S. Federal Aviation Administration

Source: U.S. Federal Aviation Administration

Figure 1

Runway Incursion Severity Distribution, U.S. Towered Airports, 2003–2006

	FY 2003		FY 2004		FY 2005		FY 2006		Total	
	Number	Rate per Million Operations	Number	Rate per Million Operations	Number	Rate per Million Operations	Number	Rate per Million Operations	Number	Rate per Million Operations
Category D	181	2.88	178	2.82	203	3.22	224	3.65	786	**3.14**
Category C	110	1.75	120	1.90	95	1.51	75	1.22	400	**1.60**
Category B	22	0.35	16	0.25	15	0.24	7	0.11	60	**0.24**
Category A	10	0.16	12	0.19	14	0.22	24	0.39	60	**0.24**
Total	**323**	**5.10**	**326**	**5.20**	**327**	**5.20**	**330**	**5.40**	**1,306**	**5.20**

FY = FAA fiscal year, Oct. 1 through Sept. 30.

Source: U.S. Federal Aviation Administration

Table 1

Of the more than 500 U.S. towered airports, 215 (43 percent) had no runway incursions, 215 had one to five incursions and 47 airports (9 percent) had six to 10 incursions from 2003 through 2006. Twenty-seven airports (5 percent) had more than 10 runway incursions, including two airports that had more than 30.

The numbers and rates of incursions were little changed from 2003 through 2006, with an average of 5.2 incursions per million operations (Table 1, p. 49). The three more incursions in 2006 compared with 2005 brought the rate for that year to 5.4 per million operations, a 4 percent increase.

Runway Incursion Severity

From 2003 through 2006, 120 of the 1,306 runway incursions were category A or B. Four category A runway incursions ended in collisions during the four-year period — three in 2003 and one in 2005. One of those collisions involved a commercial aircraft, a freighter, and no fatalities resulted.

"The composition of runway incursions has changed over the four-year period," the report says. "Category B incursions decreased substantially from 22 in [2003] to seven in [2006]."

Commercial aviation operations accounted for 582 of the total 1,306 incursions, or 45 percent, in the 2003–2006 period.[4]

At least one commercial aircraft was involved in 23 category A incursions and 14 category B incursions during the four-year period (Table 2). The two categories combined

Severity of Commercial Aviation Runway Incursions, U.S. Towered Airports, 2003–2006

	FY 2003	FY 2004	FY 2005	FY 2006	Total
Category D	80	79	100	106	**365**
Category C	50	54	39	37	**180**
Category B	6	3	3	2	**14**
Category A	3	6	6	8	**23**
Total	**139**	**142**	**148**	**153**	**582**

FY = FAA fiscal year, Oct. 1 through Sept. 30.

Note: Incursions involve at least one commercial aviation aircraft.

Source: U.S. Federal Aviation Administration

Table 2

FAA Classification of Runway Incursions

Operational Errors/ Deviations	An operational error (OE) is an action of an air traffic controller (ATC) that results in: • Less than the required minimum separation between two or more aircraft, or between an aircraft and obstacles (e.g., vehicles, equipment, personnel on runways). • An aircraft landing or departing on a runway closed to aircraft. An operational deviation (OD) is an occurrence attributable to an element of the air traffic system in which applicable separation minima were maintained, but an aircraft, vehicle, equipment, or personnel encroached upon a landing area that was delegated to another position of operation without prior coordination and approval.
Pilot Deviations	A pilot deviation (PD) is an action of a pilot that violates any Federal Aviation Regulation. For example, a pilot fails to obey air traffic control instructions to not cross an active runway when following the authorized route to an airport gate.
Vehicle/ Pedestrian Deviations	A vehicle or pedestrian deviation (V/PD) includes pedestrians, vehicles, or other objects interfering with aircraft operations by entering or moving on the movement area without authorization from air traffic control. Note: This runway incursion type includes mechanics taxiing aircraft for maintenance or gate re-positioning.

FAA = U.S. Federal Aviation Administration

Source: U.S. Federal Aviation Administration

Table 3

Numbers and Rates for Incursion Types, U.S. Towered Airports, 2003–2006

	FY 2003		FY 2004		FY 2005		FY 2006		Total	
	Number	Rate per Million Operations	Number	Rate per Million Operations	Number	Rate per Million Operations	Number	Rate per Million Operations	Number	Rate per Million Operations
Pilot Deviations	174	2.8	173	2.7	169	2.7	190	3.1	706	**2.8**
Operational Errors/Deviations	89	1.4	97	1.5	105	1.7	89	1.5	380	**1.5**
Vehicle/Pedestrian Deviations	60	1.0	56	0.9	53	0.8	51	0.8	220	**0.9**
Total									**1,306**	**5.2**

FY = FAA fiscal year, Oct. 1 through Sept. 30.

Source: U.S. Federal Aviation Administration

Table 4

represented 6 percent of commercial aircraft incursions. The annual number of category A incursions involving a commercial aircraft was largest — eight — in 2006. Category B incursions declined over the four years and represented a smaller percentage of the total for commercial aircraft than those of Category A.

Persistent Pilot Deviations

FAA categories split runway incursions into three error types: pilot deviations, operational errors/deviations and vehicle/pedestrian deviations. The criteria are in Table 3.

Pilot deviations were found in 706 of 1,306 incursions in the four-year period, or 54 percent (Table 4). "During that time, the FAA focused efforts on reducing pilot deviations through awareness, education, procedures and surface technology initiatives," the report says.

Nevertheless, the rate was 0.4 per million operations higher in 2006 than the period's lowest rate. The rate of pilot deviations was 2.8 or 2.7 per million from 2003 through 2005, rising in 2006 to 3.1 per million. During the four-year period, 55 of 120, or 46 percent, of incursions in categories A and B involved pilot deviations, the FAA says.

Limiting the picture to commercial aviation, pilot deviations were responsible for 273 incursions, or 47 percent of the total of 582 in all categories (Table 5). Operational errors/deviations accounted for 222 incursions, or 38 percent, and 87 incursions, or 15 percent, were ascribed to vehicle/pedestrian deviations.

"The total number of combined category A and category B operational errors/deviations involving a commercial aircraft increased from [2003] through [2005] and decreased by one in [2006]," the report says. "Category A incursions increased during the four-year period, with a total of four commercial aviation operational errors/deviations in [2006] compared to one in [2003]." No commercial operational errors/deviations in category B occurred in 2006.

Numbers and Types of Runway Incursions, Commercial Aviation, U.S. Towered Airports, 2003–2006

	FY 2003	FY 2004	FY 2005	FY 2006	Total
Pilot Deviations	63	67	74	69	**273**
Operational Errors/Deviations	50	58	54	60	**222**
Vehicle/Pedestrian Deviations	26	17	20	24	**87**
Total					**582**

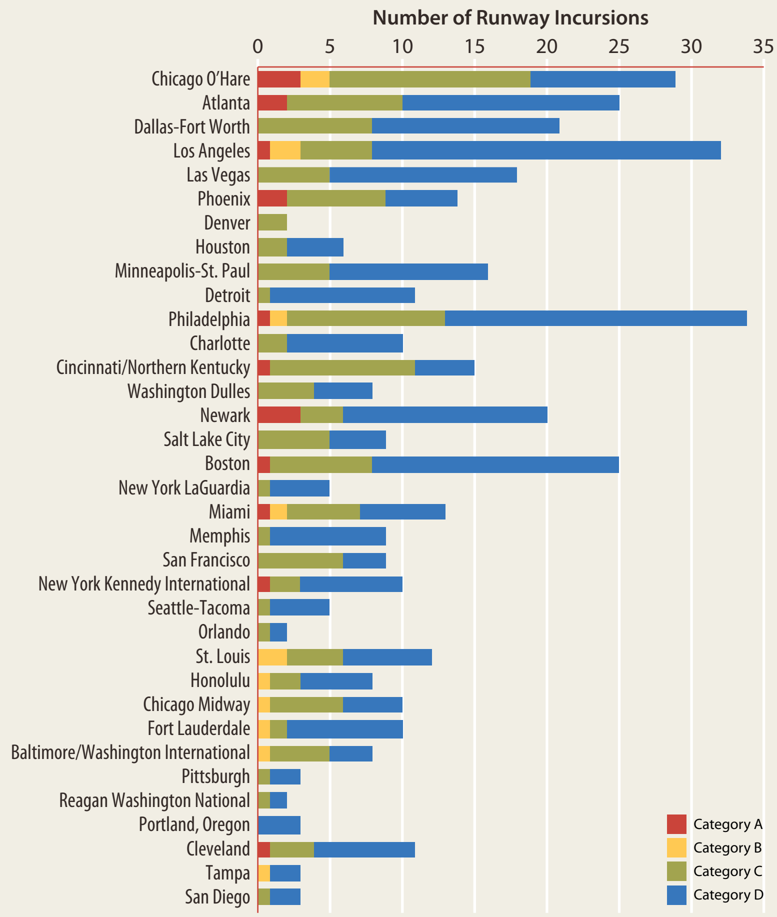
FY = FAA fiscal year, Oct. 1 through Sept. 30.

Note: Incursions involve at least one commercial aviation aircraft.

Source: U.S. Federal Aviation Administration

Table 5

Numbers and Severity of Runway Incursions at 35 U.S. Airports, 2003–2006



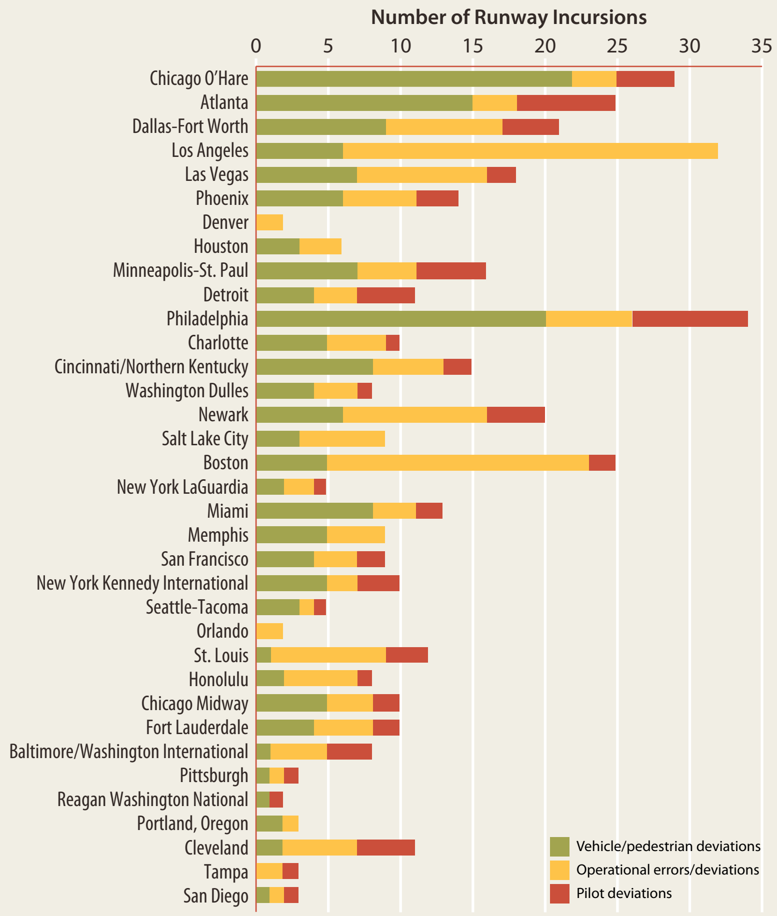
FY = U.S. Federal Aviation Administration fiscal year, Oct. 1 through Sept. 30.

Notes: The 35 airports are those identified in the FAA Operational Evolution Partnership. Airports arranged in decreasing number of operations (FY 2003 through FY 2006).

Source: U.S. Federal Aviation Administration

Figure 2

Numbers and Types of Runway Incursions at U.S. Airports, 2003–2006



FY = U.S. Federal Aviation Administration fiscal year, Oct. 1 through Sept. 30.

Notes: The 35 airports are those identified in the FAA Operational Evolution Partnership. Airports arranged in decreasing number of operations (FY 2003 through FY 2006).

Source: U.S. Federal Aviation Administration

Figure 3

Of the 87 commercial aviation vehicle/pedestrian deviations in the four-year period, seven, or 8 percent, were in category A or B.

"Five of these seven incursions were in category A; the number of category A incursions fluctuated during this period," the report says. "Category B commercial aviation incursions classified as vehicle/pedestrian deviations decreased from two in [2003] to zero in each of the following years included in this period."

Airports identified in the FAA Operational Evolution Partnership (OEP), known as OEP-35 airports, primarily handle commercial aviation and have a large traffic volume. Their runway incursion records were analyzed for correlations between incursions and traffic. Figure 2 (p. 51) shows the numbers and severity of incursions at the OEP-35 airports for the 2003–2006 period. At these airports, category A and B incursions accounted for 4 percent and 3 percent, respectively, of the total.

The numbers and types of incursions at the OEP-35 airports are shown in Figure 3. Operational errors/deviations were the largest single category, at 42 percent of the total. Pilot deviations, at 40 percent, and vehicle/pedestrian deviations, at 18 percent, were next in the ranking. ●

Notes

1. FAA. *FAA Runway Safety Report: Runway Incursion Trends and Initiatives at Towered Airports in the United States, FY 2003 through FY 2006.* Accessible via the Internet at <www.faa.gov/runwaysafety/pdf/rireport06.pdf>.

2. Throughout the study period, the FAA defined a runway incursion as "any occurrence in the airport runway environment involving an aircraft, vehicle, person or object on the ground that creates a collision hazard or results in a loss of required separation with an aircraft taking off, intending to take off, landing or intending to land." According to the definition, an aircraft could mistakenly enter a runway without a clearance, but that would not be classified as an incursion if no conflict were created. On Oct. 1, 2007, the FAA adopted the International Civil Aviation Organization's definition, which refers to the "incorrect presence" of an aircraft, regardless of whether there is a conflict.

3. For the sake of readability, fiscal years from this point on are referred to in the text as calendar years. The FAA fiscal year is Oct. 1 through Sept. 30. The reader should keep in mind that, for example, "2006" actually means "fiscal year 2006."

4. Commercial operations, as used in the report, involve airlines, charter services and air cargo.

At Your Surface

The FAA has implemented most of its planned runway and ramp safety improvements, but ASDE-X implementation is lagging.

REPORTS

Aviation Runway and Ramp Safety: Sustained Efforts to Address Leadership, Technology, and Other Challenges Needed to Reduce Accidents and Incidents

U.S. Government Accountability Office (GAO). Report no. GAO-08-29. November 2007. Figures, tables, appendixes. Available via the Internet at <www.gao.gov/new.items/d0829.pdf> or from GAO.*

The U.S. Federal Aviation Administration (FAA) is implementing its Next Generation Air Transportation System (NextGen) to better manage air traffic, both in flight and on the ground. The GAO was asked by a U.S. congressional subcommittee to evaluate (1) the progress being made in addressing runway safety and what additional measures, if any, could be taken, and (2) the factors affecting progress in ramp safety and what is being done to address them.

"FAA and other aviation stakeholders have taken steps to address runway and ramp safety, but the lack of coordination and leadership, technology challenges, the lack of data and human factors–related issues impede further progress," the report says.

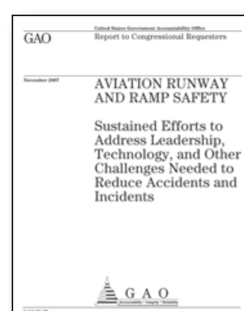
The GAO analysis determined that the FAA had completed or was implementing 34 of the 39 initiatives in its 2002 national runway safety plan. Four initiatives had been canceled, and one — meeting published milestones for Airport Surface Detection Equipment, Model X (ASDE-X) — had not been achieved.

"Most of the completed objectives involved (1) developing and distributing runway safety education and training materials to controllers, pilots and other airport users; (2) supporting and developing new technologies intended to reduce the potential for runway collisions; and (3) assessing and modifying procedures to enhance runway safety," says the report. "The results of our survey of experts indicated that the most effective actions that FAA was taking were lower-cost measures, such as enhancing airport markings, lighting and signage."

One system being tested by FAA is runway status lights, embedded in runways, which change color to warn pilots when a runway is not clear, and require no input from controllers. Also in the testing stage is a similar system of flashing lights visible to aircraft on approach, to alert pilots that a runway is occupied and unsafe for landing.

To operate automatically, runway status lights require data from surface surveillance systems such as ASDE-X or its earlier version, ASDE-3. The main value of the surveillance systems, however, is to give controllers a better understanding of what is going on throughout the network of runways and taxiways by integrating data from various sources, including radar and aircraft and vehicle transponders.

ASDE-X "has experienced cost increases and schedule delays from its original baselines and is encountering some operational difficulties," the report says. "At the same time, additional technology to prevent runway collisions is years away from deployment. … FAA has revised its cost and schedule plans twice since 2001 to deploy ASDE-X at 35 airports by 2011." As of August 2007, ASDE-X was commissioned at 11 airports.


GAO
Report to Congressional Requesters
AVIATION RUNWAY AND RAMP SAFETY
Sustained Efforts to Address Leadership, Technology, and Other Challenges Needed to Reduce Accidents and Incidents
GAO

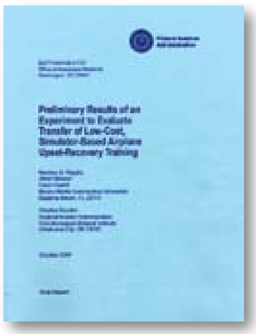
"Although it took about four years for ASDE-X to be commissioned at those 11 airports, FAA plans to deploy the system at the remaining 24 additional airports in less than four years," the report says. "Furthermore, not all 11 ASDE-X commissioned airports have key safety features of the system. For example, as of August 2007, three of the ASDE-X commissioned airports did not have safety logic, which generates a visible and audible alert to an air traffic controller regarding a potential runway collision. Moreover, five airports, including the three lacking safety logic, do not have a system enhancement that allows ASDE-X to alert controllers of potential collisions on intersecting runways or runways intersecting taxiways during inclement weather."

In addition, "air traffic controller fatigue, which may result from regularly working overtime, continues to be a matter of concern," the report says. "We found that, as of May 2007, at least 20 percent of the controllers at 25 air traffic control facilities, including towers at several of the country's busiest airports, were regularly working six-day weeks."

Improvement of ramp safety is being hindered by a lack of a complete source of data on ramp accidents and lack of comprehensive standards, the report says.

"We found no federal or industrywide standards for ramp operations," the report says. "The federal government has generally taken an indirect role in overseeing ramp safety; airlines and airports typically control the ramp areas using their own policies and procedures. Meanwhile, some airlines and airports have initiated their own efforts to address ramp safety, and aviation organizations have begun collecting ramp accident data. We asked experts to provide their views on those industry efforts, and they indicated that the most effective ones were being taken mainly by airlines, for example, by setting safety targets and using ramp towers."

The GAO recommends that the FAA take measures that include "preparing a new national runway safety plan, improving data collection on runway overruns and ramp accidents, and addressing air traffic controller overtime and fatigue issues that may affect runway safety."



Preliminary Results of an Experiment to Evaluate Transfer of Low-Cost, Simulator-Based Airplane Upset-Recovery Training

Rogers, Rodney O.; Boquet, Albert; Howell, Cass; DeJohn, Charles. U.S. Federal Aviation Administration (FAA) Office of Aerospace Medicine. DOT/FAA/AM-07/27. Final report. October 2007. 21 pp. Figures, tables, references. Available via the Internet at <www.faa.gov/library/reports/medical/oamtechreports/2000s/media/200727.pdf> or from the National Technical Information Service.**

Upset-recovery training is becoming widespread as a means of reducing the likelihood of loss of control in flight, which was second only to controlled flight into terrain as a cause of fatal accidents worldwide. Many training programs seek to teach recovery from unusual attitudes, such as extreme pitch and bank angles, using classroom instruction and low-cost training devices. The report says that the experiment it describes was an attempt to evaluate the effectiveness, which had previously been little researched, of such training.

The experiment was designed to test the hypothesis that a group of trained participants — the experimental group — will outperform a group of untrained participants — the control group — in an actual airplane in flight. The control and experimental groups, pilots studying at Embry-Riddle Aeronautical University, numbered 28 and 30 participants with 277.3 and 235.9 mean flight hours, respectively.

The experimental group received 10 hours of classroom and 10 hours of simulator-based aerobatics and upset recovery training. The simulations used Microsoft Flight Simulator 2002 software running on computers with high-fidelity graphics cards. Aerobatics and upset recovery procedures were practiced under simulated visual meteorological conditions and instrument meteorological conditions. The control group received no classroom or simulator training.

Flight testing was performed using a Beech Bonanza E33C equipped with a flight data recorder (FDR) and a cockpit-mounted video recorder (VR). The VR was focused on the participant's instrument panel and showed airspeed, vertical speed, altitude, attitude, g force, manifold pressure and yoke movement. The FDR added measurements of yoke movement and rudder pedal displacement.

"During testing, each participant was subjected to four randomly ordered upsets," the report says. "For each upset, a participant was told to close his or her eyes while the safety pilot induced the upset. Then — when instructed to do so — the now open-eyed participant assumed control of the airplane and attempted to recover it to straight and level flight." The safety pilot intervened if needed. If a participant pilot returned the aircraft to straight and level flight with no verbal or physical assistance from the safety pilot, the recovery was considered successful; otherwise, unsuccessful.

The experiment encountered practical problems, such as recording-equipment failures, described in the report. The researchers "failed to obtain, or discarded, a significant amount of data," says the report.

Nevertheless, using what they had, the researchers analyzed the data and found statistically significant differences in some measures related to the four categories of upset — nose-high upright, nose-low upright, nose-high inverted and nose-low inverted.

"Experimental group performance exceeded control group performance 44.4 percent of the time," the report says. "This superiority appeared in all four [categories of] upsets and in six of the nine dependent measures [such as average g during pullout]. By contrast, in three dependent measures — altitude loss, seconds to first roll and rudder input — there was never a significant difference between experimental and control group performance."

Time Series Analyses of Integrated Terminal Weather System Effects on System Airport Efficiency Ratings

Pfleiderer, Elaine M.; Goldman, Scott M.; Chidester, Thomas. U.S. Federal Aviation Administration (FAA) Office of Aerospace Medicine. DOT/FAA/AM-07/28. Final report. October 2007. 28 pp. Figures, tables, references. Available via the Internet at <www.faa.gov/library/reports/medical/oamtechreports/2000s/media//200728.pdf> or from the National Technical Information Service.**

The FAA has adopted the System Airport Efficiency Rate (SAER), a metric of air traffic control's ability to handle arrivals or departures by adjusting for weather, averaged over time. But, the report says, although the SAER has been widely accepted and used at U.S. airports, the question remains whether it is "sensitive enough to evaluate the efficacy of interventions aimed at improving performance during inclement weather."

One such intervention is the Integrated Terminal Weather System (ITWS), a suite of weather information products for improving air terminal planning, capacity and safety. ITWS integrates sensors and information systems from the FAA and National Weather Service into displays of current and predicted weather conditions for controllers and facility managers to use in decision making.

To assess SAER's ability to measure the effectiveness of ITWS, researchers used time series analysis, in which "data are statistically modeled to remove the lingering effects of previous scores, general trends and the lingering effects of preceding random errors," the report says. "Once outside sources of systematic variation have been removed, interventions may be tested to determine whether they have an effect."

Two time series analyses were conducted for each of 13 major U.S. airports. "Though some statistically significant effects were found (both positive and negative), the patterns of these effects were not consistent enough to draw any definite conclusions about the efficacy of the ITWS implementation," the report says. "Though the SAER is clearly doing what it was intended to do on a daily basis, it may 'control out' the variance needed to detect the consequences of interventions."

WEB SITES

U.S. Federal Aviation Administration (FAA), <www.faa.gov>

The FAA Web site is so large and diverse that users may not be aware of all the resources it contains.

To help, *ASW* sifted through the FAA Web site for free educational materials and learning tools. Following is a partial list of direct links. Videos listed are in color with sound. Several are also available with captions. All are viewable online with standard Internet video players. Manuals, booklets and brochures can be read online, downloaded or printed.

- "Physiology of Flight" is a video collection of numerous health topics such as fatigue, oxygen equipment, physics of the atmosphere and self-imposed stress: <www.faa.gov/safety/programs_initiatives/health/physiologyvideos>.

- "Aircrew Survival" videos cover hot and cold land survival; survival kits, life rafts and accessories; and surviving on open water: <www.faa.gov/safety/programs_initiatives/health/aircrewsurvivalvideos>.

- Pilot Safety Brochures are written for commercial and general aviation pilots. The FAA says, "Brochures acquaint pilots with the physiological challenges of the aviation environment." Subjects are varied and include alcohol and flying, hearing and noise, spatial disorientation, fatigue, vision and medications. Most are five to six pages with color illustrations. Instructions for obtaining hard copy versions are included in brochures: <www.faa.gov/pilots/safety/pilotsafetybrochures>.

- *Reducing the Number of Vehicle/Pedestrian Deviations at Your Airport* is a brochure written for airport operators discussing requirements for vehicle operators and vehicles: <www.faa.gov/runwaysafety/pdf/vpdrev.pdf>.

- The video package, "Driving on the Airport Operations Area," was produced in English and Spanish versions and has a facilitator's guide and booklet: <www.faa.gov/runwaysafety/aoa.cfm>.

- "Test Your Knowledge" is five online self-assessment exercises for pilots about airport taxiway markings, taxi and air traffic control instructions, runway incursions and situational awareness: <www.faa.gov/runwaysafety/knowledge.cfm>.

- *Runway Safety: It's Everybody's Business* is a 119-page, illustrated handbook about runway incursions. Written for pilots and controllers, the subtitle explains its focus —*What Pilots Can Do to Improve the Safety of Surface Operations*: <www.faa.gov/runwaysafety/pdf/handbook.pdf>.

- "ILS, PRM & SOIA Approaches: Information for Air Carrier Pilots" lists training videos on the instrument landing system, parallel runway monitor system and simultaneous offset instrument approaches. There is also a question and answer review for pilots: <www.tc.faa.gov/acb300/330_video_PRMSOIA.asp>.

- "Controlled Flight Into Terrain (CFIT) Education and Training Aid" includes two volumes and a video. The introduction says, "Preventing CFIT accidents is the major goal of this training aid." Some sections of the training aid are aimed at upper level management, industry regulators and operators. Other sections contain information about training programs, selected readings and "CFIT causal factors, traps and solutions": <www.faa.gov/education_research/training/media/cfit/volume1/titlepg.pdf>. The video does not appear online. The training package with video is available from Flight Safety Foundation, which played a key role in its development.

- "Wake Turbulence Training Aid" was developed to reduce the number of accidents and incidents through pilot and air traffic controller education. The complete document is online: <http://www.faa.gov/education_research/training/media/wake/03SEC1.PDF>.●

Sources

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441 G St. NW, Room LM
Washington, DC 20548 USA
Internet: <www.gao.gov>

** National Technical Information Service
5385 Port Royal Road
Springfield, VA 22161 USA
Internet: <www.ntis.gov>

— *Rick Darby and Patricia Setze*

Throttle Trouble

Inadvertent thrust increase caused a fatal overrun.

BY MARK LACAGNINA

The following information provides an awareness of problems in the hope that they can be avoided in the future. The information is based on final reports by official investigative authorities on aircraft accidents and incidents.

JETS

'The Crew Failed to Perceive the Cause'

Airbus A310. Destroyed. 125 fatalities, 41 serious injuries.

The A310 overran the runway while landing at Irkutsk, Russia, the morning of July 8, 2006. The airplane struck the reinforced concrete airport perimeter fence and several brick garages before stopping, said the report by the Russian Interstate Aviation Committee. Both pilots, three cabin crewmembers and 120 passengers were killed. Three cabin crewmembers and 38 passengers were seriously injured. Twenty-two passengers sustained minor injuries, and 15 escaped injury. The A310 was destroyed by the impact and fire.

The airplane was on a scheduled flight from Moscow. The captain, 45, had 10,611 flight hours, including 1,056 flight hours in type. He had flown Antonov An-24s, Boeing 757s and Tupolev Tu-154s before transitioning to A310s in May 2005. The copilot, 48, had 9,771 flight hours, including 158 flight hours in type. He had flown An-26s as a captain and Tu-154s as a copilot before transitioning to A310s two months before the accident. The report noted that while transitioning from the three-pilot Tu-154 to the two-pilot A310, neither the captain nor the copilot had received crew resource management training on two-pilot operations. The pilots had conducted 12 previous A310 flights together.

The flight crew that had conducted the previous flight in the accident airplane had reported a malfunction of the thrust reverser on the left engine, and it had been deactivated by maintenance personnel in accordance with the A310's minimum equipment list before the airplane departed from Moscow.

The flight to Irkutsk was uneventful. The report noted, however, that the copilot used an incorrect radio frequency to report to air traffic control (ATC) that they were beginning descent. After correcting the error, the copilot told the captain, "I didn't switch it over. … It's night, and we're not getting enough sleep."

The Irkutsk airport was reporting surface winds from 270 degrees at 4 m/second (8 kt), 3,600 m (2 1/4 mi) visibility with weak rain showers and an overcast ceiling at 190 m (623 ft). The runway was wet, and braking action was reported as good.

The crew disengaged the autopilot and autothrottles while conducting a nondirectional beacon (NDB) approach to Runway 30. After the airplane touched down in the runway touchdown zone — about 200–300 m (656–984 ft) from the threshold, the spoilers deployed and the autobrakes activated in the "LOW" mode. "The captain moved the right engine (no. 2) thrust reverser [lever] forward," the report said. "However, simultaneously with the subsequent reduction of the reverse mode of engine no. 2, engine no. 1 started to speed up (forward thrust), which led to an increase in airplane speed and the onset of torque that pulled the airplane to the right. The crew failed to perceive the cause of what was happening."

In accordance with the engine manufacturer's recommendation, the captain had not moved the lever for the deactivated left thrust reverser. Postaccident experiments indicated that he might have inadvertently moved the left throttle lever forward with the palm of his hand when he used his fingers to move the right thrust reverser lever aft. The report said that shaking and vibration of the airplane from contact with the rough runway likely contributed to the unintended movement of the left throttle lever, which caused engine power to increase to 60 percent of maximum takeoff thrust. The airplane's groundspeed, which had decreased to 165 km/hour (89 kt), began to increase. The left throttle lever movement also caused the spoilers to retract and the autobrakes to disengage.

The left throttle lever movement also caused the spoilers to retract and the autobrakes to disengage.

The pilots received aural and visual warnings that the airplane was not configured properly for takeoff. Because the warnings were not related to landing and were not expected by the pilots, they might have contributed to their inability to recognize the developing situation. "The unusual behavior of the airplane, especially the strong turn to the right, increased the mental and physiological load on the pilots and facilitated the distraction of attention from control over the engine rpm and speed," the report said.

The copilot did not comply with a requirement to continuously monitor engine parameters and airspeed during the landing. The airplane was about 850 m (2,789 ft) from the end of the 2,425-m (7,956-ft) runway when the captain said, "What's wrong?" The copilot replied, "Speed increasing." The captain told the copilot, "Reverse once again." The copilot moved the right thrust reverser lever, but, because of the position of the left throttle lever, the thrust reverser doors on the right engine did not unlock.

Maximum wheel braking was applied, but "because of the significant forward thrust of the left engine … the braking force came to equal the total thrust of the engines, [and] speed stabilized [at] about 180 km/hour [97 kt]," the report said.

Aircraft rescue and fire fighting (ARFF) vehicles arrived about one minute after the airplane came to a stop. The report said that 67 occupants were evacuated by flight attendants and 11 were rescued by ARFF and municipal fire and rescue personnel before rescue efforts were halted six minutes later because of intense flames inside the cabin. The fire was extinguished about 2.5 hours later. Of the 120 fatalities, 119 were caused by acute carbon monoxide poisoning, and one was caused by severe trauma and burns.

Engine Separates During Departure

Boeing 747-100. Substantial damage. No injuries.

Nighttime visual meteorological conditions (VMC) prevailed when the airplane departed from Chicago for a cargo flight to New York on Oct. 20, 2004. The 747 was climbing through 15,000 ft over Lake Michigan when the flight crew heard a loud bang, detected a left yaw and observed indications that the no. 1 — left outboard — engine had failed, said the report by the U.S. National Transportation Safety Board (NTSB).

"A visual inspection by the crew of the no. 1 engine to check for damage revealed that the [mounting] pylon was still in place but the engine was missing," the report said. The crew diverted to Detroit and landed without further incident.

Most of the no. 1 engine was recovered from the lake bottom, about 270 ft (82 m) below the surface, during the summer of 2005. Examination of the engine showed that an uncontained separation of about half of the second-stage turbine disk rim had occurred in flight, creating a severe imbalance that caused the turbine exhaust case to break up and release the engine.

The report said that an anti-seize compound that is not authorized for use because it causes corrosion had been used on second-stage turbine bolts during maintenance of the engine and no preservation procedures had been performed before the engine subsequently was placed in storage for five years. Only a visual inspection of the high-pressure turbine and turbine exhaust case had been performed before the components were installed on the no. 1 engine of the accident airplane 94 operating hours before the separation occurred.

'All Clear' Signal Given Prematurely

Airbus A320-200. Substantial damage. No injuries.

Light rain was falling, but visibility was good when the aircraft was pushed back from its stand onto a taxiway at London Heathrow Airport the afternoon of June 26, 2006, for a scheduled flight to Munich, Germany. The A320 was given a long pushback to a relatively narrow part of the taxiway, to allow another aircraft to be taxied to the stand, said the report by the U.K. Air Accidents Investigation Branch (AAIB).

The pushback was conducted by a marshaller and the driver of a towbarless tractor. After the pushback was completed, the tractor was disconnected and parked near the A320's right engine. The marshaller did not signal the tractor driver to reposition the vehicle outside the aircraft movement area before disconnecting his headset and giving the flight crew the "all clear" hand signal.

The marshaller then got into the tractor and was told by the driver that the vehicle could not be driven forward because a warning light indicated that the nosegear cradle retracting mechanism had malfunctioned, causing the "drive inhibit" system to engage. Neither ground crewmember used the drive inhibit override button. "[They] heard the aircraft's engines start to increase power and saw the aircraft start to move," the report said. "They both got out of the tractor in an attempt to indicate, with hand signals, that they wanted the aircraft to stop. [When] it became apparent that the flight crew were not looking in their direction … they both returned to the tractor to make another attempt to move it and also for their own protection."

The commander could not see the tractor, and the copilot's view of the tractor was blocked by a windshield post. The pilots heard a "graunching" sound but felt no impact when the bottom of the right engine nacelle struck the rear of the tractor and pushed it out of the way. They observed no abnormal indications but decided to have the aircraft inspected after they were clear of the narrow portion of the taxiway. "Just as the commander was about to transmit a request for ATC to dispatch a vehicle to inspect the aircraft, he heard a transmission [by the tractor driver] advising ATC to stop an aircraft as it had hit a tractor," the report said. "Realizing that they were the aircraft involved, the crew stopped the aircraft and applied the parking brake. At the same time, ATC advised them to stop the aircraft."

The right engine nacelle struck the rear of the tractor and pushed it out of the way.

The right engine was shut down, and ARFF personnel observed substantial damage but no fuel leaks. The pilots then taxied the aircraft on one engine to a stand, and the 83 passengers disembarked.

Taxiway Mistaken for Takeoff Runway

Cessna Citation CJ1. No damage. No injuries.

The pilot had been on duty nearly 13 hours when he was cleared to take off on Runway 36L at Memphis (Tennessee, U.S.) International Airport the night of Oct. 11, 2007. He turned onto parallel Taxiway M and began the takeoff, toward a Bombardier CRJ200 that was holding at an intersection, facing away from the Citation, about 5,320 ft (1,622 m) away.

"The tower controller made two transmissions to advise that the aircraft was departing on a taxiway," the NTSB report said. The Citation pilot did not acknowledge the warnings until the airplane lifted off the taxiway. "He did not realize the centerline lights were green until he was near flying speed, so he continued the takeoff and offset to the left of the taxiway immediately after liftoff," the report said, noting that runway centerline lights are white. The Citation passed 400–500 ft (122–152 m) over the regional jet.

"The Memphis air traffic quality assurance manager stated that there had been a number of previous attempts to commence takeoff from the 150-foot [46-m] wide taxiway but that the mistake had always been caught before takeoff," the report said.

Stomach Bug Incapacitates PIC

Boeing 767-300. No damage. No injuries.

The 767 was en route from Nagoya, Japan, to Cairns, Queensland, Australia, with two flight crewmembers, seven cabin crewmembers and 162 passengers the night of July 9, 2007. The aircraft was about 1,390 km (751 nm) from Cairns when the pilot-in-command (PIC) collapsed on the cockpit floor after getting out of his seat to go to the lavatory, said the report by the Australian Transport Safety Bureau (ATSB).

"There was no response from the PIC to the copilot's questioning," the report said. "The copilot switched on the cockpit lights and saw that the PIC appeared to be staring into space and remained unresponsive." The copilot summoned the cabin service manager, who administered oxygen to the PIC and then helped him to the lavatory. Medical assistance also was provided by MedAire, through a radio link, and by a medical practitioner who was a passenger aboard the flight.

The aircraft was midway between Guam and Cairns. The copilot decided to continue the flight to Cairns because of tropical storms on the route to Guam. About 50 minutes after he collapsed, the PIC returned to the cockpit. The copilot remained the pilot flying. When the 767 entered Australian airspace, the PIC transmitted a "PAN" call and requested that emergency services be on standby for the landing, which subsequently was conducted without further incident.

"The PIC was subsequently examined and cleared to return to flight duties by a designated aviation medical examiner (DAME)," the report said. "The DAME determined that the PIC probably had been affected by a gastrointestinal illness that had previously been experienced by members of the PIC's family."

Parking Brake Set During Pushback

Embraer 135LR. Substantial damage. No injuries.

The tug used to push the airplane from the gate at Newark, New Jersey, U.S., on July 24, 2006, was larger and more powerful than the tug preferred for regional jet pushbacks but "was approved, with caution, at stations where a preferred tug was not available," the NTSB report said.

"As the tug began to move, the landing gear tires skidded against the tarmac, and the pushback was aborted," the report said. "Approximately 14 inches [36 cm] of skid marks were observed near the main landing gear tires. The airplane sustained damage to the forward pressure bulkhead, forward longerons and nose landing gear."

NTSB said that the probable cause of the accident was "the captain's failure to follow company procedures, which resulted in pushback with the parking brake set." The report said that the captain and the ramp marshaller had not complied with aircraft operating manual requirements that the marshaller query, and the captain verbally confirm, that the parking brake is released before pushback is begun.

TURBOPROPS

Broken Turbine Blade Causes Engine Fire

Bombardier DHC-8-400. Substantial damage. No injuries.

The airplane was climbing through 13,500 ft, en route from Sandefjord, Norway, to Bergen with 27 passengers on May 19, 2004, when the flight crew heard a bang, felt a jolt and observed indications that the left engine had failed. "Shortly later, the fire alarm actuated," said the report by the Accident Investigation Board of Norway.

The crew conducted the "Engine Failure/Fire/Shutdown" checklist, declared an emergency and turned back to Sandefjord. While conducting the checklist, the crew shut down the left engine and discharged a fire extinguisher bottle into it. The fire warning light remained illuminated, however, so the crew discharged the second fire extinguisher bottle into the engine. The warning light stayed on, but the approach and landing were conducted without further incident. The report said that the engine fire likely was extinguished by the extinguishing agent from one or both of the bottles, or went out by itself about seven minutes before the landing.

After the Dash 8 came to a stop on the runway, the right engine was shut down and the passengers were evacuated. ARFF personnel sprayed foam into the left engine, which was not burning but was still very hot.

Examination of the Pratt & Whitney Canada (PWC) PW150A engine showed that one of the first-stage low-pressure compressor blades had fractured due to fatigue. The resulting compressor imbalance caused major internal damage and an oil leak from a crack in the fuel heater. "This oil flowed backward and was ignited by the hot exhaust gases at the rear of the engine," the report said. "The fire caused major damage to the engine and caused the fire alarm to continue even after the engine had been cooled completely."

After the accident, PWC issued several service bulletins, recommending engine inspections and installation of an improved first-stage compressor.

Inadequate Rotation Leads to Overrun

Fairchild Metro III. Minor damage. No injuries.

The center of gravity (CG) was at the forward limit when the Metro crew began the takeoff from Lasham Airfield in Hampshire, England, for a cargo flight on Oct. 10, 2006. The copilot, the pilot flying, said that he pulled the control column "a bit" after the commander called "rotate," but the aircraft did not respond, the AAIB report said.

He pulled the column "a bit more," but the aircraft still did not respond. "He reported that he then pulled the control column back half to three-quarters of its full travel," the report said. "The nose of the aircraft pitched up a small amount but no further. He advised the commander of the problem. The commander took control and, after trying to rotate the aircraft himself without success, he rejected the takeoff by applying reverse thrust and maximum braking."

The Metro overran the 1,797-m (5,896-ft) runway and came to a stop in a grassy area 34 m (112 ft) from the end of the runway. One tire was damaged, and the brakes on all four main wheels were replaced because of wear and suspected overheating.

"During the investigation, the manufacturer and another [Metro] operator were contacted regarding the handling characteristics of the aircraft during takeoff," the report said. "They confirmed that, with a forward CG, the handling pilot would be required to pull the control column back a large amount in order to rotate the aircraft and complete the takeoff."

"With a forward CG, the handling pilot would be required to pull the control column back a large amount."

The pitch trim had been set in the middle of the takeoff range, rather than in the nose-up position recommended for a forward CG. "This would have exaggerated the need for a large aft movement of the control column during rotation," the report said.

The crew's relative inexperience was a factor in the incident, the report said. The commander had 2,150 flight hours, including 1,915 flight hours in Metros, of which 250 flight hours were as commander in type. The copilot had 585 flight hours, including 295 flight hours in type.

Electrical Discharge Damages Engine

Cessna 208. Substantial damage. No injuries.

The float-equipped airplane departed from Strahan, Tasmania, Australia, with 10 passengers for a chartered sightseeing flight on Feb. 5, 2006. The Caravan was at 4,500 ft when the pilot observed the chip detector warning light, indicating the presence of metallic fragments in the engine oil and abnormal engine wear.

"The pilot decided to land the plane as soon as possible," the ATSB report said. "During the diversion, five minutes after the chip detector light illuminated, a loud noise was heard, and the engine lost power. The pilot immediately feathered the propeller and carried out a forced landing on Lake Burbury." The airplane came to a stop on a mud bank, with its floats clear of the water.

Examination of the engine revealed pre-existing thermal damage to the no. 1 main shaft bearing that was consistent with electrical discharge, or arcing. "The source of the electrical discharge damage was a starter/generator that was replaced due to a malfunction 18.7 hours prior to the engine failing," the report said. Examination of the failed unit showed that insulation on the armature windings had been overheated and damaged during one or more engine starts and had created a short circuit through the starter/generator to the engine. The failed unit had been operated 852 hours since its last overhaul and had 748 hours remaining before its next scheduled overhaul.

The report said that PWC records showed that there were 42 previous PT6A starter/generator electrical discharge incidents worldwide, most of which led to bearing failures. Among recommendations based on the Lake Burbury accident, ATSB said that PWC should electrically isolate the starter/generators from the no. 1 main shaft bearings in PT6A engines.

PISTON AIRPLANES

Airplane Hits Trees During Night Approach

Aero Commander 500B. Destroyed. One fatality.

The pilot was conducting a cargo flight from Grand Rapids, Michigan, U.S., to Gaylord, Michigan, the night of Nov. 16, 2005. The Gaylord airport had 3/4 mi (1,200 m) visibility in light snow and mist, a broken ceiling at 800 ft, an overcast at 1,200 ft and temperature and dew point both at minus 1 degree C (30 degrees F), the NTSB report said.

The glideslope for the instrument landing system (ILS) approach to Runway 09 was reported as unmonitored and out of service, so the pilot requested and received clearance from ATC to conduct the localizer approach, which has published minimums of 1,700 ft — 381 ft height above touchdown — and 1/2 mi (800 m) visibility.

ATC radio and radar contact were lost after the pilot was cleared to change to the airport advisory frequency. The wreckage of the Aero Commander was found in a wooded area about a mile from the runway. NTSB said that the probable cause of the accident was "clearance not maintained with terrain during a nonprecision approach."

Crossfeed Misuse Leads to Fuel Starvation

Cessna T303 Crusader. Destroyed. Six serious injuries.

The heaviest passengers and baggage were in the rear of the aircraft, and the CG was more than 1.0 in (2.5 cm) aft of the aft limit throughout the round-trip flight between Denham (England) Airfield and Durham Tees Valley Airport near Darlington on Aug. 5, 2006. The T303 was 156 lb (71 kg) over its maximum takeoff weight and did not have adequate fuel reserves for the round-trip flight when it departed from Denham, the AAIB report said. The airports are about 178 nm (330 km) apart.

After landing at Durham Tees Valley Airport, the pilot checked the fuel gauges, which indicated about 60 gal (227 L) remaining, and decided not to have the aircraft refueled before the return flight to Denham. "The pilot, who suffered serious head injuries during the accident, had very poor recollection of some aspects of the flight," the report said. "He could remember operating the fuel crossfeed and thought he may have retarded one of the throttles to idle in order to conserve fuel." This likely occurred during descent, when the front-seat passenger observed the pilot turning rotary controls and noticed that one fuel gauge was "in the red marking" and the other was "just above the red marking."

Noting that use of the fuel crossfeed system is prohibited during landing or when less than 10 gal (38 L) remain in the selected tank, the report said that the system was being used to deliver fuel from the left tank to both engines when the pilot turned left onto final approach at Denham Airfield. Both engines lost power due to fuel starvation during the turn, and airspeed decreased. The aircraft then stalled and descended into a densely wooded area. There was no fire. The six occupants were unable to exit the aircraft; they were treated by paramedics and transported by ambulances to a hospital.

Heart Problem Incapacitates Pilot

Piper PA-23-160 Apache. Destroyed. One fatality.

Nighttime VMC prevailed for the cargo flight from Peoria, Illinois, U.S., to Smithfield, North Carolina, on Nov. 9, 2005. The door opened on departure, and the pilot returned to the airport to close it. During the second departure, the Apache was about 44 nm (81 km) from Peoria when the pilot reported a problem with the right engine and requested clearance to return to the airport, the NTSB report said.

The approach controller issued a heading to Peoria and asked the pilot if he was declaring an emergency. The pilot said, "Negative. It's just … developing partial power. I'm in good shape." The controller said that the Bloomington, Illinois, airport was about 7 nm (13 km) from the airplane's position, and the pilot requested a vector to Bloomington.

The pilot established radio communication with the Bloomington airport traffic control tower. After he reported downwind and was cleared to land, his transmissions included several expletives and the sound of heavy breathing. The pilot did not respond to transmissions by the controller. The Apache crashed and burned in a field about 1 nm (2 km) from the airport.

"The pilot's autopsy revealed evidence that a tear in the aorta (aortic dissection) had occurred prior to the accident and resulted in the rapid accumulation of blood around the heart, substantially impairing heart function and leading to impairment or incapacitation," the report said. "This type of tear in the aorta typically [results in] a sudden onset of severe pain [and] would most likely have been fatal regardless of the circumstances under which it occurred." The report noted that the pilot had been receiving treatment for hypertension and diabetes, and had obtained a "special issuance" airman medical certificate.

HELICOPTERS

Downwash Forces Rotor Into Tail Boom

Hughes OH-6A. Substantial damage. No injuries.

The OH-6A, a military version of the Model 500, had been landed and shut down at a private landing site near Newbridge, Ireland, on Oct. 13, 2006, a few minutes before a Eurocopter EC-120B passed in close proximity while being maneuvered to land. Downwash from the Eurocopter's main rotor caused one of the main rotor blades on the OH-6A to flap down and strike the tail boom, said the report by the Irish Air Accident Investigation Unit.

"As the main rotor of the Hughes OH-6A is not equipped with a rotor brake, it is free to rotate in the effect of downwash," the report said. "Damaged was caused to the tail boom, a main rotor blade and its associated rotor damper."

Wind Gust Causes Control Loss

Bell 206B JetRanger. Substantial damage. One minor injury.

A local airport was reporting winds at 16 kt, gusting to 27 kt, when the pilot prepared to depart from a private landing site in Stockport, Cheshire, England, on April 30, 2007. "Having lifted into the hover, approximately into wind, the pilot turned and hover-taxied the helicopter downwind in order to give himself the full length of the field for the takeoff," the AAIB report said.

The pilot then conducted a spot turn to the right, to position the helicopter into the wind. "Although he would normally have carried out the spot turn to the left, on this occasion, he was keen to keep some nearby power cables in sight," the report said. "Carrying out a spot turn to the right involved reducing the thrust produced by the tail rotor."

A sudden loss of tail rotor effectiveness occurred when the wind gusted during the spot turn. The JetRanger struck the ground and rolled onto its right side. The pilot was not injured. The passenger sustained a minor injury.

"The wind speed at the time of the accident was probably in excess of the demonstrated maximum sideways and rearwards airspeed [i.e., 17 kt] to which the helicopter had been [certified]," the report said. ●

Preliminary Reports

Date	Location	Aircraft Type	Aircraft Damage	Injuries
Dec. 2, 2007	Coeur d'Alene, Idaho, U.S.	Cessna Citation IISP	substantial	8 none
The Citation departed the right side of a slush-covered runway while landing with a left crosswind at 19 kt, gusting to 29 kt.				
Dec. 3, 2007	Whittier, Alaska, U.S.	Eurocopter BK 117C-1	destroyed	4 fatal
The helicopter is presumed to have crashed in the ocean during an air ambulance flight in instrument meteorological conditions (IMC) from Cordova to Anchorage.				
Dec. 4, 2007	New Castle, Delaware, U.S.	Beech Duke	destroyed	1 fatal
The Duke was departing in visual meteorological conditions when it entered a steep left turn and descended to the ground. Examination of the wreckage indicated that the right flap was fully extended and the left flap was retracted.				
Dec. 5, 2007	Columbus, Ohio, U.S.	Cessna 208 Caravan	destroyed	2 fatal
The cargo airplane struck terrain while departing in IMC from Rickenbacker International Airport.				
Dec. 9, 2007	Kiev, Ukraine	Beech C90B King Air	substantial	5 fatal
The King Air, en route from the Czech Republic, struck terrain on approach to Zhulyany Airport.				
Dec. 10, 2007	Salmon, Idaho, U.S.	Beech 200 Super King Air	destroyed	2 fatal, 2 none
Visibility was 1 mi (1,600 m) in snow showers when the pilot departed from the uncontrolled airport under visual flight rules, intending to obtain an instrument clearance in flight. He was attempting to return to the airport when the airplane struck a hangar. The pilot and one passenger were killed.				
Dec. 13, 2007	Curaray-Loreto, Peru	Bell 204B	destroyed	5 serious
The helicopter struck terrain while departing from an oil-exploration site.				
Dec. 15, 2007	Gulf of Mexico	Bell 407	destroyed	2 none
The pilot lost tail-rotor control while en route between offshore platforms and ditched the float-equipped helicopter. Both occupants exited into a life raft before the helicopter was overturned by high waves and sank.				
Dec. 16, 2007	Providence, Rhode Island, U.S.	Bombardier CRJ200	substantial	34 none
Ceiling was 300 ft and visibility was 1 1/2 mi (2,400 m) in mist when the regional jet landed hard and ran off the left side of the runway.				
Dec. 17, 2007	Greenville, South Carolina, U.S.	Bombardier CRJ200	minor	NA none
During pushback from the gate, the tow bar broke and the airplane's nose penetrated the tow vehicle's windshield.				
Dec. 17, 2007	Vernal, Utah, U.S.	Beech C-99	substantial	1 none
Visibility was 4 mi (6 km) in haze when the cargo airplane touched down before reaching the runway. The landing gear collapsed, and the C-99 came to a rest on the runway.				
Dec. 20, 2007	Mount Patterson, Antarctica	Douglas DC-3T	substantial	10 minor
The turboprop-converted DC-3 struck snow drifts while departing from a remote research site.				
Dec. 20, 2007	Andros Island, Bahamas	Cessna 208B Caravan	substantial	2 none
The airplane was returning to the United States from a missionary flight to the Dominican Republic when the engine lost power. The pilots ditched the Caravan and were rescued by a sailboat before the airplane sank.				
Dec. 26, 2007	Almaty, Kazakhstan	Canadair Challenger 604	destroyed	1 fatal, 3 serious
The Challenger made a fuel stop in Almaty during a business flight from Germany to Thailand. On takeoff in nighttime IMC, the airplane veered off the runway, struck a wall and caught fire.				
Dec. 30, 2007	Sabang, Indonesia	GAF Nomad	destroyed	5 fatal, 2 NA
About 15 minutes after departing for a maritime surveillance flight, the flight crew reported engine problems. While returning to Sabang, the Nomad crashed in adverse weather about 200 m (656 ft) offshore and sank. Two occupants were rescued.				
Dec. 30, 2007	Bucharest, Romania	Boeing 737-300	substantial	123 none
The 737 was accelerating through about 90 kt on takeoff when the left engine and main landing gear struck an airport-maintenance vehicle on the runway. The airplane then ran off the left side of the runway. Visibility was 250 m (820 ft) in fog.				

NA = not available
This information, gathered from various government and media sources, is subject to change as the investigations of the accidents and incidents are completed.