AviationSafety WORLD

THE JOURNAL OF FLIGHT SAFETY FOUNDATION

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AUGUST 2006

CHANGES AT THE Speed of Flight

You are reading the second issue of *Aviation Safety World*. I sincerely hope that you like what you see, for I am very proud of the new format of Flight Safety Foundation's publication and of our staff who have done so much to make this change, the first in some 18 years. When we launched the inaugural issue of *Aviation Safety World* at a reception held in Washington last month, it was very well received, and I have been getting nothing but rave reviews since.

At the Washington reception, we announced other big news. After a career of more than 53 years in aviation, the past 12 of which have been at the helm of Flight Safety Foundation, it was announced that I will retire from my position as president and CEO later this year.

Named as my successor was William (Bill) R. Voss, a 30-year professional in aviation. Bill in 2004 left his management position at the U.S. Federal Aviation Administration (FAA) to serve with the International Civil Aviation Organization (ICAO) in Montreal where, for the past two and a half years, he has been director of the Air Navigation Bureau. Prior to joining ICAO, Bill gained considerable experience serving for 23 years in a variety of senior positions with FAA. Forty-nine years of age, he holds a masters degree in public administration and a bachelor of science degree in aviation maintenance management.

In addition, he holds certificates as an airframe and powerplant mechanic, airline transport pilot (single- and multi-engine) and FAA control tower operator. He is also a qualified flight instructor and ground instructor. Importantly, by virtue of his position with ICAO, he is also well known in international circles, where he has established an excellent reputation for his aviation safety work.

From this, you will see that Bill is extremely well qualified to move into the captain's seat at the beginning of October. I will work with him to effect a smooth transition. Further, I expect to continue to be involved with Flight Safety Foundation and its activities for some time to come. More details will be announced in due course. Meanwhile, I know that you will join me in welcoming Bill and wishing him well in his new assignment.

So you can see that there are big changes going on at Flight Safety Foundation, a unique organization. For nearly 60 years, it has been in the forefront of promoting aviation safety improvements and, over the years, has been credited with numerous safety initiatives, many of which are now taken for granted. Today, its position is firmly established and it is on a sound financial footing.

All of us at the Foundation now look forward to beginning a new chapter that will start us on the way to even greater heights, further improving aviation safety and benefiting all who fly.

Stuart Matthews
President and CEO
Flight Safety Foundation

AviationSafetyWORLD

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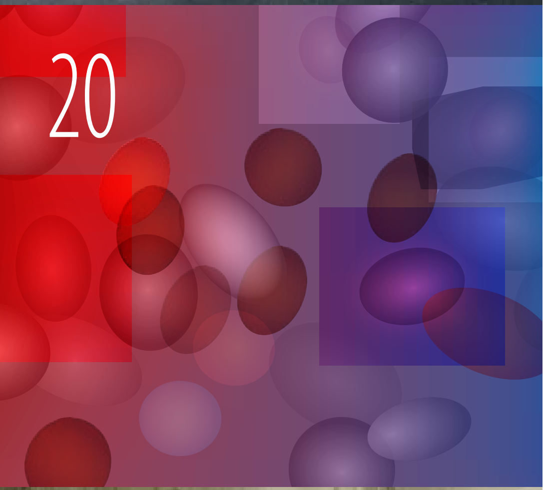

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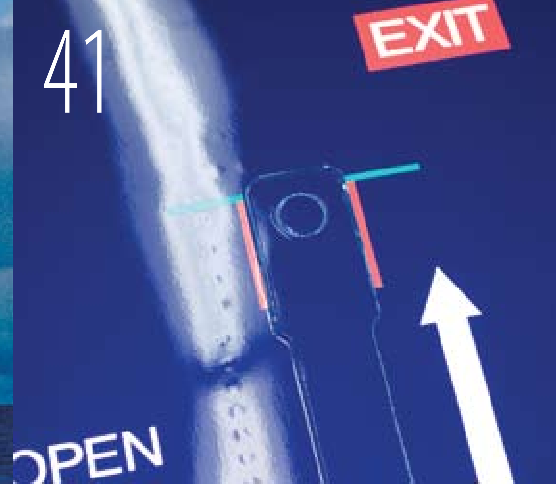

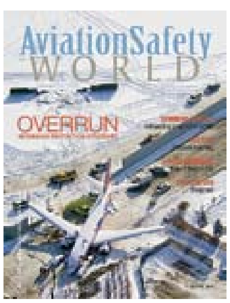

About the Cover
Southwest Airlines accident at Midway International Airport.
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Share Your Knowledge

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>.

The publications staff reserves the right to edit all submissions for publication. Copyright must be transferred to the Foundation for a contribution to be published, and payment is made to the author upon publication.

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Serving Aviation Safety Interests for More Than 50 Years

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 900 member organizations in 142 countries.

MemberGuide

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NOT GOOD Enough

Not exactly a fear of success, but a fear of the consequences of success has been growing in the global aviation community. The safety foot soldiers, especially those hard at work on specific safety programs in the developed world, looking at this new fear from the framework of their own dedication may see it as irrational, reflecting a need to worry about something — anything — all of the time.

The increasing rarity of fatal commercial aircraft accidents in the developed world, combined with increasingly sophisticated safety programs rooting out accident-triggering events and chain enablers, lead many to believe that an accident rate already sharply improved will decline even more over the next decade. They probably are correct.

This, say the worriers, is exactly the problem.

Mike Ambrose, director general of the European Regions Airline Association, is a dedicated worrier. He remembers the state of airline safety when he joined a U.K. carrier at the start of his career: "It was normal for a large airline to have one hull loss accident each year. Now, few current airline CEOs have had the experience of an accident."

It's said that generals who early in their careers experienced war first-hand are the most reluctant to leap into battle on slim pretexts because they know all too well the consequences of crossing that line, a concern that weighs less heavily on the generals minted in the luxury of a peacetime in which war is gamed, not fought, thus becoming an abstraction. Similarly, could a new airline manager have the same depth of concern about safety as one who has dealt with an accident aftermath or walked through hot wreckage?

Ambrose and others fear that the heavy lifting that got us where we are today will be given scant consideration by the new managers of today and, even worse, tomorrow. "They can tend to believe this level of safety is a given, so will more easily pass responsibility for safety down the authority chain." He hastens to add that this is not the case with the first-rank carriers around the world.

To be sure, sometimes the way we talk about safety advancements can tend to foster a perception that safety is a "given," that it can be installed.

The real-world *deus ex machina* of aviation safety technology, most would agree, is the protection offered by terrain awareness and warning systems (TAWS) against the deadliest type of accident. We keep repeating that no aircraft with an operating TAWS has suffered a controlled flight into terrain accident. While everyone connected to aviation safety knows that humans retain the ability to put an aircraft into such a perilous position that even TAWS cannot save it, is it not plausible that newly minted managers coming from outside the industry will take in the sage wisdom about the efficacy of TAWS and assign safety a lower rung on his worry ladder?

At press time the widely read newspaper *USA Today* had a lead story headlined "Airways are the safest ever," by Alan Levin, an experienced and skeptical observer of the aviation industry. He led the piece relating a TAWS save similar to the series Dan Gurney is writing for this publication. Levin goes on to say, "Risks in the airways have hardly disappeared. … But there is also little doubt that safety is improving dramatically." He acknowledges, "Dozens of safety enhancements have driven the accident rate down," and says safety professionals worry that a string of nasty accidents could begin tomorrow.

All of this is precisely the case. And while we can take satisfaction for accomplishments to date, we cannot relax or allow others to do so.

Outgoing International Civil Aviation Organization Council President Dr. Assad Kotaite in these pages last month warned against overconfidence: "There is absolutely no room for complacency where safety is concerned, there never was and there never will be."

Taking the Ultra-Long-Range View

The International Federation of Air Line Pilots' Associations (IFALPA) would like to recognize the contribution of Flight Safety Foundation in sponsoring a series of international workshops, in conjunction with other industry participants, that were designed to develop guidance and recommendations for industry in advance of ultra-long-range (ULR) operations being introduced. This proactive measure, involving industry stakeholders including regulators, operators, manufacturers, scientists and pilots, resulted in the development of guidance material that addresses the important ULR issues.

ULR flight operations have become a reality with the recent introduction of new aircraft that are capable of flying nonstop halfway around the world, with block times greater than 16 hours and flight-duty periods from 18 to 22 hours. By introducing daily flights between Singapore and New York, which average 18.5 flight hours per leg, Singapore Airlines has shown that ULR operations can be safely flown by following the recommended operational guidelines developed by the Foundation in conjunction with aviation experts from around the world, including representatives from IFALPA.

IFALPA urges the promotion and adoption of the FSF ULR Crew Alertness Steering Committee recommendations and guidance material (*Flight Safety Digest*, August–September 2005) to all regulatory agencies that will be providing the oversight that is necessary to maintain standards of safety during these longer range operations. Additionally, IFALPA has distributed the Foundation's guidance material to all its member associations.

I would like to thank Flight Safety Foundation for its efforts in producing this guidance material and for continuing to play an important role in global flight safety issues.

Capt. Dennis Dolan
President, IFALPA
Chertsey, Surrey, England

Corrections

An article on page 30 of the July issue should have said that the Mexico City airport has 70 approaches per hour during high-density hours. On page 32, the article should have said that Capt. A. Ranganathan currently is employed by SpiceJet.

Aviation Safety 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>.

AUG. 21–23 ➤ Suspected Unapproved Parts Conference. Australian Civil Aviation Safety Authority. Sydney. <sup2006@casa.gov.au>, +61 (0)2 6217 1316.

SEPT. 6–7 ➤ FAA/ATA 18th International Symposium on Human Factors in Maintenance and Ramp Operations. U.S. Federal Aviation Administration and Air Transport Association of America. Orlando, Florida, U.S. Sherri D. Brooks, <hfsymposium@gmail.com>, <www.atausa.org/registration>, +1 724.601.4646.

SEPT. 11–14 ➤ Incidents to Accidents: "Breaking the Chain." International Society of Air Safety Investigators 37th International Seminar. Cancun, Mexico. Ann Schull, <isasi@erols.com>, <www.isasi.org>, +1 703.430.9668.

SEPT. 12–13 ➤ Communicating for Safety: Rising to Today's Aviation Challenges. National Air Traffic Controllers Association. Dallas. <http://safety.natca.org>, +1 202.628.5451.

SEPT. 19–21 ➤ 2006 Conference on Risk Analysis and Safety Performance in Aviation. U.S. Federal Aviation Administration. Atlantic City, New Jersey, U.S. Rosanne Weiss, <rosanne.weiss@faa.gov>, <http://aar400.tc.faa.gov/FlightSafety/Conference2006.htm>, +1 609.485.4370.

SEPT. 25–27 ➤ Air Medical Transport Conference. Association of Air Medical Services. Phoenix. Natasha Ross, <nross@aams.org>, <www.aams.org>.

SEPT. 25–27 ➤ Crisis Management Conference 2006. International Air Transport Association. Warsaw. Alison Zahynacz, <zahynacza@iata.org>, <http://iata.org/events/crisis2006>, +1 514.874.0202, ext. 3353.

SEPT. 27–29 ➤ Worldwide Symposium on Air Navigation: Flying Through Congested Skies. International Civil Aviation Organization and McGill University. Montreal. <icaohq@icao.int>, <www.icao.int>, +1 514.954.8219.

OCT. 2 ➤ Safety Seminar. International Federation of Air Line Pilots' Associations. Rio de Janeiro. Arnaud du Bedat, <arnauddubedat@ifalpa.org>, +44 (0)1932 571711.

OCT. 3–5 ➤ Bombardier Learjet Safety Standdown 2006. Wichita, Kansas, U.S. Dawn Pepperd, <dawn.pepperd@aero.bombardier.com>, +1 316.946.7240.

OCT. 3–5 ➤ IAFPA Conference. International Aviation Fire Protection Association. Dublin. Colin Simpson, <colin@fire.org.uk>, +44 (0)7879 872994.

OCT. 17–19 ➤ National Business Aviation Association Annual Meeting and Convention. Orlando, Florida. Jan Kelliebrew, <jkelliebrew@nbaa.org>, <www.nbaa.org>, +1 202.783.9283.

OCT. 23–26 ➤ International Air Safety Seminar (IASS). Flight Safety Foundation, International Federation of Airworthiness and International Air Transport Association. Paris. Namratha Apparao, +1 703.739.6700, ext. 101, <www.flightsafety.org>.

OCT. 23–25 ➤ SAFE Association 44th Annual Symposium. Reno, Nevada, U.S. Jeani Benton, <safe@peak.org>, <www.safeassociation.com>, +1 541.895.3014.

NOV. 1–3 ➤ Third Annual International Aviation Safety Forum. U.S. Federal Aviation Administration and Air Transport Association of America. Chantilly, Virginia (near Dulles International Airport). <www.faa.gov/news/conferences>.

NOV. 6–12 ➤ Blue Angels Seminar 2006. National Transportation Safety Board Bar Association. Pensacola, Florida, U.S. Tony B. Jobe, <jobelaw@msn.com>, <www.ntsbbar.org>, +1 985.845.8088.

NOV. 12–14 ➤ AAAE Runway Safety Summit. American Association of Airport Executives. Boston. <aaaemeetings@aaae.org>, <www.aaae.org>, +1 703.824.0500.

NOV. 14–17 ➤ Aircraft Maintenance & Reliability Seminar. Transportation Systems Consulting Corp. Tampa, Florida, U.S. <www.tsc-corp.com>, +1 727.785.0583.

NOV. 17 ➤ IS-BAO (International Standard for Business Aircraft Operations) Implementation Workshop. Long Beach, California, U.S. International Business Aviation Council. <info@ibac.org>, +1 514.954.8054.

DEC. 5–6 ➤ Airport, Port & Transport Security Europe. London. Sarah Kershaw, <skershaw@ibeltd.com>, <www.apts-expo.com>, +44 (0)1303 850259.

DEC. 6–7 ➤ Approach-and-Landing Accident Reduction (ALAR) Workshop. Flight Safety Foundation. Tokyo. James M. Burin, <burin@flightsafety.org>, +1 703.739.6700, ext. 106.

Aviation safety event coming up? Tell industry leaders about it.

***Aviation Safety World*, the journal of Flight Safety Foundation, includes an events calendar in every issue. 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 until the issue dated the month before 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.

Safety News

Review Urged of Continued Engine-Out Flight

The U.K. Air Accidents Investigation Branch (AAIB) is recommending a review of policies on the continuation of public transport flights after an in-flight engine shutdown.

The recommendation — that the U.K. Civil Aviation Authority (CAA), the U.S. Federal Aviation Administration and other agencies develop "clear guidance" for such flights — follows AAIB's investigation of the Feb. 20, 2005, flight of a British Airways 747 from Los Angeles to London Heathrow International Airport. The 747's no. 2 engine began to surge immediately after takeoff, and the flight crew shut down the engine and continued the flight across the continental United States and the North Atlantic, but then diverted to Manchester (England) Airport because of concerns about insufficient fuel reserve remaining if the flight were continued to Heathrow.

The AAIB report said that the crew's decision to continue the flight — rather than jettison fuel and return to Los Angeles or divert to another airport en route — was in accordance with the operator's policies. Those policies had been approved by CAA and were similar to policies of some other international airlines that operate four-engine airplanes, the report said.

"No evidence was found to show that the flight continuation posed a significant increase in risk, and the investigation established that the aircraft landed with more than the required minimum fuel reserves," the report said. "However … there was a variation in operators' policies … from 'land at the nearest suitable airfield' to no policy at all. With the introduction of public transport flights of up to 16 hours duration, it is considered that clear guidance should be provided to operators on the possible consequences of continued operation following an [in-flight engine shutdown], particularly when this occurs early in the flight."

Eurocontrol Initiates Air-Ground Safety Effort

The European Organisation for the Safety of Air Navigation (Eurocontrol) has begun a series of air-ground safety initiatives intended to address communications issues that contribute to hazardous situations such as runway incursions, level busts (deviations from assigned altitudes), use of standard phraseology, call-sign confusion and other radio problems.

National aviation authorities in Europe are implementing programs to ensure that regular flight crew proficiency checks include air-ground communications safety issues; to improve the reliability of the radio frequency change process; and to ensure compliance with procedures recommended by the International Civil Aviation Organization for standard phraseology, procedures and best practices for flight crews and air traffic controllers. All related safety improvements should be in effect in late 2007, Eurocontrol said.

"Air-ground communications issues are among the key safety risk areas in air traffic management, and for this reason, we are committed to advocating the swift implementation of these actions," said Tzvetomir Blajev of Eurocontrol.

The initiatives were begun with the cooperation of the International Air Transport Association, the European Cockpit Association, Flight Safety Foundation, the International Federation of Air Traffic Controllers' Associations and the European Regions Airline Association.

Expanded Safety Margin Sought for Landings on Slippery Runways

The U.S. Federal Aviation Administration (FAA) wants to tighten requirements for turbojet pilots in calculation of runway distances required for landing on snow- and ice-contaminated runways.

FAA said that a 15 percent margin between the actual airplane landing distance and the available landing distance is the "minimum acceptable safety margin." According to FAA's plan, by Sept. 1, 2006, turbojet operators will be required to have procedures for ensuring that "a full-stop landing, with at least a 15 percent safety margin beyond the actual landing distance, can be made on the runway to be used, in the conditions existing at the time of arrival and with the deceleration means and airplane configuration that will be used."

FAA's action follows a Dec. 8, 2005, accident in which a Southwest Airlines Boeing 737 skidded off a snowy runway at Chicago Midway International Airport, plowed through a barrier fence and finally stopped on a roadway. No one in the airplane was injured, but one person on the ground — a six-year-old boy — was killed and 12 other people were injured (see "Rethinking Overrun Protection," page 13).

After the accident, FAA reviewed relevant information and found that "approximately 50 percent of the operators surveyed do not have policies in place for assessing whether sufficient landing distance exists at the time of arrival, even when conditions … are different and worse than those planned at the time the flight was released."

Port Authority of New York and New Jersey

New Findings in N.Z. Helicopter Accident

The New Zealand Transport Accident Investigation Commission (TAIC), which reopened its investigation of a fatal 2001 accident involving a converted military helicopter near Taumarunui, now says that a bent tail-rotor blade pitch link that failed during flight caused the loss of control and in-flight breakup of the Bell UH-1H Iroquois.

TAIC did not determine why the link was bent, but its revised final report on the accident said that the link was damaged earlier in the June 4, 2001, positioning flight and that the damage "allowed it to crack and eventually fail from bending fatigue."

The helicopter was destroyed in the accident, and all three occupants were killed.

The original accident report, released in February 2002, said that the accident likely had been caused by the tail-rotor pitch-control mechanism coming loose because of incorrect maintenance. In the revised April 27, 2006, accident report, TAIC said that the investigation had been resumed because of "new and material evidence from two other UH-1 accidents that could have affected the conclusions in the original report."

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Pilots Warned Against Ignoring In-Flight Procedures

The head of the Australian Civil Aviation Safety Authority (CASA) says pilots who deliberately deviate from published instrument approach procedures face "strong action" from regulators.

CASA CEO Bruce Byron cited three recent fatal aviation accidents that occurred while pilots appeared to be conducting global navigation satellite system/area navigation (GNSS/RNAV) instrument approach procedures, with significant departures from the published procedures (see *Aviation Safety World*, July 2006, page 69).

"Barring dire in-flight emergency, there can be no excuse for deviation from published instrument approach procedures," Byron said in a letter addressed to all Australian pilots.

"CASA will take strong action against pilots who deliberately deviate from these procedures and will take similarly strong action against aircraft operators who, either expressly or impliedly, compel their pilots to deviate from the procedures."

Report Examines Wire-Strike Accident Trends

Wire strikes remain a significant safety concern for general aviation aircraft — especially those involved in agricultural operations and other aerial work — in Australia, according to a study by the Australian Transport Safety Bureau.

The study examined 117 wire-strike accidents and 98 wire-strike incidents that were reported in Australia between 1994 and 2004. The wire-strike accident rate ranged from a low of 0.1 in 2003 to a high of 0.9 in 1997 and 1998. "The figures suggested a downward trend beginning in 1998, with a return to previous accident rates in 2004," the report said.

Seventy-five accidents (64 percent) involved agricultural operations.

"The findings reinforce the clear danger to pilots flying at low level because of wires, particularly when conducting aerial agriculture operations and other aerial work," the report said.

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In Other News …

The United States has upgraded its aviation safety rating of **Ecuador** after a reassessment by the U.S. Federal Aviation Administration of Ecuador's civil aviation authority. The Category 1 rating means that the Ecuadorian authority was found to be licensing and overseeing air carriers in accordance with standards of the International Civil Aviation Organization. … U.S. Secretary of Transportation **Norman Y. Mineta** has resigned after more than five years on the job. … **Chris Glaeser**, formerly director of flight safety, quality assurance and industry affairs at Northwest Airlines, has joined Alaska Airlines as vice president of safety. … TAG Aviation USA has named **Doug Schwartz** as vice president of flight operations and standards; he formerly was aviation director for AT&T. … **Russ Lawton**, formerly director of operations at Wyvern Consulting and a leading U.S. aviation safety specialist, has become director of safety and security for the National Air Transportation Association's Safety 1st Program.

Photo: U.S. Department of Transportation

Norman Mineta

Uncontained Engine Failure Under Investigation

The U.S. National Transportation Safety Board is investigating the uncontained failure of an engine on an American Airlines Boeing 767 during ground maintenance tests at Los Angeles International Airport on June 2, 2006. During a test run, the no. 1 engine's high-pressure turbine stage-one disk broke into pieces that penetrated both wing fuel tanks, the fuselage and the no. 2 engine; a fuel-fed fire damaged the left wing and the rear fuselage. Three maintenance technicians in the airplane were not injured. Preliminary examination of the disk pieces indicated fatigue cracking.

Compiled and edited by Linda Werfelman.

Giovanni Bisignani is director general and CEO of the International Air Transport Association.

We Need to Do Even Better

BY GIOVANNI BISIGNANI

We should be proud. Despite the enormous financial losses of the past several years, airlines have kept firmly focused on our number one priority — safety. The hull loss rate for 2005 was our lowest ever — 0.76 hull losses for every million flight sectors. That is equivalent to one for every 1.3 million flights.

International Air Transport Association (IATA) member airlines did much better, with a hull loss rate of 0.35 per million sectors, or one accident for every 2.9 million flights. These are the lowest figures ever, a testimony to our industry's responsible approach to transporting over two billion passengers safely each year.

Still, every accident is one too many. And the spate of accidents during the summer of 2005 focused our attention again on the need to do even better. Over the past 10 years, the accident rate has improved 42 percent. Our target is a hull loss rate of 0.65 for 2006 — half the 1.34 recorded in 1998.

Global Standards and Harmonization

There is no panacea for safety. Global standards and harmonization are behind the tremendous progress so far. And transparency is critical. Shadow boxing is not the answer. The recent decision of the International Civil Aviation Organization (ICAO) to publish the results of its Universal Safety Oversight Audit Programme (USOAP) is to be applauded. Effective and systematic follow-up to improve the deficiencies will be the next critical step.

And that does not mean simply throwing money at the problem. The World Bank's decision to hold back funding of infrastructure projects pending compliance with USOAP is a major signal. Where compliance has not been achieved, an effective plan of action is necessary.

Our industry cannot tolerate even a few governments that are not taking safety seriously. At the recent IATA Annual General Meeting in Paris, June 4–6, IATA for the first time named four states for which we have a particular concern: the Democratic Republic of Congo, Swaziland, Equatorial Guinea and Sierra Leone. Quite simply, flags of convenience have no place in a safe industry. All four are making progress. And IATA's technical experts in Africa are working closely with these governments to help lay plans for improvement. We need to see results fast.

Airline Efforts

At the same time, we recognize that solutions begin at home. IATA is working closely with its member airlines, guided by the Six Point Safety Program. The program includes a systematic approach to safety that converges efforts in safety auditing — the IATA Operational Safety Audit (IOSA), infrastructure safety, data management and analysis, safety management systems, flight operations, and cargo safety.

IOSA is at the core of our efforts on safety. Since its launch in 2003, it has filled an important void as the industry's only global standard for operational safety management. The standards are based on ICAO standards and were developed in cooperation with many of the leading regulators to combine industry best practice. The goal has always been to raise the bar on safety. We have a tough standard that is making a difference in the industry.

Program management is world-class. IOSA standards are freely available to any commercial airline — IATA member or nonmember. IATA manages the program, data collection and quality control from its own budget as a part of our commitment to safety. Seven independent audit organizations form a competitive market for auditing services. We have seen the price of auditing drop significantly since the program started. And the entire process was ISO 9001:2000 approved in 2005.

Already, 102 airlines are on the IOSA registry (Figure 1). Fully 189 IATA member airlines — representing 75 percent of scheduled international traffic — are in the audit process. And 57 nonmember airlines have seen the value and have chosen to participate. Soon, the cargo operations version of IOSA will be available.

Following a recommendation of our Board of Governors, the 62nd IATA Annual General Meeting approved a resolution to make IOSA a condition of IATA membership. By the end of 2006, all IATA members must have committed to an IOSA audit. The audit must be conducted by the end of 2007. And by the end of 2008, any audit findings must be corrected. Any new airline joining IATA will not have its membership confirmed until the audit is complete and all findings are corrected. And all IATA airlines must maintain a valid IOSA registration following the two-year audit cycle. The message is clear: Airlines that do not meet this standard have no place in IATA.

Governments are seeing IOSA benefits: Safety improvement requires coordination and cooperation. Recently, IATA signed a landmark agreement with ICAO to exchange safety and audit information at the international level. Individual governments already are using IOSA results in an effective way. In 2004, the United States allowed its carriers to submit IOSA audit data when its carriers were code-sharing with non-U.S. partners. The major airline alliances have followed on with this by using IOSA as their measure of quality in safety for their members.

Recently, we have seen governments taking even more proactive steps. Chile, Egypt and Madagascar have made IOSA registration a requirement for their airline certification process. Jordan, Bahrain, Turkey, Tunisia, Mexico, Hungary, Nigeria and Ethiopia are in the process of similar action. And the Arab Civil Aviation Conference concluded that from 2008, any carrier flying into the region must be on the IOSA registry.

IOSA is not just for IATA members, and we appreciate the support of the Flight Safety Foundation and other organizations in promoting IOSA as a global standard for safety.

There is clearly a role for IOSA in Europe's current efforts to raise the bar on safety. Blacklists alone are not the answer. IATA encourages Europe to incorporate IOSA in their approach. It is a transparent measure of an airline's safety management capabilities. As the European Union Aviation Safety Committee examines its next steps, IOSA must be a part of the consideration.

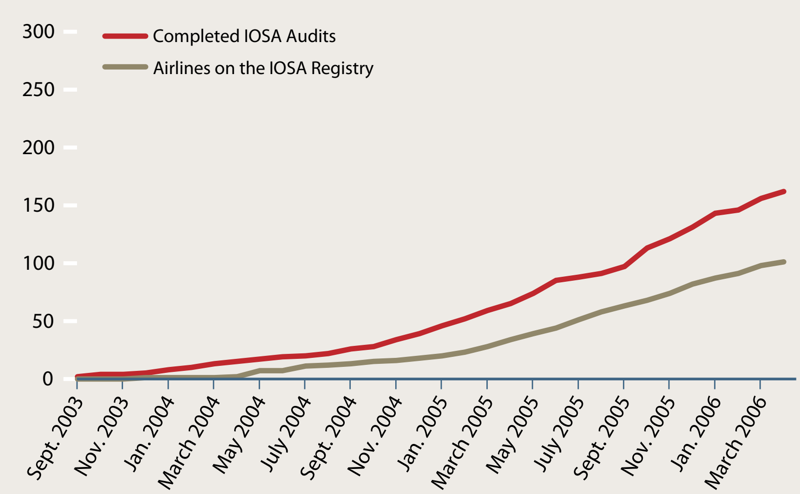
Partnership for Safety

For some airlines, IOSA will be a real challenge. There is no denying that the standards are tough. To help facilitate the leap for carriers with the greatest need, there is the IATA Partnership for Safety (PfS) program. Following a successful 2005 launch in Africa, where the accident rate is 12 times the global average, the PfS has been expanded to include Latin America. The aim of the program is to help airlines in developing nations reach IOSA standards by providing awareness training, gap analysis and technical support. IATA is funding this initiative with a US$3 million investment. Manufacturers such as CFM and Pratt & Whitney also are providing funding and support.

On the Right Track

The safety commitment of all parties of the industry — governments, airlines and suppliers — has made air transport the safest mode of transportation. But the right to claim this great achievement must be won with every flight. Global standards and harmonization are the pillars of success. While being completely committed to further improvements in safety, we must also look to export our successful approach to other critical parts of the airline business that could also benefit from greater cooperation among stakeholders. Security comes to mind … . ●

Industry Moves Toward Universal Audits



Source: IATA

Figure 1

Engineered Arresting Systems Corp.

Rethinking Overrun Protection

Midway International Airport's December 2005 accident makes airport operators reconsider installing the latest engineered materials arresting system.

BY WAYNE ROSENKRANS

Workers install EMAS blocks during 2006 beyond the departure end of Runway 17R at Laredo (Texas, U.S.) International Airport.

Airports with substandard runway overrun areas are rethinking installing engineered materials arresting systems (EMAS) in light of the availability of improved materials and a demonstration of the tragic consequences of failing to arrest an aircraft sliding off the end of a runway.

The process many airport operators used to conclude EMAS would not be practical at their facilities captured attention at a U.S. National Transportation Safety Board (NTSB) June 2006 public hearing on the Dec. 8, 2005, overrun accident at Midway International Airport in Chicago. Southwest Airlines Flight 1248, a Boeing 737-700, landed on snow-contaminated Runway 31C, rolled past the end of the runway at a groundspeed of about 50 kt, and knocked down a blast fence and a perimeter fence to encounter motor vehicle traffic on an off-airport street, NTSB said. A six-year-old boy was killed in a car hit by the 737.

Each generation of EMAS in service — developed since 1986 by Engineered Arresting Systems Corp. (ESCO), FAA and the Port Authority of New York and New Jersey — has provided an elevated arrestor bed, composed of prefabricated blocks of aerated portland cement, beyond the departure end of a runway. "First and foremost, we are trying to maximize deceleration within the limits of the landing gear," said G. Kent Thompson, vice president of airport engineering and sales for ESCO, during the hearing. "As tires crush the material, it creates a tire–material interface at the leading edge of the wheel [that] provides a decelerative load, a drag load, to slow the airplane down. That load is transmitted up through the landing gear and the support structure for the landing gear to decelerate and stop the aircraft. A very important point is that EMAS does not rely on friction."

A computer model showed that the latest-generation EMAS would have safely stopped the 737 at Midway, according to testimony at the hearing. ESCO performed modeling with data from the NTSB investigation to simulate the Midway overrun. "We did a quick design simulation with EMAS at the end [of Runway 31C]. … The weight of the aircraft was about 118,000 lb [53,524 kg]," Thompson said. "The runway exit speed was based on a couple of different ways that the data were [obtained by NTSB] — one indicated 51 kt and the other 53 kt, so we looked at both [speeds]. The conditions [also included] maximum reverse thrust by the time the aircraft left the runway end and the 0.08 runway friction [coefficient]. The performance model indicated that the plane would stop from 51 kt at 198 ft [60 m] beyond the runway end, or about 206 ft [63 m] beyond the runway end if the airplane was going 53 kt. The key [finding] is that [the airplane] would stop before it reached the existing blast fence, which was at 229 ft [70 m] from the runway end."

Technology Opens Possibilities

A few years before the accident, the City of Chicago Department of Aviation and the U.S. Federal Aviation Administration (FAA) had determined that EMAS was not practical at the airport. In 2000 and 2004, EMAS for Midway "was rejected as a standard option because there was not enough room for a standard EMAS system," said David L. Bennett, director of the FAA Office of Airport Safety and Standards. "The technology for getting a 40 kt-plus performance [nonstandard EMAS] in an area that size … was really just not known to us. [Soon after the Midway accident, the City of Chicago] and FAA … took another really hard look at what could be done with runway safety areas at the airport. What had changed was the availability of some new technology."

Nonstandard EMAS installations later were approved by FAA for Midway, funded and

Allan Goldstein, Aerial Images Photography

The Southwest Airlines Boeing 737 overrun accident in December 2005 has inspired a closer look at protective measures.

Engineered Arresting Systems Corp.

Loads generated by tires crushing the arrestor-bed material — not friction — safely decelerate the airplane.

scheduled for installation in 2006 and 2007 at four runway ends. Rick Marinelli, manager of the FAA Airport Engineering Division, said that jet blast-resistant materials recently tested at La Guardia Airport in New York enable Midway "to put an EMAS about 35 ft (11 m) from the end of a runway instead of 75 ft (23 m), so we get 40 more ft (12 m) of arrestor bed, which makes the difference between it being a practical solution at Midway and not being a practical solution, according to our published guidance."

In a presentation to directors of civil aviation participating in an October 2005 International Civil Aviation Organization (ICAO) meeting, FAA said that, on average, 10 overruns annually occur in the United States. "Since 1982, there have been 23 fatalities, over 300 injuries and uncounted millions of dollars in aircraft damage at U.S. [air carrier] airports," FAA said. "The majority of the severe overruns occurred at airports where the runway does not have a [runway] safety area that extends the full … 1,000 ft (300 m) beyond the runway end. There are many reasons for an overrun: engine failures which result in insufficient power to complete the takeoff, thrust reverse failures, brake failures, improper flap settings, pilot misjudgments and snow/ice on the runway surface."[1]

Five Enhancement Choices

Planning an EMAS installation involves selecting one "design aircraft," also called the "critical aircraft" — an airplane type that regularly uses the runway and would place the greatest demand on the EMAS. Usually, this is the largest or heaviest airplane. EMAS is one of five options that FAA says must be considered by airport operators subject to U.S. Federal Aviation Regulations Part 139, *Certification of Airports,* for improving runway safety areas. The other options are relocating, shifting or realigning the runway; reducing runway length to create a larger runway safety area when the existing runway length exceeds what is required for the existing or projected design aircraft; a combination of runway relocation, shifting, grading, realignment or reduction; or declared distances. Declared distances is an alternative airport-design methodology allowing the airport owner, subject to FAA approval, to publish distances to satisfy airplane operators' requirements for takeoff run available, takeoff distance available, accelerate-stop distance available and landing distance available — with the runway beyond these distances available as runway safety area.

Typically Nonstandard

FAA designates an EMAS installation as "standard" if it can safely decelerate the design aircraft from a maximum runway exit speed of 70 kt and if it includes 600 ft (183 m) of space for undershoot (i.e., a total 600 ft length of runway safety area). To be designated as a "nonstandard" EMAS, the arrestor bed either provides deceleration for the design aircraft from a slower maximum runway-exit speed (40 kt to 70 kt) or has less than 600 ft available for undershoots. "Thirteen of 20 systems [in service] are nonstandard EMAS," Thompson said. "[Their] performance ranges from the minimum [runway exit speed] of 40 kt up to about 60 kt with the Boeing 767."

The width of an arrestor bed is the same as the runway width. Its "setback" — which provides a buffer for jet blast — has the shape of a shallow ramp ascending from the runway level and is 75 ft (23 m) long for a standard EMAS. Stepped areas along two sides and the back help aircraft occupants to descend from the arrestor bed to ground level without falling. The ramp and steps also facilitate access by aircraft rescue and fire fighting (ARFF) vehicles. "The ramp allows a smooth transition as the nosewheel and main [landing] gear of the aircraft roll into the [shallowest part of the arrestor] bed, and minimizes the vertical loads on the aircraft," Thompson said. "The rear of the bed is the deepest part, and that is where the maximum depth [of crushed blocks provides] the maximum deceleration for the airplane."

The new assumptions that make EMAS installations at Midway practical send a signal to many U.S. and non-U.S. airport operators that this solution might, after all, enhance their overrun protection. Fifteen months earlier, EMAS technology passed another milestone when FAA for the first time accepted a standard EMAS as equivalent to a standard runway safety area when vertical guidance from a glideslope or visual navigation aid (such as a precision approach path indicator) is available for undershoot protection.[2]

By June 2006, arrestor beds had been installed beyond the ends of 20 runways at 15 U.S. airports and one runway at the airport in Jiuzhaigou, China. More installations are scheduled at five airports in the United States, the Jiuzhaigou airport and one airport in Madrid. Some U.S. airports — such as Little Rock, Arkansas — have installed EMAS and brought the dimensions of their runway safety areas into conformance with Part 139.

After the design phase and fabrication of blocks, a typical EMAS installation takes six weeks: four weeks for site preparation and two weeks to install the blocks. Blocks typically represent 80 to 90 percent of overall cost, and site-preparation work is a significant variable. A standard EMAS typically costs US$3 million to $6 million, not counting changes such as relocation of a localizer antenna, Thompson said. A nonstandard EMAS typically costs $2 million to $4 million.

Airplane arrestments, although few, have shown that airport operators usually need to replace only the damaged portion of an arrestor bed if the EMAS is used. Repair of the arrestor bed that stopped a Boeing 747 at John F. Kennedy International Airport in New York in December 2005 cost about $2 million, the most expensive repair known to ESCO.

Surviving Jet Blast

Like other airport authorities, Chicago officials had monitored EMAS developments through forums such as Airports Council International conferences and communication with other airports, airlines and ESCO, according to James Szczesniak, assistant commissioner, airport planning, Chicago Department of Aviation. Their thinking about EMAS also has been influenced by early reports and photographs from La Guardia, he said at the hearing.

Compared with La Guardia, "we have similar fleet mixes, similar weather conditions and similar setback constraints," Szczesniak said. "With a 35 ft setback and the fleet mixes that exist at both Midway and La Guardia, an EMAS is subject to [forces similar to] Category 5 hurricane winds on a regular basis when aircraft are departing. We knew technology would ultimately solve our issues, but … there was no way we would be able to install the old-generation EMAS without it being destroyed [by jet blast]."

FAA explained the source of this concern during the ICAO meeting. "The early problem with the [La Guardia] EMAS top coating related to jet-blast damage has been solved," FAA said. "At the time an EMAS was installed on the roll-out end of Runway 22 at La Guardia [in 1997], the recommended setback distance was for the arresting system to start 100 ft [30 m] from the runway end. Due to a very short [runway] safety area and a desire to obtain as much arresting capability as possible, the La Guardia EMAS started 35 ft (10.5 m) from the runway end. Repeated exposure to jet blast from departures damaged the EMAS beyond repair, and it was removed." During the hearing, Marinelli clarified that this EMAS gradually was destroyed by "a combination of jet blast and acoustic energy, the low-frequency vibration from the engines."

"There was no way we would be able to install the old-generation EMAS without it being destroyed."

An arrestor bed at John F. Kennedy International Airport was crushed by a McDonnell Douglas MD-11 in 2003.

Port Authority of New York and New Jersey

Beyond Chicago officials' qualms about durability, maintenance costs were a concern, Szczesniak said. Maintenance of early arrestor beds involved repainting the exposed cement-type hardcoat surface with an elastomeric paint and recaulking external seams between blocks to control moisture. Current EMAS installations typically have a factory-applied or site-upgraded jet blast-resistant coating designed to last three to five years; the "next generation" jet blast-resistant coating currently used has been designed for more than 10 years of service before repainting, according to ESCO. "Minimal recaulking" has been required at most installations, and the latest sealant reduces maintenance, the company said.

FAA's June 2006 practicability determination for Midway concurred with Chicago officials' judgment that they could not extend their runway safety areas outside of airport property, shorten runways or use declared distances without adversely disrupting operations, Szczesniak said. An aerial image of the airport with color overlay "shows areas outside airport boundaries that would [have been] required, [including] numerous residential dwellings, commercial [buildings] and major arterial roadways," he said. "[We would have had] to acquire about 700 houses and 130 businesses, relocate a number of major roadways and do some rail work … to provide a full standard [runway] safety area for the airport. That was going to cost, in land acquisition alone, $300 million, approximately … We could see that was impracticable. For all four installations, [the total cost will be] approximately $40 million," a price that includes localizer antenna relocations.

EMAS Arrestments

According to FAA, NTSB, ESCO and JDA Aviation Technology Solutions, a consultant to airport operators on EMAS issues, recent U.S. commercial airplane arrestments help confirm that EMAS performs as predicted by the ESCO computer model:

- In May 1999, American Eagle Flight 4925, a Saab 340B commuter aircraft weighing about 22,000 lbs (9,979 kg) with 30 occupants, overran the departure end of Runway 4R at Kennedy with an estimated runway-exit speed of 75 kt. NTSB said that the airplane traveled approximately 248 ft (76 m) across the arrestor bed before it came to a stop. "Computer modeling indicates that in the absence of the EMAS, an exit speed of only 70 kt would have resulted in the aircraft reaching Thurston Basin [a waterway approximately 600 ft (183 m) beyond the end of the runway]," FAA said. "The aircraft … was brought to a halt with only minor damage. The only injury occurred during the evacuation of the aircraft when a passenger twisted an ankle." ESCO said that this airplane was extracted from the EMAS within four hours by removing crushed blocks and pulling the airplane backwards with a tow vehicle attached to each main gear. The runway reopened without delay, and repairs to the arrestor bed were completed in 15 days.

- In May 2003, a McDonnell Douglas MD-11 operated by Gemini Air Cargo with a weight of about 470,000 lb (213,191 kg) was safely arrested during a low-speed overrun on Runway 4R at Kennedy. The aircraft was extracted from the arrestor bed within a few hours.

- In the January 2005 overrun on Runway 4R at Kennedy, a Polar Air Express cargo 747 with a weight of about 610,000 lb (276,694 kg) and an exit speed greater than 70 kt was stopped safely by the arrestor bed.

Damage to aircraft during these arrestments has been minimal, according to ESCO. Thompson said that he received reports that the 747 — following airworthiness inspections and replacement of nine tires — was returned to normal flight operations within a few days.

The FAA *Airport/Facility Directory* contains entries about the installation

A Saab 340B arrestment occurred in 1999 at John F. Kennedy International Airport.

Port Authority of New York and New Jersey of EMAS at specific runway ends, and the Notice to Airmen (NOTAM) system communicates advisory information to pilots about an EMAS out of service, such as during repairs after the arrestment of an airplane.

NTSB has advocated and supported wider use of EMAS. "EMAS is not a substitute for, nor a safety equivalent to, a standard-size [runway safety area]," NTSB said in 2003. "However, because EMAS does provide an additional level of safety for those runways at which it is installed, the Board supports the installation of EMAS at those runways in which the [runway safety area] is less than the minimum standards," established in FAA Advisory Circular 150/5300-13, *Airport Design*.

Citing a March 2000 overrun in Burbank, California, U.S., NTSB recommended that FAA proactively require that all Part 139 certificated airports "upgrade all runway safety areas that could, with feasible improvements, be made to meet the minimum standards," and "install [EMAS] in each runway safety area available for air carrier use that could not … be made to meet the minimum standards."

Improvement Targets

These recommendations influenced FAA's Runway Safety Area Program, implemented in October 1999, which currently aims to accelerate the improvement of runway safety areas to standard — or within 90 percent of standard — faster than relying on Part 139, Bennett said. "We found 456 runways that were not within [90 percent of] standard but could be improved, and that became our target group," he said. In the 2000–2006 period, "we have done more than 200 [runway safety area] projects … and 34 are scheduled for completion in fiscal year 2006." The schedule calls for airport operators to complete upgrades at 92 percent of the targeted runways by 2010 and for 86 percent of all Part 139 runways to "substantially meet" standards by 2015.

Hearing participants raised a common question about EMAS: What would happen to an airplane striking an arrestor bed during an undershoot? The EMAS advisory circular says, "EMAS shall be designed so as not to cause control problems for aircraft undershoots touching down in the arresting system." Thompson added, "[FAA] ran a series of simulations, landing into an EMAS at different flap settings and conditions, and their conclusion was that there was no loss of control of the aircraft. Basically, [the airplane does not experience enough] strut compression while still flying to substantially penetrate the [arrestor] bed, so it skips off of the arrestor [bed] and at flying speeds, one skip and you're on the runway."

Recent reports from ICAO meetings of civil aviation authorities show a continuing process of correcting substandard runway end safety areas. Nevertheless, few countries have reported their compliance with ICAO standards. In 2002, "of 188 signatories to ICAO, 136 have not provided information on compliance, 24 advise they are in compliance [and] 13 advise there are differences [compared with standards for the runway end safety area in Annex 14, *Aerodromes*]," the New Zealand Civil Aviation Authority (CAA) said.[3]

Although EMAS is not covered in ICAO standards and recommended practices, some countries anticipate this technology in current or pending regulations. The Australian Civil Aviation Safety Authority, for example, says, "Where it is not practicable to provide the full length of runway end safety area, the [aerodrome's] provision may include an engineering solution to achieve the objective of the runway end safety area, which is to enhance airplane deceleration."[4] In September 2005, CAA also discussed EMAS in its proposal to implement runway end safety areas on specified runways. CAA said, "ICAO and other regulatory authorities do not approve engineered solutions as an equivalent for a 240 m runway end safety area. The CAA does not consider that these engineered materials provide an equivalent for the runway end safety area, and currently none provide for undershoot."

Regarding international acceptance, Bennett said, "FAA plans to present a discussion paper to the Aerodrome Working Group of the [ICAO] Aerodromes Panel at its next meeting. FAA will share the U.S. experience with [EMAS] and propose that ICAO adopt standards/recommendations similar to ours." ●

Notes

1. International Civil Aviation Organization. "Runway Safety Areas/Engineered Materials Arresting Systems." A presentation by the United States of America to the North American, Central American and Caribbean directors of civil aviation meeting in Tegucigalpa, Honduras, Oct. 11–14, 2005.
2. U.S. Federal Aviation Administration. Order 5200.9, *Financial Feasibility and Equivalency of Runway Safety Area Improvements and Engineered Material Arresting Systems.* March 15, 2004.
3. Watson, Doug. New Zealand Civil Aviation Authority. "Runway End Safety Area (RESA)" NPRM 04–03 Part 139 *Aerodromes — Certification, Operation and Use.* September 2005.
4. Australian Civil Aviation Safety Authority. *Manual of Standards Part 139 — Aerodromes.*

Weighing the Risks of Hypoxia Training

Training sessions are a boon to aviation safety — but only when proper safeguards are applied.

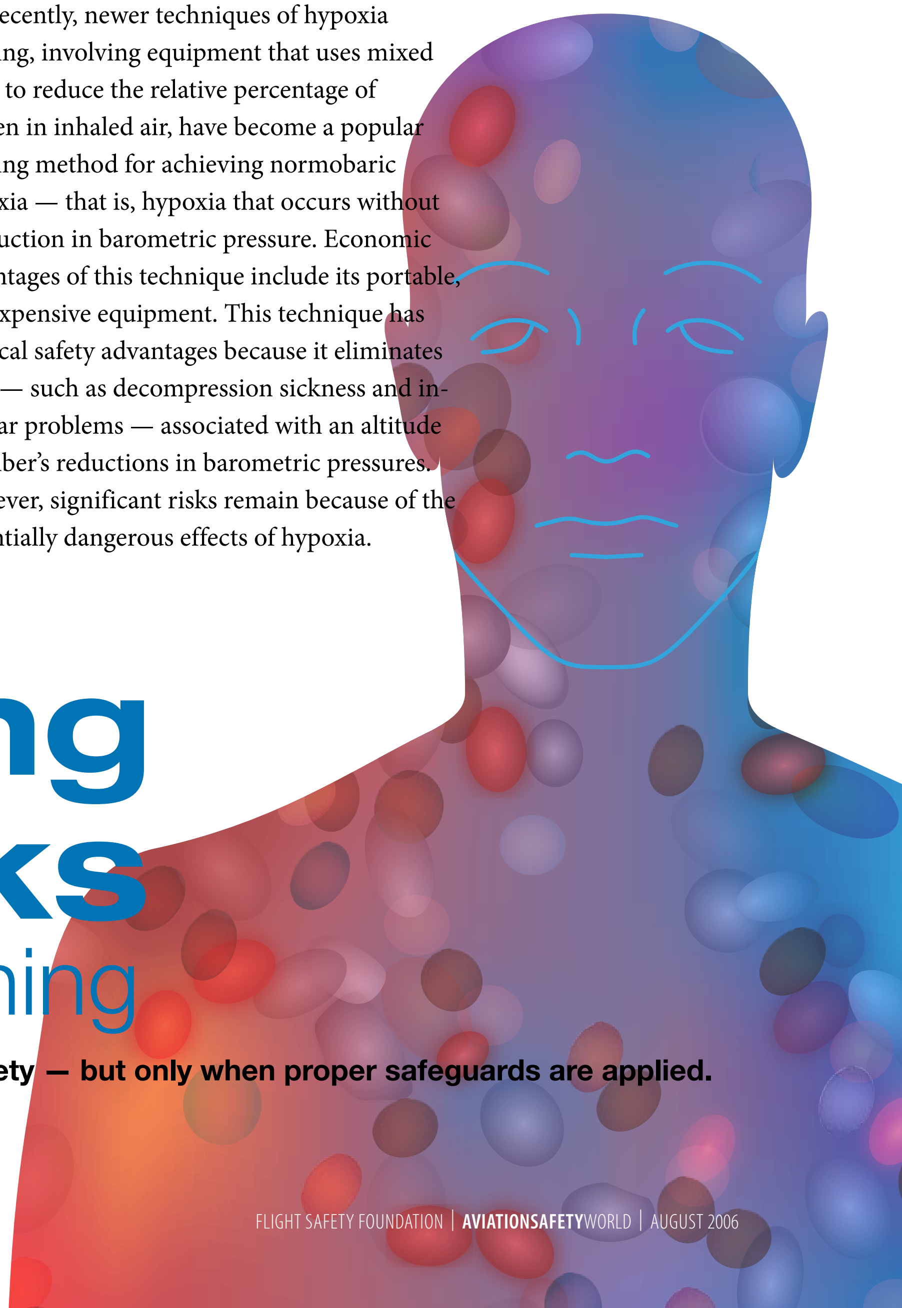
BY QUAY SNYDER, M.D.

Hypoxia remains a serious threat to aviation safety nearly 100 years after the first death in aviation attributed to this phenomenon. Training all flight crewmembers to recognize the early symptoms of hypoxia and take prompt corrective action is an essential component of any comprehensive aviation safety program. With the advent of very light jets and increased single-pilot high-altitude operations, this training takes on an even greater significance.

Hypoxia training is valuable if conducted safely, with appropriate participant screening, careful administration and pre-exposure education. If conducted without proper safeguards and participant education, however, hypoxia demonstrations can expose participants to career- and health-threatening risks without adequately training them in the prompt recognition and proper response to this insidious killer. When selecting training vendors, participants should exercise diligence in determining the safety and value of the training offered.

Until recently, hypoxia training was primarily conducted using hypobaric "altitude" chambers. These chambers have provided valuable experiences to flight crewmembers in the recognition of personal hypoxia symptoms, the subtle incapacitating effects of hypoxia and the unpleasant physiological effects of rapid decompression. Hypobaric training, which uses standard air composition at reduced barometric pressures, is associated with some medical risks because of the effects of trapped gases and brief exposures to hypoxia. To mitigate these risks, careful medical screening, in addition to the requirement that participants hold a current medical certificate or military flight authorization, is uniformly required. Medical monitoring with emergency equipment and/or an emergency medical treatment plan is standard. Additionally, detailed instructions are given to participants regarding restrictions on flying after training and the necessity of promptly reporting to medical authorities any unusual symptoms that occur as long as 12 to 48 hours after the training session.

Recently, newer techniques of hypoxia training, involving equipment that uses mixed gases to reduce the relative percentage of oxygen in inhaled air, have become a popular training method for achieving normobaric hypoxia — that is, hypoxia that occurs without a reduction in barometric pressure. Economic advantages of this technique include its portable, less expensive equipment. This technique has medical safety advantages because it eliminates risks — such as decompression sickness and inner ear problems — associated with an altitude chamber's reductions in barometric pressures. However, significant risks remain because of the potentially dangerous effects of hypoxia.



When administered with careful medical screening prior to exposing an individual to hypoxia, a normobaric hypoxia demonstration can be conducted safely, without compromising the effectiveness of the training. Combining the demonstration with simulator training increases the value of this training by showing the subtle — yet significant — incapacitating effects of early hypoxia. These effects become apparent very soon after exposure to hypoxia because of the complex cognitive tasks required to operate an aircraft simulator. As a result, there is no need for prolonged hypoxia exposure in an attempt to demonstrate more obvious cognitive defects, such as difficulty with writing, responding to simple questions and physical coordination, and physical changes, such as changes in skin color (cyanosis).

Upon the first recognition of any hypoxia symptoms, pilots should immediately take the appropriate corrective action (don an oxygen mask and select 100 percent oxygen flow). In flight, by the time physical symptoms are recognized, dangerous cognitive defects may already have jeopardized the pilot's ability to take the proper corrective action.

Providers of hypoxia training should carefully "screen out" potential students with pre-existing heart disease, carotid artery disease, peripheral vascular disease, seizure history, diabetic complications, anemia, recent surgery and many other conditions. Exacerbation of any of these conditions — with potentially serious medical consequences — is possible with hypoxic exposure. A medical response plan should be in place for complications experienced during training.

"Screen-in" medical criteria should include a current medical certificate and a pre-training health questionnaire to report interim medical conditions. Participants should sign an informed-consent form for the risks involved.

Participants in normobaric hypoxia demonstrations sometimes are monitored using pulse oximetry — a non-invasive method of estimating arterial oxygen concentration, often through a probe attached to a finger.[1] Unfortunately, research has shown that pulse oximetry does not adequately reflect the reduced oxygen concentrations in the blood of a hyperventilating and hypoxic person.[2] Using this tool as a safety method may provide a false sense of security.

Two key points determine the value of hypoxia training. First, the pilot must learn to recognize early signs of hypoxia. Second, the pilot must be taught to immediately take corrective action by donning an oxygen mask to rapidly clear those symptoms.

As an aerospace medicine physician engaged in the full-time practice and advocacy of aviation safety, I applaud the recent interest in hypoxia training for business aviation. Safety is enhanced by well-administered training programs. Nevertheless, programs administered in a cavalier fashion do not fulfill the goal of enhancing safety. Rather, they could put the valuable practice of hypoxia training at increased risk in the event of a medical disaster during a training program conducted without proper medical screening and administration. Furthermore, the true value of the training is compromised by a false sense of security derived from participating in inadequate training.

The optimum training for hypoxia using mixed gas breathing techniques should combine several elements:

- Instruction in the physiology of hypoxia and hyperventilation is critical for pilot education prior to experiencing the effects;
- Appropriate medical screening of participants is prudent from a liability perspective and required from an ethical perspective;
- Administration of the training should be conducted in a safe manner, highlighting the seriousness of hypoxia in aviation;
- Training should be directed toward early recognition and prompt corrective action when exposed to hypoxia;
- When possible, providing the training in a flight simulator allows for a more realistic demonstration of the subtle, dangerous effects of hypoxia and for practice of the desired learned behavior to correct the condition; and,
- Individuals and companies seeking hypoxia training should thoroughly investigate vendors for attention to participant safety and educational value in each program. ●

Quay Snyder, M.D., is president and CEO of Virtual Flight Surgeons, an aeromedical consulting firm. He also is a commercial pilot with 2,400 flight hours, a flight instructor and a U.S. Federal Aviation Administration designated pilot examiner. He is a member of the Flight Safety Foundation Corporate Advisory Committee and the National Business Aviation Association Safety Committee. The author and his company do not provide hypoxia training.

Notes

1. Traditionally, pilots who undergo hypoxia training in hypobaric training chambers have not been monitored with pulse oximetry.
2. Ernsting, John. "Aeromedical Considerations for High Capacity Long-Haul Passenger Aircraft." Paper presented at the Airline Medical Directors Annual Scientific Meeting, Orlando, Florida, U.S., May 13, 2006.

Illustration: Susan Reed (FSF)

European Ramp Checks Find Increase



The rate of 'major' deficiency findings in 2005 was highest for aircraft based in the ICAO Western and Central African Region and the Eastern and Southern African Region.

BY RICK DARBY

Ramp inspections of aircraft at European airports turned up a higher rate of deficiency findings per inspection in 2005 than in the previous year but a lower rate of "major" deficiency findings per inspection. The inspections were carried out under the Safety Assessment of Foreign Aircraft (SAFA) program, a combined effort of the European Civil Aviation Conference (ECAC) and Joint Aviation Authorities.[1]

Deficiency findings per inspection averaged 1.56 in 2005, compared with 1.49 in 2004 and 1.24 for the 2000–2005 period (Table 1). From a peak rate of 2.83 in 1996, the rate had declined steadily until 2004.

The rate of findings per item inspected, which ECAC says "might give a better understanding," has also trended up recently. "For every 100 [SAFA] checklist items inspected, on average 3.0 findings were established in the years up to 2003," ECAC said. "In 2004, this increased to 4.6 findings per 100 items inspected and further increased in 2005 to 4.7 findings per 100 items inspected."

A checklist comprising 54 items is used for the inspections. Although the criteria for passing inspections are standardized, not all items are checked in each inspection.

Findings were categorized according to their severity: Category 1 represented "minor" findings, Category 2 "significant" findings and Category 3 "major" findings, based on the degree of deviation from International Civil Aviation Organization (ICAO) standards in Annex 1, Annex 6 and Annex 8. The rate of Category 3 findings per inspection fell from 0.24 in 2004 to 0.22 in 2005 (Table 1). (Rates have been rounded for this article.) The 2005 rate was still higher than the 2000–2005 average of 0.18 and higher than in any of the four years before 2004.

ECAC also reported the rates for combined Category 2 and 3 findings per inspected item in four areas: the flight deck, the passenger cabin, the general condition of the aircraft and the cargo compartment. Each area included three inspection items.

On the flight deck, the highest deficiency rate — 0.13 findings per inspected item — involved documentation, particularly the flight operations manual. ECAC said that "frequent" findings included "no approval by the State [nation] of [the] operator, content of the manual does not meet the ICAO standards, [and] the manual is not up to date or has been drafted by another

in Safety Deficiencies

Photos: European Civil Aviation Conference and Joint Aviation Authorities SAFA Program

airline." Equipment — for example, the lack of a terrain awareness and warning system — was second. Deficiencies related to the minimum equipment list were third.

In the passenger cabin, "emergency exits, lighting and marking, torches [flashlights]" had the highest deficiency rate, at 0.06 findings per inspected item. "The findings mainly concerned emergency exit lights which were not functioning properly; torches which were not available, in poor condition or not available in sufficient quantity; and non-installation or inadequate functioning of floor proximity (emergency) escape path marking systems." "Access to emergency exits," with findings such as obstruction by catering boxes, luggage and cargo, had nearly an equal rate. "Cabin attendant's station and crew rest area," which was largely concerned with whether required harnesses were in place and seats folded correctly, was third in the rate of deficiency findings per inspected item.

"Wheels, tires and brakes" topped the list of findings in general aircraft condition inspections, with a rate of 0.04 deficiencies per inspected item. ECAC cited "tires worn beyond limits, cuts in the tire, leakage of hydraulic fluid in landing gear areas [and] brakes worn beyond limits." The next-highest rate was for leakage of hydraulic fluid from areas other than the landing gear

'Major' Deficiency Findings: A Two-Year Rising Trend

Results of Safety Assessment of Foreign Aircraft Program, 2000–2005

		Number of Findings				Rate of Findings per Inspection			
Year	Number of Inspections	Category 1 (Minor)	Category 2 (Significant)	Category 3 (Major)	Total	Category 1 (Minor)	Category 2 (Significant)	Category 3 (Major)	All Categories
2000	2,394	1,274	1,035	278	**2,587**	0.53	0.43	0.12	**1.08**
2001	2,706	1,258	1,221	389	**2,868**	0.47	0.45	0.14	**1.06**
2002	3,234	1,384	1,219	461	**3,064**	0.43	0.38	0.14	**0.95**
2003	3,414	1,212	1,439	591	**3,242**	0.36	0.42	0.17	**0.95**
2004	4,568	2,349	3,375	1,075	**6,799**	0.51	0.74	0.24	**1.49**
2005	5,457	3,437	3,873	1,182	**8,492**	0.63	0.71	0.22	**1.56**
Total	**21,773**	**10,914**	**12,162**	**3,976**	**27,052**	**0.50**	**0.56**	**0.18**	**1.24**

Rates have been rounded.

Source: European Civil Aviation Conference and Joint Aviation Authorities

Table 1

Highest, Lowest Rates of 'Major' Deficiencies Vary by Factor of Five

Safety Assessment of Foreign Aircraft Program, Deficiencies by ICAO Region, 2005

		Number of Findings				Rate of Findings per Inspection			
ICAO Region	No. of Inspections	Category 1 (Minor)	Category 2 (Significant)	Category 3 (Major)	Total Findings	Category 1 (Minor)	Category 2 (Significant)	Category 3 (Major)	All Categories
APAC	145	106	101	43	250	0.73	0.70	0.30	1.72
ESAF	92	80	123	69	272	0.87	1.34	0.75	2.96
EUR/NAT	4,505	2,664	3,058	832	6,554	0.59	0.68	0.18	1.45
MID	368	283	345	154	782	0.77	0.94	0.42	2.13
NACC	214	143	99	29	271	0.67	0.46	0.14	1.27
SAM	83	101	71	17	189	1.22	0.86	0.20	2.28
WACAF	50	60	76	38	174	1.20	1.52	0.76	3.48

APAC = Asian and Pacific ESAF = Eastern and Southern African EUR/NAT = European and North Atlantic ICAO = International Civil Aviation Organization
MID = Middle East NACC = North American, Central American and Caribbean SAM = South American WACAF = Western and Central African

The ICAO region shown is based on the state of registration of the aircraft inspected.

Source: European Civil Aviation Conference and Joint Aviation Authorities

Table 2

and leakage of oil, fuel and water. The lowest rate for the three inspection items was for deficiencies related to the powerplants and pylons.

In the cargo compartment, "safety of cargo on board" had the highest deficiency rate, at 0.11. "In several cases, it was established that cargo … was not properly secured," ECAC said. "Heavy items (such as spare wheels) were not restrained, which might lead to damage of the aircraft in case of rapid acceleration/deceleration. In other cases, barrier nets were either not installed or in poor condition. Cargo containers and pallets were in poor condition. Locks to secure the containers were not in the proper position or unserviceable." Findings related to "dangerous goods" and the "general condition" of the cargo compartment had the second and third highest rates, respectively.

Findings of a SAFA inspection can lead, depending on the seriousness of the deviations, to several actions. The aircraft commander is asked to address the deficiencies brought to his or her attention. Occasionally, if the inspectors have cause to believe the commander does not intend to take the necessary measures, the authorities ground the aircraft until the corrections are made. In other cases, the aircraft crew is allowed to depart under operational restrictions, such as a requirement that substandard seats be unoccupied. Category 2 and 3 findings are communicated to the civil aviation authority that oversees the operator's home base.

In 2005, 13 aircraft were grounded, 47 were placed under flight restrictions and 708 required corrective actions before departure was authorized.

Under the SAFA program, officials from any of the 42 ECAC member countries can perform ramp checks on parked aircraft[2] based in other countries, whether those countries are ECAC members or not. During 2005, 32 ECAC countries performed 5,457 inspections on equipment of 748 operators from 133 countries. No attempt was made to inspect equal numbers of aircraft from each country or operator.

The rates of findings can be affected by the practice of most ECAC countries concentrating their inspections on operators that have been found deficient in the past, and by greater efficiency over time as inspectors have gained experience, ECAC says.

Under this method, inspection results for 2005 were tabulated by ICAO region (Table 2). The rate of Category 3 findings was highest for the Western and Central African Region and the Eastern and Southern African Region, and the lowest for the Northern American, Central American and Caribbean Region. "For each category of findings, the relative number of findings is higher for operators from non-ECAC States than for those from ECAC States," ECAC says. ●

Notes

1. Data are from a European Civil Aviation Conference report that can be found on the Internet at <www.jaa.nl/safa/safa.html>.

2. Aircraft types inspected in 2005 were predominantly airliners and business jets, along with a few smaller general aviation aircraft. Some helicopters were included.

Learning From Experience: Incident No. 2

Misidentified Fix

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Second in a series focusing on approach and landing incidents that might have resulted in controlled flight into terrain but for timely warnings by TAWS.

BY DAN GURNEY

A premature descent for the final segment of a nonprecision approach in this incident might have resulted from a mistake in identifying the final approach fix (FAF). Moreover, the flight crew's continuation of the descent until a terrain awareness and warning system (TAWS) warning occurred indicates a possible breakdown in cross-checking and monitoring.[1]

The crew of the modern, glass-cockpit aircraft was conducting a VOR/DME (VHF omnidirectional radio/distance measuring equipment) approach in daytime instrument meteorological conditions. The approach chart shows that a minimum altitude of 3,940 ft should be maintained until reaching the FAF, 11.7 nm DME from the VOR/DME station. However, TAWS data indicate that the descent was begun 16.0 nm from the station — 4.3 nm before reaching the FAF (Figure 1, page 26).

The aircraft was 540 ft above ground level and 4.5 nm (8.3 km) from the runway threshold when the TAWS generated a "TERRAIN, PULL UP" warning. The crew stopped the descent and conducted a missed approach, climbing away safely.

The author's analysis of the incident, which was reviewed by a select group of aviation safety professionals and airline pilots, considered the following as potential threats to safely conducting the instrument approach:

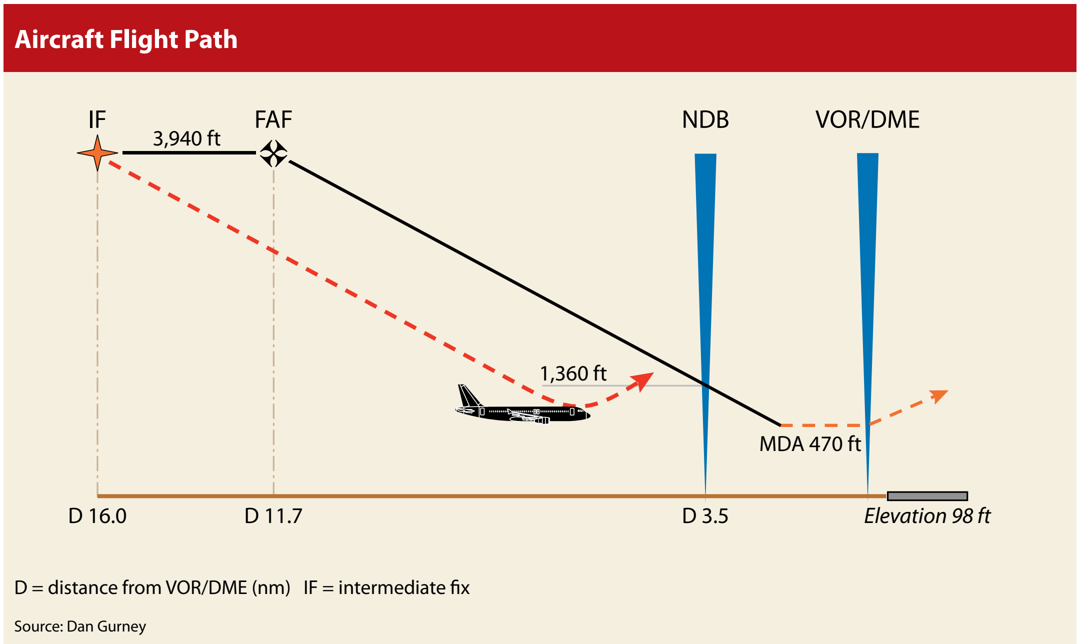


Figure 1

- The aircraft operator uses metric altimeter procedures. The approach chart includes a table for converting specific, pertinent altitudes from feet to meters, but the altitude/range table included on the chart shows altitudes only in feet. If the crew had not prepared their own altitude/range table, they would have had to mentally convert the range values to meters.
- The VOR/DME station is not colocated with the runway threshold; it is 0.2 nm (0.4 km) from the threshold. This would have added to the mental workload.
- The location of the FAF at 11.7 nm DME results in a long final descent.
- The approach procedure includes an initial approach fix at 25 nm DME and an intermediate fix at 16 nm DME. Both fixes are shown in a dotted box in the plan view of the approach procedure with a note that the ranges are not to scale (Figure 2); the initial approach fix and the intermediate fix are not shown in the profile view of the published approach procedure.

A likely explanation for the premature descent is that the crew mistook the intermediate fix for the FAF. The intermediate fix is 4.3 nm from the FAF.

The error might have resulted from a simple misinterpretation of the chart, incorrect programming of the flight management system (FMS) or misinterpretation of the waypoints programmed in the FMS or displayed by the electronic flight instrument system (EFIS).

After the premature descent was begun, the aircraft was flown below the usual flight path. Before reaching the nondirectional beacon (NDB) 3.5 nm from the VOR/DME station, the

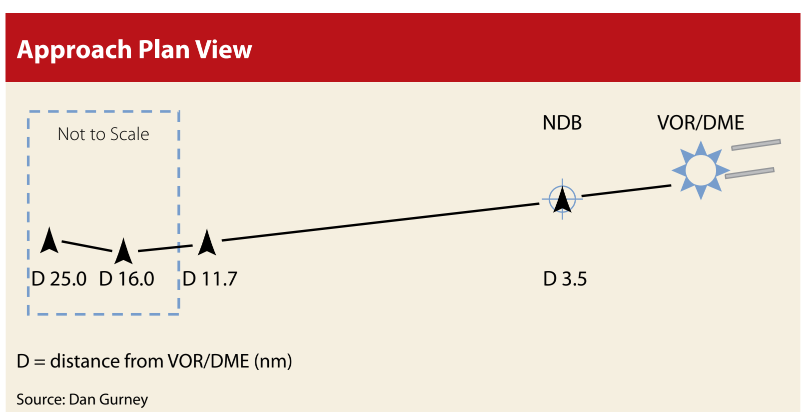


Figure 2

aircraft descended below 1,360 ft, the minimum altitude for crossing the NDB. (The aircraft did not descend below the minimum descent altitude, 470 ft.)

The following factors might have been involved in the continued flight below the expected flight path and in the premature descent below the NDB minimum crossing altitude:

- Altitude/range was not monitored during the descent.
- The airport or the runway threshold was not programmed as a "TO" waypoint in the FMS and/or was not displayed on the EFIS map.
- The NDB symbol displayed on the EFIS map was mistaken for the airport or the runway.

Lessons to Be Learned

Simple mistakes or misinterpretations of published approach procedures often occur. They must be identified by careful cross-checking and monitoring. Flight Safety Foundation research on approach and landing accidents and serious incidents has shown that crew resource management failures involving cross-checking and coordination are involved in nearly two-thirds of the events.[2]

It appears likely in this incident that both pilots made the same error in identifying the FAF. Standard operating procedures (SOPs) must guard against such occurrences by requiring two complete sets of charts in the cockpit and that the pilot flying and the pilot not flying (pilot monitoring) use the charts during the approach briefing. SOPs also must require the crew to cross-check that their understandings of the approach procedure agree.

During an approach briefing, most crews check that their chart dates agree, but how many cross-check that their understandings of the procedure agree?

The incident also suggests that special approach briefings, as well as stricter cross-checking and monitoring, may be required when nonstandard procedures such as metric altimeter procedures are used.

Flight crews should ensure that the airport or runway is displayed on the EFIS map before beginning a descent for the final segment of an approach. During descent, altitude/range checks should be conducted using a published table, a table prepared before flight or mental calculations, using 300 ft per nm for a three-degree glide path.

Moreover, one of the most important lessons to be learned from this incident is that *altitudes* should be the basis for altitude/range checks during descent. If the crew waits until crossing a specific fix or reaching a specific range, the aircraft might already have descended below the required check altitude, resulting in reduced terrain clearance. ●

It appears likely in this incident that both pilots made the same error in identifying the FAF.

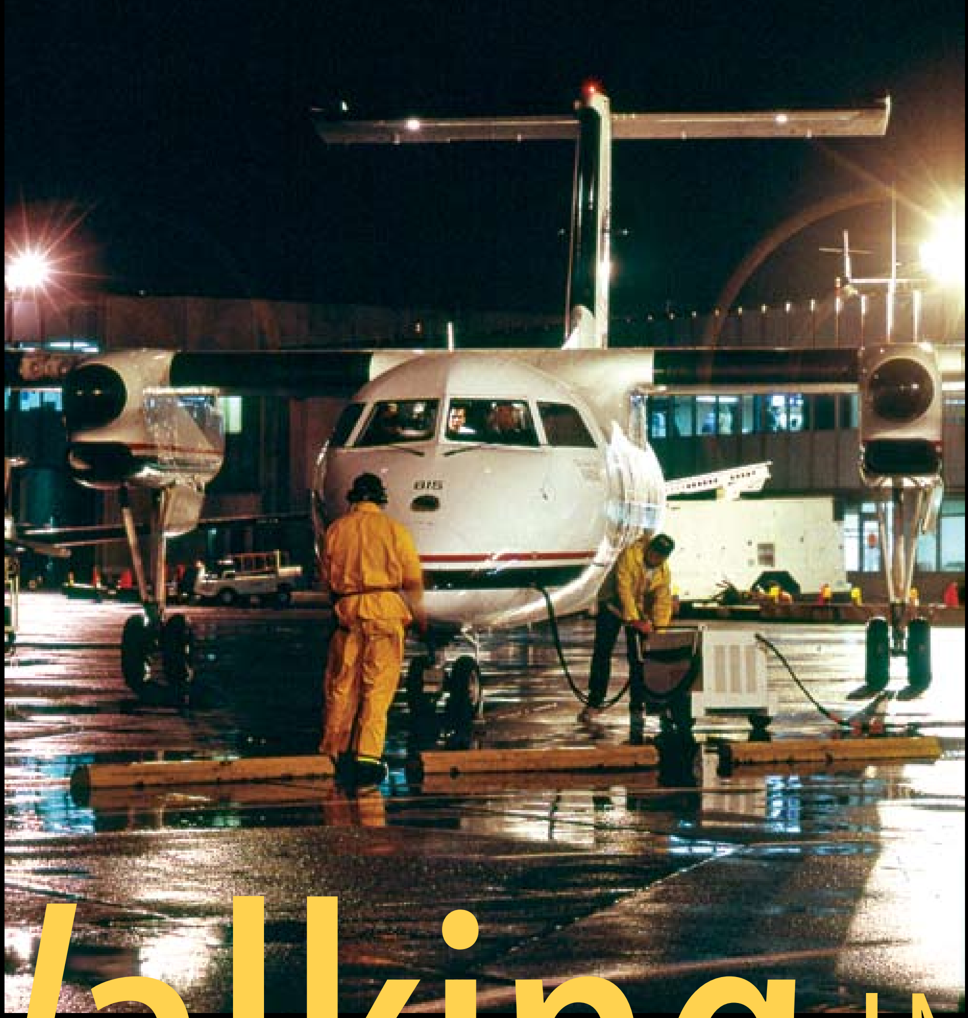
[This series, which began in the July issue of *Aviation Safety World*, is adapted from the author's presentation, "Celebrating TAWS Saves, But Lessons Still to Be Learned," at the 2006 European Aviation Safety Seminar and the 2006 Corporate Aviation Safety Seminar.]

Dan Gurney served in the British Royal Air Force as a fighter pilot, instructor and experimental test pilot. He is a co-author of several research papers on all-weather landings. Gurney joined BAE Systems in 1980 and was involved in the development and production of the HS125 and BAe 146, and was the project test pilot for the Avro RJ. In 1998, he was appointed head of flight safety for BAE Systems. Gurney is a member of the FSF CFIT/ALAR Action Group, the FSF European Advisory Committee and the FSF steering team developing the "Operators Guide to Human Factors in Aviation."

Notes

1. *Terrain awareness and warning system* (*TAWS*) is the term used by the International Civil Aviation Organization to describe ground-proximity warning system (GPWS) equipment that provides predictive terrain-hazard warnings; *enhanced GPWS* (*EGPWS*) and *ground collision avoidance system* (*GCAS*) are other terms used to describe TAWS equipment.

2. FSF Approach-and-landing Accident Reduction (ALAR) Task Force. "Killers in Aviation: FSF Task Force Presents Facts About Approach-and-landing and Controlled-flight-into-terrain Accidents." *Flight Safety Digest* Volume 17 (November–December 1998) and Volume 18 (January–February 1999).



Walking INTO

Accidents involving human contact with propellers and rotor blades persist, despite safety efforts to prevent them.

BY CLARENCE E. RASH

People continue to come into contact with spinning propellers and rotor blades, often with fatal consequences, even though the danger they represent is well known. Although not common, these accidents continue to claim flight crewmembers, passengers and ground personnel. Most are preventable.

Aircraft manufacturers and operators have implemented a variety of paint schemes to increase blade conspicuity — visibility — and have developed safety programs to emphasize propeller and rotor-blade hazards.

"Constant care and vigilance [are] required to keep the number of … accidents at a minimum," the Australian Civil Aviation Safety Authority (CASA) said in a 2003 advisory circular that discussed the prevention of injuries caused by spinning propellers and rotor blades.[1]

The primary risk presented by a spinning blade is that it is difficult — often impossible — to see. In addition, noise from the engine and slipstream/rotor downwash may obscure noise from the blades.

"It is often difficult for a pilot to appreciate the level of confusion that a non-aviator may suffer in the vicinity of an aeroplane with its engine(s) running," CASA said. "The area to the rear

Trouble

© Copyright Hartzell Propeller

of an aircraft is where slipstream and noise are most evident, while the front of the propeller area may be relatively quiet. … Pilots of high-wing singles or twins have to be particularly aware of the risk of a passenger moving from the exit doors forward … toward the propellers. Pilots of helicopters have to be alert to the possibility of people walking into the tail rotor while focusing on the engine and main-rotor disc when approaching or leaving the cabin."

Propeller tip speeds — which approach the speed of sound during takeoff — are dangerous even at the slower speeds involved in ground operations. For example, at typical engine idling speeds of 1,000 to 1,200 revolutions per minute (rpm), propeller tip speeds are 200 to 300 mph (322 to 483 kph) or more.[2]

One common scenario for propeller-strike injuries and deaths involves maintenance and ground personnel working around airplanes.

For example, a ramp service employee received serious injuries when he was struck by a rotating propeller blade on a Saab-Scania 340B at General Mitchell International Airport in Milwaukee on Nov. 13, 2004. A report by the U.S. National Transportation Safety Board (NTSB) said that the captain recalled that he had shut down the left (no. 1) engine before arriving at the gate, parked the airplane and — after being told that the wheel chocks had been installed on the left side of the airplane — feathered the right (no. 2) propeller. The captain said that he heard "three or four quick thumps" and was signaled to shut down the right engine.[3]

"When he exited the aircraft, he saw the ramp service employee lying beneath the aircraft," the report said. "An employee on the ramp [later] stated that the ramp employee involved walked outside of the left wing with two chocks toward the nose of the aircraft. She reported that he walked to the nose landing gear, slowed down and then continued walking around to the other side of the aircraft. … She heard the 'sound of something hit the propeller' and she saw the individual 'flip and land on the ground.'"

The injured employee had been hired about one month before the accident and had received one week of general training, followed by specific training that had included instructions to always "chock the main landing gear by approaching from the rear," the report said.

Another accident scenario involves hand-propping to start a small airplane's engine.

For example, an NTSB report cited the pilot's "inadequate start procedure" as the probable cause of a Nov. 25, 1998, accident in London, Kentucky, U.S., in which the pilot of a Beech C35 Bonanza was killed as he hand-propped his airplane.[4]

None of the airplane's wheels had been chocked in front, and the ground was damp after heavy rain the previous evening, the report said. The pilot tried unsuccessfully to start the engine with the electric starter, then hand-propped it.

"The engine fired, and the propeller spun, hitting the pilot," the report said.

Spinning helicopter main-rotor blades have unique risk characteristics because the space occupied by the rotor blades is large — with a typical 40-ft (12-m) rotor-disc span that extends as much as 13 ft (four m) beyond the sides of the helicopter — and can be easily accessible. Rotating helicopter blades are especially dangerous to people outside the aircraft when the helicopter is being powered down and the centripetal force on the main-rotor blades is reduced, allowing them to droop closer to the ground. Because of their height, they are associated with head trauma more often than with any other type of injury.

A typical helicopter main rotor turns about 450 rpm, with tip speeds of as much as 500 mph (805 kph) — far exceeding the minimum force required to cause serious injury or death if they strike someone.

Paint bands on propellers and rotor blades become visible concentric circles when in motion, helping ground personnel identify and avoid their dangerous arcs.

For example, published reports described an accident in March 2006 in Nibong Tebal, Malaysia, in which an official of a housing development company was killed when he was struck on the head by a rotor blade of a Eurocopter AS 365 Dauphin. The accident occurred as the official walked away from the helicopter after checking to ensure that one of its doors was latched securely before what was to have been an aerial tour for several schoolchildren.[5]

Tail-rotor blades — designed to counteract the torque of the main rotor by generating a sideways force to control yaw and maintain the direction of flight — rotate up to seven times faster than the main-rotor blades, with blade-tip speeds of about 900 mph (1,448 kph; see "Unconventional Tail Rotors"). Tail-rotor blades have been cited in nearly three-quarters of U.S. helicopter rotor-blade accidents.

For example, an NTSB report cited a hospital security guard's failure "to maintain clearance with the operating tail rotor" as the probable cause of a Jan. 22, 2001, accident at a hospital helipad in Quincy, Illinois, U.S., in which the security guard received serious injuries.[6]

The security guard — who was responsible for keeping unauthorized people away from the Bell 206L-1 LongRanger — walked into the tail rotor while crewmembers were preparing for departure on an emergency medical services flight. The security guard had attended a training session about one year before the accident that discussed "how to approach the aircraft in a safe manner while the rotors are in operation," the report said.

Well-Known Hazard

A review of the NTSB accident database found that, from 1982 through early 2006, there were 166 accidents in which people were struck by propellers or rotor blades; of these, 137 (83 percent) involved airplanes and 29 (17 percent) involved helicopters. The accidents were more than three times more frequent during the first five years of this period, when 56 accidents occurred, than during 2001–2005, when 16 accidents were recorded.[7]

The causes and circumstances of propeller and rotor-blade accidents have been recognized for many years. In the early 1970s, as part of a nationwide accident-prevention program, the U.S. Federal Aviation Administration (FAA) initiated an effort to educate pilots about the hazards.[8]

As part of that effort, in June 1975, FAA published the first of several advisory circulars that discussed fatalities and serious injuries caused by spinning propellers and rotor blades, and issued recommendations to prevent these accidents, which "with proper education and discipline … could be reduced to zero."[9]

The FAA effort was credited with helping to achieve a substantial decrease in propeller/rotor blade accidents. A 1993 analysis of NTSB reports on propeller/rotor blade accidents by the FAA Civil Aeromedical Institute (CAMI; now the Civil Aerospace Medical Institute) showed that the annual average number of accidents peaked in 1970–1974 at 25.6. The subsequent decline resulted in an annual average of 15.8 accidents from 1975–1979 — about 40 percent fewer than the previous half decade.[10]

That decline "seems attributable to several actions taken by the FAA in the mid-1970s," the CAMI report said. "The methods included safety seminars, handouts, posters, a film depicting an actual accident resulting from improper hand-propping and the

Unconventional Tail Rotors

Conventional tail-rotor designs in helicopters have from two to five blades and rotate in the vertical plane. The length of the tail-rotor blades typically is in proportion to the length of the main-rotor blades; typically, a tail-rotor blade is about 4.0 ft (1.2 m) long, and the tail-rotor disc span is about 8.0 ft (2.5 m). The bottom edge of this span can be 5.0 ft to 6.0 ft (1.5 m to 1.8 m) above the ground.

Two alternative designs that significantly reduce the risk of injuries associated with tail-rotor blades are the fenestron and the NOTAR — or NO TAil Rotor.

The fenestron, patented by Aérospatiale and in use on helicopters manufactured by Eurocopter, resembles a conventional tail rotor in that both systems have spinning blades that generate an aerodynamic force to counteract the torque of the main-rotor blades. However, a fenestron's blades are mounted within a shroud, or enclosure, that forms part of the tail fin of the helicopter. This also is known as a "fan tail" design. In addition, a fenestron has between eight blades and 13 blades, compared with conventional tail rotors, which seldom have more than four blades. Fenestron blades are smaller than conventional tail-rotor blades and rotate at faster speeds.

Because of the fenestron's enclosure within the shroud, its blades are far less likely to come in contact with people — or with trees, electric power lines and other obstructions.

The NOTAR design, in use on the more recent models of MD Helicopters, eliminates the tail-rotor apparatus and in its place uses jets of compressed air that are forced out of two slots on the right side of the tail boom. MD Helicopters says that the result is the creation of "a boundary-layer control called the Coanda effect. The result is that the tail boom becomes a 'wing,' flying in the downwash of the rotor system, producing up to 60 percent of the anti-torque required in a hover."[1] The jets of air change the direction of the airflow in the tail boom to create an aerodynamic force that opposes the main-rotor torque.

Andy Logan, chief technology officer for MD Helicopters, said that by eliminating the tail rotor, the NOTAR system has eliminated the cause of more than 25 percent of helicopter accidents worldwide. He said that the system also has secondary benefits that are "subtle and many," including improved access to confined spaces, an ability to operate closer to obstructions and quieter operations.

— CER

Note

1. MD Helicopters. *NOTAR Technology*. <www.mdhelicopters.com>.

release of FAA advisory circulars on the hazard of propellers."

Another notable decline occurred from 1985–1989, when the annual average was 7.2 accidents — down 48 percent from the annual average of 14 accidents in 1980–1984. The decrease resulted partly from the "steady improvement in general aviation accident statistics," as well as from a decrease in the number of hours flown, the report said.

The CAMI report said that, of the 104 propeller/rotor blade accidents that occurred from 1980 through 1989, 81 accidents (78 percent) involved airplanes; 21 accidents (20 percent) involved helicopter rotor blades, including 15 accidents that involved tail-rotor blades; and two accidents (2 percent) involved seaplanes. Nearly half of the rotor-blade accidents were fatal.

The 104 accidents resulted in 106 deaths and injuries; of those killed and injured, 66 percent were passengers, 16 percent were ground crewmembers, 14 percent were pilots, and 3 percent were spectators. One-third of all deaths and injuries occurred during deplaning, 25 percent occurred as the victim was assisting the pilot, 18 percent occurred during hand-propping a propeller, and 14 percent occurred during enplaning.

Twenty-seven percent of the accidents occurred during dusk or darkness, "when ordinary propeller conspicuity, even at a well-lighted airport, would be considerably reduced," the report said. About 44 percent of those accidents involved people providing assistance to pilots, 29 percent were deplaning accidents, and 13 percent were enplaning accidents.

A similar study of U.S. Army helicopter accident records found that 24 rotor-blade-strike injuries, half of which involved tail-rotor blades, occurred from 1972 through 1991.[11] Eleven of the injuries (46 percent) resulted in fatalities, mostly from head trauma. Of the 24 people injured, half were crewmembers, seven (29 percent) were passengers, three (13 percent) were ground crewmembers, and two (eight percent) were bystanders. During the years included in the study, one rotor-blade-strike fatality occurred approximately every 1.7 years. When data were analyzed in five-year periods from 1972 through 1991, a downward trend in accident frequency was similar to the trend identified in the 1993 study of U.S. civil helicopter accident data.

Paint Schemes

For decades, manufacturers and operators have used various methods to help prevent injuries caused by rotor blades and propellers. One involves the use of different paint schemes to increase the conspicuity of rotating rotor blades and propellers. This strategy was suggested as early as 1954, when the U.S. Navy began using a black, red and white pattern on propeller blades; when the propeller is in motion, this pattern results in the visual effect of concentric circles.[12]

In the years that followed, blade conspicuity was studied repeatedly; researchers often reached different conclusions, and manufacturers used a variety of paint schemes on propellers and rotor blades.

Today, for example, many airplanes and helicopters have stripes of high visibility paint on their propellers and rotor blades, and many helicopter tail rotors still have a black-and-white paint scheme — which was designated as "most conspicuous" in a 1978 report by CAMI.[13] Among the most recent recommendations is one from Defence Research and Development Canada, which calls for two brightly colored stripes, discontinuous from one blade to the next, on each of the four main rotor blades of the CH-146 Griffon combat support helicopter. This configuration is designed to produce a circular flickering effect as the blades rotate.[14]

Among the factors that affect the conspicuity of propellers and rotor blades are color contrast between elements of the blade color scheme and color contrast between the blade color scheme and backgrounds. Brightness contrast between elements of the blade color scheme and brightness contrast between the blade color scheme and backgrounds also are considered, as are the patterns of colors on the blades, the rotational speed of the blades, and the size and number of blades.

Hartzell Propeller paints contrasting blade-tip markings on the forward surfaces of its propellers — and on both forward and aft surfaces of pusher-type propeller installations. The company encourages its customers — aircraft manufacturers and aircraft modifiers — to choose blade-tip stripes in contrasting colors, such as white tip stripes on a black blade, or red and black stripes on a white blade, said Richard Edinger, vice president for certification and flight safety at Hartzell.

"We have observed propellers (more commonly those in military use) where one or more blades are painted with alternating stripes of black and white the full length of the blade, and the remaining blades are painted with the reverse arrangement," Edinger said. "This gives a noticeable strobing effect, although the appearance would probably be very unappealing to many."

Recommendations to aircraft owners and operators are that they maintain or adopt a paint scheme to enhance propeller/rotor blade conspicuity. However, an existing paint scheme should not be changed unless a specialist has determined that the new paint scheme will not interfere with pilot vision, induce flicker vertigo or result in an unbalanced blade condition.

Other engineering strategies also are recommended to aid in preventing deaths and injuries associated with propeller/rotor blade strikes.

For example, audible or visual warning signals sometimes are used to alert helicopter pilots if doors are opened while the engine(s) are being operated. This lets pilots know if passengers unexpectedly attempt to exit the helicopter.

Additional lighting of the rotor blades — with wing lights or tail boom lights aimed at the blades, for example — can increase conspicuity at dusk, in darkness or in other low-light conditions. Other solutions include blade markings that are visible only at idling speeds and flashing strobe lighting to direct attention to the tail-rotor blades.[15]

Safety Programs

Although engineering solutions are vital to accident prevention, aviation safety specialists also recommend well-designed and well-implemented safety programs that address human factors. Programs to reduce propeller/rotor-blade accidents should involve pilots and other crewmembers, ground personnel, passengers and airport/heliport managers.

For example:

- Airport managers should provide safety barriers and related markings to ensure that unauthorized people do not loiter among parked aircraft;
- Operators should ensure that all personnel receive recurrent safety training in the risks of working around propellers and rotor blades. Warning signs displayed within aircraft cabins and in passenger pre-boarding areas should describe the risks presented by propellers and rotor blades and the enplaning and deplaning methods developed to minimize those risks;
- Airport personnel should direct passengers from terminal doors to their aircraft, or rope stanchions should be provided to designate appropriate walkways. Helicopter passengers should be told always to approach and depart the helicopter from the front — *never* from the rear; if a helicopter landing area is on or adjacent to a hill, passengers should not approach or depart the helicopter on the upslope side so that they avoid the area of lowest rotor clearance;
- Before starting an engine, flight crewmembers should ensure that all personnel are clear of all propellers or rotor blades. Only individuals with experience in hand-propping an airplane should perform the procedure; when they do, a person familiar with the procedure should be at the controls;
- People who must walk beneath a helicopter's main-rotor blades should crouch low well before approaching the blades. If they are suddenly blinded by dust or debris, they should stop moving and crouch lower; a better alternative is to sit and wait for help. They should not try to feel their way to or from the helicopter. No one should reach up for any object that might be blowing away or chase after the object;
- Whenever possible, engines should be shut down before enplaning or deplaning passengers. When engines must be kept operating, flight crewmembers should tell passengers — before they exit the aircraft — which path to follow to avoid propellers and rotor blades. A helicopter pilot should orient the helicopter with its tail rotor away from the passengers' route to or from the helicopter; and,
- Pilots, maintenance personnel and others working in and around aircraft should behave at all times as though ignition switches are "on." If they are carrying long tool rods or other equipment as they approach a helicopter, the equipment should be positioned horizontally to avoid possible contact with the main-rotor blades.

Aircraft manufacturers and operators have tried for years to prevent accidents in which people are struck by spinning propellers and rotor blades. Today, although these accidents are infrequent, they often are fatal.

Nevertheless, authorities say, with attention to blade conspicuity and safety programs, most of these accidents can be avoided. ●

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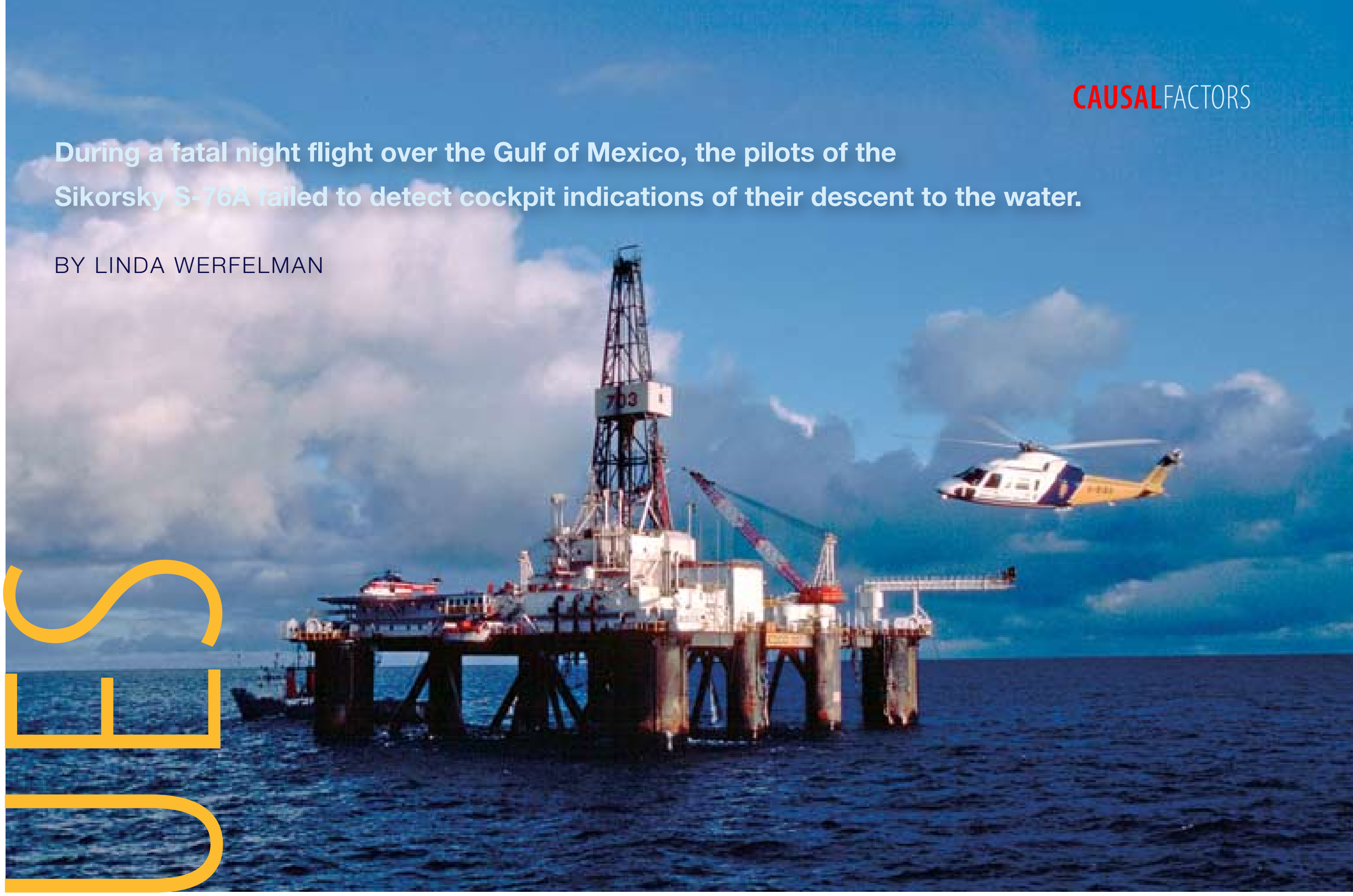
MISSED CUES

During a fatal night flight over the Gulf of Mexico, the pilots of the Sikorsky S-76A failed to detect cockpit indications of their descent to the water.

BY LINDA WERFELMAN



The flight crew of a Sikorsky S-76A failed to "identify and arrest the helicopter's descent" before it struck water in the Gulf of Mexico, killing all 10 occupants, the U.S. National Transportation Safety Board (NTSB) said in its final report on the accident.[1]

The controlled-flight-into-terrain (CFIT) accident occurred about 1918 local time March 23, 2004, in night visual meteorological conditions (VMC) about 70 nm (130 km) south-southeast of Scholes International Airport in Galveston, Texas, U.S. The Era Aviation helicopter was transporting eight service personnel to an oil-drilling ship that was en route to a location 180 nm (333 km) south-southeast of the airport. The helicopter was destroyed by impact forces.

"The helicopter crashed into the water at a high airspeed, a shallow descent angle and a near-level roll attitude," the report said. "The flight crew was not adequately monitoring the helicopter's altitude and missed numerous cues to indicate that the helicopter was inadvertently descending toward the water."

Era Aviation records showed that the S-76 departed from Galveston at 1845 for what was expected to be a 45-minute flight to an oil and gas platform where the helicopter was to be refueled before continuing the flight to the ship. Radar data showed that after takeoff, the helicopter was flown on a south-southeasterly course. The crew flew the helicopter to 1,800 ft and maintained that altitude until about 1858, when radar data showed a 300 fpm rate of descent. At 1900, radar data showed that the helicopter was about 35 nm (65 km) south-southeast of Galveston at 1,100 ft, with a 250 fpm rate of descent. No further radar returns were received because the helicopter was beyond the 60 nm (111 kilometer) radar-coverage range.

At 1914, the crew radioed a company dispatcher to make a position report, told the dispatcher that the helicopter had enough fuel to continue to the drilling ship and requested updated coordinates for the ship. There were no further communications from the crew.

At 1918:25, the helicopter's cockpit voice recorder (CVR) — whose recording was described as "mostly unintelligible" — recorded "the sound of decreasing background noise." The CVR recording stopped at 1918:34.

The dispatcher's records showed that she radioed the crew at 1923 to provide the updated ship coordinates but received no response. She tried again at 1931, when her records said that she was going to ask ship personnel to make radio contact with the crew. At 1934, the records indicated that someone on the ship was attempting to contact them. The dispatcher tried again at 1946 and 2008. There was no response to any calls. The report said that the dispatcher told investigators that during her communications with the crew, "everything sounded normal, with no strange background noises," and that she had received no emergency calls or distress calls from the crew.

The wreckage of the helicopter was found March 25 in waters about 186 ft (57 m) deep.

First Flight for Accident Crew

The captain of the accident helicopter, who held an airline transport pilot certificate with a rotorcraft rating, had 7,288 flight hours, including 5,323 flight hours as pilot-in-command (PIC) of multiengine helicopters, 3,913 flight hours in operations in the Gulf of Mexico, 1,489 flight hours in S-76s and 1,028 flight hours at night. He also held a first-class medical certificate. He was a U.S. Army pilot from 1980 until 1988 and a U.S. Coast Guard pilot from 1988 until 1999, when he was hired by Era Aviation.

The dispatcher told investigators that during her communications with the crew, "everything sounded normal."

The captain usually worked from 0530 until 1930, but he was told — before he began five days off before the accident flight — that when he returned to work, it would be on a night shift. The day of the flight, he reported for work at 1700. The accident flight was the first flight of his workday and his first flight with the copilot.

The copilot had a commercial pilot license with a rotorcraft-helicopter rating; he also held a first-class medical certificate. He had 1,941 flight hours, including 1,371 flight hours as PIC, 1,027 flight hours in operations in the Gulf of Mexico, 438 flight hours in S-76s and 63 flight hours at night. He received a flight instructor certificate in 1999 and worked as a flight instructor in 2000 and 2001, until he was hired by a Grand Canyon, Arizona, U.S., operator in March to be a line pilot; three months later, he was hired by Era Aviation.

The copilot had worked the night shift for several duty periods and had been off duty March 4–17, 2004; on March 18–20, he attended daytime ground school for the Bolkow 105 in Lake Charles, Louisiana, U.S.; on March 21–22, he drove his car about 630 mi (1,014 km) from Lake Charles to Galveston. He resumed work on the night shift on March 23; the accident flight was his first flight of the new duty period.

Era Aviation, with headquarters in Anchorage, Alaska, U.S., began operating in the Gulf of Mexico in 1979. The company had 87 pilots, including the accident pilots, and seven S-76A helicopters, including the accident helicopter, in the Gulf, as well as six other helicopter models.

The accident helicopter was a transport category, twin-engine helicopter manufactured in 1984 and exported to a South African operator. The helicopter was transferred to Era Aviation in 2001. At the time of the accident, the helicopter had accumulated 10,075 flight hours and 2,882 cycles.

The helicopter was equipped with an electronic flight instrument system (EFIS) and a Honeywell SPZ-7000 dual digital automatic flight control system (DDAFCS), which includes autopilots, flight directors, flight control computers, air data components and autotrim.

The dual autopilots provide stability through two modes: the stability augmentation system (SAS) and the attitude retention mode (ATT). Only one mode may be selected at a time. Both modes provide heading hold, yaw damping and autotrim, and automatic turn coordination. The SAS mode — which is selected for extensive maneuvering, typically during the initial and final phases of flight and during hovering — also provides short-term rate damping during manual flight. The ATT mode provides pitch and roll attitude retention during manual flight to automatically return a helicopter to the reference attitude after an in-flight disturbance.

The dual flight directors — flight director 1 (FD1) for the left-seat pilot and flight director 2 (FD2) for the right-seat pilot — aid in maintaining flight path or attitude by providing command cues on the attitude director indicators (ADIs), the top screens on EFIS displays. The flight director is selected by pressing the "FD1/2" button on the autopilot controller. When the button is pressed, FD1 or FD2 is automatically coupled to the autopilot (AP1 or AP2) and remains coupled as long as the autopilot and its ATT mode are engaged.

"Coupling allows the flight director's computed pitch and roll attitude corrections to be input to the autopilot so that the pilot does not have to manually control the helicopter according to the command cues on the ADIs," the report said. "The 'CPL' button on the autopilot controller automatically illuminates in green and indicates 'ON' when the autopilot and the flight director are coupled. The primary method to decouple the autopilot and the flight director is by pushing the CPL button. Once decoupling occurs, the pilot must fly the helicopter manually. No aural warning occurs when the autopilot and flight director become decoupled.

"During normal operations, the illumination, or absence of illumination of the CPL button is the only direct annunciation of the status of the couple function. Because of its location on the center pedestal, the CPL button is out of the pilots' routine instrument scan."

The report said that during the accident investigation, Era Aviation pilots, including the chief pilot and the director of training, were "not able to fully explain the flight director and coupling status annunciations and command cue presentations associated with the SPZ-7000" and a successor unit, the SPZ-7600.

The helicopter was certified, equipped and maintained in accordance with U.S. Federal Aviation Regulations (FARs), and — except for its CVR — there were no structural, engine or system failures involving any of its components.

'Background Noise'

Accident investigators analyzed the CVR recordings and found that three of the four audio channels contained no usable audio information and the fourth audio channel contained information of poor audio quality from the cockpit area microphone, with most of the recording "obscured by a high level of background noise," the report said. The problem apparently resulted from incorrectly positioned configuration switches, which were located outside the pilots' view.

Weather conditions in Galveston seven minutes after the helicopter's departure included visibility of 10 mi (16 km); few clouds at 2,800 ft, overcast at 4,000 ft and winds from 110 degrees at 11 kt. At the time of the accident, about 8 percent of the moon was illuminated. The report said that, although VMC prevailed, there would have been few visual references outside the helicopter.

The Era Aviation dispatcher said that the pilots had called her on the radio after takeoff but had been unable to hear her, probably because the helicopter was not high enough. No audio

Sikorsky S-76A

The Sikorsky S-76 — whose development benefited from research and design on the military Sikorsky UH-60 Black Hawk — is a twin-turbine commercial helicopter configured to accommodate 12 passengers and two pilots. The helicopter was first flown in 1977.

The S-76A has a maximum takeoff weight of 10,300 lb (4,672 kg), a maximum cruising speed of 145 kt and a service ceiling of 15,000 ft. It has a maximum range of 404 nm (748 km) with 12 passengers, standard fuel and 30-minute reserves. The S-76A is powered by two Allison 250-C30 turboshaft engines, each rated at 650 shaft horsepower (485 kw).

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


U.S. National Transportation Safety Board

Wreckage of the S-76A is pulled from the Gulf of Mexico.

record was available because the tape deck in the company's Gulf Coast headquarters was not functioning the night of the accident.

The helicopter was not equipped with a flight data recorder (FDR), and one was not required. The S-76A was one of several helicopter models exempt from U.S. Federal Aviation Administration (FAA) requirements for FDRs.[2]

Training Emphasized Control Systems

During initial ground training, the pilots received 40 hours of classroom instruction, including four hours on the flight control and automatic flight control systems, two hours on the avionics system, three hours of familiarization with aircraft flight manuals and four hours on the caution warning, electrical power and lighting systems. The training incorporated information from the Era Aviation S-76 *Pilot Training Manual*, including detailed discussions of both analog and digital flight control systems.

Initial ground training included discussions of aeronautical decision making, crew resource management (CRM) and CFIT. The training director described the accident captain as the "most vocal and active participant in the class" during the CFIT portion of training, noting that he had discussed his U.S. Coast Guard flight experience as well as risk factors associated with night flight to an offshore platform.

S-76 pilots received 10 hours of initial flight training, including a flight check; 36 hours of recurrent ground and instrument training; and at least six hours a year of recurrent simulator flight training, including approaches to oil rigs, instrument procedures, weather factors and CRM procedures. At least two hours of night instrument flight rules (IFR) flight and at least two approaches to an oil rig to 200 ft with visibility of 0.6 mi (1.0 km) were included.

The report said, "Era Aviation's simulator coordinator, who was also an S-76A check airman, stated that, before the accident, coupling indications and related issues were not a focus of the DDAFCS portion of ground or simulator flight training. He also stated that, after the accident, Era Aviation focused the DDFACS portion of the training on improving a pilot's situational awareness regarding the system and decreasing the possibility of confusion between pilots."

FAA radar data were available — through land-based radar sites — for a portion of the flight, while the helicopter was within range of the FAA's Houston radar site, which provides maximum radar coverage of 60 nm. Radar data were unavailable as the helicopter was flown 35 nm farther southeast.

FAA plans to implement the automatic dependent surveillance–broadcast (ADS–B) system to aid in surveillance of low-flying aircraft in areas such as the Gulf with little or no radar coverage. ADS–B relies on position information transmitted by individual aircraft using global positioning system (GPS) technology to provide air traffic controllers and operators with surveillance of aircraft in areas with little or no radar coverage.

Initially, plans were for the ADS–B system to be in place in the Gulf in fiscal 2013, which begins Oct. 1, 2012; in March 2006, however, FAA said that implementation of the program would begin in fiscal 2007, which begins Oct. 1, 2006.

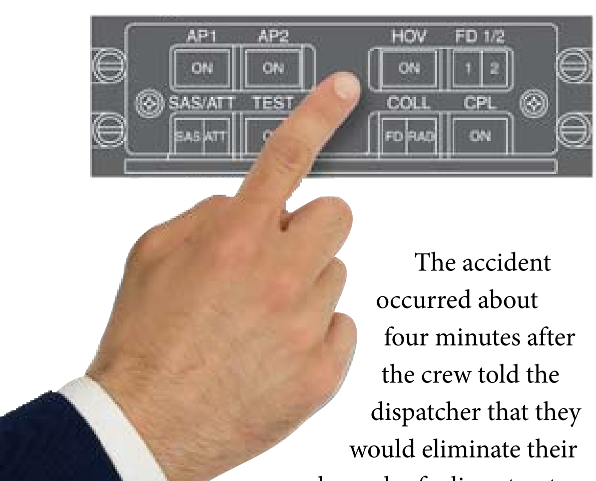
Simulated Accident Scenarios

Accident investigators used a full-motion S-76A simulator to identify four likely scenarios that might have contributed to the inadvertent descent into the Gulf of Mexico. Each assumed that the pilots were using the DDAFCS:

- The right-seat pilot (captain) "maintained control but did not select altitude-hold mode";
- The left-seat pilot (copilot) "coupled the flight director but did not select altitude-hold mode";
- The left-seat pilot "selected the altitude-hold mode but did not couple the flight director"; and,
- The left-seat pilot "selected the altitude-preselect mode but did not couple the flight director."

"It is clear … that the flight crew should have been actively monitoring cockpit instrumentation showing the helicopter's altitude, especially because of the lack of outside visual references," the report said. "The flight crew would have been presented with salient cues to detect the helicopter's descent and proximity to the water."

The report said that both pilots had adequate experience not only in the accident helicopter but also with the S-76A EFIS-DDAFCS configuration and with night operations. Both also had received adequate CFIT training.



U.S. National Transportation Safety Board and iStockphoto Inc.

The accident occurred about four minutes after the crew told the dispatcher that they would eliminate their planned refueling stop to proceed directly to the drilling ship — a decision that would have required them to coordinate a course change, receive updated ship coordinates from the dispatcher and reprogram the helicopter GPS, the report said.

"It is also possible that the flight crew initiated a change in control from one pilot to the other or a change in flight control method from automatic (coupling of the autopilot and flight director) to manual flight or vice versa," the report said. "Such changes require effective crew coordination, including continuous cross-checking and monitoring of instruments to ensure that the intended system inputs have correctly been made."

Crew coordination may have required more effort than usual because the accident flight was the first flight in which the captain and copilot had worked together, the report said.

"New crew pairings have been associated with increased errors and less effective communication patterns than crew pairings with crewmembers who have previously flown together," the report said. "During critical phases of flight, a lack of familiarity can affect a flight crew's ability to coordinate effectively. However, because of the poor quality of the CVR recording, it was not possible for the [NTSB] to determine whether crew coordination was a factor in this accident."

The report said that the crew might have intended to couple the autopilots and flight director to automatically maintain heading and altitude while they completed tasks involving the destination change.

"However, the pilots could have incorrectly programmed the flight director mode selector and either not have detected this situation or have misinterpreted it, given the available system feedback," the report said. "It is also possible that the pilots were in the process of reprogramming the flight director mode selector."

The report said that the pilots might have chosen to maintain the appropriate flight path manually, without using the coupling feature. If they had begun a gradual descent, the autopilots' ATT mode, which provides stability during manual flight, would have maintained the flight trajectory with "minimal, if any, physical cues," the report said.

"Significant deviations in altitude or flight path, if controlled by automation, may develop without detection by the flight crew, especially when the flight crew is focused on other tasks," the report said. "The only reliable way for pilots to detect such deviations is through continuous monitoring of cockpit instrumentation. Although the opportunity for successful monitoring would be increased with two flight crewmembers rather than an individual pilot, research indicated that an over-reliance on automation and a failure to monitor were unaffected by the presence of a second pilot in the cockpit."

TAWS Not Installed

Investigators did not determine whether the pilots were using an automated system to control altitude and flight path. Nevertheless, the report noted that, because of the possibility for errors in monitoring automated systems, other technologies, such as the terrain awareness and warning system (TAWS), have been developed to provide warnings of potential collisions with terrain. Helicopters are not required to be equipped with TAWS, and at the time of the accident, TAWS was not installed in any of the S-76A helicopters operated by Era Aviation.

The report said that if the accident helicopter had been equipped with TAWS, aural and visual warnings "should have provided the flight crew with ample time to recognize that the helicopter was descending toward the water, initiate the necessary corrective actions and recover from the descent."

As a result of the investigation, NTSB issued the following safety recommendations on March 24, 2006, to FAA:

- "Require all existing and new U.S.-registered turbine-powered rotorcraft certificated for six or more passenger seats to be equipped with [TAWS];

- "Ensure that all operators of helicopters equipped with either the SPZ-7000 or SPZ-7600 [DDAFCS] provide training that includes information on flight director and coupling status annunciations; the command cue presentations when only the pitch or the roll mode is engaged; and, if applicable, the differences between the SPZ-7000 and the SPZ-7600;

- "Ensure that the infrastructure for the [ADS–B] Program in the Gulf of Mexico is operational by fiscal year 2010 [beginning Oct. 1, 2009]";

- "Until the infrastructure for the [ADS–B] program in the Gulf of Mexico is fully operational, require principal operations inspectors of Gulf of Mexico aircraft operators to inform the operators about the benefits of commercial flight-tracking systems and encourage the operators to acquire such systems"; and,

- "Require all operators of aircraft equipped with a [CVR] to test the functionality of the CVR before the first flight of each day as part of an approved aircraft checklist and perform a periodic maintenance check of the CVR as part of an approved maintenance check of the aircraft."

As of early June 2006, FAA had not filed official responses to the recommendations.

On March 7, 2006, as a result of this investigation and the investigation of an August 2005 accident in which an S-76C struck the Baltic Sea after takeoff from Tallinn, Estonia, NTSB issued two other safety recommendations to FAA[3]:

- "Require all rotorcraft operating under [FARs Parts 91 and 135] with a transport category certification to be equipped with a [CVR] and [an FDR]. For those transport category rotorcraft manufactured before Oct. 11, 1991, require a CVR and an FDR or an onboard cockpit image recorder with the capability of recording cockpit audio, crew communications and aircraft parametric data."

  [In response, FAA said that it would "review and identify changes in [FDR] technology … to ensure that current technology used in airplanes is appropriate to helicopter operations" and then consider changes in its regulations. FAA also will "consider applications of new technology for [CVR] and FDR systems for rotorcraft specifically."]

- "Do not permit exemptions or exceptions to the flight recorder regulations that allow transport category rotorcraft to operate without flight recorders and withdraw the current exemptions and exceptions that allow transport category rotorcraft to operate without flight recorders."

  [In response, FAA said that it would review existing exemptions, "re-evaluate the analysis upon which the exemptions were originally granted" and require a complete revalidation when requests are submitted to continue the exemptions, which usually are issued for two-year periods. Because regulations allow an exception to the FDR requirement for some aircraft manufactured before Aug. 18, 1987, FAA said that it "will not be able to justify the installation of an FDR in these types of aircraft due to a combination of technical and economic considerations."] ●

Notes

1. U.S. National Transportation Safety Board (NTSB). *Controlled Flight Into Terrain, Era Aviation, Sikorsky S-76A++, N579EH, Gulf of Mexico, About 70 Nautical Miles South-Southeast of Scholes International Airport, Galveston, Texas, March 23, 2004*. Aircraft Accident Report NTSB/AAR-06/02. March 7, 2006.
2. After the accident, Sikorsky began to install flight data recorders in all new commercial aircraft, including the S-76.
3. The accident in Estonia was the first involving a large helicopter equipped with a flight data recorder (FDR). The NTSB report described the FDR data collected during that accident investigation as "extremely valuable."

Managing the ESCAPE

Consider an active passenger safety briefing, plain-language commands and keeping cabin crewmembers in sight to speed an evacuation.

BY WAYNE ROSENKRANS

When 159 airline passengers volunteered for a series of evacuations from two cabin simulators, some recommended explicit survival-related phraseology with less concern about passenger comfort, said the report of a study funded by the Australian Transport Safety Bureau.[1]

Three researchers from Cranfield University in the United Kingdom and Virgin Blue Airlines of Australia conducted 16 experimental evacuations (trials) in April 2005. Their objectives were influenced by a 2004 forum on best practices conducted through the Asia Pacific Cabin Safety Working Group of the Australian Society of Air Safety Investigators. Eight unnamed Australian and Asian airlines provided their passenger evacuation policies, commands, procedures and event history; cabin crew training manuals; and safety briefing cards for the Airbus A300, A320 and A340; Boeing 737, 747 and 777; BAE Systems BAe 146; de Havilland Dash 8; and McDonnell Douglas MD81/87/90.

The researchers took particular interest in variations among the airlines. For example, not all airlines required cabin crews to brief passengers on checking for fire or obstructions before opening overwing exits. Experiences of individual airlines — such as passengers inadvertently opening exits after a demonstration because of misunderstood instructions — were cited as reasons. Similarly, brace commands typically were part of planned-evacuation briefings, but only one airline's standard operating procedures required brace-position details to be provided during the preflight safety briefing.

"Standard procedures and cabin crew commands vary among operators, and there is no common set of commands and procedures that apply to passenger evacuations," the report said. "Dual-lane flows significantly increase evacuation rates [according to other research], yet results from [the forum] showed that many [widebody aircraft] operators do not require their cabin crew to command passengers to move through exits two at a time."

Minor variations were found among commands to board and descend slides, but the command currently favored by many cabin safety researchers — "Jump and slide" — was not in common use. Another example was crewmember instructions for life vests (life jackets). "One of the operators … did not want cabin crew to get caught up in mandatory [life vest] procedures during an evacuation," the report said. "This operator was involved in the conduct of research evacuation trials during which they found that not all passengers reacted to the set [memorized]

commands. In response to this, cabin crew then had to change the words slightly to make the passenger respond appropriately."

To complement participant surveys and interviews, the researchers analyzed time-coded video recordings of the trials in the university's Boeing 737 simulator and the upper deck of its Large Cabin Evacuation Simulator.[2] Four subgroups of participants completed four trials — two in each simulator type — under one of four scenarios.

The controlled conditions of the scenarios in the 737 simulator enabled comparison of an active safety briefing with a passive safety briefing; basic commands compared with basic commands supplemented by "tactile" commands, for example, telling passengers to use hands to feel their way to exits in a dark cabin; dual-lane-flow evacuation commands compared with absence of these commands in the widebody simulator; and the effectiveness of the cabin crew's gestures, eye contact and other nonverbal communication when a half-height bulkhead or a full-height bulkhead blocked passengers' views in the widebody simulator.

The passive method limited crewmembers to reading standard announcements after requesting passengers' attention. The active method required crewmembers to physically and mentally involve passengers in the safety briefing by pointing out exit locations, counting rows in forward and aft directions to the nearest exits, and practicing the recommended brace position.

"The results [of the study] showed that an active safety briefing had statistically significant[3] advantages over a passive safety briefing … that the visibility of the cabin crew influenced passenger perceptions of evacuation effectiveness [and] that participants generally had a low understanding of why they might be required to take certain actions in emergency situations," the report said. "This suggested that it is important that operators take passenger expectations and comprehension into account when devising evacuation commands. … Indeed, the commands provided by crew and the safety knowledge of passengers may be particularly critical in those evacuations where conditions are difficult — such as in low visibility, where the aircraft has landed at an usual angle, or in the presence of smoke."

In the 737 simulator trials, researchers looked for any benefit from the cabin crew providing additional instructions on how to evacuate in darkness. "[In these trials,] the crewmember at the front of the cabin called 'Move to the rear of the cabin,' 'Use your hands' [and] 'Feel your way' to establish a flow to the exit."

Researchers using the Large Cabin Evacuation Simulator focused on any benefit from the cabin crew using dual-lane flow instructions. "In order to provide a further test of the efficacy of the commands, an exit redirection took place, in which participants [without prior knowledge of the exit(s) available] were instructed to move from the upper right forward exit to the upper left forward exit after approximately 10 seconds," the report said.

Surveys of participants before the trials revealed various misconceptions about safety issues, despite the participants' prior exposure to safety briefings. For example, some said that they did not understand what the command "Brace, brace, brace" means, the report said. They would prefer an explanation during the preflight safety briefing or to hear crewmembers repeat a simpler command such as "Heads down, stay down" or "Heads down, feet back."

Others had not comprehended instructions about oxygen masks. "It was … evident from the responses that some people had not grasped the fact that if people did not act quickly, they would lose consciousness," the report said. "It was also evident that most people would assist family, friends and traveling companions first, and that they did not always appreciate that they had to put their own mask on first in order to be able to do so."

Participants' suggestions for clear communication included the following:

- "Listen to this briefing. It could save your life."
- "[Cabin crews briefing passengers about oxygen masks] never mention unconsciousness, they must do that. As it is usually done, it sounds a bit selfish — you first."
- "Brace. Emergency landing position."
- "Leave everything."

The report said that analysis of mean evacuation times found the following results:

- "There was no significant effect on evacuation times of the use of tactile commands … [or] the type of briefing. … Participants who received the active briefing rated it as significantly more helpful [and associated with a higher level of confidence] in the evacuation than the passive briefing … [and] rated finding [an open] door [and using the evacuation slide] as significantly easier than participants in the passive briefing … moving through the exit itself was rated as

Participants evacuate from Cranfield University's Large Cabin Evacuation Simulator in a scenario with dual-lane flow commands and half-height bulkheads.

significantly more difficult by participants in the passive [briefing]."

- "Participants evacuating without dual-lane flow commands were significantly quicker than participants evacuating with dual-lane flow commands. … The cabin crew did not instruct passengers to come forward and queue along the wider cross aisle, and hence there was little scope [space in main aisles] for passengers to comply with the commands [and] it was possible for passengers to mass through the exits in a disorganized fashion when they were not in dual-lane flows — this would not have been possible had slides been used."

- "Participants evacuating in high-visibility conditions (with half-height bulkheads) were not significantly faster than participants evacuating with low visibility (full-height bulkheads). … The half-height bulkheads meant that cabin crew could actually be seen by passengers, who rated the crew's nonverbal communication as significantly more useful in the high-visibility evacuations."

Improvising evacuation commands works in some circumstances, but in others "overtraining" cabin crewmembers — i.e., ensuring recall of infrequently used commands through practice — is more appropriate. Cabin safety research so far does not tell airlines whether one phrase is superior to another, but current findings should be considered in developing and refining emergency procedures. ●

FSF editorial note: This article, except where noted, is based on the Australian Transport Safety Bureau report *Evacuation Commands for Optimal Passenger Management* by Lauren J. Thomas and Antoinette Caird-Daley of the Human Factors Group, School of Engineering, Cranfield University; and Sophie O'Ferrall of Virgin Blue Airlines. The 85-page report, published in April 2006, contains tables, figures, appendixes, photographs and illustrations. The report is available at <www.atsb.gov.au>.

Notes

1. Participants comprised 84 men and 75 women aged 20–50 (with a mean age of 30.9 years), who were normally fit and healthy, and had various levels of experience as airline passengers.

2. Cranfield University's Boeing 737 cabin simulator is a single-aisle facility, containing 10 rows of seats, a fully functional Type III exit, two Type I exits, a service door and an evacuation slide on one of the rear Type I exits. The university's Large Cabin Evacuation Simulator is a twin-aisle, double-deck modular cabin configurable similarly to an Airbus A340 (or other aircraft); for the study, it was equipped with an evacuation platform outside the upper left forward Type A door instead of a slide.

3. The report said, "In this [study] context, statistical significance means that the probability that the observed differences are due to the experimental effects is over 95 percent."

CFIT CHECKLIST Goes Digital

A free Microsoft Excel worksheet reveals risk factors and solutions without manual calculations.

BY WAYNE ROSENKRANS

Appealing to pilots who would rather make selections from a computer display than perform manual calculations, the creators of a new Microsoft Excel worksheet seized an opportunity to rekindle interest in a highly regarded educational tool for reducing the risk of controlled flight into terrain (CFIT). Called the Flight Safety Foundation (FSF) *CFIT Checklist* worksheet, this user-friendly software can be downloaded free from the FSF Web site <www.flightsafety.org> for use on computers equipped with Microsoft Windows operating systems. The worksheet primarily helps flight crews and others assess CFIT risks for specific flights, identify factors that reduce those risks and enhance pilot awareness of CFIT risk.

Although FSF staff have received proposals for similar concepts, this FSF *CFIT Checklist* worksheet was designed from the outset to be equivalent to the printed FSF *CFIT Checklist*. That means wording, calculations and CFIT risk scores correspond between the two formats, except for minor changes required to take advantage of Microsoft Excel functions.

Despite its name, and unlike a conventional computer spreadsheet, the FSF *CFIT Checklist* worksheet does not display columns or rows for data entry. Instead, users select factors applicable to a proposed flight from a series of lists. The worksheet is divided into three tabbed parts where numerical values have been assigned to factors that the pilot/operator simply selects as applicable to each flight. After selecting risk-assessment factors on the first tab and selecting risk-reduction factors on the second tab, the worksheet automatically calculates and displays intermediate scores and their meaning, and displays a CFIT risk score on the third tab.

A negative CFIT risk score indicates "significant CFIT threat" per the consensus of international specialists convened for the FSF CFIT Task Force and later, the FSF Approach-and-Landing Accident Reduction (ALAR) Task Force and various civil aviation authorities. If the CFIT risk score is negative, users should reconsider the second part of the checklist to determine what changes can be made to reduce the risk. All selections can be reset in one step if desired. A companion document called "Troubleshooting.txt" answers basic questions and offers suggestions for first-time users.

The FSF *CFIT Checklist* worksheet was developed as a collaborative effort by staff from the U.S. Federal Aviation Administration (FAA) and the Foundation. William L. McNease, an FAA flight standards inspector, and Gerald H. Pilj,

The worksheet's third tab displays a CFIT risk score.

an FAA aircraft certification engineer, initiated the project. Pilj programmed the worksheet's interface and automated functions. FAA is not responsible for the accuracy of this educational tool and does not require its use by U.S. aircraft owners and operators.

Laminated copies of the FSF *CFIT Checklist* produced by the International Civil Aviation Organization in Arabic, Chinese, English, French, Russian and Spanish still can be ordered from the Foundation. Also, PDF format versions of these checklists are among the elements of the FSF *ALAR Tool Kit* CD and can be downloaded at no charge from <www.flightsafety.org/pdf/cfit_check.pdf>. Versions in other languages are available from other sources such as TAM Brazilian Airlines (Portuguese) and Malév Hungarian Airlines (Hungarian).●

C-FOQA Advances

BY J.A. DONOGHUE | FROM PHOENIX

"I don't think we can continue to say we are better than the air carrier world if we do not embrace FOQA." This challenge to corporate aviation was made by Ted Mendenhall, vice chairman of Flight Safety Foundation's Corporate Advisory Committee (CAC) and program coordinator of the FSF Corporate-Flight Operational Quality Assurance (C-FOQA) team leading the drive to get corporate operators the safety benefits airlines are reaping from FOQA programs.

Speaking to the CAC at the 51st annual Corporate Aviation Safety Seminar (CASS), Mendenhall said that the program has endured a number of delays but now has produced an operational system that recently delivered the first three-month package of data to the C-FOQA operator. The operator, he reported, was "pleased" with the results.

He said that the program to develop C-FOQA technology and procedures had "a painfully slow start" that was especially disappointing after the program — first envisioned as a one-year demonstration — was launched two years ago with a bang, 22 operators signing on to participate. However, cost increases drove some away, and a few more were put off by legal questions about protecting operators' employees from disciplinary actions for violations the FOQA data might reveal — and even resistance from pilots after they had received signed protection guarantees. The number of operators dropped to 10, with no more than 13 airplanes involved.

But now there are quick access recorders (QARs) installed in participating aircraft, collecting data similar to those on an airline-standard flight data recorder (FDR). The collected data are forwarded for processing to Austin Digital (ADI), a leader in such processing for airlines such as AirTran, Lufthansa, United, Etihad, Continental, Southwest and Northwest.

ADI had a problem, Mendenhall said, getting digital FDR proprietary data from the original equipment manufacturers (OEMs) that would allow it to make sense of what was recorded. Earlier, there had been trouble matching software with the QARs and issues with the operators' information technology departments. Most of these problem areas were solved once "the right guy to talk to" was found, he added.

The QARs' output can be taken either through a removable data storage card or through a cable download, the download process taking five minutes for three to four months worth of data, Mendenhall said. That data file is transmitted encrypted to ADI via the Internet, processed through ADI's system and posted encrypted by a different process than the transmission and protected with double-password protection on ADI's eFOQA Web site, the final password changed each time by a key-fob sized piece of hardware ADI provides to each customer.

"The primary focus [of initial C-FOQA efforts] is the unstabilized approach; we're also looking at tailwind landings," Mendenhall said.

Illustration: Susan Reed (FSF)

Emily McGee (FSF)

The cost to equip aircraft that already have digital FDRs is about $20,000 each for the small and light QARs, although less was reported. A subscription for ADI's services is about $10,000 annually. Mendenhall cautioned that operators getting into C-FOQA will need their OEM's help for a while.

Jim Burin, Flight Safety Foundation director of technical programs, summed up: "Most of the lessons have been learned about how to install and operate the system. And the OEMs are going to benefit; there are a lot of problems [C-FOQA] can solve."

Noting that the C-FOQA campaign is in its early days, Mendenhall said that it is too early to predict eventual pilot acceptance of C-FOQA. However, it was noted that airline pilots had the same reluctance to expose their flight records to management inspection, even though the data are stripped of identifying elements, but most now enthusiastically endorse the program.

Another C-FOQA system was displayed at the seminar by Flight Data Services (FDS), a U.K. firm that recently opened a Phoenix office. Unlike the layered FSF C-FOQA program, FDS handles the entire process from hardware to data transfer to analysis and reporting. FDS cited CityJet and Hong Kong Express as airline customers.

"Threat and error management would examine what contributed to that error and how it was managed."

A new safety initiative, threat and error management (TEM), was proposed to the CAC by Peter Stein, base manager/chief pilot for Johnson Controls, who explained that TEM developed out of some U.S. airlines' line operations safety audit programs.

"The 'threat' is external to the crew, such as weather, runway hazards or air traffic control issues," while the "error" is "within the crew," he said. "TEM would examine what contributed to that error and how it was managed."

The proposed program would train 5,000 business aviation professionals in TEM techniques in a four-to-six hour classroom course, using a case-study approach with a business aviation focus. It was suggested during discussion that TEM appears to have the potential to "give maintenance [workers] something focused on what they do."

Key to success of the effort, Stein said, is building strategic relationships among groups such as the National Business Aviation Association, the Professional Aviation Maintenance Association, insurers and OEMs, plus enlisting expert advisers in this field.

Michael L. Barr, interim director of the University of Southern California's aviation safety programs, volunteered that the school would provide training for TEM instructors, adding that USC already has a syllabus and instructors for such a program. Further, Barr said that USC would welcome a role in developing metrics to measure the before/after consequences of initial TEM training.

The CAC accepted the proposal; Stein is to report on the TEM project at the CAC meeting prior to the next CASS. Subsequent to the CASS meeting a workshop has been scheduled for later this year to discuss TEM development and its introduction into corporate aviation.

On other topics at CASS, Robert Matthews, analysis team leader of the U.S. Federal Aviation Administration's Office of Accident Investigation, agreed with industry sentiment when he said that the upcoming onslaught of very light jets (VLJs) presents "at least a temporary new risk."

But then he looked at VLJs from another angle and decided, "I think VLJ capabilities will help improve safety in the long term. About one-half of [Federal Aviation Regulations] Part 135 fatal accidents could have been cut if the aircraft had VLJ characteristics." Noting the technology being designed into the aircraft, in part to allow single-pilot operations, he said that VLJs will have enhanced automation capabilities needed for today's busy airspace.

"I expect relatively high accident rates early," he said. "But the number should stabilize, and stabilize at relatively low levels." ●

Members by Region

Canada/USA

Airlines

ATA Airlines
Air Canada
Air Transport International
AirTran Airways
Alaska Airlines
Aloha Airlines
American Airlines
Astar Air Cargo
Atlas Air
Baron Aviation Services
CargoJet Airways
Champion Air
Continental Airlines
Continental Micronesia
Delta Air Lines
Era Helicopters
Evergreen International
FedEx Express
Forward Air International Airlines
Kitty Hawk Aircargo
NetJets
Northwest Airlines
Omni Air International
Omniflight Helicopters
UPS Airlines
US Airways
United Airlines
Virgin America
World Airways

Low-Cost Carriers

JetBlue Airways Corp.
Southwest Airlines
WestJet Airlines

Regional Airlines

Air Transat
Atlantic Southeast Airlines
Caribbean Sun Airlines
Comair
First Air
Frontier Airlines
Laker Airways (Bahamas)

Helicopter

Alpine Helicopters
Arkansas Children's Hospital
Blue Hawaiian Helicopters
Campbell Helicopters
CHC Helicopters Canada
PHI

Airports

Vancouver International Airport Authority
Westchester County Airport

Manufacturers & Engine

Airbus
Avionica
Boeing Commercial Airplanes
Bombardier Aerospace Aircraft Services
Calspan Corp.
Dassault Falcon Jet
GE Aviation
Gulfstream Aerospace
Honeywell
Indal Technologies
Lockheed Martin Corporate Aircraft
Pratt & Whitney
Pratt & Whitney Canada
Raytheon Aircraft Co.
Rockwell Automation
Rolls-Royce North America
Safe Flight Instrument Corp.
Teledyne Controls
UTFlight

Maintenance & Repair

WCF Aircraft Corp.

Corporate

3M Aviation
ACM Aviation
AFLAC
AGRO Industrial Management
AMSAFE Aviation
AT&T
Abbott Laboratories
AirFlite
Air Logistics, a Bristow Co.
AirNet Systems
Alberto-Culver USA
Alcoa
Alticor
Altria Corporate Services
Amerada Hess Corp.
American Electric Power Aviation
American Express Co.
Amgen
Anadarko Petroleum Corp.
Anheuser-Busch Cos.
Aon Corp.
Archer Daniels Midland Co.
Armstrong World Industries
Ashland
Avaya Aviation
Sanofi-Aventis
Avjet Corp.
B&C Aviation
BP America
Ball Corp.
Bank of America
Bank of Stockton
Barnes & Noble Bookstores
Basin Electric Power Coop.
Battelle Memorial Institute
Baxter Healthcare Corp.
Bechtel Corp.
BellSouth Corporate Aviation
Blue Cross Blue Shield of Tennessee
Bombardier Club Challenger
Bombardier FlexJet
Bristol-Myers Squibb Co.
Brunswick Corp.
Business & Commercial Aviation
C&S Wholesale Grocers
CCI Pilot Services II
Campbell Sales Co-Flight Operations
Cape Clear
Cargill
Caterpillar
Cessna Aircraft Co.
Chevron Corp.
Cigna Corp.
Cingular Wireless
Citigroup Corporate Aviation
Coca-Cola Bottling Co. Consolidated
The Coca-Cola Co.
Colleen Corp
ConocoPhillips
ConocoPhillips Aviation Alaska
Corporate Angel Network
Corporate Aviation Service
Corporate Flight Alternatives
Corporate Flight International
Costco Wholesale
Cox Enterprises
Crescent Heights Flight Operations
Crown Equipment Corp.
CTB
Cummins
Darden Restaurants
Deere & Co.
Dillard's
Dominion Resources
The Dow Chemical Co.
Dow Corning Corp.
DuPont
Duncan Aviation
EG&G Technical Services
EVASWorldwide
Earth Star
Eastman Chemical Co.
Eastman Kodak Co.
Eaton Corp
Eclipse Aviation Corp.
Eli Lilly & Co.
EMC Corp.
Emerson Electric Co.
Entergy Services
Execaire
ExxonMobil Corp.
FHC Flight Services
First Quality Enterprises
FL Aviation
FlightWorks
Florida Power & Light Co.
Flowers Industries
Flying Lion
Ford Motor Co.
Fuqua Flight
GTC Management Services
Gannett Co.
Gaylord Entertainment Co.
GEICO Corp.
General Dynamics
General Electric Co.
General Mills
General Motors Corp.
Georgia-Pacific Corp.
Group Holdings
H. Beau Altman Corp.
H.J. Heinz Co.
Halliburton Co.
Harley-Davidson Motor Co.
Harris Corp.
Hewlett-Packard Aviation
Hillenbrand Industries
Hilton Hotels Corp.
The Home Depot
Honeywell
Huntsman
IBM Flight Operations
IMS Health
Imperial Oil
Interlaken Capital Aviation Services
International Paper
JCPenney Co.
JP Morgan Chase
Jeld-Wen
Jeppesen
Jet Aviation
Jetport
Johnson & Johnson
Johnson Controls
K-Services
KB Home
KaiserAir
Kellogg Co.
KeyCorp Aviation Co.
Koch Business Holdings
The Kroger Co.
Level 3 Communications
Liberty Global
Limited Brands
Lucent Technologies
M&N Aviation
Magic Carpet Aviation
Marathon Oil Co.
The Marmon Group
Masco Corp. Flight Department
McCormick & Company
McDonald's Corp.
The McGraw-Hill Companies
McWane
MedAire
Mente
Merck & Co.
Milliken & Co.
Monsanto Aircraft Operations
Motorola
Mutual of Omaha
NetJets International
Nissan Corporate Aviation
Norfolk Southern Corp.
Northern Jet Management
Novartis Aviation
Owens Corning
Owens-Illinois General
PPG Industries
Parker Drilling Co.
Parker-Hannifin Corp.
Pentastar Aviation
PepsiCo
Pfizer
Pfizer AirShuttle
The Pictsweet Co.
Pilot Corp.
Pioneer Hi-Bred International
Principal Financial Group
Printpack

Procter & Gamble
Progress Energy
Quest Diagnostics
Quizno's Aviation Department
RJ Reynolds Tobacco Co.
Raytheon Co.
Richmor Aviation
Rosemore Aviation
Sanofi-Aventis
S.C. Johnson
SCANA Corp.
Sizeler Realty Co.
Schering-Plough Corp.
The Schwan Food Co.
Sears Holdings Corp.
Shamrock Aviation
Shaw Communications
Shaw Managed Services
Shell Aircraft International
Signature Flight Support
Sky River Management
Skyservice Airlines
Sony Aviation
Sprint Corp.
St. Paul Travelers
Steelcase North America
SunTrust Banks
Sunoco
Supervalu
Target Corp.
TeamLease
Tennessee Valley Authority
Texas Instruments
The Timken Co.
TransCanada
Tudor Investment Corp
USAA
The United Co.
United States Steel Corp.
Universal Underwriters Group
Universal Weather & Aviation
UnumProvident Aviation Dept.
Valero Energy Corp.
Verizon
Victory Aviation
W.W. Grainger
Wachovia Corp.
Waitt Media
Wal-Mart Aviation
Whirlpool Corp
Wyvern Aviation Consulting
Xerox Corp
Yum! Brands Aviation
Zeno Air

Charter

Access Air
Addison Jet Management dba Imaginaire
Air Serv International
American Jet International
Bombardier Skyjet
Chantilly Air
Cloud Nine Aviation
Corporate Jets
DC Global Aviation
Elite Air
Epps Air Service
Global Aviation
Heritage Flight
Jackson Air Charter
Key Air
Knollwood Aviation
Million Air Richmond
Pinnacle Air
Premier Air Charter Corp.
Quaker Enterprises
Rainin Air
Trans-Exec Air Service
USAirports Air Charters
Universal Jet Aviation
World Class Aviation
World Class Charters
Xpress Air

Academia

Air Routing International
Airbus North America Customer Services
Airline Training Associates
Atlanta Technical College
Aviation Technical Library
Bowling Green State University
CAE SimuFlite
Central Georgia Technical College
Central Missouri State University
Corporate Aviation Systems
Daniel Webster College
Dudley Knox Library Serials
Embry-Riddle Aeronautical University-Mesa, Arizona
Embry-Riddle Aeronautical University-Prescott, Arizona
Embry-Riddle Aeronautical University-Daytona Beach, Florida
Embry-Riddle Aeronautical University-Albuquerque, New Mexico
Embry-Riddle Aeronautical University-Oklahoma City, Oklahoma
Embry-Riddle Aeronautical University-Randolph AFB, Texas
FlightSafety International
Florida Memorial College Library
GT Baker Aviation School
Middle Tennessee State University
Mission Safety International
Mountain Reading Service
Northwestern University Library
Purdue University
Renton Technical Library
Rochester Institute of Technology
Saint Louis University
Southeastern Oklahoma State University
Southern Alberta Institute of Technology
Southern California Safety Institute
Southern Methodist University
St. Philips College LRC
University Aviation Association
University of North Dakota
University of Oklahoma
University of Southern California
Vaughn College of Aeronautics
V1 Aviation Training
Virtual Flight Surgeons

Government/CAAs

120G-AIS
39 AS-SEF
Aero Club Kadena AFB
Alberta Government, Air Transportation Services
Army Aero-AOBC NJ
DA-COLLECT ALBAT-Defence Dept.
Defence Department Regional Library
Department of Homeland Security, Immigration & Customs Enforcement
Drug Enforcement Administration-Aviation Division
National Defence Headquarters-Canada
Nav Canada
Navy Air Test & Evaluation Squadron
Transportation Safety Board of Canada
Transport Canada
U.S. Army Flight Training Department
U.S. National Aeronautics and Space Administration-Langley Research Center
U.S. Naval Safety Center
U.S. Air Force Safety Center
U.S. Coast Guard-Washington, DC
U.S. Federal Aviation Administration (FAA)
U.S. National Transportation Safety Board
USDA Forest Service
Washington Airports Task Force

Insurance

AIG Aviation
Global Aerospace
Liberty Mutual Group
Nationwide Insurance
United States Aviation Underwriters
Willis Global Aviation

Aviation Associations

American Association of Airport Executives
ACI Pacific
Air Canada Pilots Association
Air Line Pilots Association
Air Transport Association of America
Air Transport Association of Canada
Airline Professional Association,
Teamsters Local 1224
Allied Pilots Association
Canadian Business Aviation Association
Ebsco Subscription Service
Frontier Airline Pilots Association
Helicopter Association International
Independent Pilots Association
International Society of Air Safety Investigators
Maintenance and Ramp Safety Society
National Aeronautic Association of the USA
National Air Traffic Controllers Association
National Air Transportation Association
National Association of Flight Instructors
National Business Aviation Association
Professional Aviation Maintenance Association
Rand Corp.
Regional Airline Association
Swets Information Services

Consulting/Vendor

Alertness Solutions
Aviation Mobility
Aviation Personnel International
Flightscape Incorporated
IHS Aviation Information
The Metropolitan Aviation Group
PAR Tech Travel
Safegate Airport Systems
Safety Focus Group
Safety Operating Systems
The VanAllen Group

Individuals

Malcolm B. Armstrong
Michael S. Baum
Sheila C. Beahm
J. Jeffrey Brausch
William Buehler
Alan Cruce
Sushant Deb
Anthony Destefano
Thomas A. Duke
Randy Duncan
Orin Godsey
Jerry B. Hannifin
Margaret A. Johnson
Daniel Johnson
Jennifer Kniffin
Randy Lewis
W.R. Long
Michael W. McKendry
Nazrul Mozumder
Ellen Overton
Robert L. Prince
David Robertson
S. Harry Robertson
Ronald Schleede
Doug Schwartz
Rusty Scioscia
Seven Stars Group
John J. Sheehan
Jane K. Toth
Carl W. Vogt
David Vornholt
Terry Yaddaw

Mexico & Central America

Airlines

ABC Aerolineas
Aeromexpress
Aviateca
COPA
Estafeta Carga Aérea
LACSA-Lineas Aereas
MasAir Cargo Airline
Mexicana Airlines
TACA International Airlines

Regional Airlines

Aero California
Aeroméxico
Aviacsa Airlines
Lineas Aereas Azteca
Transportes Aeromar

Aviation Associations

ASPA de México
Colegio de Pilotos Aviadores de México

Caribbean & West Indies

Airlines

Air Jamaica
BWIA West Indies Airways
Cayman Airways
Cubana
LIAT (1974)

Academia

Inter American University of Puerto Rico

Government/CAAs

Bahamas Civil Aviation Authority
Cayman Islands Civil Aviation Authority

South America

Airlines

Aerolíneas Argentinas
AeroRepublica
Austral
Avianca Airlines
LAN Airlines
LAN Argentina
LAN Ecuador

LAN Chile Cargo
LAN Peru
Lloyd Aéreo Boliviano
PLUNA Lineas Aereas Uruguayas
Pantanal Linhas Aéreas
Surinam Airways
TAM Brazilian Airlines
TAME
Tampa Cargo
TANS -Transportes Aereas Nacionales de la Selva
Transportes Aéreos del Mercosur
VARIG Brazilian Airlines
VASP Brazilian Airlines
Varig Logistica

Regional Airlines

Aeropostal Alas de Venezuela
Gol Linhas Aereas
Southern Winds

Manufacturers & Engine

Embraer

Corporate

Carbones del Cerrejon

Charter

Morro Vermelho Taxi Aereo

Government/CAAs

CENIPA-Brazil
Colombia Civil Aeronautical Authority
Guyana Civil Aviation Authority

Aviation Associations

Sindicato Nacional dos Aeronautas

Consulting/Vendor

Inter Assessoria Aeronautica

Individuals

Dr. Sam Slattery
Torong Guyana

European & North Atlantic

Airlines

Adria Airways
Aer Lingus
Aeroflot Russian Airlines
Aerosweet Airlines
Air Atlanta Icelandic
Air Contractors
Air Europa
Air France
Air Malta
Alitalia
Armavia
Armenian International Airways
Austrian Airlines
Azerbaijan Airlines
Blue Wings
BMED
bmi
Belavia-Belarusian Airlines
Britannia Airways
British Airways
British European
Cargolux Airlines International
Carpatair
Cat Aviation
Compagnie Aérienne Corse
Contact Air Flugdienst
Corse Air International
Croatia Airlines
Czech Airlines
DBA Luftfahrtgesellschaft
Denim Air
DHL Air
Estonian Air
European Air Express
European Air Transport
Finnair
GB Airways
Hahn Air Lines
Iberia Airlines of Spain
Iberworld Airlines
Icelandair
JSC Siberia Airlines
JSC Volga-Dnepr Airlines
KLM Royal Dutch Airlines
LOT Polish Airlines
LTU
Lauda Air-Austria
Lithuanian Airlines
Lufthansa Cargo
Lufthansa German Airlines
Luxair
MK Airlines
Macedonian Airlines-Macedonia
Malév Hungarian Airlines
Martinair Holland
Montenegro Airlines
MyTravel Airways-U.K.
Olympic Airlines
Pulkovo Aviation Enterprise
Royal Air Maroc
SAS Braathens
SATA
Samara Airlines
Scandinavian Airlines System
Sterling Airlines
Sundt Air, Norway
Swiss Air Ambulance
Swiss International Air Lines
TAP Portugal
TAROM-Romanian Air Transport
TNT Airways
Thomas Cook Airlines
Thomsonfly
Transaero Airlines
Transavia.com
Turkish Airlines
Ukraine International Airlines
Virgin Atlantic Airways
Volare Airlines
Yugoslav Airlines (JAT)

Low-Cost Carriers

Air Baltic
Air Luxor
Meridiana
Ryanair

Regional Airlines

Aegean Airlines
Air Astana
Air Austral
Air Berlin
Air Bosna
Air Iceland
Air Moldova
Air Nostrum
Air One
Albanian Airlines
Alpi Eagles
Atlasjet International Airways
Binter Canarias Unipersonal
Blue Panorama Airlines
Blue1
Cimber Air
Cirrus Airlines
Cityjet
Eastern Airways
easyJet
Eurowings Luftverkehrs
Falcon Air
First Choice Airways
Hapag-Lloyd Flug
Helios Airways
Hellas Jet
Hemus Air
KLM Cityhopper
Lufthansa CityLine
Malmo Aviation
Norwegian Air Shuttle
Portugália Airlines
Regional
SN Brussels Airlines
Skyways Express
Spanair
Vladivostok Air
Wideroe's Flyveselskap

Helicopter

ANWB Medical Air Assistance-The Netherlands
Barcinova y Gestion
Basis Koksijde-Belgium
CHC Europe
Luxembourg Air Rescue
Norsk Helikopter

Airports

Amsterdam Airport Schiphol
Athens International Airport
Budapest Airport
Fraport
Vienna International Airport

Manufacturers & Engine

Air Support
Antonov Design Bureau
BAE Systems
Dassault Aviation
Eurocopter Deutschland
SNECMA
Saab Aircraft
Sagem Défense Sécurité
Thales Aerospace

Maintenance & Repair

Air Atlanta Aero Engineering
Fokker Services

Corporate

DaimlerChrysler Aviation
Dasnair
Dunell Aviation International
Eurojet Holdings
Jetflite
Netjets Transportes Aereos
PrivatAir-Switzerland
Rabbit-Air

Charter

Zimex Aviation

Academia

British Library
Cranfield University
Horizon Swiss Flight Academy
Institut Français de Sécurité Aérienne
KTHB Aero Library-Sweden
London Metropolitan University
Lund University
SAS Flight Academy
Sabena Flight Academy
Solavia

Government/CAAs

Accident Investigation Board-Norway
Agenzia Nazionale per la Sicurezza del Volo
Air Corps Library
Air Traffic Services Authority-Bulgaria
BEA France
Central Joint Aviation Authorities
Denmark Aircraft Accident Investigation Board
Denmark Civil Aviation Administration
Deutsches Zentrum fuer Luft- und Raumfahrt
DGAC-Direction du Contrôle de la Sécurité, France
ENAC-Ente Nazionale Aviazione Civile
Embassy of France (DGAC)-U.S.
Estonian Civil Aviation Administration
Finland Accident Investigation Board
Finnish Civil Aviation Authority
Hellenic Air Accident Investigation Board
Hellenic Civil Aviation Authority
Icelandic Civil Aviation Administration
Instituto Nacional de Aviação Civil
Irish Aviation Authority
Luftfahrt-Bundesamt
Malta Department of Civil Aviation
Marinevliegkamp de Kooy-The Netherlands
NAVIAIR
National Aerospace Laboratory (NLR)
Netherlands Civil Aviation Authority
Norway Civil Aviation Authority
Poland Civil Aviation Office
RAF Centre of Aviation Medicine-UK
Royal Norwegian Air Force
STK Skandinavisk Tilsynskontor
Statens Haverikommission
Swedish Civil Aviation Authority
U.K. Civil Aviation Authority
VERVOER-BEDRIJFSERKENNING-Belgium

Insurance

Avicos Insurance Co.
Inter Hannover
LMA (Lloyd's Market Association)
La Réunion Aérienne
Marsh
Partner Reinsurance Co.
SPL Swiss Pool for Aviation Insurance
Swiss Reinsurance Company-FSBG

Aviation Associations

ANPAC (Associazione Nazionale Piloti Aviazione Commerciale)
The Air League-United Kingdom
Airports Council International
Association of European Airlines
Associação dos Pilotos Portugueses de Linha Aérea
Dutch Airline Pilots Association
Eurocontrol
EuroPress Polska
European Regions Airline Association
Flight Safety Foundation International (Moscow)
Guild Air Pilots & Navigators
Hellenic Airline Pilots Association
IFSC-Italian Flight Safety Committee
International Federation of Air Line Pilots' Associations
International Federation of Airworthiness
Internacional Transport Workers Federation
Sindicato Nacional de Pessoal de Voo da Aviacao Civil-Portugal

SwissALPA- AEROPERS
Syndicat National des Pilotes de Ligne
Unione Piloti
Vereinigung Cockpit-German Air Line Pilots' Association

Consulting/Vendor

CEFA Aviation
Flight Data Services
HTS Worldwide
Saferflight

Individuals

Angel Arroyo
Bart Bakker
Katia DeFrancq
Paul Fremont
Michael R.O. Grueninger
Gennadily Cosí
Wim Huson

Middle East

Airlines

AMC Airlines
Afriqiyah Airways
Ariana Afghan Airlines
Arkia Israel Airlines
Caspian Airlines
Cyprus Airways
DHL International
EgyptAir
EgyptAir Cargo
Egyptian Aviation Services
El Al Israel Airlines
Emirates
Etihad Airways
Gulf Air
Iran Air
Iraqi Airways
Kuwait Airways
Libyan Arab Airlines
Middle East Airlines-AirLiban
Midwest Airlines
NetJets Middle East
Oman Air
Pakistan International Airlines
Palestinian Airlines
Qatar Airways
Royal Flight of Oman
Royal Jordanian Airlines
Saudi Arabian Airlines
Sri Lankan Airlines
Syrianair
Tunisair
Yemenia, Yemen Airways

Regional Airlines

C.A.L. Cargo Airlines
Iran Aseman Airlines
Israir Airline and Tourism
Kish Air
Mahan Airlines Services Co.
Trans Mediterranean Airways

Helicopter

Petroleum Air Services

Manufacturers & Engine

Israel Aircraft Industries
Sirocco Aerospace International

Corporate

Saudi Aramco

Charter

National Air Services
Royal Jet

Academia

M&M Aviation Consultancy

Government/CAAs

Air Force Academy-Dundigal, India
Amiri Flight-Abu Dhabi
DGCA-Director General of Civil Aviation, India
Egyptian Meteorological Authority
International Airport Projects-Saudi Arabia
Kuwait Directorate General of Civil Aviation

India

Airlines

Air India
Indian Airlines
Kingfisher Airlines
Sahara Airlines

Regional Airlines

Jet Airways

Aviation Associations

Skycare Aviation Safety Society

Individuals

Shabnam Kinkhabwala

Africa

Airlines

Aero Zambia
AfriJet Airlines
Air Algérie
Air Botswana
Air Gabon
Air Madagascar
Air Malawi
Air Mauritius
Air Namibia
Air Senegal International
Air Seychelles
Air Tanzania Co.
Air Zimbabwe
Angola Airlines (TAAG)
Cameroon Airlines
Commercial Airways
Ethiopian Airlines
Inter Air
Kenya Airways
Liñhas Aeréas de Moçambique
Royal Swazi
Rwandair Express
Safair
Sierra National Airlines
Solomon Airlines
Sudan Airways
South African Airways
Tassili Airlines
Virgin Nigeria Airways

Regional Airlines

Air Gemini
Bellview Airlines
Nationwide Airlines
SA Airlink
Zambian Airways

Airport

Cape Verde Islands Airports & ATC Authority

Maintenance & Repair

Anglo American Aircraft Section

Charter

Solenta Aviation
Sonair

Government/CAAs

Ghana Civil Aviation Authority
South African Civil Aviation Authority

Aviation Associations

Air Traffic Navigation Services

Australia & New Zealand

Airlines

Air New Zealand
BHP Billiton
Qantas Airways

Low-Cost Carriers

Virgin Blue Airlines

Regional Airlines

Air Nelson
Cobham Flight Operations & Services (Australia)

Helicopter

Telstra Childflight

Academia

Edith Cowan University
Raaf College Library
RMIT Carlton (TAFE) Library
Trace University
University of New South Wales

Government/CAAs

Airservices Australia
Australia Civil Aviation Safety Authority
Australian Directorate Defence Aviation & Air Force Safety
Australian Transport Safety Bureau
Defence Library Service-Albatross
Defence Library Service-Canberra
Defence Library Service-Oakey
Department of Transport & Regional Services-Australia
New Zealand Civil Aviation Authority
New Zealand House of Representatives
New Zealand Transport Accident Investigation Commission

Aviation Associations

Australian Federation of Air Pilots
Aviation Safety Foundation-Australia
Flight Attendants' Association

Asia & Pacific

Airlines

Air China International Corp.
Air Koryo
Air Macau
Air Marshall Islands
Air Niugini
Air Pacific
Air Tahiti Nui
Air Vanuatu
AirAsia
Airfast Indonesia
All Nippon Airways
Asiana Airlines
Biman Bangladesh Airlines
Cathay Pacific Airways
China Airlines
China Cargo Airlines
China Eastern
China Southern Airlines
Dragonair
EVA Airways Corp.
Far Eastern Air Transport Corp.
Garuda Indonesia
Hainan Airlines Co.
JAL Express
JALways Co.
Japan Airlines International
Japan Asia Airways
Korean Air
MIAT Mongolian Airlines
Malaysia Airlines
Mandarin Airlines
Nippon Cargo Airlines
Philippine Airlines
Polynesian Airlines
Royal Brunei Airlines
Shanghai Airlines
Shenzhen Airlines
Simrik Air
Singapore Airlines
Thai Airways International
Turkmenistan Airlines

Regional Airlines

Air Caledonie
Air Japan Co.
Air Nippon Co.
Air Tahiti
Bangkok Airways
Japan TransOcean Air
Phuket Airlines
Shandong Airlines
SilkAir
Singapore Airlines Cargo
TransAsia Airways
Xiamen Airlines

Helicopter

Aero Asahi Corp.

Manufacturers & Engine

Ishikawajima-Harima Heavy Industries Co.

Academia

Air Force Academy, Education & Training Center for Aviation Safety
Aletheia University
Hanseo University
Institute of Transportation, MOTC

Government/CAAs

Brunei Department of Civil Aviation
Civil Aviation Authority-Singapore
General Administration of Civil Aviation of China, Center of Aviation Safety & Technology
Hong Kong Civil Aviation Department
Korea Air Force Risk Management Agency
Republic of Singapore Air Force
Taiwan Civil Aeronautics Administration

Aviation Associations

Air Line Pilots Association-Singapore
Association of Asia Pacific Airlines
Association of Air Transport Engineering & Research-Japan
Aviation Safety Council
Flight Safety Foundation-Taiwan
Japan Aircraft Pilots Association
Japan International Transport Institute
Polyspring Enterprises Co.

Individuals

Lo Sheng-Chiang

Commercial Jet Hull Losses, Fatalities Rose Sharply in 2005

The year's numbers, including more than a fourfold increase in fatalities, showed why the industry's excellent record overall should not breed complacency.

BY RICK DARBY

By relative standards, 2005 was not a good year for the worldwide commercial jet fleet[1] in terms of hull-loss and fatal accidents, according to data compiled by Boeing Commercial Airplanes in its annual statistical summary.[2]

Last year's hull losses totaled 22, compared with 14 in 2004, and the 49 accidents last year were responsible for 805 fatalities — almost 4.5 times the 180 in 2004 (Table 1, page 52). The summary did not calculate year-over-year changes in rates, but showed 19.2 million departures in 2005, an increase of about 10 percent from the 17.5 million in 2004.

Thirty-one of the total 49 accidents, or 63 percent, occurred in either the approach or landing phase of flight. Of the 805 fatalities, accidents during approach or landing accounted for 260, or 32 percent. The Boeing report varies slightly from the Flight Safety Foundation analysis of the 2005 record, due to the inclusion of several accidents the Foundation believed were not operational hull losses (*Aviation Safety World*, July 2006, page 17). Boeing counted a taxiway collision as two accidents.

In the 10-year period 1996–2005, there were 5,957 accidents. In the 10-year period 1995–2004, the equivalent number was 5,612.

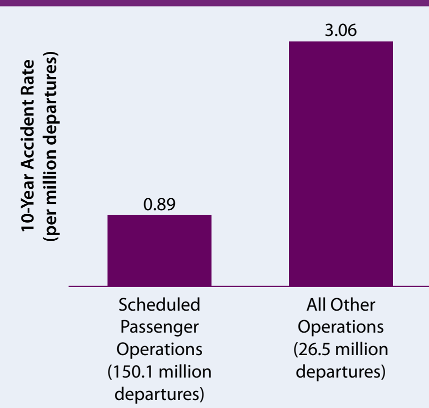
Scheduled passenger operations had lower rates of hull-loss and fatal accidents in the 1996–2005 period than other types of operations, such as unscheduled passenger, charter and cargo flights (Figure 1).

Analysis of the primary cause of accidents in the same period, as determined by the investigating authorities, shows that 55 percent of accidents with known causes were attributed to the flight crew, followed by the airplane, at 17 percent (Figure 2, page 53).

Fatal accidents from 1987 through 2005 were analyzed according to the Commercial Aviation Safety Team/International Civil Aviation Organization taxonomy (Figure 3, page 53). Of 237 total fatal accidents, those with the largest number of on-board fatalities were classified

Scheduled Passenger Flights Were Safer

Hull Loss and/or Fatal Accidents, by Type of Operation, Worldwide Commercial Jet Fleet, 1996–2005



Other operations included unscheduled passenger and charter, cargo, ferry, test, training and demonstration flights.

Source: Boeing Commercial Airplanes

Figure 1

2005 Accidents

Airplane Accidents, Worldwide Commercial Jet Fleet, 2005

Date	Airline	Airplane Type	Accident Location	Hull Loss	Fatalities	Phase	Description
Jan. 3	Asia Airlines	737-200	Banda Aceh, Indonesia	X		Landing	Airplane struck water buffalo
Jan. 8	Aero Republica	MD-80	Cali, Colombia	X		Landing	Landing overrun
Jan. 12	Myanmar Airways	F28	Myeik, Myanmar (Burma)			Landing	Nose landing gear collapse
Jan. 18	Novair	A321	Sharm El-Sheikh, Egypt			Landing	Tail strike
Jan. 23	Spanair	MD-80	Asturias, Spain			Landing	Hard landing
Jan. 24	Atlas Air	747	Düsseldorf, Germany	X		Landing	Landing overrun in snowstorm
Jan. 25	Republic of Yugoslavia	F100	Podgorica, Yugoslavia			Landing	Veered off icy runway
Feb. 1	Air France	A319	Paris, France		1	Parked	Cabin attendant fell
Feb. 2	El Al Israel Airlines	747	Tel Aviv, Israel			Takeoff	Thrown tire tread after takeoff
Feb. 3	Kam Air	737	Kabul, Afghanistan	X	104	Approach	Crashed into mountain
Feb. 25	Syrianair	727	Kuwait City, Kuwait			Landing	Runway excursion
March 2	Continental Airlines	777	Newark, New Jersey, U.S.			Takeoff	Tail strike
March 6	Delta Air Lines	757	Boston, Massachusetts, U.S.			Taxi	Flight attendant injured during taxi
March 7	Iraq Ministry of Defense	A310	Tehran, Iran			Landing	Veered off runway
March 19	Ethiopian Airlines	707	Entebbe, Uganda	X		Landing	Landing overrun into lake
April 1	El Al Israel Airlines	737	Tel Aviv, Israel			Parked	Cabin attendant fell
April 7	ICARO	F28	Coca, Ecuador	X		Landing	Hard landing short main landing gear collapse
April 14	Merpati Nusantara Airlines	737	Ujung, Pandang, Indonesia			Landing	Veered off runway
April 20	Iranian Air Force	707	Tehran, Iran	X	3	Landing	Landed short, crashed into lake
May 5	Northwest Airlines	DC-9	Minneapolis, Minnesota, U.S.	X		Parked	Hit by fuel truck while parked
May 10	Northwest Airlines	DC-9	Minneapolis, Minnesota, U.S.	X		Taxi	Aircraft collision during taxi
May 10	Northwest Airlines	A319	Minneapolis, Minnesota, U.S.			Taxi	Aircraft collision during taxi
May 13	Delta Air Lines	MD-80	Denver, Colorado, U.S.			Climb	Air turn back — loss of pressurization
May 13	Lufthansa Cargo	747	Sharjah, United Arab Emirates			Landing	Left main gear partially retracted
May 22	Skyservice Airlines	767	Punta Cana, Dominican Republic			Landing	Hard de-rotation — skin wrinkling
May 26	Alitalia	MD-80	Prague, Czech Republic			Pushback	Failure of nose landing gear
May 31	Adam Air	737	Jakarta Soekarno, Indonesia			Landing	Right main landing gear collapsed
June 7	UPS	MD-11	Louisville, Kentucky, U.S.			Landing	Nose wheel separated
June 12	Chanchangi Airlines	727	Lagos, Nigeria			Landing	Off-runway excursion
June 19	Mahfooz Aviation	707	Addis Ababa, Ethiopia	X		Landing	Hard landing — main landing gear collapse
July 1	Biman Bangladesh Airlines	DC-10	Chittagong, Bangladesh	X		Landing	Veered off runway — main landing gear collapse
Aug. 2	Air France	A340	Toronto, Ontario, Canada	X		Landing	Runway overrun — burned
Aug. 9	Saudia	MD-90	Cairo, Egypt			Landing	Engine fire on landing
Aug. 14	Helios Airways	737	Grammatikos, Greece	X	121	Climb	Flight crew incapacitation
Aug. 16	West Caribbean Airways	MD-82	Machiques, Venezuela	X	160	Cruise	Loss of control
Aug. 19	Northwest Airlines	747	Agana, Guam	X		Landing	Nose landing gear–up landing
Aug. 23	Tans	737	Pucallpa, Peru	X	45	Landing	Crash landed in swamp
Aug. 24	SAS	A340	Shanghai, China			Takeoff	Tail strike on takeoff
Sept. 5	Mandala Airlines	737	Medan, Indonesia	X	145	Takeoff	Crashed during takeoff
Sept. 8	Saudia	747	Colombo, Sri Lanka		1	Taxi	Evacuation fatality and injuries
Sept. 18	Spirit Airlines	A321	Ft. Lauderdale, Florida, U.S.			Landing	Tail strike
Oct. 9	Sahara India Airlines	737	Mumbai, India			Landing	Runway overrun
Oct. 22	Bellview Airlines	737	Lagos, Nigeria	X	117	Climb	Crashed during climb
Oct. 31	MIBA Aviation	727	Kindu, D. R. Congo	X		Landing	Landing overrun
Nov. 14	Asian Spirit	BAe 146	Catarman, Philippines	X		Landing	Runway overrun
Dec. 8	Southwest Airlines	737	Chicago, Illinois, U.S.		1	Landing	Runway overrun
Dec. 10	Sosoliso Airlines	DC-9	Port Harcourt, Nigeria	X	107	Approach	Crashed during go-around
Dec. 14	FedEx	727	Memphis, Tennessee, U.S.			Pushback	Airplane collision with tow tractor
Dec. 23	Koda Air	707	Istanbul, Turkey	X		Parked	Aircraft fire on ground
49	**Totals**			**22**	**805**		

Source: Boeing Commercial Airplanes

Table 1

as controlled flight into terrain (CFIT). CFIT accidents also represented the largest number of fatal accidents, 57.

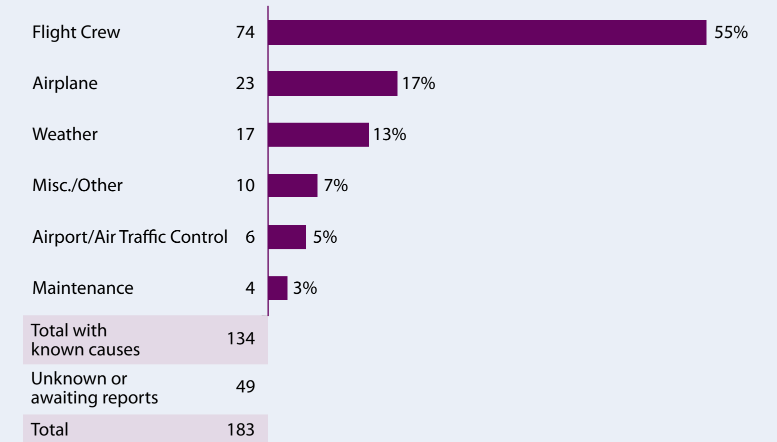
The category representing the next highest on-board fatality total was loss of control in flight, which comprised 39 accidents. Although there were slightly more fatal accidents — 40 — attributed to abnormal runway contact, the number of on-board fatalities for that category was 124, compared with 3,735 for CFIT and 2,830 for loss of control in flight.

For the second year in a row, there were no hostile events such as sabotage or terrorist acts involving aircraft. For the third consecutive year, there were no fatalities from such events.

Severe turbulence caused flight attendant injuries in four events; passenger injuries in three events; and both passenger and flight attendant injuries in three events. Four other cases of severe turbulence resulted in no injuries.●

Flight Crew Was Primary Cause of Most Accidents

Hull Loss Accidents by Primary Cause, Worldwide Commercial Jet Fleet, 1996–2005



Primary cause is determined by the investigating authority as a percent of accidents with known causes.

Source: Boeing Commercial Airplanes

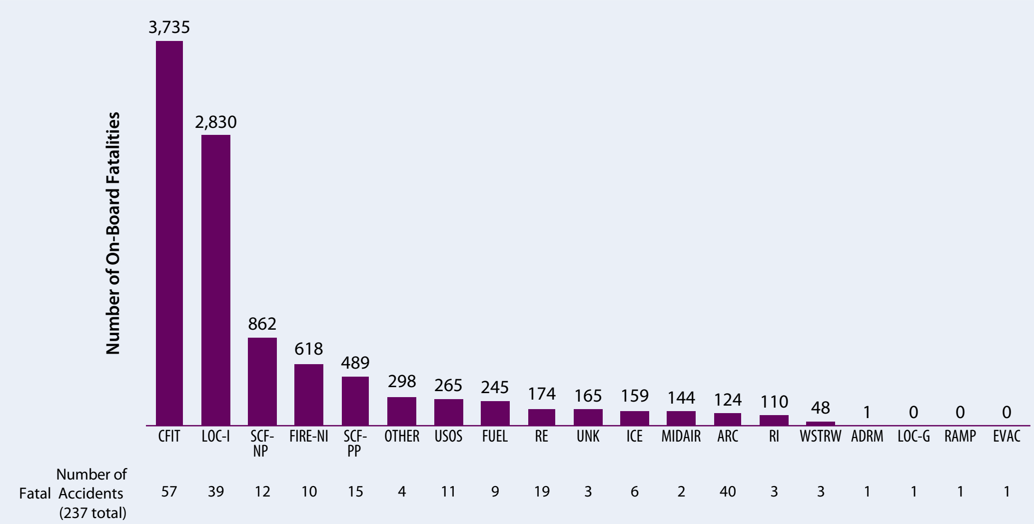
Figure 2

Notes

1. The data represent commercial jet airplanes worldwide with maximum gross weights more than 60,000 lb/27,000 kg. Commercial airplanes operated in military service and airplanes manufactured in the Soviet Union or the Commonwealth of Independent States were excluded because operational data were unavailable.
2. Aviation Safety, Boeing Commercial Airplanes, P.O. Box 3707, M/S 67-TC, Seattle, WA 98124 USA. As this article was written, the document was not yet posted on the Web, but it was expected to be available at <www.boeing.com/news/techissues>.

CFIT Was Deadliest Accident Category

Fatal Accidents by CAST/ICAO Taxonomy Accident Category, Worldwide Commercial Jet Fleet, 1987–2005



CAST = Commercial Aviation Safety Team ICAO = International Civil Aviation Organization

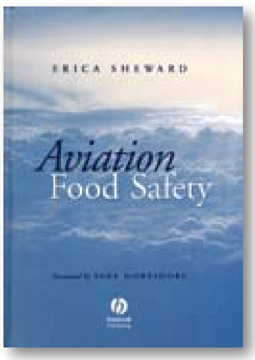
CAST/ICAO accident categories are as follows: ARC = abnormal runway contact; ADRM = aerodrome; CFIT = controlled flight into terrain or toward terrain; EVAC = evacuation; FIRE-NI = fire/smoke (non-impact); FUEL = fuel-related; ICE = icing; LOC-G = loss of control — ground; LOC-I = loss of control — in flight; MIDAIR = midair/near-midair collision; OTHER = other; RAMP = ground handling; RE = runway excursion; RI = runway incursion; SCF-NP = system/component failure or malfunction (non-powerplant); SCF-PP = system/component failure or malfunction (powerplant); USOS = undershoot/overshoot; UNK = unknown or undetermined; WSTRW = wind shear or thunderstorm.

Source: Boeing Commercial Airplanes

Figure 3

Hazard Alert! Lunch Ahead

The pilots eat different meals, of course. But what if both meals come from the same catering unit — and it's contaminated?



BOOKS

Aviation Food Safety

Sheward, Erica. Oxford, England: Blackwell, 2006. 405 pp. Figures, tables, references, index.

The words "pilot incapacitation" are likely to be associated with a cardiac crisis in the cockpit. Sheward notes, however, that according to U.K. Civil Aviation Authority data, cardiac-related incapacitation between 1990 and 1999 accounted for fewer than 3 percent of pilot incapacitations, while 54 percent of incapacitations were linked to gastrointestinal problems resulting from contaminated food or water, sometimes served aboard the aircraft.

"There has been much industry and media speculation in recent years as to the reality of both the long- and short-term health effects on crewmembers," Sheward says. "Everything from pilot deep vein thrombosis (DVT) and cabin air quality to blood-borne pathogens and cosmic radiation have found their way onto the platform for debate when discussions concerning cabin crew and cockpit crew health issues have risen to the fore. Interestingly enough, I can find no industry research that draws the same kind of personal health effects comparisons between pilots' incidence of gastrointestinal illness and incidence of gastrointestinal illness in workers on the ground."

Long-haul pilots are more likely to run risks from eating and drinking than stay-at-home workers, she says. Although flight crewmembers are officially on duty between flights, many airlines have no rules or guidance about where and what they eat, even in high-risk areas. Therefore, even though procedures require a captain and first officer to eat meals that differ from the other's during a flight, the risk from food-borne pathogens is not reduced as much as it could be.

"This is a wonderful example of the industry offering a less than ideal solution to what is a big problem," Sheward says. "It is obvious to anyone who knows anything about the likely causes of food poisoning (including the airlines themselves!) that it will matter not a jot that the pilots have consumed different meals if there is found to be an inherent hygiene problem at the catering unit from whence both meals were ultimately sourced. The nature of airline catering logistics provides for a situation where the same personnel can pack different meals in the same unit."

Cabin crewmembers can add to the risk of contaminated food for the pilots and passengers through ignorance, the author says. She once saw a flight attendant on a corporate aircraft become perplexed when all the refrigerated space became filled up and no room was available for two servings of sushi. "Eventually, accepting that all appropriate food storage areas were, by this time, fully laden, she threw open the front lavatory door and placed the two sushi trays on the toilet seat!" says Sheward. She also has seen meals being removed from behind blankets in overhead bins where they had been stored during a flight and placed in the oven racks for the return flight.

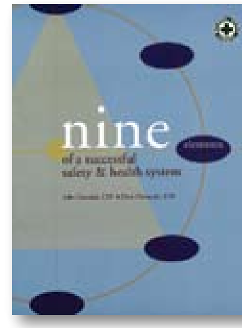
She says that the aviation industry, both in its commercial and corporate sectors, fails to train flight attendants in food service hygiene as it does for emergency evacuations, medical emergencies and crew resource management.

In a chapter on airline food, tables list 41 outbreaks of food poisoning between 1947 and 1997 — some of which affected multiple flights — caused most often by the organisms *Salmonella* and *Staphylococcus*. “Thousands of flights have been affected and over 9,000 passengers and crew have been reported to have suffered food poisoning; the number of reported deaths involved in these tables stands at 11,” the author says. She believes the number of people affected is under-reported: “The perceivably isolated incidents involving less than a critical mass of five passengers and crew will, historically, be dealt with by the airlines’ internal mechanisms and will remain under the detection threshold for statistical analysis.”

Passenger concerns and complaints about the quality of food served in flight have distracted the aviation industry from food safety issues, the author says. “Unless the broadest possible view is taken of the potential application that food and drink provision may have in the aviation safety arena, then the logical chain of events and protocols that need to be established in order to secure supply chain integrity will also not be effectively established,” she says.

Nine Elements of a Successful Safety & Health System

Czerniak, John; Ostrander, Don. Itasca, Illinois, U.S.: National Safety Council, 2005. 178 pp. Tables, index.



“Safety management systems differ from traditional safety programs in many ways,” the authors say. “In a traditional safety program, management decides the injury rate is too high, and then the safety director tries different tactics, such as incentive programs or safety committees, to reduce the injury rate. The tactics may or may not be effective.

“In a safety management system, the nine elements necessary for a system to succeed are clearly defined and understood by the management group. A gap analysis is performed, which reveals any deficiencies within the system. Priorities are chosen to close the gaps and responsibilities and accountabilities are spread throughout the management structure. The organization evaluates the effectiveness of the new efforts, building on successes and learning from failures.”

A safety management system thus differs from typical *ad hoc* safety measures. According to Czerniak and Ostrander, it is organized, structured and involves management in a visible way. The basic components are administrative and management elements, operational and technical elements, and cultural and behavioral elements.

Each of the nine elements is discussed in its own chapter, and sub-elements are called out in the margins (e.g., “Element 6.3: Management must determine the scope and nature of the organization’s occupational safety program and allocate resources to provide appropriate services”).

In the aviation industry, the book will be most useful for developing safety management systems to counteract workplace hazards in shop floor settings such as maintenance hangars. Some of its principles, however, may be applicable to operations as well.

REPORTS

A Milestone of Aeromedical Research Contributions to Civil Aviation Safety: The 1000th Report in the CARI/OAM Series

Collins, William E.; Wade, Katherine. U.S. Federal Aviation Administration (FAA) Office of Aerospace Medicine (OAM). DOT/FAA/AM-05/3. Final report. March 2005. 109 pp. Figures, photographs, appendixes. Available via the Internet at <www.faa.gov/library/reports> or through the National Technical Information Service.*

This 1,000th published report from the FAA aeromedical research center, established as the Civil Aeromedical Research Institute (CARI) in 1960 and now the Civil Aerospace Medical Institute (CAMI), offers a retrospective view of the organization’s history and accomplishments in fields such as protection and survival; emergency evacuation; accident toxicology; radiation; spatial disorientation; and stress.

Theme-related sections describe the research areas and cite some of the people who contributed to CARI/CAMI’s accomplishments. The report concludes with a number of “historical vignettes,” reprints of articles published earlier in cumulative indexes of CARI/OAM publications, looking back at the organization's development. The author or co-author of several of these is Stanley R. Mohler, M.D., director of CARI from 1961 to 1965 and a longtime contributor to the FSF publication *Human Factors & Aviation Medicine*.

Photographs — including a two-page center spread in color — illustrate CARI/CAMI's activities and experiments designed to enhance knowledge. The cast of characters in the photographs includes many anthropomorphic test dummies, including Oscar and Elmer, the first — in 1949 and 1950, respectively — and Sierra Suzie, a female dummy shown having her hair made up.

Reexamination of Color Vision Standards, Part II. A Computational Method to Assess the Effect of Color Deficiencies in Using ATC Displays

Xing, Jing; Schroeder, David J. U.S. Federal Aviation Administration (FAA) Office of Aerospace Medicine. DOT/FAA/AM-06/6. Final report. March 2006. 18 pp. Figure, tables, annex, references. Available via the Internet at <www.faa.gov/library/reports> or through the National Technical Information Service.*

Part I of the report (*Aviation Safety World*, July 2006, page 63) described study findings that showed that colors are used more widely than ever in air traffic control displays. Part II examines how people with color vision deficiencies — 8 to 10 percent of males but few females — perceive colors, and how that affects their interaction with color displays.

Using a computational algorithm that simulates how color deficient individuals perceive color, the researchers were able to calculate the effects of color deficiency on three kinds of tasks involved in a controller's work: attention — noticing a target; identification — distinguishing one target from another; and segmentation — visually and mentally organizing a complex scene into meaningful patterns. They performed the same type of analysis on the readability of text. Finally, they tested the ability of redundant cues such as flashing, brightness and size to compensate for color deficiency.

The result was a series of tables that show at a glance the effects of varied color coding on color deficient controllers. The researchers caution that, while the tables may be useful in a general way, they are not precise. For one thing, they do not recognize degrees of color vision deficiency; for another, controllers might use color-coded information more efficiently in the laboratory than in an operational setting (fewer tasks, less fatigue) or more efficiently in an actual work situation (because of experience and familiarity).

The report also notes that certain combinations of colors are not effective even for those with normal color vision. Red text, often used for emergency alerts, actually appears dimmer than many other colors and does not draw the attention that was intended.

WEB SITES

The Civil Aviation Authority of Singapore (CAAS), <www.caas.gov.sg>

The mission of the Civil Aviation Authority of Singapore (CAAS) is "to provide the highest standard in safety, quality and service in civil aviation and airport operations," the CAAS Web site home page says. This is accomplished, in part, through its rules and regulations, guidelines and manuals. These are available in full text on line.

Of particular note is the handbook "Rules and Regulations for Airside Drivers," 13th edition, 2006. The handbook addresses safety rules for the airside, airside markings and safety signage, radio telephony procedures, vehicle requirements, and passenger loading bridge operations. Text is based on CAAS rules and regulations, specific International Civil Aviation Organization (ICAO) documents and annexes, and Airports Council International materials.

This 71-page guidance document contains color illustrations, diagrams, photographs, definitions, tables and figures. The handbook is located in the "Regulations and Guidelines" section of the Web site. While the information presented in the handbook is specific to Singapore airports and CAAS operations, much could be applied in other settings.

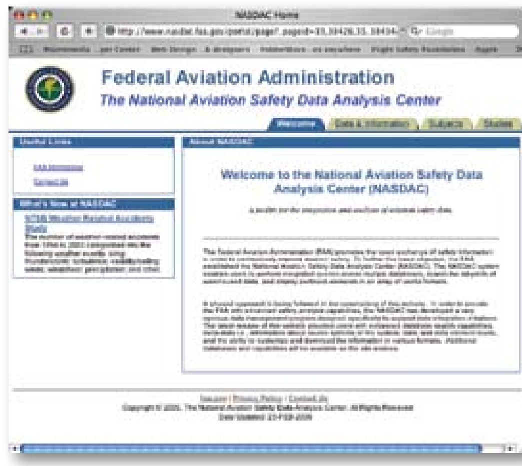
U.S. Federal Aviation Administration (FAA) NASDAC, <www.faa.gov/safety/data_statistics/nasdac>

The U.S. National Aviation Safety Data Analysis Center (NASDAC) Web site is a collection of databases provided by FAA, which says that its NASDAC system allows for an open exchange of safety information.

The NASDAC collection is data rich. The site is organized into eight databases:

- The Air Registry contains records for civil aircraft registered in the United States;
- The Aviation Safety Reporting System (ASRS) contains anonymous reports of unsafe occurrences and hazardous situations;
- The Bureau of Transportation Statistics database provides reports of activity statistics on individual airlines for a six-year period, 1995–2000;
- The Near Midair Collision System records are subjective, based on reporters' perspectives, and have been investigated by FAA inspectors;
- The U.S. National Transportation Safety Board (NTSB) Aviation Accident and Incident Data System includes reports of events from 1983 to the present. Data are presented in report format with electronic links to full reports at the NTSB Web site;
- The FAA Accident/Incident Data System contains records of incidents for all categories of civil aviation. Accident data are derived from the NTSB Aviation Accident and Incident Data System;
- The NTSB Safety Recommendations to the FAA with FAA Responses database includes records from 1963 to the present; and,
- The World Aircraft Accident Summary (WAAS) is described as "[providing] brief details of all known major operational accidents involving air carriers operating jet and turboprop aircraft and helicopters and the larger piston-engined types worldwide."

Several special reports are also available at this Web site.



REGULATORY MATERIALS

Construction or Establishment of Landfills Near Public Airports

U.S. Federal Aviation Administration (FAA) Advisory Circular (AC) 150/5200-34A. Jan. 26, 2006. 7 pp. Appendix. Available from FAA via the Internet at <www.airweb.faa.gov>.

Visual Guidance Lighting Equipment Approval Program

U.S. Federal Aviation Administration (FAA) Advisory Circular (AC) 150/5345-57, March 7, 2006. 15 pp. Figure, appendixes. Available from FAA via the Internet at <www.airweb.faa.gov>. ●

Source

* National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161 USA
Internet: <www.ntis.gov>

Books, reports and regulatory materials in InfoScan are available to FSF members on site in the Jerry Lederer Aviation Safety Library <www.flightsafety.org/library.html>.

— Rick Darby and Patricia Setze

Icing Triggers Stall on Takeoff

Challenger crew lacked winter flying experience.

BY MARK LACAGNINA

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

JETS

Wings Not Checked for Contamination

Canadair Challenger 600. Destroyed. Three fatalities, three serious injuries.

The flight crew landed the airplane at Montrose (Colorado, U.S.) Regional Airport about 0910 local time Nov. 28, 2004, to refuel during a charter flight from Van Nuys, California, to South Bend, Indiana, (see *Aviation Safety World*, July 2006, page 10). The airplane was being operated by Air Castle Corp. doing business as Global Aviation.

The airplane was on the ramp about 45 minutes in a light snowfall with the auxiliary power unit operating. The first officer, 30, who had 1,586 flight hours, including 30 flight hours in type, remained in the cockpit. The captain, 50, who had 10,851 flight hours, including 913 flight hours in type, observed the refueling. The lineman who conducted the refueling told investigators that the captain examined the underside of the right wing near the right main landing gear but remained near the wing tip and walked away from the airplane when the refueling was completed.

The flight crew did not request deicing services, said the report by the U.S. National Transportation Safety Board (NTSB). Cockpit voice recorder (CVR) data indicated that about 16 minutes before takeoff, the captain asked the first officer, "How do you see the wings?" The first officer said, "Good," and the captain said, "Looks clear to me." A witness, a pilot, on the ramp said that he did not see either pilot conduct a tactile examination of the wing surfaces.

The captain's logbooks indicated that during winter months from January 2000 to November 2004, he had conducted 18 flights at airports in Canada and the northern United States. "None of the flights were performed in winter weather conditions similar to the conditions that prevailed for the accident flight," the report said. Investigators found no documentation that the first officer previously had operated an airplane in winter weather conditions.

The airport was reporting 1.25 mi (2.01 km) visibility in light snow and mist, a few clouds at 500 ft and an overcast ceiling at 900 ft. Temperature was 1 degree C (34 degrees F), and dew point was minus 2 degrees C (28 degrees F). Airport elevation was 5,759 ft.

At 0949, the crew started the engines, and the first officer radioed on the common traffic advisory frequency that they were taxiing to Runway 35, which was 10,000 ft (3,050 m) long. The airport operations manager radioed that snow-removal operations were being conducted on the runway.

The Challenger was near Runway 31, which was 7,500 ft (2,288 m) long and 150 ft (46 m) wide. The airport operations manager told investigators that a snowplow had cleared a 40-ft

(12-m) swath down the center of the runway along its entire length.

After some discussion, the crew decided that the airplane's runway-length requirement was 7,200 ft (2,196 m) if they did not use engine bleed air for the anti-ice systems during takeoff. "We'll go for three one then. You agree?" the captain said. The first officer replied, "These numbers are always conservative anyway."

The report said that the runway-length requirements discussed by the crew were for a dry runway. "According to the QRH [quick reference handbook] available to the flight crew, the required takeoff runway length for the airplane, given the runway conditions and the use of anti-ice systems, was greater than 11,000 ft [3,355 m]," the report said. Before takeoff, the crew selected the bleed-air anti-ice system for the engine cowlings.

As the airplane was taxied to Runway 31, a passenger recalled seeing "slushy clumps of snow and water" slide across his window.

The crew began the takeoff at 0958. The report said that the airplane accelerated normally to rotation speed. Soon after rotation, however, the CVR recorded the sound of an aural alert that accompanies activation of the airplane's stick-pusher (stall-prevention) system. The report said this indicates that although angle-of-attack (AOA) was high, a positive rate of climb had not been achieved. "An aerodynamically clean airplane at a similar calculated airspeed would have begun establishing a positive climb rate after rotation at an AOA lower than that required for activation of the stick-shaker or stick-pusher," the report said.

The airplane was not equipped with, and was not required to be equipped with, a flight data recorder (FDR). Passengers said that the airplane was about 20 ft to 50 ft above the runway when it abruptly banked left, right and left, and then struck the ground. The initial impact occurred 44 ft (13 m) off the left side of the runway and about 636 ft (194 m) from the departure end. The airplane then slid about 1,390 ft (424 m), and a fire erupted. The captain, flight attendant and a passenger were killed; the first officer and two passengers received serious injuries.

NTSB said that the probable cause of the accident was "the flight crew's failure to ensure that the airplane's wings were free of ice or snow contamination that accumulated while the airplane was on the ground, which resulted in an attempted takeoff with upper wing contamination that induced the subsequent stall and collision with the ground." A contributing factor was "the pilots' lack of experience flying during winter weather conditions."

Based on the findings of the investigation, NTSB recommended that the U.S. Federal Aviation Administration "develop visual and tactile training aids to accurately depict small amounts of upper wing surface contamination, [and] require all commercial airplane operators to incorporate these training aids into their initial and recurrent training."

Rapid Rotation Blamed for Tail Strike

Boeing 737-800. Minor damage. No injuries.

Surface winds at the Sydney, Australia, airport were from 030 degrees at 20 kt, gusting to 30 kt, when the flight crew began a takeoff from Runway 34L for a passenger flight to Darwin on Feb. 1, 2005. The pilot-in-command (PIC) and copilot sensed that the tail struck the runway during lift-off. A flight attendant confirmed that an unusual noise was heard during rotation.

The crew conducted the checklist for a tail strike on takeoff and returned to the airport for an uneventful, overweight landing. "An engineering inspection [showed that] a crushable cartridge, fitted to minimize damage during a tail strike, was damaged and required replacement," said the report by the Australian Transport Safety Bureau.

The PIC had applied an average rotation rate of 3.7 degrees per second.

The report said that the PIC had applied an average rotation rate of 3.7 degrees per second and had increased the nose-up pitch attitude to 10.9 degrees during lift-off. FDR data showed that during the 23 previous takeoffs conducted in the airplane, the average rotation rate was 2.2 degrees per second and the average pitch attitude was 5.5 degrees.

"While the PIC needed to react quickly and precisely to manage roll in the gusty crosswind conditions, a more measured input of pitch control was required during the aircraft's rotation to maintain the allowable tail-clearance margin," the report said. "The almost doubling of the average pitch rate of rotation during the takeoff indicates that the PIC exceeded the recommended rate. It is possible that the PIC used a similar style of control input for pitch that he was using to manage roll."

Inexperience Cited in Ground Mishap

Embraer 170. Minor damage. One fatality.

A 5,900-lb (2,676-kg) mobile baggage belt loader was driven beneath the airplane while it was being prepared for a US Airways Express flight from Washington Reagan National Airport on June 6, 2005. The driver was wedged into her seat by the lower fuselage of the airplane and the belt loader's steering wheel, which had been bent back and down on impact. She died of asphyxiation due to thoracic compression, said the NTSB report.

A witness told investigators that he believed the driver's foot might have slipped off the brake pedal when she attempted to stop the belt loader. The report said that the driver was wearing leather shoes with hard rubber foam soles. The sky was overcast, but no precipitation was falling on the ramp; temperature was 68 degrees F (20 degrees C).

The driver had not driven a belt loader before being hired by the airline as a fleet service agent about a month before the accident and receiving driver training. NTSB said that the probable cause of the accident was "the inexperience of the driver (fleet service agent) in the operation of a belt loader."

TURBOPROPS

Engine Shutdown Precedes Control Loss

Mitsubishi MU-2B-60. Destroyed. Two fatalities.

Soon after departing from Runway 35R at Centennial Airport in Englewood, Colorado, U.S., for a cargo flight on Dec. 10, 2004, the pilot told ATC that he needed to return to the airport. While on left downwind for Runway 35R, the pilot — who had 2,495 flight hours, including 364 flight hours in type — declared an emergency and said that he had shut down one engine.

The controller observed the airplane overshoot the turn from left base to final approach and cleared the pilot to land on Runway 28 at his option. The pilot did not respond. A witness saw the airplane enter a steep left bank and descend to the ground.

Examination of the wreckage indicated that the left propeller had been feathered, but nothing was found that would have precluded normal operation of the left engine, said the NTSB report.

NTSB said that the probable cause of the accident was "the pilot's failure to maintain minimum controllable airspeed during the night visual approach, resulting in a loss of control and uncontrolled descent into terrain." A contributing factor was "the precautionary shutdown of the left engine for undetermined reasons."

Ice Accumulation Forces Descent

Beech King Air 200. Substantial damage. No injuries.

Two pilots and two paramedics were aboard the airplane when it departed from Prince George, British Columbia, Canada, on Jan. 19, 2005, to pick up two patients in Cranbrook. Icing conditions were encountered during cruise at 15,000 ft. "The aircraft's ice-protection equipment dealt effectively with the icing conditions until about 45 minutes after takeoff, when the aircraft began to accumulate ice at a rate that exceeded the capabilities of the ice-protection equipment," said the report by the Transportation Safety Board of Canada (TSB).

Airspeed decreased from 230 kt to 150 kt, and the crew had to conduct a descent with maximum available engine power to avoid a stall. ATC cleared the crew to descend to 13,900 ft, the minimum safe altitude for the area, but the crew said that they were unable to maintain altitude. When the airplane descended below 10,800 ft, the minimum obstacle clearance altitude for the area, ATC provided radar vectors away from high terrain and toward Kelowna, which had visual meteorological conditions (VMC). The report said that the airplane descended at 1,500–2,000 fpm in a power-on stall condition.

"Several minutes later, the pilots advised that they were clear of cloud and proceeding to Kelowna," the report said. "Accumulated ice, up to six inches [15 cm] thick, was shed during the approach to Kelowna, where an uneventful landing was made."

The report said that none of the weather information the pilot had reviewed on an Internet site before the flight had indicated forecast or actual icing conditions along the route. However, the pilot had not reviewed the graphical area forecast, which called for mixed moderate icing conditions along the route between the freezing level and 16,000 ft.

The airplane operator removed the King Air's engines from service after the incident because they had been operated in excess of maximum inter-turbine temperature and torque limits for about seven minutes during the flight.

Refueling Postponed, Then Omitted

Embraer EMB-110P1. Substantial damage. One serious injury.

After landing at Savannah (Georgia, U.S.) International Airport on the morning of Dec. 9, 2005, the pilot radioed a fuel order. While exiting the airplane, she was told by another pilot that he had heard a "popping noise" from an engine. The pilot, who had 2,250 flight hours, including 195 flight hours in type, was conducting an engine run-up when the fuel truck arrived. "The pilot elected not to refuel the airplane at that time and continued the run-up," said the NTSB report. "No anomalies were noted during the run-up, and the airplane was taxied back to the ramp and parked."

The pilot returned to the airport that night to conduct a positioning flight to pick up cargo in Columbia, South Carolina. "[She] did not reorder fuel for the airplane, nor did she recall checking the fuel tanks during the preflight inspection," the report said.

The airplane departed from Savannah at 2100 local time and was in cruise flight when the "FUEL" annunciator light illuminated. The fuel-quantity indicators showed less than 200 lb (91 kg) of fuel remaining. The pilot told ATC that the airplane had minimum fuel and requested radar vectors to the nearest airport. Both engines lost power on final approach to Orangeburg (South Carolina) Municipal Airport, and the airplane struck trees about 0.25 nm (0.46 km) from the runway at 2240.

NTSB said that the probable causes of the accident were "the pilot's inadequate preflight inspection and her failure to refuel the airplane, which resulted in total loss of engine power due to fuel exhaustion."

PISTON AIRPLANES

Stress Causes Landing Gear Failure

Beech Queen Air. Substantial damage. No injuries.

The airplane was on a cargo flight from Coventry, England, to Knock, Ireland, on Dec. 20, 2005. Because of adverse weather conditions at Knock, the commander diverted the flight to Sligo, Ireland, which had "benign" weather conditions with surface winds from 170 degrees at 12 kt, said the report by the Irish Air Accident Investigation Unit.

The airplane veered left after touchdown on Runway 11 and departed the runway onto grass. Neither pilot was injured. The commander, 62, who had 10,208 flight hours, including 83 flight hours in type, told investigators that he taxied the airplane slowly back onto the runway and to the apron.

The airport manager told investigators that he was concerned that the landing gear might collapse, causing the airplane to block the runway, and he instructed the commander to stop taxiing. "The aircraft was manhandled to the parking area, with one individual keeping the port [left] wheel in line," the report said.

Examination of the airplane showed that the left main landing gear torque link had fractured at both its lower and upper attachment points. The report said the fractures were caused by a "single-event overload" that occurred because the airplane was landed with the left wing low and either with the wheel brakes applied or with significant lateral drift and a tail-low attitude.

No Forecast of Mountain Wave Activity

Cessna P210N. Destroyed. Two fatalities.

About 2030 local time on Feb. 10, 2005, the airplane was cruising at 9,000 ft over mountainous terrain during a charter flight from Fresno, California, U.S., to Santa Monica when the pilot reported extreme turbulence and requested a lower altitude. "The aircraft then dropped off [ATC] radar, and no further radio transmissions were received," the NTSB report said.

The wreckage of the airplane was found near Lebec, California, two days later. The pilot and his passenger had been killed.

The report said that no advisories for turbulence at 9,000 ft were in effect when the accident occurred. An automated weather observation system near the accident site was reporting wind gusts to 45 kt.

NTSB said that the probable cause of the accident was "the pilot's in-flight loss of control due to the flight's encounter with unforecasted localized mountain wave activity with severe to potentially extreme turbulence, downdrafts and rotors."

HELICOPTERS

Vortex Ring State Cited in Loss of Control

Agusta–Bell 412HP. Substantial damage. One fatality, two minor injuries.

The air ambulance crew were conducting their ninth approach during an air-sea rescue training flight for the Swedish army on March 25, 2003. Weather was clear, and winds were light. During the approach, the flight crew followed an exercise plan in which, after bringing the helicopter to a hover about 100 ft above the water, the commander operates the cyclic control and anti-torque pedals to maneuver the helicopter laterally while the copilot operates the collective control to maneuver the helicopter vertically.

The final approach was conducted to a hole in the ice on a lake near Karlsborg with one medical orderly inside the cabin and another medical orderly on the right landing skid. The helicopter was about 65 ft above the water when a high descent rate developed. The copilot's attempts to reduce the descent rate failed, and the helicopter struck the ice, said the Swedish Accident Investigation Board's report. The helicopter rolled over on impact, and the ice broke.

The pilots and the medical orderly inside the cabin exited the helicopter as it began to sink. "Outside the helicopter, the commander tried to help [the other] medical orderly … by holding his head above the surface," the report said. "However, he was finally obliged to let go as the helicopter sank deeper." The commander had not been able to release the orderly's safety harness because the orderly had donned his life vest over the harness.

The report said that the flight crew had used increasingly higher airspeeds and tighter flight paths during the approaches, and that the helicopter's pitch attitude was unusually high during the last approach. The high descent rate had developed when the helicopter, with a high power setting and zero airspeed, sank into the main rotor downwash and entered a vortex ring state, also called settling with power, in which airflow through the rotor is disturbed.

A contributing factor was the "simultaneous maneuvering by both pilots, [which] allowed small or no chance of discovering in time that they were approaching the helicopter's limit for safe flight," the report said.

Glassy Water Cited in Roll-Over

Bell 206B. Substantial damage. One fatality, two minor injuries.

The float-equipped helicopter was engaged in water-sampling operations at several lakes north of Vancouver, British Columbia, Canada, on Oct. 26, 2005. Aboard the helicopter were the pilot and two Environment Canada employees, all of whom wore life vests. The TSB report said that the pilot had extensive experience flying helicopters and the passengers recently had received underwater emergency escape training.

After landing on eight lakes, the pilot attempted to land on Devil's Lake. The winds were calm, "and the water was quite glassy and shaded from the sun by hills," the report said. "When glassy water conditions exist, humans are not able to judge with accuracy the distance to the surface of the water by looking at it." The helicopter was not equipped with a radio altimeter.

The pilot conducted a shallow approach to the middle of the lake, using visual cues from the shoreline 200–400 m (656–1,312 ft) away and small ripples on the water. "Before the pilot anticipated touching down, the helicopter struck the surface of the lake and flipped onto its back," the report said. "It remained afloat supported by the floats, but the cabin was submerged."

A main rotor blade had fractured on contact with the water and had penetrated the front of the helicopter. The pilot and front-seat passenger had been struck by debris. The report said that the pilot's helmet had protected him from serious head injuries, but the front-seat passenger had received critical head injuries and was unconscious. The front-seat passenger was rescued from the helicopter by the rear-seat passenger, but she died about six days later from her injuries. ●

Preliminary Reports

Date	Location	Aircraft Type	Aircraft Damage	Injuries
May 24, 2006	Georgetown, Bahamas	Israel Aircraft Industries Westwind	substantial	5 minor, 3 none
The airplane was on an air-ambulance flight from San Juan, Puerto Rico, to Norfolk, Virginia, U.S., in nighttime visual meteorological conditions (VMC) when the left generator failed. The crew diverted the flight to Florida but then encountered additional electrical system problems, including low battery voltage. They declared an emergency and diverted to Exuma International Airport. A total electrical system failure apparently occurred during approach. The right main landing gear tire burst after touchdown, and the airplane veered off the right side of the runway about 0055 local time.				
May 28, 2006	Narita, Japan	Boeing 767-300	none	none
The flight crew were distracted during climb and did not set their altimeters to 29.92 in Hg. While leveling at their assigned flight level, 260, they received a terrain awareness and warning system resolution advisory.				
May 29, 2006	Dortmund, Germany	Saab 340	NA	none
Soon after departing from Dortmund for a scheduled passenger flight to Poland, the airplane was struck by lightning, which caused a loss of some flight instruments. The crew returned to Dortmund and landed without further incident.				
May 30, 2006	Juarez, Mexico	Schweizer 269D	destroyed	3 fatal
The helicopter, operated by the Mexican government, was on a local flight in VMC when it struck terrain.				
May 30, 2006	Chantilly, Virginia, U.S.	Embraer 170	substantial	1 serious, 60 none
The crew were not able to raise the landing gear handle after departing from Houston for a scheduled United Express flight to Washington Dulles International Airport. They conducted the abnormal checklist, and the landing gear retracted. During a visual approach to Runway 19R at Dulles, the crew observed a "LG LEVER DISAG" message and conducted a go-around. The crew found that the main landing gear had extended but the nose landing gear had not extended. After briefing the flight attendants and passengers of the problem, the crew conducted an emergency landing on Runway 19L. After stopping the airplane on the runway, an evacuation was conducted using the slides at the two rear doors. One passenger suffered a broken ankle during the evacuation.				
May 30, 2006	Washington	Eurocopter EC-135P1	substantial	1 fatal, 3 serious
The helicopter was on an emergency medical services flight between two hospitals in Washington. The pilot, who had 15,613 flight hours, including 914 flight hours in type, said that the helicopter began to "shuffle" and no. 1 engine speed increased during the first approach to the helipad. He reduced power from the no. 1 engine and conducted a go-around. The pilot said that he was maneuvering the helicopter for another approach when it began to vibrate and then entered a spin. The helicopter struck a tree and the ground at a golf course. The preliminary report said that the patient, who was critically ill, later died in the hospital for reasons not yet determined.				
May 31, 2006	Juneau, Alaska, U.S.	Bell 206L-1	substantial	3 minor, 4 none
The preliminary report said that flat lighting and whiteout conditions existed as the pilot maneuvered the helicopter above a glacier during a charter sightseeing flight. The main rotor blades struck the ice, and the helicopter descended onto the glacier.				
June 1, 2006	Bocas del Toro, Panama	British Aerospace Jetstream 31	substantial	18 NA
Rain was falling at the airport when the Air Panama flight overran the runway on landing and came to a stop in a marsh.				

Continued on next page

Preliminary Reports

Date	Location	Aircraft Type	Aircraft Damage	Injuries
June 2, 2006	Groton, Connecticut, U.S.	Learjet 35A	destroyed	2 fatal, 3 minor
Weather conditions at the airport included 2.0 mi (3.2 km) visibility in mist and a 600-ft broken ceiling when the airplane struck approach lights and water near the approach end of Runway 05. Both pilots were killed.				
June 3, 2006	Manassas, Virginia, U.S.	Dornier 328-300	substantial	2 minor, 6 none
The crew rejected a takeoff from Runway 34R because of an "altitude miscompare." The airplane overran the runway and was brought to a stop on a road.				
June 5, 2006	Bangalore, India	Bell 407	substantial	2 none
A hard landing occurred after rotor speed decreased during a training flight.				
June 5, 2006	Bandanaira, Indonesia	CASA 212	substantial	18 NA
There was heavy rainfall at the airport when the airplane veered off the runway on landing.				
June 6, 2006	Wuyishan, China	Boeing 737	NA	none
The runway reportedly was contaminated with water when the China Eastern Airways flight veered off the runway on landing.				
June 6, 2006	Gulf of Mexico	Bell 206L-1	none	1 serious, 3 none
A passenger was struck by the tail rotor while boarding the helicopter at an offshore platform.				
June 7, 2006	Medellín, Colombia	Boeing 747-200F	substantial	5 none
The Tradewinds International Airlines positioning flight overran the wet, 3,500-m (11,484-ft) runway after the crew rejected the takeoff because of an engine failure.				
June 9, 2006	Anyang, South Korea	Airbus A321	substantial	none
The Asiana Airlines flight encountered a hailstorm that destroyed the radome and weather radar equipment, and cracked the windshields, obstructing the flight crew's vision. An emergency landing was conducted without further incident in Seoul.				
June 15, 2006	East Midlands, England	Boeing 737-300	substantial	2 none
The airplane was on a cargo flight from Belgium to London Stansted Airport. Because of low visibility at Stansted, the crew diverted to East Midlands Airport and were conducting a Category III approach when the airplane touched down short of the runway, damaging the right main landing gear. The crew conducted a go-around, diverted to Birmingham and landed without further incident.				
June 15, 2006	Catania, Sicily	Boeing 737-400	NA	NA
The left nosewheel separated on takeoff from Catania. The flight, operated by Air One of Ireland, landed in Rome without further incident.				
June 17, 2006	San Juan, Puerto Rico, U.S.	Boeing 757	minor	177 none
The right engine failed during a US Airways flight from Saint Thomas, Virgin Islands, to Charlotte, North Carolina, U.S. The crew diverted the flight to San Juan and landed without further incident.				
June 20, 2006	Chicago	McDonnell Douglas MD-83	substantial	136 none
The crew of the American Airlines flight, inbound from Los Angeles, conducted a go-around during its first approach to O'Hare International Airport because of an apparent malfunction of the nose landing gear. The airplane circled the airport for about 45 minutes. The flight crew briefed the flight attendants and passengers about the problem and their intentions, and reportedly conducted a zero-g maneuver in an unsuccessful attempt to jar the nose gear loose. The crew then landed the airplane safely with the nose gear retracted.				
June 21, 2006	Jumla, Nepal	de Havilland Canada DHC-6	destroyed	9 fatal
The Twin Otter, operated by Yeti Airlines, struck a mountain during a go-around. Elevation of Jumla Airport is 9,400 ft.				
June 22, 2006	Colorado Springs, Colorado, U.S.	Excel-Jet Sport-Jet	substantial	2 minor
The experimental single-engine very light jet struck terrain during takeoff for a flight test.				
June 24, 2006	Upland, California, U.S.	Cessna Citation Ultra	destroyed	3 serious
Witness reports indicated that the airplane, inbound from San Diego, might have been on a go-around after touching down on the 3,865-ft (1,179-m) runway when it struck terrain and burned about 600 ft (183 m) from the departure end of the runway about 2225.				

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.

Sources: Australian Transport Safety Bureau, Aviation Safety Network, *Flight International*, Flight Safety Foundation–Taiwan, *Flight Safety Information*, U.S. Federal Aviation Administration, U.S. National Transportation Safety Board