AviationSafety WORLD

ALAR
SPREADING THE MESSAGE

RETURN OF THE KILLERS
2005 Safety Review

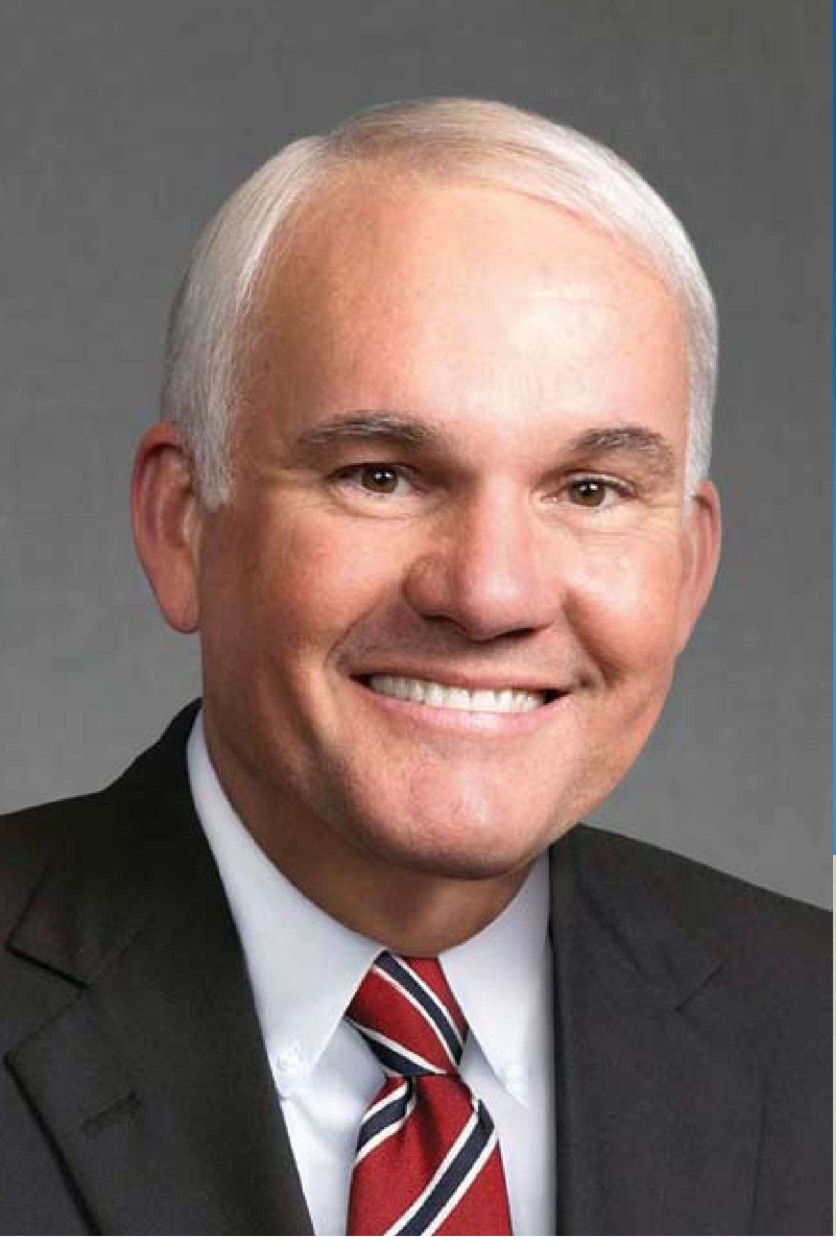
CORE LOCK
Resisting restarts

HYPERTENSION
Recognition is the key

LEADERS LOG
Kotaite, Auer & Blakey

THE JOURNAL OF FLIGHT SAFETY FOUNDATION

INAUGURAL ISSUE JULY 2006



FSF PUBLICATIONS: GROWING Stronger

For nearly 60 years, Flight Safety Foundation publications have been recognized as an authoritative source of information that has contributed significantly to improving aviation safety. In the past, we have produced separate publications to address various safety topics, but now we are making big changes to that format.

The same quality will be found each month in *Aviation Safety World*, in an up-to-date, engaging format. In addition to the kinds of articles that you have been used to reading, *Aviation Safety World* will include editorials, letters to the editor and more timely coverage of issues facing the industry.

I would like to be the first to congratulate the FSF publications staff for a job well done. Led by Director of Publications Jay Donoghue, the staff has worked countless hours to make the transition to this new journal a reality.

As many of you know, the Foundation was launched after the Second World War by that era's aviation industry leaders. As we launch our new publication, we have the support of today's leaders, and I'm extremely pleased that several of them have contributed to this inaugural issue. Marion Blakey, Administrator of the U.S. Federal Aviation Administration, provides a look at new U.S. initiatives on page 43. Andre Auer, Chief Executive of the Joint Aviation Authorities in Europe, examines the transition to the European Aviation Safety Agency on page 24, while Dr. Assad Kotaite, President of the International Civil Aviation Organization (ICAO), provides a briefing on the results of the recently held Directors General of Civil Aviation Conference on a Global Strategy for Aviation Safety. You can find that article on page 12.

Dr. Kotaite's term as ICAO President will soon end. During his time commercial aviation has seen many changes, and he has been instrumental in successfully guiding the worldwide industry, often through difficult times. I know that you all join me in wishing the best for Dr. Kotaite as he leaves ICAO and returns to private life. He has been an incomparable president. The aviation industry owes much to him and we will all miss him greatly.

In this first issue of *Aviation Safety World*, we bring you up to date on our Approach-and-Landing Accident Reduction (ALAR) program. There is also an interesting piece on how to best calculate passenger and baggage weights, a current concern in the regional airline and air taxi industry. This might be controversial, so let us have your views because we are eager to hear from you! And tell us what you think of the new format, the other information we have provided and what we ought to include in the future.

I am confident that you will like the look of our new magazine and that you will find it even more informative and useful than our publications have been in the past.

Stuart Matthews
President and CEO
Flight Safety Foundation

AviationSafetyWORLD

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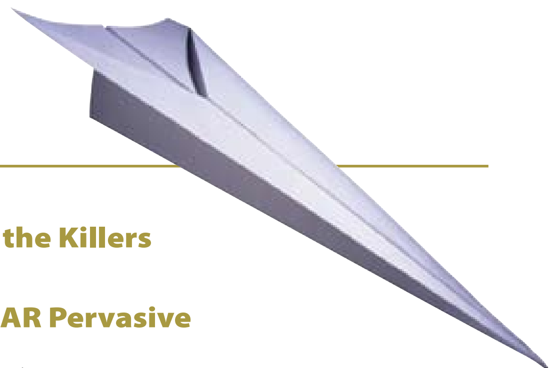

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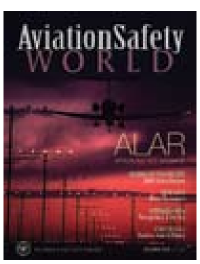

About the Cover
Runway 24R approach lights at
Los Angeles International Airport.
©2006 Chris Sorensen Photography

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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.

Subscriptions: Subscribe to *Aviation Safety World* and become an individual member of Flight Safety Foundation. One year subscription for 12 issues includes postage and handling — US$350. Special Introductory Rate — $280. For more information, please contact the membership department, Flight Safety Foundation, 601 Madison Street, Suite 300, Alexandria, VA 22314-1756 USA, +1 703.739.6700 or <membership@flightsafety.org>.

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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.

Member**Guide**

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MOVING Forward

"This is certainly different," you probably are saying to yourself as you page through this inaugural issue of *Aviation Safety World*. That change was initiated last year when Flight Safety Foundation's Board of Governors declared that the Foundation was doing a great job of developing safety information, but that information was not getting out to enough people in the industry, especially people outside of the core safety community. It was decided that the seven existing publications would be merged into a new, modern publication, the journal you see today.

When we sat down to design this new publication, we knew it had to be as serious and as credible as its predecessors. Further, it could not retreat from any of the topics previously covered. But, beyond that, we were directed to make *Aviation Safety World* a more timely publication with a wider scope of information, arranged and displayed in a more reader-friendly manner. The design you see was largely developed by Production Designer Ann L. Mullikin who, after years of confinement in an outdated format and a palette that rarely departed from black and white, displayed her underutilized talent in developing the look and feel of today's publication.

Next, we added some new features to expand the scope of information available to the safety community, including a new calendar of aviation safety events around the world. We will strive to make this comprehensive, but we need help from our readers to make this happen.

We also invite readers to tell us what they think about the safety topic of the day, recent events or anything else that has aviation safety as its central theme. We will publish these letters in our new AirMail section.

Further outside input will be invited from aviation leaders around the world in our new LeadersLog section.

In the belief that there is value in listening to different points of view, we have launched the InSight section, an occasional feature in which we present thoughts that may differ from mainstream safety community thinking.

This editorial page also is new, giving me a monthly opportunity to expose my weak, unorganized thinking patterns. I look forward to seeing what kinds of letters I can provoke with this page.

A news section will bring you brief items on safety-related events from around the globe.

Some of the other departments will be very familiar to readers of the now-departed *Flight Safety Digest*. ThreatAnalysis is a series looking at real-life safety risks, CausalFactors examines the details of an accident of particular interest, DataLink will be our monthly statistics feature, InfoScan will review new books and other publications, with additional reviews of various safety-related web sites. And OnRecord will provide accident details from recently-issued reports.

But the heart of this journal will be the feature stories in which our experienced and knowledgeable staff, supplemented by contributors, take a long, hard look at today's safety issues. These will be presented in a slightly less academic manner than before, with a less-cluttered presentation and fewer end notes, but retaining that rich core of information so vital to this publication's mission. Some of the lengthier pieces of information that used to fill *Flight Safety Digest* will be summarized in these pages, with directions to a place on the <www.flightsafety.org> web site where the complete document can be found.

We hope you find this new approach to aviation safety information useful. And, as I said earlier, we invite your comments. While we put a lot of work into creating *Aviation Safety World*, we do not pretend that it is a finished product. No publication that seeks to be a living part of an intellectually vibrant community can ever stay at rest, but must continually evolve to meet the changing needs of its readers.

Red Light, Green Light

I would like to congratulate the *Accident Prevention* publication on the Flight Safety Foundation Web site. [*Accident Prevention* was one of the previous publications now superseded by *Aviation Safety World — ed.*] It is, indeed, a huge contribution to aviation safety.

I would like to note, however, that in the January 2006 *Accident Prevention* (page 2), it is stated that "the precision approach path indicator (PAPI) showed three green lights and one red light, indicating that the aircraft was slightly low."

A PAPI indication of only one red light would mean that the aircraft is higher than the normal path, and not lower, as stated above.

Rafael Costa
Zurich, Switzerland

Thanks From COSCAP-SA

On behalf of the members of the Steering Committee of the Cooperative Development of Operational Safety and Continuing Airworthiness Program–South Asia (COSCAP-SA) and myself, may I express our deepest appreciation to Flight Safety Foundation for its continued and invaluable support to the COSCAP-SA Program.

The latest support in kind was making available the services of the CFIT/Approach-and-Landing Action Group (CAAG) Team to conduct the Approach-and-Landing Accident Reduction (ALAR) Workshop in New Delhi in January 2006. The ALAR Workshop has had a tremendous impact and will undoubtedly go a long way in developing the right kind of awareness about safety issues and ALAR in particular. I am pleased to inform you that there were 111 participants at the workshop.

The workshop was very well received, and it was very gratifying to see the professionalism with which the CAAG Team conducted themselves. To say the least, the excellent rapport that they developed during the workshop is indicative of the exceptional professional knowledge and insight that they possess. Their immense knowledge on various ALAR-related issues and the high quality of presentations speaks volumes about not only their personal ability but also of the very high standards that Flight Safety Foundation maintains. I would like to place on record, on behalf of the COSCAP-SA Steering Committee, our sincere appreciation to Jim Burin, Gary Hudson, Carlos Limon, Kyle Olsen, John Long and Bernard Vignault.

Our special thanks go to Jim Burin, director of technical projects for the Foundation and chairman, CAAG, for working closely with COSCAP-SA and for his tremendous efforts in organizing to bring the ALAR Workshop to the South Asian region.

It is a source of encouragement to see Flight Safety Foundation's support to the regional program. We look forward to your continued patronage in working towards a safer environment.

Kamal Kumar, KC
Chairman, COSCAP-SA
Colombo, Sri Lanka

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>.

JULY 3–7 ➤ Safety Assessment of Aircraft Systems (course). Cranfield University School of Engineering. Cranfield, Bedfordshire, United Kingdom. <shortcourse@cranfield.ac.uk>, <www.cranfield.ac.uk>, +44(0) 1234 751206.

JULY 12–15 ➤ Lawyer-Pilots Bar Association. Uncasville, Connecticut, U.S. <lpba@lan2wan.com>, <www.lpba.org>, +1 410.571.1750.

JULY 17–23 ➤ Farnborough International Airshow 2006. Farnborough Airport, Farnborough, United Kingdom. <enquiries@farnborough.com>, <www.farnborough.com>.

JULY 17–20 ➤ International Aviation Training Symposium: "Creating a Global Partnership Through Safety, Capacity Building and Training." U.S. Federal Aviation Administration Academy and Air Traffic Control Association. Oklahoma City, Oklahoma, U.S. <www.atca.org>, +1 703.299.2430.

JULY 24–27 ➤ Air Line Pilots Association 52nd Annual Air Safety Forum: "Strong, Focused, Safe — 75 Years of Pilots in Command." Washington, D.C. <www.alpa.org>, +1 703.689.2270.

JULY 31–AUG. 4 ➤ 24th International System Safety Conference. The System Safety Society. Albuquerque, New Mexico, U.S. Cathy Carter, <syssafe@ns.gemlink.com>, <www.system-safety.org>.

AUG. 10–12 ➤ 4th Annual Latin American Business Aviation Conference and Exhibition (LABACE). Associação Brasileira de Aviação Geral and National Business Aviation Association. São Paulo, Brazil. Jan Kelliebrew, +1 202.783.9283, <jkelliebrew@nbaa.org>, <www.labace.aero>.

AUG. 20–24 ➤ 8th Joint Annual Meeting of Bird Strike Committee USA/Canada and American Association of Airport Executives. St. Louis, Missouri. Catherine Pawlowicz, <aaaemeetings@aaae.org>, <www.aaae.org>, +1 703.824.0500.

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

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

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

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.

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 new publication 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

U.K. CAA Alters Policy for Emergency Flights Over Cities

The U.K. Civil Aviation Authority (CAA) is revising its policy for the handling of aircraft by air traffic services in emergency situations in which the intended flight path passes over densely populated areas. CAA said that the action was required because of safety issues identified in recent incidents, including an April 24, 2004, incident in which the flight crew of an Evergreen International Airlines Boeing 747-100 was directed to fly the disabled cargo airplane over some of the most congested neighborhoods in London (see *Airport Operations*, January–February 2006).

The revised policy — an amendment to the *Manual of Air Traffic Services* Part 1 (Civil Aviation Publication 493) — says, "It is desirable that aircraft in emergency should not be routed over densely populated areas, particularly if there is reason to believe that the aircraft's ability to remain in controlled flight is compromised or that parts of the aircraft could detach in flight. If this is inconsistent with providing the most appropriate service to the aircraft, for example, when any extended routing could *further* jeopardize the safety of the aircraft, the most expeditious route is the one that should be given."

In the April 2004 incident, after the failure of one engine, crewmembers told air traffic control (ATC) that they had observed anomalies in indications for the three operative engines. They conducted an emergency approach and landing at London Heathrow Airport.

During the emergency, ATC personnel discussed the possibility that the aircraft's cargo might include dangerous goods being shipped by the U.S. military; Heathrow Airport is not considered suitable for diversion of an aircraft that requires special ATC handling while carrying dangerous goods. No one was injured in the incident, and the airplane was not damaged; nevertheless, in its final report on the incident, the U.K. Air Accidents Investigation Branch recommended a CAA review to determine whether ATC training prepared controllers to handle such emergencies and "whether sufficient guidance is provided on the avoidance of built-up areas when vectoring aircraft in emergency."

NTSB Identifies Risks in EMS Operations

The U.S. National Transportation Safety Board (NTSB) has recommended improved training and equipment requirements for emergency medical services (EMS) operations. The recommendations resulted from an investigation of 55 accidents involving EMS aircraft during a three-year period (see *Flight Safety Digest*, April–May 2001).

In its *Special Investigation Report on Emergency Medical Services Operations*, NTSB criticized the U.S. Federal Aviation Administration's (FAA's) use of less stringent requirements for EMS operations without patients on board than for patient-transport flights, the lack of flight-risk evaluation programs and consistent and comprehensive flight-dispatch procedures, and the absence of requirements for technology such as terrain awareness and warning systems (TAWS) to improve safety.

NTSB expressed concern that "without requirements, some EMS operators will continue to operate in an unsafe manner, which could lead to further accidents. Although [NTSB] recognizes that the nature of EMS operations involves some risks, operators should be required to provide the best available tools to minimize those risks and help medical personnel, flight crews and patients arrive at their destinations safely."

NTSB's safety recommendations called for more stringent requirements for all flights with medical personnel in the aircraft; development of flight risk-evaluation programs; use of formal dispatch and flight-following procedures with up-to-date weather information and help in flight risk-assessment decisions; and installation of TAWS on EMS aircraft and adequate training in their use.

The 55 accidents, including 24 fatal accidents, reviewed during the investigation resulted in 54 fatalities and 18 serious injuries. The investigation found that, as the number of flight hours per year flown by EMS helicopter operations increased from 162,000 in 1991 to 300,000 in 2005, the accident rate also increased. The report said that the average accident rate during the 10-year period from 1992 through 2001 was 3.53 accidents per 100,000 flight hours, but the rate during the last five years of that period, from 1997 through 2001, was 4.56 accidents per 100,000 flight hours.

No 'Common Causes'

Fatal airline accidents have become so rare in developed countries that "common causes" no longer exist, said Nicholas A. Sabatini, U.S. Federal Aviation Administration associate administrator for aviation safety.

Sabatini told a meeting of the International Society of Air Safety Investigators that the accident rate for passenger jets in developed countries is about 0.004 per 100,000 departures.

"How do you explain how safe point zero-zero-four is?" he asked. "Here's one way: You must fly every day for 43,000 years to get to an even chance of being killed in an airline accident."

Without common causes of accidents, the new era of aviation safety depends on a "prognostic" — or predictive — approach of gathering more data, discerning trends, identifying accident precursors and sharing information, he said.

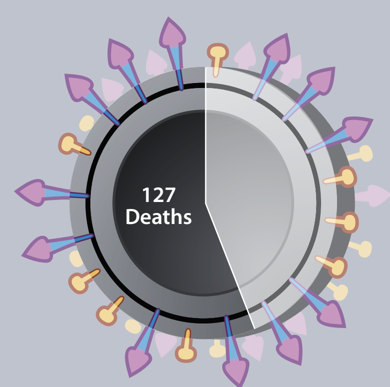
Guidelines Issued for Bird-Strike Cleanups

Public health specialists and representatives of the aviation industry have developed guidelines for maintenance personnel responsible for cleaning up after bird strikes (see *Human Factors & Aviation Medicine*, November–December 2005).

The International Air Transport Association (IATA) said that discussions with biosafety specialists at the United Nations World Health Organization (WHO) resulted in recommendations calling for those involved in cleanup activities to wear disposable gloves and, "if body contact [with bird remains] is unavoidable while cleaning the engine, … a disposable coverall."

Other recommendations included avoiding use of pressurized air or pressurized water to clean any part of the aircraft hit by a bird; removing the bird remains and placing them in a plastic bag; ensuring that the gloves touch no part of the face; removing the gloves and disposable coveralls and placing them in the same plastic bag, and then sealing the bag and disposing of it along with normal garbage; and washing hands thoroughly with soap and water.

In late May 2006, WHO said that 224 confirmed human cases of avian flu had been reported worldwide. Of those, 127 people had died. Public health specialists are concerned about the possibility that avian flu — now relatively rare in humans — might evolve into a highly contagious human disease with the potential to kill many of those who become infected.



224 Cases of Avian Flu in Humans
Late May 2006

Study Rejects Use of Infant 'Slings' for Child Restraint

Infant carriers, also called slings, are not capable of restraining infants in an aviation accident, according to a study conducted for the Australian Transport Safety Bureau (ATSB). Turbulence tests performed as part of the study found that with a 9 g pulse — a force equivalent to nine times standard gravitational acceleration — infant dummies were ejected from the slings; in some instances, they were crushed between the front row seat back and the body of the adult dummy that had held them.

In their report — *Child Restraint in Australian Commercial Aircraft* — the researchers who conducted the study said that children younger than 24 months are safer if they are placed in automotive child restraint systems instead of being held on an adult's lap or restrained by standard aircraft lap belts. Nevertheless, 14 of the 20 models of child restraint systems that were tested could not be adequately installed in an airplane seat or were difficult to fit within the available space.

The study recommended encouraging the use of child restraint systems — either systems designed specifically for aircraft use or compatible automotive systems. Other recommendations included calls for tests of automotive child restraint systems that incorporated an upper tether strap, and installation of "lap sash or harness-type" seat belts for adults holding infants.

Icing Accident Prompts Call for New Training Aids

The U.S. National Transportation Safety Board (NTSB) has recommended changes in pilot training to aid in identification of upper wing surface contamination. The recommendations were issued as a result of the investigation of a Nov. 28, 2004, accident in Montrose, Colorado, U.S., in which the flight crew of a Canadair CL-600-2A12 failed to ensure that the airplane's wings were free of ice and snow before takeoff.

Photo courtesy of NTSB

Pilots should use touch to detect small ice particles, NTSB said.

The safety recommendation said that the U.S. Federal Aviation Administration should "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."

The CL-600 struck the ground during takeoff from Montrose Regional Airport. The captain, flight attendant and one passenger were killed, and the first officer and two passengers received serious injuries in the accident, in which the airplane was destroyed. The NTSB accident investigation found that the airplane was parked for 40 to 45 minutes during freezing precipitation and was not deiced before takeoff.

"The flight crewmembers would have seen the contamination if they had carefully visually examined the airplane's upper wing surfaces," an NTSB statement said.

The investigation also resulted in a safety recommendation that the U.S. Department of Transportation require that passengers on air taxi flights conducted in accordance with Federal Aviation Regulations Part 135 be told "the name of the company with operational control of the flight, including any 'doing business as' names contained in the operations specifications, the aircraft owner and the name(s) of any brokers involved in arranging the flight."

In Other News …

The JAL Group, parent company of Japan Airlines, has opened a Safety Promotion Center in the maintenance area of Haneda Airport in Tokyo to promote awareness of aviation safety among its employees. The safety center features exhibits from a JAL Boeing 747 that broke up during a domestic flight in Japan in August 1985.

Eurocontrol says that the second phase of its programs for the mandatory installation of the traffic-alert and collision avoidance system (TCAS II, also known as the airborne collision avoidance system) has been completed. John Law of Eurocontrol said completion of phase 1, which involved large civil aircraft, and phase 2, which involved smaller aircraft of more than 5,700 kilograms/12,500 pounds or 19 passenger seats, means that the European air traffic system can "take maximum benefit from this important safety net."

The U.S. Federal Aviation Administration has installed a prototype of a new light emitting diode taxiway light system at Prescott (Arizona, U.S.) Municipal Airport. The technology is designed to help pilots see when they are approaching runway hold lines and thereby reduce the risk of runway incursions.

The European Regions Airline Association has recommended establishment of an independent, centralized European Transportation Safety Board in place of national investigation authorities as part of the harmonization of European accident investigation procedures.

Chile Adopts Safety Audit Standards

Chile has become the first country to announce plans to incorporate the International Air Transport Association's (IATA's) operational safety audit (IOSA) into its airline certification process. IOSA standards, developed by IATA in cooperation with the International Civil Aviation Organization (ICAO) and industry regulators, are considered a global benchmark for safety. About 150 airlines — responsible for 70 percent of scheduled international air traffic — are either undergoing the audits or have completed the audit process.

Compiled and edited by Linda Werfelman.

Cockpit Smoke Solution

According to Air Safety Week, at least once a day somewhere in North America a plane has to make an unscheduled or emergency landing because of a smoke and in-flight fire event.

Statistics from FAA Service Difficulty Reports clearly show that in-flight fires, smoke or fumes are one of the most significant causes of unscheduled or emergency landings and account for 3 precautionary landings per day based on 1,089 events during a 10 month period in 1999.

A pilot encountering smoke in the cockpit so thick that the instruments cannot be seen can utilize a relatively simple device, which provides a clear view.

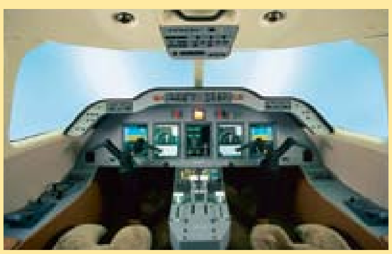
The Emergency Vision Assurance System (EVAS) provides a clear space of air through which a pilot can see flight instruments and out the front windshield for landing. The pilot still relies on the oxygen mask for breathing, smoke goggles for eye protection and employs approved procedures for clearing smoke from the aircraft. When smoke evacuation procedures are not sufficient, EVAS provides emergency backup allowing the pilot to see and fly the aircraft to a safe landing.

EVAS measures 3 x 8.5 x 10 inches when stowed, the approximate space of a Jeppessen navigation manual. When needed, the pilot removes the IVU (Inflatable Vision Unit) from the EVAS case and pulls a tab to activate the system. The IVU inflates with one lobe above and one below the glareshield. According to EVASWorldwide, the manufacturer, the whole process takes 15-20 seconds. The pilot leans forward, placing his smoke goggles in contact with the EVAS clear window, giving him an unimpaired view of both vital instruments and the outside world.

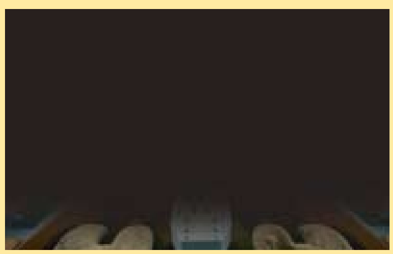
After it is activated, EVAS is continually pressurized with filtered cockpit air to maintain volume, and preserve a clear view. The device is independent of aircraft power, relying on a self-contained battery-power supply, pump and filters in each storage case. EVAS systems are designed to run for at least two hours, and filter down to .01 microns. The system requires virtually no installation.

While FAA regulations require smoke detectors, fire extinguishers, smoke goggles and oxygen masks, pilots point out that these safeguards and all other systems and equipment for flight safety are useless if the pilots cannot see to control and land the aircraft.

EVASWorldwide uses a fleet of mobile cockpit demonstration units to show potential customers the benefits of the system. EVAS demonstrations use a fog generator to reduce cockpit vision so the pilot cannot see his hand in front of his face. Smoke goggles offer no vision improvement, though they do protect the eyes. After EVAS is deployed, the pilot can clearly see both the vital instruments and out through the windshield. It is truly an amazing experience. Most pilots are sold on the benefits of EVAS on the spot.



Normal cockpit visibility



Uncontrolled smoke in the cockpit –No visibility

Uncontrolled smoke in the cockpit –Visibility with EVAS

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CURRENTLY SEEKING LAUNCH AIRLINE CUSTOMER

'No Room for Complacency'

BY DR. ASSAD KOTAITE

Transparency and sharing of safety information are fundamental tenets of a safe air transport system. They also were the underlying theme of the International Civil Aviation Organization (ICAO) conference of directors general of civil aviation (DGCAs), held March 20–22, 2006, in Montreal, Canada, to formulate a global strategy for aviation safety in the 21st century.

DGCAs from 153 contracting states responded positively to the call for greater openness by agreeing to post results from the organization's Universal Safety Oversight Audit Programme (USOAP) on the ICAO public Web site.

I took the initiative of proposing to the ICAO Council the convening of the conference because a series of six major fatal accidents in August and September of 2005 was a dramatic reminder that systemic deficiencies identified under USOAP since 1999 were still present. As I told the meeting, there is absolutely no room for complacency where safety is concerned, there never was, and there never will be.

A series of six major fatal accidents in August and September of 2005 was a dramatic reminder that systemic deficiencies identified under USOAP since 1999 were still present.

USOAP consists of regular, mandatory, systematic and harmonized safety audits carried out by ICAO in its 189 contracting states to assess the level of implementation of ICAO standards and recommended practices (SARPs), identify safety concerns or deficiencies, and provide recommendations for their resolution.

Summary safety reports from USOAP to appear on the ICAO Web site will cover eight critical areas: aviation legislation, operating regulations, structure of the civil aviation administration and safety oversight function, technical guidance material, technical personnel, licensing and certification obligations, continuing surveillance obligations, and resolution of safety issues. States will be able to add complementary data to help evaluate the level of safety in their country. They can publish more extensive, or even full, audit reports if they wish.

Although the deadline for posting the results was set for March 23, 2008, as chairman of the conference, I urged the DGCAs to comply as soon as possible within the two-year time frame. By the end of the meeting, some 70 states had already authorized ICAO to publish the information on its Web site; others have since forwarded their approval.

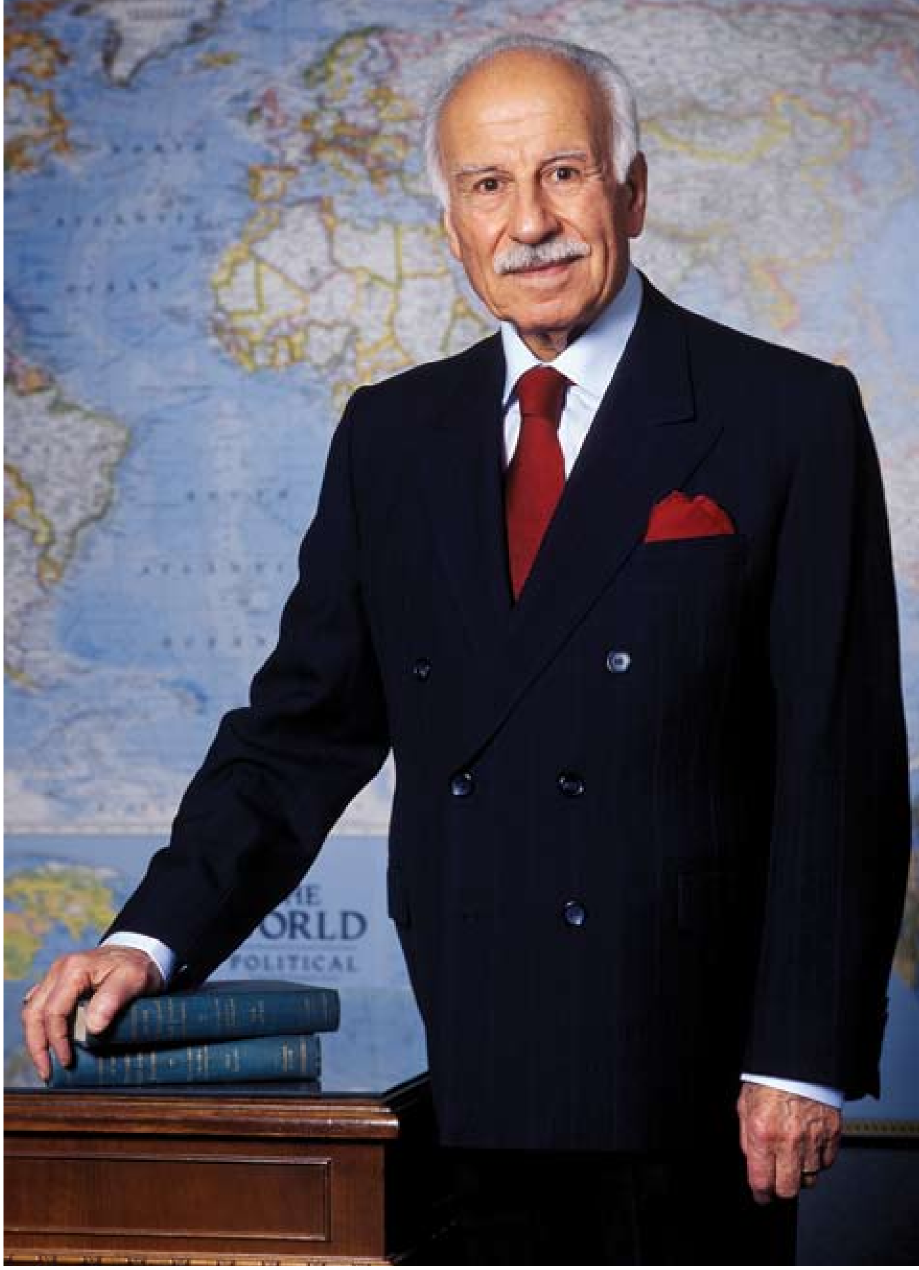
A progress report will be submitted to the next regular session of the ICAO Assembly in the fall of 2007, and a full announcement on transparency achieved will be issued on March 23, 2008, listing those states that have failed to meet the deadline.

This historic decision and measures taken at the conference, which attracted 566 participants, including delegates from 26 international organizations, will foster mutual trust between states, increase public confidence in air travel and help maintain the integrity of the safest and most efficient means of mass transportation ever created.

In addition to concluding that the public should be able to access, without delay, the information necessary to make an informed decision about the safety of air transportation, the conference made a number of key recommendations on sharing of information, among them that:

- The Council of ICAO should ensure that contracting states have access to reliable and timely information on registration, ownership and control of aircraft habitually used in international navigation;
- The Council should study the possibility of establishing an expanded database application that would allow contracting states to voluntarily share airworthiness information related to aircraft habitually involved in international operations; and,

- States of design and registry of aircraft should conclude an airworthiness agreement as stipulated in the ICAO *Airworthiness Manual* (Doc 9760) as a means of promoting the exchange of continuing airworthiness information between the states.



In the spirit of transparency, ICAO and the International Air Transport Association (IATA) signed, prior to the conference, a memorandum of cooperation on sharing safety-related information from our respective safety audit programs, in order to better identify potential safety risks and prevent aircraft accidents. The IATA Operational Safety Audit (IOSA) program is the first global standard for airline safety management, and the IOSA Registry is publicly accessible on the IATA Web site at <www.iata.org>.While sharing of information can strengthen the overall system, we must also strengthen the components of the system — that is, the safety oversight capabilities of individual civil aviation administrations. This is particularly significant for contracting states that lack the necessary human, technical or financial resources. Much of the answer lies in the implementation of sustainable regional safety oversight organizations. These organizations can be established only by coordinated efforts from ICAO, states, industry and donors.

It is essential that national civil aviation authorities, industry and funding institutions cooperate fully in the provision of technical assistance and guidance around the world. ICAO stands ready to help coordinate multilateral assistance when that is the preferred approach so that states may build the required safety oversight capacity and implement safe practices.

While safety-oversight auditing is effective in identifying and promoting corrective action, it should not be seen as an end in itself. Equally important is the ability to bring about improvements. Resources allocated to audits and to remedies must be evaluated carefully, so that no disproportionate amount is allotted to auditing at the expense of safety enhancements.

Experience in the industry itself has demonstrated that the implementation of safety management systems (SMSs) is the most effective way of addressing the need for increased supervision with a relatively small workforce. Many of our member states are now implementing or looking into SMS. At ICAO, we have just adopted standards for establishing SMSs.

Another promising avenue is the commitment to implementing a safety culture throughout the air transport infrastructure and at all levels —states, operators, manufacturers, service providers and associations.

Together, the actions and proposals adopted by the conference and highlighted in the final declaration are vital elements of a global strategy that I am confident will ensure the continued safety of civil aviation in the 21st century. ●

Dr. Assad Kotaite is retiring in July 2006 after nearly 30 years as president of the Council of the International Civil Aviation Organization. He will be succeeded by Roberto Kobeh González, who has been Mexico's representative to the Council since 1998. He will serve as Council president until after the next election in fall 2007.

Text of ICAO Declaration on Sharing Information

The following is the text of the declaration approved by the directors general of civil aviation during their meeting March 20–22, 2006, in Montreal, Canada:

Whereas the Convention on International Civil Aviation and its Annexes provide the essential framework required to meet the safety needs of a global aviation system;

Whereas the Directors General of Civil Aviation have a collective responsibility for international civil aviation safety;

Recognizing that the safety framework must be fully utilized by all stakeholders and continuously evolve to ensure its sustained effectiveness and efficiency in the changing regulatory, economic and technical environment of the 21st century;

Recalling that transparency and sharing of safety information are fundamental tenets of a safe air transportation system;

Recalling that recognition as valid of certificates and licences of other States is governed by Article 33 of the Convention and applicable Standards;

Recalling the role of ICAO in the settlement of disputes;

Recognizing that mutual trust between States as well as public confidence in the safety of air transportation is contingent upon access to adequate safety information;

Recognizing that safety is a shared responsibility, and advancements in global safety can only be possible through the leadership of ICAO, and a cooperative, collaborative and coordinated effort among all stakeholders; and

Recognizing that further improvements in aviation safety within and among States require a cooperative and proactive approach in which safety risks are identified and managed;

The Directors General of Civil Aviation:

1. *Commit* to reinforce the global aviation safety framework by:

a) sharing as soon as possible appropriate safety-related information among States, all other aviation stakeholders and the public, including the disclosure of information on the results of their safety oversight audit as soon as possible and, in any case, not later than 23 March 2008;

b) exercising safety oversight of their operators in full compliance with applicable SARPs, assuring themselves that foreign operators flying in their territory receive adequate oversight from their own State and taking appropriate action when necessary to preserve safety;

c) expeditiously implementing safety management systems across the aviation industry to complement the existing regulatory framework;

d) developing sustainable safety solutions, including the formation or strengthening of regional and sub-regional safety oversight organizations and initiatives; and

e) promoting a just culture;

The Conference:

2. *Calls upon* States to base the recognition as valid of certificates and licences of other States exclusively on safety considerations and not for the purpose of gaining economic advantage;

3. *Calls upon* States, ICAO, industry, and donor organizations to direct resources towards the establishment of sustainable safety oversight solutions;

4 *Calls upon* States, ICAO and industry to support the coordinated implementation of safety management systems;

5. *Calls upon* ICAO to:

a) develop and actively support information exchange mechanisms that allow for an unrestricted flow of safety information between all aviation stakeholders;

b) develop by June 2006 a strategy to communicate safety information effectively to the public;

c) develop a mechanism under Article 21 of the Convention to make available aircraft registration and operator information;

d) develop guidelines and procedures to verify the conditions for recognition as valid of certificates and licences, in keeping with Article 33 of the Convention; and

e) study the development of a new Annex on safety oversight, safety assessment and safety management;

6. *Calls upon* States to demonstrate the political will to address aviation safety shortcomings, this includes the establishment, where necessary, of an autonomous Civil Aviation Authority which is empowered and adequately funded to provide effective safety oversight; and

7. *Calls upon* States and industry to closely coordinate with ICAO their safety initiatives to ensure optimum benefits to global aviation safety and to reduce duplication in effort.

MembershipUPDATE

A Flight Safety Foundation Salute

Flight Safety Foundation appreciates all of its members and their continued support in our campaign to improve aviation safety around the world, a campaign that next year enters its seventh decade. In that light, the Foundation would like to salute members that have supported the Foundation for many years.

Members for 50 years or more: 3M Aviation, Air Canada, Air France, Air Line Pilots Association, International, Alcoa, Boeing Commercial Airplanes, Chevron Corp., Cigna Corp., ExxonMobil Corp., IBM Flight Operations, Imperial Oil, Marathon Oil Co., Procter & Gamble, United Airlines, United States Aviation Underwriters, United States Steel Corp., UTFlight and VARIG Brazilian Airlines.

Members for 40 to 49 years: Air New Zealand, Alitalia, All Nippon Airways, Cathay Pacific Airways, Eastman Kodak Co., Ethiopian Airlines, FlightSafety International, Global Aerospace, Iberia Airlines of Spain, Indian Airlines, Japan Airlines International, Lufthansa German Airlines, Marsh Ltd., Mexicana, Milliken & Co., Olympic Airlines, Pfizer AirShuttle, Philippine Airlines, Rolls-Royce North America, Scandinavian Airlines System, Sindicato Nacional dos Aeronautas, South African Airways, Sunoco, Swiss Reinsurance Co., TAP Portugal, The Timken Co. and Whirlpool Corp.

These distinguished aviation names have helped to create the safe operations that characterize the airline and corporate aviation networks that exist today.

Join The Foundation

If you are not already a supporting member of Flight Safety Foundation, you are invited to join today. The FSF roster of more than 900 members from 142 countries represents a "who's who" of industry leaders from airlines, helicopter and airplane manufacturers, corporate operators, suppliers, insurance companies, regulators and others. Some of the benefits of membership include:

- Help reduce risks and prevent accidents by supporting the Foundation's worldwide aviation safety goals;
- Receive *Aviation Safety World*, a new magazine developed from decades of award-winning publications;
- Receive member-only mailings throughout the year of special reports on important safety issues such as:
  - Controlled flight into terrain (CFIT);
  - Approach-and-landing accidents (ALAR);
  - Human factors and fatigue countermeasures;
  - Ground accident prevention;
  - Corporate flight operational quality assurance (FOQA); and
  - Runway incursions.
- Your company name on the FSF membership list and Internet site shows the world your commitment to safety;
- Experience the benefits of networking with your peers and customers;
- Receive a US$100 member discount for registration at each of three FSF annual aviation safety seminars. The next such event is the 59th annual International Air Safety Seminar, Oct. 23–26, 2006, at the Le Meridien Montparnasse in Paris. For agenda information and to register online, visit our Web site <www.flightsafety.org> or contact Namratha Apparao, membership services coordinator, at apparao@flightsafety.org or +1 703.739.6700, ext. 101;
- Receive proceedings of all three FSF annual seminars — whether or not you attend;
- Use the services of the FSF Jerry Lederer Aviation Safety Library; and
- Receive special discounts for FSF safety services, including IS-BAO audits and internal evaluations. ●

— Ann Hill, director, membership and development, Flight Safety Foundation

2005: The Year in Review
Return of the Killers

BY JIM BURIN

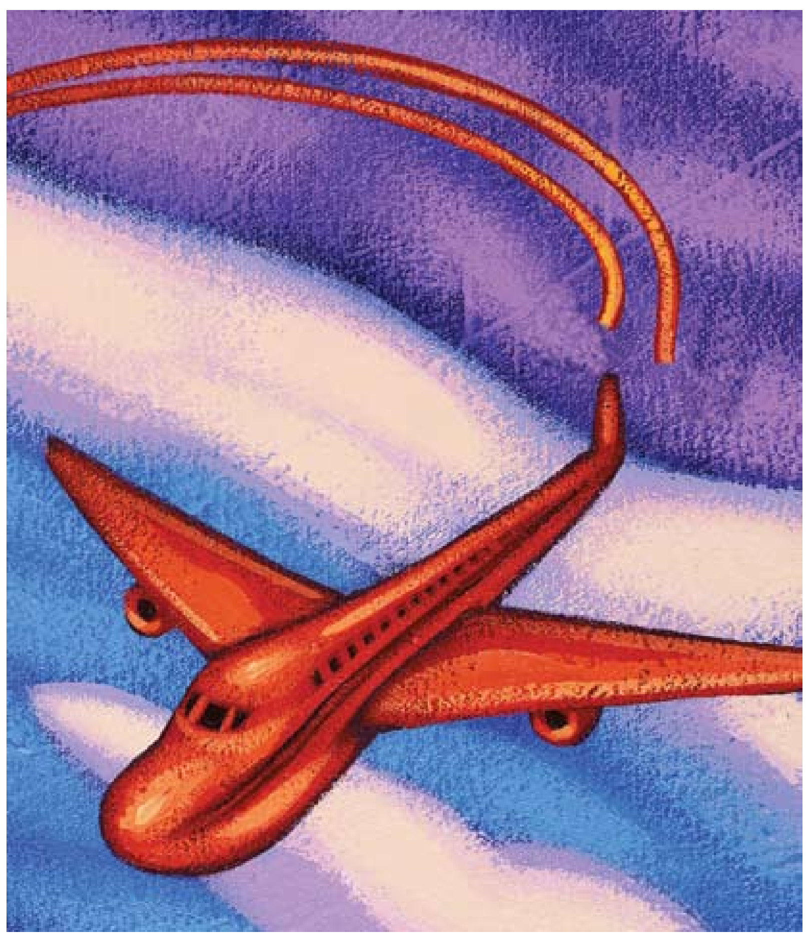
Aviation's historic killers made an unwelcome comeback in 2005. Controlled flight into terrain (CFIT) and loss of control (LOC) accidents returned after a brief hiatus, and the consequences were predictable. The 778 commercial jet fatalities last year were slightly more than average but seem especially bad compared to the record low 196 deaths in 2004.

In 2004, there was only one LOC accident and, for the first time, not a single commercial jet CFIT accident. In 2005, however, commercial jets were involved in five CFIT accidents and three LOC accidents that produced more than 70 percent of the year's fatalities (Figure 1, page 18). Significantly, all five CFIT accident aircraft came from that 8 percent of the world fleet not equipped with a terrain awareness and warning system (TAWS), repeating once again the pattern of the past; every CFIT accident to date has involved an aircraft lacking this vital piece of equipment.

Overall, the safety record of all levels of professionally flown jet and turboprop aircraft — commercial, cargo and corporate — was only slightly below average despite the big jump from 2004. As has been the case for the last 20 years, approach and landing accidents (ALAs), CFIT and LOC claimed the majority of aircraft and accounted for the majority of fatalities, with ALAs continuing to cause more than half of the hull loss accidents for all categories of aircraft. Figure 2 (page 18) shows that from 1995–2004, CFIT and LOC caused 62 percent of the fatalities during the 10-year period.

The number of aircraft in the active air carrier and corporate/business jet fleet grew during the year, the jet transport fleet growing 1.9 percent to 22,517, and the business jet numbers increasing 1.2 percent to 13,535, while the turboprop numbers remained essentially flat, up 0.2 percent to 12,931.

One statistic stands out in 2005: While 29 percent of the turboprop fleet is Eastern-built, they accounted for 52 percent of the turboprop hull loss accidents. This is in contrast to the



record of Eastern-built turbojet aircraft, comprising 14 percent of the turbojet fleet and accounting for 16 percent of the turbojet hull losses.

Despite the Eastern-built turboprop fleet's disproportionately high proportion of accidents, many of those accidents had little to do with where the aircraft was built and a lot to do with the dangers of operating in relatively high-risk areas.

Nineteen Hull Losses

Altogether in 2005, there were 19 hull loss accidents of commercial jet airplanes over 60,000 pounds/27,000 kilograms maximum takeoff weight (MTOW), including all cargo and passenger operations for Western-built and Eastern-built aircraft (Table 1, page 19); 16 were Western-built aircraft. The 19 hull loss accidents included 13 ALAs, five CFIT accidents and three LOC accidents. Eight of the 19 hull losses had zero fatalities.

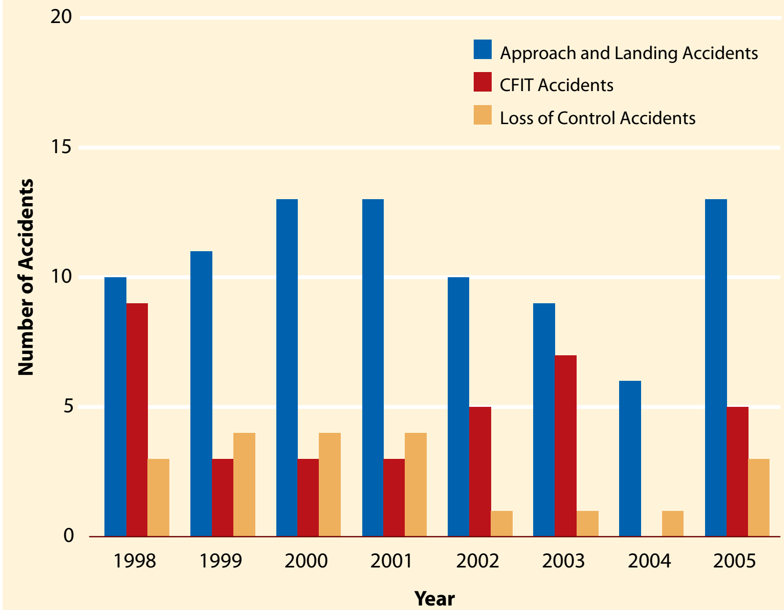
Going down in size, there were 15 hull loss accidents involving turbojet aircraft less than 60,000 pounds MTOW in commercial or corporate/business service (Table 2, page 20), well above the historic average of seven or eight per year for that class of aircraft. Of those 15 hull losses, eight were ALAs, one was a CFIT accident, and three were LOC accidents.

There were more than twice as many turboprop hull losses, 39 (Table 3, page 21), as there were commercial jet hull losses, 19. In this category are all Western-built and Eastern-built turboprop aircraft with more than 14 seats. Of the 39 turboprop hull losses, 19 were ALAs and nine were CFIT accidents.

Of the 13 commercial jet ALAs in the year, seven had zero fatalities. Also, eight of the 15 hull losses for turbojets less than 60,000 pounds MTOW were ALAs, as were 49 percent of the turboprop hull losses.

The hull loss ALAs' history for all aircraft clearly shows that the aviation industry must continue to focus on this high-risk area. Most, if not all, of the causes of these accidents are well documented and addressed in the Flight Safety Foundation *ALAR Tool Kit*.

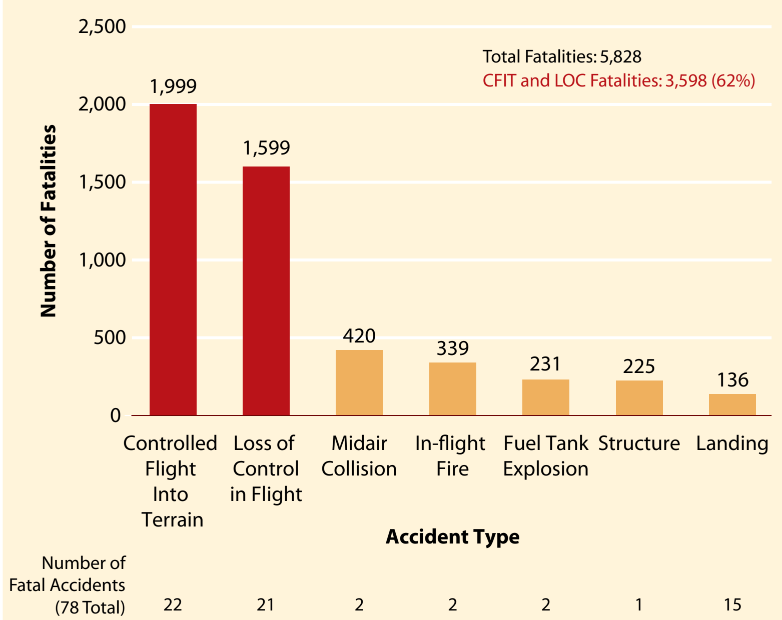
Hull-loss Accidents, Worldwide Commercial Jet Airplanes (> 60,000 lb), 1998–2005



Source: Boeing, Airclaims

Figure 1

Worldwide Airline Fatalities, By Accident Type, 1995–2004



Source: Boeing

Figure 2

Preliminary data on commercial jet LOC accidents in 2005 indicate that two of the three were caused by improper takeoff configuration. The history of LOC accidents over the past 13 years does not show a consistent pattern, although the number of LOC hull losses had decreased during the three years running up to 2005. The revised version of the *Airplane Upset Recovery Training Aid*, issued last year, hopefully will continue the pre-2005 trend.

CFIT Persists

The 2005 burst of CFIT accidents after their absence in 2004 has not significantly altered the slow but measurable decrease in the five-year rolling average in the number of CFIT accidents since 1998. However, the shallow slope of the five-year average trend lines is testimony to the fact that despite increased awareness, increased training and some exciting new technologies, CFIT remains a major challenge, especially when the nine commercial turboprop CFIT accidents in 2005 are added to the turbojet totals. It is significant and worth repeating that every one of those 15 CFIT accidents in 2005 — and indeed every CFIT accident in history — happened to aircraft not equipped with TAWS.

Last August was especially challenging, with five hull loss accidents in one month, more than a quarter of such accidents for the entire year. However, with the worldwide average at fewer than 0.8 hull losses per million departures, an accident has become almost a statistically random event, and five accidents in a month is no more unusual than zero accidents in three or four months — but they obviously get a lot more media coverage.

A great example of that randomness is this: The "worst" year for aviation safety was 1983, with a rate of 2.41 hull loss accidents per million departures; the "best" year was 1984, with a rate of 0.67. Thus, the best and worst happened in consecutive years and more than 20 years ago.

Still Safe

Yet, despite the spike in CFIT and LOC accidents last year, aviation remains

Hull-loss Accidents, Worldwide Commercial Jets (> 60,000 lb)
January 1, 2005–December 31, 2005

Date	Operator	Aircraft	Location	Phase	Fatal	
Jan. 8, 2005	AeroRepública	MD-80	Cali, Colombia	Landing	0	
Jan. 24, 2005	Atlas Air	747-200	Dusseldorf, Germany	Landing	0	
Feb. 3, 2005	Air West Cargo	Il-76	Khartoum, Sudan	Approach	7	
Feb. 3, 2005	Kam Air	737-200	Kabul, Afghanistan	Approach	104	C
March 19, 2005	Race Cargo Airline	707-300	Entebbe, Uganda	Approach	0	C
March 23, 2005	Airline Transport	Il-76	Mwanza, Tanzania	Takeoff	8	L
April 7, 2005	ICARO Air	F-28	Coca, Ecuador	Landing	0	
April 20, 2005	Saha Air	707-300	Tehran, Iran	Landing	3	
June 19, 2005	Mahfooz Aviation	707	Addis Ababa, Ethiopia	Landing	0	
July 1, 2005	Biman Bangladesh	DC-10	Chittagong, Bangladesh	Landing	0	
Aug. 2, 2005	Air France	A340	Toronto, Canada	Landing	0	
Aug. 14, 2005	Helios Airways	737-300	Grammatikos, Greece	Enroute	121	
Aug. 16, 2005	West Caribbean	MD-82	Machiques, Venezuela	Enroute	160	L
Aug. 23, 2005	TANS Peru Airlines	737-200	Pucallpa, Peru	Approach	45	C
Sept. 5, 2005	Mandala Airlines	737-200	Medan-Polonia, Indonesia	Takeoff	104	L
Oct. 22, 2005	Bellview Airlines	737-200	Lissa, Nigeria	Climb	117	
Oct. 31, 2005	MIBA Aviation	727	Kindu, DR Congo	Landing	0	
Nov. 11, 2005	Royal Airlines Cargo	Il-76	Khak-e Shahidan, Afghanistan	Approach	8	C
Dec. 10, 2005	Sosoliso Airlines	DC-9	Port Harcourt, Nigeria	Approach	109	C

C CFIT accident L Loss of control accident

Source: Boeing, Airclaims

Table 1

Every one of those 15 CFIT accidents in 2005 — and indeed every CFIT accident in history — happened to aircraft not equipped with TAWS.

Commercial aviation has never had a year with zero accidents, and there has never been (and never will be) a flight with zero risk.

Hull-loss Accidents, Worldwide Commercial/Corporate Jets (< 60,000 lbs)
January 1, 2005–December 31, 2005

Date	Operator	Aircraft	Location	Phase	Fatal	
Jan. 1, 2005	Jet Services	Citation II	Ainsworth, NE, USA	Approach	0	C
Jan. 28, 2005	Million Air	Learjet 35	Kansas City, MO, USA	Landing	0	
Feb. 2, 2005	Platinum Jet	Challenger 600	Teterboro, NJ, USA	Takeoff	0	
Feb. 21, 2005	Scott Aviation	HS 125	Bromont, Canada	Approach	0	
Feb. 16, 2005	Circuit City Stores	Citation V	Pueblo, CO, USA	Approach	8	
Feb. 24, 2005	Colima State Gov.	Westwind	Morelia, Mexico	Enroute	7	
March 8, 2005	Air Global	Citation I	Caracas, Venezeula	Approach	2	
May 9, 2005	Compas Acquisitions	Sabreliner	Brownwood, TX, USA	Takeoff	0	
May 15, 2005	Weibel Scientific	Citation I	Atlantic City, NJ, USA	Landing	0	
May 20, 2005	Jet 2000	Falcon 20	Moscow, Russia	Descent	0	
July 15, 2005	Aspen Aviation	Learjet 35	Vail, CO, USA	Landing	0	
Sept. 1, 2005	USA Jet	Falcon 20	Elyria, OH, USA	Takeoff	0	
Sept. 16, 2005	Viação Cometa	Citation 525	Rio de Janeiro, Brazil	Climb	2	
Nov. 5, 2005	Houston Cardiac Assoc.	Citation I	Houston, TX, USA	Takeoff	2	
Dec. 28, 2005	Skyward Aviation	Learjet 35	Truckee, CA, USA	Landing	2	

C CFIT accident

Source: Airclaims

Table 2

remarkably safe. In 1947, commercial aviation had about 600 fatalities while flying approximately 9 million passengers. Over the past three years, commercial aviation has averaged about 500 fatalities a year while flying approximately 2.4 billion passengers a year — fewer fatalities with almost 300 times more passengers.

Over the last four-plus decades since the introduction of the jet airliner, the hull loss accident rate has steadily declined. In fact, the rate has decreased by an average of 32 percent per decade, an impressive accomplishment for an already safe system.

The goal of Flight Safety Foundation is to make aviation safer by reducing the risk of an accident. But some ask what personal lessons can be learned from such data. With less than one hull loss accident per million departures in the world for commercial aviation, and with corporate and general aviation accident rates improving, the odds are against any particular aircraft operator having an accident in 2005, or in any year. However, it cannot be forgotten that every flight presents the opportunity for an accident. Commercial aviation has never had a year with zero accidents, and there has never been (and never will be) a flight with zero risk. So, there is still work to do and challenges to address to make the world's safest mass transportation system even safer.

Maintaining declining hull loss rates while the number of departures continues to climb (Figure 3, page 22) has been achieved for several reasons.

First, the aircraft are better. Each new generation of aircraft has been safer, and the accident rates show that. The hull loss accident rates of the newer aircraft have started low and stayed there. For example, until the recent Airbus A340 accident in Toronto, there had not been an accident involving the newest generation of aircraft — the Boeing 777 and 717, and the A340 and A330 — in over 14 years of commercial operation.

Training is another area of great progress. With the advent of programs like the advanced qualification program (AQP), line-oriented flight training (LOFT) and others, training has been a great asset in reducing risk. And technology has made simulators much more effective training devices.

Technology has also been helpful in other areas. For example, the traffic-alert and collision avoidance system (TCAS) continues to reduce the risk of midair collisions, and the midair collision safety record reflects its great success. Head-up displays (HUDs) are entering the world fleets, and operators using them are quite impressed with their capabilities and their risk reduction potential. Electronic flight bags (EFBs), like HUDs, are just

Hull-loss Accidents, Worldwide Commercial Turboprops (> 14 Seats)
January 1, 2005–December 31, 2005

Date	Operator	Aircraft	Location	Phase	Fatal	
Jan. 8, 2005	Service Air	Antonov 12	Uganda	Approach	6	
Jan. 13, 2005	AirNow	Embraer 110	USA	Landing	1	
Jan. 22, 2005	ANAF	Antonov 8	D.R. Congo	Approach	0	C
Jan. 27, 2005	Farnair Hungary	Let 410	Romania	Approach	2	C
Feb. 16, 2005	Trident Aviation	DHC-5 Buffalo	Sudan	Approach	0	C
Feb. 22, 2005	Missionary Aviation	DHC-6 Twin Otter	New Guinea	Approach	2	C
Feb. 22, 2005	TAM	Convair CV-580	Bolivia	Takeoff	0	
March 16, 2005	Regional Airlines	Antonov 24	Russia	Approach	28	C
March 26, 2005	W. Caribbean Airways	Let 410	Colombia	Climb	8	
March 28, 2005	Aerocaribbean	Ilyushin 18	Venezuela	Takeoff	0	
March 31, 2005	RPS Air Freight	Antonov 12	Yemen	Takeoff	0	
April 12, 2005	GT Air	DHC-6 Twin Otter	Indonesia	Enroute	17	C
May 1, 2005	Wideroe	DHC-8	Norway	Landing	0	
May 3, 2005	Airwork NZ	Metro	New Zealand	Enroute	2	
May 4, 2005	Kisangani Airlift	Antonov 26	D.R. Congo	Enroute	11	
May 7, 2005	Aero-Tropics	Metro	Australia	Approach	15	C
May 25, 2005	Victoria Air	Antonov 12	D.R. Congo	Enroute	26	
June 2, 2005	Marsland Aviation	Antonov 24	Sudan	Takeoff	7	
June 2, 2005	TAG	Let 410	Guatemala	Climb	0	
June 4, 2005	AerOhio	DHC-6 Twin Otter	USA	Landing	0	
June 8, 2005	Shuttle America	Saab 340	USA	Landing	0	
June 10, 2005	748 Air Services	HS 748	Kenya	Landing	0	
June 29, 2005	Mango Airlines	Antonov 26	Congo	Landing	0	
June 30, 2005	Gorkha Airlines	Dornier 228	Nepal	Approach	0	C
July 16, 2005	Equatair	Antonov 24	Guinea	Enroute	61	
July 27, 2005	Wilson International	Let 410	Sudan	Landing	0	
July 27, 2005	Business Aviation	Let 410	Sudan	Landing	0	
Aug. 6, 2005	Tuninter	ATR 72	Sicily	Enroute	16	
Sept. 5, 2005	Kavatahi Airlines	Antonov 26	D.R. Congo	Approach	11	C
Sept. 8, 2005	TMK Air	DHC-6 Twin Otter	D.R. Congo	Climb	0	
Sept. 9, 2005	Air Kasai	Antonov 26	Congo	Enroute	13	
Sept. 19, 2005	Dynamic Air	Metro	Netherlands	Takeoff	0	
Oct. 4, 2005	Wimbi Dira Airways	Antonov 12	D.R. Congo	Landing	2	
Oct. 30, 2005	Trade Air	Let 410	Bergamo, Italy	Takeoff	3	
Nov. 8, 2005	Air Now	Embraer 110	USA	Climb	0	
Dec. 9, 2005	Air Now	Embraer 110	USA	Enroute	0	
Dec. 16, 2005	NatureAir	DHC-6 Twin Otter	Costa Rica	Approach	0	
Dec. 19, 2005	Chalk's Ocean Airways	Grumman G-73T	USA	Climb	20	
Dec. 23, 2005	AZAL	Antonov 140	Baku, Azerbaijan	Climb	23	

C CFIT accidents

Source: Airclaims

Table 3

… Success in reducing the risk of an accident [grew out of] the safety community's decision to be guided by data.

coming into widespread use, but they bring significant improvements to information available in the cockpit. And the success of TAWS is well known and indisputable, one piece of equipment that may have saved more lives than any other single piece of aviation equipment.

Another source of success in reducing the risk of an accident is the safety community's decision to be guided by data. Data are used first to identify the high-risk areas and then to monitor the success of the safety interventions devised to manage that risk. Being data-driven also means that industry efforts are not dissipated in an attempt to equally address every potential safety issue but are focused on the high-risk areas in order to achieve the greatest reduction in risk for our efforts.

That does not mean that hazards such as bird strikes are not important, but it does mean their priority is lower than that of the proven killers: CFIT, ALAs and LOC.

New Data Sources

The effort to get the data needed to prioritize our efforts has moved beyond simply studying accidents; there are so few accidents, it is hard to get enough data from accidents alone. This need has brought about the use of new sources of data, proactive and preventative sources like incident data and data from programs like flight operational quality assurance (FOQA), aviation safety action programs (ASAP) and line operations safety audit (LOSA). This new use of data has shifted the emphasis of safety efforts from historic to diagnostic, and soon to predictive.

In addition, new programs are emerging that use shared data, making the data ever more powerful. Examples are the U.S. Federal Aviation Administration's voluntary aviation safety information-sharing program (VASIP) and the International Air Transport Association's safety trend evaluation analysis data exchange system (STEADES).

The only cautionary note about this strategy is that organizations should not get so overloaded with data that they spend most of their resources on gathering and organizing the data and not enough effort analyzing it.

Western-built Jet Air-transport Traffic and Hull-loss Rates, 1995–2005

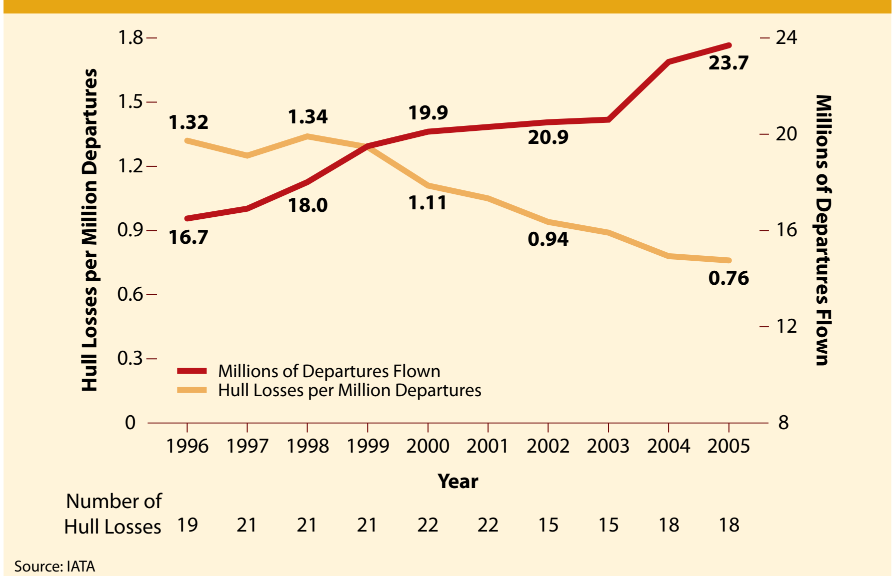


Figure 3

Today's focused safety efforts are more cooperative, both within regions and between government and industry. The U.S. Commercial Aviation Safety Team (CAST) is a great example of industry and government working together on a common safety agenda. The Pan American Aviation Safety Team (PAAST) is an example of a regional safety effort that has made impressive progress in reducing the risk of accidents in Latin America. The International Civil Aviation Organization (ICAO) cooperative development of operational safety and continuing airworthiness programs (COSCAP) are attempting to do the same thing in regions of the world that have never before benefited from this type of effort. ICAO has also become much more active in international safety issues such as English language proficiency, CFIT prevention and the recently passed change to Annex 13 that protects safety information from inappropriate use in judicial proceedings.

Public Expects Better

The public benefits every day from our success in reducing the accident rate. However, despite the impressive record and great success, they expect better. That was evident after the five tragic hull loss accidents in August prompted the public to question the safety of air travel.

In an industry where the risk will never be zero, we face a constant challenge in meeting the public's expectation of perfection as the minimum acceptable standard. However, the aviation industry continues to successfully address that challenge and is continually working to make aviation safer by reducing the risk of an accident. ●

— Jim Burin is director of technical programs for Flight Safety Foundation.

JAA–EASA Transition

BY ANDRE AUER

EASA and JAA are working hand in hand to establish a single, strong European authority in civil aviation matters with safety as the top priority.

What? A new aviation publication? One more on the already long list? Is this really needed? These are the questions which immediately popped up when I heard the first rumors of a new magazine. But when I heard that it was from Flight Safety Foundation, the question marks became immediately an exclamation mark, for many reasons:

- *It is efficient*. I started to be a little bit lost in the different publications, with different approaches, coming at different intervals from the Foundation. A publication combining and streamlining the numerous FSF journals is more than welcome!
- *It is needed*. It will help to increase the awareness of all the great things the Foundation has been doing for nearly 60 years and will be doing in the future for the safety of aviation.
- *It is in the spirit of the Foundation*. That means that it will be available to all interested parties.
- *It will be good*. At least, I hope so. But in the light of the great contributions of the Foundation in the past, I expect nothing else. I have seen with great pleasure that the Foundation has the sort of wisdom which Einstein applied: We cannot solve problems by using the same kind of thinking we used when we created them.

As it would be somewhat unfair to expect good things from others while not contributing to them myself, please find herewith an update on the integration of Joint Aviation Authorities (JAA) activities into the European Aviation Safety Agency (EASA), including our efforts to improve safety training in Europe:

Regulation 1592/2002 of the European Commission on common rules in the field of civil aviation and establishing EASA came into force in September 2002. EASA began operation one year later in the fields of certification and maintenance. JAA continued to be active in operations, licensing and formation, and in running the SAFA (Safety Assessment of Foreign Aircraft) Programme. In order to prepare a smooth transition of these JAA activities into EASA without any safety gap, a report containing a road map to be followed was elaborated and adopted during 2005 — the Future of JAA (FUJA) Working Group report. The actions emerging from that report can be summarized as follows, taking also into account that the European Commission published in November 2005 a legislative proposal to extend the activities of EASA in the fields of air operations, pilot licensing and third-country aircraft:

- EASA is expected to take over activities in the field of operations and licensing in the second half of 2008.
- EASA will be responsible for the SAFA activities as of Jan. 1, 2007.
- EASA is in the process of establishing an EASA Safety Strategy Initiative (ESSI), which will be, in some new way still to be defined, the continuation of the JAA Joint Safety Strategy Initiative (JSSI).

Central JAA (CJAA) will close its doors in Hoofddorp, Netherlands, but will continue, as of Jan. 1, 2007, as JAA-T (T for transition) with a liaison office in the EASA building in Cologne, Germany, and with a training office in Hoofddorp.

The JAA Liaison Office will ensure the relationship between EASA and the civil aviation authorities of the non-EASA JAA countries, and continue with the general management of the

Joint Aviation Requirements until EASA becomes fully active. Technical work will be undertaken by EASA based on a mandate from JAA.

The JAA Training Office will ensure that the aviation community is sufficiently familiar with the European aviation safety rules and will assist the non-EASA countries in their efforts to become EASA members. Since its beginning, CJAA has developed some 22 training courses ranging from JAA and EASA rules to more practical courses such as nominated post-holder training and auditing techniques training. To accommodate these increasing requirements, a new state-of-the-art training center is currently being prepared in Hoofddorp.

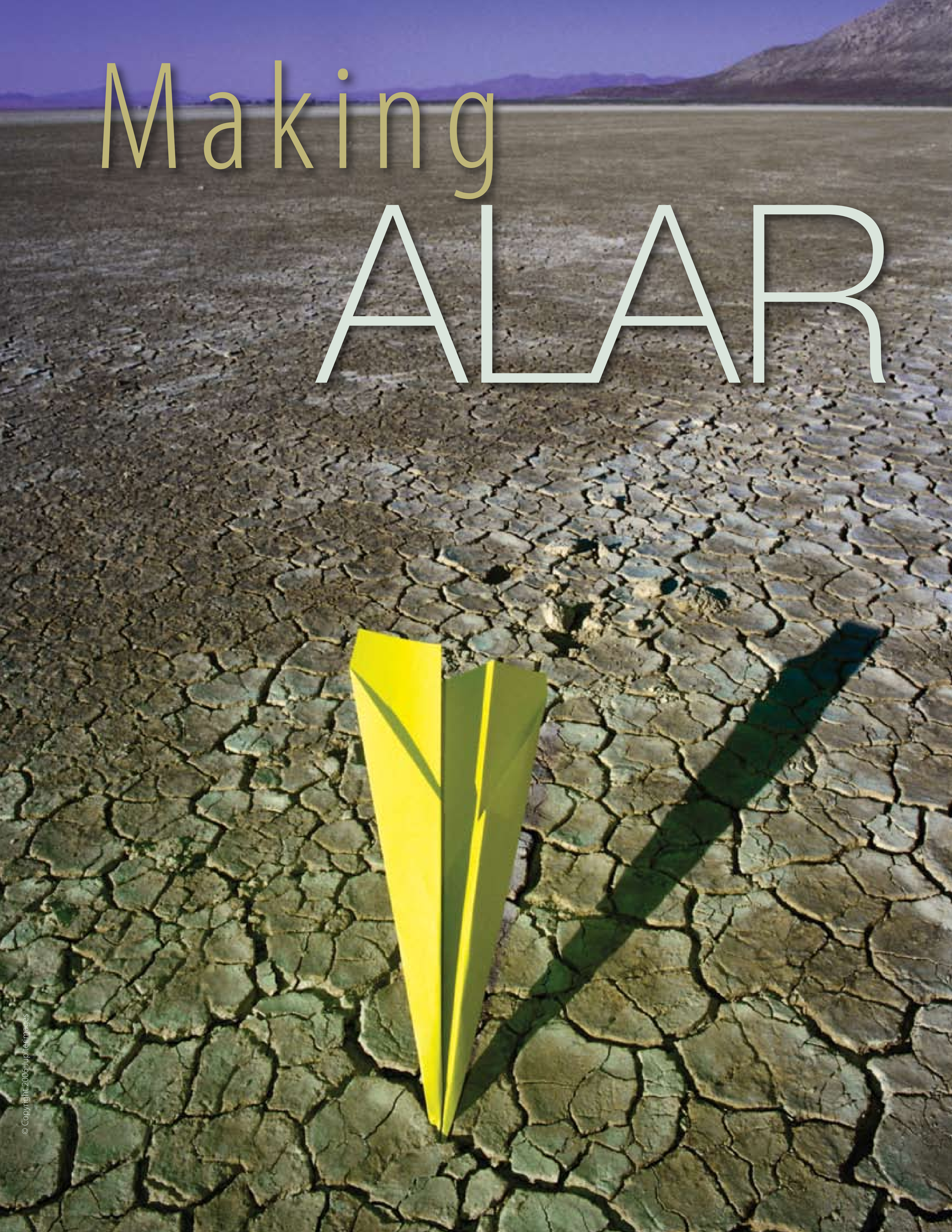
In addition, CJAA has brought together in a consortium called EASTO (European Aviation Safety Training Organisation) a number of internationally recognized organizations involved in aviation safety. EASTO aims to become one of Europe's leading aviation safety training centers. It is expected that the consortium will be expanded in the near future to include more European partners. The management, secretariat and training location of EASTO will be at the JAA Training Office.

In short, EASA and JAA are working hand in hand to establish a single, strong European authority in civil aviation matters with safety as the top priority.

All my congratulations and best wishes for many happy landings for the new publication! ●

Andre Auer, Chief Executive, Joint Aviation Authorities

Making ALAR



pervasive

Five years of workshops have propelled the FSF *Approach and Landing Accident Reduction Tool Kit* into many corners of the world. That's not enough.

BY WAYNE ROSENKRANS

As the projection screen darkened and chandeliers illuminated a hotel conference room in New Delhi, a workshop attendee expressed concern about the up-and-down history of certain types of accidents since the Flight Safety Foundation (FSF) *ALAR Tool Kit* was released in early 2001.[1] "[Can] we really say that the approach and landing accident reduction [ALAR] program has really worked in the reduction of the CFIT?" he asked presenters at the ALAR workshop.[2,3]

"We don't say it's really worked," replied Jim Burin, FSF director of technical programs. "That's why we're still doing workshops. So we in no way claim victory or say that we have done our job … we've reduced the controlled flight into terrain rate by 30 percent but it's not zero. We think that we have helped reduce the risk of approach and landing accidents but we sure haven't eliminated them."

Even though India has recorded six years of accident-free airline operations, the Foundation was invited to present a workshop updated for airlines that did not exist when Indian specialists conducted their first national ALAR seminar in 2002. This 22nd workshop marked the sixth year of the FSF global ALAR outreach through regional team leaders (see "Regional Team Leader Updates," page 37).

Worldwide from 2001–2005, 47 approach and landing accidents (ALAs) involving hull loss occurred among large commercial jets — those heavier than 60,000 lb/27,000 kg maximum takeoff weight. A total of 870 deaths occurred in 19 of these accidents. During the period, controlled flight into terrain (CFIT) accidents claimed 17 of these aircraft; 889 deaths occurred in 14 of these accidents. This persistence of ALAs remains a critical issue in aviation safety, Burin said.[4]

No final report of an ALA investigation in this period identified a causal factor that made the FSF CFIT/ALAR Action Group say, "We missed that one." "Yet, 13 of 19 hull-loss accidents during 2005 were ALAs, including five CFIT accidents in commercial jets and 12 in commercial turboprops," he said. "This contrasts sharply with 2004 when — for the first time in many years — there were no CFIT accidents among large commercial jets and fewer than 50 percent of the hull-loss accidents in these aircraft were ALAs." (See "Foundation Refines ALAR Strategies," page 29.)

Recent CFIT accidents have occurred exclusively among the 8 percent of the world's airline fleet that still operates without any ground-proximity warning technology. Terrain awareness and warning system (TAWS) equipment has reduced this risk for most airline operations, and helped to achieve the decline in the rate of CFIT accidents, said FSF President and CEO Stuart Matthews.

"The Foundation's position is that as one element of CFIT-prevention measures, no airline currently should be operating without TAWS," Matthews said. "To date, no large commercial jets equipped with TAWS have been involved in a CFIT accident."

India's ALAR Leadership

After the New Delhi workshop, several aviation safety professionals on the front lines of ALAR efforts in India told *Aviation Safety World* that they are applying current knowledge while actively seeking the latest safety analyses available from competitors, civil aviation authorities and international organizations (see "Highlights of the ALAR Workshop," page 30).

P.K. Chattopadhyay, joint director general, Directorate General of Civil Aviation (DGCA) of India, said, "India's biggest aviation-safety challenge at the moment is the tremendous growth rate of aviation — 23 percent in 2004 and 2005. Yet, airline operations in this country have become much easier — we are progressing very fast in the use of modern air traffic control [ATC] equipment at almost every airport. Our ATC radar coverage currently is well done, and flights are now operating with reduced vertical separation minimums across India and some RNP 5 en route flight path navigation standards."[5]

Achieving airline safety targets throughout South Asia requires selectively adopting key recommendations of the South Asian Regional Aviation Safety Team (SARAST), U.S. Commercial Aviation Safety Team (CAST) and ALAR task forces, he said. Elements of the FSF *ALAR Tool Kit,* for example, were adapted and supplemented by Indian specialists to produce DGCA's *ALAR India Tool Kit* in 2002.

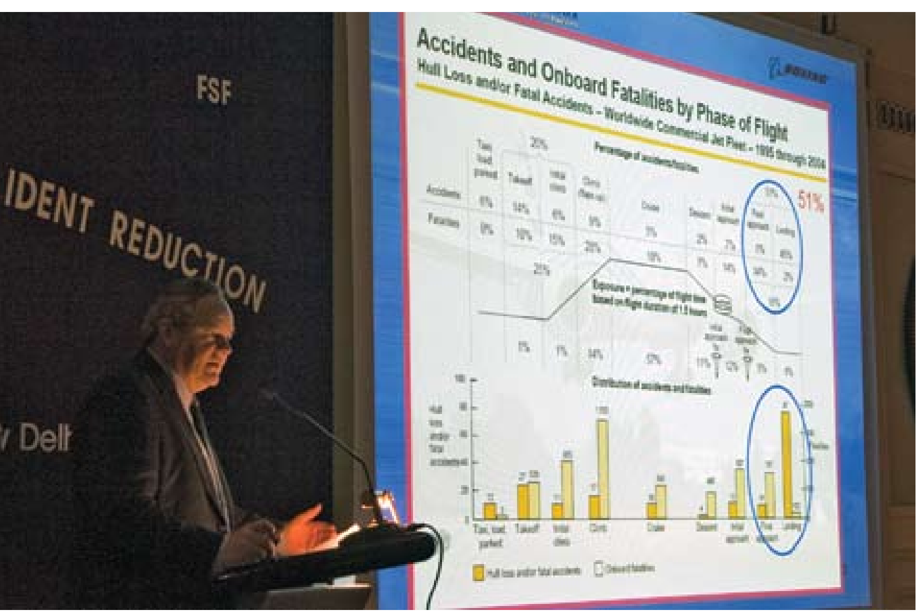
"India has not had an airline accident [since July 2000]," Chattopadhyay said. "DGCA has been taking a very predominant and proactive role in providing the *ALAR India Tool Kit.* We also have accepted 10 CAST safety enhancements as recommended in the SARAST meetings."

Emerging technologies should accelerate development of a more cost-effective and ALAR-oriented civil aviation infrastructure. "We are thinking very widely about communications, navigation, surveillance [CNS] and air traffic management [ATM] in India, including future use of India's GPS-aided geo-augmented navigation [GAGAN] system, which includes a satellite that will provide proper coverage of the entire Indian sky when it is in position and certified [in 2010]," Chattopadhyay said. "DGCA already has approved GPS as primary navigation for oceanic routes. We also want to make GPS the primary navigation system for land areas, including GPS approaches, but we have not completed this work yet."[6]

Preparation for the transition includes revising aeronautical charts that did not comply with World Geodetic System 1984 (WGS-84), the standard used for GPS navigation and terrain/obstacle data, he said.

Among completed infrastructure improvements, the Airports Authority of India in December 2005 equipped Runway 28 at New

Capt. Gary E. Hudson, senior safety pilot for The Boeing Co., addresses the New Delhi workshop.



Wayne Rosenkrans (FSF)

Foundation Refines ALAR Strategies

The Flight Safety Foundation (FSF) Board of Governors sees value in further data analysis of approach and landing accidents (ALAs) to ensure the most effective use of the FSF *ALAR Tool Kit* and ALAR workshops, said FSF President and CEO Stuart Matthews. "We will update the *ALAR Tool Kit* at the appropriate time, but my prediction is that we will not find reasons to change its safety recommendations in the near future," Matthews said. "If we were to see a consistent trend of ALAs dropping to fewer than 50 percent of hull-loss accidents, however, we then could tackle some more compelling issue based on risk."

Meanwhile, the board of governors wants to place the knowledge already available into the hands of many more airline pilots, Matthews said.

"The Foundation's key research question for 2006 is 'Are our ALAR strategies still valid?' — so we formally will look back at the past six or seven years of safety data," said FSF Executive Vice President Robert Vandel. "Ideally, we would like to know if data support the hypothesis that there has been a measurable result, a high probability of cause-and-effect relationship between ALAR strategies and the accident rate. We are open to updating the *ALAR Tool Kit* based on whatever we learn. We also want to keep our commitment to the FSF ALAR Task Force to maintain the integrity and relevance of their work."

Nevertheless, within overarching recommended practices for preventing ALAs, some priorities might shift in a future version of the *ALAR Tool Kit,* said Jim Burin, FSF director of technical programs. "Detailed analysis of the most recent ALAs and other recent research might show that something unrecognized has been occurring, such as a higher risk of runway overruns," Burin said.

Having disseminated more than 33,000 copies of the *ALAR Tool Kit* CD and conducted 22 workshops does not ensure that everyone takes full advantage of the work afterward, however.

"Some aviation safety professionals have just begun to get their arms around the breadth of the *ALAR Tool Kit* content," Vandel said. "The message still is not out broadly enough — the ALAR outreach has not really covered the globe. It competes for resources from civil aviation authorities and airlines in every country."

Building an FSF ALAR strategy on the concept of regional team leaders was a sound beginning, Burin said. The most critical strategy refinement in 2006 must be to effectively target the individuals responsible for implementing operating rules and procedures known to prevent ALAs, he added.

Wayne Rosenkrans (FSF)

Burin

Working with the International Air Transport Association and the Industry Safety Strategy Group, the Foundation recently helped to ensure that ALAR was factored into the Global Aviation Safety Roadmap, the government-industry strategy led by the International Civil Aviation Organization to raise airline operations worldwide to a common high level of safety, Burin said.

The Foundation's ALAR work has been supported generously by the aviation community, and before the end of 2006, the Foundation plans to organize a third workshop in the United States and a second workshop in Europe, Vandel said.

— WR

Delhi's Indira Gandhi International Airport with ILS Category IIIb capability.[7]

"New Delhi is where we get the maximum amount of fog, and that is where we have the most morning arrivals, including international flights," Chattopadhyay said. "We have ensured that our national airlines — Air India and Indian Airlines — have a large number of pilots trained for CAT IIIb."

Some private airlines accept delays at New Delhi when very low visibility occurs rather than incur the added expense of meeting stiffer training requirements. Pilots must have CAT IIIa qualification for a minimum of one year before seeking CAT IIIb qualification, he said.

"DGCA prefers that all operators — at least all those operating to New Delhi — train their pilots for CAT IIIb qualification and equip their aircraft accordingly," Chattopadhyay said.

In requiring Indian airlines to maintain flight operational quality assurance (FOQA)

Highlights of the FSF ALAR Workshop

Among take-away messages from Flight Safety Foundation's approach and landing accident reduction (ALAR) workshop in New Delhi were updates on ALAR-related safety enhancements in the United States developed by the Commercial Aviation Safety Team (CAST), said Kyle Olsen, acting manager of the Aircraft Certification Service, Transport Aircraft Directorate, U.S. Federal Aviation Administration. "In November 2005, 47 of 84 safety enhancements with a cost of about US$1 billion were on the prioritized list to be implemented," Olsen said. "The selected enhancements provide … a 73 percent overall projected risk reduction by 2007, and a slightly higher risk reduction by 2020. As of January 2006, 31 had been completed."

The seven states of the International Civil Aviation Organization (ICAO) Cooperative Development of Operational Safety and Continuing Airworthiness Program (COSCAP)–South Asia have agreed to implement 27 CAST safety enhancements. "CAST projects a 60 percent risk reduction after their 27 safety enhancements are implemented," he said.

Many actions taken by ICAO have positively influenced or soon will influence ALAR efforts, said Jim Burin, FSF director of technical programs. For example, TAWS is required after Jan. 1, 2007, for all aircraft with maximum certificated takeoff weight greater than 5,700 kg/12,500 lb or carrying nine or more passengers, although this requirement currently applies only to turbine-engine airplanes for which the individual certificate of airworthiness was issued on or after Jan. 1, 2004.

During 2006 and 2007, ICAO's ALAR-related work includes introduction of GPS approach procedures with vertical guidance (APV) from satellite-based augmentation systems (SBAS); quality assurance for approach-procedure design; improved design criteria for circling approaches; new standards for electronic terrain and obstacle data; revised basic criteria for the global navigation satellite system; and development of additional required navigation performance (RNP) approach criteria.

Bernard Vignault, flight operations safety enhancement engineer, Flight Operations Support and Line Assistance, Airbus, said, "Aircraft manufacturers have included the elements of a stabilized approach from the FSF *ALAR Tool Kit* in their materials and expect operators to incorporate them into their documentation. For vertical situational awareness, aircraft manufacturers are working so that, in the future, most transport aircraft will be equipped with vertical displays … first to show the terrain, but also the minimum safety altitudes and even the weather."

The president of the Mexican air traffic controllers association since 2002 has conducted ALAR workshops for both pilots and air traffic controllers, said Capt. Carlos Limón, deputy president of the International Federation of Air Line Pilots' Associations. "In Mexico City, we have 900 daily approaches — 70 per hour during high-density hours," Limón said. "The only way to accommodate this rate and fully utilize both runways is with visual approaches. As of 2006, however, all Mexican air traffic controllers can be assumed to be familiar with cockpit workload and ALAR practices."

— WR

Presenters Limón, Olsen and Capt. Fareed Ali Shah, ICAO COSCAP–South Asia, learn workshop details from P.K. Chattopadhyay, DGCA of India.

Wayne Rosenkrans (FSF)

programs, DGCA works towards having flight data from every scheduled flight analyzed.

"DGCA-approved inspectors review FOQA exceedances, and a DGCA officer goes to the airline, checks that exceedances were identified in the preceding month and asks what the airline has done to follow up," Chattopadhyay said. "We only want to verify that airlines keep records of what refresher training has been done and how it has gone. DGCA does not use FOQA data for the purpose of punitive action, but we do identify the crew for the purpose of confidential counseling or refresher training."

DGCA also has worked to reduce the risk of helicopter ALAs. "[Indian operators] had been having very frequent helicopter accidents — 18 in the three years prior to March 31, 2005," Chattopadhyay said. "A number were ALAs, and some were CFIT accidents. Others involved wire strikes, striking part of an offshore helideck, heavy lifting, offshore operations or mountain operations. The biggest risks occurred during political campaigns before elections when helicopters are operated within confined areas to crowded helipads. From this date [through late January 2006], there were no helicopter accidents."

DGCA initiatives included face-to-face discussions with operators, letters specifying safety issues to address, guidance to achieve precision in writing operations manuals and procedures, a new discrete pilot-to-pilot communications frequency and improved ground security around helipads.

Monsoon ALAs

Operation in Indian monsoon[8] conditions requires additional pilot qualifications and equipment-operating standards. A DGCA advisory circular and annual updates reiterate the training requirements and specify that before takeoff, every transport aircraft crew must ensure that certain equipment is serviceable, such as TAWS, thrust reversers, wiper motors, antiskid braking system, weather radar, anti-icing and deicing. "We want to ensure that a pilot who is flying in weather — especially in the monsoon months — not be overtaxed," Chattopadhyay said.

The clear link between monsoonal heavy-rain conditions and ALAs in India drives many ALAR-related activities, several airline safety professionals said.

"The risk is primarily visibility-related but also involves engine performance, wet runways and slippery conditions — managing those factors during landing is critical," said Harpreet A. de Singh, deputy general manager, Training (Operations), Air India. "In the heaviest rain, pilots

Wayne Rosenkrans (FSF)

De Singh teaches a refresher course in Mumbai to Air India instructors responsible for combined CRM, ALAR and security training.

cannot see a thing even with wipers at full speed. All of the risk factors discussed in ALAR materials can be present. Highlights of monsoon training are repeated as part of the annual refresher to reinforce knowledge about severe conditions even for captains operating the same type aircraft. DGCA requires that in many other career situations — such as a new captain or a captain changing aircraft type — pilots also repeat monsoon training."

SpiceJet uses FOQA data analysis to monitor the performance of crews and aircraft in monsoon conditions, said J.V. Naidu, the airline's manager of flight safety and security. Monsoon operations are expected to generate exceedances.

"Most of our exceedances involving high vertical acceleration occurred during the 2005 monsoon season," Naidu said. "They included high vertical accelerations during cruise and at touchdown, and prompted us to issue a safety circular, including analysis of an incident in which two passengers were injured. We usually don't select for review the type of airspeed exceedance in turbulence that occurs during monsoons, however."

In India during the monsoon, if airport visibility is decreasing, it probably will go to zero — but the pilot can expect zero visibility to last only for half an hour, Naidu said.

"For the ceiling to rise from ground level to 1,000 ft may take another 45 minutes, but the ceiling then will maintain that height," he said. "So, although we have had CAT IIIb capability at New Delhi, we hardly ever use it — maybe eight or nine times a year. Otherwise, low visibility may delay a flight for three hours. Maybe after three or four years of analyzing FOQA data, we will see the risks entirely differently, however."

ALAR India Origins

When DGCA and Indian airlines received a prerelease version of the FSF *ALAR Tool Kit* in September 2000, safety professionals nationwide were asked to critically review the contents, said de Singh.

Capt. Dilip Kharkar, chief flight operations inspector for DGCA (now retired), set up the ALAR Task Force–India and chaired a project involving all the major airlines of India at the time. A core team of coordinators for the task force comprised Capt. A. Ranganathan of Air Sahara (currently with Spicejet), V.K. Ginotra of Alliance Air and de Singh.[9]

DGCA found that about 60 percent of accidents in Indian civil aviation in 1986–1998 were ALAs; 50 percent of the ALAs were CFIT accidents, accounting for about 80 percent of fatalities; 60 percent of the ALAs were caused by flight crew errors; 90 percent of ALAs and CFIT accidents occurred in adverse weather

Extensive photography and video recordings, directed by Capt. A. Ranganathan of SpiceJet, show monsoon conditions in India's *Adverse Weather Operations Training Kit.*

D. Satyajit

conditions; and 60 percent occurred in hilly terrain. Most ALAs were caused by noncompliance with standard operating procedures and adverse weather conditions. The ALAR Task Force–India also scored Indian airline ALA causal factors as aircraft, 11 percent; maintenance, 8 percent; weather, 7 percent; ATC/airport, 9 percent; and flight crew, 62 percent.

Members of ALAR Task Force–India in April 2002 compared their experience with findings and recommendations of the FSF ALAR Task Force. With support from the Aeronautical Society of India, de Singh conducted the train-the-trainer ALAR seminar in New Delhi for all Indian airlines.

Some Indian instructors experienced difficulty, however, when they initially tried to cover the Foundation's entire CD in classes and materials, according to Ranganathan. Several pilots of international airlines also found the large amount of text a barrier to self-study, he said.

"Instructors soon focused on using the 'ALAR Briefing Notes' element, and I decided to illustrate key points as much as possible with photos and videos to improve understanding," Ranganathan said.

The 34 documents in the briefing notes are based on the conclusions of the FSF ALAR Task Force, data from CAST and the European Joint Aviation Authorities Safety Strategy Initiative. Each briefing note includes statistical data related to the topic, recommended standard operating procedures, discussion of factors that contribute to excessive deviations and suggested accident-prevention strategies.

"Before the 'ALAR Briefing Notes,' pilot communication about this subject was more like a grapevine, with individuals relying on their own conclusions," de Singh said. "Official recognition of the safety issues and FSF recommendations have been very important for pilots."

While the ALAR Task Force–India produced the *ALAR India Tool Kit,* Ranganathan was assigned by DGCA to produce a companion product called *Adverse Weather Operations Training Kit.* "Our task force found that more than 45 percent of all aviation accidents in India took place in the monsoon seasons, so I agreed to pass on my experiences of flying in the monsoons since 1973," Ranganathan said. "*Adverse Weather* uses a lot of material from the 'ALAR Briefing Notes.' I also use several videos [of operations in India] to highlight landing errors and especially to get across to young pilots the importance of ALAR."

D. Satyajit

With these products in hand, some former task force members currently work at the interpersonal level to disseminate ALAR information more widely in India, de Singh said.

A related task is to obtain updated Indian accident data and incident data from DGCA to analyze variations in causal factors or emerging ALA trends in India, de Singh said.

"We can begin a new analysis as soon as we receive the DGCA reports," de Singh said. "Especially given our air transport expansion plans, India could be a case study of threat-and-risk management required during rapid growth."

ALAR Influences

Methods used to implement ALAR tactics in operations at Air India, SpiceJet and Jet Airways varied. "At Air India, ALAR training is coupled with crew resource management [CRM] training and security training," de Singh said. "We have produced video recordings of Air India simulator scenarios based on feedback and examples from some of the captains in our CRM class. The scenarios were not India-specific but had happened within Air India."

Safety professionals have to be especially vigilant about possible negative trends coming from

"Before the 'ALAR Briefing Notes,' pilot communication about this subject was more like a grapevine, with individuals relying on their own conclusions."

the pace of airline expansion. "Our ALAR emphasis of recent years has been absolutely essential in staying on the right track during this rapid growth, for example," de Singh said. "Out of concern about pilots' adequate integration of procedures and familiarization, we have not been in a rush. We are in a phase where we must watch airline developments with a lot of caution for the next three or four years. The new airlines and legacy airlines alike have to train their crews so deeply that they can respond instinctively to any situation."

Some Indian specialists expect the infrastructure issue of replacing nonprecision approaches to be resolved in the broader context of worldwide transition to CNS ATM, including GPS approaches and required navigation performance area navigation (RNP RNAV) approaches, according to de Singh.

"Some Indian nonprecision approaches could be supplemented by ILS installations in the future," she said. "A more modern infrastructure for instrument approaches throughout India definitely would enhance safety. With airline routes expanding very fast, we are now flying from airports like Amritsar and many airports close to New Delhi — all of them affected by fog."

Air India also has been developing proprietary constant-angle nonprecision approaches — also known as constant-descent final approach for nonprecision approaches — as an intermediate risk-reduction step. "Our proposed approach charts — with all the distance-to-height ratios and the visual descent points marked — are ready," de Singh said.

Despite all they have accomplished, de Singh and Ranganathan said that they have observed many opportunities to improve ALAR efforts in India. From de Singh's perspective, ALAR outreach has yet to engage enough of the mid-level airline professionals and government officials. Moreover, Indian airlines' lack of a recognized forum for discussing ALAR seems to constrain information exchange, several specialists agreed.

ALAR-related FOQA data analysis within Air India has prompted reconsideration of requirements for downwind landings, said Capt. M.B. Morris, joint general manager, Air Safety; Arvind D. Waghmare, deputy chief engineer, Air Safety; and S.N. Gupta, general manager, Air Safety (Engineering).

"At specific airports during certain times of the year, our pilots land with a tail wind component of less than 10 kts," Morris said. "But a runway-overrun incident at Mumbai involving one of our aircraft during the 2005 monsoon season prompted us to ask 'How does this practice affect the approach and landing phase?' There can be a tendency to land deep — beyond the touchdown zone — and to float longer, so we made a software modification to report an exceedance if the pilot flares and floats for more than 11 seconds, because this means wasting a lot of available runway. Since mid-2005, we have analyzed the approach segment below 1,000 ft and the landing of every flight to see if there was a strong tail wind component or floating for more than 11 seconds. This is the type of targeted ALAR tactic we can use in addition to complying with the minimum DGCA requirements. Because our pilots land at such a variety of airfields — many of very limited length — a

Wayne Rosenkrans (FSF)

Waghmare watches Capt. Y.C. Mathur, a consultant, analyze FOQA data at Air India's Air Safety Department in Mumbai.

Iqbal K. Mohammed

float of more than 11 seconds could mean either they will experience blown tires while trying to stop the aircraft or have a runway overrun. We pass these exceedances to Training for whatever action they see fit."

Comparison of FOQA data to ATC instructions also has identified issues that affect ALAR, especially with increasing airspace congestion.

"We know that Indian ATC has had to increase the arrival rates and departure rates within norms that DGCA has laid down, but when controllers instruct a flight crew to descend below 10,000 ft with no speed restriction, what [is the flight crew] to understand?" Morris said. "Can the aircraft safely operate in the terminal area at 300 kts or 320 kts? We addressed this by training pilots to reduce speed — even when ATC says no speed restriction below 10,000 ft — to 250 kts before entering the terminal area, to 230 kts within 20 nm, 210 kts within 15 nm, 180 kts to intercept the final approach course, then 160 kts down to the four-mile final. Otherwise, crews would be in congested airspace with a much greater turning radius. They gradually reduce speed by this procedure, consistent with being absolutely stabilized at 1,000 ft, one of the elements of the stabilized approach. All FOQA data should show this pattern of speed control."

Air India's FOQA program is nonpunitive, and safety specialists currently are evaluating software to enhance pilot counseling with exceedance visualization, Waghmare said.

"Knowing the cultures and background of our crews, we also would be able to replay a serious incident in CRM courses and to refine CRM concepts — all with the crew de-identified," Waghmare said.

SpiceJet, which began domestic service in May 2005 using a low-fare business model, applies ALAR principles in computer-based instruction; classes taught by the vice president of operations, chief pilot and general manager of training; and seminars and examinations for route familiarization and adverse-weather operations.

The company exceeds DGCA minimum requirements in capturing up to 1,400 flight parameters and generating tabular and graphical printouts, said Anirudh Choudhary, safety assurance analyst for SpiceJet.

"We monitor all parameters but currently give more emphasis to exceedances that involve factors that could lead to an incident or accident if not controlled," Choudhary said. "For example, an airspeed exceeding a structural-limit speed such as maximum operating velocity or maximum operating Mach, or exceeding a flap/slat extension speed or a late extension of landing flaps — those are given more importance. We also keep a record of all TAWS warnings."

Managers of the FOQA program must take into account the current traffic environment in congested Indian airspace. "Normally, a crew will not exceed 250 kts below 10,000 ft," Choudhary said. "But at New Delhi, where the aircraft may be number 17 in the landing sequence, the ATC instruction may be, 'Either you hold or you exceed 250.' If data show that the pilot exceeded 300 kts, that is a problem. But 270 or 280 kts in this situation is OK."

"A float of more than 11 seconds could mean either they will experience blown tires while trying to stop the aircraft or have a runway overrun."

"We developed our own analysis of potential causes for ALAs and exceedances … [and] developed a seven-page ALAR guideline document."

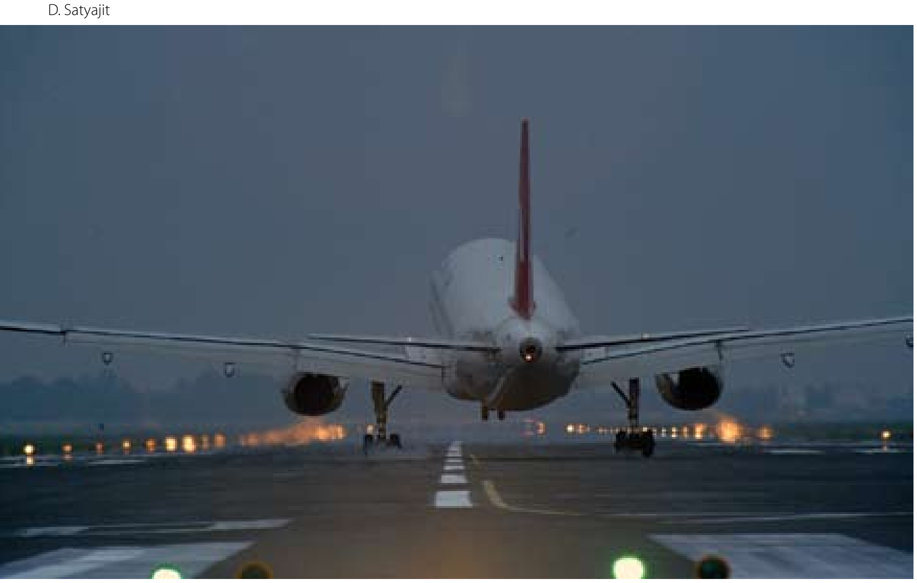
The most common exceedance was high taxi speed; these exceedances decreased month by month after pilot counseling and awareness programs were conducted. Exceedances typically are not intentional, Naidu said. In addition to complying with DGCA requirements for its FOQA program, the airline conducts performance monitoring using operational data from the airframe and engines. "Centralized reports cover any exceedance selected to be reported to Engineering and Operations — such as a flap-extension speed exceeded by 10 kts or more," Naidu said.

Other ALAR-related FOQA data showed short flares — three seconds or less. Standard operating procedures specify that the flare should be held longer than four seconds. "In one short-flare exceedance, the aircraft dropped 30 ft in three seconds," Naidu said. "FOQA data also showed a few long flares — under DGCA criteria, floating more than 10 seconds — in which the crew used excessive length of the runway."

SpiceJet had 28 captains by January 2006, most of them arriving at SpiceJet during the previous three months, said Capt. R.P. Barnwal, manager of safety assurance for the airline.

"We developed our own analysis of potential causes for ALAs and exceedances," Barnwal said. "We also developed a seven-page ALAR guideline document. Except for FOQA, captains would not know about many of these issues."

D. Satyajit



In detecting late flap extension for landing, for example, the company's exceedance limit is that the airplane should be fully configured for landing at 600 ft, Choudhary said. "For trend-monitoring purposes, we have kept that limit at 1,000 ft," he said.

During the approach phase, the analysts use the following for exceedance levels:

- Below 500 ft, approach speed greater than V_{REF} plus 25 kts;
- At 200 ft, airspeed greater than V_{REF} plus 20 kts;
- At touchdown, airspeed greater than V_{REF} plus 15 kts;
- During any segment of the approach and landing, airspeed less than V_{REF}.

Data monitoring focuses on maximum rate of descent during approach; average percent engine rpm during approach; maximum localizer deviation; and maximum glideslope deviation; pitch attitude during the last 1,000 ft and at touchdown; acceleration, rate of descent and airspeed at touchdown; and maximum pitch and roll at touchdown.

"Without software tools, analysts could not detect approach speed high or low in the data," Naidu said. "In all approach-airspeed exceedances through January 2006, the issue was airspeed low — less than V_{REF}. Among all exceedances during approach, the most common issues were high vertical acceleration or approach speed low or, at the time of flap selection, the airspeed was high."

Capt. Ranbir Singh, general manager of FOQA for Jet Airways, said that the main source of ALAR-related training enhancements within the airline has been pilot input and information and recommendations from accident and incident investigations.

"The best examples might be our stress on adherence to SOPs, which are reviewed periodically, and emphasizing the use of automation for the approach," Singh said.

FOQA analysis with voluntary pilot reports, line operations safety audits and similar tools

Regional Team Leader Updates

Previous Flight Safety Foundation (FSF) articles and news releases highlighted the work of CFIT/ALAR Action Group regional team leaders in 2001–2003. Regional team leaders periodically provide updates.

At the New Delhi ALAR workshop, Capt. Fareed Ali Shah, regional flight operations expert and program coordinator for the International Civil Aviation Organization (ICAO) Cooperative Development of Operational Safety and Continuing Airworthiness (COSCAP)–South Asia, said, "Seven CFIT ALAs in 2004–2005 in this region continue to be a cause of concern." Based in Colombo, Sri Lanka, COSCAP–South Asia comprises Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka. Since June 2002, their South Asian Regional Aviation Safety Team has promoted CFIT prevention and ALAR practices, including regulatory aspects. "CFIT/ALA issues have been discussed at the last couple of [team] meetings," Shah said. "In 2005, adoption of 10 U.S. Commercial Aviation Safety Team safety enhancements related to ALAR was discussed at length by the state directorates general of civil aviation."

The ALAR experience of airlines, regulators and air traffic service providers in Mexico, Central America, South America and Caribbean countries makes a useful case study for any regional team, said Capt. Carlos Limón, deputy president of the International Federation of Air Line Pilots' Associations. "Crews are the last resort against ALAs," Limón said. As of 2006, Pan American Aviation Safety Team (PAAST) members had briefed about 13,000 pilots from 35 airlines — about 76 percent of pilots in Mexico, Central America, South America and the Caribbean; facilitated ALAR training of instructor pilots; and briefed air traffic controllers. Most of the region's major airlines have incorporated ALAR into the initial and recurrent training of pilots.

"Our Mexican success showed that these kinds of safety initiatives can be implemented nationally with a relatively low cost when all the sectors of the industry coordinate work with a single goal," he said. "Many Mexican air force pilots and air traffic controllers voluntarily attended ALAR seminars, and some then became volunteer ALAR instructors. Our success among Mexican commercial airlines has been measurable as a reduction in national rates of ALAs, and since ALAR implementation began in 2001, Mexico has not experienced a CFIT accident in an airline jet."

PAAST members met in March 2006 to discuss methods of continuing ALAR initiatives in addition to their work on runway incursions, according to Raymond Ybarra, ICAO regional director in Lima, Peru. Members also are pursuing low-cost options for producing FSF *ALAR Tool Kit* CDs for ongoing efforts.

As of early 2006, more than 700 *ALAR Tool Kit* CDs had been distributed during workshops and missions to states in ICAO's North American, Central American and Caribbean Region (NACC), and upon request by regional flight schools and other aviation organizations, said Capt. Jan Jurek, NACC's Mexico City-based regional officer–operations. The fifth ALAR/CFIT workshop presented by PAAST was held in May 2006 in Curacao, Netherlands Antilles, where a team of regional presenters was augmented by specialists from Airbus, Boeing and FAA. Jurek said that the region's CFIT/ALAR efforts struggle with an insufficient supply of CDs and FSF *CFIT Checklists* to meet demand, difficulty recruiting presenters for workshops in remote locations, and problems coordinating ICAO specialists.

Wayne Rosenkrans (FSF)

Demuren

FSF–West Africa helped to obtain a Nigerian regulation requiring completion of an ALAR course as a condition for initial issuance and renewal of a pilot license, according to Dr. Harold O. Demuren, the organization's president and director general–CEO of civil aviation of the Nigerian Civil Aviation Authority. Computer systems for training and record keeping were being implemented by the agency in early 2006 to support this requirement, and the change was being coordinated with airline training departments, he said. FSF–West Africa recently has worked with ICAO's COSCAP–Banjul Accord Group (English-speaking West African nations), based in Abuja, on regional safety-oversight efforts compatible with ALAR recommendations.

Since FSF–Iceland and the Foundation conducted a 2002 ALAR workshop, awareness of stabilized-approach criteria has improved within

Icelandair, according to Oddgeir Arnarson, the airline's safety officer. "In May 2004, ALAR material was prepared and released as an FSF–Iceland venture," Arnarson said. "The following autumn, Icelandair used this material for its flight crews during ground school recurrent training." The material includes a Microsoft PowerPoint presentation that contains, among other elements, nonprecision approach charts for Icelandic airports that demonstrate the complexity of step-down operations vs. constant-angle descents, plus methods of conducting stabilized approaches with adequate anticipation of a go-around on every approach.

South African Airways continues to apply *ALAR Tool Kit* elements introduced when it hosted a 2001 ALAR workshop, according to Capt. Cobus Toerian, flight safety specialist for the airline. Elements were incorporated into all fleet operations training, safety presentations for new pilots, simulator sessions, conversion courses and command courses.

"We still use the *CFIT Checklist* whenever we audit/review Africa and Indian Ocean destinations, and it has been a nice tool both for standardization and to show airfield authorities how the *ALAR Tool Kit* identifies what is deficient — that deficiencies are not our opinion alone — and they listen," Toerian said. "A 'go-around culture' has been well manifested, and crews even are reporting the various events for statistical benefit. All fleet safety pilots, fleet captains and CRM facilitators have the *ALAR Tool Kit,* and we use the data to brush up and refresh these pilots wherever and whenever we can."

During 2004, COSCAP–North Asia conducted ALAR seminars in North Korea and Mongolia and issued an advisory bulletin on CFIT/ALAR crew training to assist states developing legislation, regulations and/or standards, said Capt. Len Cormier, ICAO's chief technical advisor for COSCAP–North Asia. The program also arranged the 2005 FSF ALAR workshop in South Korea.

As of 2006, the program's North Asian Regional Aviation Safety Team focused on adopting ALAR-related CAST safety enhancements, including regulations and training for the terrain awareness and warning system, standard operating procedures, precision-like approach implementation, flight operational quality assurance and voluntary reporting programs, crew resource management, ALAR and CFIT-prevention training, safety culture, safety management systems, minimum safe altitude warnings, and ATC CFIT prevention-training.

— WR

contribute to ALAR efforts, he added. "FOQA program staff manage voluntary reports from pilots," Singh said. "We receive a good amount of information from pilots calling on mobile phones from the cockpit when the aircraft is on the ground — often immediately after a near incident or an actual incident. Air Safety and FOQA staff analyze trends with the help of 100 percent monitoring of digital flight data recorders and random monitoring of cockpit voice recorders, with an assurance to pilots that the purpose is only to monitor trends and not for punitive action. Greater cooperation is needed among airlines in India, to share each other's experiences and learn from each other's mistakes. A semiannual meeting for this purpose would help. Jet Airways pilots and air traffic controllers also meet periodically for lunch or dinner and have free and frank discussions for better understanding of each other's problems."

Practices absorbed into Jet Airways' safety culture have included effectively using TAWS, educating pilots on CFIT and reducing the number of approaches with a high rate of descent, Singh said.

Relatively new airlines have the opportunity to incorporate ALAR knowledge from day one and often have ALAR-related advantages inherent in their equipment. But they cannot afford to be complacent, Singh said.

"Jet Airways, for example, has the latest equipment compared with the older airlines, and that is a great ALAR-related advantage," Singh said. "The disadvantage is that some pilots do not expect failures. When they do have failures or malfunctions, their reactions are slower or they overreact. Some pilots react only to failures and do not bother to monitor for any degradation in the systems. Older Indian airline pilots always expect some system failures, so they continuously monitor any trend or degradation in the systems."

Comprehensive, well-executed ALAR projects have been crafted by aviation safety professionals worldwide, Matthews said. By careful design, the Foundation has functioned only as a facilitator and catalyst, sharing consensus-based, data-driven solutions that others can adopt using their local expertise. ●

Notes

1. The Flight Safety Foundation (FSF) *ALAR Tool Kit* provides on compact disc (CD) a unique set of pilot briefing notes, videos, presentations, risk-awareness checklists and other tools designed to help prevent approach and landing accidents (ALAs) and controlled flight into terrain (CFIT). The tool kit is the culmination of the nine-year Foundation-led efforts of more than 300 safety specialists worldwide to identify the causes of ALAs and CFIT, and to develop practical recommendations for the prevention of these accidents.

2. The FSF approach and landing accident reduction (ALAR) workshop in New Delhi on Jan. 27, 2006, was attended by 111 aviation safety professionals from 11 airlines, five government and military agencies, two helicopter operators and three other organizations. The workshop was hosted by the Directorate General of Civil Aviation of India and the International Civil Aviation Organization (ICAO) Cooperative Development of Operational Safety and Continuing Airworthiness Program (COSCAP)–South Asia. Meeting facilities were sponsored by Air Sahara and Kingfisher Airlines. Volunteer presenters at New Delhi were Jim Burin, FSF director of technical programs; Capt. Gary E. Hudson, senior safety pilot, commercial airplanes, The Boeing Co.; Capt. Carlos Limón, deputy president of the International Federation of Air Line Pilots' Associations (IFALPA); Capt. John Long (retired), air safety representative for the Air Line Pilots Association, International; Kyle Olsen, acting manager of the Aircraft Certification Service, Transport Aircraft Directorate, U.S. Federal Aviation Administration; and Bernard Vignault, flight operations safety enhancement engineer, Flight Operations Support and Line Assistance, Airbus.

3. In 2003–2005, the following presenters also helped the FSF CFIT/ALAR Action Group to conduct ALAR workshops: Michel Béland, technical officer, Operations/Airworthiness Section, ICAO; Capt. David C. Carbaugh, chief pilot, Flight Operations Safety, Boeing Commercial Airplanes; Jim Daily; Capt. Andrés Fabre, director of flight operations, MasAir; Capt. Al Garin, Airbus A330 captain for US Airways; Capt. Angel Goñi, a representative of Aviation Pilots Union Association (ASPA) of Mexico and IFALPA; Dick McKinney, a captain retired from American Airlines; Capt. Tom Phillips of ALPA; and Michel Trémaud, senior director of customer services and head of safety management, Airbus.

4. Data for 2001 and 2002 included only Western-built large commercial jets; data for 2003–2005 included Western-built and Eastern-built large commercial jets.

5. Required navigation performance (RNP) in which a certified aircraft is capable of tracking within 5.0 nm (9.3 km) either side of the flight-path centerline.

6. The GPS-aided geo-augmented navigation (GAGAN) system will provide augmented information to aircraft flying within Indian flight information regions, according to India's March 2006 presentation to an ICAO advisory group. Space-based augmentation of GPS signals — using an Indian geostationary satellite, ground reference stations, uplink stations and a mission control center — initially will make GPS-based Category I precision approaches (decision height 200 ft and runway visual range limitation of 2,400 ft/800 m or 1,800 ft/550 m with touchdown zone and centerline lighting) widely available to Indian airports without requiring separate ILS ground infrastructure and systems. The Indian Space Research Organization's GSAT-4 satellite is scheduled to be launched in December 2006.

7. Decision height 100 ft above ground level and runway visual range limitation of 1,200 ft (350 m).

8. Directorate General of Civil Aviation, India. *Adverse Weather Operations Training Kit.* October 2002. The kit said that the Indian monsoon season basically involves a periodic reversal of winds generated by complex thermal conditions and land-sea interaction in the presence of mountain systems. Typical wind circulation causes extreme amounts of rain. Significant aviation hazards during monsoon months, but not limited to these months, include deteriorating surface visibility due to heavy showers, low cloud ceilings and strong surface winds over peninsular India. The Indian monsoon conditions typically occur over Kerala in the first week of June each year and within a few weeks dominate the Indian subcontinent until the end of September.

9. Other task force members in 2001–2002 included Capt. R.J. Darukhanawala of DGCA; Capt. Russi D. Bunsha and Capt. Mark Morris of Air India; Capt. V.K. Verma and Capt. Ashok Raj of Indian Airlines; Capt. S.S. Virk, Capt. N.S. Sra and Capt. S. Tomar of Jet Airways; Capt. F. Chhoi of Air Sahara; Capt. Javed Ahmad of Alliance Air; and Capt. J.P. Singh of Blue Dart Air. Capt. Len J. Cormier of COSCAP–South Asia was a facilitator of ALAR implementation.

Tim de Groot, AirTeam Images

Learning From Experience

Night VMC

First 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

Throughout the history of aviation, controlled flight into terrain (CFIT) has been a major cause of fatal accidents. In response to this hazard, the industry developed and implemented the ground-proximity warning system (GPWS) and the more capable and reliable terrain awareness and warning system (TAWS).[1] To date, no aircraft equipped with TAWS has been involved in a CFIT accident.

Nevertheless, there have been some close calls. The industry has recorded an increasing number of "saves" in which TAWS provided flight crews with timely warnings of threatening situations. Some events were sufficiently serious that investigations by national authorities were required; official reports on at least two of these events have been published.[2] Other TAWS saves have been investigated by the aircraft operators and manufacturers to gain an understanding of how the flights were exposed to terrain or obstacle hazards and to identify the circumstances that prevented the crews from detecting the threats before TAWS provided timely warnings.

This report is the first in a series that will discuss six TAWS saves after premature final descent for landing. TAWS data provided information on each aircraft's location, altitude and airspeed; approach charts were used to determine the expected flight path of each aircraft in normal operations. The author's analyses of the incidents were reviewed by a select group of aviation safety professionals and a few airline pilots. Many factors identified as likely to have been involved in these incidents correlated with the well-documented factors identified in studies of CFIT accidents by the Approach-and-landing Accident Reduction Task Force.[3]

The incidents involved different operators and regions of the world, but there were several interesting similarities. Each incident involved a modern aircraft equipped with a flight management system (FMS) and an electronic flight instrument system (EFIS). All but one incident involved a large commercial aircraft. All occurred during nonprecision approaches.

Night Visual Approach

Incident no. 1 involved a widebody aircraft capable of FMS vertical navigation (VNAV) that was being flown on a visual approach in nighttime visual meteorological conditions to a major airport in a geographically remote area.

The crew likely had a charted VOR/DME (VHF omnidirectional radio/distance measuring equipment) approach procedure for reference. Figure 1 shows the vertical profile of the approach procedure and the flight path of the aircraft. The final approach fix (FAF) is 5.0 nm (9.3 km) from the VOR/DME location and 5.4 nm (10.0 km) from the runway threshold.

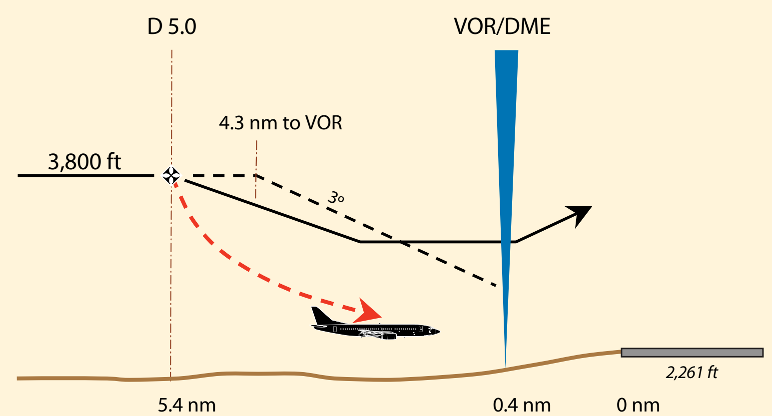
After crossing the FAF, the aircraft was flown below the expected flight path. A TAWS "TERRAIN, PULL UP" warning was generated when the aircraft was 250 ft above ground level — 124 ft above airport level — and at 1.5 nm DME. The crew recovered from the 300 feet-per-minute descent and conducted an uneventful landing.

The following features of the approach procedure were considered as having contributed to the incident:

- The three-degree glide path begins at 4.3 DME, *not* at the FAF. If a crew misinterprets this point, a descent begun at the FAF could result in a low flight path.
- Similar problems might occur if the crew entered the DME information into the FMS for a VNAV approach without cross-checking the threshold crossing altitude.
- The approach chart does not have an altitude/range table to aid the crew in monitoring the descent. The crew might not have prepared their own table or programmed a correct VNAV approach profile. Thus, they might have had to rely on mental calculations of altitude/range to monitor the approach.
- The VOR/DME station is not colocated with the runway threshold. Thus, a descent below the three-degree glide path might be conducted if the crew were to use DME for altitude/range checks, believing zero to be at the threshold. Without the mental manipulation of adding 0.4 nm to all DME indications, an altitude error of 120 ft below the proper glide path would result from using the typical altitude/range check of 300 ft per nm.[4] In addition, the approach chart's depiction of the DME offset is not to scale. The actual distance, 0.4 nm (0.3 km), is scaled as approximately 1.5 nm (2.8 km), which could add confusion and an opportunity for error in mental calculations; it could also increase mental workload.

After crossing the FAF, the aircraft was flown below the expected flight path.

Aircraft Flight Path



D = distance from VOR/DME

Source: Dan Gurney

Figure 1

Although the crew apparently did make that location mistake and began the descent at the FAF, none of the scenarios discussed above matched the incident aircraft's recorded flight path. Nevertheless, each can be considered a potential threat to flight safety.

Black Hole Approach

As Figure 1 shows, the flight path of the incident aircraft had a noticeable bow shape consisting of an initial steep descent that slowly flattened out, resulting in a low vertical speed. This is typical of a flight path flown by a pilot following a false visual cue — and conducting a classic "black hole approach."

A black hole approach typically occurs during a visual approach conducted on a moonless or overcast night, over water or over dark, featureless terrain where the only visual stimuli are lights on and/or near the airport. The absence of visual references in the pilot's near vision affects depth perception and causes the illusion that the airport is closer than it actually is and, thus, that the aircraft is too high. The pilot may respond to this illusion by conducting an approach below the correct flight path (i.e., a low approach). In the extreme, a black hole approach can result in ground contact short of the runway.

The preconditions for a black hole approach were present:

- A night visual approach.
- A long, straight-in final approach.
- A runway in a remote location with few lights in the local area but with a town in the distance beyond or to the side of the airport.
- Up-sloping terrain before the runway.

Conditions conducive to a black hole approach are a pre-existing threat that can be identified or avoided, or at least the effects mitigated, by the crew prior to an approach. Threat information can be gained from the chart and discussed during the approach briefing, and from an airport briefing guide prepared by the operator from a survey or audit. When a black hole threat is identified, additional awareness and monitoring defenses must be implemented.

Without cross-monitoring or intervention alerting the pilot flying of any flight path deviation, a threat condition can quickly become a significant safety hazard. In black hole conditions, there is no point in the pilot not flying (pilot monitoring) using the same visual references as the pilot flying, because both pilots could encounter the same visual illusion. An altitude/range table or an electronically defined VNAV flight path would provide the basis for independent monitoring, and altitude checks should be made every 300 ft/one nm.

The runway always should be shown on the EFIS map display. If the EFIS is capable of displaying a vertical profile, it must be monitored during final approach.

In this incident, if the pilot flying did indeed fly the aircraft below the optimum glide path because of a visual illusion, it is likely that the crew's cross-monitoring was inappropriate or nonexistent. The safety resources either were unavailable or not used; but, primarily, the crew's mental picture of where the aircraft was in relation to the runway apparently deteriorated to a low level. TAWS saved the flight from the combination of threats, an error-provoking situation and the apparent false perception encountered during this approach. ●

[This article was 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 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. Australian Transport Safety Bureau (ATSB) Aviation Safety Investigation Report 200402747 discusses a Boeing 737 flight crew's misinterpretation of an approach chart and incorrect programming of an FMS for a nighttime instrument approach in July 2004. U.K. Air Accidents Investigation Branch (AAIB) Bulletin 9/2005 discusses a premature descent conducted during a visual approach by the crew of a de Havilland Dash 8 and the crew's delayed response to a TAWS warning in March 2005.

3. 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).

4. Although 300 ft per nm facilitates mental calculation of altitude vs. range, an aircraft actually descends 318 ft per nm on a three-degree glide path.

Scoring Points for Safety

BY MARION C. BLAKEY

With the sporting community riveted to this summer's World Cup soccer action in Germany, one thing is clear: No matter what country you are from, a goal is a goal.

It is the same with aviation. There is only one common tongue spoken here, and it is called safety.

Aviation safety is a shared responsibility. The U.S. Federal Aviation Administration has developed many productive relationships over the years with a wide variety of groups, and one of the most successful relationships has been with Flight Safety Foundation.

I like to think of the Foundation as one of the sentinels of the skies. Its influence can be found on nearly every major global safety initiative in the last decade, including the use of flight data recorders and in-flight collision warning systems.

That's not all. The Foundation has taken a leading role in evaluating and recommending safety improvements for a considerable number of operators, including some of the largest aviation organizations in the world.

These successes are a testament to the Foundation's mission — to emphasize safety at every turn. And it has been in practice since the Foundation first opened its doors nearly six decades ago. There's no telling how many lives have been saved by its work.

If we're to continue to reduce the risks of accidents, we have to determine where the risks lie and then go about eliminating, mitigating or managing them before an accident happens. Data acquisition and analysis are critical to this endeavor.

The aviation community has widely accepted and supported the concept of Aviation Safety Information Analysis and Sharing (ASIAS) as the next safety frontier.

This fundamental program offers an effective way to further improve upon aviation's remarkable safety record. The beauty of ASIAS is that it transitions the safety community from the forensic approach of studying accidents to the more proactive diagnostic approach.

In the United States, we're developing VASIS, the Voluntary Aviation Safety Information System. VASIS aggregates Flight Operational Quality Assurance (FOQA) data and Aviation Safety Action Program (ASAP) data from several airlines to help us figure out where the safety threats are. Once we know where to look, we can analyze the problems, design a solution and then share it with all our stakeholders.

We all agree that the objective and subjective data we gather need to be shared and integrated. Without that, we aren't able to see national, fleet or geographic trends. That's where huge advances in safety will come.

It is obvious to everyone that we need to move to a place where everyone's data can be de-identified and aggregated.

Marion Blakey is administrator of the U.S. Federal Aviation Administration.

Of course, no talk of aviation safety would be complete without mentioning ADS-B, or Automatic Dependent Surveillance–Broadcast.

Known to many as the next-generation ATC transponder, ADS-B allows pilots in the cockpit and air traffic controllers on the ground to "see" aircraft traffic with much more precision than before.

When fully developed, the system will provide reliable, accurate, real-time information about aviation traffic. ADS-B systems can further enhance safety through features such as automatic traffic callouts or warnings of an imminent runway incursion.

The benefits are clear. ADS-B will take us to even higher heights of safety.

The FAA and Flight Safety Foundation have made tremendous headway in the world of aviation safety. But I am even more excited by what the future holds for our partnership.

Let me thank our friends at the Foundation for the opportunity to appear in this inaugural issue of *Aviation Safety World*. When it comes to making our skies that much safer, you are winners in my book. Score one for aviation. ●

CoreLock

Investigators consider possibility of a condition that could prevent an in-flight restart.

BY MARK LACAGNINA

A rare condition that could freeze an engine core after an in-flight flameout and prevent a windmill restart has come to light as a result of the continuing investigation of a 2004 regional jet accident. "Core lock," as it is known by engineers, can occur when the more rapidly cooling engine components increase turning resistance to the rotating components to the point of preventing a windmill restart of an engine.

Investigators for the U.S. National Transportation Safety Board (NTSB) are seeking to determine whether core lock might have prevented the flight crew of a Bombardier CRJ200 from restarting the engines after they flamed out during an upset at Flight Level (FL) 410, approximately 41,000 ft, on Oct. 14, 2004. The pilots were unable to restart the GE CF34-3B engines, and they were killed when the airplane struck terrain in a residential area while gliding toward the Jefferson City (Missouri, U.S.) Memorial Airport. No one on the ground was injured.

The nearly 3,300 pages of information that have accumulated as of May 2006 in the public docket on the accident investigation include assertions by engineers at Bombardier and GE Transportation that core lock cannot occur in the CF34-3B turbofan unless N_2 — high-pressure rotor speed, or core speed — decreases to zero after an in-flight engine shutdown or flameout. A GE representative said that core lock can occur only if recommended operating procedures are not followed. The only known events before the accident have involved engine tests, not engines in service.

The underlying issue is differences in the expansion and contraction rates of engine components as their temperatures change. Simply stated, if an engine is shut down or flames out at altitude, the static components cool and contract more quickly than the rotating components because of their lower mass and more direct exposure to internal airflow.

In engineering terms, the static components have a faster thermal time constant than the rotating components. If the high-pressure rotor — the engine core — stops rotating, contact between the static seals and the shafts can contribute substantially to overall drag, or turning resistance, in the engine and prevent the core from being turned by the relatively low-torque rotational force available from ram air during an attempted windmill restart.

Engine Screening

Bombardier's first encounter with core lock occurred about 30 years ago during a flight test of a CL604 Challenger, which has the same CF34-3B engines as the CRJ200. After an engine was shut down, N_2 dropped to zero percent while the airplane was flown to its restart altitude/airspeed envelope, and the core could not be rotated by ram air for a restart.

GE isolated the problem to contact between components of the high-pressure-turbine interstage seal — a static, pressurized honeycomb component — and the rotating seal teeth on the outer torque coupling. The company initially established a more rigorous break-in procedure in the factory test cell. When this proved inadequate, the company developed an in-flight screening procedure to check CF34-3A1 and -3B/3B1 engines.

Bombardier adopted the screening procedure for production aircraft flight tests. The procedure for the CRJ200 involves flying the airplane to FL 310, throttling an engine to idle for five minutes, then shutting down the engine. The five-minute operation at idle is intended to stabilize engine temperatures before shutdown and prevent thermal damage during restart and acceleration. A drift-down is conducted at 190 kt, or a lower airspeed if necessary to achieve zero percent N_2. About 8.5 minutes after shutdown, the airplane's nose-down pitch attitude is increased to achieve an airspeed of 320 kt, which typically provides enough ram-air torque for a windmill restart. The windmill restart typically is attempted at FL 210. The screening procedure is designed to verify that the engine core will resume turning during the windmill-restart attempt.

Bombardier initially found that the cores in 20 percent of the engines failed to break free during the windmill-restart attempts. The rate was reduced to 11 percent in the early 1990s by design changes incorporated by GE that increased the clearances on the interstage seals. Information gathered during the accident investigation to date indicates that the failure rate currently is 1.5 percent to 4.0 percent.

Grind-in Procedure

Bombardier developed a follow-up procedure for engines that do not pass the screening. The "break-in" or "grind-in" procedure involves restarting the engine using bleed air from the operating engine, which provides more torque than the ram air used during a windmill restart attempt. The airplane is flown back to FL 310, and the engine is shut down again. This time, the drift-down is conducted at a higher airspeed, about 240 kt, to maintain 4 percent N_2 for eight minutes to 10 minutes. This is when the break-in occurs. The engine is restarted again with bleed air from the operating engine, and the screening procedure is repeated.

According to GE, no engine has failed to restart using bleed air from the operating engine after the grind-in procedure. Bombardier said that only one engine has failed the repeated

Bombardier CRJ200

The Canadair Group of Bombardier began design studies of the Canadair Regional Jet (CRJ) in 1987. The first model, the CRJ100, entered service in 1992 with General Electric CF34-3A1 engines. The CRJ200, introduced in 1995, has the same airframe and upgraded CF34-3B1 engines.

The high-bypass CF34 turbofan engine is flat-rated at 9,200 lb (41 kilonewtons) takeoff thrust on the CRJ200 and also is used on the Bombardier Challenger business jets. The engine is a derivative of the TF34, which powers the U.S. Air Force Fairchild Republic A-10 and the U.S. Navy Lockheed S-3A. CF34 engines have accumulated more than 25 million flight hours.

Two versions of the 50-passenger CRJ200 currently are in production. The extended-range model has a maximum takeoff weight (MTOW) of 51,000 lb (23,134 kg) and a range of 1,345 nm (2,491 km). The long-range model has an MTOW of 53,000 lb (24,041 kg) and a range of 1,700 nm (3,148 km).

Both models have a maximum payload of 13,100 lbs (5,942 kg). Normal cruise speed is 0.74 Mach/424 kt; high-cruise speed is 0.81 M/474 kt. Maximum operating altitude is 41,000 ft.

Standard flight deck equipment includes a six-display electronic flight instrument system, a two-display engine indicating and crew alerting system, dual attitude heading reference systems, a traffic-alert and collision avoidance system and digital weather radar.

Bombardier also produces the larger CRJ700, CRJ705 and CRJ900 models, which have CF34-8 series engines. More than 1,300 CRJs are in operation worldwide.

Sources: Bombardier, GE Transportation and *Jane's All the World's Aircraft*

screening procedure. The engine was returned to GE, which found that a machining process had not been performed on one of the seals when the engine was manufactured.

Bombardier told NTSB that there have been no reports of core lock in service. The company said that in-flight engine shutdowns overall are rare, occurring at a rate of 0.016 per 1,000 flight hours. During a public hearing, a Bombardier engineer said that he was aware of about 350 in-flight engine shutdowns in CRJs, most of which were performed by the flight crews following malfunction indications.

Positioning Flight

Not all CF34-3 engines undergo the GE/Bombardier screening procedure. Some are shipped directly from the GE factory to CRJ200 and Challenger operators. The accident airplane had been operated by Pinnacle Airlines since it was manufactured in 2000. Preliminary information indicates that the left engine had undergone the screening procedure but does not specify whether the right engine also had undergone the procedure.

The left engine had been installed on the airplane in April 2004 and had accumulated 8,856 hours and 8,480 cycles at the time of the accident. The right engine had been installed new in October 2003 and had accumulated 2,304 hours and 1,971 cycles.

At the time of the accident, Pinnacle Airlines, a subsidiary of Northwest Airlines, employed more than 800 pilots and operated 110 CRJs. Another flight crew had been scheduled to fly the accident airplane from Little Rock, Arkansas, to the airline's base in Minneapolis, Minnesota, but the flight was delayed because of a problem with the bleed air sensing loop in the right engine. Maintenance personnel replaced the loop and released the airplane for service later that day.

The accident flight crew were on standby duty at the airline's base in Detroit, Michigan, at 1700 local time when they were assigned to conduct the positioning flight. They dead-headed on a company flight from Detroit and arrived in Little Rock at 2040. The accident flight departed about 2141.

The captain, 31, had 6,900 flight hours, including 973 flight hours in type and 150 flight hours as pilot-in-command in type. The first officer, 23, had 761 flight hours, including 22 flight hours in type.

Pitch Excursions

Flight data recorder (FDR) data indicate that soon after takeoff, the airplane's nose-up pitch attitude was increased abruptly to 22 degrees, resulting in a vertical acceleration (load) of 1.8 g — that is, 1.8 times standard gravitational acceleration — and activation of the stall-protection system's stick shaker.

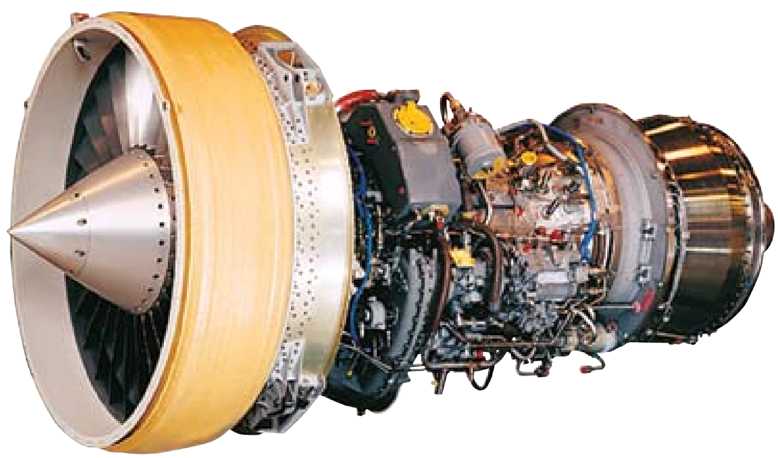
The CRJ200's stall-protection system includes angle-of-attack (AOA) sensors mounted on both sides of the forward fuselage. The system has three "trip points": When AOA increases to the first trip point, the engine autoignition systems are activated to help prevent the engines from flaming out. At the second trip point, the stick-shaker motors are activated, causing the control columns to vibrate — warning the crew of an impending stall. At the third trip point, a warning horn, or warbler, is activated, red "STALL" warning lights are illuminated and the stick-pusher motor is activated, generating 80 lb (36 kg) of forward force on the control columns. The stick-pusher trip point is set to prevent AOA from increasing to stall AOA and to prevent airflow disturbed by the wings at high AOA from entering the engines and causing them to flame out.

While climbing to their assigned altitude, 15,000 ft, the captain and first officer exchanged seats, and the first officer assumed control of the airplane. The airplane was being hand-flown in level flight at 15,000 ft when control-column inputs caused the nose to pitch up about 17 degrees, resulting in a 2.3-g load, then to pitch down, resulting in a 0.3-g load. The control-column inputs were repeated soon thereafter, resulting in similar loads. Substantial rudder-control inputs then were applied.

Allure of FL 410

The airline had dispatched the flight to FL 330, but the crew requested and received clearance from air traffic control to climb to FL 410. "Investigators formed the impression that there was a sense of allure to some pilots to cruise at FL 410 just to say they had 'been there and done that,'" said a report on a human factors analysis conducted by NTSB for the investigation.

The FDR recorded two more pitch excursions as the airplane climbed through FL 250. The first occurred when the control column was moved aft, with the autopilot engaged. Pitch attitude increased to more than 10 degrees, resulting in a 1.9-g load and a climb rate of more than 5,000 fpm for several seconds. The second excursion, which occurred after the autopilot disconnected, resulted in a nearly 15-degree nose-up pitch attitude.



The autopilot then was re-engaged, and a climb rate of 3,000 fpm initially was selected. The selected climb rate was reduced to 1,400 fpm and then to 1,000 fpm.

Recommended cruise-climb airspeeds for the CRJ200 vary from 0.70 Mach for a long-range climb to 0.77 Mach for a high-speed climb. The crew maintained about 0.60 Mach until the airplane reached FL 350. The selected climb rate then was reduced incrementally from 1,000 fpm to zero fpm, and the airplane was flown level at 36,500 ft for about a minute. Airspeed increased to 0.65 Mach, and the crew selected a climb rate of 500 fpm and maintained that climb rate until the airplane reached FL 410. During this time, airspeed decreased to 0.57 Mach.

The airplane's climb-performance charts indicate that under the existing conditions, which included an airplane weight of about 38,000 lb (17,237 kg) and outside temperatures of about minus 46 degrees Celsius (minus 51 degrees Fahrenheit) — about 10 degrees above standard — a climb rate of 500 fpm at the recommended 0.7 Mach climb speed could be maintained only to FL 380.

'We're Losing Here'

The airplane was at FL 410 for about 3.5 minutes. The controller commented on the unusually high altitude, and the captain said, "We don't have any passengers on board, so we decided to have a little fun and come on up here."

With the autopilot holding altitude, airspeed decreased to 0.53 Mach, about 150 kt, and AOA increased to nearly 7 degrees. The captain told the first officer, "We're losing here. … This thing ain't going to hold altitude, is it." He then asked the controller for clearance to descend to FL 390 or FL 370 and was told to stand by.

The airplane stalled, rolled 82 degrees left and pitched 32 degrees nose-down.

At 2154, the stick shaker activated and the autopilot disconnected. The control column was moved aft, increasing pitch attitude to nearly 8.5 degrees. The stick pusher activated, reducing pitch attitude to minus 3.5 degrees and AOA to zero degrees. The control column again was moved aft, increasing pitch attitude to eight degrees and AOA to 11 degrees, which prompted another stick pusher activation.

During the next 20 seconds, this cycle was repeated three times, with the amplitude of the pitch changes increasing each time. The airplane then stalled, rolled 82 degrees left and pitched 32 degrees nose-down.

'Declaring Emergency'

During the upset, both engines flamed out, apparently because of inlet airflow disruption, and the air-driven electrical generator automatically deployed. Substantial movements of the control column and rudder pedals were recorded for the next 14 seconds. The crew recovered control of the airplane at about FL 380.

The captain declared an emergency, and the controller cleared the crew to descend to FL 240. The captain later requested, and received, clearance to descend to 13,000 ft.

A performance study by NTSB found that from 30,000 ft, the airplane was in gliding range of six airports suitable for a landing. From 20,000 ft, the airplane could have reached five of the airports. From 10,000 ft, only one suitable airport was within gliding range; that airport was in Kaiser Lake Ozark, Missouri.

The captain began to brief the first officer on the "Double Engine Failure" checklist procedure, noting that airspeed should not be less than 300 kt. "Push it up there," he said. "Three hundred knots." FDR data indicated, however, that the maximum airspeed attained during the descent was 236 kt.

The "Double Engine Failure" checklist says that a windmill restart should be attempted below FL 210 and that a target airspeed of 240 kt should be maintained until ready to begin the procedure. The minimum airspeed for a windmill restart is 300 kt, and the checklist cautions that an altitude loss of 5,000 ft can be expected while accelerating from 240 kt to 300 kt.

The checklist says that below 13,000 ft, a restart using bleed air from the auxiliary power unit (APU) should be attempted with airspeed between 170 kt and 190 kt.

During the briefing, the captain noted that N_2 must be at least 12 percent for a windmill restart. He then said, "We're not getting any N two at all, so we're going to have to go to thirteen thousand feet. … We're going to use the APU bleed air procedures."

The controller inquired about the nature of the emergency, and the captain said that the airplane had stalled and that one engine had failed at FL 410. "So, we're going to descend down now to start our other engine."

The controller replied, "Understand controlled flight on a single engine right now," and said that he would relay that information when he handed off the flight to the next controller.

APU Restarts Fail

The airplane was descending through about 18,000 ft when the captain established radio communication with the next controller. The crew then donned their oxygen masks. The cabin altitude had increased from about 8,000 ft to about 16,500 ft.

The captain briefed the first officer on the APU-assisted restart procedure and then requested clearance from the controller to descend to 11,000 ft. When asked his intentions, the captain said, "We're going to start this other engine and … make sure everything's OK."

The airplane was descending through 13,000 ft when the crew attempted unsuccessfully to start the left engine. An attempt to restart the right engine also failed. The airplane was descending through 10,000 ft when the pilots exchanged seats again and the captain assumed control of the airplane. He told the first officer to advise the controller that neither engine was operating and to request vectors to an airport.

The first officer told the controller that they needed vectors to the closest airport. "We're descending fifteen hundred feet per minute. We have nine thousand five hundred feet left."

The controller cleared the crew to the Jefferson City airport, which was almost directly ahead. She also provided information on the surface winds — 290 degrees at six kt — and the radio frequency for the instrument landing system (ILS) approach to Runway 30. The airport had 10 miles (six km) visibility and a 4,400-foot overcast.

The crew again attempted to restart the engines. "Why isn't the [expletive] engine going anywhere?" the first officer asked.

"I don't know," the captain said. "We're not getting any N two."

The controller told the crew that the airport was at their 11 o'clock position and eight nm (15 km). "From you, it is a three sixty heading." The first officer said that they did not have the airport in sight. The controller said, "Keep turning left. It's now about a three fifty heading."

The first officer told the captain that he had the approach end of the runway in sight and that he should turn slightly right. A few seconds later he said, "We're not going to make it."

The crew apparently were maneuvering to land on a road when the airplane struck trees in a residential area 2.5 nm (4.6 km) south of the airport at about 2215. It then traveled 1,234 ft (376 m) through the backyards of several residences and across a street before striking a concrete retaining wall. The airplane was destroyed by the impact and a post-accident fire.

Breaking Free

According to NTSB, FDR data indicate that the engine cores were beginning to break free just before the impact. A GE engineer who participated in the tear-down inspections of the engines told investigators that although the right engine had significant over-temperature damage that would have prevented it from producing power, there was no indication that the core in either engine was not free to rotate.

FDR data indicate that the engine cores were beginning to break free just before the impact.

"As long as core rotation is maintained, you will not have core lock," the engineer said. GE has no data indicating that core lock has occurred in 25 million hours of CF34 engine operation in service, he said. When asked whether he considered core lock to have been involved in the accident, the engineer said, "We don't know."

Bombardier has revised the "Double Engine Failure" checklist for the CRJ200. Among the changes is a cautionary note that says that "failure to maintain positive N_2 may preclude a successful relight." The checklist also says that airspeed should be increased if necessary to maintain a positive N_2 indication.

Among actions taken by the airline after the accident were the establishment of a minimum climb speed of 250 kt/0.7 Mach above 10,000 ft and a prohibition against flying above FL 370.

Information gathered by NTSB during public hearings on the CRJ200 accident indicates that core lock has occurred in engines other than the CF34; however, the engine types were not specified in the public docket. ●

The information in this article is based on the NTSB public docket as of May 1, 2006, and is subject to change as the accident investigation proceeds.

Blood Pressure Near Redline

High blood pressure grounds pilots because of the risk of sudden incapacitation, but prompt treatment can return blood pressure to normal and put pilots back in cockpits.

BY LINDA WERFELMAN

Hypertension — consistently high blood pressure — affects more than 600 million people worldwide.[1] Most are unaware they have this serious condition, which is a primary risk factor for heart attack and stroke. As dangerous as hypertension is, if diagnosed and treated, it can be brought under control, sometimes by simple diet and lifestyle strategies.

Victims of high blood pressure often remain unaware of their problems because hypertension typically has no symptoms. Undetected, the condition persists, increasing the heart's workload and contributing to changes in the heart and other parts of the cardiovascular system that ultimately can lead to a major medical problem.

Pilots have the added concern that medical problems associated with untreated high blood pressure may cause sudden incapacitation, the International Civil Aviation Organization (ICAO) says in its *Manual of Civil Aviation Medicine*.

Blood pressure is the force of the blood as it pushes against the walls of the arteries — the blood vessels that carry blood from the heart through other parts of the body — measured in millimeters of mercury.

Measurements of blood pressure contain two numbers: *Systolic* pressure is recorded when the heart beats (contracts), and *diastolic* pressure is recorded between beats, when the heart is at rest. When a blood pressure measurement is written or spoken, systolic pressure comes first; for example, the measurement for someone with systolic pressure of 120 millimeters of mercury and diastolic pressure of 80 millimeters of mercury is expressed as 120 over 80 (120/80).

What's Normal?

The ICAO manual says that a pilot's systolic and diastolic blood pressures "shall be within normal limits." However, reaching a consensus about what "normal" means is difficult.

Many medical specialists now say that normal, healthy blood pressure for adults is lower than previously believed — that is, less than 120/80 — and that high blood pressure is indicated by consistent measurements of *either*

140 or higher systolic *or* 90 or higher diastolic, *or both* (Table 1). Specialists once believed that blood pressure naturally increased as people aged, but they now say that this typically is not true and that a blood pressure of 120/80 is a reasonable goal for adults of all ages.

Nevertheless, ICAO says that blood pressure readings from about 100/60 to 150/90 "appear to be reasonable as normal at any age, including the common appearance of labile [changeable] hypertension in middle age, but should not be considered as regulatory levels."

Anthony Evans, M.D., chief of ICAO's Aviation Medicine Section, said that "as a rule, the lower the blood pressure, the better — assuming it is not so low as to precipitate fainting, and the risk increases as pressure increases. The figure of 150/90 is a reasonable one for considering initiation of drug therapy — when the risk of side effects of medication might be acceptable in view of the reduction in the risk of a cardiovascular event."

An individual's blood pressure fluctuates throughout the day, depending on the type of activity being performed at a particular time and the level of excitement or nervousness. However, an individual's blood pressure should be about the same any time he or she is sitting or standing still.

There are two types of high blood pressure. About 95 percent of all cases are *essential* — or *primary* — high blood pressure, cases for which there is no precise cause. Nevertheless, there are many contributing factors, including overweight, lack of exercise, stress and a family history of high blood pressure (see "Risk Factors," page 52).

The remaining 5 percent are cases of *secondary* high blood pressure, a condition brought about by a disease, typically a disease involving the kidneys or adrenal glands; a complication of pregnancy; or an adverse reaction to legal or illegal drugs. Sometimes the drugs involved can appear harmless: Researchers reported in 2005 on a study that found that women who took daily high doses of over-the-counter pain relievers — acetaminophen and non-steroidal anti-inflammatory drugs (NSAIDs) — for several years were more likely to develop high blood pressure than women who did not take the pain relievers.[2]

Although most people with high blood pressure experience no symptoms — and often realize that they have high blood pressure only after they suffer a heart attack or stroke — some symptoms may develop when high blood pressure becomes more advanced. These symptoms include headache — typically an ache in the back of the head, felt upon waking — dizziness, an irregular or very fast heartbeat, frequent nosebleeds, shortness of breath, weakness or fatigue.

Blood pressure is checked during almost all visits to a health care provider with a medical instrument called a sphygmomanometer. The sphygmomanometer functions like this: Its rubber cuff is wrapped around the upper arm and inflated, compressing a large artery in the arm and briefly stopping the flow of blood. Air in the cuff is released, and as the blood begins to pulse through the artery again, it makes a sound heard by a health care practitioner listening to the pulse through a stethoscope. The sounds continue until the pressure in the artery exceeds the pressure in the cuff. The health care practitioner records the sound's start and stop — systolic pressure is the pressure indicated on the sphygmomanometer gauge when the first sound is heard, and diastolic pressure is the pressure indicated when the last sound is heard.

Classification of Blood Pressure Levels

Classification	Systolic Pressure[1]		Diastolic Pressure[1]
Normal	Less than 120	*and*	less than 80
Pre-hypertension[2]	120–139	*or*	80–89
Stage 1 Hypertension[2]	140–159	*or*	90–99
Stage 2 Hypertension[2]	160 or more	*or*	100 or more

1. Systolic pressure is recorded when the heart contracts and is higher than diastolic pressure, which is recorded when the heart relaxes. Blood pressure is expressed, in millimeters of mercury, as systolic pressure/diastolic pressure.
2. Hypertension is consistently high blood pressure.

Source: U.S. National Heart, Lung and Blood Institute

Table 1

A single reading that indicates above-normal blood pressure is not sufficient for a diagnosis of high blood pressure. Two or more above-normal readings recorded during several weeks or several months are required before health care practitioners issue a diagnosis. Because some people have "white-coat hypertension" — an increase in blood pressure during visits to medical offices — patients sometimes are asked to monitor their blood pressure at home to provide additional information to be used in the diagnosis. Some patients also are asked to wear a monitor that records their blood pressure over a period of 24 hours or more.

If a pilot has an above-normal blood pressure reading, civil aviation authorities typically require further evaluation of his or her condition.

For example, the European Joint Aviation Authorities' (JAA's) *Manual of Civil Aviation Medicine* describes high blood pressure as "the most powerful and prevalent of all the coronary vascular risk factors" and says that, if a diagnosis of high blood pressure is made, the pilot should be considered temporarily unfit and issuance of a medical certificate should be delayed pending further evaluation of the pilot's health. The evaluation should include checks of blood cholesterol, blood sugar and weight; a review of family history of high blood pressure; and a check of the patient's history of using tobacco and alcohol, JAA says.

The U.S. Federal Aviation Administration (FAA) says that if a pilot with no known history of high blood pressure has blood pressure readings that are consistently higher than 155/95, "further investigation is required. Initially, this should consist of recording the blood pressure twice a day (morning and evening) for three consecutive days. If at least four of these six readings are 155/95 or less and the applicant is otherwise qualified, then no further action is required and the certificate can be issued."[3]

However, if the three-day evaluation period confirms that the pilot has high blood pressure, treatment typically is required to stabilize his or her blood pressure before medical certification is considered, FAA says.

Unhealthy Consequences

If high blood pressure is not controlled, a number of serious health problems can result, including the following:

- Damage to the arteries, including arteriosclerosis, the hardening and narrowing of the arteries; atherosclerosis, an accumulation of plaque — deposits of cholesterol and calcium — on the inner walls of the arteries; and aneurysm, an abnormal bulge in an artery or other blood vessel;
- Damage to the heart from the thickening of the muscle in the left ventricle, the main pumping chamber of the heart. The

Risk Factors

Many factors can contribute to high blood pressure. Some are outside an individual's control, such as age (high blood pressure is more likely to develop as people grow older), race and ethnicity (high blood pressure is more common among blacks than people of other races) and a family history of high blood pressure.

Other risk factors are "lifestyle factors" that can be controlled. These factors include:

- Overweight;
- Lack of exercise;
- A diet containing too much fat and salt, and too many calories;
- Tobacco products;
- Excessive alcohol consumption;
- Some prescription medications (such as oral contraceptives), over-the-counter medications (such as cold medicines) and illegal drugs; and,
- Stress.

— LW

muscle thickens as it pumps blood against the increased pressure in the arteries. In addition, because the thickened muscle may not be capable of pumping enough blood, fluid can accumulate in the lungs or the feet and legs;

- Damage to the brain from a blocked or a ruptured blood vessel in the brain, which can result in a stroke;
- Kidney damage because of weak, narrow blood vessels in the kidneys that prevent them from functioning properly; and,
- Damage to the blood vessels in the eyes, which can result in loss of vision.

In addition, people with high blood pressure often have one or more additional — and sometimes related — metabolic disorders, including high insulin levels, excess weight and abnormally high cholesterol levels. These disorders increase the likelihood of diabetes, heart disease or stroke.

Changes in Diet, Exercise May Help

High blood pressure sometimes can be reduced to normal levels with changes in diet and exercise. For many people who have only slightly elevated blood pressure, these lifestyle changes often are the only treatment required.

Reducing the amount of sodium in the diet can help to lower blood pressure, as can consumption of a low-fat, low-cholesterol diet that emphasizes fruits, vegetables, whole grains, low-fat dairy products, fish and poultry; red meat typically is considered acceptable in small amounts. In studies by the U.S. National Heart, Lung and Blood Institute (NHLBI) of more than 400 people, those who consumed this type of diet and reduced sodium intake to 1,500 milligrams a day experienced a reduction in blood pressure — in some cases, the reduction was measured within two weeks after dietary changes were implemented.[4,5]

A program of increased physical activity typically reduces both systolic pressure and diastolic pressure by about 10 points, often after only a few weeks. The increased activity also helps reduce weight and improve blood cholesterol levels and blood glucose levels, resulting in a reduced risk of heart attack or stroke.[6] In fact, the American College of Sports Medicine says that people with high blood pressure who exercise and are in good physical condition have lower death rates than people with high blood pressure who are unfit. Many health care specialists recommend at least 30 minutes of exercise — walking, jogging, swimming, cycling or other aerobic activity — most days of the week.

If lifestyle changes are not sufficient to reduce blood pressure to normal levels, medication can be prescribed. Different classes of medication, in different combinations, can be used, depending on a number of factors, including other medical conditions and lifestyle issues.

In recent years, an increasing number of medications have been developed that — because of their effectiveness and relative lack of side effects — are considered acceptable for treating high blood pressure in pilots, including:

- Angiotensin-converting enzyme (ACE) inhibitors, which decrease the heart's workload by easing the flow of blood from the heart. Side effects include tiredness, flushed skin, heartburn, or swelling of the abdomen, ankles or feet;
- Angiotensin-II receptor antagonists, which act in much the same way as ACE inhibitors. Side effects are minimal;
- Calcium-channel blockers, which relax the muscles around the coronary arteries, dilate the arteries and increase the flow of blood to the heart. Side effects include a dry cough;
- Some beta blockers, which slow the heart rate and decrease blood pressure. Side effects include fatigue, cold hands and feet, weakness, dizziness and dry mouth; and,
- Thiazide diuretics and potassium-sparing diuretics, which reduce the amount of

sodium and water in the body, thus reducing blood pressure. Diuretics, which typically are less expensive than most blood pressure medications and have minimal side effects, may be more effective in lowering blood pressure.

Despite the widespread acceptability of these medications, pilots should consult an aeromedical specialist, such as a designated medical examiner, before taking the drugs and should try them first while on the ground to ensure their effectiveness and absence of side effects.

Some medications — primarily older medications initially prescribed during the 1950s and 1960s — typically are unacceptable for pilots, including centrally acting agents, which prevent the brain from sending signals to the nervous system to increase the heart rate and to narrow the blood vessels. Side effects include liver damage, some forms of hemolytic anemia (an insufficient supply of red blood cells), tiredness and dry mouth.

Before a pilot with high blood pressure can be issued a medical certificate, civil aviation authorities typically require that a cardiologist — or in some cases, a general practitioner — must confirm that the pilot's blood pressure has been stabilized for at least two weeks with an acceptable type of treatment and that the pilot has experienced no side effects. The pilot may be required to undergo subsequent examinations by a cardiologist; changes in the type or dosage of medication typically also require grounding — usually for two weeks — and reassessment. In some cases, the pilot may be restricted to flying as part of a multiple-pilot crew or with a safety pilot.

Taking anti-hypertension medicine as prescribed is important. People who stop taking the medicine or adjust dosages without a physician's approval risk an increase in blood pressure.

High blood pressure is among the most common risk factors for a number of serious medical problems, including heart attack and stroke. With prompt treatment, either in the form of lifestyle changes or medication, blood pressure can be reduced to normal levels, and pilots can retain medical certification. ●

Notes

1. Safe Stroke Alliance for Europe (SAFE). *Stroke — A Preventable Catastrophe.* <www.safestroke.org>.

2. Brigham and Women's Hospital. *Popular Pain Killers Shown to Increase Risk of High Blood Pressure in Women.* <www.brighamandwomens.org>.The study — part of the larger Nurses Health Study — did not examine the effects of pain relievers on high blood pressure in men.

3. U.S. Federal Aviation Administration. *Hypertension.* <www.faa.gov>.

4. U.S. National Heart, Lung and Blood Institute (NHLBI). *NIH News Release: NHLBI Study Finds DASH Diet and Reduced Sodium Lowers Blood Pressure For All.* Dec. 17, 2001.

5. NHLBI. *Facts About the DASH Eating Plan.* <www.nhlbi.nih.gov>. The DASH diet also contains elements recommended as protection against other diseases, such as coronary artery disease, high cholesterol, some cancers and osteoporosis.

6. Hagberg, James M. *Exercise Your Way to Lower Blood Pressure.* <www.acsm.org>.

Further Reading From FSF Publications

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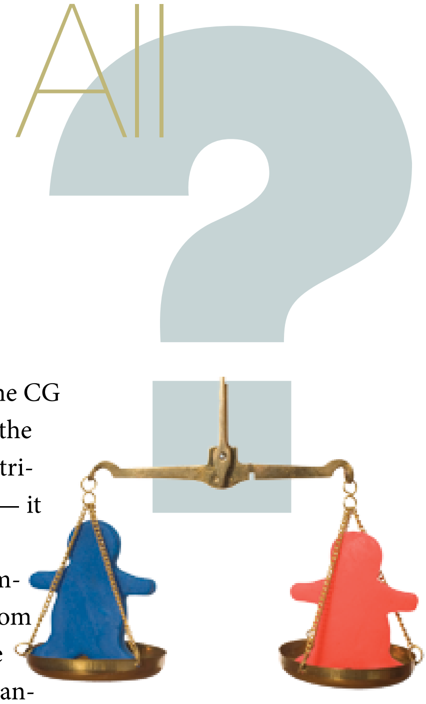
One Size Fits All?

The Danger of Average Weights

BY KEITH GLASSCOCK



Look around any airport terminal and you'll see that few passengers, or their bags, meet the average weights prescribed under current weight-and-balance programs. The differences between the prescribed average weights and the actual weights of passengers and their baggage — and variations in their distributions throughout the airplane — can lead to significant errors in weight-and-balance calculations.

Weight-and-balance errors have been involved in accidents and incidents. While civil aviation authorities, including the U.S. Federal Aviation Administration (FAA), have attempted to lessen the danger by increasing the prescribed average weights, the underlying causes of errors remain.[1]

A study conducted by the author, using computer-aided data modeling, shows that a center of gravity (CG) calculated from average weights is more often erroneous than not. The study used a hypothetical airplane with 132 passenger seats arranged in 22 rows with three seats on each side of the aisle. Zero fuel weight is 118,000 lb (53,525 kg). The body weights of the hypothetical adult passengers were created from an analysis of data from the National Health and Nutrition Examination Survey conducted in 2000 by the U.S. Department of Health and Human Services.

With many different ways — approximately 1.5×10^{161} — to distribute the 132 passengers in the cabin, the first phase of the study examined the worst case of distributing the passengers by weight, with the heaviest at one end of the cabin and the lightest at the other end. With this distribution, the resulting change in moment would cause an overall difference in airplane CG of 8.4 in (21.3 cm) at 118,000 lb. Although the probability of this worst-case passenger distribution is extremely small — 1 in 7.7×10^{160} — it could happen.

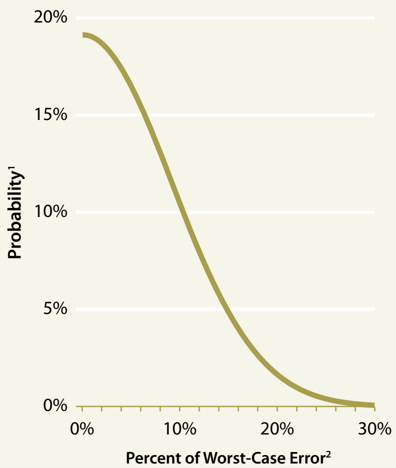
For the second phase of the study, a computer was used to generate 10 million random passenger distributions and to calculate the resulting CGs. Comparing the mean and standard deviations of these CGs to CGs calculated using FAA's average passenger weight — 169 lb (77 kg), not including allowances for carry-on baggage or clothing— produced a calculation of error probabilities.[2]

Figure 1 (page 56) shows the probability of errors between CGs calculated from the hypothetical passenger weights and CGs calculated from average weights as a percentage of the worst-case error (8.4 in). Figure 1 shows, for example, the probability that 2 percent of the random passenger loadings will result in an error approximating 18.5 percent of the worst-case error. Thus, for the hypothetical airplane, there is a 1 in 50 chance that the CG error caused by the passengers will be approximately 1.6 in (4.1 cm) at 118,000 lb. The data show that as the probability decreases, the magnitude of the error increases until the worst-case error is reached.

Baggage, especially checked baggage, also has a significant effect on CG location. Carry-on baggage is a very small portion of total airplane weight. Calculations using FAA survey results for carry-on baggage show that the effect of a worst-case distribution — heaviest baggage at the front or at the rear of the cabin — is approximately 1.7 in (4.3 cm) at 118,000 lb.

Calculations for checked baggage are far more complex than for carry-on baggage.

Probability of CG Error Caused by Random Seating of Passengers



Notes

1. Probability is the sum of forward and aft error probabilities.
2. Chart excludes zero error. Worst-case CG error for hypothetical airplane and 132 adult passengers is 8.4 in (21.3 cm) at 118,000 lb (53,525 kg).

Source: Keith Glasscock

Figure 1

However, some estimates can be made, using FAA survey results for checked baggage and the following assumptions:

- There are 200 checked bags for the flight.
- None of the bags is classified as heavy.
- The baggage is distributed evenly below the entire length of the cabin.

The worst-case effect of checked baggage on overall airplane CG is approximately 3.0 in (7.6 cm) at 118,000 lb. Like the worst-case passenger distribution, the probability of such an arrangement is exceedingly small. Unfortunately, the probabilities of errors less than worst-case are indeterminable; there are too many variables in how the baggage is loaded to allow for any reasonable predictions of probability.

Children can exacerbate CG error. Many airlines have weight-and-balance programs that allow the difference between the prescribed average weights of adults and children to be applied as a weight credit; the weight credit is calculated at the cabin centroid, the CG of the cabin if all seats are loaded equally, instead of the child's actual seat position.

Moreover, in the hypothetical airplane, the effect of a single child seated in the first or the last row is significant. The FAA-prescribed average weight for children, aged two through 12, is 82 lb (37 kg). If a child seated in the first or last row actually weighed only 40 lb (18 kg), the CG error would be approximately 1.0 in (2.5 cm). Obviously, several children seated at the extreme front or rear of the cabin could create a large CG error.

Calculations using only the effects of passengers and baggage indicate that a total worst-case CG error of approximately 13.1 in (33.3 cm) is possible for the hypothetical airplane. The effects of crewmembers and children easily could increase that amount by one inch.

The significance of such an error depends on the approved CG range. For example, the McDonnell Douglas MD-81 has an approved CG range at zero fuel weight of approximately 53 in (135 cm). If the hypothetical airplane had that CG range, the total error caused by passengers and baggage alone would be equal to approximately 25 percent of the available CG range.

Accident reports continue to show the risk of operating overweight and/or out-of-balance aircraft. While ongoing mitigation efforts will reduce the risk, the only way to eliminate the risk is with accurate CG determination based on the actual weights of passengers and all items placed aboard the aircraft and their actual locations within the aircraft. Electronic scales and computer programs can be used to accomplish this. In addition, several companies are certifying or marketing systems that compute weight and balance by weighing the entire airplane before departure. A concerted effort by commercial aircraft operators and regulators must be made to place these technologies in service. ●

Keith Glasscock recently was graduated summa cum laude by Embry-Riddle Aeronautical University with a bachelor of science degree in professional aeronautics. He has been employed since 2001 as a pilot for a large regional airline and has provided classroom instruction to fellow pilots on a variety of safety topics. Glasscock also has 15 years of experience in aircraft maintenance.

Notes

1. The U.S. Federal Aviation Administration (FAA) increased the prescribed average weights of passengers and pilots by 10 lb, flight attendants by 30 lb and checked baggage by five lb. A new category called "heavy checked baggage" was created for bags with actual weights between 50 and 100 lb; the prescribed average weight is 60 lb.
2. FAA Advisory Circular 120-27E, *Aircraft Weight and Balance Control.* June 10, 2005.

InSight is a forum for expressing personal opinions about issues of importance to aviation safety and for stimulating constructive discussion, pro and con, about the expressed opinions. Send your comments about the author's call for computing aircraft CG based on the actual weights and distributions of passengers and baggage to J.A. Donoghue, director of publications, Flight Safety Foundation, 601 Madison St., Suite 300, Alexandria VA 22314-1756 USA.

Air Taxis Show Best Safety Gain Among U.S. Operators

FARs Part 121 accidents trended upward, but were lower than in 12 years in the past two decades.

BY RICK DARBY

Accidents, fatalities and accident rates increased in 2005 for air carriers operating under U.S. Federal Aviation Regulations (FARs) Part 121[1] compared with 2004, according to preliminary data from the U.S. National Transportation Safety Board (NTSB). Accidents and rates also increased for FARs Part 135[2] commuter operations, in which there were no fatal accidents for the second year in a row.

There were 39 accidents, including three fatal accidents, in Part 121 operations in 2005, compared with 30 and two, respectively, in 2004 (Table 1). Accidents per 100,000 departures increased year-over-year from 0.272 to

Airliners: Not Quite as Good as 2004

Accidents, Fatalities and Rates, U.S. Air Carriers Operating Under FARs Part 121, Scheduled and Nonscheduled Service, 1996–2005

	Accidents		Fatalities				Accidents per 100,000 Flight Hours		Accidents per 1,000,000 Miles Flown		Accidents per 100,000 Departures	
Year	All	Fatal	Total	Aboard	Flight Hours	Departures	All	Fatal	All	Fatal	All	Fatal
1996	37	5	380	350	13,746,112	8,228,810	0.269	0.036	0.006	0.001	0.450	0.061
1997	49	4	8	6	15,838,109	10,318,383	0.309	0.025	0.007	0.001	0.475	0.039
1998	50	1	1	0	16,816,555	10,979,762	0.297	0.006	0.007	0.000	0.455	0.009
1999	51	2	12	11	17,555,208	11,308,762	0.291	0.011	0.007	0.000	0.451	0.018
2000	56	3	92	92	18,299,257	11,468,229	0.306	0.016	0.007	0.000	0.488	0.026
2001*	46	6	531	525	17,814,191	10,954,832	0.236	0.011	0.006	0.000	0.383	0.018
2002	41	0	0	0	17,290,198	10,508,473	0.237	—	0.006	—	0.390	—
2003	54	2	22	21	17,467,700	10,433,164	0.309	0.011	0.007	0.000	0.518	0.019
2004	30	2	14	14	18,882,503	11,023,128	0.159	0.011	0.004	0.000	0.272	0.018
2005	39	3	22	20	19,471,000	11,245,000	0.200	0.015	0.005	0.000	0.347	0.027

Notes

2005 data are preliminary.

Flight hours, miles and departures are compiled by FAA.

Since March 20, 1997, aircraft with 10 or more seats used in scheduled passenger service have been operated under FARs Part 121.

Year followed by an asterisk is one in which an illegal act was responsible for an occurrence in this category. These acts, such as suicide, sabotage and terrorism, are included in the totals for accidents and fatalities but are excluded for the purpose of accident rate computation.

Other than the persons aboard aircraft who were killed, fatalities resulting from the Sept. 11, 2001, terrorist act are excluded from this table.

Source: U.S. National Transportation Safety Board

Table 1

0.347, up 28 percent, and fatal accidents from 0.018 to 0.027, a 50 percent increase.

The Part 121 rate of accidents per 100,000 departures for 2005 was, however, lower than in 12 of the years in the 1986–2005 period. In the 10 years preceding 2005, only 2004 had a lower accident rate. The fatal accident rate was the highest since 1997.[3]

In Part 135 commuter operations[4] (Table 2), the rate of accidents per 100,000 departures increased to 1.176, a 58 percent increase from 0.743 in 2004. There were six accidents in 2005, compared with four in 2004.

The accident rate per 100,000 flight hours for Part 135 air taxi operations[5] decreased year-over-year from 2004 to 2005, in all accidents and in fatal accidents (Table 3, page 59). Rates for this category were based on flight hours rather than departures because departure information was not available. The 2005 rate for fatal accidents, 0.34, was 52 percent lower than in 2004, 0.71, and the lowest in the 1986–2005 period.

Numbers of fatalities and fatal accidents for the Part 135 air taxi category were the lowest in the 20-year period. Fatal accidents decreased 52 percent, from 23 to 11, between 2004 and 2005, and on-board fatalities dropped 75 percent, from 63 to 16.

There were 18 passenger fatalities in Part 121 operations in 2005, a 64 percent increase from the 11 in 2004 (Table 4, page 59). Enplanements per passenger fatality decreased from 64.6 million to 41.7 million, equivalent to a 35 percent increase in the fatality rate. The two serious passenger injuries among Part 121 air carriers were the lowest in the 20-year period — including the years 1998 and 2002, when there were no fatalities.

The one hull-loss accident that occurred in Part 121 operations in 2005 represented a rate of 0.051 hull-losses per million flight hours, compared with four hull-loss accidents and a rate of 0.212 in 2004 (Table 5, page 59). The 2005 rate was the lowest in the past 20 years, except for 1998, when there were no hull-loss accidents, and was a 76 percent decrease from 2004. ●

Commuters: Accident Rates Up

Accidents, Fatalities and Rates, U.S. Air Carriers Operating Under FARs Part 135 Commuter Operations, 1996–2005

	Accidents		Fatalities				Accidents per 100,000 Flight Hours		Accidents per 1,000,000 Miles Flown		Accidents per 100,000 Departures	
Year	All	Fatal	Total	Aboard	Flight Hours	Departures	All	Fatal	All	Fatal	All	Fatal
1996	11	1	14	12	2,756,755	3,515,040	0.399	0.036	0.019	0.002	0.313	0.028
1997	16	5	46	46	982,764	1,394,096	1.628	0.509	0.065	0.020	1.148	0.359
1998	8	0	0	0	353,670	707,071	2.262	—	0.158	—	1.131	—
1999	13	5	12	12	342,731	672,278	3.793	1.459	0.248	0.095	1.934	0.744
2000	12	1	5	5	369,535	603,659	3.247	0.271	0.267	0.022	1.988	0.166
2001	7	2	13	13	300,432	558,052	2.330	0.666	0.162	0.046	1.254	0.358
2002	7	0	0	0	273,559	513,452	2.559	—	0.168	—	1.363	—
2003	2	1	2	2	319,206	572,260	0.627	0.313	0.042	0.021	0.349	0.175
2004	4	0	0	0	302,218	538,077	1.324	—	0.086	—	0.743	—
2005	6	0	0	0	300,000	510,000	2.000	—	0.130	—	1.176	—

Notes

2005 data are preliminary.

Flight hours, miles and departures are compiled by FAA.

Since March 20, 1997, aircraft with 10 or more seats used in scheduled passenger service have been operated under FARs Part 121.

Based on a February 2002 FAA legal interpretation, any FARs Part 135 operation conducted with no revenue passengers aboard will be considered a nonscheduled flight operation. This interpretation applies to accidents beginning in 2002. It has not been retroactively applied to 36 accidents, nine of them fatal, for the 1983–2001 period.

Commuter operations were previously referred to as scheduled operations. The terminology has been updated to reflect definitions in FARs Part 119.3 and terminology used in Part 135.1.

Source: U.S. National Transportation Safety Board

Table 2

Air Taxis: A Good Year for Safety

Accidents, Fatalities and Rates, U.S. Air Carriers Operating Under FARs Part 135 Air Taxi Operations, 1996–2005

	Accidents		Fatalities		Accidents per 100,000 Flight Hours	
Year	All	Fatal	Total	Aboard	All	Fatal
1996	90	29	63	63	2.80	0.90
1997	82	15	39	39	2.65	0.48
1998	77	17	45	41	2.03	0.45
1999	74	12	38	38	2.31	0.37
2000	80	22	71	68	2.04	0.56
2001	72	18	60	59	2.40	0.60
2002	60	18	35	35	2.06	0.62
2003	74	18	42	40	2.53	0.61
2004	66	23	64	63	2.04	0.71
2005	66	11	18	16	2.02	0.34

Notes

2005 data are preliminary.

Flight hours are estimated by FAA. Miles flown and departure information for FARs Part 135 air taxi operations are not available.

In 2002, FAA changed its estimate of air taxi activity beginning in 1992. In 2003, FAA again revised flight activity estimates for 1999 to 2002. Both revisions have been applied retroactively to these rates.

Air taxi operations were previously referred to as nonscheduled operations. The terminology has been updated to reflect definitions in FARs Part 119.3 and terminology used in Part 135.1. Part 135 air taxi operations encompass charters, air taxis, air tours or medical services when a patient is aboard.

Source: U.S. National Transportation Safety Board

Table 3

Airliner Fatalities: Number and Rate Up

Passenger Fatalities, Injuries and Rates, U.S. Air Carriers Operating Under FARs Part 121, 1996–2005

Year	Passenger Fatalities	Passenger Serious Injuries	Total Passenger Enplanements (millions)	Enplanements per Passenger Fatality (millions)
1996	319	19	592	1.9
1997	2	21	648	324.0
1998	0	12	650	0.0
1999	10	46	676	67.6
2000	83	11	701	8.4
2001	483	7	629	1.3
2002	0	11	619	0.0
2003	19	10	654	34.4
2004	11	3	711	64.6
2005	18	2	751	41.7

Notes

Injuries exclude flight crew and cabin crew.

Since March 20, 1997, aircraft with 10 or more seats used in scheduled passenger service have been operated under FARs Part 121.

Source: U.S. National Transportation Safety Board

Table 4

One Airliner Hull Loss

Hull Losses and Rates, U.S. Air Carriers Operating Under FARs Part 121, 1996–2005

Year	Hull Losses	Aircraft Flight Hours (Millions)	Hull Losses Per Million Flight Hours
1996	5	13.746	0.364
1997	2	15.838	0.126
1998	0	16.817	0.000
1999	2	17.555	0.114
2000	3	18.299	0.164
2001	5	17.814	0.281
2002	1	17.290	0.058
2003	2	17.468	0.114
2004	4	18.883	0.212
2005	1	19.471	0.051

Note

Since March 20, 1977, aircraft with 10 or more seats used in scheduled passenger service have been operated under FARs Part 121.

Source: U.S. National Transportation Safety Board

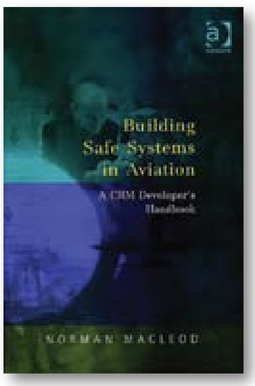
Table 5

Notes

1. *Operating Requirements: Domestic, Flag and Supplemental Operations.*
2. *Operating Requirements: Commuter and On Demand Operations and Rules Governing Persons On Board Such Aircraft.*
3. Fatalities in the Sept. 11, 2001, terrorist attacks were not included in the accident rate calculations, but were included in accident and fatality totals.
4. *Commuter operations* under Part 135 are defined on the FSF Web site at <www.flightsafety.org/pubs/glossary>.
5. *Air taxi operations* under Part 135 are defined on the FSF Web site at <www.flightsafety.org/pubs/glossary>.

Training Crewmembers in the 'Soft Skills'

Crew resource management (CRM) is a component of technical proficiency, not a separate function, a trainer says.



BOOKS

Building Safe Systems in Aviation: A CRM Developer's Handbook

MacLeod, Norman. Aldershot, England: Ashgate, 2005. 186 pp. Figures, tables, index, references.

"So far, little of what has been done in the name of CRM [crew resource management] training can be said to have delivered results," the author says. "If we follow the narrow guidance on CRM training contained in published syllabi, then there is every chance that what we offer will continue in the grand tradition of systematic impotence."

MacLeod calls CRM the "soft skills," which involve *management* of the technical skills of piloting, such as aircraft configuration and control.

"CRM skills allow the crew to judge the rate of progress toward the desired goal, detect deviations from the desired trajectory, initiate recovery action, develop alternate plans and so on," he says. "When looked at in this context, the traditional separation of CRM from technical proficiency seems fundamentally flawed."

The author believes that CRM needs to be seen as "an integral part of competent workplace performance" and not only as a formula for threat and error management.

"The first observation I would make on the error management model is that it seems to treat safety as a static property of the system," he says. "We set up a series of rules, and, provided they are followed, then the aircraft will remain safe. Unsafety arises when departures from the rules occur. The second point I would make is that an absence of failure does not indicate the presence of safety. Individuals will differ in terms of their basic ability, level of competence, degree of motivation, tolerance of stress and so on. Each combination of qualities and characteristics possesses its own inherent level of risk. Although the observed performance may be compliant, the extent to which the actor contributes to the burden of risk borne by the operation is masked."

After examining the various concepts of CRM, the author says that the primary goal of CRM training is "to develop the social and cognitive skills that are exercised together with technical, systems-related skills in order to achieve safe and efficient aviation." But, he adds, CRM also requires analysis of the organization in which those skills are expected to be practiced.

Beginning with a discussion of the meaning of safety, a term that he says is complex because it involves not only individual acts but also the interaction of individuals and of various factors, he continues with a look at the "fuzzy concept" of a safety culture.

MacLeod describes his methodology for the rest of the book:

"I then want to explore the process of work and how people learn about their jobs. Next … we will look at how we define the desired performance expected of crews. With our behavioral framework … , we will look at translating goals into activities designed to achieve those goals.

"We will examine in detail the methods available for delivering training before, in the final section of the book, I look at the problem of measurement, both in terms of effectiveness of training and in terms of behavior on the line. My goal is to provide facilitators with a complete tool kit in order to support them in shaping CRM to meet their own company's needs."

The author considers contradictions and paradoxes that can exist with CRM. For example, most CRM courses include studying accidents and incidents to discover causal factors and learn lessons.

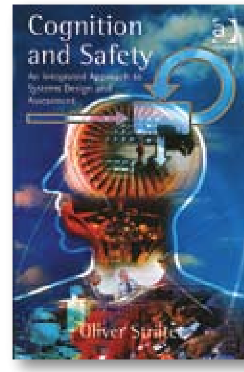
"At the same time, we run the risk of reinforcing the 'otherness' of failure," he says. "Because we ourselves have never had direct experience of the events being analyzed, we can easily attribute the failure to some shortcomings exhibited by the actors in the event and sleep happily in the knowledge that it could never happen to us. …

"How, then, do we take this illogical model into account when developing our courses? First, we need to establish the concept that the laws of probability tell us that we are all equally exposed to a risk. Rarity of an event within our experience does not mean that we are less likely to encounter that event. Probability and consequence have long presented problems for the selection of appropriate case studies to use in training. Pilots, especially, are adept at dismissing the actions of colleagues involved in accidents as aberrations.

"Moreover, the individuals in the classroom would never be so stupid as to commit the mistakes made by the accident crew. It can be very difficult — at times impossible — to get the class to identify cause, as opposed to stating what the crew *should* have done. The more removed the case study in terms of seriousness, geographical location, scale of disaster and so on, the more readily some trainees can deny the lessons to be drawn from the event."

Cognition and Safety: An Integrated Approach to Systems Design and Assessment

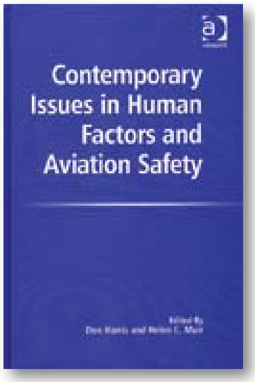
Sträter, Oliver. Aldershot, England: Ashgate, 2005. 288 pp. Figures, tables, bibliography, indexes.



Integrating cognitive issues — those related to thought processes and knowledge acquisition — with system design is the focus of this book by Oliver Sträter of Eurocontrol and the Institute of Technology, Munich, Germany.

"Humans at the working level are forced to make decisions based on constraints from targets set at the management level, the procedures and interfaces given, the required communications with working partners and the operational tasks to be performed," the author says. "This leads to the phenomena of induced mental workload. The term 'induced' comprises the additional effort due to the type of interaction with the system. A frequently stated selling argument [for] automation is that it reduces workload. However, induced workload may cause an even higher net workload for the user than the workload an automated system is designed to reduce. Cognitive psychology consequently becomes a considerable contribution to ensure safety at the working level."

The frequent observation that human error is involved in a large proportion of accidents and incidents is sometimes attributed to the reliability of equipment, from which it naturally follows that human factors plays a large role. The author believes that this is not the whole story and that technology can induce some types of human error. "In particular, those human errors occurring due to problems of the human-machine interaction are often incorrectly assigned as errors of the humans at the working level," he says.



Problems of technology versus cognition are not limited to failures to understand or correctly operate automated systems. In addition, Sträter says, operators sometimes must make judgments while under time and task pressure about the status of a system and its validity in the particular situation, which can lead to two complementary error types:

- "If one fails to notice the automatic function is out of service and should intervene (usually called error of omission)"; and,
- "If one wrongly perceives the automated system as not functioning and acts according to his/her own understanding of the situation, although the automatic system is working properly (usually called error of commission)."

The midair collision between a Tupolev Tu-154 and a Boeing 757 over Germany on July 1, 2002, was an example of the second type of error, the author says: "Nothing would have happened if the controller had not intervened in the automatic procedure." (See *Flight Safety Digest*, March 2004.)

The issues entailed by integrating cognitive psychology and design are discussed under chapter headings that include, among others, "The Cognitive Processing Loop"; "Mechanisms of Cognitive Performance and Error"; "Implications for Cognitive System Design"; "Assessment of Cognitive Performance in Safe Operations"; and "Integration of Cognitive Performance."

Contemporary Issues in Human Factors and Aviation Safety

Harris, Don; Muir, Helen C. (editors). Aldershot, England: Ashgate, 2005. 342 pp. Figures, tables, references, index.

This volume collects papers published during the first four years of publication of the journal *Human Factors and Aerospace Safety*. The papers, now presented as chapters, are classified under the headings of design, operations and training, and air traffic management.

Among the titles are "Head-up Displays and Visual Attention: Integrating Data and Theory"; "Passenger Safety in Future Very Large Transport Aircraft"; "A Review of the Benefits of Aviation Human Factors Training"; "Teamwork at 35,000 Feet: Enhancing Safety Through Team Training"; "Why We Need New Accident Models"; "Controller Workload, Airspace Capacity and Future Systems"; and "Spinning Paper Into Glass: Transforming Flight Progress Strips."

"When the papers are assembled together, it is … noticeable that no longer can the components in the aerospace system be considered in isolation," the editors say. "Safety can only be assured through the integration of its disparate component parts — design, operations, training, air traffic management and passenger safety. All must work together in harmony."

REPORTS

Examining ATC Operational Errors Using the Human Factors Analysis and Classification System

Scarborough, Alfretia; Bailey, Larry; Pounds, Julia. FAA Office of Aerospace Medicine. DOT/FAA/AM-05/25. Final report. December 2005. 35 pp. Available via the Web at <www.faa.gov/library/reports> or through the National Technical Information Service.*

The report describes a study that attempted to systematically examine the underlying human factors causes of operational errors (OEs). The study consisted of three phases: (1) a literature review to identify error models and taxonomies that have been used to classify OEs; (2) selection of an error model or taxonomy for use in the ATC environment; and (3) application of the selected error model or taxonomy to a subset of the items identified by FAA as OE causal factors.

The report says that the Human Factors Analysis and Classification System (HFACS), which "identifies and organizes latent errors using a hierarchical structure involving organizational influences, unsafe supervisory actions, preconditions for unsafe acts and unsafe acts," was found to be a useful taxonomy for classifying the causal factors associated with

OEs. A larger percentage of OEs were classified as skill-based errors than as decision errors.

The study also demonstrated, the report says, that "the 'causal factors' listed in the current OE reporting system [are] lacking in information concerning organizational factors, unsafe supervisory acts and the preconditions of unsafe acts. It is recommended that greater attention be placed on developing a more comprehensive human factors assessment of OE causes across all levels."

Reexamination of Color Vision Standards, Part I: Status of Color Use in ATC Displays and Demography of Color-Deficit Controllers

Xing, Jing; Schroeder, David. FAA Office of Aerospace Medicine. DOT/FAA/AM-06/2. Final report. February 2006. 19 pp. Available via the Web at <www.faa.gov/library/reports> or through the National Technical Information Service.*

FAA standards are used to screen air traffic controller applicants for color deficiency (deficits in color perception) because some job tasks require controllers to discriminate colors. The existing standards were based on analysis of tasks performed in the 1980s, and during the past decade, the use of colors in ATC has increased significantly. In addition, the rapid development of display technologies, the lack of consistent color design among different equipment manufacturers and displays that allow users to define their own color schemes mean that colors used to show the same information vary considerably in ATC facilities.

The report is the first step in an effort to re-examine the color vision standards used for selecting FAA controllers.

The researchers first performed a medical database study to identify the number of controllers with a color deficiency and determined that it was less than 1 percent of controllers in the current workforce. They then investigated the status of color use in ATC displays at three control towers, three terminal radar approach control (TRACON) facilities and three en route centers.

The report summarizes the main findings as follows:

- "All the basic colors and some non-basic colors are being used in ATC displays;
- "Critical information typically involves the use of red or yellow colors; [and,]
- "Colors are used mainly for three purposes: drawing attention, identifying information and organizing information."

The results raise questions about the adequacy of current FAA job-related color vision tests, the report says.

REGULATORY MATERIALS

Fatigue, Fail-safe, and Damage Tolerance Evaluation of Metallic Structure for Normal, Utility, Acrobatic, and Commuter Category Airplanes

FAA Advisory Circular (AC) 23-13A. Sept. 29, 2005. 74 pp. Figures, tables, references, appendixes. Available from FAA via the Web at <www.airweb.faa.gov> or the U.S. Government Printing Office.***

This AC presents an acceptable means of showing compliance with FARs Part 23, *Airworthiness Standards: Normal, Utility, Acrobatic, and Commuter Category Airplanes*. It provides information about approval of continued operational flight with known cracks in the structure of small airplanes, regardless of their certification basis. This AC clarifies the use of AC 20-128A, *Design Considerations for Minimizing Hazards Caused by Uncontained Turbine Engine and Auxiliary Power Unit Rotor Failure*, in the evaluation of rotorburst structural hazards in small airplanes. This AC consolidates existing policy documents and some technical reports into one document.

This AC supersedes AC 23-13, *Fatigue and Fail-Safe Evaluation of Flight Structure and Pressurized Cabin for Part 23 Airplanes*, dated April 15, 1993.

WEB SITES

Flight Safety Foundation, <www.flightsafety.org>

We would like to call attention in this first *Aviation Safety World* to the Web site of the magazine's publisher, Flight

Safety Foundation. Call us immodest if you want, but we think that it's an extraordinary resource.

The Web site contains the archives of FSF publications in PDF format, going all the way back to the 1980s, including a search engine. Titles include *Flight Safety Digest*, *Accident Prevention*, *Aviation Mechanics Bulletin*, *Cabin Crew Safety*, *Airport Operations*, *Human Factors & Aviation Medicine*, and *Helicopter Safety*.

A subject-specific resource guide is available to researchers at the aviation-related sites page within the Library section. It is a brief, concentrated collection of links to other Web sites that also focus on aviation safety.

The research guide is divided into categories that include accident and incident information; civil aviation authorities; regulations, standards and recommended practices; and data and statistics. Most entries link to primary sources of information at government and non-government sites. For example, researchers can link to accident reports, civil aviation rules and procedures, and transportation safety statistics from many countries.

Authoritative sources from around the world are represented. Most sources offer English as a language choice for viewing their web sites.

A limited list of aviation association and commercial metasites are included. (A metasite contains significant and varied amounts of information on a common theme — in this case, aviation safety.)

CHIRP, <www.chirp.co.uk>

CHIRP, managed by The CHIRP Charitable Trust, is a confidential, independent and voluntary incident-reporting program funded by the U.K. Civil Aviation Authority. "The objective of CHIRP is to promote safety in the aviation and maritime sector for employees and others by obtaining, distributing and analyzing safety-related reports which would not otherwise be available; [while] at all times keeping the identity of the reporter confidential," says the site.

Individual entries (comments and questions) in CHIRP's publication, *Feedback*, may be followed by responses from appropriate government departments. Aviation reports are categorized as air transport, cabin crew or general aviation. All information pertains to the United Kingdom, but the information revealed in the reports may be useful to anyone interested in aviation safety.

Feedback is available in full-text, dating back to 1996. Quarterly issues contain figures, tables and photos.

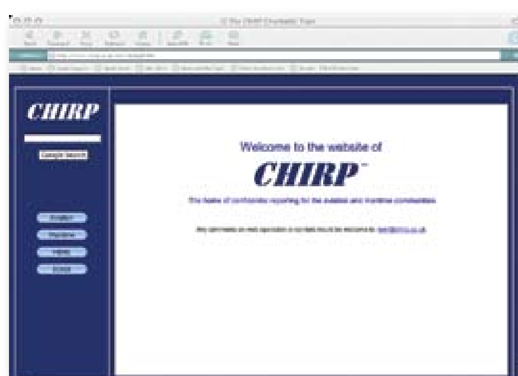
—Rick Darby and Patricia Setze

Sources

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

** U.S. Department of Transportation
M-30
3341 Q 75th Ave.
Landover, MD 20785 U.S.

*** U.S. Government Printing Office
732 N. Capitol St. NW
Washington, DC 20401 U.S.
Web: <www.access.gpo.gov>



Excessive Aft CG Causes Freighter Tail Strike

The MD-11F pitched nose-up when thrust was applied for takeoff for a two-engine ferry flight.

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

Improper Training Cited as a Factor

Boeing MD-11F. Minor damage. No injuries.

The flight crew was conducting a ferry flight from Anchorage, Alaska, U.S., to the operator's maintenance base in Atlanta, Georgia, on Oct. 8, 2004, with the no. 2 engine inoperative and the fuselage center landing gear (CLG) retracted to reduce drag and improve initial climb performance. When they released the wheel brakes and applied thrust for takeoff, the airplane pitched nose-up and the tail struck the runway. The crew rejected the takeoff. An inspection of the airplane disclosed minor damage to the tail.

The operator, World Airways, told the U.S. National Transportation Safety Board (NTSB) that the crew had calculated the airplane's center of gravity (CG) with the CLG extended. "They noted that they were unaware at the time of the incident flight that the airplane's aft limit of CG moved significantly forward with the CLG retracted," NTSB said in its final report on the incident. "The operator said that while the appropriate weight-and-balance information was provided in an appendix to the approved Boeing airplane flight manual, the Boeing MD-11 Two-Engine Ferry Operations Manual the crew was using did not reference any change in the CG with the CLG retracted. The ferry manual also recommends, in the 'Pre-Takeoff' checklist, that the CLG be retracted."

As a result of the miscalculation, the airplane's CG was 3.2 percent of mean aerodynamic chord aft of the limit. The report said that the pitch-up was exacerbated by the absence of thrust from the no. 2 engine, which is mounted high on the tail of the airplane.

Boeing told investigators that the ferry manual for the MD-11 was derived from the manual for the Douglas DC-10, which has a shorter fuselage and does not have a more forward CG limit when the CLG is retracted. "Boeing personnel noted that although the MD-11's ferry manual recommends that the CLG be retracted for a two-engine ferry, it is not essential."

NTSB said that the probable causes of the incident were "the operator's failure to provide sufficient weight-and-balance information to the flight crew, which resulted in a [CG] aft of the limit and a tail strike during the takeoff roll." Factors included "the operator's improper training of the flight crew on two-engine ferry procedures, the flight crew's incorrect calculation of the [CG], the company dispatcher's failure to comply with the proper weight-and-balance procedures, and the airplane manufacturer's unclear/conflicting information contained in their two-engine ferry manual."

After the incident, Boeing issued a flight operations bulletin that said that the two-engine ferry manuals for the DC-10 and MD-11 are out of date and provided information on how operators can obtain current information on two-engine ferry performance and procedures.

Pneumatic Leak Causes Fire Alarm

Airbus A330. No damage. No injuries.

Soon after rotating the airplane for takeoff from Dublin, Ireland, about 1000 local time on June 4, 2004, for a scheduled passenger flight to New York, the flight crew received a fire warning for the no. 2 engine. They declared an emergency, shut down the no. 2 engine and landed the airplane on Runway 28, the departure runway.

After the airplane was inspected by the airport fire officer, it was towed from a taxiway to a gate, where the passengers were disembarked normally. Engineers on site found a pneumatic duct leak in the no. 2 engine and overheat damage to the electrical harness.

"A full post-event inspection revealed that a V-band clamp at the 14th stage manifold lower engine port had detached, allowing hot air (greater than 600 degrees Celsius [1,112 degrees Fahrenheit]) to bleed into the engine core compartment," said the Irish Air Accident Investigation Unit in its final report on the incident. "There was a circumferential split along one of the V-band clamp segments. Localized heat distress was noted over an area of 12 square in [77 square cm], particularly to the electrical harness outer jackets."

They declared an emergency, shut down the no. 2 engine and landed the airplane on Runway 28, the departure runway.

The inspection also found that a lock wire had failed on an adjustment sleeve, causing a misalignment of the manifold. The misalignment resulted in prolonged cyclic tension loading of the clamp, one of three that attach the manifold to the engine ports. The clamp failed because of a fracture that was initiated and propagated by the tension loading, the report said.

Hawker Overruns Slush-Covered Runway

British Aerospace Hawker 700. Minor damage. No injuries.

Nighttime visual meteorological conditions prevailed for the flight from Columbus, Ohio, U.S., to Teterboro, New Jersey, on March 8, 2005. The pilots had not flown together previously, and the pilot-in-command (PIC) told investigators that the copilot's English language proficiency was inadequate.

The copilot obtained the Teterboro automatic terminal information system information, which included surface winds from 320 degrees at 21 kt gusting to 28 kt, 10 mi (six km) visibility in blowing snow and thin slush on all surfaces. The copilot relayed some of the information to the pilot. "However, the copilot did not relay information about the runway conditions to the pilot, nor did the pilot ask about the runway conditions," NTSB said in its final report on the incident.

The crew conducted a visual approach in moderate to severe turbulence to Runway 01, which was 7,000 ft (2,135 m) long. The controller told the crew that the winds were from 340 degrees at 20 kt and that the crews of a Bombardier Challenger and a Gulfstream III had reported good braking action on landing. The report noted that the Challenger and Gulfstream were equipped with thrust reversers. The Hawker did not have thrust reversers.

The Hawker PIC told investigators that he conducted the approach with 25 degrees of flap and at 139 kt — V_{REF} (landing reference speed) plus 20 kt — because of the winds.

The report said that the crew completed a takeoff and landing data card that indicated that 4,240 ft (1,293 m) of dry runway was required for landing at the airplane's gross weight, at 119 kt and with full flaps. The airplane flight manual indicated that landing distance on a 7,000-ft, contaminated runway was equivalent to a landing distance of 3,200 ft (976 m) on a dry runway.

The PIC said that he reduced airspeed to 134 kt over the runway threshold and touched down slightly past the touchdown zone at 129 kt. After telling the copilot to select full flaps, he extended the spoilers. The PIC said that the airplane appeared to decelerate until it reached the midpoint of the runway.

The airplane overran the runway at about 30 kt and was stopped about 230 ft (70 m) past the departure end. The pilots and the two passengers then evacuated the airplane.

NTSB said that the probable cause of the incident was the PIC's "inadequate in-flight planning" and that contributing factors were "inadequate crew coordination, gusty winds and a slush-covered runway."

TURBOPROPS

Departure From Procedure Leads to CFIT

Raytheon Beech King Air 200. Destroyed. 10 fatalities.

The airplane, operated by Hendrick Motorsports, was being used to transport company employees from Concord, North Carolina, U.S., to an automobile race in Martinsville, Virginia, on Oct. 24, 2004. The captain, 51, had 10,733 flight hours, including 210 flight hours in type. The first officer, 31, had 2,090 flight hours, including 121 flight hours in type.

Weather conditions at Martinsville's Blue Ridge Airport included five mi (eight km) visibility, an overcast ceiling at 600 ft and calm winds.

As the King Air neared the airport about 1230 local time, the flight crew was instructed to hold, as published, at 4,000 ft over the final approach fix (FAF) for the localizer approach to Runway 30. The hold was issued because another airplane was on the approach. The King Air crew was turning outbound in the holding pattern when they were cleared to conduct the approach. The crew conducted a continuous turn to establish the airplane on the localizer course inbound.

In its final report on the accident, NTSB said, "An examination of the radar data showed that the airplane flew an approach that was displaced about five nm [nine km] compared with the published approach."

The airplane crossed the FAF at 3,900 ft. The published minimum altitude for crossing the FAF was 2,600 feet. The crew began a descent about two minutes after crossing the FAF and leveled off at 2,600 ft as the airplane crossed the missed approach point (MAP), which was near the runway threshold. The minimum descent altitude (MDA) was 1,340 ft.

The airplane was about one nm (two km) beyond the MAP when the crew began a descent. The descent was stopped at 1,400 ft about five nm from the MAP. "The airplane maintained level flight between 1,400 and 1,500 feet for the next 1 minute 13 seconds," the report said.

A minimum safe altitude warning (MSAW) was generated when the airplane was 2.5 nm (4.6 km) from the airport; the MSAW lasted about 15 seconds. The approach controller told investigators that he did not observe or hear the warning. "However, the MSAW alert was not a factor in this accident because, at the time of the alert, radar services had already been terminated and the airplane was not under the control of ATC [air traffic control]," the report said.

The airplane was about eight nm (15 km) beyond the MAP when the crew began a climb straight ahead and reported a missed approach. The report said that a performance study indicated that the airplane would have remained clear of terrain if the crew had initiated a climbing right turn, as specified by the published missed approach procedure.

The airplane, which was not equipped with a terrain awareness and warning system (TAWS), was near the extended runway centerline and about 10 nm (19 km) from the runway when it struck Bull Mountain at an elevation of about 2,400 ft.

NTSB said that the probable cause of the accident was "the flight crew's failure to properly execute the published instrument approach procedure, including the published missed approach procedure, which resulted in controlled flight into terrain [CFIT]." A contributing factor was "the flight crew's failure to use all available navigational aids to confirm and monitor the airplane's position during the approach."

Convair Starved for Fuel

Convair 580. Destroyed. One fatality, one minor injury.

The airplane was being operated by Air Tahoma on a DHL Express cargo flight from Memphis, Tennessee, U.S., to Covington, Kentucky, on Aug. 13, 2004. The captain, 49, had 25,000 flight hours, including 1,337 flight hours in type. The first officer, 37, had 2,488 flight hours, including 145 flight hours in type; he was the pilot flying.

In its final report on the accident, NTSB said that the captain made an error in his preflight weight-and-balance calculations, which showed that the airplane was not within takeoff limits. Based on his experience and observation of normal nose gear strut extension, he decided to take off and recompute the weight and balance in flight. The investigation found that the airplane was within limits for takeoff.

At 0026 local time, about 48 minutes after takeoff, the captain told the first officer that he was going to "balance out the fuel." The report said that the airplane flight manual prohibits the transfer of fuel from one wing tank to the other. "To do so might build up excessive pressure in a tank, which could result in structural failure or cause fuel to overflow through the vents," the manual says. Crossfeed is permitted only to supply fuel from a wing tank to the engine on that wing and to the engine on the other wing; the shutoff valve must be closed and the boost pump must be turned off for the wing tank that is not being used. The captain did not close the shutoff valve for the right wing tank while crossfeeding fuel from the left wing tank to the right engine.

The first officer told the captain that he was applying "a lot of force" to keep the wings level.

"Postaccident fuel boost pump testing revealed that, in this configuration, all of the fuel from the left fuel tank not used by the engines could transfer into the right fuel tank in a relatively short period of time," the report said.

The captain completed the weight-and-balance calculations about 0034. He told investigators that he had been preoccupied and "stressed" while trying to identify the error in the preflight calculations.

The airplane, which had been modified with turboprop engines, was descending through 11,000 ft about 0039 when the first officer told the captain that the control wheel felt "funny" and that he was applying "a lot of force" to keep the wings level.

The airplane was at 4,000 ft at 0043 when the captain reported the runway in sight. The approach controller cleared the crew to conduct a visual approach to Runway 36R at the Cincinnati/Northern Kentucky International Airport, where visual meteorological conditions prevailed. The controller said, "Keep your speed up."

The first officer said, "What in the world is wrong with this plane? [It] is acting so funny."

The captain said, "We'll do a full control check on the ground." He then began conducting the "In Range" checklist; according to the company's operating procedures, the checklist should be conducted before descending below 12,000 ft.

At 0046, the first officer again commented on the airplane's unusual handling characteristics, saying, "Can you feel it? It's like swinging back and forth."

The captain said, "Yeah. We've got an imbalance on this … crossfeed I left open." The report said that he noticed the fuel imbalance while checking the fuel tank shutoff valve and crossfeed valve positions as required by the "In Range" checklist.

Soon thereafter, the fuel supply in the left wing tank was exhausted, and a loss of power occurred in both engines as the airplane was descending through 2,400 ft. The captain reported "engine problems" to the tower controller but declined an offer to have emergency equipment standing by.

The airplane struck terrain about one nm (two km) south of the airport at 0049. The first officer was killed, and the captain received minor injuries.

NTSB said that the probable cause of the accident was "fuel starvation resulting from the captain's decision not to follow approved fuel-crossfeed procedures." Contributing factors were "the captain's inadequate preflight planning, his subsequent distraction during the flight and his late initiation of the 'In-Range' checklist; [and] the flight crew's failure to monitor the fuel gauges and to recognize that the airplane's changing handling characteristics were caused by a fuel imbalance."

After the accident, Air Tahoma revised its procedures to require that crossfeeding be conducted only if necessary for flight safety, and that the checklist be used and be placed in the throttle quadrant as a reminder to the crew that crossfeeding is in progress.

Strong Gust Blamed for Runway Excursion

Aerospatiale-Alenia ATR 72. No damage. No injuries.

The airplane was being operated by Mount Cook Airline on a scheduled flight from Christchurch, New Zealand, to Queenstown on Oct. 5, 2005, with 47 passengers and five crewmembers aboard. Reported weather conditions at Queenstown included surface winds from 170 degrees at 15 kt, gusting to 25 kt. The crew of a Boeing 737 had reported wind shear on final approach. Four minutes before landing on Runway 23, the ATR 72 flight crew was told by the tower controller that the winds were from 160 degrees at 25 kt and that wind velocity was increasing. The crew briefed for a possible go-around.

Soon after touchdown about 1440 local time, a strong gust struck the airplane and caused it to veer toward the side of the runway. "The gust probably exceeded the aeroplane's crosswind limit and prevented the captain [from] correcting the weathercock," said the New Zealand Transport Accident Investigation Commission (TAIC) in its final report on the incident. "A contributing factor was the reduced effectiveness of the nosewheel steering, because the first officer had not moved the control column far enough forward to ensure [that] there was sufficient weight on the nosewheels."

After touchdown, the captain had turned over the flight controls to the first officer, according to the airline's standard procedure, and had placed his left hand on the nosewheel steering tiller while keeping his right hand on the throttles. He was preparing to select ground idle when the gust struck the airplane.

"The captain said he noticed the control column was not quite as far forward as he would have expected it to be for the conditions," the report said.

After the airplane veered off the runway, a cabin crewmember shouted to the passengers, "Emergency. Grab your ankles." The crew steered the airplane back onto the runway after it rolled on grass parallel to the runway for about 630 m (2,067 ft). The crew then taxied the airplane to the terminal.

PISTON AIRPLANES

'Extreme' Weather Cited in Chieftain CFIT

Piper Chieftain. Destroyed. Three fatalities.

The airplane was scheduled for a charter flight with two passengers from Essendon, Australia, to Mount Hotham on July 8, 2005. While taxiing for takeoff from Essendon, however, the pilot — who had 4,770 flight hours, including 1,269 flight hours in type — changed his destination to Wangaratta. "At the time, the weather conditions in the area of Mount Hotham were extreme," said the Australian Transport Safety Bureau in its final report on the accident.

At 1647 local time, 18 minutes after takeoff, the pilot changed the destination to Mount Hotham and asked a Flightwatch operator to telephone the airport and relay an estimated time of arrival of 1719. "The airport manager, who was also an accredited meteorological observer, told the Flightwatch operator [that], in the existing weather conditions, the aircraft would be unable to land," the report said.

The Flightwatch operator relayed the information to the pilot, who responded, "Our customer is keen to have a look at it."

At 1714, the pilot obtained an instrument flight rules clearance to conduct a global navigation system (GPS) approach to Runway 29. At 1725, he radioed the airport manager that the airplane was on final approach and requested that he activate the runway lights. The airport manager told the pilot that the runway lights were on but received no response.

Air traffic control radar data indicated that the pilot did not conduct the GPS approach as published. "The pilot … conducted a truncated procedure that did not follow any of the prescribed tracks," the report said.

On July 11, the crew of a search helicopter found the wreckage on a ridge about five km (three nm) southeast of the airport and left of the extended runway centerline. "The aircraft had flown into trees in a level attitude, slightly banked to the right," the report said. "Initial impact with the ridge was about 200 ft [61 m] below the elevation of the Mount Hotham aerodrome. The aircraft had broken into several large sections, and an intense fire had consumed most of the cabin."

Weather conditions at the airport at the time of the accident included an overcast ceiling at 100 ft to 200 ft and a visibility of 300 m (984 ft) in snow showers. The report said that the conditions were significantly worse than the published approach minimums.

Before the accident, the pilot had been observed to land at the airport in weather conditions below approach minimums. "An arrival method, of which he had frequently spoken, was to fly down a valley to the southeast of Mount Hotham aerodrome, locate the Great Alpine Road and follow it back to the aerodrome," the report said. "The aircraft appeared to be tracking adjacent to the Great Alpine Road on the last segment of the [accident] flight."

Deicing Boot Separates … Again

Britten-Norman Trislander. No damage. No injuries.

The airplane was rolling for takeoff from Alderney, England, with nine passengers aboard on April 24, 2005, when the crew heard a muffled bang. "All indications were normal, so the takeoff was continued," said the report by the U.K. Air Accidents Investigation Branch (AAIB). After landing in Guernsey, a deicing boot was observed to be missing from the propeller on the right engine.

The report said that on July 23, 2004, a deicing boot had separated from the left propeller on the same airplane during a departure from Guernsey. The boot penetrated a cabin window and injured a passenger. Investigators found that a required filler material had not been applied to the root end of the boot. The absence of the filler allowed moisture to contact and damage the adhesive. "This left a small disbonded area which grew under stress until the deicing boot finally separated," the report said.

After the 2004 accident, AAIB identified about 100 deicing boots installed without the filler after the propellers were overhauled by the same shop. The shop also had installed the boot on the airplane involved in the 2005 incident. Although the required filler had been used, the adhesive had not bonded adequately to the leading edge of the propeller blade.

"These poorly bonded areas provide a means for moisture to 'fast-track' to the center of the joint and, as a result, possibly accelerate the rate of degradation of the adhesive bond," the report said.

AAIB found that adhesive bond strength can be affected by several factors, including temperature, humidity, cure time of the paint finish on the blade and the techniques used to apply adhesive to the boot and to install the boot on the blade. Bond strength also is affected by "compatibility issues between the boots and adhesives," the report said.

The report concluded that "apparently quite minor deviations in the [bonding] process can cause a reduction in bond strength or allow the generally poor peel strength of adhesives to be exploited by mechanical or environmental damage, [which] can lead to boot separation."

HELICOPTERS

Whiteout Conditions Blamed for Rollover

Eurocopter AS350 BA Squirrel. Substantial damage. No injuries.

The helicopter, operated by The Helicopter Line, was on a charter flight Aug. 17, 2005, to transport seven passengers ("helihikers") to a snowfield above New Zealand's Franz Josef Glacier. The pilot, 46, had 1,644 flight hours, including 315 flight hours in type.

The landing area had been marked with flags mounted on cane poles, but the markers had been covered by snow, leaving a totally white environment, said the report by TAIC.

The pilot intended to conduct a slow, run-on landing. During the approach, however, the helicopter became enveloped in blowing snow and began to drift right. The landing skids contacted the soft surface snow, and the helicopter rolled onto its right side. "The pilot and passengers were able to vacate the helicopter and, other than some bruising, were not injured," the report said.

TAIC said that the accident was caused by "the pilot unknowingly entering whiteout conditions as he approached to land on the snow."

Fuel Contamination Causes Engine Failure

Robinson R44 Astro. Minor damage. No injuries.

The pilot and two passengers were on a private flight from Redditch, England, to Bedstone on Feb. 4, 2006. The helicopter was in level flight at 1,000 ft above ground level when the pilot felt "a couple kicks in yaw" that he believed were caused by turbulence from a ridge that he had just flown over.

The pilot began a right turn and lowered the collective control. He then observed and heard low rotor speed warnings and "became aware that the engine noise had stopped," said the report by AAIB. The main-rotor blades struck several trees as the pilot conducted a fast, run-on autorotative landing on a ridge. The helicopter then collided with a fence and a metal farm gate.

The report said that the engine failure was caused by water contamination of the helicopter's fuel system. Investigators found water in the gascolator and fuel bowl. About one liter (one quart) of water was drained from the main fuel tank and one-half liter (one-half quart) of water was drained from the auxiliary fuel tank.

"There was no evidence of water contamination of the fuel supply at the local airfield," the report said. "It is possible that the source of the water was condensation accumulating in the unusable portion of the fuel tanks over a period of time. It is also possible that the owner [the pilot] did not detect the presence of water during the fuel water-sediment checks." ●

Preliminary Reports

Date	Location	Aircraft Type	Aircraft Damage	Injuries
April 23, 2006	Kousseri, Cameroon	Antonov 74TK-200	destroyed	6 fatal
The airplane was being operated by the Libyan air force on a cargo flight from Sebha, Libya, to N'Djamena, Chad. The crew rejected the landing at N'Djamena. The airplane struck terrain near Kousseri.				
April 24, 2006	Lashkar Gah, Afghanistan	Antonov 32B	destroyed	7 fatal
The airplane, leased by the U.S. government, was being landed when a truck crossed the runway. The flight crew maneuvered the airplane off the runway, and it slid into a settlement of nomads. The fatalities included three people on the ground.				
April 25, 2006	Nogales, Arizona, U.S.	General Atomics Predator B	substantial	none
The certified pilot, who was operating the unmanned aerial vehicle (UAV) from a ground control station, said that his console "locked up" and he transferred control to a console that was manned by a camera operator. The pilot said that he failed to adhere to a procedure that requires equipment in the consoles to be matched before transfer of control. The "STOP/FEATHER" switch in the camera-operator's console was in the fuel-cutoff position, resulting in termination of fuel flow to the UAV's turboprop engine. The aircraft struck terrain about 26 nm (48 km) northwest of Nogales at 0341 local time. No one on the ground was hurt.				
April 27, 2006	La Ronge, Saskatchewan, Canada	Convair 580	destroyed	1 fatal, 2 serious
The airplane, which had been converted into an air tanker to fight forest fires, was being operated by the provincial government on a training flight. The crew conducted several touch-and-go landings. Witnesses observed that the propeller on the no. 1 engine was windmilling after the last touch-and-go. The airplane climbed slowly, turned onto the crosswind leg and then descended into a swampy area.				
April 27, 2006	Amisi, Congo	Convair 580F	destroyed	8 fatal
The airplane was being operated by LAC–SkyCongo on a cargo flight from Goma when it struck terrain on approach to the Amisi airport.				

Continued on next page

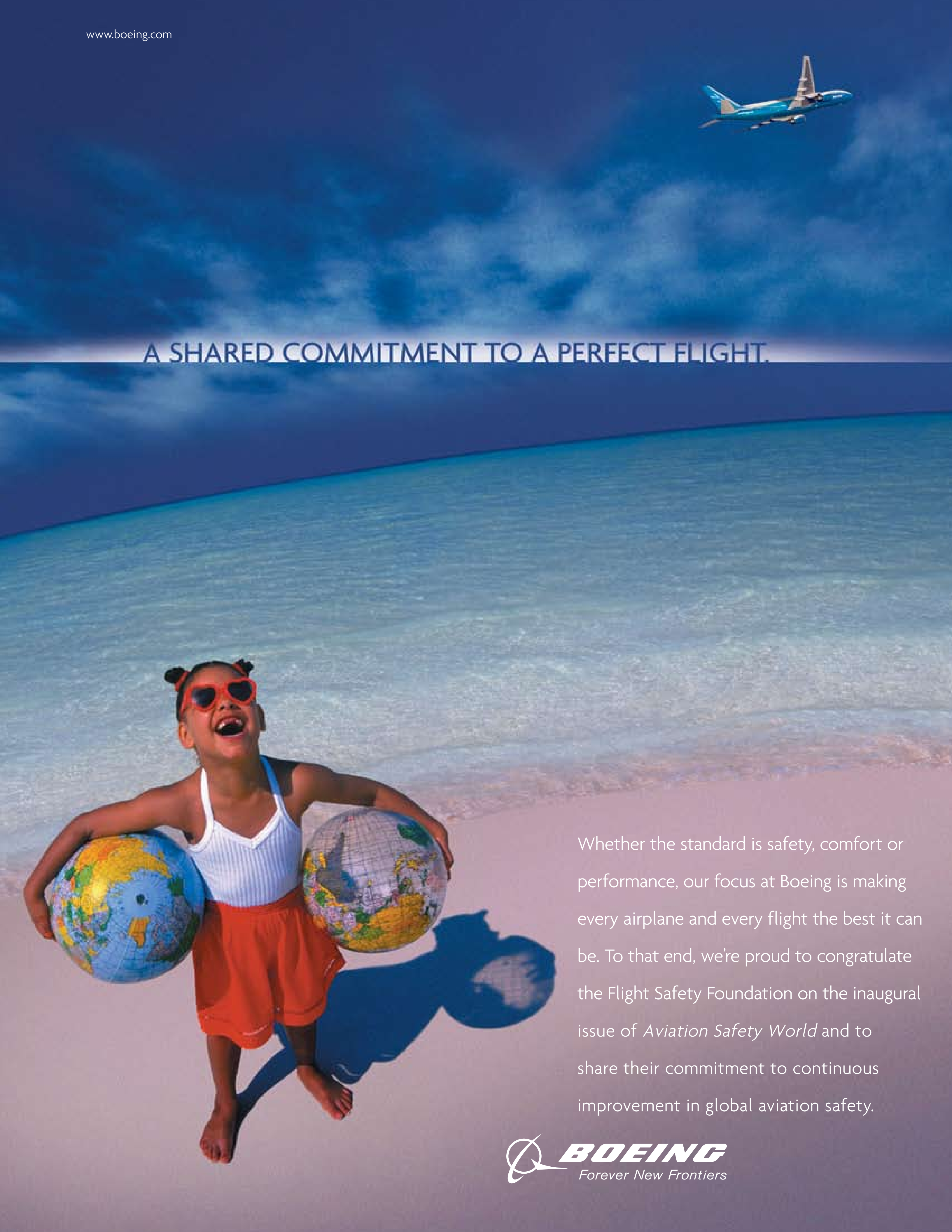
Preliminary Reports

Date	Location	Aircraft Type	Aircraft Damage	Injuries
April 27, 2006	Raleigh, North Carolina, U.S.	Beech C90A	minor	none
The King Air was at 17,000 ft on a corporate flight from Concord, North Carolina, to Chantilly, Virginia, when the pilot saw smoke and flames emerge from the lower left windshield frame. The flames stopped, but the smoke persisted when he deactivated the windshield heating system. The pilot declared an emergency and landed the airplane without further incident.				
April 30, 2006	Kaunakakai, Hawaii, U.S.	Partenavia P68	substantial	2 serious, 3 minor
The airplane, operated by Tora Flight Adventures, struck terrain while departing from a private airstrip about 2000 local time. A passenger said that the airplane had banked steeply after lifting off from the grass airstrip and that the engines were still running after the airplane struck the ground.				
May 3, 2006	Sochi, Russia	Airbus A320	destroyed	113 fatal
The airplane, operated by Armavia, was on a scheduled flight to Sochi from Yerevan. Weather conditions at the airport included 4,000 m (2.5 mi) visibility, a broken ceiling at 600 ft and an overcast ceiling at 2,700 ft. The crew rejected an approach to Runway 06 and were cleared to conduct an approach to Runway 02. The airplane was being maneuvered over the Black Sea when it struck the water about six km (three nm) southwest of the airport.				
May 3, 2006	Sullivan, Ohio, U.S.	Hughes 269B	substantial	none
The helicopter was in level flight about 600 ft above ground level when the pilot heard a loud bang. The helicopter began to yaw, and the pilot determined that tail-rotor control had been lost. During the forced landing in a field, the right landing skid collapsed. The preliminary report said that the tail-rotor drive shaft had failed.				
May 4, 2006	Lincoln, Nebraska, U.S.	BAE 125-800A	NA	6 minor
The crew was slowing the Hawker to conduct a stall during a maintenance test flight at 17,000 ft. They expected the stall to occur at about 106 kt, but the airplane stalled at about 126 kt and abruptly rolled and pitched nose-down. The pilot said that the airplane rolled five to seven times and descended vertically before control was regained below 7,000 ft. The preliminary report said that four passengers were aboard the airplane.				
May 5, 2006	Brussels, Belgium	4 airplanes	destroyed	none
An Airbus A320 operated by Armavia, an A320 operated by Armenian International Airways, an A320 operated by Volare and a Lockheed C-130 operated by the Belgian air force were destroyed by a fire in a maintenance hangar.				
May 5, 2006	Caracas, Venezuela	IAI Arava 201	destroyed	4 fatal, 1 NA
The airplane, operated by the Venezuelan national guard, was en route to Caracas from Puerto Ayachucho. The airplane was about 30 km (16 nm) from the airport when the crew radioed that they were descending from 6,700 ft to 5,000 ft. The wreckage was found on May 7 near the area where the radio transmission was made.				
May 5, 2006	Intracoastal, Louisiana, U.S.	Eurocopter EC120B	destroyed	1 minor
The pilot was conducting a takeoff near an offshore platform when the helicopter pitched up and began rolling left. The pilot selected the hydraulic switch on the collective control but did not regain control of the helicopter, which entered a nose-down spin and descended into the Gulf of Mexico.				
May 6, 2006	Mersin, Turkey	Antonov An-2	destroyed	5 NA
The airplane was en route from Izmir to Adana when it struck mountainous terrain.				
May 8, 2006	Marathon, Florida, U.S.	Cessna 421B	substantial	2 serious
Witnesses saw the airplane flying about 20 ft over the runway with the landing gear retracted. One witness heard a scraping sound before the corporate pilot radioed that he was conducting an emergency go-around; the airplane climbed to about 100 ft, then disappeared from the witness's view. The airplane was found nearly submerged in a canal. Several power lines and poles near the accident site had been damaged.				
May 10, 2006	Camp Hill, Alabama, U.S.	Piper 602P	destroyed	2 fatal
The Aerostar broke up in flight at 16,000 ft while being maneuvered to reverse course in a thunderstorm. A convective SIGMET was in effect for a line of thunderstorms 40 nm (74 km) wide and moving at 35 kt. Tops of the thunderstorms were reported at 44,000 ft.				
May 17, 2006	Portland, Oregon, U.S.	Boeing 757	NA	none
The airplane, operated by United Airlines, was departing from Portland when the left wing slat failed to retract and the emergency slide on the left wing deployed but did not inflate. The crew returned to Portland and landed without further incident.				
May 18, 2006	Fairbanks, Alaska, U.S.	Douglas DC-9	substantial	none
The crew conducted a go-around after the right wing struck the ground during an attempted landing on Runway 19R. Winds were from 250 degrees at six knots.				

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: Aviation Safety Network, U.S. Federal Aviation Administration, U.S. National Transportation Safety Board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