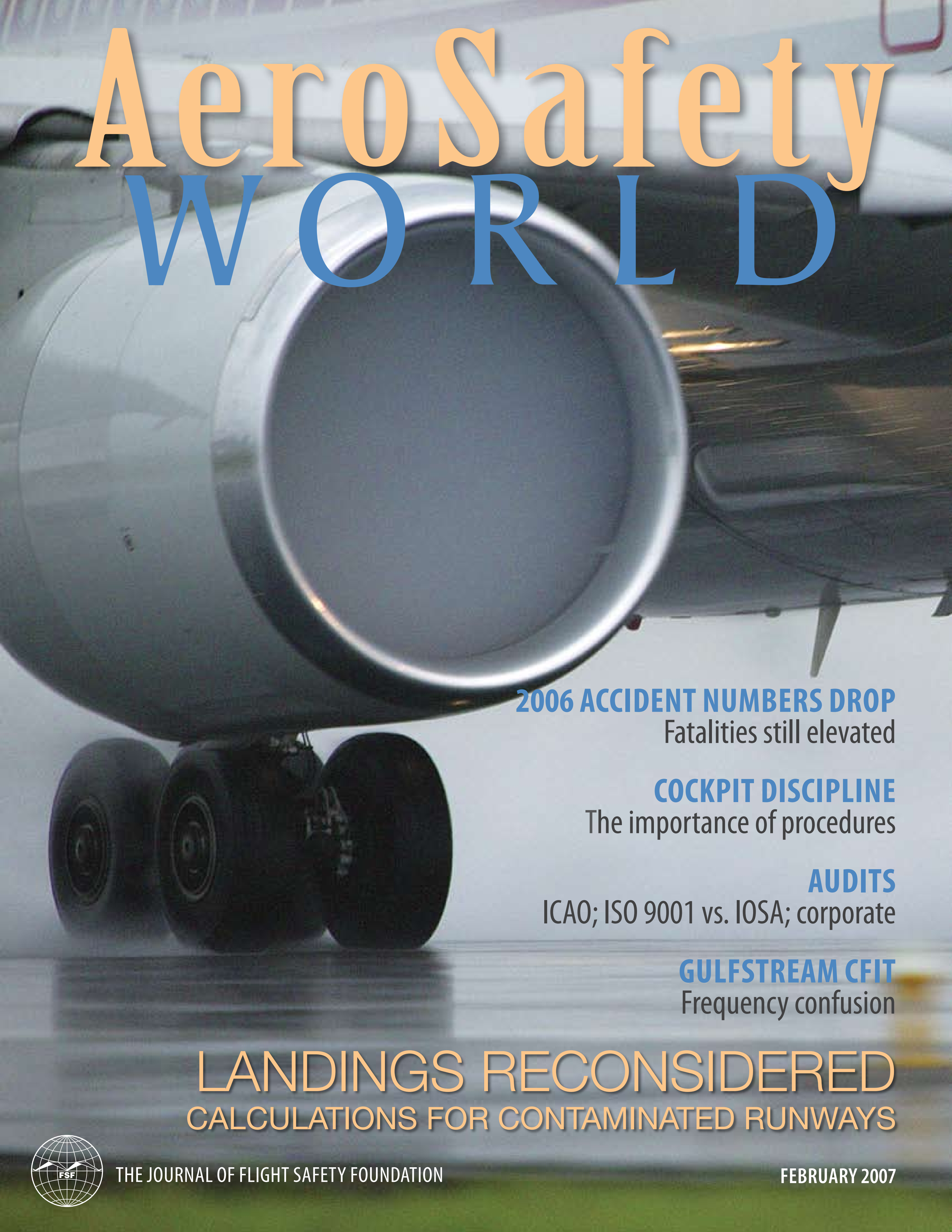

AeroSafety WORLD

2006 ACCIDENT NUMBERS DROP
Fatalities still elevated

COCKPIT DISCIPLINE
The importance of procedures

AUDITS
ICAO; ISO 9001 vs. IOSA; corporate

GULFSTREAM CFIT
Frequency confusion

LANDINGS RECONSIDERED
CALCULATIONS FOR CONTAMINATED RUNWAYS

THE JOURNAL OF FLIGHT SAFETY FOUNDATION

FEBRUARY 2007

UNNATURAL Acts

I've spoken recently about the importance of connections that must be formed among the regulator, the boardroom and the operation. These connections are being implemented as we put safety management systems in place around the world. That is a huge step forward, but more needs to be done. We need to build connections that let us solve safety problems across our professions, and that doesn't come naturally.

As a community, we have done a very good job of dealing with problems that focused on individual safety disciplines. In the last 20 years we have overhauled the entire concept of maintenance and airworthiness to deliver a fleet that is extraordinarily safe and reliable. We have applied human factors expertise to every inch of the cockpit to prevent and contain inevitable human errors. We have reduced the risk of controlled flight into terrain accidents through improved technology, training and procedures.

What remains are the problems that cross disciplines and communities. Here's one example of this sort of problem: runway safety. When I travel around the world, everybody I talk to is worried about runway incursions, runway excursions and runway confusion. This problem requires air traffic control, airports and airline operations to work together. Another example of a problem that crosses disciplines is midair collisions. Read the press reports about the Brazil crash if you want to see how difficult it can be to solve problems across air traffic control and flight operations.

Let's be honest. Working across professions in our business is not easy. At 18, I went to mechanic school with a brand-new commercial pilot certificate. I learned quickly about the divide that separates those two professions. At 25, I went to air traffic control school with airline transport pilot and mechanic licenses and learned my prior experience was definitely not appreciated, but could be overlooked if I never mentioned it again! In my 30s, I started working with airport engineers and found out that after basically living at airports for more than 20 years, I had almost nothing in common with the people who ran them.

That is the challenge for us now. Accidents don't respect the cultural walls we have erected, so we are going to have to do some things that don't come naturally. We will have to build connections that bind together the safety systems that drive our disparate professions. At every level, we have to build mechanisms that allow for the exchange of data and the development of solutions that cross disciplines. This isn't a new idea; good safety managers have been doing this for years. But it can't be haphazard. It needs to be part of our new culture.

This will be a long-term leadership challenge. At FSF, we will be looking for ways to rise to that challenge. In the next few months, we will be kicking off a runway safety initiative that brings air traffic control, airports and flight operations together to solve problems. At every opportunity we will be looking for a chance to solve the cross-cutting problems, build those connections and create a culture where such unnatural acts become commonplace.

William R. Voss
President and CEO
Flight Safety Foundation

AeroSafetyWORLD

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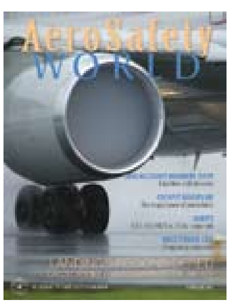

About the Cover
A new look at stopping distances
on contaminated runways.
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AeroSafetyWORLD

William R. Voss, publisher,
FSF president and CEO
voss@flightsafety.org, ext. 108

J.A. Donoghue, editor-in-chief,
FSF director of publications
donoghue@flightsafety.org, ext. 116

Mark Lacagnina, senior editor
lacagnina@flightsafety.org, ext. 114

Wayne Rosenkrans, senior editor
rosenkrans@flightsafety.org, ext. 115

Linda Werfelman, senior editor
werfelman@flightsafety.org, ext. 122

Rick Darby, associate editor
darby@flightsafety.org, ext. 113

Karen K. Ehrlich, web and print
production coordinator
ehrlich@flightsafety.org, ext. 117

Ann L. Mullikin, production designer
mullikin@flightsafety.org, ext. 120

Susan D. Reed, production specialist
reed@flightsafety.org, ext. 123

Patricia Setze, librarian
setze@flightsafety.org, ext. 103

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Flight Safety Foundation
601 Madison Street, Suite 300, Alexandria, VA, 22314-1756 USA
tel: +1 703.739.6700 fax: +1 703.739.6708

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UNINTENTIONAL Drift

Pilots are unusually capable people. If you don't believe me, just ask any pilot. They'll confirm it.

Before cramming my inbox, pause and let me add two more things. First, I wasn't kidding and, second, to do what pilots do they must have a high degree of self-confidence and a tendency to be candid, even blunt, in their communications because that is what is needed for the job.

The ability to function intuitively in three dimensions is something a pilot takes for granted but is not shared by many in the population. Considering the high level of skills and training most pilots have, and the evident love of the profession and therefore the attention paid to it, some understanding is achieved about why pilots have a good deal of self-confidence.

This self-confidence is justified and confirmed on a daily basis when they flout the law of gravity and return to talk about it. If such a bedrock law of nature can be overcome so routinely, maybe other rules can also be rejected, or at least modified. But pilots know that gravity cannot be ignored, and that its effects can be mitigated for relatively brief intervals only if numerous protocols are observed.

Yet, how pilots can get themselves and their aircraft into trouble is a subject that certainly will remain a topic of exhaustive examination after all of us are long gone simply because there seem to be an infinite number of routes through which this can occur.

In the past several months, *ASW* has included stories that examined the trouble pilots can get themselves into by pushing too hard in their attempts to complete the mission. "Pressing the Approach" detailed examples of how the desire to complete an approach kept crews from recognizing how badly out of shape their situation had become (*ASW*, December 2006, p. 28).

In this issue we are told that corporate pilots' desire to get the job done and please the customer leads them to bend the rules, even to the point of violating procedures established for their protection (p. 35). While that story discusses "procedural intentional noncompliance," that's not what this discussion concerns. It is the unintentional noncompliance borne in the effort to solve an evolving problem.

The paradox is that the same self-confidence that allows pilots to do the job also can evolve, through experience, into allowing an in-flight situation to move one step closer to an unsafe condition, or even an accident. The authors of the "Pressing" story said the willingness to push an approach despite numerous problems piling up comes from having gone a bit outside the lines before and getting away with it. The next time, maybe a little bit more outside, and the drift sets in. This insidious but very human behavior deserves a great deal of attention.

On the other hand, it is difficult to get one's mind around accidents that happen because pilots invited disaster by casting aside reason and training, violating rules in ways that dare fate to take its revenge. The Pinnacle accident report is the most obvious one of this sort recently, but there are others less egregious, such as the Teterboro Challenger accident in which aircraft weight and balance got inadequate consideration. But these are more basic, traditional problems.

It is the unintentional standards drift that needs further discussion to keep the idea working on the conscious level.

Plotting Failures and Successes

Reading the President's Message (*ASW* 12/06, p. 1) — the words, "Step back for a moment to consider the white space above the line. That space represents the accidents that did not occur" — triggered an image in my mind going back to the Challenger Space Shuttle mishap. *Engineering Ethics*, a book by Rosa L.B. Pinkus, is dedicated to a thorough analysis of that accident.

The proper use of statistics is discussed, and it is concluded, among other things, that on the evening before the launch, the wrong graph was made up. It plotted seal failures as a function of temperature (book fig. 14.5). This graph shows that three launches below 60 degrees F had failed joints (five in total). Four launches above 60 degrees F had failed joints (five in total).

But the graph included only the seven flights in which a failure had occurred, and the database essentially stopped at 53 degrees F at the lower end.

However, had they plotted *all* available seal statistics against temperature (book fig. 14.6) — based on 23 flights — it would have been clear that there was an inverse relationship between failure and temperature. This graph with also the successes shows that all three launches (i.e., 100 percent) below 60 degrees F had failed joints (five in total). Only four out of 20 launches (i.e., 20 percent) above 60 degrees F had failed joints (five in total).

(This was statistically a nonsignificant sample, but it was what they should have worked with, a situation familiar to engineers.) The flights in which no damage occurred were grouped toward the high-temperature end of the scale, and the single high-temperature failure was a far outlier. Because the predicted temperature the morning of the launch was below 40 degrees F, the inevitable conclusion would have been *not* to launch because of the high likelihood of the failure of a nonredundant seal.

Now, in aviation, we all do the same as in pre-Challenger days: we plot failures, and almost never failures *and* successes. In other words, this is the "white space" that William Voss talks about.

If we want to raise the safety bar, a better understanding of today's statistics would be a big bonus. Recording both failures and successes could do that.

Rudi den Hertog
Fokker Services

Balancing Act

Mr. Chiles's assertions in the InSight column (*ASW* 12/06, p. 24) are at odds with the U.S. Federal Aviation Administration advisory circular — 120-27E, *Aircraft Weight and Balance* — he references. He appears to have taken the position that using average weights is without risk because there are envelope constrictions to compensate for other center of gravity (CG) error-causing phenomena. For passenger seating, Mr. Chiles claims that envelope curtailments eliminate the negative safety aspects of using average weights. His reasoning is that the FAA requires CG curtailments to compensate for passengers leaving empty seats at other-than-expected locations. However, Mr. Chiles fails to note that air carriers are allowed to eliminate the curtailments when all seats are filled (the scenario in the original article; *ASW* 7/06, p. 55).

Mr. Chiles defeats his own argument with, "Cabins are frequently subdivided into separate loading zones to further reduce potential error and to minimize reductions of the certified limits." Taken to the extreme, an operator can designate every row of seats as a zone. Then there is no longer a need for curtailments because the location of every empty seat is known. That technique is used by at least one U.S. airline.

On Jan. 8, 2003, 21 people died in Charlotte, North Carolina, because the airplane was out of CG. The U.S. National Transportation Safety Board seems to believe that increased average weights would not have prevented the airplane from departing with the CG aft of limits.

While not easy or inexpensive, we must find solutions that will guarantee that an airplane is within its weight-and-balance limits prior to flight. Until we do that, every takeoff is playing the odds. Making "reasonable" assumptions will not change that fact.

Keith Glasscock

Editorial note: Keith Glasscock is the author of the original InSight article on this subject, "One Size Fits All? The Danger of Average Weights."

MARCH 1–3 ➤ Heli-Expo 2007 Conference & Exhibition. Helicopter Association International. Orlando, Florida, U.S. Marilyn McKinnis, <marilynmckinnis@rotor.com>, <www.heliexpo.com>, +1 703.683.4646.

MARCH 6–7 ➤ Human Factors in Aviation — Academics and Application. Morning Star Aviation Safety. San Antonio, Texas, U.S. Capt. David L. Bair, <davidbair@morningstaraviation.net>, <morningstaraviation.net/home.php?page=conferences>, +1 720.981.1802.

MARCH 12–14 ➤ 19th annual European Aviation Safety Seminar (EASS): "Staying Safe in Times of Change." Flight Safety Foundation and European Regions Airline Association. Amsterdam, Netherlands. Namratha Apparao, <apparao@flightsafety.org>, <www.flightsafety.org>, +1 703.739.6700, ext. 101.

MARCH 13–14 ➤ 13th Annual Middle East Airline Engineering & Maintenance Conference. Aviation Industry Conferences. Abu Dhabi, United Arab Emirates. Daisy Munro, <daisym@aviation-industry.com>, <www.aviationindustrygroup.com>, +44 (0)20 7931 7072.

MARCH 16–20 ➤ Dubrovnik '07: 62nd IFALPA Conference. International Federation of Air Line Pilots' Associations. Dubrovnik, Croatia. <www.ifalpa.org/conference>.

MARCH 20–22 ➤ Aviation Industry Expo. National Air Transportation Association and the Professional Aviation Maintenance Association. Orlando, Florida, U.S. Jill Hilgenberg Ryan, <jill.hilgenberg@cygnusexpos.com>, <aviationindustryexpo.com>, +1 952.894.8007, 800.827.8009, ext. 3349.

MARCH 20–25 ➤ Australian International Airshow. Aerospace Australia. Victoria, Australia. <expo@airshow.net.au>, + 61 3.5282.0500.

MARCH 26–29 ➤ 34th Annual International Operators Conference. National Business Aviation Association. San Diego. Dina Green, <dgreen@nbaa.org>, <web.nbaa.org/public/cs>, +1 202.783.9357.

MARCH 26–30 ➤ Worldwide Symposium on Performance of the Air Navigation System. International Civil Aviation Organization Air Navigation Bureau. Montreal. <perf2007@icao.int>, <www.icao.int/icao/en/anb/meetings/perf2007/index.html>, +1 514.954.5831.

MARCH 27–29 ➤ Aerospace Testing Expo 2007. UKIP Media and Events. Munich, Germany. Ben Drew, <bendrew@ukintpress.com>, <www.aerospacetesting-expo.com>, +44 (0)1306 743744.

MARCH 28–31 ➤ Aircraft Electronics Association 50th Annual Convention & Trade Show. Reno, Nevada, U.S. <info@aea.net>, <www.aea.net>, +1 775.789.2000, 800.501.2651.

APRIL 2–4 ➤ Maintenance Management Conference. National Business Aviation Association. San Diego. Dina Green, <dgreen@nbaa.org>, <web.nbaa.org/public/cs>, +1 202.783.9357.

APRIL 2–5 ➤ 58th Annual Avionics Maintenance Conference. ARINC. Phoenix, Arizona, U.S. Roger S. Goldberg, +1 410.266.2915.

APRIL 4–5 ➤ 8th Annual Airline Line Maintenance Conference. Aviation Industry Conferences. Lisbon, Portugal. <amandap@aviation-industry.com>, <www.aviationindustrygroup.com>, +44 (0)207 931 7072.

APRIL 15–18 ➤ FAA Tech Transfer Conference and Exposition. American Association of Airport Executives, U.S. Federal Aviation Administration, et al. Atlantic City, New Jersey, U.S. Tom Zoeller, <tom.zoeller@aaae.org>, <www.aaae.org>, +1 703.824.0500.

APRIL 16–17 ➤ ACI–NA Public Safety & Security Spring Conference. Airports Council International–North America. Spokane, Washington, U.S. Amy Peters, <apeters@aci-na.aero>, <www.aci-na.org>, +1 202.293.8500.

APRIL 17–19 ➤ MRO 2007 Conference & Exhibition. *Aviation Week*. Atlanta. Lydia Janow, +1 212.904.3225, 800.240.7645.

APRIL 18–19 ➤ ERA Regional Airline Conference. European Regions Airline Association. Lisbon, Portugal. Paula Bangle, <paula.bangle@eraa.org>, <www.eraa.org/inside-era/RAC07.php>, +44 (0)1276 856495.

APRIL 24–26 ➤ 9th Annual Canadian Airport Management Conference. Airports Council International–North America and Canadian Airports Council. Ottawa. <meetings@aci-na.aero>, <www.aci-na.org>, +1 202.293.8500.

APRIL 25–27 ➤ 2nd China International Conference & Exhibition on Avionics and Test Equipment (AvioniChina). Grace Fair. Shanghai. Jasper Shi, <jasper@gracefair.com>, <www.gracefair.com/avi_home.htm>, +86 10 64390338, ext. 85.

MAY 7–9 ➤ 4th International Aircraft Rescue Fire Fighting Conference & Exhibition. *Aviation Fire Journal*. Las Vegas. <www.aviationfirejournal.com/vegas/contact.htm>, +1 914.962.5185.

MAY 8–10 ➤ 52nd annual Corporate Aviation Safety Seminar: "Safety — The Foundation for Excellence." Flight Safety Foundation and National Business Aviation Association. Tucson, Arizona, U.S. Namratha Apparao, <apparao@flightsafety.org>, <www.flightsafety.org>, +1 703.739.6700, ext. 101.

MAY 13–17 ➤ Aerospace Medical Association 78th Annual Scientific Meeting. New Orleans. Russell B. Rayman, M.D., <rrayman@asma.org>, +1 703.739.2240, ext. 103.

MAY 15–17 ➤ Fifth Anniversary RACCA Conference. Regional Air Cargo Carriers Association. Scottsdale, Arizona, U.S. <stan@raccaonline.org>, <www.raccaonline.org/html/conference.html>, +1 508.747.1430.

MAY 15–17 ➤ Wildlife Hazard Management Workshop. Embry-Riddle Aeronautical University, Center for Professional Education. Charlotte, North Carolina, U.S. Billy Floreal, <florealb@erau.edu>, <www.erau.edu/ec/soctapd/seminar_progs.html>, +1 386.947.5227.

MAY 22–24 ➤ European Business Aviation Convention & Exhibition (EBACE 2007). National Business Aviation Association and European Business Aviation Association. Geneva. Kathleen Blouin, <kblouin@nbaa.org>, <www.ebace.aero>, +1 202.783.9364.

MAY 28–30 ➤ Airport Show Dubai. Dubai, United Arab Emirates. <mail@theairportshow.com>, <www.theairportshow.com>, +9714 3329029.

JUNE 3–5 ➤ 3rd Annual International Airfield Operations Area Expo & Conference. *Airport Business*. Milwaukee. Carmen Seeber, <carmen.seeber@cygnuspub.com>, <www.aoaexpo.com>, 800.547.7377, ext. 1622, +1 920.563.6388, ext. 1622.

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

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

Check, and Re-Check

The U.S. Federal Aviation Administration (FAA) should require air carrier aircraft operators to establish procedures requiring flight crews to "positively confirm and cross-check the airplane's location at the assigned departure runway" before beginning a takeoff, the U.S. National Transportation Safety Board (NTSB) says.

The NTSB issued the safety recommendation as a result of its ongoing investigation of an Aug. 27, 2006, accident in which a Comair Bombardier CRJ100 crashed during a predawn takeoff in Lexington, Kentucky, U.S. Of the 50 people in the airplane, 49 were killed, and one — the first officer — was seriously injured.

"The airplane had been cleared by air traffic control (ATC) for takeoff on Runway 22, which is 7,003 ft [2,136 m] long; however, the crew mistakenly taxied onto Runway 26, which is 3,500 ft [1,068 m] long, and attempted to take off," the safety recommendation says. "The cockpit voice recorder (CVR) did not record any indication that either pilot was confused about the aircraft's position, but no statements were made confirming the aircraft's position. CVR and flight data recorder data indicate that, as the airplane accelerated during the initial takeoff roll, both pilots noted the absence of edge lights on the runway but continued the takeoff roll."

The safety recommendation says that flight crews of aircraft operated under U.S. Federal Aviation Regulations Part 121 should confirm their location before the aircraft crosses the hold-short line for takeoff.

An accompanying safety recommendation says that the FAA should require Part 121 operators to provide "specific guidance to pilots on the runway lighting requirements for takeoff operations at night."

Thorn Airfield Lighting

MU-2B Training Proposal Revised

The U.S. Federal Aviation Administration (FAA) last month clarified some of the special training requirements that it proposed in September for Mitsubishi MU-2B pilots (see *ASW*, 1/07, p. 32). In a supplemental notice of proposed rule making, the FAA provided the following revised definitions:

- "*Initial/transition training* means the training that a pilot is required to receive if that pilot has fewer than 50 hours of documented flight time manipulating the controls, while serving as pilot-in-command [PIC], of [an MU-2B] in the preceding 24 months;
- "*Requalification training* means the training that a pilot is: eligible to receive in lieu of initial/transition training if that pilot has at least 50 hours of documented flight time manipulating the controls, while serving as [PIC], of [an MU-2B] in the preceding 24 months; [or] required to receive if it has been more than 12 months since that pilot successfully completed initial/transition, requalification or recurrent training. Successful completion of initial/transition training can be used to satisfy the requirements of requalification training; [and,]
- "*Recurrent training* means the training that a pilot is required to have satisfactorily completed within the preceding 12 months. Successful completion of initial/transition or requalification training within the preceding 12 months satisfies the requirement of recurrent training. A pilot must successfully complete initial/transition training or requalification training before being eligible to receive recurrent training."

— ML

Mitsubishi Heavy Industries America

Airprox Attributed to Unapproved Descent

The failure of a Tupolev Tu-154M flight crew to comply with air traffic control instructions resulted in an airprox — or aircraft proximity — event involving an Airbus A319 near Zurich, Switzerland, the Swiss Aircraft Accident Investigation Bureau (AAIB) said.

The radar recording showed that, at the closest point, the two airplanes had an altitude difference of 300 ft and a lateral separation of 1.5 nm (2.8 km).

The final AAIB report on the Feb. 14, 2005, event said that the Tu-154M was being ferried from Warsaw, Poland, to Zurich and was nearing Zurich when an air traffic controller told the pilots to descend from Flight Level (FL) 170 (approximately 17,000 ft) to FL 150. At the time, the A319, en route to Zurich from Cologne/Bonn, Germany, was in level flight at FL 130.

The report said that the Tu-154M crew believed that their clearance was for a descent to FL 110. Their airplane descended to FL 133 before they began a climb back to FL 140, as directed by the controller.

Each flight crew received a traffic advisory from the on-board traffic-alert and collision avoidance system (TCAS) and established visual contact with the other airplane; the controller received a warning from the short-term conflict alert system, the report said.

"It must remain open as to why the crew of the Tu-154M was of the opinion it had received an instruction to descend to FL 110," the report said. However, one possibility was that the controller's instruction repeated the word "one" several times, and "given the many 'ones,' during execution, it could subsequently have caused the crew to erroneously continue its descent," the report said.


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New Life for Aging Helicopters

The U.S. Federal Aviation Administration has begun a five-year program to apply aging aircraft reliability techniques to helicopters. The project also will evaluate the characteristics of new composite materials in a variety of operating conditions.

"The margin for error in flying a helicopter, especially in rescue missions, is very slim," said Sankaran Mahadevan, a Vanderbilt University professor of civil and environmental engineering who is the project's principal investigator. "We want to make sure that helicopter pilots don't have to deal with equipment failure, such as metal fatigue, on top of the challenges of shifting winds, unseen obstacles like power lines, birds flying into the blades and space limitations of maneuvering in tight spots."

Taking Steps to Fix Faulty Generators

The U.K. Air Accidents Investigation Branch (AAIB) has issued a series of safety recommendations as a result of its preliminary investigation of a Sept. 15, 2006, incident involving the in-flight failure of an auxiliary power unit (APU) generator on an Airbus A319-111. The airplane had been dispatched with the APU generator on line in place of the faulty no. 1 main generator, under provisions of the operator's minimum equipment list.

During cruise on the flight from Alicante, Spain, to Bristol, England, the airplane was near Nantes, France, when the APU generator disconnected, the AAIB report said. As a result, power was lost for some flight instruments and all radio telephony (RTF) communication, and the crew was unable to manually reconfigure the electrical system to recover the services. Instead, they selected the emergency transponder code and continued the flight in accordance with the flight plan. At Bristol, the crew used the emergency landing gear extension system and landed the airplane safely.

The AAIB issued safety recommendations calling for Airbus to revise the "fault-monitoring logic of the generator control unit [on A320-series aircraft, from which the A319 was derived] to prevent the monitoring system from incorrectly interpreting a fault within the [unit] as an external system fault" and to modify the electrical system to "automatically transfer the electrical feed to the AC essential bus bar in the event of the loss of the no. 1 main AC bus bar."

Two other recommendations called on Airbus to advise operators of A320s in which RTF communications rely on a single bus bar that they could experience a loss of all RTF communications and to modify the digital audio management units to ensure that power supplies for RTF communications have "an improved level of segregation."

Wire Watch

Citing statistics showing that nearly 75 percent of wire strike accidents and incidents involve wires that pilots had previously identified, the Civil Aviation Safety Authority (CASA) of Australia is warning aerial agriculture pilots to be "extra vigilant" about the risks of wire strikes.

"Preflight planning has to be extremely thorough to identify wire strike risks, while wire awareness must be maintained at all times during low-level flight," CASA said. A CASA report quoted Phil Hurst, chief executive officer of the Aerial Agriculture Association of Australia, as saying that planning and risk management are essential in aerial agriculture operations and should include a hazard checklist to identify wires and a survey flight from a safe altitude.

Data show that 119 wire strike accidents occurred in Australia from 1994 through 2004; of these, 74 accidents, or 62 percent, involved aerial agricultural flights.

More Reports of Bird Strikes

The number of reported bird strikes in the United Kingdom increased significantly during the two years following a 2004 legislative change that required all bird strikes in U.K. airspace to be reported, according to a report prepared for the U.K. Civil Aviation Authority (see *ASW*, 1/07, p. 37). The previous requirement was for reporting bird strikes that resulted in aircraft damage.

Nevertheless, the report said that there was a continuing need for reminders to airports and aircraft operators to share not only bird strike reports but also warnings of bird activity. The report also recommended increased efforts to publicize the proper methods of reporting bird strikes and providing feedback on the reports.

The report said that researchers found significant variations in information sharing. For example, the report said, "Some aircraft operators routinely copy their bird strike reports to the aerodrome management, seeing such exchange as vital. Others do not; indeed, one aircraft operator who was interviewed said that he had deliberately decided not to do so, as the resulting additional paperwork would tend to dilute the significance of more important messages."

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In other news …

The **Civil Aviation Administration of Moldova** has warned that an Antonov An-28 being prepared for operation by an unknown operator in the Democratic Republic of the Congo is not airworthy (see *ASW*, 12/06, p. 18). …The **General Administration of Civil Aviation of China (CAAC)** and **Japan Airlines** have reached an agreement calling for the airline to work with the Civil Aviation Safety Institute of China on several projects "aimed at contributing to the development of global flight safety." … **Steven R. Chealander**, a former captain with American Airlines and pilot in the U.S. Air Force, has been sworn in as a member of the U.S. National Transportation Safety Board. … **Switzerland** has become the fourth non-European Union country to become a member of the European Aviation Safety Agency; the others are Iceland, Liechtenstein and Norway. … **David North**, former editor-in-chief of *Aviation Week & Space Technology* and current chairman of the *AeroSafety World* editorial advisory board, has received the 2006 Lauren D. Lyman Award for excellence in aviation journalism from the Aerospace Industries Association.

Compiled and edited by Linda Werfelman.

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TOO OLD TO FLY?

ICAO has increased the mandatory upper age limit for airline pilots to 65, but some wonder if a limit is really necessary.

BY LINDA WERFELMAN

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Most people are in their 40s or older when they become aware that they are experiencing gradual age-related physical and mental changes. The effects of aging are different for everyone, however, and the age-related developments that present problems for some people at 40 may materialize for others when they are considerably younger or older — or they may not materialize at all.

The effect of aging on pilot performance has been the subject of numerous studies; results have been mixed. The Aerospace Medical Association (AsMA) said that, because of the significant differences in study findings,


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"a clear understanding of the relationship between age, pilot performance and safety [is] difficult."[1] Many national civil aeromedical authorities have dealt with the issue by imposing an upper age limit — for commercial airline pilots. In November, the International Civil Aviation Organization (ICAO) increased its mandatory age limit from 60 to 65 for pilots-in-command; in recent years, some national civil aviation authorities have rejected limits altogether.

"Pilot cognitive performance has been shown to generally decline with age."

Unavoidable Changes

Age-related physiological changes are unavoidable (see "Help for Aging Bodies," page 13, and "Changing With Age," page 14).

Some of these changes, like wrinkled skin and graying hair, have no real effect on the body's ability to function — and no effect on a pilot's ability to fly an airplane.

Other changes, however, can diminish vision, hearing or mental acuity, all of which can present problems — often correctable — for pilots and other crewmembers.

Still other changes, most notably cardiovascular disease and associated heart attacks and strokes, can — rarely — present the risk of sudden incapacitation. When the first age limits were imposed on commercial airline pilots in the 1960s, sudden incapacitation often was cited as a major concern. Subsequent studies have found that, although the risk of in-flight incapacitation increases with the pilot's age, it does not present a significant risk to the safety of flight — in part because, with two-pilot crews, another pilot is available to take the controls in the event the pilot flying is incapacitated.[2]

A number of studies have examined the effects of age-related changes — physical and mental — on flight performance and have concluded that these changes usually are "progressive and continuous," AsMA said in a summary of study findings. Often, mental changes are of greater concern to aeromedical specialists than physical changes.

"Pilot cognitive performance has been shown to generally decline with age, with the possible exception of time-sharing tasks," AsMA said. "While pilot performance on most memory tasks has shown age-related declines, aviation expertise has been shown to reduce age differences on more aviation-related memory tasks. Some studies document age-related declines in attention, while others show that the performance of older subjects equals that of younger subjects."

The AsMA report said the review of study findings resulted in three conclusions: "First, performance on measures of most (not all) cognitive functions decline with advancing age. Second, the group of average effects may not predict the performance of any specific individual. Third, there are limited data demonstrating that the observed 'declines' in test performance are predictive of any changes in performance in the cockpit."

A 2006 study of pilot error in air carrier accidents found that the "prevalence and patterns of pilot error … do not seem to change with pilot age."[3]

Age 60 Versus Age 65

For decades, regulatory authorities have adopted upper age limits in an attempt to reduce risks. In 1919, ICAO's predecessor, the International Commission for Air Navigation, established a limit of age 45. ICAO began recommending an age-60 limit in 1963 — four years after what was then the U.S. Federal Aviation Agency (FAA) imposed a mandatory age-60 limit — and ICAO's recommendation became a mandatory standard for pilots-in-command in 1978. In November 2006, a revision of the ICAO standard increased the upper age limit to 65 for commercial pilots of two-pilot aircraft, on the condition that only one pilot per flight crew is older than 60. In addition, ICAO said that an aeromedical exam is required every six months for pilots 60 and older.[4]

The ICAO Air Navigation Commission, which recommended the change, said that, since 1978, when the age-60 limit was adopted, "the increase in longevity and associated good health into old age in many states, the progress of medical science, the introduction in incapacitation training for multi-pilot operations and advances in aircraft technology have altered the flight safety risk associated with aging pilots."[5]

When the standard took effect, several countries held to the old age-60 limit. Of those, at least one — the United States — was considering increasing the limit to 65.

Even after the ICAO change, some aeromedical specialists — including aeromedical authorities that have abolished age limits in several countries — said that commercial pilots should not be barred from the flight deck simply because of age.

"The big things that brought on the age-60 rule aren't factors any more," said Dr. Stanley R. Mohler, professor emeritus of aerospace medicine at Wright State University in Dayton, Ohio, U.S., and a member of the Federal Aviation Administration (FAA) panel that studied age limits in the late 1950s, before the FAA's adoption of the rule.

"In the 1960s, heart disease was the big risk. Alcoholism was a factor because there were more heavy drinkers. … Today, stroke is increasingly rare among healthy pilots with their blood pressure under control. Cancer is still a risk, but with a flight physical every six to 12 months, it will be diagnosed. If a pilot has Alzheimer's, he won't pass the simulator check," said Mohler, a staff member at the U.S. National Institutes of Health Center for Aging Research when he served on the FAA panel, and later chief of the Federal Aviation Administration Civil Aeromedical Research Institute (now the Civil Aerospace Medical Institute). "And the main cause of sudden incapacitation is food poisoning, which has nothing to do with age."

The normal aging process is separate from disease, and in evaluating a pilot's fitness for flight,

Help for Aging Bodies

Medical specialists say there are some things that can be done to cope with the effects of aging, such as:[1,2]

- Eat a healthy diet low in fats, cholesterol and sodium that includes plenty of fruits and vegetables and an adequate amount of fiber — 25 grams daily for women and 38 for men. Specialists sometimes recommend dietary supplements such as B vitamins to reduce risks of dementia and to maintain sharp thinking, and calcium and vitamin D for strong bones;
- Don't smoke;
- Limit alcohol consumption;
- Exercise regularly. Many specialists recommend at least 30 minutes of brisk walking or other similar activity most days of the week. In addition, weight training and weight-bearing exercises like walking can help strengthen bones;
- Limit exposure to the sun, and use sunscreen; and,
- To reduce the risk of Alzheimer's disease and other forms of dementia and to keep your thinking sharp, obtain at least six hours of sleep a night and challenge the brain with activities such as solving crossword puzzles, reading, learning a foreign language or developing new hobbies.

— LW

Notes

1. U.S. National Library of Medicine; U.S. National Institutes of Health (NIH). *Aging Changes in …* <www.nlm.nih.gov/medlineplus>.
2. "How Our Bodies Age (and What You Can Do About It)," *The Washington Post*. Dec. 5, 2006.

Changing With Age

Aging begins at birth, but the effects that most people associate with middle age and old age typically begin to become obvious during their 40s. During this decade, most people develop presbyopia, difficulty focusing their eyes on nearby objects. The decline in visual acuity continues so that by about age 50, objects at intermediate-distance — about the distance between a pilot's eyes and an instrument panel — also are difficult to see. These visual problems can be corrected with eyeglasses.

Slightly later, beginning at about age 50, many people notice age-related hearing loss, also known as presbycusis, the most common of the forms of hearing loss that are associated with damage to the inner ear, the auditory nerve or auditory nerve pathways in the brain. Age-related hearing loss may be partly a result of the amount of noise a person has been exposed to over a lifetime. It affects men more often than women and begins after age 20. About 25 percent of people from ages 65–75 have age-related hearing loss; the figure increases to 70 to 80 percent for people older than 75.[1] Hearing aids often are prescribed, and most pilots with hearing loss that impairs communication either use hearing aids or develop their own coping strategies.

Because the inner ear also is the source of control for maintaining balance, or equilibrium, age-related deterioration of the ear structure sometimes makes it more difficult to maintain balance.

Although changes in vision and hearing are most pronounced, other senses also diminish with advancing age:[2]

- Taste suffers because the number of taste buds declines, beginning around age 40 for women and around age 50 for men. During their 60s, some people experience a decreased sensitivity to taste sensations, typically losing salty and sweet tastes first and then bitter and sour; and,
- During the 70s, a loss of nerve endings in the nose may reduce the sense of smell.

A number of musculoskeletal changes also may occur, including osteoarthritis — a deterioration of the cartilage in the joints that can result in pain, swelling and restricted mobility — which affects millions of people worldwide. The United Nations World Health Organization (WHO) estimates that osteoarthritis affects 9.6 percent of men and 18 percent of women over age 60.[3] Osteoarthritis can affect any joint but most often the knees and hips. In most cases, pilots with osteoarthritis in a knee can continue flying, unless the knee's range of motion is significantly restricted or medication impairs mental functioning; if corrective surgery is required, they can return to flight duties after recovery.

In addition, people usually begin to lose height after age 40 — about 0.4 in (1.0 cm) every 10 years. At the same time, as the proportion of body fat increases, especially around the center of the body, including abdominal organs, cells may be lost from the muscles and internal organs and the bones may become less dense — a condition known as osteopenia, which sometimes progresses to osteoporosis. Eventually, the skin becomes thinner and less elastic, resulting not only in wrinkles but also in a lessened ability to feel pressure, vibration and temperature.[4]

As age increases, the risk increases of developing cardiovascular disease — a group of diseases affecting the heart and blood vessels, such as heart attack and stroke. The heart rate may slow, and abnormal rhythms called arrhythmias may develop. Blood pressure sometimes increases.[5]

The body's immune system begins a slow decline after young adulthood, and it gradually becomes less able to detect malignant cells. As a result, cancer risk increases with age.[6]

With advancing age, the brain and spinal cord lose nerve cells and weight. The breakdown in nerve cells may slow reflexes. Thought, memory and thinking may slow *slightly* as a normal part of aging. More dramatic declines result from diseases such as Alzheimer's disease, which is not part of the normal aging process.[7]

— LW

Notes

1. U.S. National Library of Medicine (NLM); U.S. National Institutes of Health (NIH). *Age-Related Hearing Loss*. <www.nlm.nih.gov/medlineplus/ency/article/001045.htm>.
2. NLM; NIH. *Aging Changes in the Senses*. <www.nlm.nih.gov/medlineplus/ency/article/004013.htm>.
3. Woolf, Anthony D.; Pfleger, Bruce. "Burden of Major Musculoskeletal Conditions." *Bulletin of the World Health Organization* Volume 81 (2003): 646–656.
4. NLM; NIH. *Aging Changes in Body Shape*. <www.nlm.nih.gov/medlineplus/ency/article/003998.htm>.
5. NLM; NIH. *Aging Changes in the Heart and Blood Vessels*. <www.nlm.nih.gov/medlineplus/ency/article/004006.htm>.
6. NLM; NIH. *Aging Changes in Immunity*. <www.nlm.nih.gov/medlineplus/ency/article/004008.htm>.
7. NLM; NIH. *Aging Changes in the Nervous System*. <www.nlm.nih.gov/medlineplus/ency/article/004023.htm>.

"only three things matter," Mohler said. "They are the ability to perform, freedom from impairing diseases — if you have them but they don't impair you, so what? — and motivation to keep flying."

William R. Voss, president and CEO of Flight Safety Foundation and former director of the ICAO Air Navigation Bureau, agreed that age is not a good indicator of a pilot's fitness for flight.

"The possibility of incapacitation of a pilot causing an accident in a modern, multi-crew airplane is extremely remote," Voss said. "It hasn't been a problem in age-60 states, and it hasn't been a problem in age 65 states [that adopted an age-65 limit years before ICAO's action]."

The current debate should focus not on age limits but on "doing a better job of assessing medical fitness regardless of age," he said.

Dr. Anthony Evans, chief of ICAO's Aviation Medicine Section, agreed that age limits are "quite good at reducing risks but unfair to some and probably generous to others. By that, I mean some individuals are fit to continue operating when elderly, but others are not."

Nevertheless, an age limit might be the best technique for determining pilot fitness, Evans said.

"As we don't have adequate assessment tools to accurately determine who is in one group or another, a one-size-fits-all approach, based on average risk (one that fits in with generally accepted norms of retirement) is the fairest system," he said. "Without a retirement age, the logical conclusion is that pilots will operate until they fail a medical or an operational check. Without a culture change, there will continue to be a reluctance [by medical examiners and check pilots] to fail an experienced pilot, with his career (perhaps a glittering one) ending in failure."

Evans said that medical evaluations and simulator checks developed to determine whether pilots have age-related problems would help identify those who are no longer fit for flight but are "far from being 100 percent accurate."

Dr. Dougal Watson, principal medical officer for the Civil Aviation Authority in New Zealand, which has no upper age limit for pilots, said that although age influences various aspects of safety-related human performance, it is not the most significant factor.

"On purely medical-safety grounds, an argument to do away with age-based exclusion criteria has a very solid foundation," Watson said. Nothing in New Zealand's aviation safety record indicates that the absence of an upper age limit has caused safety problems — or that it offers any safety advantages, he said.

Nevertheless, he added, "Age *is* an important factor. … As age increases, so does the risk of cardiovascular incapacitation (heart attacks, etc.) and neurological incapacitation (cerebrovascular — strokes … etc.), while mental/physical performance and capacity reduces. A safe certification system that does not utilize age-based exclusion criteria must, therefore, consider those age-related risk factors."

In New Zealand, aeromedical certification involves a "structured system of cardiovascular risk assessment," which closely resembles cerebrovascular risk assessment, as well as periodic operational performance evaluations, Watson said. The result is that some pilots are denied aeromedical certification "because of age-related medical factors, rather than because of their age alone."

In Canada, where government regulations have never included an upper age limit, Dr. Jay Danforth, Transport Canada's acting director of civil aviation and marine medicine, agreed that "maybe we should be looking at ways to risk-identify those in the older age group," perhaps with more frequent medical evaluations and/or checks of age-specific ailments. "We're continually trying to fine-tune and evaluate the efficiency of our medical assessment process."●

Notes

1. Aerospace Medical Association (AsMA). "The Age 60 Rule." *Aviation, Space and Environmental Medicine* Volume 75 (August 2004): 708–715.
2. Ibid.
3. Li, Guohua; Grabowski, Jurek G.; Baker, Susan P.; Rebok, George W. "Pilot Error in Air Carrier Accidents: Does Age Matter?" *Aviation, Space and Environmental Medicine* Volume 77 (July 2006): 737–741.
4. The International Civil Aviation Organization (ICAO) issues both *recommended practices* and mandatory *standards*. If ICAO's member states do not comply with a recommended practice, they are asked to inform the ICAO Council; if they deviate from a standard, notification is required.
5. ICAO. "Changes to Annex 1 Include New Upper Age Limit for Pilots." *ICAO Journal* Volume 61 (March–April 2006).

Further Reading From FSF Publications

FSF Editorial Staff. "Memory Lapses Usually Do Not Signal Serious Medical Problems." *Human Factors & Aviation Medicine* Volume 52 (July–August 2005).

Mohler, Stanley R. "Prompt Treatment May Minimize Knee Problems and Their Interference With Flight Duties — and Daily Routines." *Human Factors & Aviation Medicine* Volume 51 (July–August 2004).

Mohler, Stanley R. "Early Diagnosis is Key to Correcting Age-Related Vision Problems Among Pilots." *Human Factors & Aviation Medicine* Volume 47 (September–October 2000).

FSF Editorial Staff. "Heredity, Disease, Aging Present Crewmembers With Increased Risk of Hearing Loss." *Human Factors & Aviation Medicine* Volume 47 (July–August 2000).

Declines in accidents showed progress in 2006, but the number of fatalities remained stubbornly high as traditional risk categories continued to take a toll.

The major accident record for commercial jets, business jets and commercial turboprops worldwide in 2006 was a marked improvement over the preceding year. However, accidents in all categories resulted in the deaths of 903 people, with more than half of all major accidents continuing to occur during the approach and landing phase of flight (see "Changing Accident Classification," page 21). And loss of control (LOC) accidents involving commercial jets and controlled flight into terrain (CFIT) accidents involving commercial turboprops again accounted for the majority of fatalities in the respective categories.

While the number of accidents declined, the commercial jet fleet last year flew 5.2% more departures. The commercial turboprop fleet size was virtually unchanged. Approximately 10 percent of the world's commercial jet fleet is Eastern-built, while almost 25 percent of the commercial turboprop fleet is Eastern-built (Table 1). The business jet fleet showed the largest growth rate, with a 2 percent increase from 2005.

A brief review of data on commercial jet accidents for the previous two years will help put the 2006 results in perspective. In 2004, there were 13 major accidents involving Western-built and Eastern-built commercial jets in scheduled and unscheduled passenger and cargo operations worldwide, with 196 fatalities. That year was the first in history without a commercial jet CFIT accident, and less than half of the major accidents occurred during approach and landing.

In 2005, commercial jets were involved in 16 major accidents with 778 fatalities. Of that total, 10 occurred during approach and landing, five were CFIT accidents, and three were LOC accidents.

BY JIM BURIN

A Mixed Year

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In 2006, however, there were 11 major accidents involving commercial jets, with a total of 745 fatalities (Table 2). The accident total included six approach and landing accidents, one CFIT accident and three LOC accidents. The commercial jet major accident rate last year showed a significant decline to fewer than 0.40 major accidents per million departures, while the five-year moving average of that rate resumed the downward trend interrupted by the 2005 record (Figure 1, page 18). Accident rates can be calculated only for Western-built aircraft because there are no reliable worldwide exposure data for Eastern-built aircraft.

Business jets were involved in 10 major accidents in 2006, just slightly above the historical average for this type of aircraft, in which 19 people died, down from 15 accidents and 23 fatalities in 2005 (Table 3, page 18). Nine accidents happened in the first eight months of the year, and nine of the 10 were approach and landing accidents.

The Fleet — 2006

Aircraft category	Western-built	Eastern-built	Total
Commercial jets	17,609	1,839	19,548
Commercial turboprops	4,774	1,710	6,484
Business jets	—	—	12,724

Source: Ascend

Table 1

Major Accidents, Worldwide Commercial Jets
January 1, 2006–December 31, 2006

Date	Operator	Aircraft	Location	Phase	Fatal	
Feb. 8, 2006	UPS	DC-8F	Philadelphia, USA	Enroute	0	
May 3, 2006	Armavia	A-320	Alder-Sochi, Russia	Approach	113	🟠
July 9, 2006	S7 Airlines	A-310	Irkutsk, Russia	Landing	126	
Aug. 22, 2006	Pulkovo Aviation	TU-154	Nr. Donetsk, Ukraine	Enroute	170	🟠
Aug. 27, 2006	Comair	CRJ-100	Lexington, KY, USA	Takeoff	49	🟠
Sept. 1, 2006	Iran Air Tours	TU-154	Mashhad, Iran	Landing	28	
Sept. 29, 2006	GOL	B-737	Sao Felix, Brazil	Enroute	154	
Oct. 3, 2006	Mandala Airlines	B-737	Tarakan, Indonesia	Landing	0	
Oct. 10, 2006	Atlantic Airways	BAE-146	Stord-Sorstokken, Norway	Landing	4	
Oct. 29, 2006	ADC Airlines	B-737	Abuja, Nigeria	Takeoff	96	
Nov. 18, 2006	Aerosucre Colombia	B-727	Bogota, Colombia	Approach	5	🔵

🔵 CFIT accident 🟠 Loss-of-control accident

Source: Ascend

Table 2

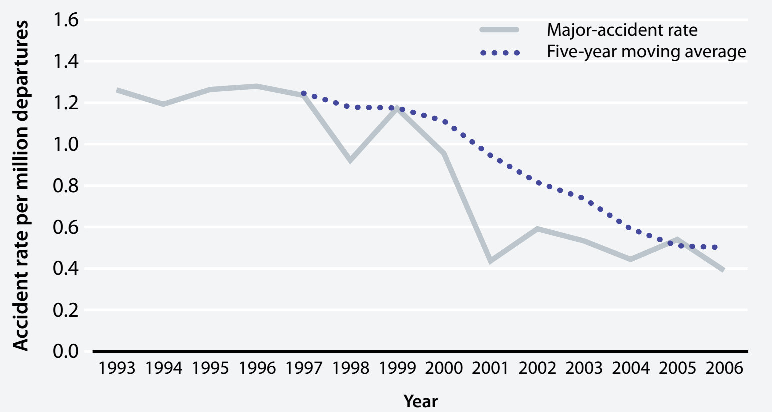
There were 23 major accidents last year involving commercial turboprops, including all Western-built and Eastern-built turboprop aircraft with more than 14 seats, with 139 fatalities (Table 4, page 19). The total was down from 247 deaths in 39 commercial turboprop accidents in 2005, but there were more than twice as many accidents as the total for commercial jets last year. Eleven of the commercial turboprop accidents occurred during approach and landing, and five were CFIT accidents.

Persistent Killers

As has been the case for the last 20 years, the types of fatal accidents that continue to predominate are CFIT, approach and landing and LOC. Recent data clearly show the importance of eliminating these types of accidents: In 2004, there were 196 commercial jet fatalities. In 2005, there were 778 commercial jet fatalities. The difference? There were no CFIT accidents and only one LOC accident in 2004, compared with five CFIT accidents and three LOC accidents in 2005. The eight accidents accounted for more than 70 percent of 2005 fatalities.

The five-year moving average of commercial jet CFIT accidents continues to improve, but slowly (Figure 2, page 20). Despite a 30 percent decrease in CFIT accidents since 1998, a look at the average trend line highlights the difficulty of sustaining low CFIT accident numbers. The average number of commercial jet CFIT accidents for the past decade has been stuck at around four, while the average number of CFIT accidents

Western-Built Commercial Jet Major-Accident Rates, 1993–2006



Note: Worldwide departures are estimated through Dec. 31, 2006. Total departure data are not available for Eastern-built aircraft.

Source: Ascend

Figure 1

Major Accidents, Worldwide Business Jets
January 1, 2006–December 31, 2006

Date	Operator	Aircraft	Location	Phase	Fatal	
Jan. 2, 2006	Avcom	Hawker 700	Kharkov, Ukraine	Approach	3	
Jan. 24, 2006	Goship Air	Citation Ultra	Carlsbad, CA, USA	Landing	4	
Feb 15, 2006	Jet 2000	Falcon 20	Kiel, Germany	Landing	0	
Feb. 16, 2006	Lech Air	Citation I	Busckin, Iraq	Approach	6	●
June 2, 2006	International Jet Charter	Lear 35	Groton, CT, USA	Approach	2	●
June 26, 2006	Great Ideas Corp	Hawker F3	Barcelona, Venezuela	Landing	0	
July 5, 2006	Vigojet	Saberliner	Mexico City, Mexico	Landing	0	
July 19, 2006	Tomco II	Citation Encore	Cresco, IA, USA	Landing	2	
Aug. 28, 2006	Netjets	Hawker 800	Carson City, NV, USA	Descent	0	
Dec. 30, 2006	Fact Air	Sabreliner	Culiacan, Mexico	Approach	2	

● CFIT accident

Source: Ascend

Table 3

involving all commercial aircraft — jets and turboprops — has been about 12 a year.

The ability of the terrain awareness and warning system (TAWS) to help prevent CFIT accidents remained unchallenged in 2006 as, once again, no TAWS-equipped aircraft was involved in a CFIT accident. The fact that there has never been a CFIT accident involving a TAWS-equipped aircraft is ample proof that the best way to reduce the risk of a CFIT accident is to install TAWS.

The fact that approach and landing accidents in 2006 accounted for slightly more than half of the major accidents involving commercial jets and commercial turboprops, plus eight of the nine business jet major accidents, clearly shows that the industry must continue to focus on improving safety in this phase of flight.

Most, if not all, of the causes of these accidents are well-documented and addressed in the Flight Safety Foundation *Approach-and-landing Accident Reduction (ALAR) Tool Kit*. These accidents frequently involve nonprecision approaches, adverse weather, unstable approaches and the failure to go around. The Foundation's CFIT/ALAR Action Group (CAAG) has conducted 24 workshops around the world to disseminate the risk-reduction interventions of the *ALAR Tool Kit*. In 2006, workshops were conducted in Caracas, New Delhi and Tokyo.

There is no consistent historical pattern for commercial jet LOC major accidents, although the numbers after 2000 showed good improvement until 2005, when the three-year moving average reversed and began a rising trend. Hopefully, the revised version of the Airplane Upset Recovery Training Aid distributed by Airbus and Boeing will assist in reducing the risk in this critical area.

Challenge of Error

When considering the statistics, it must be remembered that the Foundation's goal is to make aviation safer by reducing the risk of an accident. Commercial aviation has never had a year with zero accidents, and there has never been a flight with zero risk. There are challenges still to address.

One of the challenges is human error. Human factors specialists and aviation safety professionals agree that human error must be addressed if there is to be continued success in reducing risk. FSF founder Jerome Lederer said, "The alleviation of human error … continues to be the most important problem facing aerospace safety." Note that he said "alleviation," not "elimination."

There are many aviation safety efforts underway around the world, but few directly address the issue of human error. Most of the information on human performance and human error deals with flight crews, because that is where most of the data are available. However, everybody makes mistakes — pilots, air traffic controllers, maintenance personnel and even management people. Errors are the downside of having a brain. And there are many reasons why people make errors — training, design, corporate culture and fatigue, to name just a few.

The first step in addressing this challenge is to admit that human error is a problem and acknowledge that it is not going to go away. In 1985, the Lautman-Gallimore report from Boeing said that flight crew error was a causal factor in 70 percent of accidents from 1977 to 1984. In the 22 years since that report was released, there have been many technological advances and a lot of projects to improve various aspects of aviation safety, but there has not been much progress on this challenge. A 1999 report by the National Aerospace Laboratory (NLR)—Netherlands said that flight crews were a factor in 69 percent of accidents from 1970 to 1997. Data from Boeing about the primary causes of aircraft accidents from 1983 to 2002 show that flight crews are the leading cause of about 68 percent of all accidents. We also have data showing the involvement in accidents of errors by air traffic controllers, maintenance personnel and others.

Major Accidents, Worldwide Commercial Turboprops (> 14 Seats)
January 1, 2006–December 31, 2006

Date	Operator	Aircraft	Location	Phase	Fatal	
Jan. 2, 2006	Ruenzori Airways	Antonov 26	Fataki, DR Congo	Climb	0	
Jan. 24, 2006	Aerolift	Antonov 12	Mbuji Mayi, DR Congo	Landing	0	
Feb. 5, 2006	Air Cargo Carriers	Shorts 360	Watertown, WI, USA	Enroute	3	
Feb. 8, 2006	Tri Costal Air	Metro II	Paris, TN, USA	Enroute	1	
March 11, 2006	Air Deccan	ATR 7	Bangalore, India	Landing	0	
March 18, 2006	Ameriflight	Beech 99	Butte, MT, USA	Enroute	2	●
March 28, 2006	Phoenix Avia	Antonov 12	Payam, UAE	Climb	0	
March 31, 2006	TEAM	Let 410	Saquarema, Brazil	Enroute	19	●
April 16, 2006	TAM	Fokker-27	Guayaramerin, Bolivia	Landing	1	
April 24, 2006	Air Million Cargo	Antonov 2	Lashkar, Afghanistan	Landing	2	
April 27, 2006	LAC Skycongo	Convair 580	Amisi, DR Congo	Landing	8	
May 23, 2006	Air Sao Tome	DHC-6 Twin Otter	San Tome, Africa	Approach	4	
June 5, 2006	Merpati Nusantara	CASA 212	Bandanaira, Indonesia	Landing	0	
June 21, 2006	Yeti Airlines	DHC-6	Jumla, Nepal	Approach	9	●
July 7, 2006	Mango Airlines	Antonov 12	Goma, DR Congo	Climb	6	
July 10, 2006	PIA	Fokker 27	Multan, Pakistan	Takeoff	45	
July 12, 2006	TransAfrik	Lockheed Hercules	Kigoma, Tanzania	Approach	0	
July 29, 2006	Adventure Aviation	DHC-6	Sullivan, MO, USA	Takeoff	6	
Aug. 3, 2006	Tracep	AN-28	Bukavu, DR Congo	Approach	17	●
Aug. 4, 2006	AirNow	EMB-110	Bennington, VT, USA	Approach	1	●
Aug. 13, 2006	Air Algerie	Lockheed Hercules	Piacenza, Italy	Enroute	3	
Aug. 28, 2006	Paraguay Air Service	Nomad 22B	Cerrillos, Argentina	Enroute	0	
Nov. 17, 2006	Trigana Air Service	DHC-6	Puncak Jaya, Inodnesia	Enroute	12	
Dec. 30, 2006	Sky Relief	DHC-5	Nairobi, Kenya	Takeoff	0	

● CFIT accident

Source: Ascend

Table 4

Some interventions help provide a level of defense when mistakes are made. These include crew resource management (CRM), threat and error management (TEM), and improved decision making, all of which can improve human performance and reduce the risk or the consequences of an error.

Unfortunately, human error is a tough nut to crack. It is not easy to solve a human error problem with a hardware change or technology update. And passing a rule will not help; human error does not normally lend itself to regulatory fixes.

One part of the solution is education and increased awareness. A good CRM course, training on TEM, an in-depth discussion about fatigue, learning the basics about risk management and decision making, studying the lessons learned from an accident — all help improve human performance and reduce human error.

Technology is another way to address this challenge. It does not have to be a high-tech solution; it can be as simple as a mechanical guard on a critical switch. Examples of technologies that have helped reduce the impact of human error are flight operational quality assurance (FOQA), engineered materials arresting system (EMAS), traffic alert and collision avoidance system (TCAS), minimum safe altitude warning (MSAW) system, and TAWS. Note that most of these are not designed to prevent human error. EMAS, TCAS, MSAW and TAWS are designed to mitigate an error once it happens. In fact, these systems are designed to function only if there is an error.

Other tools useful in addressing human error are standard operating procedures (SOPs), culture surveys and a corporate commitment to a just culture. The role of SOPs in reducing human error is major, and it has been addressed in several efforts, such as the Standard Operating Procedures Template, an element of the FSF *ALAR Tool Kit.*

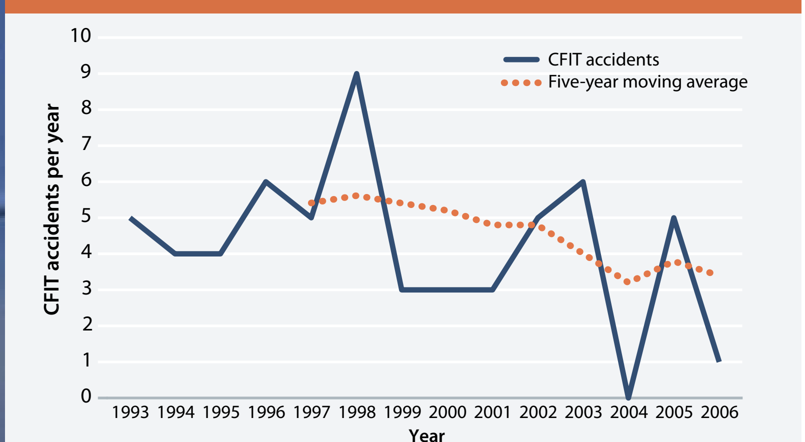
Surveys assist in identifying an organization's culture; the type of culture can directly affect how human error is addressed. The Airline Management Self-Audit developed by the FSF Icarus Committee was one of the first of these surveys (*Flight Safety Digest* 11/96). Today, more sophisticated surveys benchmark an organization's culture against similar groups, highlight areas for improvement and, most importantly, provide interventions to enable movement toward a just culture.

A just culture is one that establishes an atmosphere of trust, in which personnel are encouraged to provide essential safety-related information and acknowledge errors, but where there is a distinct and acknowledged line between acceptable and unacceptable behavior. This fosters an environment in which human error can be identified and addressed.

Human error will never be eliminated. Like risk, it will be present and needs to be addressed as long as we fly aircraft. However, the goal is to eliminate as much of it as possible. The key is to start the effort. Borrowing a slogan coined elsewhere, the industry needs to wage a "war on error."

The latest data from Boeing on the primary causes of accidents from 1996 to 2005 show flight crew factors still dominate, but they are down from nearly 70 percent to 55 percent. It is unclear if this decrease indicates progress in reducing human error, or just a reflection of the fact that we are now looking for errors beyond those made by pilots. Dan Maurino, coordinator

Western-Built Commercial Jet CFIT Accidents. 1993–2006



CFIT = Controlled flight into terrain

Source: Ascend

Figure 2

Changing Accident Classification

After much thought, Flight Safety Foundation has departed from the use of "hull loss" or "total loss" as appropriate definitions for the most severe type of aircraft accident. Starting with this report, the Foundation will use "major accident," as defined below.

Effective aviation safety efforts are driven by data to document our performance and measure our progress. Today, there are new methods to determine safety performance, some that use non-accident data to identify potential problems and predict high risk areas before an accident occurs. However, accidents and accident rates remain the bottom line of aviation safety.

There are many different ways to determine what constitutes an accident and how to derive accident rates. The differences stem from how terms are defined. The definitions of accidents used by most national authorities largely are based on the definitions in International Civil Aviation Organization Annex 13, *Aircraft Accident and Incident Investigation*.

Ultimately, there must be a determination of what constitutes an accident, accompanied by a measure of the severity of the accident. One measure of severity is "hull loss," a manufacturer-developed term that has been widely used. A hull loss is an accident in which airplane damage is beyond economic repair. Another classification scheme used by the insurance industry differentiates "total loss" accidents, in which either the aircraft is destroyed, the damage cannot be repaired or the cost of repairs exceeds the insurance value. It is important to note that "total loss" does not mean the aircraft never flies again; in fact, several "total loss" aircraft are flying today. Accidents also are differentiated by the involvement of fatalities or substantial aircraft damage.

As mentioned above, the Foundation now uses the term "major accident" as the defining measure. A major accident involves any of the following three conditions:

- The aircraft is destroyed, which is defined as sustaining damage that exceeds a threshold defined by the Ascend Damage Index (ADI) developed by Paul Hayes of Ascend, formerly Airclaims. ADI is the ratio of the costs of repair and the projected value of the aircraft had it been brand-new at the time of the accident. If the ADI exceeds 50 percent, the accident is considered major; or,
- There are multiple fatalities; or,
- There is at least one fatality, and the aircraft is substantially damaged.

The use of the major accident classification criteria ensures that an accident is not determined by an aircraft's age or by its insurance coverage, and it gives a more accurate reflection of the high risk areas that need to be addressed.

— JB

of flight safety and human factors for the International Civil Aviation Organization, said, "The discovery of human error should be considered the starting point of an investigation, not the end point." This accurately reflects the progressive and proactive approach necessary to successfully address the challenge of human error.

If there is an accident, the question is not "Was there human error?" If there was an accident, there was human error. The questions are "Why was there human error?" and, more importantly, "What can be done to prevent or reduce the probability of it happening again?"

Over the past six years, the number of accidents has decreased as the number of departures has increased. This is an impressive accomplishment. But, to reduce the risk even more and to keep the accident rate coming down, we must address human error. We must acknowledge it, educate all aviation personnel on it and devise ways, both technical and nontechnical, to address it. Only by doing this will we truly be able to make aviation safer by reducing the risk of an accident.●

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

Knowing the Distance

The complexities in deceleration performance of turbojet airplanes on slippery runways readily generate misunderstanding and confusion among pilots and dispatchers. For the current winter flying season, U.S. airlines and other turbojet operators were urged to voluntarily update procedures to leave flight crews no doubt about landing performance or safety margins. But uncertainty prevails in whether such updates will comply with eventual changes to the U.S. Federal Aviation Regulations (FARs).

A safety review by the U.S. Federal Aviation Administration (FAA) — which found deficiencies in how some airlines determine landing distance and unexplained inconsistencies among airlines — prompted this special focus, which is linked to the investigation of a U.S. airline accident in December 2005. The U.S. National Transportation Safety Board (NTSB) and the FAA urgently recommended last year that operators of turbojet airplanes ensure that flight crews reassess landing distance capability during normal operations if weather, runway conditions, airplane weight or braking systems have changed as of the time of arrival compared with conditions used for dispatch. During 2007, the FAA will pursue related rule making that includes a 15 percent landing-distance safety margin already applied in European regulations. At press time, the FAA was coordinating a charter order to establish an aviation rulemaking committee (ARC) to obtain industry recommendations on issues in the safety alert, according to Jerry Ostronic, an aviation safety inspector coordinating this activity within the FAA. The next step will be an announcement in the *Federal Register* after the FAA administrator signs the order; the announcement date had not been set, Ostronic said.

Attention to these issues complements the continuing initiative by the air transport industry to reduce the risk of all types of approach and landing accidents.[1]

The FAA plans to require commercial and fractional turbojet flight crews to confirm landing distance capability on arrival in specific situations.

BY WAYNE ROSENKRANS

"A review of the current applicable [FARs] indicates that the regulations do not specify the type of landing distance assessment that must be performed at the time of arrival, but operators are required to restrict or suspend operations when conditions are hazardous," the FAA said. "Most of the data for runways contaminated by snow, slush, standing water or ice were developed to show compliance with European Aviation Safety Agency and Joint Aviation Authorities airworthiness certification and operating requirements. The FAA considers the data developed for showing compliance with the European contaminated runway certification or operating requirements, as applicable, to be acceptable for making landing distance assessments for contaminated runways at the time of arrival."

In *Safety Alert for Operators* no. 06012, "Landing Performance Assessments at Time of Arrival (Turbojets)," the FAA said that the fall 2006 recommendations, and presumably the rule making under way, apply to all turbojet operations conducted under FARs Parts 121, 135, 125 and 91 Subpart K, which apply to air carriers; commuter and on-demand operators; airplanes seating 20 or more passengers or with 6,000-lb (2,722-kg) payload capacity; and fractional ownership operators, respectively.

Situations such as in-flight emergencies or abnormal and irregular configurations of the airplane involving engine failure or flight-control malfunctions may require a flight crew to make an exception. For example, they could elect instead to use the "actual/absolute deceleration performance capability of the airplane without an added safety margin to determine whether safety requires continued flight or an immediate landing," the FAA said.

Assessing landing distance at the time of arrival only occasionally would come into play. "This assessment does not mean that a specific calculation must be made before every landing," the FAA said. "In many cases, the before-takeoff criteria, with their large safety margins, will be adequate to ensure that there is sufficient landing distance with at least a 15 percent safety margin at the time of arrival. Only when the conditions at the destination airport deteriorate while en route … or the takeoff was conducted under the [FARs alternate airport] provisions … would a calculation or other method of determining the actual landing distance capability normally be needed."

Reverse Thrust Credit?

With investigation of the accident continuing, the NTSB asked operators to adopt the safety alert's guidance without delay. "We think airlines should voluntarily adopt the procedures contained in the FAA's [safety alert] now, as we are entering another winter flying season," NTSB Chairman Mark Rosenker said in December 2006.

The accident occurred during a snowstorm Dec. 8, 2005, as Southwest Airlines Flight 1248, a Boeing 737-700, landed on snow-contaminated Runway 31C at Chicago Midway Airport (see *ASW*, 8/06, p. 13, and 12/06, p. 11). The airplane overran the runway at about 50 kt, rolled through a blast fence and a perimeter fence, and struck two cars on an off-airport street, killing a six-year-old boy in one of the cars.

According to the NTSB, while holding before the approach to Midway, the flight crew obtained the landing runway assignment, surface wind and braking action reports, and used an on-board laptop performance computer to calculate expected landing performance under wet-fair braking conditions with immediate deployment of thrust reversers upon touchdown. The thrust reverser deployment, however, occurred 18 seconds after touchdown. As a result, the NTSB recommended that FAA prohibit flight crews from relying on deceleration provided by the thrust-reverser system during en route calculations of landing distance — a practice currently allowed for operators of specific transport category airplanes.

FAA initially responded to the NTSB, and its own safety review, by announcing a policy that was to have been effective last October. Subsequently, FAA issued the safety alert incorporating revisions based on public comments, such as objections by the National Air Transportation Association (NATA) and the National Business Aviation Association, which argued that rule making — not a policy — was required by law and that the associations' members operated turbojet airplanes in situations unlike those of airlines. "We believe there are sufficient unique issues within the Part 91 Subpart K and 135 operational environment that make special consideration, separate from Part 121 operational requirements, necessary to ensure creation of a successful regulatory solution," said James Coyne, NATA president. "As it is likely the FAA's rule making will be based upon the [safety alert], NATA remains concerned that the ultimate notice of proposed rule making … may create unnecessary problems and safety concerns for Part 91 Subpart K and Part 135 operators … unduly burden the industry or unnecessarily restrict airport access."

Airline Inconsistencies

FAA reviewed pilot and dispatcher training, procedures and flight operations. Its review also considered non-U.S. requirements. Operating manuals at about half of the responding airlines "did not have policies in place for assessing whether sufficient landing distance exists at the time of arrival, even when conditions … are different and worse than those planned at the time the flight was released," the FAA said.

Among airlines that had implemented such policies, some lacked "procedures that account for runway surface conditions or reduced braking action reports." Many did not apply a safety margin to the expected actual landing distance. "Those that do [apply a safety margin were] inconsistent in applying an increasing safety margin as the expected actual landing distance increased," the FAA said.

Some of the airlines had developed performance data — or obtained products from vendors — that indicated landing distances less than those in the airplane manufacturer's performance data for the same conditions. "In other cases, an autobrake landing distance chart [was] misused to generate landing performance data for contaminated runway conditions," the FAA said. "Also, some operators' data have not been kept up to date with the manufacturer's current data."

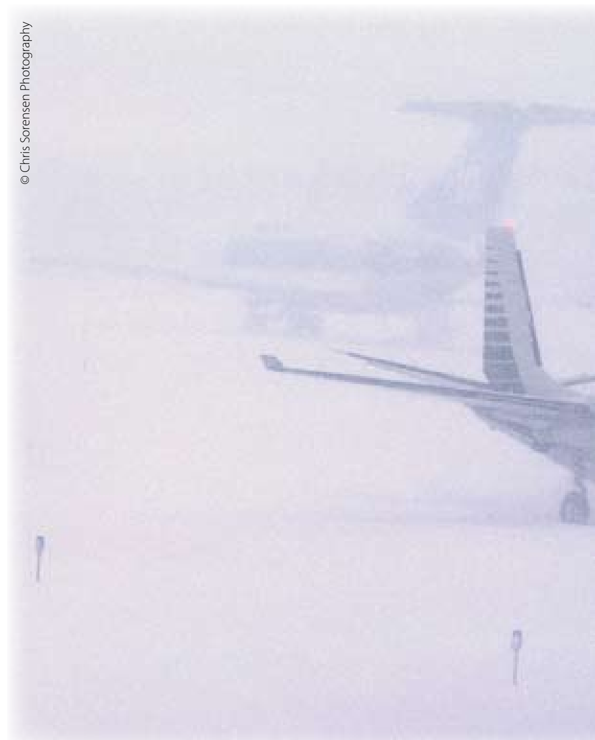
When allowed by the FAA, reverse thrust credit was not applied uniformly by flight crews at the time of arrival. "Pilots may be unaware of these differences," the FAA said. "In one case, there were differences found within the same operator from one series of airplane to another within the same make and model. The operator's understanding of the data — with respect to reverse thrust credit and the information conveyed to pilots — were both incorrect."

Landing Distance Basics

Determining whether a turbojet airplane can be brought safely to a full stop on a specific contaminated runway first requires knowledge of the *actual landing distance,* the maximum deceleration capability known to be possible in the landing conditions — with no safety margin added by the flight crew. This distance accounts for reported meteorological and runway surface conditions, runway slope, airplane weight, airplane configuration, approach speed, use of autoland or a head-up guidance system, and ground deceleration devices.

Although dispatchers and flight crews typically do not directly use the *unfactored certified landing distance* — the landing distance required by FARs during aircraft certification without any safety factors added — the FAA recommends that pilots understand its use as the foundation of operational landing distances. This distance — demonstrated by test pilots — is based on uncommon flying techniques such as high sink rates at touchdown and approach angles much different from line operations. This distance also requires a dry, level (zero slope) runway at standard day temperatures without autobrakes, autoland systems, head-up guidance systems or thrust reversers, so actual landing distance would be significantly longer in line operations.

Before takeoff, the *factored landing distance* for the destination airport must be determined by a dispatcher or flight crew. This landing distance must incorporate the required safety margins. Under the applicable FARs, if the factored landing distance does not comply with the requirements, the airplane can depart if the dispatcher/flight crew specifies an alternate airport that



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complies. At the time of arrival, flight crews also have to consider the validity of any external information and whether it applies to their flight. "Operators and pilots should use the most adverse reliable braking action report, if available, or the most adverse expected conditions for the runway, or portion of the runway, that will be used for landing when assessing the required landing distance prior to landing," the FAA said.

"Because pilot braking action reports are subjective, flight crews must use sound judgment in using them to predict the stopping capability of their airplane."

International teams have been working for more than a decade to establish a uniform worldwide method of measuring and communicating slippery runway conditions. "Unfortunately, joint industry and multinational government tests have not established a reliable correlation between runway friction under varying conditions, type of runway contaminants, braking action reports and airplane braking capability," the FAA said. "Therefore, operators and flight crews [likewise] cannot base the calculation of landing distance solely on runway friction meter readings."

Landing Distance Refresher

Boeing Commercial Airplanes last year presented briefings about airplane deceleration on slippery runways — specifically using the 737-700 as a case study. "During the investigation into a recent 737 landing overrun accident, it was discovered that there is misunderstanding and confusion among some crews and operators about several issues relating to airplane performance on slippery runways," said Mark Smith, air safety investigator, Boeing Air Safety Investigation, at Flight Safety Foundation's International Air Safety Seminar in Paris in October 2006. Like the FAA, he emphasized that a key operational difference is that no reverse thrust is used to establish factored landing distance for the airplane flight manual (AFM). Reverse thrust is used, however, to establish actual landing distance data, which Boeing calls "advisory data" in its quick reference handbook (QRH), because this is the recommended standard operating procedure for landings.

AFM landing distance data and QRH landing distance data both are derived from the flight test demonstration landing distance, which assumed the same "max manual" braking on a dry runway and the same transition distance, a one-second period for deployment of automatic speed brakes and initial brake application. However, in the AFM, the air distance varies for each airplane model as measured from 50 ft above the runway threshold to touchdown. In the QRH, the air distance is fixed at 1,000 ft (305 m) for simplicity.

To prepare AFM data, manufacturers must multiply the landing distance from the flight test demonstration by a factor of 1.67 to obtain regulatory dry landing distance and then must multiply this dry landing distance by a factor of 1.15 to obtain the regulatory wet/slippery landing distance. To prepare QRH data, manufacturers must use the landing distance from the flight test demonstration as the distance for dry braking action. The manufacturer then typically determines from analytical computation the airplane's capability for landing on a wet, snow-covered or ice-covered runway. "The QRH for the 737-700 provides [landing distances and corrections at the reference weight] for braking using 'max manual' braking or an autobrake setting … for each braking condition," Smith said.

Training ideally should cover how the method of brake application affects airplane deceleration performance relative to use of reverse thrust and runway braking action. "The deceleration from reverse thrust is always additive when using manual brakes, whether on a dry or a slippery runway," Smith said. "Conversely, the deceleration from reverse thrust may be additive when using autobrakes, depending on the autobrake setting and the [dry or slippery] runway conditions. Reverse thrust becomes the most effective deceleration device as runway conditions deteriorate."

Most importantly, slippery runway conditions require different — sometimes counterintuitive — techniques compared with landing on a dry or wet runway. ●

Notes

1. The Flight Safety Foundation *Approach-and-Landing Accident Reduction Tool Kit* contains comprehensive briefing notes about assessing landing distance capability for contaminated runways and how turbojet landing overruns have occurred.

Working With EASA

The U.K. Civil Aviation Authority's Safety Plan complements the work of the European Aviation Safety Agency.

BY MIKE BELL

Michael J. Bell is a U.K. CAA Board Member and Group Director Safety Regulation

There has been a radical change in the way aviation is regulated in Europe. The European Aviation Safety Agency (EASA) was created on Sept. 28, 2003. EASA became responsible for the airworthiness design standards of most civil aircraft registered in the European Union.

The U.K. Civil Aviation Authority (CAA) remains very much in business within its own realm. As a national aviation authority, the CAA's Safety Regulation Group still has a statutory duty for all aspects of regulation not covered by EASA, and is responsible for safety oversight of the U.K. aviation industry, as distinguished from EASA's pan-European rules and standards. It also has the strategic goal to develop our world-class U.K. aviation safety environment, in partnership with industry, by driving continuous improvements in aviation safety in the U.K., and, in partnership with EASA, across Europe (see *ASW*, 10/06, p. 46).

The European Union established EASA with the legal authority to be the rule-making and standard setting organization for aviation safety regulation on behalf of all its member states. EASA has already taken responsibility for aircraft and product certification, rules related to the design and maintenance of aircraft products and parts, and standards for organizations designing, producing and maintaining products and parts. Over time, its rule-making role is expected to extend to aircraft operations, flight crew licensing, aerodromes and air traffic management safety.

To deliver results meeting this challenging goal, the CAA developed and published its safety plan for 2006/7–2010/11. In producing this plan, we recognized that there were significant opportunities for more clarity and transparency — for ourselves and our stakeholders — about our safety priorities and how we determined them. In essence, we wanted a safety plan that was:

- Essential for safety.
- Defensible, to us and our industry.
- Unique to the CAA.

This strategic view complements the CAA's ongoing tactical risk management program, which includes risk identification during oversight visits and the assessment of individual mandatory occurrence reports for potential action.

The Mandatory Occurrence Reporting Scheme (MORS) is fundamental to the CAA's tactical and strategic management of risk, as these processes are only as good as the data that guide them. Established 30 years ago, MORS has been at the forefront of "just culture" ideals and heavily influenced the development of the European Directive on Occurrence Reporting, 2003/42/EC, which requires such a scheme for all EU member states. Despite the mandatory requirement, it is the commitment of the U.K. aviation industry to the theory and practice of just culture ideals that makes the system work so effectively.

The CAA's latest development of its strategic risk management framework is more data driven than ever before, starting with the analysis of fatal accidents involving large public transport airplanes worldwide. Figure 1 provides an overview of the contributing factors in accidents that occurred between 1995 and 2004, as determined by the CAA's Accident Analysis Group. Note that the categories are not mutually exclusive.

To identify safety vulnerabilities, we used multi-disciplinary teams, considered each of the most prevalent accident types and, supported by the data, worked through potential contributions from each major element of the aviation system: aircraft design, aircraft maintenance, air traffic control, airport design, and flight operations. By looking across all sectors, with a mixture of expertise, we minimized the potential for overlooking gaps in safety barriers and also helped knowledge transfer in our organization.

Inevitably, many more actions were suggested than were practicable. Resources in particular are always limited, and the suggested actions were subjected to rigorous peer review and prioritization. Several criteria were used, including statistical safety risk, perceived safety risk and likely effectiveness and efficiency.

European national aviation authorities, in particular, must also use one other criterion: the regulatory environment. While EASA will, within a couple of years, very likely take responsibility for rule-making activity in operations and licensing, member states retain responsibility for oversight of that activity. Therefore, actions have been prioritized that do not necessarily require rule making or formal regulatory intervention, but are aimed at supporting the judgment of regulators and helping industry to improve its own safety performance.

Did we get it right? Well, we listened to the safety concerns of U.K. industry and also matched the risks we identified to other studies, and we seem to be in the right place. For example, Flight Safety Foundation lists controlled flight into terrain, approach and landing, loss of control, and human factors as the top four issues requiring attention. All of these feature in the CAA safety plan, with flight crew human factors issues together in a section we've called "Supporting Pilot Performance."

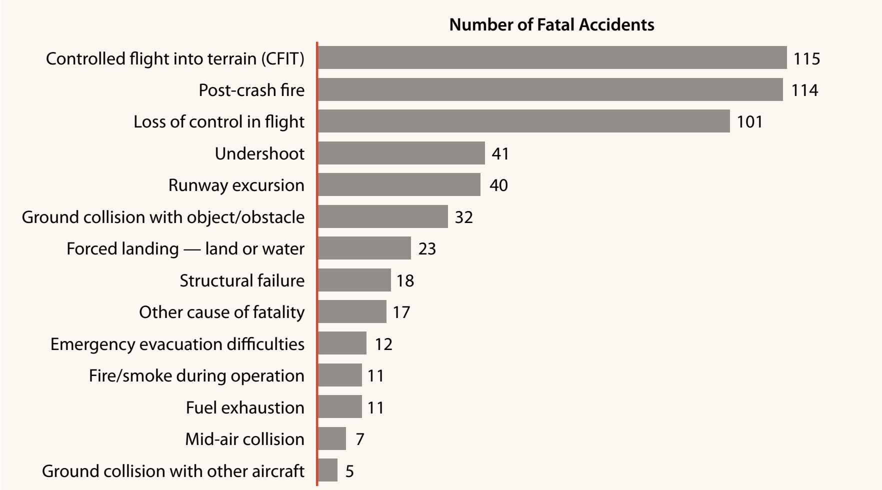
Of course, the CAA is subject to other influences on its regulatory strategy. The U.K. government is, rightly, demanding that all U.K. regulators perform better in terms of risk management and use the output to help determine their work program. The CAA's risk management strategy, embodied in the safety plan and described briefly here, has been fully endorsed by the U.K. government as good regulatory practice, and we are committed to developing the model further for the benefit of U.K. industry.

EASA is developing its own safety strategy for the areas in which it has competence, called the European Strategic Safety Initiative (ESSI), and future U.K. safety plans will contain CAA actions undertaken as part of ESSI, but we will continue to look to improve safety performance specifically in the U.K. It is almost certain that human factors issues will dominate as we complement EASA rule making with data driven oversight and safety improvement, continuing to focus on areas that are not best addressed by rule making alone. Success will require closer cooperation between the CAA and its stakeholders than ever before, facilitated by industry's safety management systems. We have recently laid the foundations for this as part of preparations for the development of the next safety plan.

The CAA's safety plan and commitment to safety improvement clearly demonstrate that in the new European environment, the national aviation authority has a key role to play. By aligning our tactical and strategic activities with that of EASA, striving for seamless safety oversight and complementary safety improvement processes, we can and must help EASA to drive continuous safety improvement across the continent.●

Note: You can find a copy of the *CAA's Safety Regulation Group Safety Plan 2006* at <www.caa.co.uk/safetyplan>.

Fatal Accidents Worldwide, 1995–2004



Notes: More than one contributing factor can be allocated for each accident.

Includes fixed-wing turbine-powered aeroplanes for a which a variant has MTWA > 12,500 lbs or 5,700 kg (includes business jets).

Source: U.K. CAA Fatal Accident Database

Figure 1

A precision instrument approach that was flown "outside the stabilized approach window" ended when the Gulfstream III struck a light pole and terrain about 3 nm (6 km) from the runway, said the U.S. National Transportation Safety Board (NTSB) in its final report on the Nov. 22, 2004, accident. The airplane was destroyed, and the pilots and flight attendant were killed. An occupant of a vehicle received minor injuries.

NTSB concluded that the probable cause of the accident was "the flight crew's failure to adequately monitor and cross-check the flight instruments during the approach," and that contributing factors were "the flight crew's failure to select the instrument landing system [ILS] frequency in a timely manner and to adhere to approved company approach procedures, including the stabilized-approach criteria."

The airplane's ground-proximity warning system (GPWS) remained silent during the approach, but the investigation did not reveal why the system failed. The air traffic control (ATC) minimum safe altitude warning (MSAW) system generated one warning, but it came too late to prevent the accident. Nevertheless, the report said that the MSAW system had "performed as designed, given the alert thresholds established for the [Houston] airport area" (see "Tightening a Safety Net," page 33).

The accident occurred near William P. Hobby Airport in Houston, where the crew was scheduled to pick up former U.S. President George H.W. Bush and others for a charter flight to Ecuador. The airplane was operated by Business Jet Services, an aviation-management company that conducts on-demand flights under U.S. Federal Aviation Regulations Part 135. "At the time of the accident, the company had about 100 employees, including 35 Part 135 pilots, and a fleet of 13 airplanes, seven of which were Gulfstreams," the report said.

The captain, 67, had about 19,000 flight hours, including 15,700 flight hours as pilot-in-command (PIC) and 1,000 flight hours in Gulfstreams. He was a check airman and former chief pilot for the company. The first officer, 62, had about 19,100 flight hours, including 17,700 flight hours as PIC and 1,700 flight hours in Gulfstreams. He had been named chief pilot after the captain retired from the position in July 2004 to reduce his work schedule.

Dense Fog

The pilots were scheduled to begin the positioning flight from Dallas Love Field to Houston Hobby at 0500 local time, but the departure was delayed 30 minutes by weather conditions at both airports. An advisory for dense fog had been issued for the area. The terminal forecast for Houston Hobby called for 1/4 mi (400 m) visibility in fog and 100 ft vertical visibility.

Cockpit voice recorder (CVR) data indicate that at 0543, the flight crew obtained the automatic terminal information service (ATIS) report for Houston Hobby. The ATIS report said that the winds were calm, visibility was 1/8 mi (200 m) in fog, runway visual range (RVR) for Runway 04 was variable between 1,600 and 2,400 ft (400 and 800 m), and the ceiling was broken 100 ft above ground level (AGL).

The first officer briefed the captain on the ILS approach to Runway 04, which had published minimums of 244 ft and 1,800 ft (550 m) RVR. The positioning flight was being conducted under the general operating rules of Part 91, which does not prohibit pilots from beginning an instrument approach when the reported visibility is below the published minimums.

The report said that the approach briefing did not adhere to company standard operating procedures (SOPs), which call for the pilot flying, the captain in this case, to conduct the briefing. The first officer also omitted two required briefing items: airplane configuration and the final approach fix (FAF) altitude.

At the captain's request, the first officer entered waypoints for the following ILS/localizer approach fixes into the flight management system (FMS): CARCO, an intermediate fix

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Outside the Window

The Gulfstream III was flown below the glideslope on an unstabilized approach. There were no GPWS warnings, and only one MSAW warning just before impact.

BY MARK LACAGNINA

14.3 nm (26.5 km) from the runway threshold; ELREN, a stepdown fix for the localizer approach, 7.3 nm (13.5 km) from the threshold; and EISEN, the FAF, 4.3 nm (8.0 km) from the threshold. The Hobby VOR (VHF omnidirectional radio), which is on the airport, had previously been entered into the FMS. The report said that after a brief discussion with the captain about whether the VOR was required for the approach, the first officer likely deleted it from the waypoint sequence.

"The MFD [multifunction display] only displays a chronological number for each approach waypoint; therefore, it is possible that the flight crew forgot that the first officer removed the [VOR] waypoint from the FMS, causing them to mistakenly believe that the last waypoint displayed on the MFD (EISEN) was the airport," the report said. "Regardless, an FMS serves as a secondary navigation aid on an ILS approach. The pilots should have been relying on the primary navigational aids during the approach."

Tuned to the VOR

At 0558, the approach controller cleared the crew to fly directly to CARCO "for the ILS runway four." The first officer told the captain, "I'll set up our ILS in here, one oh nine nine." When the first officer entered the localizer frequency, 109.9 MHz, into the navigation receivers, it would have been the standby frequency until selected as the active frequency. He neglected to select it as the active frequency and to check the Morse-code identifier of the active frequency. As a result, the previously selected Hobby VOR frequency remained active.

The airplane was 29 nm (54 km) northwest of the airport at 11,000 ft when the approach controller told the crew to descend to 3,000 ft. At 0609, the first officer told the captain that they were "five miles … from CARCO." The approach controller then told the crew to turn left to 070 degrees and to maintain 2,000 ft or above until established on the localizer.

The airplane was descending through 2,900 ft at 0611 when the first officer said, "Localizer's alive" (Figure 1). Neither pilot was aware that the navigation receivers were still tuned to the VOR. The captain began a left turn and asked the first officer to obtain a current RVR report. The tower controller told the crew that RVR was 1,600 ft.

The captain then told the first officer, "I can't get approach mode on my thing." The first officer said that he also was unable to select the autopilot/flight director approach mode. "What [is] wrong with this?" the first officer asked. The captain said, "I don't know. What do we have set wrong?"

Gulfstream III

© John Padgett/airliners.net

The Grumman American — now Gulfstream Aerospace — G-1159A Gulfstream III first flew in 1979. Compared with its predecessor, the Gulfstream II, the airplane has a longer fuselage, more fuel capacity and a redesigned wing, with extended-chord leading edges and winglets.

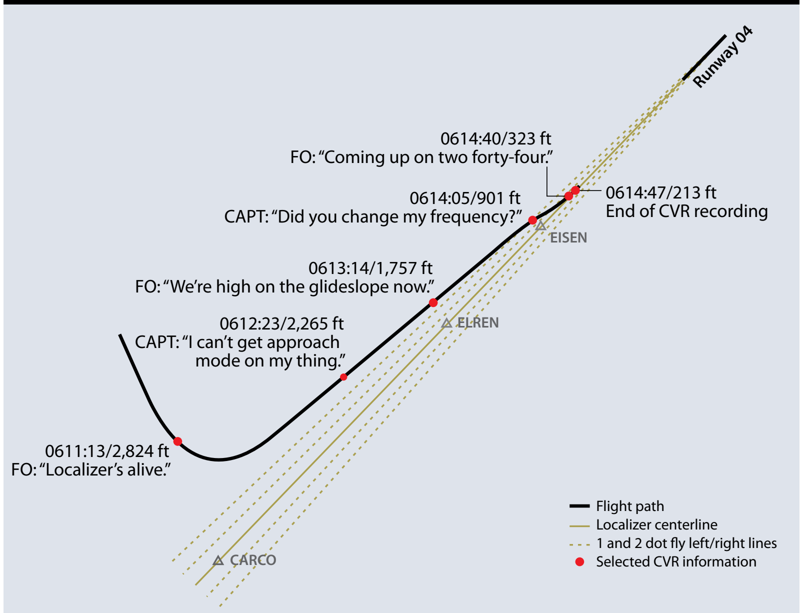
The airplane accommodates two pilots and up to 14 passengers. Maximum fuel capacity is 28,300 lb (12,837 kg). Maximum takeoff weight is 69,700 lb (31,616 kg). Maximum landing weight is 58,500 lb (26,536 kg).

Each of the two Rolls-Royce Spey 511-8 turbofan engines produces 11,400 lb static thrust (50.7 kilonewtons). Maximum cruise speed is Mach 0.85. Long-range cruise speed is Mach 0.77. Maximum operating altitude is 45,000 ft. Range is 4,100 nm (7,593 km). Stall speed at maximum landing weight is 105 kt.

Production was terminated in 1986, after 202 G-IIIs were built.

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

Flight Path Relative to Localizer



CAPT = captain CVR = cockpit voice recorder FO = first officer

Times are local.

Source: U.S. National Transportation Safety Board

Figure 1

The report said that the approach mode could not be selected because the navigation receivers were not tuned to a valid ILS frequency and were not receiving ILS signals.

Display Confusion

When the airplane descended through 2,000 ft at 0613, it was about 1,000 ft below the glideslope (Figure 2, page 32). Nevertheless, the first officer told the captain, "We're high on the glideslope now." Later, while descending through 1,700 ft, 700 ft below the glideslope, the first officer said that the airplane was "on the glideslope now."

Both pilots likely misidentified the airspeed fast/slow indicators on their electronic attitude director indicators (EADIs) as glideslope indicators.

Both pilots likely misidentified the airspeed fast/slow indicators on their electronic attitude director indicators (EADIs) as glideslope indicators. "The fast/slow indicator shows airspeed guidance relative to a target airspeed," the report said. "The glideslope and fast/slow indicators are the same color and about the same size. Each indicator consists of a moving pointer on a rectangular display, and each display has markers above and below the rectangle to indicate the degree of deviation."

The fast/slow indicator is displayed continuously. The glideslope indicator is displayed only when a valid ILS frequency has been selected as the active frequency in the navigation receiver. "If a valid [ILS] frequency has not been selected, the side of the screen where the glideslope indicator should appear remains blank," the report said.

According to standards recommended by the U.S. Federal Aviation Administration (FAA), glideslope indicators should be displayed on the right side of electronic instruments, as shown in Figure 3 (page 32).[1] However, the standards were published in 1987, three years after the accident airplane was manufactured. The EADIs in the accident airplane were configured to display the glideslope indicator on the left side.

"Five other company airplanes flown by the accident pilots were configured with the glideslope indicator on the left," the report said. "Of these airplanes, four had fast/slow indicators on the right side, and one had no indicator on the right side. Three of the company airplanes flown by the accident pilots had the glideslope on the right side."

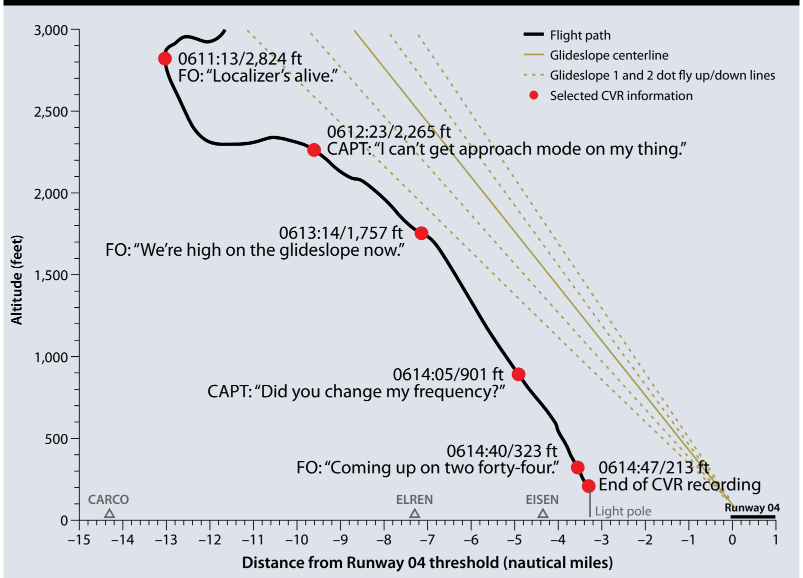
'What Happened?'

The airplane was descending through 1,000 ft at 0614 — about one minute before impact — when the first officer selected the ILS frequency as the active frequency. The captain said, "What happened? Did you change my frequency?" The first officer said, "Yeah. … The VOR frequency was on. We're all squared away now. … You got it."

At this point, the EADIs would have displayed a full-scale deviation below glideslope and nearly a full-scale deviation left of the localizer course. The report said that the absence of any comment by either pilot about the glideslope deviation indicates that they continued to misidentify the fast/slow indicators as the glideslope indicators.

The captain, in an apparent reference to the localizer course, said, "I don't know if I can get

Flight Path Relative to Glideslope



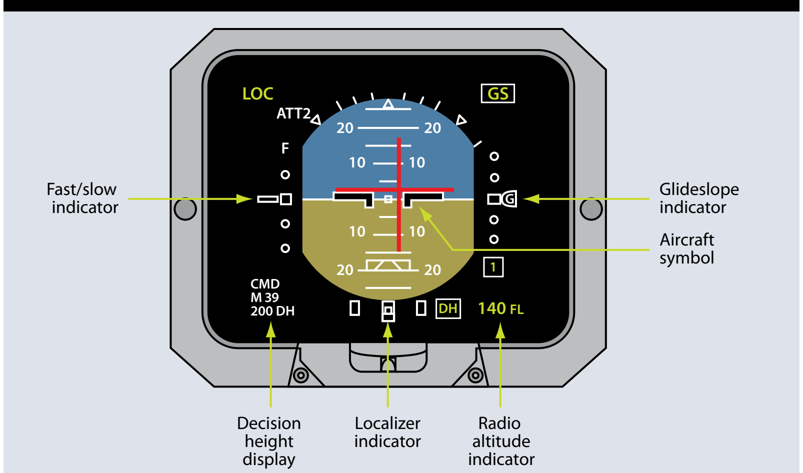
CAPT = captain CVR = cockpit voice recorder FO = first officer

Times are local.

Source: U.S. National Transportation Safety Board

Figure 2

Standard EADI



EADI = electronic attitude director indicator

This display arrangement conforms to U.S. Federal Aviation Administration recommended standards published in 1987. The EADI in the accident airplane, which was built in 1984, displayed the fast/slow indicator on the right side and the glideslope indicator on the left side.

Source: U.S. National Transportation Safety Board

Figure 3

back on it in time." The first officer said, "Yeah, you will. … You're squared away now." The captain conducted a right turn. The airplane was beyond EISEN and descending through 900 ft — 800 ft below the glideslope — when it intercepted the localizer course.

The first officer did not make altitude callouts or course-deviation callouts required by company SOPs. "The [pilot monitoring] is required to call out when the airplane is 1,000, 500, 200 and 100 ft above the DH [decision height, 200 ft] and when the localizer and glideslope [indications] deviated one dot or more," the report said.

The company's criteria for a stabilized approach required that within 500 ft of touchdown zone elevation, deviations from the localizer and glideslope must be less than one dot, and descent rate must be less than 1,000 fpm. "If the airplane is not within these criteria, the [pilot monitoring] should call out 'missed approach,' and a go-around should be executed," the report said. "The CVR did not record either pilot call for a missed approach or initiate a go-around."

At 0614:40, the first officer said, "OK, coming up on two forty-four," the decision altitude. The captain completed the "Before Landing" checklist at 0614:42 and told the first officer to select full flaps.

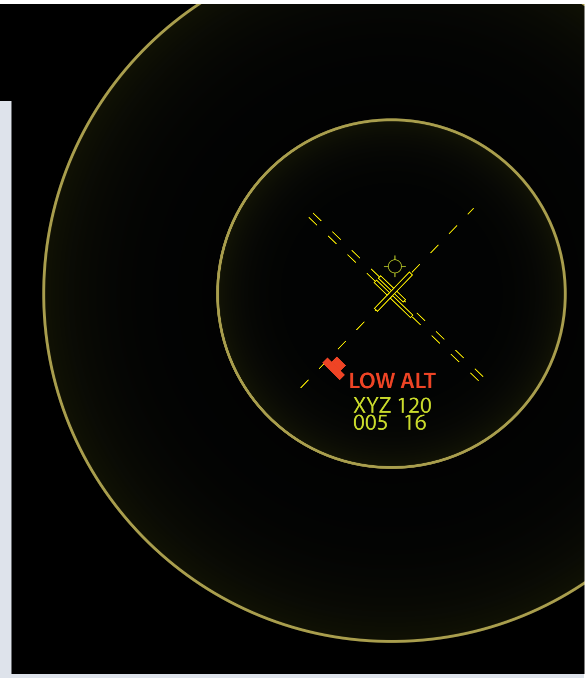
Beginning at 0614:45, the first officer said "up" seven times in quick succession. Simultaneously, the tower controller told the crew to "check your altitude." The airplane struck the light pole at 0614:47.

No Ground Prox Warnings

The report said that flight simulations and bench tests approximating the accident flight profile indicated that the GPWS should have generated warnings that the airplane was below the glideslope and too close to terrain, as well as aural alerts at radar altitudes of 500 ft, 300 ft and 200 ft.

Maintenance personnel had conducted a functional check of the GPWS about eight months before the accident.[2] Company pilots

Tightening a Safety Net



The Gulfstream III crash was among 10 controlled flight into terrain (CFIT) accidents cited by the U.S. National Transportation Safety Board (NTSB) last summer when it called for improvements to the minimum safe altitude warning (MSAW) system (*ASW*, 9/06, p. 9).

When installed in en route and terminal facilities, MSAW software processes air traffic control radar data to determine if an aircraft is below, or is predicted to descend below, a programmed minimum safe altitude. If so, the system generates an aural alarm, which typically lasts for about five seconds, and a visual alarm that consists of the flashing letters "LA" or "LowAlt" next to the aircraft's data block on the controller's radar display. When a controller detects an MSAW alarm, he or she is required to issue a safety alert to the flight crew or to inform the controller who is in radio contact with the crew.

NTSB found that the controllers involved in the CFIT accidents in which safety alerts were not issued or were issued too late were otherwise conscientious and attentive in performing their duties but did not understand how the MSAW system was configured and operated in their areas. For example, approach controllers were not aware that tower controllers do not receive aural alarms until aircraft are within a specific distance — typically 5 nm (9 km) — of the airport. This can create a critical gap between the time an arriving aircraft is handed off to a tower controller and the time the controller begins to receive an aural alarm for the aircraft.

"Aural alarms are particularly important in tower facilities because controller attention must mainly be focused on aircraft visible through the windows, rather than on a radar display, and the aural alarm is the primary method used to draw attention to the radar display," NTSB said. Two of the CFIT accidents illustrate these issues:

On Dec. 17, 2002, an Airbus A330 descended prematurely and more steeply than normal during a localizer approach to Agana, Guam, in instrument meteorological conditions (IMC). The accident involved minor damage but no injuries to the 115 occupants when the airplane struck power lines atop a hill but remained airborne. A ground-proximity warning system (GPWS) warning then prompted the crew to conduct a missed approach. Investigators found that MSAW alarms had been generated for more than a minute at the approach control facility as the airplane descended from about 1,700 ft to 700 ft. The approach controller said that she heard the aural alarm but believed that a second aural alarm would sound if the situation was not resolved. Because of the gap between handoff and generation of aural alarms, an alarm sounded in the tower about the same time the A330 crew told the controller that they were conducting a missed approach.

In an Aug. 4, 2005, accident that was still being investigated at press time, a Mitsubishi MU-2B descended below the glideslope and struck terrain during an instrument landing system (ILS) approach in nighttime IMC to Centennial Airport near Denver, Colorado, U.S. The airplane was about 10 nm (19 km) from the airport when the approach controller handed off the flight to the tower controller. MSAW alarms began 65 seconds before impact, but only a visual alarm appeared on the tower controller's radar display until the airplane was about 5 nm from the airport. An aural alarm then sounded, and the tower controller immediately issued a safety alert to the pilot. There was no acknowledgement, and the airplane crashed a few seconds later, killing the pilot.

Because the system is based on minimum altitudes for instrument flight operations, MSAW service is provided to pilots operating under instrument flight rules but is available only on request to pilots operating under visual flight rules. The digital terrain maps used in MSAW data processing at terminal facilities comprise 2-nm (4-km) squares, each with an assigned minimum altitude. "The software provides alarms when an aircraft is presently within 500 ft of the depicted minimum altitude or is predicted to be within 300 ft of the minimum altitude within 30 seconds," NTSB said. "Different rules are applied to aircraft known to be executing an instrument approach procedure, recognizing that the flight is intentionally descending to ground level."

A problem that has plagued the system from the start is unwarranted, "nuisance," alarms. NTSB said that overexposure to nuisance alarms causes controllers to assume that MSAW alarms are invalid and to "tune them out." To reduce them, MSAW software parameters typically are modified so that alarms are not generated for aircraft that are flown below minimum instrument altitudes during visual approaches. However, this means that an alarm may not be generated until an aircraft is substantially below the expected instrument approach altitude in IMC. This was the case in the G-III accident: "The system provided only 11.5 seconds of warning before the aircraft struck the pole, which was not sufficient time for the controller handling the airplane to recognize the alarm and warn the crew," NTSB said.

Modifying software to apply different alarm parameters for aircraft on visual approaches and aircraft on instrument approaches could improve the effectiveness of the MSAW system while keeping nuisance alarms to a minimum, NTSB said.

The U.S. Federal Aviation Administration (FAA) has told NTSB that it modified some MSAW parameters to improve system accuracy and reduce nuisance alerts, and was gathering data under a safety alert assessment plan that will help determine if further changes are necessary. The FAA said that it also strengthened requirements for issuing safety alerts and was developing new computer-based training aids for controllers.

— ML

who had recently flown the airplane told investigators that the GPWS functioned normally during preflight tests. The company's director of training said that he had received a glideslope warning while flying below the glideslope during a visual approach.

"The only common failure that could prevent activation of the GPWS glideslope and altitude callouts is a radio altimeter failure," the report said. "However, a review of Business Jet Services' maintenance records and the CVR transcript found no evidence indicating any problems with the radio altimeter. The GPWS unit and the radio altimeter were destroyed during impact; therefore, [investigators] were unable to determine why the GPWS did not operate as expected."

One Altitude Warning

The MSAW system generated a warning 11.5 seconds before the crash occurred. "The [tower] controller began issuing a warning to the flight crew about 7.5 seconds after the alert activated, which was about three to four seconds before impact with the light pole," the report said.

The FAA told investigators that MSAW parameters are set so that a "nuisance alarm" is not generated when an aircraft descends below the glideslope during a visual approach. "Because the present MSAW design does not provide any way to alter system performance to treat aircraft flying visual approaches differently from aircraft flying instrument approaches, aircraft that deviate from instrument approach limits during IMC [instrument meteorological conditions] may not generate an MSAW alert until they are well below the expected instrument approach altitude," the report said.

NTSB made no new recommendations based on the findings of the investigation. However, the report made reference to recommendations issued in July 2006 to improve the effectiveness of the MSAW system (*ASW*, 9/06, p. 9).●

This article is based on U.S. National Transportation Safety Board Accident Brief NTSB/AAB-06/06, "Crash During Approach to Landing, Business Jet Services, Ltd., Gulfstream G-1159A (G-III), N85VT, Houston, Texas, November 22, 2004." The 27-page report contains illustrations.

Notes

1. U.S. Federal Aviation Administration Advisory Circular 25-11, *Transport Category Airplane Electronic Display Systems*.
2. The accident occurred before the March 29, 2005, regulatory deadline for installation of terrain awareness and warning systems (TAWS) in turbine airplanes with six or more passenger seats.

Discipline *as* Antidote

BY PETER V. AGUR JR.

© Chris Sorensen Photography

The importance of procedures and the adherence to procedures cannot be overstated.

Event One: While sitting in the forward passenger seat of a light jet a few years ago I received a thorough safety briefing from the copilot as his chief pilot started the engines … without a checklist. That got my attention since both pilots knew I was part of a team of auditors conducting a safety review of the flight department. The chief pilot advanced the power levers to taxi just as his copilot stepped over the center console. Strike two. Finally, the chief pilot began the takeoff roll as his right-seater tried to discreetly hand his captain his seat belt. Strike three.

Event Two: A senior executive with direct responsibility for a major company's aviation department recently called me. He explained that one of his staff had flown in the jump seat on a short relocation leg. The only other people on board were the crew, including Becky, the flight attendant. Due to the aircraft's light weight, its takeoff and climb performance were especially impressive. Hand-flying the airplane during a steep initial climb-out, the captain looked back at his jump seat passenger and said, "Watch. It really [ticks] off Becky when I do this." The ensuing maneuver could easily be described as aerobatic.

Event Three: Years ago, I was called in at the last minute to fly as copilot for a pop-up charter trip in the company's E-55 Beech Baron. My captain was also our company president and my boss. The customers were three cattle buyers. With two pilots up front, one full-sized passenger was crammed into the kiddie seat in the baggage compartment. My boss taxied out and started the takeoff. Although he had been an F-4 pilot flying in Vietnam, I don't think he had ever handled an aircraft with a center of gravity so far to the rear. Neither had I. The aircraft rapidly began to oscillate in pitch attitude, the excursions getting more violent with each gyration. I called for the controls as we hit the zero-g apex of the next cycle. The aircraft settled down; the stomach of the passenger on the kiddie seat didn't.

These three events are what a friend calls "stupid pilot tricks," but to be more specific I'll use the term PINC, coined by David Huntzinger, the newly installed chief of safety at Korean Air, for Procedural Intentional Non-Compliance. One of the most frequent contributors to aircraft accidents and incidents is PINCs.

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PINCs are not always committed in the loose manner of the cited examples. They are often the result of well-meaning pilots trying to do their job but willfully taking risks to achieve what should be the secondary goal, "completing the mission." These pilots lose sight of their first responsibility: managing risks to ensure safe outcomes. However, when your efforts to get there include fudging the rules, you do raise risks.

PINCs raise risks, and there are a lot of PINCs happening out there every day. But if you are in a position to *do* so, you can take a straightforward series of steps that are critical to prevent PINCs in your organization: (1) gain commitment, (2) budget and develop the resources and (3) ensure performance management.

Gain Commitment

Everyone *says* they want safety. But if there were never a gap between mouth and movement there would be no PINCs. We all learn early in life about the two sets of rules to live by: the formal rules — written or stated — and the "real" rules — those the game is actually played by. When there is a significant difference between the two, the "real" rules become the standard. The solution is to establish and maintain a universal commitment to the formal rules — that is, flight operations manuals, policies, procedures, etc. That emphasis must start at the very top of the organization.

If the chief executive officer (CEO) of your organization is truly committed to safety, your safety program is set up to succeed. A safety-committed CEO knows a PINC is grounds for severe repercussions, whether it is perpetrated by a technician, a scheduler, a flight crew or a senior passenger. A safety-committed CEO is your chief enforcement officer. Anything less leaves the door open for informal rules and resultant PINCs.

I've only met one executive who deliberately pushed his crews to be unsafe. He raced offshore powerboats and climbed mountains for fun, and he allowed his sense of risk management to be totally skewed by his personal comfort with and affection for adrenalin. The only way to get through to him was by getting personal, pointing out that his children were being put at risk, too. His initial response was anger, but in the end his informal rules were realigned with more traditional policies and procedures.

The commitment from top management allows you to expect appropriate behaviors from passengers and service providers alike. No PINCs are permitted, period. With that understanding as a starting point, it becomes the aviation manager's responsibility to get the necessary resources into play.

Budget and Develop Resources

Aviation professionals tend to be highly service-oriented. They naturally push themselves and their equipment to get the job done, so it is critically important that their leaders and managers give them the right resources. If the service delivery team doesn't have the right resources, they will stretch the ones they have to make the customer happy. The results of these heroic efforts populate accident investigation files. Even a well meaning crew can be sorely tempted to commit a PINC rather than disappoint their passengers.

The most important resources are enough people, time and equipment to do the job. Also required are the guidelines for using them — effective policies, standards and procedures. Those policies, standards and procedures are critical in ensuring the quality and continuity of organizational and individual performance, and the avoidance of PINCs.

Some aviation managers say vague policies and procedures create the flexibility they need to get the job done. Wrong! That approach sends a loud and clear message: safety is a variable, service is an absolute. That sets the stage for people to push. Lives are lost and hillsides are littered with aircraft wreckage as a result of crews pushing. Weak policies and procedures send the wrong message.

On the other hand, standard operating procedures (SOPs) also must establish clear guidelines for the use of judgment in a way that continues to assure safety while being flexible enough to adjust to unique service needs. Some aviation managers make a case for absolute SOPs that leave no wiggle room for judgment. They are the enforcers, unwilling to take responsibility for using common sense. Overly rigid guidelines prevent the use of common sense to get the job done safely.

If you expect your folks to make informed and collaborative decisions that are biased to the safe side, it is critical to have a comprehensive set of operational policies, standards and procedures. Once those are in place, it is up to the team to perform … top to bottom.

Performance Management

Commitment and resources are the foundation of a safe operation, but it is how they are applied, how the task is performed, that determines whether the job is done safely or not. Actual movement must unerringly match the description.

Since safety starts at the top, your operational managers must not only be the champions of proper performance, they must be the models. "Do as I say, not as I do" is not an option.

Even as these mid-level leaders set the example, operational managers must also constantly catch people doing things right. They must routinely praise folks for taking the time and care to follow and implement proper procedures. That praise is best given publicly. In doing this, they are creating a culture of co-responsibility. Co-responsibility is basic to effective crew resource management. Each member is co-responsible for the rest of the team's performance. Everyone is a partner in performance. This applies in ground and scheduling operations, too.

From a managerial perspective, each PINC event deserves unique attention and action. There are a few things to consider:

- A PINC is a deliberate violation of an established policy, standard or practice.
- A PINC often raises risks.
- A PINC perpetrator is likely to commit future PINCs.

Crews who intentionally deviate from standard operating procedures are almost twice as likely to commit additional errors with consequential results.

- If other members of the organization are aware of a PINC event and they see no negative consequences, they may correctly assume management does not take the SOPs seriously. That is a nasty can of worms you do not want to open.

Therefore, contrary to the old axiom of "praise publicly and punish privately," I suggest the consequences of PINCs should be emphasized; the floggings *should* be public. Not only does this approach provide positive public reinforcement of proper behaviors, it also applies strong pressure to avoid improper behaviors to prevent such public embarrassment. The best way not to get caught doing a PINC? Don't do the deed.

A recent public flogging is documented in the records from the Oct. 31, 2006, U.S. National Transportation Safety Board public meeting on the final report of the Platinum Jet Challenger rejected takeoff and runway excursion accident at Teterboro (New Jersey, U.S.) Airport. Capt. Robert L. Sumwalt III, NTSB vice chairman, spoke up: "I'd like to speak as a board member who made a living for the last 30 years by flying airplanes. Mr. Chairman, you commented earlier that you were somewhat incredulous that a professional crew would conduct this behavior. Mr. Chairman, I would submit to you that this was not a professional flight crew. The behavior exhibited by this crew was not at all indicative of a professional flight crew. Just because someone gets paid to fly airplanes does not mean that they are professional.

"The University of Texas found that crews who intentionally deviate from standard operating procedures are almost twice as likely to commit additional errors with consequential results. In this case we saw where the crew failed to perform the weight and balance and it manifested itself in an accident.

"I strongly urge the piloting community to take the job seriously, and for the most part the piloting community does take it seriously. When we have an accident like this, not only does the crew let their passengers down, quite frankly, they let the entire profession down, and I take that very personally.

"I would urge the piloting community to follow procedures. Do it right. Do what you're paid to do. But I'd also like to point out that the operator has a responsibility to establish a safety culture. In this case we saw that there was a culture of non-compliance. There were widespread gaps, omissions, procedural deviations. A term I sometimes use is the 'normalization of deviance' where things are deviated from so often that they become the norm, and this appears to be the case here, where crews routinely were modifying — the board calls it modifying, I call it falsifying — weight and balance documents, just routinely, apparently.

"So I'd also like to send a message to the industry — it is vital for the industry to establish, and maintain a safety culture," Sumwalt concluded. That is a public flogging!

You may be interested in how the three examples I cited earlier turned out.

The seatbelt-less chief pilot was put on probation. He continued to take shortcuts for several months until he was finally let go. The rest of the organization took note and has since become highly professional in its performance.

Becky's nemesis has been suspended from his flying duties. More permanent action is pending. This pilot's future is not bright.

Unfortunately, a public flogging is not an option for the charter company president. Two years after our incident in the Baron, he was scud-running a young family from Denver to Aspen, Colorado. There were no survivors.

PINCs are a disease. Unchecked, they will infect your entire operation. That infection can have extreme consequences. Sadly, the price of PINCs is paid by innocent people. Your antidote for PINCs is discipline. ●

Peter v. Agur, Jr. is managing director and founder of The VanAllen Group, a management consulting firm to business aviation with expertise in safety and security. Agur also is a member of the FSF Corporate Advisory Committee and the National Business Aviation Association's Corporate Aviation Management Committee. He has an airline transport pilot rating and an MBA. He is an NBAA Certified Aviation Manager.

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Leading a Quest for Transparency

BY WAYNE ROSENKRANS

Releasing excerpts from their ICAO audit results, some civil aviation authorities seek financial/technical cooperation to correct deficiencies.

Two concepts — limiting secrecy and raising public awareness — drive the latest initiative by the world's directors general of civil aviation to accelerate compliance with eight critical elements of safety oversight required by the International Civil Aviation Organization (ICAO).[1] By the end of 2006, 87 of 189 member countries voluntarily had granted consent to ICAO to post downloadable audit excerpts in a publicly accessible table in the Flight Safety Information Exchange (FSIX) area of the ICAO Web site.[2] All these excerpts reflect audits dating from 1999–2001 and/or follow-up missions from 2001–2004; some states also posted separate comments updating their status to fall 2006.

In allowing the first public access to excerpts from safety-oversight audits conducted under ICAO's Universal Safety Oversight Audit Program (USOAP), the directors general decided that increasing the flow of information is essential as ICAO and the industry address 12 high-priority focus areas identified in the *Global Aviation Safety Roadmap,* their joint strategic action plan (see *ASW,* 1/07, p. 28). Releasing current audit summaries becomes mandatory March 23, 2008.

Calling this a "milestone of 2006," Roberto Kobeh González, president of the ICAO Council, said, "Such transparency and sharing of information will facilitate cooperation among states and with aviation stakeholders in correcting safety deficiencies."

Overcoming strong reservations about audit results being misconstrued, proponents of the initiative won support from the majority of directors general last March in the context of inadequate progress by some states in correcting deficiencies identified by USOAP in 1999–2001. A December 2004 report to the Council of ICAO said that, in the previous month, the Air Navigation Commission rejected a proposal to publicly identify "36 states which had not made much progress in resolving the deficiencies identified during the audits."

Lawrence Cannon, Canadian minister of transport, infrastructure and communities, in a March 2006 speech, acknowledged the past reluctance of most governments to disclose audit results. "Scrutiny can mean challenges from outside, and requires time and effort to manage information and to respond to public issues," Cannon said. "But it is also an essential piece of the puzzle that will lead us to the improved safety records of the future."

Consider the Source

ICAO schedules mandatory audits for civil aviation authorities (CAAs) on a recurring six-year cycle, and every audited CAA receives an unabridged "confidential audit final report." Before the transparency initiative, a confidentiality policy prevented nongovernmental organizations and individuals from obtaining audit results from ICAO, except when a state made the disclosure. Australia, for example, has posted its entire confidential audit final report from 1999 in a public area of the Web site hosted by the Australian Department of Transport and Regional Services.[3]

Graphs showing "lack of effective implementation" of the critical elements of safety oversight as percentages have been posted for 64 states.

In the past, ICAO automatically distributed by letter a nonconfidential summary version of each confidential report to the governments of all other ICAO contracting states. In current practice, these governments have secure access via the Internet to any state's confidential audit final reports and to ICAO's Audit Findings and Differences Database, designed to help states prioritize their corrective actions, monitor all states' updates on corrective actions and report known differences with ICAO standards and recommended practices (SARPs).

In the FSIX table, 70 of the 87 states have posted at least a one-page or two-page executive summary; the remaining 17 have consented to post excerpts of reports only from ICAO's second audit cycle, which follows the newer comprehensive systems approach.[4,5] Summary reports of audits have been posted for 35 states; summary reports of follow-up missions have been posted for 26 states; and graphs showing "lack of effective implementation" of the critical elements of safety oversight as percentages have been posted for 64 states.

At first glance, this information seems to show the overall safety effectiveness of a state and to enable state-to-state comparisons. This impression is reinforced by data expressed to hundredths of a percent on graphs, but ICAO requests that users interpret the information with awareness of its limitations. "Audit follow-up missions are not audits and are not designed to evaluate all aspects of a state's aviation framework or safety oversight system," ICAO said. "The graphic representation of the situation in the state at the time of the audit follow-up mission [is] limited to reflecting the progress made in implementing the ICAO recommendations made during the initial audit and does not purport to depict a current comprehensive evaluation of all aspects of a state's safety oversight system."

Updates by States

Variation in how states post excerpts should decrease by 2008 under ICAO guidelines for the second cycle of audits based on the comprehensive systems approach. Meanwhile, some states have posted far more information than most, providing the complete text of all their summary reports and/or adding comments to help the public evaluate their current level of effectiveness. During fall 2006, 16 states — Austria; China; Comoros; Cuba; Guyana; Hong Kong, China; Lesotho; Niger; Romania; Singapore; Switzerland; Tanzania; United Kingdom and U.K. Overseas Territories; United States; Uruguay; and Zambia — provided one to three pages of comments on progress made since their audit or follow-up mission. Typically, these comments addressed technical details within subpoints of ICAO audit findings. Some, however, depart from ICAO's comment template.

For example, Austria said, "The process of restructuring of the civil aviation authorities has finally been completed in 2005. Now all operative tasks regarding issuing and surveillance of approvals (operators, maintenance organizations, etc.) are carried out by Austro Control [which] is supervised by the Department for Civil Aviation."

China said, "Aviation safety has been improved significantly in China, with the fatal accident rate per million flight hours of scheduled services dropping from 1.428 in the 1990s to 0.298 for the past five years. … From 2001 to 2006, General Administration of Civil Aviation of China (CAAC) headquarters and regional offices employed 518 inspectors who perform safety oversight functions, increasing the number of technical personnel from 448 in 2001 to 966 in 2006, a 116 percent total increase and more than 20 percent annual increase, exceeding the 500 [inspectors] recommended in the audit follow-up in 2001."

And Switzerland said, "In January 2005, the Federal Office of Civil Aviation (FOCA) was completely reorganized. … In addition to the separation of policy-making activities from safety-related responsibilities, the FOCA has now introduced … a modern safety management system, as an integral part of its management processes … [and] foresees the introduction of a 'nonpunitive' reporting system."

Recurrent Issues

Content of each state's excerpts on FSIX is unique, but shared or recurrent issues are apparent. For example, excerpts for several states said that deficiencies had not been corrected because an organization external to the CAA — such as the ministry of transportation, national legislature or ministry of justice — had not yet approved the relevant laws or regulations or had not authorized CAA-requested personnel, training or funds. Use of ministerial decrees and orders — rather than national laws and the regulations of an autonomous CAA — also was prevalent as some states attempted to address audit findings. Numerous excerpts note problems of delegation of power to CAAs to enforce regulations and implement effective inspector training; and inadequate working conditions and remuneration for technical professionals. Excerpts for other states show in recent years similar struggles to establish basic laws, regulations, organizations and procedures.

Although some states report significant differences with SARPs, ICAO auditors sometimes noted that standards applied were not necessarily lower than ICAO's minimum requirements. Some audits were conducted while CAAs were undergoing major transformation — causing corrective actions to be delayed pending implementation of new regulations or systems. "Paper commitments" to correct deficiencies — even if ICAO accepted a detailed action plan — typically were insufficient to close audit findings unless ICAO's follow-up mission validated that commitments actually were fulfilled. Similarly, states' proposals to conduct a study of the feasibility of correcting deficiencies were not accepted as equivalent to really correcting deficiencies.

USOAP audits can seem anachronistic compared with fast-track oversight improvements in countries responding to safety recommendations in the aftermath of a recent aircraft accident. Yet, by studying ICAO's safety oversight audit excerpts on FSIX, safety professionals who are familiar with an accident's contributing factors sometimes will find the same factors echoing through words written years earlier by ICAO auditors (see *ASW*, 1/07, p. 18).●

Notes

1. The International Civil Aviation Organization (ICAO) specifically audits how effectively countries provide the following critical elements of a safety-oversight system: primary aviation legislation; specific operating regulations; state civil aviation system and safety oversight functions; technical personnel qualification and training; technical guidance, tools and the provision of safety-critical information; licensing, certification, authorization and approval obligations; surveillance obligations; and resolution of safety concerns.

2. The Internet address is <www.icao.int/fsix/auditrep1.cfm>.

3. The Internet address is <www.dotars.gov.au/aviation/safety/report/index.aspx>.

4. Regarding each of the 17 states, the Web site says, "ICAO did not solicit comments from [this] state, which recently underwent an audit under the comprehensive systems approach, as the information contained in the report of the first cycle of audit is superseded by the more recent audit [for which] information … will be disseminated in accordance with a mechanism that has been approved by the ICAO Council in June 2006 and that is being implemented."

5. ICAO. *Safety Oversight Manual – Part A, The Establishment and Management of a State's Safety Oversight System.* Document 9734. *Safety Oversight Audit Manual.* Document 9735. Second editions, 2006. In 2004, ICAO began to expand safety-oversight audits of states to include safety-related provisions in the 2005 editions of a larger number of ICAO annexes. This involved adopting the "comprehensive systems approach," which uses safety provisions from six annexes as core elements; minimizes the time interval between audits; makes all aspects of the auditing process transparent to states; validates the accuracy of statements made by states; provides a restructured safety-oversight audit report; and increases auditors' flexibility.

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Comparing the IATA Operational Safety Audit standard with the general industry quality standard, ISO 9001, shows that the airline standard is stricter.

BY SUSHANT DEB

Airline Safety Standard Exceeds ISO 9001

To maintain a safety standard, the first requirement is to have a foundation of quality assurance. In assessing airlines' most important quality assurance standard, it is helpful to review how that standard compares with another that has been widely accepted and has been widely used by other industries.

This review will refer to eight quality management principles (QMPs), derived in 2000 from the International Organization for Standardization's ISO 9001,[1] by the International Air Transport Association (IATA) for the IATA operational safety audit (IOSA) standard.[2] ISO 9001 is an approach to continually improving the quality of products and processes in business organizations. The IOSA standard is a systematic, explicit and comprehensive approach to reducing embedded threats to safety in airlines.

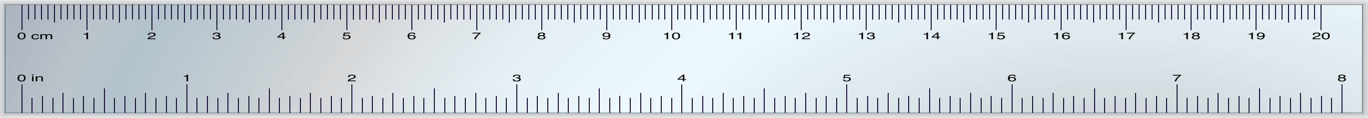
We will look at how ISO 9001 QMPs have been modified and adopted into IOSA standards. In numerous important points, IOSA can be shown to be more rigorous in quality assurance than ISO 9001.

The eight QMPs derived from ISO 9001 are listed in Table 1 with examples of their application in IOSA.

The IOSA standard goes beyond quality management into pursuit of safety.

Process Approach is described as "the application and management of activities and related resources as processes and their interactions." Both ISO 9001[3] and the guidance material for IOSA[4] require identification of the processes. The management system of the airline operator must be designed with processes and procedures to ensure an acceptable level of operational risk or safety, and to ensure that the system produces desired outcomes, such as quality service. Having a functioning management system at the top level is a fundamental requirement by both standards; however, the IOSA standard goes beyond quality management into pursuit of safety.

System Approach to Management means "being aware of what interrelated processes are in place as systems contributing to the effectiveness and efficiency of an organization." The system approach mandates reviews conducted regularly by the top management. ISO 9001[5] and IOSA[6] address this very similarly, in that the organization must have a management review process to ensure continued suitability, adequacy and effectiveness. There is not much difference between these two standards.



Factual Approach to Decision Making is "analyzing data and information to improve organizational performance." For effective decision making, organizations must collect data and information and document these in some order for performing data analysis. ISO 9001 details the documentation requirements and data analysis for decision making.[7] The IOSA standard is explicit and equally emphatic about document requirements in all eight sections.[8] Indeed, documentation and subsequent data analysis can help an airline manage planning and implementation of its safety initiatives.

Leadership involves establishing "unity of purpose and direction of the organization." Leadership, commitment and active involvement of the top management are essential for developing and maintaining an effective and efficient safety program. The Organization and Management System section of the IOSA standard focuses on *leadership*, just as ISO 9001 does. However, the IOSA standard takes this more seriously, with the leadership theme mandated in seven of its eight sections.[9]

Involvement of People entails "preparation and deployment of people at all levels of an organization." The airline business, by its nature, is a labor-intensive service industry. Thus, having employees with appropriate "preparation" is one of the most important elements of airline safety program success. And there are other reasons for an emphasis on "preparation and deployment of people," such as mandated training program requirements by civil aviation authorities; the need for safety personnel at all levels; the need for recurrent airline safety training; and the need to mitigate situations created by turnover — for example, turnover among young pilots and maintenance personnel. This QMP is mandated by ISO 9001 in two clauses only,[10] while the IOSA standard aggressively mandates this requirement in seven of eight sections.[11] Some of the common considerations among these IOSA clauses are establishing urgency; demanding performance standards and directions; setting and following the rules of behavior and making sure everyone is aware of those; setting and enforcing performance tasks and goals; challenging groups regularly with fresh information that is relevant to safety issues; and exploiting the power of positive feedback. The IOSA standard is clearly stronger.

The *Mutually Beneficial Supplier Relationship* QMP provides for "coordinating, communicating and cooperating with suppliers to achieve organizational objectives." To be successful in today's business environment, the airline must establish partnerships with both internal and external suppliers. A mutually beneficial relationship enhances the ability of all three parties to create value in ensuring safety, quality and customer service.

For external suppliers, the organization identifies key suppliers and establishes jointly a clear understanding of operational safety and quality requirements. The relationship becomes more critical when an airline outsources many processes such as maintenance, ground handling, etc. For outsourced processes, ISO 9001 requires identification of control over such processes.[12] The IOSA standard is more stringent, requiring the operator to ensure effective safety and quality oversight over such processes.[13] Furthermore, the

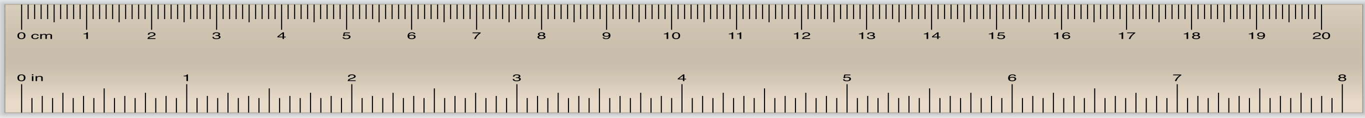
ISO 9001 Quality Management Principles Applied to IOSA

QMP	IOSA Example
Process approach	Flight operations; dispatching; ground handling; and processes and their interaction
System approach to management	Maximizing aviation safety; improving aviation quality service
Factual approach to decision making	Meeting aviation safety objectives and key aviation quality service indicators
Leadership	Establishing aviation safety management objectives
Involvement of people	Ongoing currency training; exams and certifications for safety
Mutually beneficial supplier relationship	Improving aviation operational safety products, food services, fuel services and quality services
Customer focus	Safety assurance; minimum service expectations
Continual improvement	Flight operational quality assurance; internal audits; SWOT analysis; customer satisfaction surveys

IATA = International Air Transport Association IOSA = IATA operational safety audit
QMP = quality management principle SWOT = Strengths, weaknesses, opportunities and threats

Source: Sushant Deb

Table 1



responsibility for the competent control of these functions must remain with the operating organization. And here is the real "punch" in the IOSA standard that ISO 9001 fails to mandate:

- It is unacceptable for operators to rely entirely upon the internal controls of a subcontracted organization to meet this requirement of controlling outsourced processes.
- Compliance with regulatory requirements or certification from an external body such as ISO 9001 does not lessen or alleviate the burden of responsibility for safety and quality, which always remains with the airline.

Customer Focus is concerned with "understanding and meeting customer needs to enhance their satisfaction levels." In the airline industry, with so much human contact between personnel and customers, the IOSA standard adopts this principle by focusing on employee skill levels in contact — e.g., cabin crew — and non-contact — e.g., maintenance and dispatching — categories.[14] On all counts, the IOSA standard is much more comprehensive than the ISO 9001.[15]

Continual Improvement follows this guideline: "By being continually introspective of strengths and weakness of the existing situation, an organization can identify ways to improve processes on an ongoing basis." ISO 9001 addresses this,[16] as does the IOSA standard, which introduces a common theme called "quality assurance."[17] The objective is to institute an internal evaluation program to address all safety (and quality) critical issues.

Both ISO 9001 and IOSA, then, are based on the eight QMPs. But IOSA scores higher than ISO 9001 in having the QMPs envelop operational safety and quality in the continuing improvement process.

Another example of the IOSA standard exceeding ISO 9001 is seen in how *the importance of documentation* is treated by these two standards. Both IOSA and ISO 9001 use the term "shall" to emphasize the mandatory nature of documentation. However, there is a significant difference between the ISO "shall" and the IOSA "shall":

- The ISO "shall" means a requirement to "document" a process.
- The IOSA "shall" is a broader requirement to "document and implement" a process.

The ISO does not specify the implementation as mandatory, as the IOSA does.

Airlines should be happy to note that IOSA's adoption of ISO QMPs, with their embedded quality concepts, makes IOSA the best safety assurance standard. IOSA can be an important resource in the never-ending drive for operational safety. ●

Dr. Sushant Deb is a quality management specialist who has provided ISO 9001 & AS 9100 auditing, consulting and training services since 1995, after a 20-year career in academia. He also provides IOSA gap analysis and internal auditing services to the aviation industry. He has logged over 1,400 audit days. Dr. Deb has conducted seminars and workshops in many countries during the past 30 years and published more than 120 articles and research papers. He is an independent member of Flight Safety Foundation and American Society for Quality. He can be reached at <iosa4flightsafety@yahoo.com>.

Notes

1. For an overview of the International Organization for Standardization (ISO) standards and certification, see <www.iso.org/iso/en/iso9000-14000/index.html>. For a list and description of the eight quality management principles, see <www.iso.org/iso/en/iso9000-14000/understand/qmp.html>. The latest version of the ISO standards is officially titled ISO 9001:2000, which for concision will be referred to here as ISO 9001.
2. International Air Transport Association (IATA). *IOSA Standards Manual*, 1st edition, April 2003. Montreal and Geneva: IATA.
3. Clause 4.1.
4. Organization and Management section (ORG).
5. Clause 5.6.
6. ORG 1.7.1.
7. Clauses 4.1, 4.2 and 8.4.
8. ORG 2.0, Flight Operations (FLT) 1.4, Operational Control and Dispatch (DSP) 2.0, Aircraft Engineering and Maintenance (MNT) 2.0, Cabin Operations (CAB) 3.0, Aircraft Ground Handling (GRH) 2.0, Cargo Operations (CGO) 2.0 and Operational Security (SEC) 2.0.
9. ORG 1.0, FLT 1.0, DSP 1.0, MNT 1.0, GRH 1.0, CGO 1.0 and SEC 1.0 reinforce this repeatedly.
10. Clauses 6.2.1 and 6.2.2.
11. FLT 3.0, DSP 4.0, MNT 6.0, CAB 2.0, GRH 4.0, CGO 4.0 and SEC 4.0.
12. Clause 4.1.
13. ORG 1.2.1.
14. The customer-contact category is addressed in CAB 2.3, 3.4, 3.7 and 3.8 and GRH 1.1 and 10.1. The customer-noncontact category is addressed in GRH 8.0 and 13.0, CAB 4.0 and 5.0, MNT 6.0, DSP 4.0 and 6.0, FLT 3.0, and ORG 3.0 and 5.0.
15. Clauses 5.2, 7.2 and 8.2.1.
16. Clauses 7.2.3, 8.2.1, 8.2.2, 8.4, 8.5.2 and 8.5.3.
17. ORG 4.0, DSP 3.0, MNT 5.0, GRH 3.0, CGO 3.0 and SEC 3.0.

Heavy Lifting?

Australian pilots say that when flying small and medium-size airplanes, an RNAV (GNSS) approach means a heavy workload.

BY LINDA WERFELMAN

Many pilots perceive their workloads as heavier and their losses of situational awareness as more frequent when they use area navigation global navigation satellite system — RNAV (GNSS) — approach procedures than when they use most other instrument approach procedures, a report by the Australian Transport Safety Bureau (ATSB) says (see "RNAV (GNSS) Approaches"; Figure 1, page 48).[1]

The report, based on questionnaire responses from nearly 750 Australian pilots, said that, overall, the pilots believed that among instrument approaches, only nondirectional beacon (NDB) approaches involved similarly heavy workloads and reduced situational awareness levels.

One group of pilots, however, had a different opinion. Pilots of "Category C"[2] aircraft with faster threshold-crossing speeds and increased automation — predominantly high-capacity jet airliners, defined in Australian regulations as those certified as having maximum seating capacity of more than 38 seats or maximum payload of more than 4,200 kg (9,259 lb) — typically said that RNAV (GNSS) approaches were more difficult than only daytime visual approaches and instrument landing system (ILS) approaches. These pilots also reported fewer problems with situational awareness on RNAV (GNSS) approaches, saying that they had lost situational awareness less frequently while using RNAV (GNSS) approaches than while using most other approaches. ILS approaches and daytime visual approaches were associated with fewer situational awareness problems, they said.

The report cited several likely explanations for the divergent opinions:

Firstly, the Category C pilots mostly conducted RNAV (GNSS) approaches using autopilots and have more sophisticated

Mark Wagner/aviation-images.com

autopilot systems and vertical navigation (VNAV) capabilities not available to the slower and less-complex aircraft. Secondly, … pilots [of high-capacity airliners] mostly conducted RNAV (GNSS) approaches inside controlled airspace, while Category A and B[2] aircraft [slower and less-complex aircraft] mostly operated RNAV (GNSS) approaches outside controlled airspace, where the latter increased workload levels during an approach. More detailed approach briefings and company approach procedures in high capacity airlines probably also contribute to the differences.

"Workload" was defined by the report as the number of mental and physical tasks that a pilot must perform, the complexity of the tasks and the time available for their completion. Researchers have found that increases in pilot workload typically result in decreased pilot performance, especially in cognitive matters.

The report said that although RNAV (GNSS) approaches — originally known as global satellite system nonprecision approaches — have become common in Australia since their introduction in 1998, they have been the subject of relatively little research, especially outside the realm of high-capacity airlines.

The ATSB, however, has investigated two fatal accidents that occurred in recent years while pilots were conducting RNAV (GNSS) approaches. In the first accident, which the ATSB categorized as a controlled flight into terrain accident, the pilot and all five passengers in a Piper PA-31 Cheyenne were killed when the airplane crashed during an RNAV (GNSS) approach to Benalla Aerodrome in Victoria on July 28, 2004. The final accident report said that the pilot "commenced the approach at

RNAV (GNSS) Approaches

An area navigation global navigation satellite system — RNAV (GNSS) — approach is a nonprecision instrument approach procedure that provides pilots with lateral guidance to a runway. This type of approach procedure was designed in the late 1990s.

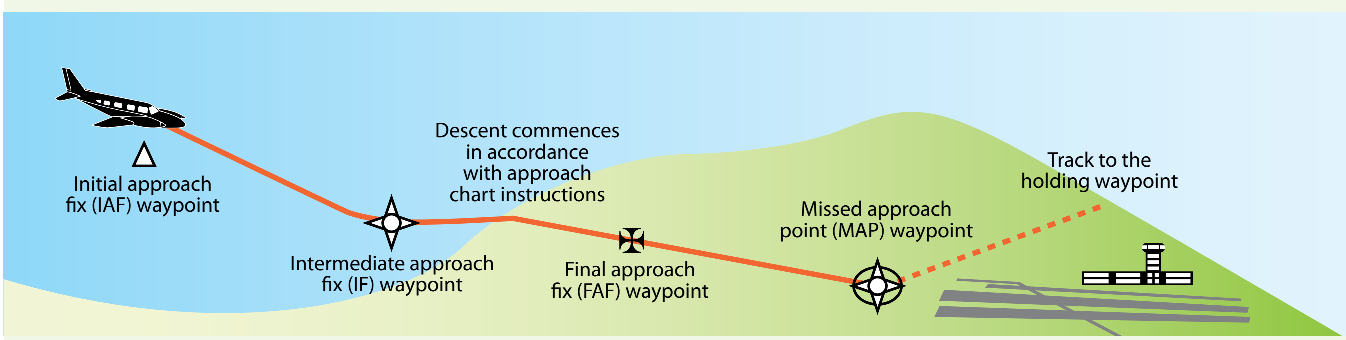
An RNAV (GNSS) uses "waypoints" — locations with specific latitude and longitude positions that are programmed into a global positioning system (GPS) receiver or flight management system (FMS).

In Australia, most RNAV (GNSS) approaches include five waypoints, each with a five-letter name. Within an approach, the first four letters of the waypoint names are the same, representing the three-letter airport identifier, followed by the direction from which the aircraft travels during the final approach. The fifth letter identifies which waypoint the aircraft is approaching, and the final four waypoints contain standard fifth letters — "I" for intermediate fix, "F" for final approach fix, "M" for missed approach point, and "H" for holding point when a missed approach is conducted.

To conduct an RNAV (GNSS) approach, pilots must select a preprogrammed approach in the GPS receiver or FMS and select one of several initial approach fixes (IAFs). The GPS or FMS then provides navigation guidance to the IAF, and a course deviation indicator on the GPS unit or on the instrument panel displays navigation error.

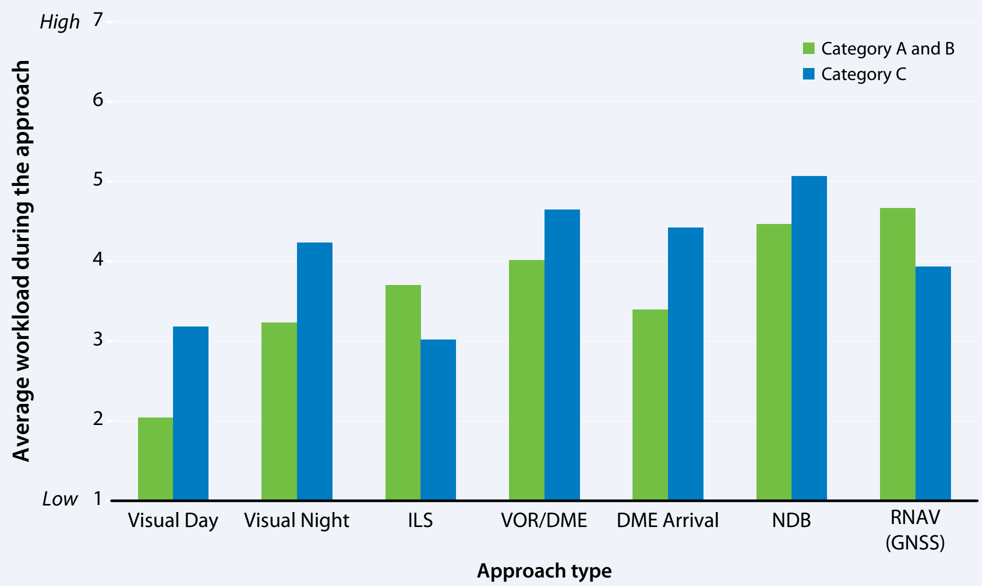
A 1996 decision by the Australian government and the aviation industry calls for RNAV (GNSS) approaches to be designed with waypoint distances of 5 nm (9 km) whenever possible. Standards established by the International Civil Aviation Organization call for descent paths of no more than 3.5 degrees for larger aircraft and 3.77 degrees for smaller aircraft.

— LW



Source: Australian Transport Safety Bureau

Pilot Characterization of Workload During Various Approach Procedures



DME = distance-measuring equipment NDB = nondirectional beacon ILS = instrument landing system
RNAV (GNSS) = area navigation (global navigation satellite system) VOR = VHF omnidirectional radio

"Category A" pilots are those who fly predominantly single-engine and small twin-engine airplanes. "Category B" pilots fly larger twin-engine propeller airplanes. "Category C" pilots fly larger, faster, more automated airplanes, predominantly jet airliners.

Source: Australian Transport Safety Bureau

Figure 1

an incorrect location" and was "not aware that the aircraft had diverged from the intended track."[3]

In the second accident, two pilots and 13 passengers were killed when a Fairchild Industries SA227-DC Metro 23 crashed during an RNAV (GNSS) approach to Lockhart River on May 7, 2005. The investigation was continuing, and an interim accident report said that items under review included "the design and chart presentation of RNAV (GNSS) approaches."[4]

Overall, the pilots said that they considered an RNAV (GNSS) approach as "safer than an NDB approach, [and] equivalent to a visual approach at night."

The research from which the ATSB's RNAV (GNSS) report was developed was intended to enhance understanding of "the experiences and perceptions of RNAV (GNSS) approaches in Australia" from the pilots who use them. For this report, the responses of the pilots — each of whom had an RNAV (GNSS) endorsement — were analyzed.

Overall, the pilots said that they considered an RNAV (GNSS) approach as "safer than an NDB approach, equivalent to a visual approach at night, but perceived it as less safe than all other approaches included in the survey," the report said. "However, … pilots [of the high-capacity airliners] differed, and assessed the RNAV (GNSS) approach [as] safer than most approaches, with the exception of the ILS and visual (day) approaches. [These] pilots indicated that automation, and vertical navigation functions in particular, increased safety."

The pilots expressed concerns about several aspects of the design of RNAV (GNSS) approaches, especially the absence of a reference for distance to the missed approach point on the global positioning system (GPS) or flight management system (FMS) display throughout the approach. In addition, they considered the limited distance references on approach charts to be inadequate, the report said.

"This response was common from respondents in all types of aircraft categories and was listed as affecting all areas of this survey," the report said. "It was one of the most common issues influencing mental workload, approach chart interpretability and perceived safety; influenced physical workload and time pressure assessments; and [was] the most common aspect of the approach that trainees took the longest to learn. The inclusion of distance to the missed approach point throughout the approach on the cockpit display and approach chart was also the most common improvement suggested by respondents."

The report said that 21.5 percent of RNAV (GNSS) approaches in Australia had "short and irregular segment distances, and/or multiple minimum segment altitude steps" — characteristics that were identified by the pilots as a major concern.

These characteristics were cited as "the most common reason pilots experience time pressures and were one of the most commonly mentioned contributors to mental workload, physical workload, lack of approach chart interpretability and perceived lack of safety."

Pilots from all categories said that RNAV (GNSS) approach charts were more difficult to interpret than charts for other approaches, the report said. The number of approaches conducted per year had no effect on the reported ease of chart interpretation. Among the reasons for the difficulty was the depiction of waypoint names with five capital letters and "only the final letter differing to identify each segment of the approach," the report said. This not only resulted in clutter on charts and on GPS and FMS displays but also increased the chances that a pilot would misinterpret a waypoint.

The pilots also said that the time and effort required to prepare for an RNAV (GNSS) approach exceeded the time and effort required for all other types of approaches.

Of all external conditions that might complicate the conduct of an RNAV (GNSS) approach, the most common was late notice of an air traffic control clearance to conduct the approach, the report said.

In evaluating their training in RNAV (GNSS) approaches, 86 percent of respondents said that their endorsement training had been adequate; the most frequent complaint cited by the other 14 percent was insufficient approach practice. Flight instructors said that the most frequent problem affecting their trainees was difficulty maintaining situational awareness, which the report said was "often related to becoming confused about which segment they were in and how far away they were from the runway threshold."

Forty-nine pilots — one in 15 — reported involvement in an event associated with an RNAV (GNSS) approach. The most frequent event, reported by 15 pilots, was a premature descent caused by misinterpretation of the aircraft's position. In addition, three pilots said that they had misinterpreted the aircraft's position but discovered the error before descending, four pilots said that they had descended below the constant-angle approach path and/or minimum segment steps, and five pilots reported other losses of situational awareness.

The pilots also cited attributes of RNAV (GNSS) approaches that they believed increased safety; the most frequently cited — by 30 percent of the pilots — was the runway alignment of RNAV (GNSS) approaches.

As a result of the study, the ATSB issued several recommendations intended to enhance the safety of RNAV (GNSS) approaches. Recommendations were issued to Airservices Australia calling for:

- "A study to determine whether the presentation of information, including distance information, on RNAV (GNSS) approach charts is presented in the most effective way;
- "A review of the 21.5 percent of approaches with segment lengths different from the 5 nm [9 km] optimum and/or multiple steps to determine whether some further improvements could be achieved;
- "A review of waypoint-naming conventions for the purpose of improving readability and contributing to situational awareness; and,
- "A review of training for air traffic control officers for the purpose of ensuring clearances for RNAV (GNSS) approaches are granted in a timely manner." A similar recommendation to the Civil Aviation Safety Authority of Australia (CASA) called for a review of pilot training to help ensure timely issuance of RNAV (GNSS) clearances.

ATSB also recommended that CASA conduct further research "to better understand factors affecting pilot workload and situational awareness during the RNAV (GNSS) approach."●

Notes

1. Godley, Stuart T. *Perceived Pilot Workload and Safety of RNAV (GNSS) Approaches*. Report no. 20050342. Australian Transport Safety Bureau (ATSB). December 2006.
2. The survey categorized four groups of respondents:
   - 145 Category A respondents flew airplanes with target threshold speeds of up to 90 kt, such as the Beechcraft 36 and 76, Pilatus PC-12, Cessna 182 and 210 and Piper PA-30;
   - 271 Category B respondents flew airplanes with target threshold speeds of 91 to 120 kt, such as the Fairchild SA227 Metro, de Havilland Dash 8, various King Air models and the Saab 340;
   - 231 Category C respondents flew airplanes with target threshold speeds of 121 to 140 kt, such as the Boeing 737 and other high-capacity jet airliners; and,
   - 42 Category H respondents flew helicopters. The relatively small number of responses "did not allow for reliable statistical analysis" within this category, the report said.
   - 58 respondents did not specify an aircraft type.
3. ATSB. Aviation Safety Investigation Report — Final. No. 200402797.
4. ATSB. Aviation Safety Investigation Report — Interim Factual. No. 200501977.

AUDIT FINDINGS AND RECOMMENDATIONS:

After the FSF Audit Team completes a safety audit, it submits a final report to the client that details the observations, findings and recommendations identified during the review. Observations are the client's policies, procedures and practices that exceed the industry best practices. Findings identify areas in which the Audit Team would like to see improvements to parallel industry best standards. Recommendations describe actions that could be taken by the client to meet industry best standards.

This article, the last in a series, will focus on the FSF Audit Team recommendations from 20 audits to correct the most frequent findings (ASW, 9/06, p. 46) related to aircraft maintenance, aircraft configuration, airport facilities and security.

Aircraft Maintenance

Maintenance management was not properly safeguarding aircraft master logs in case of fire, flood or other natural disasters in 10 audits, 50 percent of the total.

The accepted industry best practice is to provide fire-resistant storage and security cabinets for these vital documents. The aircraft and engine master logs should be secured in the special storage cabinets any time the maintenance personnel are not in their hangar office facility and whenever the aviation personnel leave the building. Some operators have chosen to have these records scanned into digital media and stored off-site.

Maintenance inspection and quality control policies and procedures were not well defined in the maintenance directives in nine audits, or 45 percent.

Although not mandatory for U.S. Federal Aviation Regulations Part 91 operators, it is prudent to establish a formal procedure to conduct a second inspection of critical maintenance tasks. A second inspection is commonly referred to as required inspection items, "a second set of eyes" or follow-up review. Its purpose is to confirm that work has been properly completed with an entry in the maintenance records/task card. Part 91 operators should identify the critical maintenance tasks on each aircraft type and publish an inspection requirement in their maintenance procedures documentation.

Technician maintenance actions and servicing were not properly signed off in the maintenance records in nine audits, or 45 percent.

The Audit Team maintenance specialists have observed that corrective action entries in the aircraft maintenance logs are incomplete or improper. "Will monitor," "Check on subsequent flight," "Being worked by OEM customer service," etc. are not proper corrective action entries without documentation that a functional check of the system or component found it to be operating within prescribed limits or tolerances. The recommended action is for a supervisor to conduct quality assurance reviews of all maintenance records for proper entries prior to filing. Improperly completed records should be reviewed with maintenance technicians to improve the quality of record keeping.

There was no inventory control system or shelf life monitoring in the stockroom in eight audits, or 40 percent.

Part 91 does not mandate a parts and materials inventory control system or shelf life control program, but it is prudent to incorporate these programs in day-to-day operations to ensure that parts and materials are serviceable and readily available when needed. A parts and materials inventory is an essential safeguard against bogus parts.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Aircraft Configuration

The aircraft weight and balance management system was not in accordance with U.S. Federal Aviation Administration Advisory Circular 120-27E, *Aircraft Weight and Balance Control*, in 11 audits, or 55 percent.

Many Part 91 operators have not focused on the fact that the advisory circular is applicable to all classes of operators. One of the more critical facets of the latest revision is the use of higher crew and passenger weights, which could significantly affect loading and center of gravity control calculations. All operators should develop an appropriate management system that ensures that the aircraft basic operating weight is properly tracked and changes are provided to the flight crews and

BY DAROL HOLSMAN

LAST ROUND

installed in the flight management system. All pilots and maintenance technicians must be trained on the requirements of the weight-and-balance management system.

Passenger safety briefing cards were not installed or did not reflect an accurate location of safety and emergency equipment in nine audits, or 45 percent.

Many operators have adopted generic passenger safety briefing cards provided by the aircraft manufacturer even though they have added additional emergency equipment such as an automatic external defibrillator, or even modified the cabin configuration. It is vital that the passenger briefing card accurately depict and describe the location and use of each item of passenger safety equipment in case there is an emergency and crewmember assistance is unavailable. The importance of an accurate passenger safety briefing card is further magnified when no trained flight attendant is assigned to the flight.

Airport Facilities

Workplace safety standards in the hangar and shops were not in accordance with U.S. Occupational Safety and Health Administration/Environmental Protection Agency (OSHA/EPA) or National Safety Council standards in 11 audits, or 55 percent.

Although OSHA and EPA seldom conduct on-site inspections at a Part 91 operator's work site, every operator is required to meet these requirements. The FSF Audit Team often finds that the operator's parent company has OSHA/EPA expertise on its staff, but the aviation department has not taken advantage of this resource to help ensure that its facilities are in compliance. All operators should conduct quarterly facility inspections and establish a tracking system to implement corrections.

Security

Current security policies did not address aircraft security at contract maintenance facilities in 11 audits, or 55 percent.

The FSF Audit Team recommends that the contract maintenance vendor work-scope agreement with the operator define the security procedures the vendor will follow during the off-site visit. While most operators send a technician with their aircraft to a contract maintenance facility, it is impossible for that representative to be on-site all the time during the visit. The Audit Team recommends that hatches and doors not to be disturbed during a visit be sealed with security tape. The flight crew should conduct a comprehensive security inspection before departing from the maintenance facility.

The facility security program was inadequate for door access control or video monitoring of entrances and hangar doors in nine audits, or 45 percent.

The majority of operators have significantly increased their facility security measures following Sept. 11, 2001. The most common deficiency is the lack of a double-door vestibule at the primary entrance, thus requiring visitors to be out in the weather while waiting for access. Installation of a video monitor system that allows visitors to be clearly viewed before they are allowed entry is an essential security measure. The Audit Team recommends magnetic strip–controlled security doors leading from the office area to the hangar and the aircraft.●

This article extends the discussion of the aviation department problems most frequently found by the FSF Audit Team, based on the final reports submitted to clients that contracted for operational safety audits during 2004, detailing the observations, findings and recommendations identified during the review (ASW, 9/06, p. 46). The recommendations cited in this story are the opinions of the FSF Audit Team.

Behavior Modification

Alcohol-related disruptive passenger behavior aboard U.K. airlines continues to decrease, but smoking-related incidents hold steady.

BY RICK DARBY

Data for reported disruptive behavior aboard U.K. airlines from April 2005 through March 2006 indicate that alcohol intoxication continued to decline as a contributing cause.[1] Alcohol was identified or suspected as a factor in 35 percent of incidents, a decline from 45 percent in the April 2001–March 2002 reporting period (Table 1).

Most disruptive behavior involving alcohol abuse did not occur because of drinks served aboard the aircraft, however. In the latest reporting period, 90 of 479 incidents (8 percent) were categorized as resulting from airline service. Consumption before boarding was implicated in a larger number of incidents in every reporting period.

Most disruptive behavior involving alcohol abuse did not occur because of drinks served aboard the aircraft.

Smoking-related incidents appear stubbornly resistant to reduction. Smoking or wanting to smoke featured in 40 percent of incidents, of which 83 percent involved lighting up in the aircraft lavatory. There was little percentage change in smoking incidents in the five yearly periods shown in Table 1.

The U.K. Civil Aviation Authority classifies disruptive passenger behavior incidents by severity — as "serious" or "significant" — according to their threat to flight and personal safety.[2] The number of serious incidents, 56, increased from 53 in the 2004–2005 reporting period, and the rate increased. There was one serious incident per 16,000 flights, compared with one per 17,000 flights in the previous reporting period, a 6 percent increase. The rate had been as low as one serious incident per 27,000 flights in the 2002–2003 reporting period.

"Some 80 percent of incidents involved male passengers, similar to previous years," the report said. "The data indicate that the predominant age group involved in disruptive passenger incidents [was] those in their 20s and 30s, and this follows the trend of previous years." About a fourth of incidents involved people traveling alone, a figure similar to those in previous years, the report said. The number of incidents involving 10 or more people traveling together was 29 in the 2005–2006 reporting period, compared with 22 the previous year.

"The majority of cases reported could be described as general disruptiveness, with verbal abuse either to cabin crew or other passengers occurring in 40 percent of cases," the report said. In about a fourth of all incidents, passengers disobeyed airline crewmember instructions.

Violence was perpetrated in 142 of the total 1,359 reported incidents (more than 10 percent), with violence against crewmembers in 64 reported incidents (less than 5 percent).

"In the majority of incidents, a warning was given to the offending passenger, and the evidence from the reports suggests that the warning was

Disruptive Passenger Behavior Incidents Aboard U.K. Airliners, 2001–2006

	April 2001–March 2002	April 2002–March 2003	April 2003–March 2004	April 2004–March 2005	April 2005–March 2006
Total incident reports	**1,055**	**648**	**696**	**1,486**	**1,359**
Severity					
Serious	52	35	28	53	56
Significant	528	613	668	1,433	1,303
Other	475	—	—	—	—
Rate					
Flights per serious incident	18,000	27,000	24,000	17,000	16,000
Passengers carried per serious incident (millions)	1.8	2.7	2.9	2.1	2.0
Incident details					
Violence involved	101	90	106	183	142
Violence toward crewmembers involved	49	48	46	79	64
Contributing factors					
Alcohol involved	472 (45%)	271 (42%)	290 (42%)	530 (36%)	479 (35%)
Alcohol — pre-boarding	198	121	85	151	118
Alcohol — served by airline	92	63	66	95	90
Alcohol — passenger's own	182	88	85	154	171
Smoking involved	385 (36%)	260 (40%)	275 (40%)	562 (38%)	546 (40%)
Smoking in lavatory	306	221	226	430	455

Notes: The U.K. CAA abolished the "other" category beginning in June 2001, which resulted in an artificially large decrease in total incidents between the 2001–2002 reporting period and the following period. Some incidents that would previously have been classified as "other" are now classified as "significant," so comparisons involving the 2001–2002 reporting period may not be accurate. The criteria for classifying "serious" incidents have remained unchanged throughout the five years.

In incidents where alcohol was involved, the subcategories do not sum to the totals because the source of the alcohol often was not known or not reported.

Serious incident is defined as "one which actually threatens flight safety or personal safety, or has the potential to do so if the situation escalates."

Significant incident is defined as "one which causes concern but which does not cause a major threat to the safety of the aircraft or its occupants."

Source: U.K. Department for Transport

Table 1

effective in 35 percent of cases, but ineffective in 31 percent of cases," the report said. The result of the warning was not reported in the remainder of the incidents.

In 16 incidents, a passenger had to be physically restrained by handcuffs or a strap, and in an additional 18 incidents some other form of restraint was applied. The flight crew decided to make an unscheduled landing in eight incidents, compared with five in the 2004–2005 reporting period and four in the 2003–2004 period. There were 10 incidents in which flight crew abandoned taxiing or takeoff procedures and returned to the gate. In 136 incidents, passengers were removed from the aircraft.

All disruptive passenger behavior has potential safety consequences and must be taken seriously, but the report said that incidents should be seen in perspective. In the 2005–2006 reporting period, U.K. airlines operated about 900,000 flights and carried about 114 million passengers. Only one in 2 million passengers caused a serious incident, the report said. It added, however, that the exposure of cabin crewmembers to passenger misbehavior was substantially higher than for passengers.●

Notes

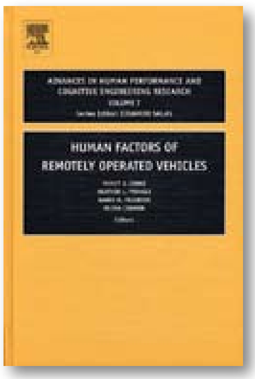
1. U.K. Department for Transport. "Disruptive Behaviour on Board UK Aircraft — 2004/05." Available via the Internet at <www.dft.gov.uk/stellent/groups/dft_aviation/documents/page/dft_aviation_613654-01.hcsp>.

2. The U.K. Civil Aviation Authority (CAA) defines a *significant incident* as "one which causes concern but which does not cause a major threat to the safety of the aircraft or its occupants."

   The CAA defines a *serious incident* as "one which actually threatens flight safety or personal safety, or has the potential to do so if the situation escalates."

Piloting From the Ground

Human factors play an important role in the operation of unmanned aerial vehicles.



BOOKS

Human Factors of Remotely Operated Vehicles

Cooke, Nancy J.; Pringle, Heather L.; Pedersen, Harry K.; Connor, Olena (editors). Amsterdam, Netherlands: Elsevier JAI Press, 2006. 412 pp. Figures, tables, references, index.

Remotely operated vehicles (ROVs) include the category of unmanned aircraft systems, also called unmanned aerial vehicles (UAVs). In her preface, co-editor Nancy J. Cooke notes that the original term UAV could give rise to the mistaken belief among the public that no humans are involved or that their involvement is peripheral or insignificant.

"The fallacy is that the automation replaces the human; no humans — no need for human factors," she says. "However, over 30 years of research has shown that automation indeed changes the human's task, but not always in a positive manner … . The human's task simply changes from one of control to one of oversight. Many mishaps are attributed to the human being 'out of the loop.'"

The book offers a look at human factors challenges associated with ROVs and the research and development work that is addressing them. The first chapter is based on two presentations of the Human Factors of UAVs Workshop sponsored by the Cognitive Engineering Research Institute, comprising UAV developers, operators and researchers. Subsequent chapters look at UAV human factors issues from the perspectives of the operator, scientists and managers of national airspace systems. A section discusses "Errors, Mishaps and Accidents" from a human factors viewpoint, with a chapter on spatial disorientation of the operator as a factor in some errors.

Further sections examine the ROV-operator interface and control of multiple ROVs through modeling, design and intelligent automation. The issue of how many ROVs a single operator can control is "highly controversial," Cooke says. Other sections focus on team control of ROVs and ROVs on the ground.

"Taken together, this work represents the state of the art in our understanding of the human considerations associated with the operation of ROVs," Cooke says. "When viewed as systems, these human considerations go beyond the interface to vehicle control and extend to the tasks of sensor operation, command and control, navigation, communication, time-sensitive targeting and mission planning. Further, they extend to applications for training ROV operators, operator selection, integration into the national airspace and design of technologies to improve remote operation."

The chapter "UAV Operators, Other Airspace Users and Regulators" will be of particular interest to readers in the aviation safety field. The authors, Stephen B. Hottman and Kari Sortland, say, "From the [U.S. Federal Aviation Administration's] perspective, a UAV is an aircraft. The operator of a UAV is some type of 'pilot' who will need to be certified as having the knowledge base that is determined to be necessary and/or appropriate and who is also proficient and skilled." That proficiency and skill will depend in part on human factors research.

REPORTS

Child Restraint in Australian Commercial Aircraft

Gibson, Tom; Thai, Kim; Lumley, Michael. Australian Transport Safety Bureau (ATSB). B2004/0241. February 2006. 86 pp. Figures, tables, photographs, glossary, references, appendixes. Available via the Internet at <www.atsb.gov.au/publications/2006/crs_final.aspx> or from ATSB.*

Infants under the age of two are not required to occupy a seat of their own on commercial airline flights in Australia, but all passengers must be restrained during taxi, takeoff, landing and turbulence. Child restraint systems (CRSs) designed for automobile seats are typically used to meet the requirement for restraint of infants.

ATSB commissioned a study of 20 CRS models installed in a typical aircraft seat according to the manufacturers' instructions.

"Fourteen of the CRS models had difficulty fitting within the available space or could not be adequately installed due to interference with the aircraft seat lap-belt latch," says the report. "Additionally, one required a top leather strap (not normally available in commercial aircraft) to be used in the installation."

The remaining CRSs adequately restrained an infant dummy during a turbulence test that produced 1 g of vertical acceleration. In a dynamic sled test, 11 CRS models restrained the infant dummies in every case, but the CRSs themselves exhibited significant forward motion, rotation and rebound motion.

The report concludes that the use of CRSs by young children and infants in Australian aviation should be encouraged. To improve their effectiveness, a number of actions are suggested — for example, "An approval system should be established to ensure that any Australian automotive CRS to be used in aircraft fits the aircraft seat and is compatible with the aircraft lap belt."

Aircraft Accidents and Incidents Associated With Visual Disturbances From Bright Lights During Nighttime Flight Operations

Nakagawara, Van B.; Montgomery, Ron W.; Wood, Kathryn J. U.S. Federal Aviation Administration (FAA) Office of Aerospace Medicine. DOT/FAA/AM-06/28. Final report. November 2006. 9 pp. Figures, table, references. Available via the Internet at <www.faa.gov/library/reports> or from the National Technical Information Service.**

One of the remarkable properties of the human eye is its ability to adapt to different light intensities, from brilliant sunlight to nighttime darkness. Yet that accommodation does not take place instantly, as anyone knows who turns out the last light at bedtime and is temporarily nearly sightless. When a pilot's eyes are adapted to a low light level, typical of the flight deck at night, exposure to a sudden bright light can result in temporary visual impairment because of glare, flashblindness — a visual interference effect that persists after the source of illumination is extinguished — and afterimages. This, in turn, degrades reaction times in response to a visual stimulus.

This report describes an FAA study to investigate operational problems experienced by pilots exposed to bright light during nighttime operations. FAA and U.S. National Transportation Safety Board databases were searched for accident and incident records from January 1982 through February 2005 that included the term "night," as well as keywords such as "glare," "bright light," "flash" and "blind." A total of 58 discrete accidents and incidents were found that identified exposure to bright light during nighttime operations as a factor.

The majority of accidents, 17 of 30, or 57 percent, occurred during the approach and landing phase of flight. Accidents in other phases of flight, in descending order of frequency, occurred during taxi, en route, and takeoff and departure. Incidents occurred most frequently during taxi, followed by approach and landing, takeoff and departure, and en route.

"Flight crewmembers were more susceptible to night vision problems during the approach and landing phases of flight, possibly due to prolonged exposure to low-light levels prior to being illuminated by airport lighting systems or other bright light sources," the report says. "In the texts of these reports, pilots commented that they lost the ability to judge distances (depth perception) after experiencing glare or from being flashblinded by approach or runway lights."

Taxiing aircraft were involved in the second largest numbers of night-vision impairment accidents, six, and incidents, 21.

"Ineffective lighting configurations in the airport environment appear to be a root cause of these visual difficulties while taxiing," the report says. "The majority of these [occurrences] involved pilots who strayed off ramps, taxiways and runways, hitting obstacles or other aircraft due to the effect of glare and/or flashblindness. In several of these mishaps, the pilots reported that inappropriate or poorly positioned ramp or apron lighting hampered their ability to distinguish runway markings or determine exactly where the taxi surface began or ended."

The report says that the researchers conducted a similar search of the U.S. National Aeronautics and Space Administration Aviation Safety Reporting System (ASRS) reports submitted from 1988 through November 2004 for reports of night vision problems resulting in unsafe conditions. Those reports are anonymous and subjective, and do not represent the findings of any accident investigation.

"The ASRS database contained 153 reports where night vision problems resulted in unsafe conditions," the report said. "Fifty-nine percent of these events occurred during taxiing operations, while 27 percent involved approach and landing maneuvers."

The report said that, although it was not the primary cause of the accident, air traffic control personnel were hampered by glare from airport lighting in the runway collision between USAir Flight 1493 and Skywest Flight 5569 at Los Angeles International Airport in February 1991, which resulted in 34 fatalities.

The report concludes with recommendations to pilots for reducing the risk of accidents caused by bright light during nighttime, such as:

- "Keep one eye shut should you look in the direction of a bright light source to maintain dark adaptation in at least one eye."
- "Use the glare shield (sun visor), bill of a cap or other opaque objects to shield your eyes from harsh ramp lighting."
- "To avoid flashblinding other pilots, dim aircraft landing lights as soon as safety concerns allow."

WEB SITES

National Aerospace FOD Prevention Inc. (NAFPI), <www.nafpi.com>

NAFPI, comprising members from the aviation and aerospace industries — including airlines, airports, manufacturers, support organizations and the military — says, "We are committed to a common goal: to educate, create awareness and promote FOD (foreign object debris/damage) prevention in all aspects of aerospace operations and manufacture."

Its mission is to "be a resource for information, training and support, and to provide an effective forum for the exchange of ideas, solutions and expertise." NAFPI's educational library supports the mission with online resources:

- The "FOD Prevention Guideline" addresses general workmanship practices, standard terminology, control methods, design considerations, operational environments, reporting, and investigation for ground and flight safety.
- Presentations from the past eight national FOD prevention conferences and a lengthy report of the inaugural self-inspection summit provide the equivalent of an instruction manual on FOD issues — what it is; practical information

on ways organizations prevent it; how to design and implement prevention programs; procedures and controls to mitigate risk; and related topics.

Information is free and can be printed or downloaded to the user's computer. Files are large and contain colorful Microsoft PowerPoint presentations, with figures, tables and photographs of FOD examples and related equipment.

Also on the Web site is the NAFPI member directory, listing contact information for its extensive network of people from Argentina to Zimbabwe who are "FOD focal points" in their organizations.

European Regions Airline Association (ERA), <www.eraa.org>

ERA identifies itself as a member-supported organization that "represents the interests of organizations involved in intra-European air transport." Nevertheless, its Web site has information for members and nonmembers alike.

The publications section links to several documents, handbooks and magazines produced by ERA. The "Emergency Planning Handbook" serves as a model for organizations with existing emergency and crisis plans, or can be used as a guide in establishing such plans. The handbook addresses responsibilities, training, staffing, security, threat assessment, contingency plans, media relations, accident and incident reporting and investigation, and related topics. The handbook is available to nonmembers for a fee.

Two featured magazines are *Fly Safely* and *Regional International*.

- *Fly Safely*, ERA's flight safety e-journal, is described as providing "authoritative information on a wide range of safety issues that affect the regional aviation industry. It is suitable for crewmembers, airline and airport employees, and management alike." Access is free.

- The monthly journal, *Regional International*, summarizes technological and regulatory information for senior management at airlines, airports, manufacturers and support services. The current issue is available in full text and color at no charge.

ERA's Air Safety Work Group provides safety-targeted awareness reports, called STARS, in full text. STARS offer generic guidelines for pilots and operators on topics such as landing overruns, crosswind landing limits and just culture. Some reports are supported by information that has appeared in *Fly Safely*. The STARS introductory page suggests uses such as reproducing the guidelines in an organization's own safety or operational publications. Nonmembers can read the STARS at no cost although they are accessed via the "Membership Center" menu. ●

Sources

* Australian Transport Safety Bureau
P.O. Box 967, Civic Square
ACT 2608
Australia
Internet: <www.atsb.gov.au>

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

— *Rick Darby and Patricia Setze*

Residual Deicing Fluid Freezes, Jams Elevator

The BAe 146 flight crew used the manual trim system to regain control and land the airplane.

BY MARK LACAGNINA

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

JETS

Pitch Oscillations Occur on Departure

British Aerospace BAe146-300. No damage. No injuries.

After departing from Frankfurt, Germany, for a cargo flight to Stuttgart on March 12, 2005, the flight crew noticed a slow pitch oscillation that increased in amplitude as the airplane climbed on autopilot from Flight Level (FL) 80 (approximately 8,000 ft) to FL 100. "The oscillation resulted in a positive angle-of-attack of up to 18 degrees and in a rate of descent of up to 4,500 fpm," said the report by the German Federal Bureau of Aircraft Accidents Investigation (BFU).

The report said that the elevator had been jammed by ice that formed when residue from the deicing/anti-icing fluid applied to the airplane before departure rehydrated and froze during climb. The crew disengaged the autopilot and regained control of the airplane with the manual elevator trim system.

"A prolonged flight [at] FL 130 under visual meteorological conditions and free of icing conditions did not change the control problems they experienced with the airplane," the report said. The crew used the manual elevator trim system while conducting an instrument landing system (ILS) approach and landing at Stuttgart Airport.

"The airplane was examined immediately after the landing, and significant amounts of frozen and swollen-up deicing fluid residues were found in the gap between elevator and horizontal stabilizer, and in the area of ailerons and rudder," the report said.

A deicing/anti-icing fluid "thickened" with a polymer to increase adhesion time had been applied to the airplane before takeoff. The report noted that the polymer in Type II, Type III and Type IV deicing/anti-icing fluids can remain as a residue in areas of the airplane that are not exposed to airflow after the water and glycol in the fluid have dried. "The polymer residue is very hygroscopic — that is, it can absorb from the surrounding air a multiple of its own weight in water (rehydration) — and thus become a gel-like mass," the report said. "Depending on the ambient air temperature, this oversaturated gel freezes [and] can restrict control-surface movements." This is particularly hazardous for airplanes with nonpowered flight controls (see "Chilling Effects," *Aviation Safety World*, September 2006, page 26).

Among BFU recommendations generated by the incident investigation was that civil aviation authorities ensure that "nonthickened" Type I deicing/anti-icing fluid, which contains a relatively small amount of polymer, is available at European airports used by airplanes with nonpowered flight controls. The report said that only one-third of European airports had Type I fluid in stock.

Crew Surprised by Vehicles on Runway

Boeing 737-86N. No damage. No injuries.

While preparing to depart from Manchester (England) Airport with 190 passengers for a charter flight to Kos, Greece, on July 16, 2003, the flight crew selected a reduced-thrust setting for a planned takeoff using the full length of Runway 06L. The crew was not aware that because of work in progress to remove rubber deposits on the departure end of the runway, available takeoff length had decreased from 3,048 m (10,000 ft) to 1,927 m (6,322 ft), said the U.K. Air Accidents Investigation Branch (AAIB) report.

The crew's performance calculations were correct for a reduced-thrust takeoff using the full runway length, but the aircraft was 9,000 kg (19,841 lb) too heavy to meet reduced-thrust takeoff-performance requirements using the decreased runway length, the report said.

Although the crew was aware that work was being performed on the runway, they believed that the work was being performed at the far end of the runway and would not affect their takeoff calculations. Information on the work-in-progress and the decreased length of the runway had been disseminated by a notice to airmen (NOTAM) and the automatic terminal information service (ATIS). However, the report said that the crew did not read the NOTAM or copy the runway information included in the ATIS broadcast.

After being told by the tower controller to "line up and wait zero six left," the crew told the controller that they would begin the takeoff from an intersection. The controller said that 1,670 m (5,479 ft) of runway were available from the intersection. Although this information provided another opportunity to become aware of the decreased runway length, the crew either missed or misinterpreted the information, the report said.

Seven vehicles were on the runway, but the crew could not see them when the takeoff was begun because the runway is higher in the middle than at the ends. "As the aircraft passed the crest of the runway, the flight crew became aware of vehicles at its far end; but, as they were now close to their rotation speed, they continued and carried out a normal takeoff," the report said. "The aircraft passed within 56 ft [17 m] of a 14-ft [4-m] vehicle."

The crew was not aware that because of work in progress to remove rubber deposits on the departure end of the runway, available takeoff length had decreased.

The crew told investigators that although they were surprised to see the vehicles, they believed that they had cleared them with a sufficient margin and that reporting the incident was not necessary. The incident was reported eight days later by the airport's air traffic control (ATC) manager and classified as a serious incident by the AAIB. The report said that among actions taken in response to the incident was a decision by the airport operator to prohibit takeoffs and landings from being conducted toward a closed section of runway with work in progress.

Lightning Damages Hydraulic Lines

Fokker F28 100. Substantial damage. No injuries.

The aircraft was on a charter flight to Darwin, Northern Territory, Australia, from Kupang, Indonesia, with five crewmembers and 14 passengers on Dec. 17, 2005. ATC told the flight crew to hold about 50 nm (93 km) south of Darwin because of thunderstorms at the airport. "The crew reported that while holding in instrument meteorological conditions at approximately 16,000 ft above ground level and between 6 and 8 nm [11 and 15 km] from any storm cells, the aircraft was struck by lightning," said the Australian Transport Safety Bureau report.

About 20 minutes after the lightning strike, the no. 2 hydraulic system low-quantity warning light illuminated, and the crew observed that the hydraulic fluid level in the no. 1 system was decreasing. The crew requested and received clearance to exit the holding pattern and fly directly to the airport.

The no. 1 hydraulic system low-quantity warning light illuminated when the crew extended the landing gear and flaps on final approach. "The landing was continued, and the aircraft was able to be taxied to the gate," the report said.

Investigators found that electrical arcing during the lightning strike had damaged two hydraulic fluid return lines to the elevator-boost unit. "The examination also found at least two strike holes to the forward- and mid-section of the aircraft fuselage," the report said. "There were approximately 90 other strike-related damage zones along the underside of the fuselage, landing gear doors and on the trailing edges of the wings and tailplane. During subsequent scheduled maintenance, further melting damage was found to the elevator flight control cables."

Crew Loses Situational Awareness

Boeing 737-800. No damage. No injuries.

During a flight from London to Ireland West Airport in Knock, Ireland, on March 23, 2006, the flight crew programmed the flight management computer (FMC) for the NDB (nondirectional beacon) approach to Runway 09. Surface winds at Knock were from 110 degrees at 15 kt, visibility was about 4,000 m (2.5 mi), and the ceiling was broken between 800 and 1,000 ft above ground level (AGL), said the Irish Air Accident Investigation Unit report.

Nearing the destination, the crew was told that the NDB approach was not available. They decided to conduct the ILS approach to Runway 27 and circle to land on Runway 09. The crew was cleared to fly directly to ELPEN, a newly established waypoint about 19 nm (35 km) east of the airport, on the extended centerline of Runway 27. The report said that ELPEN was not in the FMC database, and both pilots, who were relatively inexperienced in the 737-800, became "so engrossed in trying to reprogram the FMC that they both lost their critical situational awareness for a time."

The crew did not brief the ILS approach or conduct the "Descent" and "Approach" checklists. The report said that the approach was flown at high speed and with the aircraft improperly configured. The crew continued the approach to 400 ft AGL, which was 200 ft lower than the minimum height prescribed by the operator for a circling approach. The aircraft's groundspeed was 265 kt when the crew gained visual contact with the runway and decided to conduct a missed approach. About the same time, the terrain awareness and warning system (TAWS) generated a "TOO LOW, TERRAIN" warning. After climbing to 4,000 ft and holding at the NDB, the crew conducted another ILS approach and landed without further incident.

The report noted that according to International Civil Aviation Organization standards, this serious incident would be classified as "controlled flight into terrain (CFIT) only marginally avoided."

TURBOPROPS

Route Deviation Into a Box Canyon

CASA 212-CC. Destroyed. Six fatalities.

The civilian flight crew was conducting a contract charter flight in Afghanistan for the U.S. Department of Defense, carrying mortar rounds and three military passengers from Bagram Air Base to Shindand on Nov. 27, 2004. A company maintenance technician also was aboard the airplane.

Shindand is west of Bagram, but company pilots typically flew about 32 nm (59 km) south after departure, to avoid mountains, before proceeding directly to Shindand, said the U.S. National Transportation Safety Board (NTSB) report. The accident crew, however, departed to the northwest at about 0738 local time, climbed to 10,000 ft and turned west into an unfamiliar valley. "We'll just have to see where this leads," the captain said. "With this good visibility … it's as easy as pie. [If] you run into something big, you just parallel it until you find a way through."

The report noted that both pilots had substantial mountain-flying experience. At 0803, the captain told the first officer, "It's about time we're going to start climbing. … We're coming up to a box up here." About 0819, a stall warning was recorded by the cockpit voice recorder (CVR). The captain said that he would make a 180-degree turn and told the first officer to "drop a quarter flaps." The first officer said, "Yeah, let's turn around." The CVR then recorded a stall warning that continued until the recording ended about 0820.

The report said that the operator's flight-locating procedures were inadequate. Search-and-rescue operations were begun at 1540 and initially focused on the standard route south of Bagram. The wreckage of the unpressurized airplane was found at 0815 the next day at 14,650 ft — about 350 ft below the top of a snow-covered ridge line. The report noted that the floor of the valley was about 11,000 ft in the area. The investigation determined that one of the military passengers had survived the impact but died at least eight hours later from his injuries, which were complicated by hypoxia and hypothermia.

NTSB said that the probable causes of the accident were "the captain's inappropriate decision to fly a nonstandard route and his failure to maintain adequate terrain clearance."

Loading, Ice Cited in Control Loss

Cessna 208B Caravan. Destroyed. One fatality.

The aircraft, which was equipped with an external cargo pod, was 488 lb (221 kg) over maximum weight for flight in icing conditions when it departed from Winnipeg (Manitoba, Canada) International Airport at 0537 local time Oct. 6, 2005, for a cargo flight to Thunder Bay, Ontario, said the Transportation Safety Board of Canada (TSB) report.

The aircraft entered icing conditions soon after takeoff. The aircraft flight manual recommends a minimum airspeed of 120 kt during climb in icing conditions, but ATC radar data indicated that the accident aircraft's airspeed decreased from 100 kt to about 90 kt and that its rate of climb steadily decreased. The aircraft reached a maximum altitude of 2,400 ft and began to descend at an average rate of 400 fpm. The pilot requested an immediate return to Winnipeg.

The report said that insufficient information was available to determine whether a wing stall or a tailplane stall led to the pilot's loss of control of the aircraft, which was in an inverted, steep nose-down and left-wing-low attitude when it crashed and burned on railway tracks in Winnipeg at 0543. The engine was developing significant power on impact, and investigators found no deicing system anomalies.

Insufficient information was available to determine whether a wing stall or a tailplane stall led to the pilot's loss of control of the aircraft.

Among recommendations based on the findings of the investigation, TSB said that the Canadian Department of Transport and the U.S. Federal Aviation Administration should prohibit 208-series Cessnas from being flown "in forecast or in actual icing meteorological conditions exceeding 'light' until the airworthiness of the aircraft to operate in such conditions is demonstrated." The report noted that the aircraft currently are certified for flight in moderate icing conditions when properly equipped.

'I Am a Bit Low Here'

Cessna 425 Conquest 1. Destroyed. Four fatalities.

Nighttime instrument meteorological conditions prevailed at Centennial Airport near Englewood, Colorado, U.S., on Aug. 13, 2005, when the pilot received vectors from ATC to the localizer course for the ILS approach to Runway 35R. The airplane was inbound on a private flight from Sandpoint, Idaho, the NTSB report said. The pilot, 62, had 5,000 flight hours, including more than 1,400 flight hours in type.

Visibility was 2 mi (3,200 m) in rain, and the ceiling was at 500 ft AGL. Decision altitude for the ILS approach is 6,083 ft, and touchdown zone elevation is 5,883 ft. The airplane was about 500 ft above the glideslope when it crossed the outer marker. Recorded radar data indicated that the airplane's flight path then deviated from the glideslope and localizer.

The tower controller observed a minimum safe altitude warning (MSAW) system warning when the airplane was at 6,800 ft, with a groundspeed of 170 kt, on final approach. The controller told the pilot, "I am getting a low-altitude alert on you." The pilot replied, "Yeah, I am a bit low here." The airplane was at 7,200 ft with a groundspeed of 150 kt about 20 seconds later when the pilot said, "I'm back on glideslope."

The airplane was at 6,500 ft about 24 seconds later when the controller issued another low-altitude warning, but there was no response from the pilot. The airplane struck hilly terrain at 6,120 ft about 2.6 nm (4.8 km) from the runway.

"The pilot did not hold a valid medical certificate at the time of the accident, and a post-accident toxicological test revealed the presence of unreported prescription medications," the report said. "No anomalies were noted with the airframe and engines." NTSB said that the probable cause of the CFIT accident was "the pilot's failure to properly execute the published instrument approach procedure."

PISTON AIRPLANES

Wing Separates in Thunderstorm

Piper Aerostar 602P. Destroyed. Two fatalities.

The pilot telephoned an automated flight service station (AFSS) the morning of May 10, 2006, to obtain a weather briefing for a business flight from Cornelia, Georgia, U.S., to Mobile, Alabama. The AFSS specialist said that a significant meteorological advisory (SIGMET) was in effect for an embedded line of thunderstorms with tops between 41,000 ft and 50,000 ft along the route from Atlanta to Mobile.

"The specialist suggested that the pilot not depart immediately because of the weather but said that it might be possible to land at an intermediate stop ahead of the weather, possibility in the Pensacola[, Florida] area or further north in the Crestview[, Florida] area, wait for the storms to pass and then continue the flight to Mobile," the report said. The pilot filed an instrument flight rules (IFR) flight plan to Pensacola, requesting a cruise altitude of 16,000 ft.

The pilot telephoned the AFSS again a few minutes later to obtain an IFR clearance with a void time. The specialist placed the pilot's call on hold while he coordinated the clearance with ATC. "When he returned to the inbound telephone line to provide the pilot with the requested IFR clearance, the pilot was no longer on the line," the report said.

The pilot departed under visual flight rules and obtained an IFR clearance from the Atlanta Air Route Traffic Control Center. The center controllers broadcast a center weather advisory and SIGMET information about a line of thunderstorms 40 nm (74 km) wide with tops at 44,000 ft moving from 280 degrees at 35 kt. However, the report said that the controllers did not tell the Aerostar pilot about intense-to-extreme precipitation echoes displayed on their radar screens.

The airplane was at 16,000 ft when the pilot reported that he was reversing course. Radio and radar contact with the airplane were lost soon thereafter. The report said that the airplane was in a vertical nose-down attitude when it struck terrain near Camp Hill, Alabama. "Examination of the wreckage revealed that the right wing separated 9 ft 2 in [2.8 m] outboard of the wing root," the report said. "The separated outboard section of the right wing was not recovered."

Engine Fails During Go-Around

Cessna 402C. Destroyed. One serious injury.

Reported weather conditions included 1/4-mi (400-m) visibility and a 100-ft ceiling when the pilot began an ILS approach to Mather (California, U.S.) Airport during a cargo flight the night of Jan. 23, 2003. The pilot told investigators that he initiated a missed approach because of the weather conditions, but when he attempted to increase power, the left engine failed.

The pilot activated the fuel-boost pump for the left engine but did not retract the landing gear or flaps. "Without the airplane configured correctly for the single-engine missed approach, the net climb performance would be negative 400 fpm," the NTSB report said. The airplane struck a utility pole and trees, then descended to the ground, where it collided with a chain link fence before stopping on a road.

Investigators were unable to determine why the engine failed. NTSB said that the probable causes of the accident were the engine failure and the pilot's "failure to correctly configure the airplane for a single-engine missed approach" and that a factor was the pilot's "decision to initiate the approach when the weather conditions were below the published approach minimums."

HELICOPTERS

Corrosion Blamed for Engine Failure

Hughes 369D. Substantial damage. No injuries.

After completing a power-line-inspection flight on Oct. 4, 2005, the pilot landed the helicopter on a farm field near Lundsbrunn, Sweden, to visit an acquaintance. After a brief visit, the pilot departed for the return flight to the operator's temporary base at Skövde.

"After a climbing hover, which was completely normal, the pilot accelerated the helicopter forward while climbing," said the Swedish Accident Investigation Board (SHK) report. "When the helicopter reached approximately 30 kt of forward speed and at a height of 5–10 m [16–33 ft] above ground level, a loud bang was heard, and the engine suddenly stopped." The helicopter descended to the ground and rolled onto its left side. The cabin remained intact, and the pilot was not injured.

A tear-down examination of the Rolls-Royce — formerly Allison — 250-C20B engine revealed major damage to the compressor blades and guide vanes. "In addition, extensive resultant damage could be seen in the direction of flow," the report said. Metallurgical examination showed that the compressor failure began with a fatigue fracture at a third-stage blade root. "Closer examination under an electron microscope revealed a small corrosion mark there and at other locations close to the blade roots," the report said.

The engine manufacturer told investigators that fatigue cracks caused by corrosion damage in the second and third compressor stages have been found in 80 engines. "This would amount to a frequency of one event per million flying hours," the report said.

The operator had conducted compressor washes every 100 hours. However, the report noted that the engine manufacturer recommends daily compressor washes for engines operated in "corrosive environments." Based on the findings of the accident investigation, SHK recommended that the Swedish Civil Aviation Authority "inform operators using this type of engine of the risk of blade corrosion and the importance of regularly washing the compressor in accordance with the manufacturer's recommendations."

Fatigue Causes Stabilizer Failure

Bell 206B JetRanger. Destroyed. Two fatalities.

About 45 minutes after departing for a pipeline-inspection flight between Cumbernauld, Scotland, and Aberdeen on Dec. 21, 2005, the helicopter entered an uncontrolled descent to the ground, killing the pilot and observer. "The investigation found that the vertical stabilizer had detached from the tail boom and struck the tail rotor," said the AAIB report. "This subsequently caused the tail rotor and associated gearbox to become detached from the tail boom."

The report said that the fatigue fractures of the forward and aft vertical stabilizer supports likely had resulted from insufficient torque applied to the four bolts that attach the supports to a mounting platform on the tail rotor gearbox. The vertical stabilizer had been removed temporarily to facilitate repair of fuselage corrosion during the summer of 2005.

Visual inspections of the supports are required every 100 hours. A 100-hour inspection of the accident helicopter had been scheduled after the pipeline-inspection flight. If the supports had not failed during the flight, the inspection likely would have revealed that they were extensively cracked, the report said.

Based on the findings of the investigation, AAIB recommended that the European Aviation Safety Agency and the civil aviation authorities in Canada, the United Kingdom and the United States require that the vertical stabilizers on Bell and Agusta-Bell 206-series helicopters be removed for inspection of the stabilizer supports. ●

Preliminary Reports

Date	Location	Aircraft Type	Aircraft Damage	Injuries
Dec. 1, 2006	San Diego, California, U.S.	Learjet 36	substantial	3 none
The Learjet was on a public-use flight from North Island Naval Air Station and was being flown in formation with another airplane. While conducting a cross-under maneuver, the pilot lost sight of the other airplane due to sun glare. While being turned away from the other airplane, the Learjet banked 70 degrees right and pitched 50 degrees nose-down. The pilot recovered control and landed without further incident. The right elevator was missing, and the left elevator was deformed; the preliminary report did not say how the damage was incurred.				
Dec. 6, 2006	Deauville, France	Raytheon Premier	minor	none
The airplane overran the runway while landing. The number of occupants was not reported.				
Dec. 10, 2006	Hesperia, California, U.S.	Bell 412SP	destroyed	3 fatal
After completing an emergency medical services flight, the helicopter struck a mountain while being flown back to its base in nighttime visual meteorological conditions (VMC).				
Dec. 10, 2006	Waco, Texas, U.S.	Cessna 310Q	destroyed	3 fatal
The airplane struck terrain during an ILS approach on a dark night. Visibility was 2 mi (3,200 m) in fog, and the ceiling was overcast at 200 ft.				
Dec. 14, 2006	Port Heiden, Alaska, U.S.	Piper PA-32-301 Saratoga	destroyed	2 fatal
The single-engine airplane struck snow-covered terrain about 10 minutes after departing from Port Heiden for a commuter flight to King Salmon, Alaska. Nighttime VMC prevailed, but intermittent snow squalls had been reported.				
Dec. 14, 2006	Dagsboro, Delaware, U.S.	Bell 407	substantial	2 fatal
Dense fog was reported in the area when the helicopter struck terrain while departing on a charter flight.				
Dec. 15, 2006	Buenos Aires, Argentina	Swearingen Metro III	substantial	2 NA
A wing struck the runway during takeoff, and the airplane veered off the pavement. Both occupants survived the accident.				
Dec. 15, 2006	Cadiz, Spain	Piper PA-34-220T Seneca	destroyed	3 fatal, 1 serious
The airplane struck terrain after loss of control during approach to Jerez de la Frontera Airport.				
Dec. 16, 2006	Mbeya, Tanzania	Cessna 310Q	destroyed	2 fatal, 4 serious
Nighttime VMC prevailed when the airplane crashed in a residential area while departing on a charter flight. No one on the ground was injured.				
Dec. 24, 2006	Pandang, Indonesia	Boeing 737-400	substantial	162 NA
The airplane overran the runway while landing at Pandang-Hasanudin Airport. All 162 occupants reportedly survived the accident.				
Dec. 25, 2006	Lawrenceville, Georgia, U.S.	Cessna 414	destroyed	3 fatal
Visibility was 1/2 mi (800 m) in fog and vertical visibility was 100 ft when the airplane struck terrain during approach.				
Dec. 26, 2006	Johnstown, Pennsylvania, U.S.	Cessna 414	destroyed	2 fatal
The airplane was en route from Morgantown, West Virginia, to Teterboro, New Jersey, when the pilot reported airframe icing and diverted to Johnstown. The airplane struck terrain on approach.				
Dec. 28, 2006	Prague, Czech Republic	Airbus A321	none	168 none
The airplane was en route from Moscow to Geneva when a passenger began fighting with other passengers and demanded that the airplane be flown to Cairo, Egypt. The passenger was subdued by other occupants and arrested after the flight was diverted to Prague.				
Dec. 29, 2006	Rapid City, South Dakota, U.S.	Beech 99	substantial	1 none
The right wing tip struck the ground after the pilot initiated a missed approach at Rapid City Regional Airport. The airplane then crashed about 10 nm (19 km) south of the airport.				
Dec. 30, 2006	Nairobi, Kenya	de Havilland DHC-5 Buffalo	destroyed	3 minor
The airplane struck a house and burned after one engine failed during departure for a cargo flight to Somalia. The cargo included 4,000 liters (1,057 gallons) of jet fuel. No one on the ground was injured.				
Dec. 30, 2006	Culiacan Rosales, Mexico	Rockwell CT-39A	destroyed	2 fatal
The airplane, a military version of the Sabreliner, was on a cargo flight when it stalled and struck houses during approach. No one on the ground was injured.				

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.

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To receive agenda and registration information, contact Namratha Apparao,
tel: +1 703.739.6700, ext. 101; e-mail: apparao@flightsafety.org.
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